

Impacts of Marine Debris and Oil

Economic & Social Costs to Coastal Communities



Karen Hall



Impacts of Marine Debris and Oil: Economic and Social Costs to Coastal Communities

The problem of marine litter and oil deposited on coasts is a common problem for coastal local communities and other organisations throughout the world. A wide range of studies and surveys employing many different methodologies have been undertaken over the years to assess the problem. These have attempted to address the problems of collecting data on the volumes, types, origin and other factors relating to marine litter and oil. There is much less research and data available about the economic and social impacts of these substances. The purpose of the project was to undertake a pilot study to investigate the cost of marine debris and oil to coastal communities and organisations. Examples include: death or injury of commercial marine life, interference with maritime traffic by damage to ships propulsion, and the costs of cleaning, collection and disposal of marine debris and oil. The project undertook to look at these and other factors and to produce a report which would attempt to identify the financial and social cost of the problem.

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FOREWORD

The practice of sealing a message in a bottle, or other type of container, and casting it into the sea in the hope that someone will find it has a long history. Over the years a surprising number of messages have been conveyed in this way. A message barrel released by Admiral Melville near Cape Barrow in Alaska in September 1899 was eventually recovered on the north coast of Iceland 6 years later, travelling approximately 4,000 km in 2,092 days. Eastward journey times for bottle messages launched in the coastal waters of New York, and later recovered on the coasts of France and the Iberian Peninsula, were on average only 550 days.

The documented movements of bottle messages, and other human artefacts, contributed greatly to our knowledge of ocean currents. However, the movements also provided a timely warning of the likely consequences of uncontrolled discharges of certain types of human wastes to the marine environment. In the early 1970's the flux of litter to the world's oceans was estimated at 6.4 million tonnes per annum. By the end of the 1980's plastics litter was identified as a possible new addition to the primary list of marine pollutants, and one of six areas of immediate concern for the marine environment on a global scale. Plastics are now the most common man-made items sighted at sea and on beaches in all geographical areas.

In seeking effective preventive and control management strategies to address the marine litter issue, policy makers and marine managers have recognised the importance of high quality research. The author's findings have made a significant contribution in this respect because we now have a more complete understanding of the "true economic costs" of the effects of marine litter. These include costs incurred in periodic or systematic beach cleaning operations and subsequent disposal of wastes to landfill on a north-west European

scale. Data have also been provided on recovery and disposal of floating and submerged items of litter or refuse in ports and harbours. Incidents involving propeller entanglements and similar damage sustained by vessels have also been examined.

The research findings also provide additional evidence of the economic and environmental benefits to be gained from improved control, reduction and minimisation of vessel and land-sources of marine litter. In the United Kingdom The Department of the Environment, Transport and The Regions has adopted a three-fold strategy to reduce pollution from all types of shipping. This consists of making controls more effective through improving regulations and their enforcement, improving the facilities for the legal disposal of waste in ports and increasing the penalties for illegal discharge.

Moreover, the recently revised Code of Practice on Litter and Refuse defines standards of cleanliness in different types of location, including beaches. It also offers practical advice and information on good practice methods and steps which might be taken to strengthen public commitment to cleanliness.

Trevor Dixon, The Tidy Britain Group
16 June 1999.



Executive Summary

Despite international legislation outlawing littering or dumping both on land and at sea, beaches are still getting covered by debris. Marine debris affects all local authorities throughout the study area to varying degrees. Due to resource shortages, priority for local authority funds may not be given to cleaning beaches and in some areas little or no cleaning is carried out.

The study received responses from 56 Local Authorities in the UK, 4 Kommunes in Denmark, 3 Kommunes in Sweden and 1 Kommune in Norway which all stated that they cleaned areas of the coastline. Local Authorities throughout the project area agreed that beach cleaning was generally done to gain and keep Beach Awards and to promote coastal tourism.

Over half of the beaches cleaned in the UK are sandy and used by large numbers of people. All of the beaches cleaned by the Danish Kommunes are sandy and also well used by the general public. In contrast, the areas of the coast cleaned in Sweden and Norway are predominantly rocky but nevertheless used by high numbers of visitors. All of the Local Authorities reported that most of their beach cleaning was done during the summer months to coincide with the tourist season.

Although there are over 150 reported incidences of small oil spillages in the UK, only 49 responding Local Authorities have an oil spill contingency plan. On the West coast of Sweden the removal of marine debris is made more difficult as a lot of it may be heavily contaminated in oil.

The total cost reported by Local Authorities throughout the study area for beach cleaning is

£2,913,795 and is divided between countries as shown.

Scotland	£ 496,400
England	£1,306,419
Wales	£ 150,419
Channel Isles	£ 248,100
Ireland	£ 129,800
Denmark	£ 144,500
Germany	£ 17,500
Norway	£ 1,100
Sweden	£ 419,976

Despite the concerns from Local Authorities and other organisations that marine debris damages the tourist industry, coastal tourism remains a profitable business in many areas.

The UK Tourist Boards responding to this survey reported that over 34.3 million people were specifically visiting the coast each year. An estimated £1.4 billion is spent by these visitors each year visiting coastal attractions. In comparison with the high numbers of tourists visiting the coast each year, the number of complaints about the state of the beach received by tourist boards remains low, with less than 200 being reported annually. These complaints are generally about dog fouling, sewage or broken glass. Tourist Boards also stated that they received few reports of actual injuries occurring on the beach or due to marine debris.

UK Health Authorities also reported few occurrences of injuries due to marine debris. However they stated that it was very difficult to identify from records if injuries happened at the coast or if marine debris was the cause of this. They also reported that many minor injuries may be self treated.

The fishing industry has long been associated with being a main contributor of marine pollution but little work has been done on the effects of marine debris and other pollution on the industry. Shetland fishermen were questioned about the effects of marine debris on their fishing activities. They responded that 92% had recurring problems with accumulated debris in nets, 69% had had their catch contaminated by debris and that 92% had snagged their nets on debris on the seabed. Many also experienced fouled propellers and blocked intake pipes.

On average 1-2 hours per week is spent clearing debris from nets. The debris could cause a restricted catch and many boats avoided particular fishing areas altogether due to the high concentrations of debris. The catch, net and other equipment could be contaminated by oil containers, paint tins, oil filters and other chemicals. This may cost up to £2,000 in lost revenue each time. Large items such as wires and old nets may be collected off the seabed and may damage the nets. A fouled propeller could cost up to £300 for the hire of a diver to disentangle it. A substantial amount of fishing time could also be lost.

It is estimated that each boat could lose between £6,000 and £30,000 per year due to the effects and presence of marine debris. If 50% of the Shetland fishing fleet was affected in the same way, the cost to the local industry could be

between £492,000 and £2,460,000. The cost of marine debris to the fishing community of the Bohus region of Sweden was estimated to be over £620,000 each year.

According to reports from fishermen in both Shetland and Esbjerg, small inshore boats appear to be more susceptible to marine debris than large pelagic boats. This may be because the larger offshore boats are fishing mid-water and are therefore less likely to collect debris on or near the sea bed. Smaller boats may also notice the presence of marine debris more than larger boats as they have less crew and a lower profit margin, so any time or money lost will affect them more.

In comparison with the commercial fishing industry, salmon farmers in Shetland were not affected as much by marine debris. On average one hour per month was spent removing debris from in or beside the cages. The main problem was that of propeller fouling and blocked intake pipes. The costs of hiring a diver to disentangle a propeller are similar to those reported by the fishermen. The salmon farmers also stated that it could cost up to £1,200 to repair or replace a damaged propeller.

Harbour Authorities throughout the UK reported over 180 incidences of propeller foulings during 1998. The cost of hiring a diver was between £100-£400. In some cases, the vessel was required to be lifted out by crane to remove the fouled material. Fouled anchors were also known to have delayed vessels and in some cases, caused safety concerns during bad weather. Additional dredging or removal of items from the seabed was also undertaken by some Harbour Authorities. The removal of floating debris may cost a Harbour Authority up to

£15,000 per year. Discarded fish boxes were a problem in many harbours.

Marina managers reported high numbers of propeller foulings among recreational vessels particularly during the summer months. Some marinas reported better waste management practice by boat owners resulting in reduced marina cleaning for their staff.

