The Impacts of Marine Litter

Marine Pollution Monitoring Management Group

Report of the Marine Litter Task Team (MaLiTT) May 2002.

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Foreword

The Marine Pollution Monitoring Management Group (MPMMG) was set up in 1974 by the Department of the Environment (DoE). It provides a management group with representation from all Government organisations with statutory marine environmental protection monitoring obligations. The Group is chaired by a representative from the Centre for Environment, Fisheries and Aquaculture Science (CEFAS). Its aim is to ensure that monitoring of the marine environment is conducted in a co-ordinated way, is as cost-effective as possible and meets national and international requirements.

MPMMG involves wider consultation on specific issues via a number of task teams. In this case, the Marine Litter Working Group was asked to provide information on the extent of problems posed by litter and make recommendations on ways to improve the situation in UK coastal waters.

In order to gather the information for this review the authors have consulted widely and this has inevitably led to a fairly protracted timetable for publication. Meanwhile, changes to the sponsoring Department now the Department for Environment, Food and Rural Affairs (DEFRA) and new initiatives on the horizon in European legislation e.g. the implementation of the Water Framework Directive (WFD) are prompting MPMMG to re-think strategies for monitoring. The net result is that this is a time of fast moving changes to the way in which we will be delivering the MPMMG remit. This report provides a wealth of background data on litter and as such stands alone in it's own right as a publishable document. However, we are now well on the way to answering some of the questions raised in the report, tackling issues on co-ordination and starting to develop methodologies for integrated monitoring and reporting of results.

An update on this report is already in hand and monitoring litter will be a key component in the revised MPMMG strategy to be published in 2003.

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1.0 Introduction

Commitments to the principles of sustainability have been undertaken in the UK through various initiatives such as, Government commitment to the Sustainable Development Convention and Agenda 21 (cf This Common Inheritance, Governments first environmental White Paper), the "Earth Summit" in Rio de Janeiro, 1992 and the United Kingdom's Darwin Initiative (HMSO, 1992). Effective pollution controls are a part of delivering sustainability.

A simple dictionary definition of litter makes use of phrases like “rubbish, small refuse, discarded waste materials, anything thrown away”. The question remains: can litter be regarded as pollution? The Oslo and Paris Commissions (OSPAR) defined the term ‘pollution’, as meaning “...the introduction by man, directly or indirectly, of substances or energy into the maritime area which results, or is likely to result in: -

- hazards to human health,
- harm to living resources and marine ecosystems,
- damage to amenities,
- or interference with other legitimate uses of the sea” (OSPAR, 1993).

It is clear that litter must be regarded as pollution, since there are examples of litter resulting in all the criteria detailed in the OSPAR definition above.

It is often erroneously assumed that much of the litter in British waters arises from foreign sources or from shipping. Similarly, other European nations regard the sources of marine litter affecting their territorial waters as foreign. However, it is clear that the sources of litter are diffuse and lie outside of the control of any one agency. It is also clear that the current lack of understanding of litter in the marine environment, contributes to a continued lack of co-ordination and impetus to organise a coherent strategy to deal with the issue.

The purpose of the Marine Litter Task Team (MaLiTT) is to report to the Marine Pollution Monitoring Management Group (MPMMG) on the status of litter in the marine environment, its impacts on different sectors of industry and the community, and to make recommendations for appropriate further actions. Its objectives are:

1. To evaluate the extent of litter in the marine environment;

2. To quantify, where possible in economic terms, the impact of litter on UK interests;

3. To seek to identify options for controlling litter, where possible recommending a national agency who should take the lead on key issues; and

4. To raise awareness of the problem of litter.

2.0 Litter in the Marine Environment

To determine the impacts of litter in the marine environment, it is necessary to consider its behaviour and identify the types of litter known to be present in the sea as well as the quantities in which they occur. Many survey schemes are already in place (see Appendix A), providing the only currently available data upon which the conclusions of the report will be based.

2.1 Types and Quantities of Marine Litter

The following list represents the main types of litter found in the marine environment:

- Plastics (fragments, sheets, bags, containers)
- Polystyrene (cups, packaging, buoys)
- Rubber (gloves, boots, tyres)
- Wood (construction timbers, pallets, fragments of both)
- Metals (drink cans, oil drums, aerosol containers, scrap)
- Sanitary or sewage related debris (tampons, condoms, faeces)
- Paper and cardboard
- Cloth (clothing, furnishings, shoes)
- Glass (bottles, light bulbs)
- Pottery/Ceramic
- Munitions (phosphorus flares)

[**NB: oil is not discussed in any detail since it is covered by other provisions and therefore, for the purpose of this report is not considered to be litter*].

Taking a world view, plastics have been shown to be the predominant type of litter found in the marine environment, for example: the Mediterranean coastline (Gabrielides *et al*., 1991); 40 miles S.W. of Malta in the Mediterranean (60-70%) (Morris, 1980); Central North Pacific (>50%)(Venrick *et al*., 1973); the North Sea (Dixon & Dixon, 1983); the North Pacific (86%)(Dahlberg & Day, 1985); the North Atlantic (60%)(Colton *et al*., 1974); N.W. Jakarta (90%) (Willoughby, 1986); beaches in N. France and Denmark (44%)(Dixon & Dixon, 1981); the coasts of Honduras (Cruz & Sosa, 1990); UK beaches 56% (Marine Conservation Society, 1999). This prevalence coincides with a dramatic increase in the production of plastic. Total plastic production in the United States increased from 2.9 million tons in 1960 to 47.9 million tons in 1985 (Robards *et al*, 1997).

2.2 The Behaviour of Marine Litter

Marine litter originates from many different **sources**, circulates through a range of **pathways**, and accumulates at various locations known as litter **sinks**.

2.2.1 Sources

The **sources** of marine litter include offshore marine, riverine and coastal. This section does not seek to identify litter sources at a national level, rather to identify the types of structures and activities that generate marine litter.

The major sources include:

- Sewage treatment works (STWs)
- Combined sewer overflows (CSOs)
- Other industrial discharges
- Urban runoff
- Shipping
- Oil rigs
- Ministry of Defence munitions
- Dereliction (piers, wrecks, etc)
- Agricultural waste
- The fishing industry
- Fly tipping
- Aquaculture
- Municipal waste
- Recreational & leisure usage

At the global scale, Faris & Hart (1994) report that nearly 80% of the world's marine debris is thought to have originated from land sources. The Marine Conservation Society (MCS) produces an annual Beachwatch report, which attempts to source beach litter collected by volunteers. In recent years tourism, fishing and sewage related debris have consistently been identified as contributing the greatest proportion of litter, regardless of geographical location (approximately 36%, 13% and 10% respectively) (1999). However, it is worth noting that the single largest proportion of litter each year is that which cannot be sourced (over 38%).

2.2.2 Pathways

Once in the sea, the **pathways** through which litter items circulate depend upon the nature of the litter item. The influences of wind, tide and current have, for example, different effects upon the circulation of floating litter as compared to items that sink.

Oceanic Drift

Extensive oceanic drift has been demonstrated by the occurrence of coded and dated multi-coloured plastic tags from Canadian lobster and crab fishing activities, which have been recorded on the west and north coasts of Ireland. Each tag has a unique serial number imprinted on it, which may be traced back to an individual fisherman. The loss of tags is presumably through storm damage or careless handling. They present an aesthetic problem as marine litter, but also act as indicators of large scale oceanic transport systems. This work is being co-ordinated in Ireland by The Marine Institute, and Agency of the Department of the Marine (Republic of Ireland) Fisheries Research Centre, Abbotstown, Dublin, (Dr Dan Minchin, *personal communication*). Canadian tags and Canadian outboard motor oil bottles have also been found on many English, Welsh and Scottish west and south facing beaches (Trevor Dixon, *personal communication*). There are many other forms of sourceable litter such as dairy produce cartons, fertilizer bags and fish boxes. However, conclusions concerning the origin of any litter item should be weighed up carefully. Sections 2.2.3 and 2.3 consider in more detail the problems associated with accurately sourcing litter.

Coastal "Cells"

Research by HR Wallingford (1993) suggested that the coastline of England and Wales can be divided into 11 major sediment “cells”. Further recent research (HR Wallingford, 1997) has also shown that the coastline of Scotland can be divided into 11 major sediment cells. A sediment cell is defined as a length of coastline which is relatively self-contained as far as the movement of sand and shingle is concerned and where interruption of such movement should not have a significant effect upon adjacent sediment cells. It is probable that litter will tend to circulate in these cells. MAFF (1995) suggested that these cells provide logical geographical boundaries defining Shoreline Management Plans, although acknowledging that sub-cells may be more practical management units. This emphasises the difficulty of litter management within purely political boundaries.

A study in Biscayne Bay, Florida, on exposure conditions suggested that the most commonly found plastic debris items undergo bio-fouling to an extent which can cause the items to become negatively buoyant (Song & Andrady, 1991). Rapid defouling of the submerged samples was also observed, leading to the conclusion that free-floating plastics at sea may, under certain conditions, undergo fouling-induced sinking followed by resurfacing as floating debris.

2.2.3 Sinks

Litter **sinks** include beaches (e.g. burial of litter in dunes) and offshore deposits of material, generally on the sea bed (Williams *et al*., 1993). These sinks may or may not be permanent. Consequently beach clearance operations, such as the removal of litter at a temporary sink, may in the long term be ineffective as the beach is replenished periodically from offshore sinks.

The summary record of the October 1995 meeting in Stockholm of the OSPAR 3rd tier Working Group on Impacts on the Marine Environment, noted that approximately 20,000 tonnes of waste are discarded into the North Sea each year (IMPACT, 1995). Furthermore, it is estimated that 15% of this waste remains in the water, 70% on the seabed and 15% on the shore.

Persistence of Litter

There is evidence that litter may circulate for a long time in the marine environment. The persistence of litter items also influences their impact; plastics in particular are highly persistent and so will tend to travel long distances through marine pathways and to accumulate in sinks. UNEP (1990) estimate that an aluminium drinks can may persist for 200-500 years in the marine environment, a plastic bottle for 450 years, and a bus ticket two to four weeks. These studies take no account of the harsh mechanical environment of the sea, and may be regarded as worst case estimates. Taking account of the complex and harsh conditions found in the open sea, a plastic bottle is more likely to persist for considerably less time. The Tidy Britain Group quote evidence suggesting that for items of litter recovered from the shores of western Europe those specimens, for which a life history could be identified, were usually less than 3 years old. However, there have also been instances where plastic bottles have been found which were over 40 years old (Trevor Dixon, Tidy Britain Group, *personal communication*).

It should be noted that in addition to litter items undergoing disintegration into smaller pieces, some items (for example, plastics) might also be degraded into alternative substances, which may or may not cause additional problems. The mechanical breakdown of plastic litter merits further investigation (see section 3.1.6 for further information).

2.3 Monitoring Marine Litter

Appendix A provides a summary of litter surveys and initiatives that exist to determine the nature and extent of littering in the marine environment and to prevent littering through education. These schemes have widely differing objectives, which are frequently poorly defined, but are generally concerned primarily with beach and estuarine litter.

When measuring litter at any point in the marine environment, it is important to establish whether the litter is being measured at a true sink or at an intermediate point in a pathway. Davenport & Rees (1993) reported low numbers of marine litter items collected in 34 out of 46 neuston net samples off Anglesey, North Wales, and concluded that legislative attempts to curb disposal of rubbish at sea were having some effect. However, the samples were taken over a period of just 3 days with no comparative surveys and it is likely that litter was being measured in a pathway rather than a sink.

One must also be wary of attributing blame to any particular source, as the litter may have been circulating freely in the environment for some time, covering large distances. Olin *et al* (1995) reports that over 50% of the litter reaching the Swedish West coast appears to have originated in the United Kingdom, attributing this to accumulation on the shore as a result of circulation currents in the North Sea. In the light of our knowledge of the behaviour of litter in the marine environment, conclusions derived by those operating these schemes must be treated cautiously.

3.0 Quantifying the Impact of Marine Litter

Having examined the findings of existing survey schemes to determine that a problem exists, it is then important to quantify the problem and thereby determine its significance to UK interests.

An approach similar to that recommended by the WHO (1990) has been chosen for this report, which focuses predominantly upon the tangible impacts of marine litter on different sectors of industrial and community interest. Where possible, the impacts are expressed in quantitative terms, ideally expressing the effects as a monetary value to enable assessment of the costs and benefits of pollution control action to UK interests. Placing a monetary value on the effects of litter is possible for some sectors (for example, damage to tourist trade, loss of nets by the fishing industry, etc.) but is more difficult for some other sectors (notably ecological impacts).

3.1 Ecological Impacts

Litter in the marine environment gives rise to a range of adverse ecological impacts, including: entanglement; ingestion; smothering; disturbance and removal of habitat through beach cleaning activities; transport of invasive species; and poisoning by breakdown products.

3.1.1 Entanglement

The **entanglement** of marine organisms in litter items is well documented and widespread. This is an emotive issue and has been used to discourage littering in the Maritime and Coast Guard Agency's anti-litter campaign, "Sea Sense". Many types of litter items can trap animals, whereas smaller items adhering to body surfaces increase drag, snag on the sea floor, or inhibit growth or development due to becoming entwined. At least 135 species of marine vertebrates and 8 species of marine invertebrates have been reported entangled in marine litter (Laist, 1997). Some entanglement-related deaths have been reported for most of these species. In almost all cases, a direct, absolute measure of the extent to which entanglement occurs or affects species at the population level does not exist (Laist, 1997). There are two main reasons for this. First, most data have been gathered on beaches where animals haul out, roost or strand. As a result, records are limited to animals that survive long enough to swim ashore or that become entangled close to shore. Second, many entanglements involve fishing nets and line, and it is rarely possible to determine if entangled animals encountered their burden of gear when nets or line were active or after the gear was lost.

Canadian research off the Newfoundland coast has found that ghost netting is a serious problem in deep still water inlets. Ghost fishing is also seen as a problem in Australia (Jones, 1995) and in California (Stewart & Yochem, 1987). This is not believed to be the case around the energetic UK coastline due to the tendency for discarded netting to become rolled up. Nevertheless, there have been cases where exotic species, such as leatherback turtles, have been recorded as suffering entanglement round UK waters (DETR, 1999). It is reported that 90% of the 30,000 gannet nests on Grassholm Island (in the Bristol Channel) now contain plastic (MCS, 1999). This indicates the extent of plastic pollution in surrounding waters as gannets collect almost all their nest material at sea. Young gannets' feet can often become entangled, resulting in serious injuries.

3.1.2 Ingestion

Ingestion of litter by animals usually occurs when litter items are mistaken for food, or by secondary ingestion with prey items. In certain seabirds, ingested items can be passed from parent to chick by regurgitation (Fry *et al,* 1987). The occurrence of litter ingestion can reach 100% in some seabird species. Day, (1985) reported that at least 50 species of seabirds were known to ingest plastic debris, though this figure is now known to be closer to 111 species (Laist, 1997). Those seabirds which are most susceptible to ingesting plastic particles are surface-feeders

(albatrosses, shearwaters, petrels, gulls) or plankton-feeding divers (auklets, puffins) (Day, 1985). A study carried out by Robards *et al* (1995), of seabirds collected over the period 1988-1990 reports that plastic ingestion by seabirds has significantly increased since a similar study by Day (1980) of data collected in 1968. The offending litter items are almost invariably plastics, which are ubiquitous in the marine environment deriving from many sources (Robards *et al*, 1995). These items can result in physical damage, mechanical blockage and impairment of foraging ability (Laist, 1987).

3.1.3 Smothering

Accumulation of litter in offshore sinks may lead to the **smothering** of benthic communities on soft and hard seabed substrates (Parker, 1990). Once on the seabed, accumulations may smother sea life, or inhibit water movement to the extent that they contribute to the creation of anoxic muds (Rundgren, 1992). When in general circulation in the sea, or resident in temporary sinks, these litter items may also smother plants and animals on the sea shore, provide solid attachment for species that would not usually occur there, in addition to providing nuclei for sand dune formation.

3.1.4 Beach Cleaning Activities

Beach Cleaning Activities are far from ecologically benign and, where regular excessive accumulations of litter or pressure from recreational and leisure interests, necessitate routine beach cleaning with machines, the biota living in or on the beach is threatened through perturbation of sand and other soft substrates. This could be avoided by hand picking of litter items rather than gross removal of everything. Together with the litter, natural habitats such as driftwood and seaweed are also removed. Archaeological damage may also occur. Beach cleaning is common practice for district councils reliant upon their tourist industry. Recent surveys suggest that 43% of UK local authorities clean beaches manually and 57 % clean using both manual and mechanical techniques; no authority uses purely mechanical methods (KIMO, 2000).

There is some concern about the impact of mechanical cleaning on the stability of beaches (Peter Hampson, British Resorts Association, *personal communication*). Removal of the biodegradable material may change the composition of the beach such that it becomes more susceptible to wind and wave action. Llewellyn and Shackley (1996) have shown that there are also some impacts on strand-line species diversity and abundance as a result of mechanical beach cleaning.

3.1.5 Transport of Invasive Species

For a number of organisms floating litter can provide an opportunity for long distance transport across the world's oceans. Although these stowaway organisms seem to be most common in warm-water regions, biologically encrusted plastic items have already been found at sites ranging from the Sub-Antarctic to the Equator (Gregory *et al*, 1984; Gregory 1990a, 1990b). Winston *et al* (1997) give a good review of the biogeographical, environmental and conservation issues connected with encrusting marine organisms and other biota.
Compared to the numbers of larvae dumped into a harbour by discharge of ballast water (Carlton, 1987; Carlton & Geller, 1993), Winston *et al* (1997) conclude that the contribution of floating plastic to environmental problems associated with the introduction of aggressive alien taxa is probably low. However, the authors qualify this conclusion with the following points:

- Dispersal by plastic debris is most likely to affect adjacent coastal regions (for instance, spread of an exotic species from a site of introduction like a populated harbour to nearby islands etc.). Litter can be rapidly dispersed along a shoreline by currents.

- The total available habitat is still increasing and is semi-permanent.

- More than 200 plants and animals are known from fouling communities and many of them have already effected a cosmopolitan distribution by travelling on ships. Travel on vessels move organisms rapidly through environments that are often hostile in terms of temperature and salinity. Despite this some may survive. A slow voyage on plastic would give encrusting biota a much better chance of survival.

Transport of terrestrial organisms (plants, invertebrates and vertebrates) on marine litter may have significant biological impact (Winston *et al*, 1997). Certainly a number of studies have shown that insects, snails, isopods, millipedes and plants can survive transport, for example, on rafts of vegetation or logs or both (Heatwole & Levins, 1972; Eno *et al*. 1997). Rafting long distances may be unlikely for vertebrates due to the rafts breaking up in bad weather. However, the local introduction of pests from populated coasts to nearby islands where attempts are being made to preserve native biota should be a cause for concern.

Cited examples of invasive marine species causing problems, which have been counted in financial terms, are not evident. However, it is possible to look at the potential for damage by considering freshwater examples such as *Dreissena polymorpha*, the freshwater mussel native to the Caspian and Black Sea. This species was inadvertently introduced to the Great Lakes, Canada in around 1986, probably from bilge waters from shipping and has caused enormous problems. Similarly, in the UK *D. polymorpha* has been known to accumulate in such numbers, that the diameter of an intake pipe from reservoir to water treatment works was reduced by more than 80% (Steve O' Neil, Anglian Water Services Ltd., *personal communication*). The costs associated with shutting off the pipe, effecting manual clearance and maintaining a clear pipe is approximately £5,000 per year, though £30,000 was initially spent over the first three years. Similarly, the annual cost to send in divers to clear *D. polymorpha* from the draw-off shafts in Rutland Water is approximately £6,000 per year (David Stretton, Anglian Water Services Ltd., *personal communication*).

3.1.6 Breakdown of Plastic Products and their Toxicity

The amount of plastic in the marine environment has been shown to be greater than previously thought. Researchers at Newcastle University collected 45 samples of sand from 3 beaches in Northumberland: all were found to contain microscopic fibres, some with more than 10,000 fibres per litre of sand (Thompson & Hoare, 1997). Most of the fibres were blue or grey and, although the origin had not been identified, the fibres appeared worn and abraded and were probably being broken up into even smaller fragments by sand grains.

Manufacturers have produced plastic wrappings and bags, which they claim will degrade much more rapidly than conventional plastics. However, these materials have been shown simply to lose elasticity and disintegrate into smaller fragments (Potts *et al*, 1973), while not actually biodegrading any faster than conventional plastics (see Klemchuck, 1990). An alternative prototype product tested by ICI, called Biopol, has been made using natural polymers of storage compounds from the bacterium *Micaligenes eutrophus.* Thompson and Dickinson (1991) showed that Biopol does actually biodegrade rather than just disintegrate. However, production costs at the time made large-scale manufacture commercially non-viable.