In 1998, the RNLI attended over 200 incidents to vessels with a fouled propeller. The rescues were divided equally between fishing vessels and pleasure craft. As noticed by the marina managers, the RNLI data confirmed that there are more incidences of recreational boats becoming fouled in the summer months. It is estimated that the cost to the RNLI to undertake these rescues is on average £900,000 each year.

In many exposed coastal areas and, in particular island areas, marine debris may be blown from the shore onto neighbouring farm land. For example, in Shetland, 96% of responding crofters had experienced problems with debris blowing onto their land. They may spend up to 3 hours per month removing debris from their fields. Debris may also collect on fences causing damage to them, and in drainage ditches. Up to five animals per croft may become entangled in marine debris each year. It is estimated that marine debris may cost affected crofters £400 each year in Shetland.

Power stations reported having to clean their water intake screens more often due to accumulations of marine debris. The amount of debris removed from the screens varies between 100-10,000 tonnes depending on location each year. This may cost the company up to £50,000

Areas affected in Shetland	Cost per Year
Beach cleaning budget (Local Authority)	£10,000
Da Voar Redd Up*	£5,000
Voluntary labour and transport costs	£45,000
Power station costs	£1,000
Harbour clean-up	£1,000
Salmon farmers	£51,840
Crofters	£600,000
Fishing Industry	£4,920,000
Lifeboat launching costs	£29,000
TOTAL	£5,662,840

* 'Da Voar Redd Up' is an annual voluntary clean up of Shetland. It includes removal of debris from beaches, roadsides and other public areas and is undertaken by various community groups

to remove the debris with additional costs for pump maintenance.

In conclusion, this research demonstrates that marine debris and oil affects a larger sector of coastal communities than previously thought. For example, if we assume that every farmer, salmon farmer and fishermen is affected by marine debris by the worst degree the cost to the Shetland community could be substantial. (see previous page).

In reality, as not everyone is affected equally by marine debris, if at all, the realistic figure would be closer to £1 million. This represents a fraction of the European coastline. If this approximation was extended to cover coastal communities throughout the study area the costs could run into billions.

This study illustrates that MARPOL and other pollution legislation is not reducing the amount of debris appearing on our shores. Currently the existing legislation proves difficult to enforce and there are no incentives for polluters to improve their waste management practices. A key problem highlighted by this project is the apparent apathy society has towards marine debris in general. Both the fishing industry and the agricultural industry have stated that they

have always had to 'put up with the problem of marine debris' and just accept that they will have to remove debris from their fields or nets. Tourists seem more concerned about dog fouling than plastics on the beach. Only when marine debris actually starts to cost individuals money does the level of concern grow. For example, a fisherman who has lost all his catch due to contamination is less likely to throw oil filters overboard as he has experienced a loss.

This study recommends that existing legislation be strengthened to discourage pollution offences; that education about the effects of marine debris is introduced to all relevant marine courses; and that there is an investigation into other ways to fund beach clean ups. The key to solving the marine debris issue is to reduce the amount of packaging and other plastics that are entering the sea from ships and other vessels. This report recommends that vessel operators and crews reduce the amount of unnecessary packaging taken to sea and improve their waste management practices at sea. The costs of marine debris should be publicised to persuade maritime users and governments to reduce dumping at sea.

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(unless otherwise stated, all photographs taken by the author © KIMO)

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Aim

Over the past decade, public awareness of coastal and marine debris has increased dramatically. The main reasons for this are:

- Legislation on bathing water quality and waste water treatment
- Blue Flags, best beach guides and the like have influenced users' choices as to where to bathe etc. have informed and empowered the public choice
- Increasing campaigns by pressure groups have kept the subject in the public eye
- An increase in recreational maritime activities has drawn the attention of more people to the quality of local coasts and sea
- An increase in contamination stories – whether it be cancerous fish, oiled seabirds, dying seals, washed up munitions or debris on beaches – has demonstrated that, despite Government legislation, the problem of marine pollution is a growing one.

Awareness is being increasingly translated into action. There has been an increase in the number of local coastal and estuarine networks, marine nature reserves, shoreline management plans, the setting up of national coastal forums and pressure groups such as the Marine Conservation Society (UK) and Surfers Against Sewage (UK) have focused attention on the issue of clean coasts and seas.

The problem of marine litter and oil deposited on coasts is a common problem for coastal local communities and other organisations throughout the world. A wide range of studies and surveys employing many different methodologies have been undertaken over the years to assess the problem. These have attempted to address the problems of collecting data on the volumes, types, origin and other factors relating to marine litter and oil. There is much less research and data available about the economic and social impacts of these substances. Although data is collected by local authorities on the physical clean up costs, there has been little research undertaken on collecting this data around Northern Seas. Little information is available on the costs to industry, tourism, fishing, agriculture, emergency services and other sectors of the community.

The purpose of the project was to undertake a pilot study to investigate the cost of marine debris and oil to coastal communities and organisations. Examples include: death or injury of commercial marine life, interference with maritime traffic by damage to ships' propulsion, and the costs of cleaning, collection and disposal of marine debris and oil. Indirect costs include aesthetic degradation and the protection and prevention of pollution. The full environmental costs of disposal are not known.

The project undertook to look at these and other factors and to produce a report which would attempt to identify the financial and social cost of the problem. This pilot project has developed methodologies to collect information and data that could be used as a model for other organisations in other areas of the EU.

1. Introduction

Human use of the oceans is extensive and varied. One of the by-products is ship-borne garbage. For centuries, vessel-generated garbage was discharged overboard - to do otherwise was to transport unnecessary weight and to invite the ever present vermin to prosper. Part of the problem, was the changing composition of garbage, which increasingly contained durable synthetic materials such as plastic packaging, cargo nets and synthetic fishing nets (Recht, 1998; Alig *et al.*, 1990).



Plate 1.1. Example of marine debris

Definition of marine debris

Marine litter has been defined as ‘solid materials of human origin that are discarded at sea or reach the sea through waterways or domestic and industrial outfalls’ (Nat. Acad. of Sci., 1975). Marine debris is a broader term and includes impacts that are not primarily aesthetic (Ribic *et al.*, 1992).

A broad definition of the generic term marine debris was adopted for the purposes of this study, as suggested by the Tidy Britain Group (1995):

- Garbage discharged to sea during the normal operations of ships or other sea-based activities, as defined by the International Maritime Organisation (IMO, 1988).
- Dumping at sea of solid wastes originating from land-based sources (Lentz, 1987).
- Sewage related debris (SRD) and other types of litter discharged to the marine environment directly through domestic outfalls and combined sewer outfalls (CSOs) or indirectly via rivers or other water courses.
- Litter from beach users, including anglers.
- Municipal or industrial solid wastes fly-tipped directly to sea, or indirectly via rivers and other watercourses.
- Municipal solid wastes lost to the marine environment from improperly managed coastal landfill sites (Dixon, 1990).

1.1 Types and Sources of Marine Debris

The direct and indirect costs of marine debris (including the costs of beach cleaning, lost tourism, damage to vessels, lost fishing time) can not be appraised without an assessment of the quantities and types of marine debris.

High concentrations of marine debris are found near shipping lanes (Vauk and Schrey, 1987), around fishing areas (Pruter, 1987) and in oceanic current convergence zones. The distance of a beach away from a population centre is one of the factors which control the quantity of litter (Gabrielides, 1991). For example, a high abundance of debris was found around Marseille, where 924 items were collected during a 30 minute tow (Galgani *et al.*, 1995).

The summary record of the October 1995 meeting in Stockholm of the Oslo and Paris Commission (OSPAR) for the Prevention of Marine Pollution Working Group on Impacts on the Marine Environment (IMPACT), noted that approximately 20,000 tonnes of waste are discarded into the North Sea each year.

Previous surveys, including Beachwatch and the International Coastal Cleanup, have identified four main sources of litter: recreational visitors to the coast, shipping, fishing and sewage outfalls. The proportion of litter on an individual beach that can be attributed to each of these sources varies according to local inputs, e.g. large tourist resorts, busy shipping lanes or fishing areas. Even beaches that are remote from any such inputs can be affected by large levels of litter carried by prevailing winds and currents.