Anecdotal evidence suggests that **breakdown of plastic products** may well be a potential source of toxic chemicals (Day *et al*, 1985), although there is little literature on the subject at present. However, it is worthy of note that as plastic litter breaks down in the environment it may release chemicals (plasticisers and other polymer constituents) and particulates into the sea. Some of these substances may be persistent, and others are known to exert adverse biological effects at very low concentrations. More research into this area, supporting initiatives by the European Council for Plasticisers & Intermediaries, is warranted.

This problem is hard to quantify in ecological terms due to a lack of published material on the subject, and is impossible to translate into monetary terms. Nevertheless, this intangible environmental cost must not be overlooked when accounting for the true extent of damage to UK interests resulting from marine litter.

3.2 Fisheries

Lart (1995) notes that much of what is known about the impact of litter on fishing activities is based on anecdotal evidence, but nevertheless recognises that the two major types of litter interfering with fishing gear include plastics and sewage related debris. Lart also recognises five types of damage to fishery interests: inconvenience and unpleasantness (no economic impact); inconvenience leading to economic loss (cleaning static nets, etc); the reduction or selective hindrance of gear by increased visibility or blocking; prevention of static fishing gear and blockage of trawls by dense litter; and the potential for ecological damage by smothering of benthos.

The experience of the UK Fisheries laboratories staff, is that very few trawls undertaken within the 12 mile limit around the coastline of Scotland are free of litter, and in some areas the quantities are quite significant (Derek Saward, (SEERAD), *personal communication*). The effect in this case is seen to be primarily aesthetic. However, Williams *et al* (1993) state that litter found in an off-shore fishing bank, located in 10m of water, has caused a serious economic loss to fishermen in Swansea Bay, though no figures are quoted. The National Federation of Fishermen's Organisation have confirmed that marine litter is a cause of concern around Britain's coasts, and particularly sewage related debris in inshore areas (Glenn Quelch, *personal communication*). Unfortunately, no attempts have been made to quantify the extent of the problem.

The major impacts of litter on fin fishery interests results from damage to nets, fouling of fishing grounds, damage to fish stocks, etc. The UK Offshore Operator's Association Limited (UKOOA) is an organisation that represents the interests of companies extracting oil and gas from offshore locations. For many years UKOOA has operated a *Fishermen's Compensation Fund* to provide compensation to fishermen whose nets or other gear were damaged by oil related debris generated by oil and gas industry-related activities or some pipeline incidents. Where seabed litter can be attributed to a particular operator, this operator is held individually responsible and is expected to negotiate and settle the fishermen's claim. The compensation fund only comes into operation where "ownership" of the litter or obstruction is not clear or is unknown. Awards from the compensation fund are managed through a committee of fishermen, and average compensation runs at approximately £250,000 per annum. The annual value of settlements by individual operators, identified as responsible for seabed litter items causing damage, is unknown.

There is a UK-wide claim system for nets lost due to MOD activities. Three types of "fasteners" (net snags) are recognised by the MOD, each with an appropriate eligibility for claims (see Table 1).

The total impact upon fisheries is hard to quantify in exact terms but, taking an arbitrary assumption that settlements by individual operators are equal to the UKOOA's *Fishermen's Compensation Fund*, the total impact of damage to gear is not less than half a million pounds annually. The experience of Shetland fishermen (KIMO, 2000) is that each boat spends on average 2 hours per week cleaning litter from their nets. Loss of catch due to contamination (e.g. oil filters or cans of paint) can be up to £2,000. Up to a days fishing can be lost due to a fouled propeller, in addition to £300 for the hire of a diver to disentangle it. The loss of 1 hours fishing for a small fishing boat can be between £30 and £100. The effects and presence of litter can result in losses of between £6,000 and £30,000 per year per boat.

Table 1: Net "Fasteners" Recognised by MOD Compensation Scheme

Type of Fastener		Eligibility for Claim
1.	Large rocks or wrecks	No eligibility for a claim
2.	Mines, bombs, shells etc. (MOD involvement) - the procedure is to discard the net on a buoy and contact the bomb disposal team	Eligible for claim
3.	Submarine entanglement	Eligible for claim

3.3 Aquaculture

Fish farming in the marine environment is a particularly significant industry in Scotland, with a total estimated value of £200m annually. Marine fish farms both produce marine litter and suffer from its consequences. The Scottish Salmon Growers Association (SSGA) (Now Scottish Quality Salmon, SQS) note that the location of the farm dictates the type of litter found (SSGA, *personal communication*) i.e. for those near towns the problem is sewage related debris. For those in remote settings the problem is from fishermen and passing ships. There are complaints about weekend yachtsmen. Farmers do admit to self-littering, but seem to be keen to clean up on a regular basis. Some salmon farmers may spend up to 1 hour per month cleaning litter from nets and walkways (KIMO, 2000). The SSGA further comment that although litter is not often regarded as an "important" issue, it can cause local difficulties. A recent report "Marine Litter in the Minch" indicates that litter arising from the fish farming industry is being tackled under a Quality Assurance Scheme run by Food Certification, Scotland (Dr Downie, SNH, *personal communication*).

The Shellfish Association of Great Britain does not perceive litter to be a big problem for the industry, possibly due to the generally "clean" location of the shellfish beds.

3.4 Human Health

Sewage related debris, medical waste and other potential biohazards are reported as being of potential danger to human health, either when stranded on beaches or circulating in coastal waters (Rees & Pond, 1994a). In particular, medical waste could cause particular problems, which has given rise to expensive beach closures in the USA. In the UK, Phillip (1993) reports that, in the period 1988-91, 4% of the needle stick injuries reported to the Public Health Laboratory Service in the South West Region of England were sustained on the beach.

Entanglement is also problematic, and particularly the entanglement of sports SCUBA divers in monofilament gill nets (BSAC, 1991, 1992, 1993, 1994). Entanglement incidents are recorded by the British Sub-Aqua Club, and there are typically one or two incidents of this nature recorded every year. All should be considered as potentially life-threatening.

Large pieces of timber can pose serious hazards to boats, posing a significant threat to life, for instance, 18"steel bolts protruding from the timbers (Peter Holmes, *personal communication*). In addition threats to fishermen specifically include, fishing gear snagging the object, or the object being caught in the net and brought on board. In the first case there could be the danger of capsizing and potential loss of life and, in the second, danger to the crew if the object (e.g. a drum) contained harmful substances. Olin *et al* (1995) claim that dumping of chemicals,

including mustard gas, routinely affects local fishermen off the Coast of Bohuslan in West Sweden, and that catches have to be discarded when ordnance gets stuck in nets. However, this input has not been quantified. Similarly there is anecdotal evidence suggesting that fishermen in the Firth of Clyde and North Channel often net munitions (Edwards, 1995).

Depending on the resources that could be made available, the types of measures that would help prevent and/or minimise the effects of such incidents could include: the deployment of surveillance aircraft to identify the location of lost objects; the notification to mariners of the location of floating or sunken containers, cargo or debris; the emergency towing of floating containers; and the transfer of cargo from a stricken vessel.

3.5 Recreational and Leisure Usage

Recreation and leisure is a major source of national income. The British residential coastal holiday market (i.e. more than one or two nights) is estimated at approximately £4.7 billion annually, with 110 million day trips to the coast worth another £1.2 billion (excluding the business and visiting friends/relations markets) (Peter Hampson, British Resorts Association, *personal communication*). It may, therefore, dominate the local economy in certain regions such as the South West peninsula of England, West Wales and the West of Scotland. People tend to avoid littered beaches (Rees & Pond, 1995) and in extreme cases in the US littering can lead to beach closures. A study of beach users on the Glamorgan Heritage Coast (Morgan *et al*., 1993), questioned about their opinions and perceptions of the beach environment, indicated great concern about perceived bathing water quality and levels of pollution and litter found on the beaches.

Consequently, littering is a high-priority issue with coastal local authorities, who may spend a great deal of money clearing litter from their beaches. A report prepared for Scottish Enterprise, Scottish Natural Heritage and the Scottish Tourist Board (1994) which looked at procedures in place to manage beach litter, gives a good example of collaboration to deal with this issue. The report made recommendations on best practise methods, mechanisms and incentives that might be applied at a local level.

It is important to examine both the "direct" and "hidden" costs when evaluating the total cost of clearing away litter. For example, direct costs include collection and disposal of litter from a beach and the hire or purchase of cleaning equipment. Hidden costs could incorporate contract management, health, education, lost revenue and harbour costs (Clive Gilbert, *personal communication*). For example, although the direct cost of cleaning the 20 designated amenity beaches in Kent's 4 maritime district councils is approximately £800,000 per year, taking into consideration hidden costs, it is estimated that the total cost of marine litter to Kent could be £6-9 million annually (Clive Gilbert, *personal communication*).

Councils are expected to supply information on annual beach cleaning activities to the Chartered Institute of Public Finance Administration. However, this should be treated with some caution, because the total costs for each Council may incorporate differing levels of application. For example, the total cost may cover beach cleaning only or include town cleaning as well. Some Councils have been known to simply use the allocated budget as a guide to complete returns, while others do not submit any.

Some attempts have been made to quantify the monetary impact of litter on Local Authorities who are responsible for maintaining their amenity beaches to a high standard for recreational and leisure usage. In a survey of 56 coastal Local Authorities (KIMO, 2000), the total cost of beach cleaning was reported to be £1,953,238 for England, Scotland and Wales. However, as this does not represent the total number of local authorities it can be assumed that the total cost to the UK is well in excess of £2 million. The following examples help to identify the magnitude and range of the problem at the local level:

- The Somerset resort of Weston-Super-Mare welcomes 2 million visitors per year, and this tourist trade is worth £14 million per annum to the local economy. Since the recreational quality of its two beaches is so important to the local community, Weston Beach is mechanically raked and swept once or twice per day in the summer, and is hand-picked in the winter. The annual cost of cleaning on the two beaches is estimated as £100,000 (Acland, 1995).

- The direct costs of cleaning approximately 40km of Suffolk coastline (most of which is shingle) is approximately £60,000 per year (Trevor Gibson, Suffolk Coastal District Council, *personal communication*).

- Carrick District Council, Devon, annually spend in the region of £32,000 cleaning 5 km of beaches (Karen Hall, KIMO, personal communication). They were also successfully sued for negligence over sewage related debris on one of their beaches resulting in legal costs, to Carrick District Council in the region of £50,000 (Nick Hibbit, Carrick District Council, *personal communication*).

Reference has been made to various local authorities and their beach cleaning activities. It should be noted that the local authorities duty to clear litter, under Section 89 of the Environmental Protection Act, 1989, only refers to beaches identified as bathing waters. Looking at England and Wales as an example, the total length of coastline is 7062 km (at a scale of 1:50,000), of which there are 448 identified bathing waters. Even assuming an average of ½km per beach, these bathing waters equate to approximately 224 km or just 3.1% of the England and Wales coastline.

Examples from Europe and the US reveal similarly high costs associated with the clean up of litter as well as the effects on local economies:

- Tourism (one of Sweden's largest industries) on the Skagerrak coast of Bohuslan in West Sweden is worth 3 billion SEK (approximately £260 million) and 3,900 man years of work per annum to the local community. It is estimated that the substantial accumulation of litter that occurs in the area depresses tourism by between 1% (Olin *et al*, 1995) and 5% (Björn Stahre, *personal communication*). Taking a worst case scenario, this equates to an annual loss to the local community of approximately £15 million and 150 man-years of work. In addition to this loss of trade, local clean-up campaigns cost approximately £937,000 per annum, or approximately £156 per m^3 of litter gathered. It is worth noting that it is estimated that only 30% of the litter is actually recovered (Pege Schelander, BOSAM, *personal communication*). The total cost of coastal littering to the Bohuslan local economy is therefore in the order of £16 million per year.

- In 1987-8, large quantities of medical waste and other litter found washed up on beaches prompted the States of New Jersey and New York to close beaches on the grounds of the potential health risks that they posed. The estimated loss to the local economy was subsequently estimated to be several billion US$; a substantial sum (Swanson *et al*, 1991).

Impacts of contaminated beaches on local property values have also been considered under *Aesthetic Intangible Costs* (section 3.1.3).

3.6 Navigation (Non-military)

The presence of litter items in the water can be problematic for commercial and pleasure boats of all types. The principal problems are fouling of intakes, propellers and anchor lines, which can create a potential loss of earnings. DEFRA, for example, have experienced problems with

their research vessel *Cirolana* being fouled by floating netting, which required a slow steam to harbour on the bow thrusters and the hire of divers to clear the obstruction. Likewise, the Scottish Environment Protection Agency's marine survey vessel had its intakes blocked by litter, causing the engine to overheat and resulting in substantial downtime and costly repairs (Peter Holmes, *personal communication*). Such an event has occurred four times in twenty years and costs in the region of £1000 per working day. Other incidents have resulted in the fouling of the propeller, which may disable the craft and put the vessel and its crew at some risk.

The UKOOA reports that there are few formal reports of incidents of fouling of oil industry equipment, although this may be due to under-reporting as there is much anecdotal evidence that it occurs.

Forth Ports plc estimate that the approximate cost for the recovery and disposal of litter at the Port of Leith is £3,000 per year (Captain MacLellan, *personal communication*). However, they also state their belief that all the litter in Leith Docks is from landward sources. Shetland Harbour Trust spends approximately £13,000 per year on waste management (Karen Hall, KIMO, *personal communication*). This includes the physical collection of floating litter from within the harbour. A survey of 42 harbour authorities in the UK (KIMO, 2000), recorded a total of 182 propeller foulings costing £50,960.

Coastguard / Rescue Services

A further indirect cost of floating marine debris is the cost of rescue services in response to vessels stricken by fouled propellers. In 1998 RNLI lifeboats attended 200 incidents around the British Isles costing between £2,200 and £5,800. In many cases the lifeboat is run entirely by volunteers, leading to costs not only to direct rescue costs, but also costs to the employers of the volunteers in lost time.

3.7 Military Activities and Navigation

The UK places considerable importance upon marine, submarine and inter-littoral military exercises as a component of its defence capability. The impacts of litter on such activities include:

- surface and submarine navigation;
- geo-acoustics;
- internal waves;
- ambient noise;
- water transparency;
- mine sweeping (e.g. oil drums and other)

No associated costs have been made available.

3.8 Power Generation

The intakes of coastal power stations are fitted with screening. There are usually two levels of screening: coarse outer screens and finer inner screens.

The coarse outer screens provide primary protection for the intake, and remove gross litter items. Typical gross litter items trapped by coarse screens include, pallets, driftwood, tyres, discarded bicycles and oil drums. These screens are cleared as necessary, usually by hand.

Finer inner screens are usually either rack or drum screens, and these are normally cleaned automatically. The major items trapped are fish and seaweed, and the siting of the intake is carefully considered at the design stage to minimise impacts arising from marine outfalls and

other potential impingements. In addition to fish and seaweed, the fine screens catch litter, and typical litter items include: plastics (particularly shredded fertiliser and carrier bags), sewage-related debris, and the whole range of litter items that cause problems on beaches.

Given the need for smooth continuous operation, power station intakes are fitted with sophisticated litter control mechanisms, and a routine maintenance schedule is followed. The impacts of litter are therefore best assessed as an incremental cost over and above clearance activities necessary to remove fish and algae. Anecdotal evidence suggests that power station intake litter clearance rates (for a typical 2000MW direct cooled plant with four $1m^3$ litter baskets – one per inlet) can vary from $4m^3$ per week to $4m^3$ per month, depending upon season and recent weather conditions (Steve Adrain, National Power, *personal communication*). When loads of litter are particularly high, it may be necessary to supplement the automated clearance mechanism with forks and rakes. In exceptional circumstances, it may even be necessary to close down the turbine or the entire power station to remove blockages. Closures, though rare and usually attributable to shoals of sprat and herring (S. Rogers, CEFAS, *personal communication*), are extremely expensive to power generators due to loss of production.

At Aberthaw, screens are cleaned every six weeks at a cost of £5,000. The pumps performance was seen to decline as the screens became gradually blocked by debris, costing approximately £500 per week (KIMO, 2000).

3.9 Seawater Abstraction

It is generally assumed that the problems experienced by non-power generation sectors of industry are similar to those experienced by power station intakes. However, this assumption must be challenged as other sectors of industry may:

- Be sited with regard to proximity to centres of population, ports, etc., and therefore abstract water containing a higher concentration of litter;
- Abstract water at substantially lower velocities and rates than power stations; and
- Not be fitted with such sophisticated litter-trapping mechanisms, nor assume a standard overhead rate for screen clearance.

A questionnaire survey of marine abstractors listed on the Environment Agency's Public Registers was conducted. Of 22 responses 5 encountered no problems with marine litter, 10 considered that litter caused problems rarely (less than 25% of the time), 6 considered it was an occasional problem (25-50% of the time), and 1 considered marine litter a very regular problem (more than 75% of the time). General litter (for instance, cans, bottles, packaging plus other items less than 30cm in size) was found in all cases, with gross litter (for instance, any items larger than 30cm in any dimension) being reported in addition by 7 respondents. Sewage related debris (for instance, condoms, panty liners, etc) only appeared in small concentrations on 2 questionnaires. One respondent, who abstracts continuously, collects approximately 10kg of general litter every day from automatic screens. The perceived source in this case is mainly from ships berthed in the dock, rather than from the estuary.

The most frequently-reported problems reported by abstractors were blocked inlet valves and restricted flow through pumps. However, fouled propellers and snagged dredging gear were reported as occasionally problematic, and some instances of actual litter-related damage were recorded (burnt out clutches, broken drive shafts on band screens and heat exchanger damage).

The financial implications to abstractors of marine litter range from minimal labour costs to clear blockages on an irregular basis, through to approximately £50,000 per year for major damage and

blockage problems (including contractor costs, in-house staff time, and downtime). One of the abstractors surveyed normally budgets for an extra 80 shifts per year (12 hour shifts on overtime) for litter-related clearance activities.

3.10 Flood Defence

The Flood Defence function of the Environment Agency engages in litter clearance for coastal defences in order to protect drains and weirs diverting waters away from vulnerable locations.

Conservative extrapolation of costs for litter clearance by Environment Agency Midland Region to cover the coastline of Great Britain would result in an annual cleaning bill in excess of £1million, ignoring the additional costs of damage resulting from defence failures due to inadequate cleaning. The costs are recouped by cross-charging affected County Councils.

3.11 Agriculture

There are instances where wind blown marine litter, especially plastic sheeting, has to be removed from agricultural land. In Shetland 91% of crofters are affected by marine litter blowing into their fields (KIMO, 2000). Problems include damage to fences and farm machinery and time taken to clear fields prior to ploughing. In addition, some farm animals have become entangled in litter, with instances of ingestion of plastics tangled in seaweed. The estimated costs associated with these impacts totalled £400 per year per croft.

The total costs associated with impacts on agriculture across the rest of the country are unknown.

3.12 Aesthetic Intangible Costs

In addition to the sectors discussed above, the presence of litter also adversely affects water-based recreational activities of all types as well as the perceived quality of the marine environment. In the riverine environment, it has been demonstrated that the amount of litter is used by the general public as an indication of water quality (Dinius, 1981; House & Sangster, 1991), and that even low quantities of litter directly impinge on the public's perception of the amenity value of a watercourse (Dinius, 1981). It is therefore probable that there will be a strong relationship between visible marine litter and the attractiveness of marine waters for recreational purposes.

These impacts on public perception also have negative effects upon the value of local property (hedonic pricing), the attractiveness of the water for amenity purposes, a consequent reduction in the quality of life, and bequest value for landscape, purity and wildlife. In some instances, it may be possible to quantify this effect by contingent valuation techniques.

3.13 Summary of Costs

Table 2, overleaf gives an overview of some example costs associated with marine litter. Perhaps most important are the sectors where it is difficult to place an economic value for instance, ecology or property devaluation. Priority should be given to assessing these, so that a true reflection of the cost impact of marine litter can be revealed.