1.1.1. Ocean-Based Sources

Ocean based sources of litter include: commercial shipping, fishing vessels, fish farming, cruise liners, military fleets, research vessels, passenger ferries, offshore oil and gas platforms and service vessels and recreational boats.

Due to the increased use of non-biodegradable products, such as plastics, larger quantities of waste are being washed up on shore where it is highly visible. Plastics are now used in the majority of fishing gear and make up a large percentage of ships' operational and galley wastes. Even in the most remote locations, accumulations of debris have been found that could only come from maritime sources (Ryan and Moloney, 1993).

Of 8,437 items (1,360 kg) found over a year (1983-84) on beaches in the German Bight, 75% consisted of plastic. 99.2% were identified as ships' waste. Most items were deposited during SE to SW winds (i.e. from the direction of the main shipping routes)(Vauk and Schrey, 1987). Horsman (1982) estimated that each crew member on a trading vessel generates and dumps 0.2 cardboard boxes; 0.3 plastic items; 0.2 bottles and 3.2 tins per day.

The loss of cargo at sea due to accidents and groundings can also add large quantities of waste to the seas. The MV Cita ran aground off the Isles of Scilly in March 1997 with the loss of containers carrying clothes, toys, batteries, polythene bags and plastic film. Much of the plastic film and bags was spread around the islands and smothered marine life on the seafloor. The Green Lily ran aground off Bressay, Shetland during severe gales in November 1997. The costs of removing large quantities of plastic amounted to £25,000 with an additional £25,000 spent removing hatch covers etc.

Despite national and international legislation prohibiting the dumping of plastic at sea since 1973 (see MARPOL 73/78), large quantities of operational and galley wastes are still dumped at sea instead of being discharged to shore reception facilities. Discarded fishing gear, also represents a major source of debris on many beaches especially in areas where commercial fishing is intensive (Jones, 1995; Walker *et al.*, 1997; Johnson, 1994).

1.1.2. Land-Based Sources

Litter may be carried out to sea or deposited on beaches from inland sources via drains, rivers and storm water systems. Coastal sources also include recreational beach users, flytipping, agriculture, local businesses and unprotected waste disposal sites. Despite laws in some countries prohibiting the dropping of litter in a public place (for example, see Environmental Protection Act 1990 (UK), Section 7.3), recreational beach users are responsible for a large proportion of beach litter. However, it is sometimes difficult to distinguish between debris left by beach users and that from boats or waterways.

1.1.3. Sewage-Related Debris

Sewage-related debris (SRD), consists of debris that has entered the marine environment via sewage outfalls and includes cotton buds, tampons, condoms and faeces. SRD represented over 7% of all items recorded in Beachwatch Surveys carried out from 1994-1996 (Beachwatch, 1998). Around 25% of all coastal outfalls in the UK do not even have preliminary treatment (screens to remove the larger items), in contrast with Denmark which has no untreated discharges (Beachwatch, 1998).

1.1.4. Plastics

Until recently the problem of plastic debris in the oceans was generally considered minor compared with other pollution issues (e.g. heavy metals, oil). As plastic floats, discarded plastic

items are a highly visible and over represented constituent of beach litter (Pruter, 1987). It is estimated that disposal of discarded plastic involves 140,000 tonnes entering the waste stream each year in the UK, of which as little as 3% ends up as litter (Min. for Env., 1987).

Plastics cause concern because of their widespread use and intrinsic properties. They have lower specific gravity than sea water which causes them to float and are not biodegradable and only slowly photo-degradable. Plastics are made of long chains of hydrocarbons that are so tightly bound that micro organisms with the ability to break down paper, for example, cannot penetrate them. The slow breakdown of plastics results in the formation of smaller fragments and fibres. A study of the quantities of microscopic plastic fibres in sand samples from Northumberland beaches (UK) showed that all contained fibres, some with more than 10,000 fibres per litre of sand (Thompson and Hoare, 1997).

Plastics have been shown to be the predominant type of litter found in the marine environment. For example on the Mediterranean coastline (Gabrielides *et al.*, 1991) the North Sea (Dixon and Dixon, 1983), the North Atlantic (60%) (Colton *et al.*, 1974), beaches in North France and Denmark (44%) (Dixon and Dixon, 1981). This prevalence coincides with a dramatic increase in the production of plastic. Total plastic production in the US increased from 2.9 million tons in 1960 to 47.9 million tons in 1985 (Robards *et al.*, 1997).

Sea bed trawls have reported increased amounts of plastic waste. In 1997, a trawl across the floor of the Mediterranean between France and Corsica collected over 300 million pieces of plastic rubbish from depths of up to 2,550m (Anon, 1997).

The United Nations Environmental Programme (1990) estimates that an aluminium drinks can may persist for 200-500 years in the marine



Plate 1.2. Plastic containers and other debris washed up on a beach in Sotenäs, Sweden

environment, a plastic bottle for 450 years and a bus ticket for 2-4 weeks. These studies take no account of the harsh mechanical environment of the sea and may be regarded as worst case estimates.

1.1.5. Pathways of Marine Debris

Once in the sea, the pathways through which litter items circulate can be dependent upon the influence of the wind, tide and current. It is well known that material floating at the surface is primarily influenced by wind and only secondarily by currents (Neumann, 1966).

According to results of a study carried out in Panama, the time frames for the movements of plastics into and out of beach areas appear to be in the order of months or a year (Garrity and Levings, 1993). The resident time of marked items on beaches appeared to be about a year. Beaches that were cleared completely accumulated about 50% of the original plastic in 3 months and 61% in 6 months. However the persistence of debris on beaches of Padre Island (Texas), appears to be days, judging by daily collections and observations of marked debris (Miller, 1993).

Ocean Drift

Extensive oceanic drift has been demonstrated by the occurrence of coded and dated multi-coloured plastic bracelets from Canadian lobster fisheries which have been recorded on the coasts of Ireland, Western Scotland and even the Eastern coasts of Shetland. In 1990, approximately 80,000 athletic shoes in containers were lost overboard in a storm in the North Pacific; at least 1,300 shoes were transported more than 2,000 km in 7-9 months (Ebbesmeyer and Ingraham, 1992; Swanson *et al.*, 1994). Fish boxes from UK ports regularly end up on the Swedish West Coast along with other traceable debris from Britain.

Sinks

Litter sinks include beaches and offshore deposits of material, generally on the seabed (Williams *et al.*, 1993); these sinks may or may

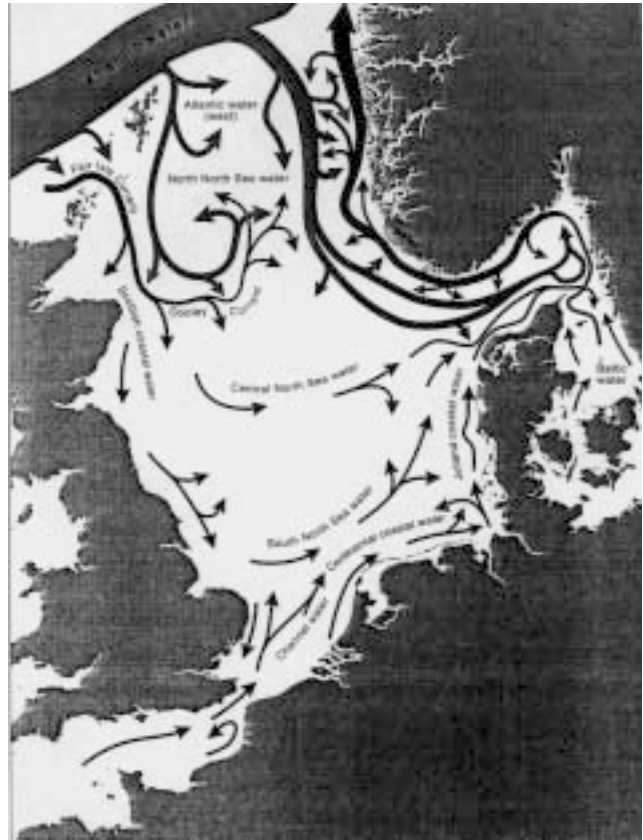


Figure 1.1. Schematic diagram of general circulation in the North Sea. The width of the arrows is indicative of the magnitude of volume transport. Source: after Turrell *et al.* (1992)

not be permanent. Consequently beach clearance operations such as the removal of litter at a temporary sink may, in the long term be ineffective.