Table 2: Summary of some Extrapolated Costs Associated with Marine Litter

Sector	Qualitative Impact	Potential Economic Impact (£ per year)	Explanation of Extrapolation
Ecological impacts	Entanglement, ingestion, smothering, beach cleaning	Unknown	What value can be applied to the potential decline and thus protection of a species?
	Long Distance transport	Unknown	Could be high based on freshwater examples (cf page 11, section 3.1.5).
	Toxic poisoning	Unknown	Potentially high - need more research.
Fisheries	Oil industry related (UKOOA fund)	250,000	Section 3.2
	Net and boat (propeller) damage from other litter sources	23,400,000	Based mainly on Shetland experience £6,000 to £30,000 /yr/boat (KIMO, 2000). UK total no of fishing boats =7,800 ((MCS, 2000a); assume 50% of boats affected (3,900) as at Shetland x by £6k.
Aquaculture	Cage Clearance etc.	316,800	Shetland experience (KIMO, 2000) 1 hr (=£80) /month x approx 330 farms (MCS, 2000a).
	Fouled Propellers and intakes	594,000	Between £150 and £1,200 per incident. Therefore using £150 x 330 boats x 1 incident / month
Tourism	Direct costs – designated beaches	1,781,543	Average annual cost of beach cleaning /km of £7,953 (based on KIMO, 2000 – see table 4.3) x the estimated total length of all 535 UK bathing beaches (MCS, 2000b) =267km.
	Direct costs – non-designated beaches	5,423,946	Average beach cleaning cost as above (£7,953) x estimated length of non-designated beaches cleaned (KIMO, 2000 – page20) 682km.
	Hidden costs	157,000,000	£6-9m just for Kent (section 3.5). Difficult to extrapolate because tourists may relocate somewhere else therefore loss may not be uniform to whole UK. Assume costs 1/6th of the minimum for Kent (£1m) x 157 coastal authorities sampled by KIMO (2000).
Navigation (non-military)	Recovery and disposal of litter in ports/harbours	5,600,000	Average of Port Leith (£3000/yr) and Shetland Harbour Trust (£13,000/yr) = £8,000 x the 700 UK ports/harbours (MCA, pers comm.).
	Rescue Services	440,000	200 incidents around UK in 1998 (KIMO, 2000) x min RNLI launch cost of £2,200
Military activities and navigation	Damage, propeller entanglement and navigational hindrances	Unknown	Unable to quantify at present.
Power generation	Screen clearances of coastal stations	414,000	£43,000 per year clearance costs at Aberthaw, plus performance decline of £26,000/yr (=£69,000) x 6
Seawater abstraction	Blockages and damage	>100,000	Up to £50,000/yr /abstractor (section 3.9)
Flood Defence	Litter clearance activities	up to 40,000	England and Wales only (section 3.10
Agriculture	Litter clearance and harm to livestock	600,000	Majority of impact expected to occur in Shetland (KIMO, 2000).
Aesthetic intangible costs	Property devaluation etc.	Unknown	Could be considerable.
Litter survey programmes		>36,000	Majority of those organisations listed in Appendix A who are involved in UK survey work (20) using perhaps 3 people per organisation (min) twice a year (min) x £300/day.
Prevention and education programmes		>250,000	All the following have varying numbers of people carrying out such work: BMIF, MCA, DETR, Agency, MCS, TBG, NALG, Bag It & Bin It. Could assume 200 people working 4 days at £300/day
	Total	**196,246,000**	

4.0 National and International Regulatory Controls of Litter in the Marine Environment

The key to controlling marine litter is to tackle it at source. This is not only consistent with the precautionary principle, but would appear to be the only management option that is economically sustainable in the longer term.

The main regulatory control of litter from shipping in the UK is MARPOL. Land sourced litter is controlled by a number of regulations, the most important of which is the Environment Act, 1990 covering England, Scotland and Wales and the 1994 Northern Ireland Litter Order. Regulations have been reinforced by subsequent international commitments to sustainable development such as the UK Governments White paper *This Common Inheritance* (1990).

One of the keys to controlling litter is to identify the source (see section 2.2) and then to apply appropriate controls. The following sections detail the International and National measures that have been implemented to date.

4.1 London Convention

The first time that the issue of disposal at sea of materials from land was addressed internationally was at the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (London Convention, 1975). This was coordinated by the International Maritime Organisation (IMO) and it covers many disposal at sea issues including sewage sludge, dredged materials, radioactivity, concrete, aircraft, etc. The UK is a signatory to the London Convention.

The Convention has recently completed a comprehensive review and amendment process. The outcome was agreement in November 1996 of a new Protocol to the Convention, which once it has been ratified and comes into effect, will strengthen the rules on dumping at sea. The most significant change is the move away from a list of what may not be dumped, to a restrictive list of materials which may be considered for sea disposal, all others being prohibited. It does not refer to litter.

4.2 MARPOL

The International Convention for the Prevention of Pollution from Ships 1973, or MARPOL as it is more commonly known, was modified in 1978 and ratified in June 1994 by 69 countries, including the UK. It regulates the types and quantities of operational and cargo wastes that may be discharged from ship to sea, taking into account the ecological sensitivity of different sea areas. Under no circumstances are plastics to be disposed of at sea.

MARPOL has five annexes, each one dealing with a specific type of waste. It is Annex V of MARPOL, which covers garbage/litter and this came in to force on December 31 1988. The North Sea and English Channel is an Annex V Special Area where there are even more stringent requirements (i.e. the disposal of all waste, with the exception of food waste, is prohibited). Annex V also requires that ships over 400 gross tonnes which are certified to carry more than 15 persons, develop and follow a written garbage management plan. These plans are to be developed by 1 July 1997 and should include the following:

- A description of the collection, processing, storage and disposal of each type of waste generated by the ship and waste that may be further categorised by local requirements e.g. hazardous and medical wastes.

- A list of waste management techniques/equipment available to be used by the ship.

- Provisions for the discharge of garbage and designation of one person responsible for the implementation of the plan.

It is worth noting that "The Government of each Party to the Convention undertakes to ensure the provision of facilities at ports and terminals for the reception of garbage". As with all international agreements, MARPOL is not legally binding until it is written into the domestic legislation of the signatory country. In the UK this sub-ordinate legislation takes the form of a variety of regulations including:

The Merchant Shipping (Port Waste Reception Facilities) Regulations 1997 (SI 1997 No 3018) (which replaced The Merchant Shipping (Reception Facilities for Garbage) Regulations 1988 (SI 1988 No 2293)), and, The Merchant Shipping (Prevention of Pollution by Garbage) Regulations 1988 (SI 1988 No 2292). Both of these Regulations give effect to Annex V of MARPOL and apply to the whole of the UK.

The Control of Pollution (Landed Ship's Waste) Regulations 1987 and Amendment of 1989 which applied in GB only, complemented the above regulations in the implementation of MARPOL. These were regulated by the Environment Agency in England and Wales and by SEPA in Scotland. They were revoked and replaced in Great Britain by Regulations 9 and 26 of The Special Waste Regulations 1996. Similar provision has been made under Regulation 9 of The Special Waste Regulations (Northern Ireland) 1998.

It is also important to remember that the mandatory plans required by the Merchant Shipping (Port Waste Reception Facilities) Regulations 1998 only deal with ship' waste under MARPOL and are not intended to be comprehensive plans for waste management for the whole port system.

Hollin & Shaw (1997), give details of a report commissioned by the DoT in 1991, which investigated how UK port reception facilities were being utilised. The principal conclusions reached were: (1) there is a high cost associated with handling small quantities of garbage, (2) the handling of restricted waste in larger ports is often inconvenient, and (3) there is restricted use of disposal facilities at some private terminals.

A Maritime and Coastguard Agency (MCA) report (1994) also concluded that although "generally adequate" there was "considerable room for improvement" regarding the provision of MARPOL facilities. A further MCA report (1995) concluded that waste facilities at ports within the UK are highly variable with the smaller ports being deficient in services for waste disposal. A general criticism also noted was that no provisions for hazardous or special solid wastes were available. The report recommended that port information should contain a detailed list of waste disposal services available, that all ports should have a minimum four category segregation system for solid wastes and that there was a need for a "mariners" waste handbook which detailed good practice.

The DETR produced useful guidelines associated with the production of port waste management plans (DETR, 1998), while the comprehensive advisory manual by Davies (1998), gives a clear worked example, using Milford Haven, of how to produce a plan. In addition, the British Marine Industries Federation (BMIF) and the Royal Yachting Association (RYA) have produced a booklet (1998) directed at recreational boating facilities, which is an excellent example of industry, users and Government working in partnership.

4.3 EC Directives

Litter is a minor component of various EC Directives, as indicated below. As with MARPOL, EC Directives are not legally binding until written into domestic legislation.

4.3.1 The EC Dangerous Substances Directive

The EC Dangerous Substances Directive (76/464/EEC) introduced community-wide requirements to control environmental concentrations of certain substances. The directive identified families and groups of substances of concern, dividing them into List I and List II on the basis of their toxicity, persistence and bioaccumulation.

The eighth and final item included in List I, which contains those substances of greatest concern, is as follows:

8. "Persistent synthetic substances which may float, remain in suspension or sink and which may interfere with any use of the waters."

No specific quality standards have been introduced by daughter Directives as for some other List I substances.

4.3.2 The EC Packaging and Packaging Waste Directive

The EC Packaging and Packaging Waste Directive (94/62/EEC) is implemented, through Producer Responsibility Obligations (Packaging Waste) Regulations 1997.

Under the UK Regulations businesses handling more than 50 tonnes of packaging wastes (90% of the market) will be required to recycle more than half of their packaging waste by 2001.

4.3.3 The EC Bathing Waters Directive

Under the Bathing Water Directive (76/160/EEC) tarry residues, floating materials such as wood, plastic articles, bottles, containers of glass, rubber or any other substances, waste or splinters must be absent from the Bathing Water to meet the guideline standard.

4.3.4 The EC Urban Waste Water Treatment (UWWT) Directive

Under the UWWT Directive (97/27/EEC) all significant discharges (more than 2000 population equivalent to estuaries and 10,000 to coastal waters) will require a minimum of primary treatment. This means that by 2005 all significant coastal discharges will have screening, which should reduce inputs of sewage related debris.

4.3.5 The EC Hazardous Waste Directive

The Hazardous Waste Directive (91/689/EEC) is implemented in the UK through the Special Waste Regulations 1996 under section 62 of the Environmental Protection Act 1990. The main purpose of the Special Waste Regulations is to provide a "cradle to grave" system of control which ensures that Special Wastes are soundly managed from the moment they are first moved as waste until they reach their final destination for disposal or recovery.

There is some concern that the apparent bureaucracy associated with these regulations is counter productive to the landing of special waste from vessels, in particular chemical drums (J. Petrie, UKOOA, *personal communication*).

4.3.6 The Council Directive on Port Reception Facilities for Ship-generated Waste and Cargo Residues

This Directive (2000/59/EC) was adopted in late December 2000. The UK, like other Member States, is required to bring into force national legislation necessary to comply with the Directive before 28 December 2002.

It is widely recognised within the international community of maritime states that, in order to leave no excuse for ships to resort to the unacceptable practice of discharging their waste at sea, there must be a properly planned system of reception facilities in ports which are easy-to-use and cost-effective. This is one of the requirements of the International Convention on the Prevention of Pollution by Ships (MARPOL 73/78). It is embodied in UK legislation in the Merchant Shipping (Port Waste Reception Facilities) Regulations 1997 (SI 1997 No 3018); and it is now set out in Directive 2000/59/EC.

The UK played an active part in negotiating the Directive, and the UK's existing regime is reflected in the Directive - with some significant additions in the form of:

- A requirement for ships to deliver their waste to port reception facilities before leaving port. (Although there is provision for ships to be exempted in certain circumstances. There is also separate provision for ships to keep their waste on board and proceed to the next port of call if they have sufficient dedicated storage capacity for the waste which has been, and will be, accumulated during the voyage.)

- Explicit references to fees for ship-generated waste, together with the requirement that cost recovery systems for waste reception facilities must not provide an incentive to ships to discharge waste into the sea.

- A requirement that ships provide notification, prior to their entry into port, of the waste which they will discharge. (Although this does not apply to fishing vessels or small recreational craft. There is also separate provision for other ships to be exempted in certain circumstances.)

4.4 National Legislation

Under the Environmental Protection Act, 1990 and the Litter (NI) Order 1994, competent authorities are responsible for keeping their land clear of litter. The competent authorities include local authorities, government departments, statutory undertakers for instance, railway companies), schools, colleges and universities.

4.4.1 Departmental and Agency Responsibilities

- The **Maritime and Coastguard Agency (MCA)** (formerly the Marine Safety Agency and the Coastguard Agency), is an executive agency of the Department of Transport. The MCA has responsibility for illegal discharges from ships and executes its duties by posting Merchant Shipping Notices, which inform all port users of new legislative requirements. Government also places a statutory duty on the Port and Harbour Authorities to ensure the provision of reception facilities consistent with MARPOL requirements. Waste management plans are overseen by the MCA. The MCA has also made considerable efforts to inform port users of the problems associated with the sea disposal of litter through education campaigns such as 'Over the Side is Over' and 'Sea Sense'.

  The **Marine Pollution Control Unit (MPCU)** (now part of MCA) was established in 1979 to exercise the responsibility accepted by Central Government for counter pollution operations at sea when spilled oil (or other dangerous substances) from ships presents a major pollution threat to UK waters or coastal interests.

  The MPCU also has responsibility for following up reports of possible illegal discharges of oil and other substances, including garbage, at sea with a view to initiating

prosecutions under the Merchant Shipping (Prevention of Oil Pollution) Regulations 1996 and the Merchant Shipping (Prevention of Pollution by Garbage) Regulations 1998.

- The competent monitoring authority for the EC Directives affecting the marine environment, as listed in section 4.3, are The **Environment Agency,** the **Scottish Environment Protection Agency** and **Department of the Environment for Northern Ireland**. These bodies have general duty to monitor the extent of pollution of Controlled Waters (including estuaries and coastal waters up to the territorial limit), in addition to wide-ranging powers and duties in respect of pollution control. It is worth noting, however, that riverbanks are excluded from control by Environment Act 1990. This gap in the legislation is important bearing in mind rivers form a major pathway for the transport of litter from land to the marine environment.

- Under the Environment Act 1990 and the Litter (NI) Order 1994, all coastal local authorities have a duty to remove litter from mean high water spring line and above from amenity beaches from May to September.

- **DEFRA, the Scottish Executive and DOENI** licence deposits in the sea under the Food and Environment Protection Act 1985 (as amended). The principal category of material licensed for disposal is dredged material but sewage sludge was also disposed of at sea until this activity ended in December 1998 under the UWWT Directive. Other categories of material licensed for deposit are for construction or other beneficial purposes. Conditions may be attached to licences, when appropriate, to prevent rubbish and litter entering the marine environment by this means.

4.5 OSPAR

The OSPAR Convention is an international agreement for the protection of the North East Atlantic. The Convention was ratified by 16 contracting parties and entered into force on 25 March 1998. The Paris and Oslo Conventions have covered marine pollution in the area of the North East Atlantic since the early 1970's. Under the new OSPAR Convention contracting parties are required to take all possible action to prevent and eliminate pollution of the North East Atlantic. They must:

- Adopt programmes and measures in pursuit of these objectives;
- Harmonise their policies and strategies;
- Apply the precautionary principle; and,
- Impose controls corresponding to best available techniques and best environmental practice.

The work of OSPAR is conducted through a secretariat and a number of working groups. The Working Group on Impacts on the Marine Environment (IMPACT), now part of the Biodiversity Committee of OSPAR, has litter included in its remit.

Sweden is the lead country for litter on IMPACT and aims to identify:

a. The Sources and Occurrence of Litter

- Assessment of sources, composition, occurrence and quantities;
- Assessment of the effectiveness of measures;
- Definition of common monitoring methodology;
- Temporal trend monitoring.

b. The Effects of Litter on Birds and Marine Life

- Assessment of research data on stomach contents in relation to health.

4.6 North Sea Conference

Marine Litter and Waste Management were among the subjects discussed by Ministers at the 5th North Sea Conference in Bergen (19 – 20 March, 2002).

Ministers expressed their concern about the fact that, despite the wide range of measures taken in recent years, marine litter was still causing environmental, safety and economic problems to marine and coastal environments, as well as to coastal communities in the North Sea States.
The Ministers agreed that litter can only be addressed by efforts from all sectors of society. As a result the Ministers:

i) emphasised the importance of the role of the voluntary sector, particularly in the mounting of clean up campaigns, information activities and educational projects (such as Beachwatch, Coastwatch and Adopt – a – Beach), and welcomed their contribution;

ii) In relation to litter from land based sources, such as tourism and recreation, sewage and waste from landfills, invited organizations concerned with promoting tourism, managing waste disposal and encouraging the public not to create litter to review their programmes to see if there are further projects which may be developed to reduce marine litter by changing public attitudes.

iii) Noted with interest the project conducted in co-operation between a number of Dutch fishermen and Dutch authorities under which litter caught in trawls is brought back to port where it can be unloaded free of charge for safe disposal and draw the attention of the relevant authorities in other North Sea States to this fruitful co-operation as a possible model for wider co-operation in this field;

iv) Committed themselves to giving priority, within their national programmes to combat litter, to programmes which effectively address the problems of marine litter (such as the Save the North Sea Project) and, where appropriate, to supporting them within the framework of the EU INTERREG IIIB North Sea Initiative; and

v) In relation to litter from the maritime transport sector and offshore installation, invited the operators to review the provisions of their environmental management systems to see how they can better control litter.

The Ministers committed themselves to implement the EC Port Receptions Facilities Directive, and strive for a co-ordinated approach in the future. They agreed to evaluate the different approaches in the meantime taking into account experiences of the Baltic Sea States ("No Special Fee System" – 100%) and experience of other North Sea States. They agreed to set up mechanisms that work as an n incentive to deliver all ship-generated waste ashore, and to exchange information on the adequacy and use of such facilities, through a harmonized system of reporting. The Ministers invited the Helsinki Commissioners with participation of the North Sea States to initiate the evaluation and deliver a report in time for the next meeting in Sweden.

5.0 Conclusions

Several conclusions can be derived from the results of the schemes outlined in Appendix A and available literature. These are listed below under the headings of what we do and do not know.

What we do know.

- With the exception of the National Aquatic Litter Group (NALG) there appears to be little co-ordination of effort to tackle the problem of marine litter[1].
- Legislation alone is ineffective in reducing marine litter.
- Despite a lack of research into the subject, there is much evidence that the economic impact of marine litter to the UK is significant.
- Large volumes of litter can accumulate in shoreline and seabed sinks.
- It is estimated that 80% of marine litter originates from land based sources.
- A significant amount of the litter items on our shores are small (less than 30cm).
- 50 - 90% of beach litter comprises plastics, which may persist in the sea for a long time.
- Much sewage related debris still originates from combined sewer overflows (CSOs).
- Sewage related debris has the greatest negative impact on public perception of water quality and fitness for bathing and other uses.
- Litter in the marine environment is of concern to the public, and has led to the establishment of many volunteer-based survey and clean-up schemes.
- Volunteers provide a cost-effective means of gathering data, and have particular value in supporting nation wide surveys for which specialist surveying would be too costly. There is an additional benefit of ownership and education.

What we do *not* know.

- We do not know how marine litter affects populations or indeed whole ecosystems.
- It is difficult to assess the economic damages associated with the impact of litter on ecological functions.
- Not enough is known about the long-term effects of persistent breakdown particles.
- We do not have enough monitoring data to source litter items accurately.
- We do not know how effective MARPOL is, since there is no monitoring system to measure any effects of the legislation.

1 Responsibility for the monitoring and regulation of, and education about, marine litter falls to a number of organisations within the UK (*UK* – MCA, local authorities, and MCS; *England and Wales* – Environment Agency and TBG; *Scotland* – SEPA and Keep Scotland Beautiful; *Northern Ireland* – EHS and Tidy Northern Ireland).

6.0 Recommendations for Further Action

There is a need to reduce the various problems caused by litter in the marine environment. This requires action on a number of fronts and in particular calls for co-ordination of existing activities in order to enhance their effectiveness.

Consideration should be given to the following:

- What co-ordinating mechanisms would be appropriate to fulfil the aim of reducing the input and impact of litter;

- The promotion of communication and education about the problem of marine litter in order to stimulate a more pro-active approach to its prevention and minimisation through collaboration between various stakeholders;

- Research into the economic[2] and ecological impacts of marine litter and the effectiveness of current measures for its control.

2 The use of risk assessment tools and contingency valuation techniques would also help to evaluate the potential economic damages that might result from the loss of ecological functions caused by varying levels of litter.

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Appendix A: Review of Surveys and Initiatives

A large number of litter surveys and initiatives exist to determine the nature and extent of littering in the marine environment and to prevent littering through education. Most of the surveys are based on some index of perception by users of the marine environment, typically recreational users of the coast or of estuaries. Given their diverse purposes and methods, these survey schemes are frequently incompatible, and their objectives are frequently poorly defined. Nevertheless, each scheme has its strengths and serves to illuminate aspects of the extent of littering in the marine environment.

The aim of this appendix is to summarise the major surveys and initiatives, past and present that support the Task Team's study of the impacts of marine litter.