1.2. Impacts of Marine Debris

The presence of marine debris on beaches and in the water has a wide range of impacts on a number of interests. Damage to wildlife, marine ecosystems, the aesthetic quality of beaches, recreational and fishing interests and risks to health and property are all part of the price that is paid for the irresponsible and accidental disposal of debris.

1.2.1. Impacts on Wildlife

The full impact of marine debris on marine species is difficult to assess because of limited research in this area and the fact that sampling is largely restricted to land-based observations. Marine debris can directly harm wildlife because



*Plate 1.3. Bird entangled in 6 pack holder
(photo: Shetland Amenity Trust)*

of entanglement, ingestion, smothering and toxicity. It is estimated that over one million birds and 100,000 marine mammals and sea turtles die each year from entanglement in, or ingestion of, plastics (Laist, 1997).

Entanglement

Fishing nets, fishing line, plastic bags, strapping bands and 6-pack carriers are the most common cause of entanglement, reducing movement and potentially resulting in serious injury and death by starvation, drowning or suffocation. At least 135 species of marine vertebrates and 8 species of marine invertebrate have been reported entangled in marine litter (Laist, 1997).

The impact of entangling marine debris can be divided into 4 main categories:

- Large debris items which trap animals may result in the drowning of air breathing species, asphyxiation of fish species that require constant movement for respiration or death by starvation or predation whilst trapped.
- Smaller debris items greatly increase the drag coefficient of animals in water, which increases the energy needed for movement and may affect the ability to forage and avoid predators. This generally results in death within months, from either starvation or predation, unless the individual can escape the entangling item.

- Small debris items become snagged on the sea floor, trapping fish and crustaceans or, on land, entangling seabirds and seals.
- Debris items become tightly bound around the organism, restricting growth or cutting off circulation to appendages.

This an emotive issue and has, for example, been used to discourage littering in the Maritime and Coastguard Agency's anti-litter campaign, 'Sea Sense' in the UK.

Ingestion

A total of 177 marine species have been reported to ingest litter items and 111 of the world's 312 species of seabird are known accidentally to eat plastic (Laist, 1997).

The impacts of ingested debris can be divided into four main categories:

- Physical damage to the digestive tract, which can lead to infections, starvation and occasionally, death.
- Mechanical blockage of the passage of food which leads to starvation and death unless the blockage is cleared.
- Impaired foraging efficiency resulting from a false sense of satiation from impaired digestive functioning.
- Release of toxic pollutants from within the debris or from the absorption of contaminant adhering to the surface of the ingested debris (3rd International Conference on Marine Debris, 1994).

1.2.2. Effect on Ecosystems

Only a few surveys have estimated the distribution and abundance of debris on the seafloor. Information detailing the impacts of debris on benthic ecosystems is sparse, but smothering of benthic and beach faunas affects natural systems at the species and possibly ecosystem level (Laist, 1997).

Smothering

Sheets of plastic on the sea floor may prevent oxygen and light reaching benthic organisms. If marine debris continues to accumulate, it could affect many productive areas on the seabed. Similar smothering can occur along coastlines as debris becomes buried and may harm organisms living beneath the beach surface. Abrasion of debris against hard substratum may also cause damage (Laist, 1997). This smothering may also affect the viability of spawning grounds (Nilsson, 1998, pers comm.). Debris may also smother benthic communities on soft and hard bottoms (Parker, 1990).

Toxicity

The accumulation of microscopic plastic fibres in sand substrates (Thompson and Hoare, 1997) may leach out toxins such as polychlorinated biphenyls and heavy metals. These can be absorbed by microalgae, which are important food sources for many marine creatures and may be bioaccumulated. The suspension of these fibres in the water column could also potentially clog the feeding apparatus of small invertebrates.

Transport of Species

Floating items of debris, including seaweed and litter items, in midwater may provide shelter and food for small fish and migrating animals as well as a method of transport for colonisation. Biologically encrusted plastic debris items have already been found at sites ranging from the sub-Antarctic to the Equator (Gregory *et al.*, 1984; Gregory 1990). A study of the stalked barnacle *Dosimia Fascicularis*, on Irish North Atlantic shores, found that tar pellets <25mm diameter and angular plastic fragments were the main attachment materials, representing 88% of substrata over the period 1986 to 1988 (Minchin, 1996). A number of studies have shown that insects, snails and plants can survive transport for example, on rafts of vegetation or logs

(Haetwole and Levins, 1972). Such transport of species can affect whole ecosystems of some oceanic islands, if alien species carried to the island have a detrimental effect on native species (Laist, 1997).

Beach Cleaning

A further indirect impact of litter on the coastal environment is the ecological impact of mechanical cleaning of beaches carried out by local authorities to keep popular beaches free of litter throughout the summer season. The use of mechanical beach cleaners may threaten the stability of some beaches, through the removal of organic matter which forms glue-holding sand grains together. Such equipment may also disrupt food chains through the removal of important components of the beach fauna (Llewelyn, 1998).



Plate 1.4. Mechanical beach cleaner

1.2.3. Impact on Communities

Apart from the environmental harm attributed to garbage discarded from vessels, numerous accounts have reported direct damage to humans (Debenham and Younger, 1991; Hodge and Glen, 1993) and described the loss of the aesthetic and recreational value of beaches accumulating substantial amounts of debris (Roehl and Ditton, 1993). Most studies have focused on the impacts of marine debris on the tourism and fisheries sectors whilst no known work has been done in other areas.

Tourism

Tourism is now one of the world's top three economic activities, accounting for an estimated 10-12 percent of the world GNP and, directly or indirectly, at least 200 million jobs world-wide (Tapper, 1997). A large proportion of tourism is concentrated in coastal regions, and caters for the demand for 'sun, sea and sand' vacations. For example, the Mediterranean region accounts for around a third of all tourism world wide, while nearly another quarter of tourism is to the Asia-Pacific region where it is mainly based on coastal resorts. The consequence of this is that tourism activities have significant impacts on the marine environment while at the same time, it is often the quality of the marine environment that attracts tourists to such destinations in the first place. Environmental damage due to pollution has high costs for the environment and human health, as well as for tourism development. Clean-up costs and efforts are often too expensive and ineffective, compared with action

to prevent damage in the first place. Although certain categories of litter may actually be hazardous or represent a health risk, more significant is the fact that much current media reporting tends to link beach litter in the minds of public with the wider issues of bathing water quality and sewage disposal. This can create in certain areas a general perception of 'dirty beaches' which is difficult to dislodge.

Fishing Interests

Most studies enumerate only such problems as propeller entanglements and damage to cooling systems, while other problems such as gear fouling are rarely mentioned. A few studies have reviewed the economic cost of such incidents as propeller entanglement (Takehama, 1990). Yet knowing the cost of marine debris to fishing operations might give a better incentive to various industries and governments to correct the problem than would the knowledge of damage to wildlife or the soiling of beaches.

2. Legislation and Beach Awards

Early international efforts to control disposal of vessel garbage and oil consisted of the International Convention for the Prevention of Pollution from Ships (1973) and its 1978 Protocol known collectively as MARPOL 73/78. The Convention was developed under the auspices of the International Maritime Organisation (IMO), a specialised multilateral UN Agency, that serves as the principal global forum for negotiated treaties and convening diplomatic conferences related to maritime safety and pollution control.

2.1. MARPOL 73/78

MARPOL currently includes five Annexes each addressing the control of a different type of pollutant.

- Annex I Oil
- II Noxious Liquid Substances
- III Packaged Goods
- IV Sewage
- V Garbage

All parties to MARPOL must adhere to Annex I and II but have the option of ratifying the other annexes. Annex V addresses solid waste generated during normal vessel operations at sea, on fixed/floating platforms and in port, as well as the solid waste generated by economic activities such as fishing and oil and gas production. Annex V (MARPOL) restricts discharge of garbage etc except for safety, due to damage of ship or accidental loss of nets. In addition, the North Sea became an effective Special Area for the purpose of MARPOL Annex V on the 18th February 1991. Consequently, the disposal of all plastics and all other garbage is prohibited in this area.