Surveys and Initiatives – UK wide		
Initiative	Adris Estuarine and Coastal Waters Classification Schemes	To classify the quality of Scottish estuaries and coastal waters. Both schemes have an aesthetics component. Categories include: human faeces, animal faeces, grease, sanitary towels, contraceptives, other sewage related debris, sewage smell, oil, tar, smell of petroleum, fishing gear, plastic wastes, refuse from ships, refuse from terrestrial sources, builders waste and mineral waste. These are recorded on a simple abundance scale.
Organisation	Scottish Environmental Protection Agency	
Type	Survey	
Initiative	Aesthetic Beach Quality Assessment	To assess the aesthetic quality of designated Bathing Beaches in England and Wales. Categories include sewage related debris, potentially hazardous litter, oil, general litter, gross litter, dog faeces and oil.
Organisation	Environment Agency/ National Aquatic Litter Group	
Type	Survey	
Initiative	Bag It & Bin It	A National 'Bag It and Bin It' campaign was launched in March 1995. The National Bag It and Bin It group is a unique partnership of water companies, sanitary protection manufacturers, non-government organisations, government agencies and environmental charities. The campaign aims to generate public awareness of the problems associated with using the toilet as a wet dustbin. This is achieved through the use of publicity materials. In addition to the National Campaign various regional efforts have been initiated by Water Companies/water and sewage undertakers, in partnership with their environmental regulators and NGOs to monitor the effectiveness of this approach.
Organisation	UK CEED (since 2000 – previously Water UK)	
Type	Education	
Initiative	Beachwatch/Adopt-a-Beach	Beachwatch is an environmental and volunteer initiative, designed to raise awareness of the problem of marine litter on Britain's beaches and provide evidence that action must be taken to reduce marine pollution at source. MCS has organised the national Beachwatch campaign since 1993. The campaign focuses on a national beach litter survey involving thousands of volunteers every September to tie in with the International Coastal Clean-up occurring in over ninety countries. An annual report of survey results is published in February. Beachwatch results have been widely used by Government and the Environment Agency as an indicator of beach litter trends. In 1999 MCS launched Adopt-a-Beach with National Lotteries Charity Board (NLCB) funding to encourage quarterly beach litter trend surveys.
Organisation	Marine Conservation Society (MCS)	
Type	Survey	
Initiative	Coastwatch UK	Coastwatch UK was an independent monitor of the conditions of the UK coastline over the period 1989 – 1996 (cf 'Coastwatch Europe' below in the International Section). Within the UK, the programme was developed to explore public health issues. Further details of Coastwatch are provided by Rees & Pond (1994b), and a critical assessment of the methodology is provided by Rees & Pond (1995).
Organisation	Farnborough College of Technology	
Type	Survey	

Initiative	General Quality Assessment	The General Quality Assessment (GQA) scheme was developed by the National Rivers Authority (NRA)(predecessor to the Environment Agency) to provide an objective classification scheme against which to measure the quality of surface waters. In the marine environment, sub-components of the GQA have been developed to measure a range of parameters including sanitary chemistry (Dissolved Oxygen and Ammonia), Nutrients, Biological Quality, Heavy Metals in Sediments, and Aesthetic Quality.
Organisation	Environment Agency	
Type	Survey	
Initiative	Lough Foyle Research Vessel: Irish Sea Study Trawls	To carry out population assessments of demersal and benthic fish and shellfish stocks. Marine litter is graded out of catches as part of the sub-sampling process. A Rockhopper Trawl (demersal fish and a prawn trawl (Nephrops and by-catch) are used twice each year at fixed trawl stations. Gross marine litter and all marine litter detected in catch sub-samples are identified where possible and recorded.
Organisation	DANI Agricultural and Environmental Sciences Division	
Type	Survey	
Initiative	Marine Litter Research Programme	The programme was launched in 1973 in response to increasing concerns about the quantities and distribution of litter in the marine environment. The primary aims are to generate accurate and representative statistics from standardised methodologies and analytical techniques showing major sources of marine litter over varying spatial and temporal scales; assess major trends concerning quantities, sources and types in relation to the strengthening of national and international controls; and to determine rates of accumulation of plastics wastes in coastal and oceanic waters around the British Isles. Marine Litter Research Programme Reports (7 to date) published by The Tidy Britain Group. Key papers published in the scientific literature. Refer also to Ribic, Dixon & Vinning (1992). Marine Debris Survey manual. NOAA Technical Report NMFS 108.
Organisation	Tidy Britain Group	
Type	Survey	
Initiative	Marine Pollution Control Unit (MPCU) Surveillance	The MPCU (an executive agency of the Department of Transport, Local Government and the Regions (DTLR), based at Southampton) was established in 1979 to exercise the responsibility accepted by Central Government for counter pollution operations at sea when spilled oil (or other dangerous substances) from ships presents a major pollution threat to UK waters or coastal interests. The responsibility for shoreline pollution lies with the Local Authorities. However, when pollution comes ashore in large quantities and combating measures are beyond the resources of the affected LA, MPCU will assist in co-ordinating the shoreline clean up. The MPCU has under contract two surveillance aircraft, Cessna 404s, which fly frequent patrols around the coast of the UK, to deter ships and platforms from discharging illegally, and to identify those who do so. Aerial surveillance flights will always report dumping of garbage at sea when spotted. The MPCU also has responsibility for following up reports of possible illegal discharges of oil and other substances, including garbage, at sea with a view to initiating prosecutions under the Merchant Shipping (Prevention of Oil Pollution) Regulations 1996, as amended, and the Merchant Shipping (Prevention of Pollution by Garbage) Regulations 1998.
Organisation	Maritime and Coastguard Agency (MCA),	
Type	Surveillance/Clean up/Enforcement	
Initiative	Northern Ireland Estuarine and Coastal Waters Classification	EHS have adopted the ADRIS classification schemes for measuring the quality of estuaries and coastal waters. Both schemes have an aesthetics component.
Organisation	Environment & Heritage Service (EHS NI)	
Type	Survey	
Initiative	SeaSearch	SEASEARCH is a voluntary scheme, which utilises amateur sub-aqua divers to describe and catalogue the different habitats around the coasts of the UK. In addition SEASEARCH aims to promote marine conservation. The Environment Agency currently sits on the national SeaSearch Steering Group, which aims to extend the programme to include recording of anthropogenic impacts, including litter.

Organisation	Marine Conservation Society (Chair)	
Type	Survey	
Initiative	Seaside Award and Blue Flag Award Schemes	Both of these coastal and beach management award schemes are administered in the UK by the Tidy Britain Group. Blue Flag Award beaches are intended more for resort beaches and must meet "guideline" standards set out in the EC Bathing Waters Directive and have adequate facilities for litter and dog refuse. Other award criteria include good access, basic amenities (public toilets, telephones, parking, and facilities for the disabled) as well as information points informing the user of facilities and water quality. Seaside Award beaches must meet the lower "mandatory" standard. There are two Seaside Awards for "rural" and "resort" beaches. While all Seaside Award beaches must be easily accessible and have information points good amenities and beach cleaning do not have to be provided at rural beaches because their attraction is likely to be due to their undeveloped and unspoilt nature. The Tidy Britain Group and their agents carry out beach litter surveys of all award beaches and many others. This information is used to inform beach managers or local authorities of problems and Awards can be withheld if the required standards are not reached. These schemes have undoubtedly raised attention to beach quality standards and the number of Awards has steadily increased since the schemes were introduced. The Awards represent a high standard, which beach management authorities now aspire to. They also increase public awareness of environmental management issues such as litter, dog refuse and bathing water quality.
Organisation	Tidy Britain Group	
Type	Survey/Award	
Initiative	Tidy Northern Ireland Group	Assessment and monitoring of those beaches applying for a Seaside Award or European Blue Flag.
Organisation	sub-group of the Tidy Britain Group	
Type	Survey/Award	
Initiative	Keep Scotland Beautiful	Assessment and monitoring of those beaches applying for a Seaside Award or European Blue Flag.
Organisation	Sub group of the Tidy Britain Group	
Type	Survey/Award	
Initiative	Underwater Clean Up	In 1999 MCS and PADI published a guide to underwater clean ups to encourage divers to survey and remove sub-tidal litter. Currently results are insufficient to provide useful data.
Organisation	Marine Conservation Society and PADI	
Type	Clean up/survey	
Surveys and Initiatives – UK Regional		
Initiative	Afonydd Glan/Clean Rivers	Under the Keep Wales Tidy "Afonydd Glan/Clean Rivers" initiative (previously the South Wales River Litter Abatement Project) 35 voluntary river care groups are active in 4 river catchments (Taff, Ogmore, Rhymney and Ebbw) with plans to expand in future years.
Organisation	Keep Wales Tidy	
Type	Survey	
Initiative	Clyde Pride	Clyde Pride was a joint venture with Keep Scotland Beautiful and local Rotary Clubs. Over 7000 volunteers turned out to clean up 37 watercourses, estuary and coastal shores, 4 lochs and a canal. Some 423 tonnes of rubbish were handpicked on one designated action day. The long-term benefit was considered to be in the publicity and education as much as the clean up itself. Similar initiatives have been carried out in the Forth and along the beaches of the Ayrshire Coast.
Organisation	Keep Scotland Beautiful and local Rotary Clubs	
Type	Clean up/education	

Initiative	Coast Care	Keep Wales Tidy is piloting a 'Coast Care' project in Pembrokeshire which includes establishing voluntary groups to monitor and influence litter from shipping activities. The scheme includes the development of Port Waste reception plans at small marinas and jetties and a rural Beach Award Scheme in conjunction with 'Green Seas' (see below).
Organisation	Keep Wales Tidy	
Type	Survey	
Initiative	Cumbria Marine Litter Project (CMLP)	The CMLP began in 1996 as a partnership between the Lake District National Park Authority, Tidy Britain Group and Copeland Borough Council. The research work program aimed to identify the problems experienced on the Cumbria Coastline brought about by marine transported litter deposited on beaches of the lake district national park.
Organisation	Cumbria	
Type	Survey	
Initiative	Dorset Beach Clean	Annual clean up of Dorset beaches involving volunteers from coastal villages. Does not include a survey or monitoring element.
Organisation	Dorset County Council	
Type	Survey	
Initiative	Green Seas	The Green Seas initiative is currently piloting an award scheme for rural beaches.
Organisation	Welsh Water	
Type	Award	
Initiative	Navigate with Nature	"Navigate with Nature" is the BMIF initiative, which targets the users of marine industry products (boats, marine oils, anti-foulants, etc.), and offers good practice advice to encourage the environmentally responsible use of those products. Navigate with Nature also aims to reduce waste originating from recreational craft through educational materials.
Organisation	British Marine Industries Federation (BMIF)	
Type	Education	
Initiative	ThamesClean	ThamesClean is a partnership between the Tidy Britain Group and the Environment Agency, co-funded by local authorities and some local industries. Its aim is to reduce the amount of solid waste in the river Thames and its tributaries throughout London. The Thames Clean survey method is based on the National River Authority's GQA *q.v.* scheme but adapted to local conditions and for compatibility with the Tidy Britain Group's approach. The programme is in its early stages but, based on the findings of its volunteer-based survey, aims to target the prime causes of litter, and to tackle them through input to the education system and by seeking ownership by industry and local authorities.
Organisation	Tidy Britain Group and the Environment Agency	
Type	Survey/education	
Initiative	Regional Sewage Debris Survey	Anglian Water's Regional Sewage Debris Survey has been conducted since 1992 to counter the perception of its customers that faecal and noxious material is problematic, and that beach debris almost exclusively originates from sewage works and overflows. The study is also intended to demonstrate the environmental benefits of the company's £266 million investment in coastal and estuarine sewage discharges to meet the EU Bathing Water Directive, to highlight possible areas where future investment should be targeted and the illustrate the principal sources of beach litter. Surveys were undertaken on 100 metre transects along beaches used by the public, and litter were categorised as either sewage or non-sewage, weathered or non-weathered. Sewage debris was further categorised as either cotton bud, panty liner, condom, wipe, or sewage-other.
Organisation	Anglian Water Ltd	
Type	Survey	
Initiative	Think Before you Flush	The campaign aims to raise public awareness of the issues associated with flushing bathroom and sanitary waste in Scotland. It encourages people to bag and bin such waste. It incorporates beach cleans and school visits where children take part in the toilet trail and the bog monster competitions. The campaign is run by the only publicly owned water and waste authority in Great Britain.
Organisation	Scottish Water	
Type	Education and Public Awareness	