By 31st January 1998, 104 parties or 93% of the world's shipping tonnage, ratified MARPOL. Of these, 87 Parties, 82% have ratified Annex V. The North Sea also became a Special Area for the purpose of Annex I as of 1st August 1999.

2.2. Convention on the Prevention of Marine Pollution by dumping of wastes and other matter - The London Dumping Convention 1972

The London Dumping Convention entered into force on 30 August 1975 on a global scale and prohibits under Annex I the dumping of plastics and other persistent synthetic materials, for example, netting and ropes at sea.

2.3. Convention for the Protection of the Marine Environment, North East Atlantic – OSPAR Convention

This convention was adopted at the Ministerial Meeting of the Oslo and Paris Commissions in September 1992. This replaces both the Oslo and Paris Conventions and will oblige Contracting Parties to apply both the precautionary and polluter pays principles and ensure that the programmes and measures they take are in accordance with the best available technology (BAT). The OSPAR Convention adopts the principles of the Oslo and Paris Conventions as shown below and came into force in March 1998.

Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft - The Oslo Convention

In Europe, a regional regime, the Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft, 1972 (Oslo Convention) entered into force in April 1974. The Convention regulates within the Northeast

Atlantic area, including the British Isles, dumping operations of industrial wastes, sewage sludge, dredged materials and other wastes disposed of at sea. It does so by prohibiting the dumping of certain categories of waste, which are dangerous to the marine environment because of their toxicity, persistence and bio-accumulation. Annex I to the Convention lists those substances, the dumping of which is prohibited, which includes persistent plastics that may float and seriously interfere with fishing and other legitimate users of the sea.

Convention for the Prevention of Marine pollution from Land-based sources –Paris Convention

The Convention for the Prevention of Marine Pollution from Land Based Sources, 1974, entered into force in May 1978 and regulates discharges to sea from rivers, directly from the coast, via pipelines, platforms and from the atmosphere.

2.4. EC Bathing Waters Directive (76/160/EEC)

The Bathing Waters Directive (76/160/EEC) has the objective of protecting the quality of identified bathing waters by specifying microbiological, physio-chemical and other characteristics to which they should conform (CEC, 1976). The Directive defines a bathing water as fresh or seawater where either bathing is explicitly authorised or bathing is not prohibited and is traditionally practised by a large number of bathers. A guideline or G value parameter in category 13 of the Directive's Annex requires an absence of tarry materials and floating materials, such as wood, plastic articles, bottles, containers of glass, plastic, rubber or any other substance. Member States should endeavour to observe G values as guidelines. In February 1994, the EC published proposals for revision of the Bathing Water Directive, which retain the current guide value for tarry residues etc, but also include a mandatory requirement that 'sewage solids' be absent

2.5. Amenity Beaches and Award Schemes

Following the introduction of the EC Bathing Waters Directive (5.3.1), amenity beaches have been designated throughout Europe. In the UK, the Environmental Protection Act (1990), Code of Practice for Litter and Refuse, states that:

“ Local Authorities should identify those beaches in their ownership or control which might reasonably be described as amenity beaches.” No explicit definition is however given, but the Code goes on to say: “Any assessment should take into account the level of use of the beach for recreational purposes.”

European Blue Flags for Beaches

The Blue Flag Campaign was introduced in 1987 by the Foundation of Environmental Education in Europe (FEEE) and is administered in the UK by the Tidy Britain Group. The beaches which passed the 'mandatory' water quality standards as defined in the EC Bathing Waters Directive were eligible, but in 1992 the criterion was changed to the higher 'guideline' water quality standard. In addition to water quality, beaches are currently judged on a further twenty-nine management criteria. Beaches which meet these criteria are likely to be major resorts.

European Blue Flag for Marinas

All licensed marinas are in principle eligible for a Blue Flag. A marina is described within the criteria as including pontoons or jetties for the mooring of pleasure craft. It should offer basic facilities such as toilets and be supervised by a local Harbour Master. In 1998, 1926 beaches and 571 marinas were awarded the Blue Flag. Nineteen countries participate (Belgium, Bulgaria, Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, The Netherlands, Portugal, Slovenia, Spain, Sweden, Turkey and the UK).

Seaside Awards (Yellow Flag)

With the introduction of the more stringent water quality criteria for the Blue Flag in 1992, many UK beaches no longer qualified for entry. Under

the Tidy Britain Group, a new award system was introduced, known as the Seaside Award which uses the lower mandatory water quality standards as its basic criterion for entry. The awards are separated into two separate categories: Rural and Resort.

Rural candidates must fulfil thirteen land-based criteria and Resorts twenty-nine. If, in addition to these criteria, the 'guideline' water quality standard has been achieved, a resort or rural beach may receive the Premier Seaside Award.

The chief drawback of award schemes for rural areas is their focus on the requirement for specific facilities and services. As they exist at present, it appears at first glance there is no appropriate incentive or measure of value for the overwhelming majority of rural and remote beaches without facilities, and a way of promoting their quality is required.



*Plate 2.1. An example of a rural beach:
Arrochar, Argyll, Scotland*

Award schemes may be used by Local Authorities to promote the quality of their area and thus increase tourism. Awards may also increase recognition of the managing agent to deflect criticism and apply pressure towards other authorities to implement remedial action (e.g. the water authorities). Local authorities may not decide to apply for Seaside Awards as they may know they may fail and do not want the bad publicity associated with failing. There may be misinterpretation of the criteria or a reluctance to incur the funding commitments of the scheme.



*Plate 2.2. An example of a resort beach:
Margate, Kent*

2.6. Non Governmental Organisations and Campaigns

The Tidy Britain Group and Keep Scotland Beautiful

The Tidy Britain Group (TBG) is a charitable company limited by guarantee that receives core funding from the UK Department of the Environment, The Regions and Transport (DETR). It campaigns to eliminate litter by raising awareness and changing people's attitudes. The Marine Litter Research Programme, the Seaside Awards and the Blue Flag Schemes are all administered by the Group.

Keep Scotland Beautiful is the Scottish Directorate of the TBG, administering the implementation in Scotland of the TBG's national programmes, whilst in Wales this is implemented by Keep Wales Tidy.

The Marine Conservation Society (MSC)

The Marine Conservation Society is one of the main UK charities solely devoted to the conservation of the marine environment. The society believes in working through persuasion and effecting change based on sound factual evidence. Since its formation in 1983, the Society has become a recognised authority on marine and coastal conservation and is regularly consulted by Government for its views on a range of marine issues.

Pollution from sewage, litter and toxic chemicals has always been a major focus and the Society compiles the Reader's Digest Good Beach Guide on an annual basis. In 1986, the campaign to 'Clean Britain's beaches' first brought the state of Britain's beaches to public attention. The Beachwatch campaign, sponsored by Reader's Digest, was launched in 1993 to raise public awareness about marine pollution and establish an effective database on marine debris on Britain's beaches. In 1996 the MCS launched the 'Adopt a Beach' initiative. The initiative is aimed at encouraging anyone who has an interest in the environment to form a group from their local community and register, quite literally, to Adopt-a-Beach. As guardians for their piece of coastline, they will be expected to carry out beach cleans whilst also categorising the nature of the debris they find.

Bag it and Bin it Campaign

The National 'Bag It and Bin It' Group, responsible for the campaign, was established in 1994 and launched the following year in recognition of the pressing need for action on sewage related debris. The aim of the group is to explain the problem associated with SRD and to discourage the general public from using their toilet systems as a wet dustbin. The group also encourages manufacturers to use biodegradable materials in their products.

Norwich Union Coastwatch UK

Coastwatch UK is part of the wider Coastwatch Europe initiative, established in 1987, which has collected data and raised the awareness of coastal zone issues at regional, national and international levels. Since 1989, a national survey has been undertaken to collect information on litter, sewage pollution, land use and biotic components.

3. Oil Pollution

Any community near the sea will be aware of the possibility of oil pollution. Usually it is only the large spills that hit the headlines and it is true that incidents involving oil tankers such as the Braer or Sea Empress, release large amounts of oil in fairly restricted areas causing considerable damage. However, there is also a chronic problem with oil pollution around coastal waters where relatively small amounts of oil come ashore, perhaps over a large area.

3.1. Introduction

Frequently tar balls, specks of oil or oiled debris come ashore on beaches. For example, the authorities researching marine debris on the West Coast of Sweden, observed that most items of debris were contaminated with oil. This low level contamination can be a great annoyance to beach users, is still capable of killing wildlife and can tarnish the good environmental image of an area. This chronic low level pollution is often under circumstances where it is not practical to mount a clean-up operation. Most of this type of pollution is not accidental and occurs from operational discharges from vessels such as washing out their tanks or bilges. These acts are for the most part illegal and also unnecessary as nearly all ports have waste oil facilities which can be used by vessels to discharge unwanted oil or tank washings.



Plate 3.1. Oil pollution on Shetland beaches following the grounding of the 'Braer'
(photo: Shetland Islands Council)

One of the reasons for the continuing problem is the difficulty of detection and prosecution of offending masters. It is all too easy for vessels

in the open sea to discharge oil (e.g. during rough weather or under the cover of darkness) with no chance of detection. It was estimated in 1981 that 3.2 million tonnes of oil reached the sea annually and that about 46% of this was derived from marine transportation, including tanker operations, other shipping activities and accidental spills from ships. There are also some releases of oil from offshore oil installations.



Plate 3.2. Removing oil from clothing following a visit to a badly littered beach on the West coast of Sweden

Oil spills from oil tankers have damaged resources in the past, and continue to pose a threat. While spills affect entire natural communities, spill damage is often measured in bird mortality, which is more easily quantified. In addition to the threat of large spills, small oil spills are an ongoing problem. The California Oil Spill Prevention and Response Agency reports that in 1993 alone, 39 lesser spills, mostly less than 1 barrel,

occurred between Bodega Bay and Cambria, mostly from fishing vessels and recreational boats.

Two miles of state beaches were closed after tar balls were spotted washing ashore along the Long Beach peninsula. The balls are a combination of ship fuel, sand and seaweed that most likely came from a passing ship. The phenomenon is typically caused by seas churning oil dumped from passing vessels. During 1994-95, Shetland Islands Council collected samples of oil from various areas of the coastline and sent them away for analysis. As each type of crude oil contains different proportions of hydrocarbons, it is possible to 'fingerprint' the different crude oils. The samples are then compared against a database of known crude oils and the origin may be identified. 94% of the samples contained crude oil which was almost certainly from tankers involved in the transportation of crude oil which had discharged oil at sea. Six percent of the samples were bilge type oil which comes from vessels pumping out their bilges or from waste oil tanks.

3.2. Causes of spills

Most incidents are the result of a combination of actions and circumstances, all of which contribute in varying degrees to the final outcome. The following analysis by IMO explores the incidence of spills of different sizes in terms of the primary event or operation in progress at the time of the spill. These "causes" have been grouped into "Operations" and "Accidents". Spills for which the relevant information is not available or where the cause was not one of those given are listed under "Other". It is apparent that:

- most spills from tankers result from routine operations such as loading, discharging and bunkering, which normally occur in ports or at oil terminals;
- the majority of those operational spills are relatively small, with some 92% involving quantities of less than 7 tonnes;
- accidents involving collisions and groundings generally give rise to much larger spills, with a fifth involving quantities in excess of 700 tonnes.

3.3. Liability and Compensation

International Conventions on Civil Liability for Oil Pollution Damage (1969)

International Conventions on the Establishment of an International Fund for Compensation for Oil Pollution Damage (1971)

These two Conventions make provisions for compensating those who suffer loss as a result of pollution caused by laden tankers carrying persistent oil in bulk. The first imposes a liability on the ship owner to pay compensation regardless of whether the pollution was caused by his fault. The second establishes an international compensation fund. Substantial revisions to these Conventions were adopted in November 1992. Claims for compensation for oil pollution damage (including clean-up costs) may be brought against the owner of the tanker which caused the damage or directly against the owner's P&I insurer. The tanker owner is normally entitled to limit his liability to an amount which is linked to the tonnage of the tanker causing the pollution.

Methodology

The aim of this study was to investigate the economic and social impacts of marine debris on coastal communities. To do this, firstly a list was drawn up of individual sectors that could be affected by marine debris.

Local Authorities

Tourism

Shipping

Fishing

Agriculture

Power generation

Each sector was assessed individually to see firstly how they could be affected by marine debris and secondly where the possible areas for costs could be found. See Figure 4.1 for a schematic representation of some of the areas covered.

Initial enquires were carried out with the various organisations which represent each different sector. For example, Shetland Fishermen's Association was contacted to discuss the problems of marine debris and the Shetland fishing fleet and Lerwick Harbour Trust were contacted for details about the problems of debris in the harbour.

At these initial interviews, the possible effects of marine debris to the various sectors were discussed, as was the best way to approach individual member or similar organisations in other countries. Initial questionnaires were drafted following these discussions, primarily to assess the extent of the problem. These were distributed to the respective individuals or organisations, firstly within Shetland and then throughout the UK and other KIMO member countries. Responses indicating a problem with marine debris were followed up with additional questionnaires asking specific questions about the nature of the incident and the costs incurred.

The questionnaires were then amended as necessary and sent to other areas of the UK using Shetland contacts, KIMO members and other

recommendations. In some sectors (e.g. Harbour Authorities), research was extended to KIMO member countries (Denmark, Sweden, Norway, Netherlands and Germany). Following responses to questionnaires, meetings with the representatives of the relevant authorities were arranged and undertaken throughout the UK and also in Denmark, Sweden, Norway and Ireland. During these meetings the problems of marine debris and oil in a particular area were viewed personally and area-specific problems were discussed.

As the results came in, they were logged into an database or a spreadsheet. Using these computer packages allowed checking on the response rate for the return of the questionnaires so that reminders could be issued. It also allowed data to be easily separated into relevant groups for analysis. Examples of some of the questionnaires used and sample responses are present in the Appendix.