Initiative	Town & Country Care Scheme (TCCS)	The Town & Country Care Scheme (TCCS) was developed in recognition of obligations towards tourism and environmental care. Beach Care is an integral part of TCCS and attempts to tackle litter abatement through education. In addition a basic monitoring of the amount, types and distribution of shoreline litter has been carried out along the North Coast. An attempt at measuring the extent and type of plastic shoreline litter on all accessible stretches of coastline and estuary within the council area was carried out by 150 students and teachers from 9 local secondary schools in 1990/91. It was concluded that measuring litter by weight can be misleading and sorting litter can be useful in identifying the main sources of pollution (J. Allen, Coleraine Borough Council, *personal communication*).
Organisation	Coleraine Borough Council, Northern Ireland	
Type	Clean up/Survey	
Surveys and Initiatives – International		
Initiative	Arc Manche	Arc Manche: a collection of Local authorities from along the Kent and Dorset coasts has collaborated with their French counterparts on the coast of Northern France to form Arc Manche. Two projects have been agreed to look into the costs and benefits to Local authorities of environmental protection and enhancement particularly with regard to marine litter. As yet no funding has been agreed.
Organisation	Local Authorities along Kent & Dorset coasts plus French counterparts	
Type	Research	
Initiative	Coastwatch Europe	In existence since 1987, this Europe-wide initiative aims to gather a large amount of baseline data in a form which is comparable between countries, regions and years; to provide an insight into the major problems and threats to the coastline; to raise public awareness of the conditions of the coastal zone; and to aid environmental education.
Organisation	University of Dublin	
Type	Survey	
Initiative	International Coastal Clean Up Initiative	For over 10 years CMC has co-ordinated an annual beach clean and survey every September in over 80 countries. Volunteers collect and itemise litter on measured stretches of coastline. The survey results are published and indications of source given. The UK's input to this world-wide initiative is co-ordinated by MCS through Beachwatch (see above for details)
Organisation	Center for Marine Conservation (CMC), USA	
Type	Survey	
Initiative	Marine Litter Monitoring Project	A sub-group of the OSPAR Impact Working Group is developing a marine litter monitoring programme to be undertaken in the Northeast Atlantic States. The programme aims to develop a methodology for monitoring quantities and sources of litter.
Organisation	OSPAR	
Type	Survey	
Initiative	Research	Kommunenes Internasjonale Miljøorganisasjon (KIMO): the local authorities international environmental organisation, launched in 1990. It comprises Local authorities in Scotland, England, Wales, Ireland, Norway, Sweden Denmark, Faroes, Netherlands and Germany with a mutual concern about the increasing levels of pollution in the northern seas. KIMO has initiated a research project to develop a methodology to work out the full costs to Local Authorities (direct and hidden) of dealing with marine litter. Entitled "Economic and social impacts of marine debris and oil on coastal communities" the work was carried out in collaboration with Napier University and was published in June 2000.
Organisation	Kommunenes Internasjonale Miljøorganisasjon (KIMO	
Type	Published Report	
Initiative	SPCC Beach Pollution Index	SPCC Beach Pollution Index (The New South Wales State Pollution Control Commission) has designed a BPI (Beach Pollution Index) to give users of Sydney beaches an indication of the pollution levels occurring on a daily basis (Achuthan *et al*, 1985). The index was based on several indicators including the number of pieces of material of sewage origin, quantities of grease, turbidity and sewage odours - semi-quantitatively. Was intended to be an instantaneous alternative to microbiological analyses to avoid lag.
Organisation	New South Wales State Pollution Control Commission	
Type	Survey	

Strengths and Compatibility

Although it is not the principal aim of this task team to offer a critique of the survey methods themselves, from considering the schemes in operation it was readily apparent that the many existing litter survey schemes operate to different objectives, and that these objectives are often poorly defined. Avoiding reference to any particular scheme, the task team conclude that:

- The objectives of any litter survey should be clearly defined to ensure that the method is appropriate to the purpose.

- Before developing or revising a survey scheme to support a new need, scheme operators should take account of other existing schemes, which may already provide data adequate to their needs.

- There is considerable scope for compatibility between existing survey methods. This will better harness the limited surveyor resource - both specialist and volunteer - and enable data sharing and interpretation between survey groups.

- Quality Assurance/Quality Control (QA/QC) is a vital component of any survey scheme. This is effected by efficient design of the survey method, training for surveyors, and verification of survey results (for example, by repeat surveys, through expert identification of collected litter items, etc).

- Different level of QA/QC will be appropriate to different needs. Whereas the use of specialists is important when assessing the success of major pollution control investment, volunteer-gathered data is adequate for providing information on the general trends in litter over time and space.

Appendix B: List of Consultees

Members of Marine Pollution Monitoring Management Group (MPMMG)	
Dr P Bird	Environment Agency
Dr D Connor	JNCC
Dr R Emmerson	DEFRA
Dr A Ferguson	Environment Agency
Mr A Franklin	CEFAS
Mr P Gilmour	Scottish Executive
Mr W Halcrow	SEPA
Mr P Holmes	SEPA
Mr J Maslin	DTI
Dr L Murray	CEFAS
Mr A Osborne	DEFRA
Dr J E Portmann	Independent Consultant
Dr H J Prosser	National Assembly for Wales
Dr R J Ramsay	Environment and Heritage Service
Dr P C Reid	SAHFOS
Dr M Service	DARD Northern Ireland
Mr J Roberts	DEFRA
Dr M Waldock (Chairman)	CEFAS
Dr D Wells	Marine Laboratory Aberdeen
Claire Vincent	Environment & Heritage Service Northern Ireland
Members of the National Aquatic Litter Group	
Dr Georgina Burney	DEFRA
Jane Bickerstaffe	INCPEN
Henning Brathaug	International Maritime Organisation
Greg Brina	Environment Agency
Andrew Coombe	WaterWatch
Gill Davies	Environment Agency
Trevor Dixon	Tidy Britain Group
David Dixon-Smith	Blackpool Borough Council
Dr AJ Downie	Scottish Natural Heritage
Bob Earll	CMS
Mark Everard	The Natural Step UK
John Galvin	Environment Agency
Trevor Gibson	Peterborough City Council
Clive Gilbert	Kent County Council
Neil Hailey	English Nature
Peter Hampson	British Resorts Association
Julie Hesketh	Water Services Association
Nick Hibbett	Carrick District Council
Peter Holmes	SEPA
David Jowett	Environment Agency

David Limpenny	CEFAS Burnham Laboratory
Mark Lloyd	Tidy Britain Group
Norman Lowe	NALG Chairman
Willie McCurdy	DANI-AESD
Robin McInnes	Coastal Manager
Rick Nickerson	KIMO, Shetland Islands Council
Sam Fanshawe	Marine Conservation Society
Fergal Quinn	British Marine Industry Federation
Kathy Pond	Robins Institute
Gareth Rees	Farnborough College of Science & Technology
Derek Saward	SEERAD
John Skidmore	Wakefield Metropolitan District Council
Sarah Soffe	Countryside Council Wales
Nigel Tansley Thomas	Tidy Britain Group
Peter Toombes	LGA
Simon Turner	Plymouth City Council
Sharon Wort	MCA
Kathy Velander	Napier University
Richard Walmsley	Environment Agency
Mike Warner	ABP Research & Consultancy Ltd
Simon Weatherley	Anglian Water
David Whitehead	British Ports Association
Allan Williams	Faculty of Applied Sciences, Bath Spa University
Alan Woods	Tidy Britain Group
Other Experts and Interested Parties	
Celia Anderson	DTI
Michael Ashley	Association of District Councils
Alan Barnden	Environment Agency
Jo Belchamber/Nic Butler	East Devon Heritage Coast Service
Teresa Bowden	Environment Agency
Teresa Brown	Environment Agency
Dr Alastair Burn	English Nature
Mr Simon Coates	DTLR
Andy Davies	ICEMEG
Dr Gillian Davies	Environment Agency
Richard Edmonds	Charmouth Heritage Coast Centre
Dr Eric Edwards, OBE	The Shellfish Association of Great Britain
Mr Neil Edwards	Research and Engineering - National Power plc
Mr Sverker Evans	Swedish Environmental Protection Agency
Dr Julie K Everard	Environment Agency
Martin Gavet	States Board of Administration
Ryland Jones	Keep Wales Tidy Campaign
Graham Hayes	Scottish Natural Heritage
Dr Harold W D Hughes, OBE	UK Offshore Operators Association Limited
Mr Alan Inder	Planning Office Hampshire County Council

Paul José	Royal Society for the Protection of Birds
Mr Bill Lart	Sea Fish Industry Authority
Roger Lilley	Friends of the Earth
Dr Dave Limpenny	CEFAS Fisheries Laboratory
Mr Craig McGarvey	Environment Agency
Dr Charlie Pattinson	Environment Agency
Morris Portsmouth	Environment Agency
Dr Siân Pullen	World Wide Fund for Nature WWF(UK)
Julian Quail	Defence Environment Policy
Mr Glenn Quelch	National Federation of Fishermen's Organisations
Graham Rabbitts	Associated British Ports Holdings Group plc
Mr P D Rees	ICI Chemicals and Polymers Limited
Mr J D Rodger	Chemical Industries Association
Dr Stuart Rogers	CEFAS
Helen M^{c}Lachlan / Laila Sadler	RSPCA Headquarters
The General Secretary	ICES
Björn Stahre	BOSAM
Colin Taylor	Nuclear Electric Ltd
Dr Ted Thairs	Water UK
Roger Vallance	Environment Agency
Tim Watson	Amoco (UK) Amoco House
Mr C Wheatley	Naval Support Command
Mr Gareth Withers	Avon County Council Planning Department
D Williams	National Trust