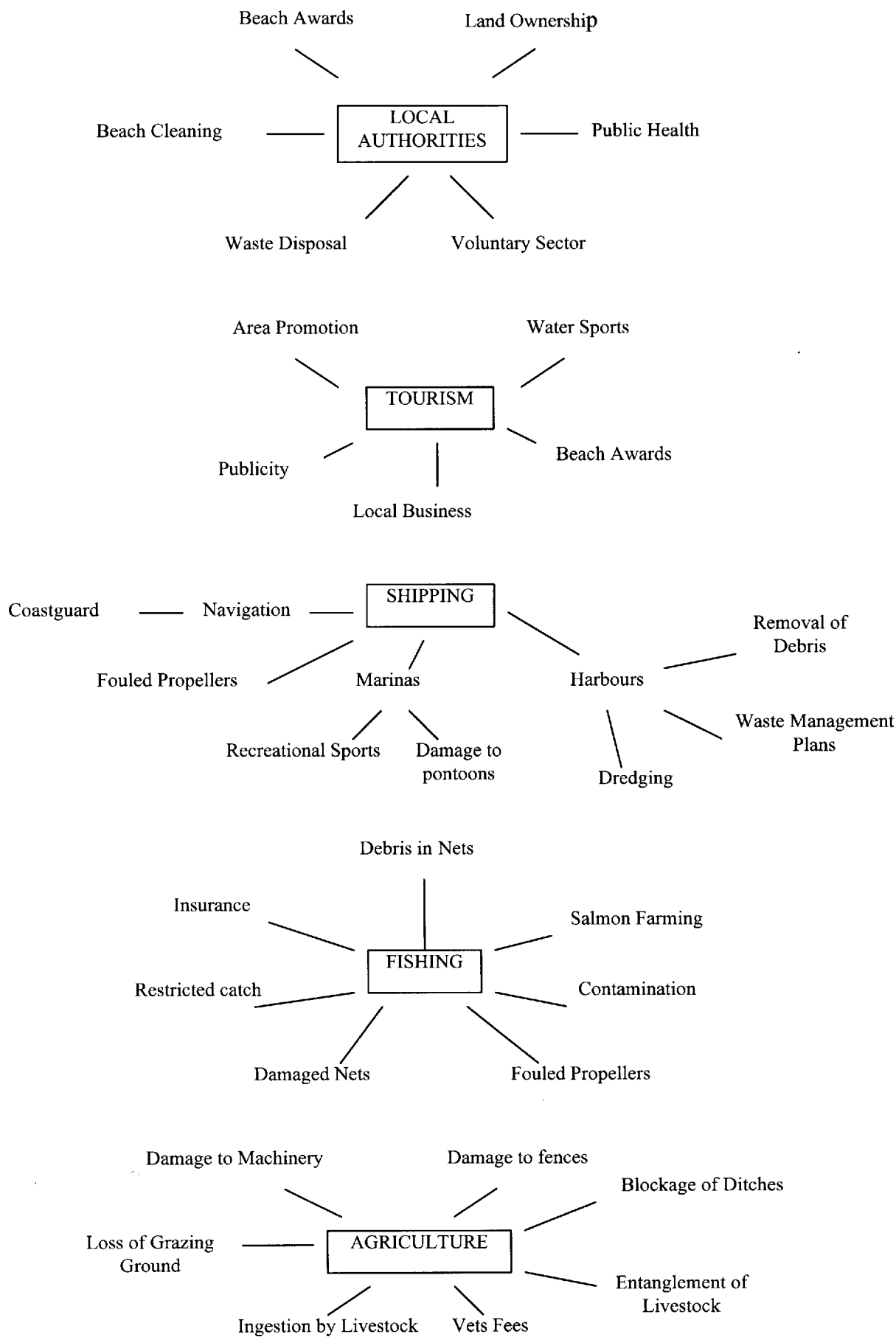


Figure 4.1. Schematic diagram indicating the possible areas which may be affected by marine debris

4. Local Authorities and Marine Debris

Councils, local communities, environmental groups and statutory bodies have been fighting the problem of marine debris, through beach clean-ups, surveys and national campaigns for decades. For many beach-goers, a prime environmental quality indicator is the general state of cleanliness of the beach with particular reference to litter. It is clear that in the case of marine debris, sewage and oil pollution, the 'polluter is not paying'. Local Authorities and their communities are paying for the failures of others.

4.1. UK Local Authorities

Local Authorities in the UK do not have any direct authority over many of the pollution issues. However they do have duties to clean-up pollution under the Environmental Protection Act on designated amenity beaches.

Environmental Protection Act 1990:

Parts II and IV of the Environmental Protection Act 1990 (EPA) contain statutory requirements which apply to some constituents and sources of marine litter. Section 34 of the EPA, which became effective on 1 April 1992, introduced a duty of care for waste management for producers, holders and carriers of controlled waste (i.e. industrial, commercial or domestic waste). The duty does not apply to householders with regard to their own domestic waste. It is therefore expected that duty holders will be discouraged from fly-tipping controlled wastes directly to beaches or indirectly by tipping to rivers and estuaries discharging to the sea.

Part IV of EPA requires local authorities or other owners of land to which the public have access, and which is in full view of the public, to keep this land clear of litter and refuse. In the associated statutory code of practice on litter and refuse, issued under Section 89(7) of EPA, amenity beaches are identified as one of eleven broad categories of land-use zones where required standards of cleanliness are clearly defined. As a minimum standard, all beaches identified by local authorities as amenity

beaches, should generally be clear of all types of litter between May and September inclusive (HMSO, 1990).

Under section 87 of the EPA, it is an offence to drop litter in any public place, including beaches. The fixed penalty for littering is £10 and no proceedings will be taken if the fixed penalty is paid within 14 days. The maximum fine for littering is £2,500, but unless caught in the act on film or by a person of a recognised authority, enforcement is difficult.

It should be noted that the Local Authorities's duty to clear litter, under section 89 of the EPA, only refers to beaches identified as bathing waters. In England and Wales the length of coastline is 7062km on which there are 448 identified bathing waters. Even assuming an average of 1/2 km per beach, these bathing waters equate to only 224km or 3.1% of the English and Welsh coastline.

UK Local Authority Survey

The most obvious and direct consequence of marine debris to local authorities is the cost of cleaning and removing debris from beaches and coastlines. A survey of local authorities was undertaken in the form of questionnaires were sent to 157 coastal local authorities around the UK and Ireland. The questionnaire asked for details on any clean-up operations that were undertaken to remove marine debris or oil from an authority's coastline.

Examples of Questions

- Do you undertake clean-up operations of the coastline within your constituency?
- For what reasons were coastal clean-up operations undertaken?
- What type were the beaches that were cleaned?
- At what frequency do the clean-up operations occur?
- How is the cleansing carried out?
- What is the length of coastline that is cleaned?
- Who are the other users of this area of coastline?
- Which department is responsible for beach cleansing?
- What is the total economic cost of the clean-up operation?
- How much of the council budget is allocated for beach cleaning?
- What anti-litter measures are present near the affected beaches?

Responses were received from 72 UK coastal Local Authorities (figure 4.2). Of these 56 Local Authorities clean areas of their coastline and 16 do not. The reasons given for not undertaking cleaning were: lack of finance, the clean up is organised by other groups or the coastline doesn't have a marine debris problem. Approximately 905 km or 6% of coastline is cleaned around the UK. A further 5,546 km of coastline is reported as not cleaned by local authorities which leaves an additional 8,098 km of coastline of which the cleansing routine is unknown (Table 4.1).

The main reasons reported for Local Authorities to clean beaches are (figure 4.3.):

- **Popular tourist area**
In 1996, 24.8 million seaside holidays were taken in the UK bringing in a revenue of £4.2 billion. In addition there

were in excess of 110 million day visits made to the UK coast which generated a further £1.2 billion (Hampson, 1997).

- **Public Health Risk**

The Public Health Laboratory Service for the South West Region of England reported that 4% of needle stick injuries were sustained on the beach during the period 1988-91.

- **Statutory Requirement**

To conform with the EC Bathing Waters Directive and the Environmental Protection Act, there is a requirement for Local Authorities to remove litter from beaches classified as bathing waters. In 1998, 11 out of the 23 identified bathing waters in Scotland failed to meet the Directive's mandatory standards for total and faecal coliforms. There have been calls for additional bathing waters to be identified in Scotland. The UK Government has announced a review of bathing waters in Scotland.

- **Blue Flag Beach**

In 1997, 224 UK beaches were awarded Seaside Awards by the Tidy Britain Group. In addition 38 resort beaches flew the European Blue Flag

- **Nature or Wildlife Reserves.**

Of the beaches cleaned, 57% are sandy; this is not surprising as this type of beach is most often used by tourists. A third of the beaches cleaned were shingle (33%), rocky coastline accounted for 9% of areas cleaned, and other types of coastline including mudflats and salt marshes constituted 1% of the beaches cleaned (figure 4.4.).

Overleaf: Table 4.1. Beach cleaning responses from Local Authorities in the UK, Denmark, Sweden, Germany and Norway. The table shows the length of beach cleaned, the weight of debris removed and the overall beach cleaning cost (£).

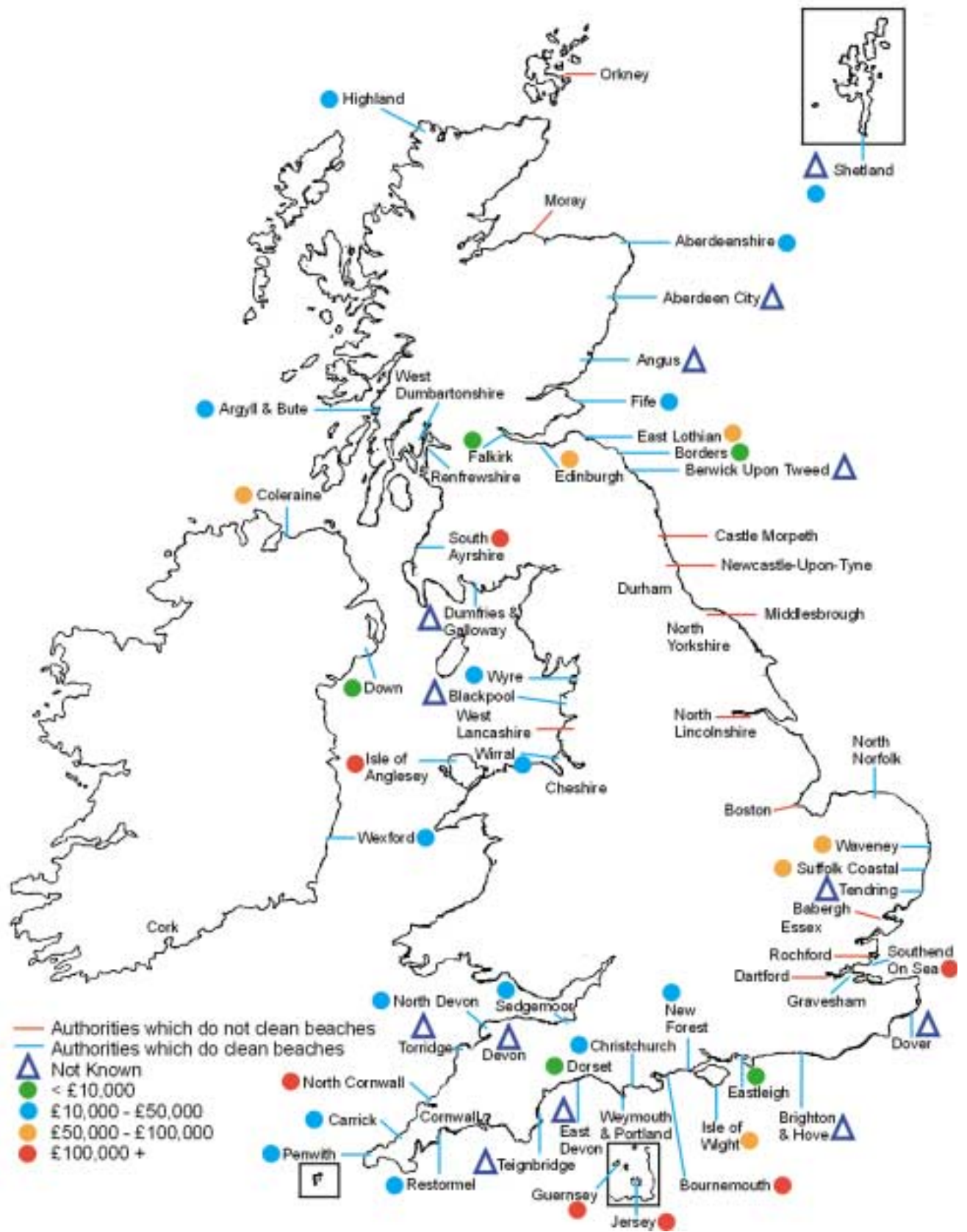


Figure 4.2. Map of UK showing which Local Authorities clean beaches and the associated costs (£) in each area if known. (1997-1998)

Table 4.1.

Area	Council	Cleanup?	Length (km)	weight (tonnes)	Cost (£)
Scotland	Aberdeen City	yes	6.4	NK	NK
Scotland	Aberdeenshire	yes	16	NK	£30,000
Scotland	Angus	yes	10	NK	NK
Scotland	Argyll & Bute	yes	NK	NK	£40,000
Scotland	Borders	yes	10	NK	£2,000
Scotland	Dumfries & Galloway	yes	varies	NK	NK
Scotland	East Lothian	yes	40	NK	£100,000
Scotland	Edinburgh, City of	yes	4.7	NK	£92,000
Scotland	Falkirk	yes	1	NK	£2,000
Scotland	Fife	yes	43	50	£38,400
Scotland	Glasgow, City of	no			
Scotland	Highland	yes	NK	NK	£15,500
Scotland	Moray	no			
Scotland	Orkney	no			
Scotland	Renfrewshire	no			
Scotland	Shetland	yes			£10,000
Scotland	South Ayrshire	yes	38	5000	£165,000
Scotland	West Dunbartonshire	yes	100	NK	£1,500
Scotland Total			269.1	5050	£496,400
England	Babergh District	no			
England	Berwick-upon-Tweed	yes	32	NK	NK
England	Blackpool Borough	yes	11.2	2800	NK
England	Boston	no			
England	Bournemouth	yes	11.3	NK	£328,900
England	Brighton & Hove	yes	11.3	NK	NK
England	Carrick	yes	4.8	NK	£31,000
England	Castle Morpeth	no			
England	Cornwall County	yes	200	250	£13,500
England	Christchurch	yes	5.2	NK	£10,500
England	Dartford	no			
England	Devon County	yes	6.4	NK	NK
England	Dorset County	yes	90	7.7	£3,320
England	Dover	yes	8	NK	NK
England	East Devon	yes	8	1	NK
England	Eastleigh	yes	4.8	NK	£5,000
England	Essex County	no			
England	Gravesham	yes	NK	NK	NK
England	Lincolnshire	yes	1	1	NK
England	Middlesborough	no			
England	New Forest	yes	NK	40	£25,000
England	Newcastle	no			
England	North Cornwall	yes	25	NK	£106,935
England	North Devon	yes	1	NK	£15,000
England	North Lincolnshire	no			
England	North Norfolk	yes	NK	NK	NK
England	North Yorkshire	no			
England	Penwith	yes	NK	NK	£36,500
England	Restormel	yes	NK	NK	£35,000
England	Rochford	no			
England	Sedgemoor	yes	11.3	NK	£41,944
England	Southend-on-Sea	yes		NK	£130,000
England	Suffolk Coastal	yes	32	NK	£61,400
England	Suffolk County	no			

Table 4.1

Area	Council	Cleanup?	Length(km)	Weight(tonnes)	Cost(£)
England	Teignbridge	yes	2.4	NK	NK
England	Tendring	yes	NK	NK	NK
England	Torridge	yes	2	NK	NK
England	Waveney	yes	20	1430	£84,420
England	West Lancashire	no			
England	Weymouth & Portland	yes	3	NK	£118,000
England	Wight, Isle of	yes	NK	NK	£30,000
England	Wirral	yes	19	NK	£30,000
England	Wyre	yes	4	500	£200,000
England Total			513.7	5029.7	£1,306,419
Wales	Anglesey, Isle of	yes	NK	NK	£150,000
Wales Total			0	0	£150,000
Channel Isles	Guernsey	yes	32.2	NK	£128,100
Channel Isles	Jersey	yes	24.1	NK	£120,000
Channel Isles Total			56.3	0	£248,100
Ireland	Ards	yes	20	NK	NK
Ireland	Coleraine	yes	10	NK	£71,800
Ireland	Down	yes	2	NK	NK
Ireland	North Down	yes	16	NK	£23,000
Ireland	Wexford	yes	10	NK	£35,000
Ireland Total			58	0	£129,800
Grand Total			897.1	10079.7	£2,330,719

Area	Kommune	Cleanup?	Length (km)	Weight (tonnes)	Cost(£)
Denmark	Blavandshuk	yes	40	NK	£65,000
Denmark	Lemvig	yes	19	NK	NK
Denmark	Hanstholm	yes	10	NK	£5,000
Denmark	Holmsland	yes	10	101	£33,000
Denmark	Sydthy	yes	24	NK	£10,500
Denmark	Thyboron-Harboore	yes	19	9	£31,000
Denmark Total			122	110	£144,500
Germany	S.D.N	yes	255	450	£17,500
Germany Total			255	450	£17,500
Norway	Alesund	no			
Norway	Fjell	yes	1	10	£1,100
Norway Total			1	10	£1,100
Sweden	Goteburg	yes	85	1	£134,300
Sweden	BOSAM	yes	3400	84	£150,416
Sweden	Sotenas	yes	120	NK	£135,260
Sweden	Munkedals	no			
Sweden Total			3605	85	£419,976
Grand Total			3983	655	£583,076
Total for all Countries			4880.1 km	10734.7 tonnes	£2,913,795

NK = details not known by the respondent

Reasons for Clean-up Operations

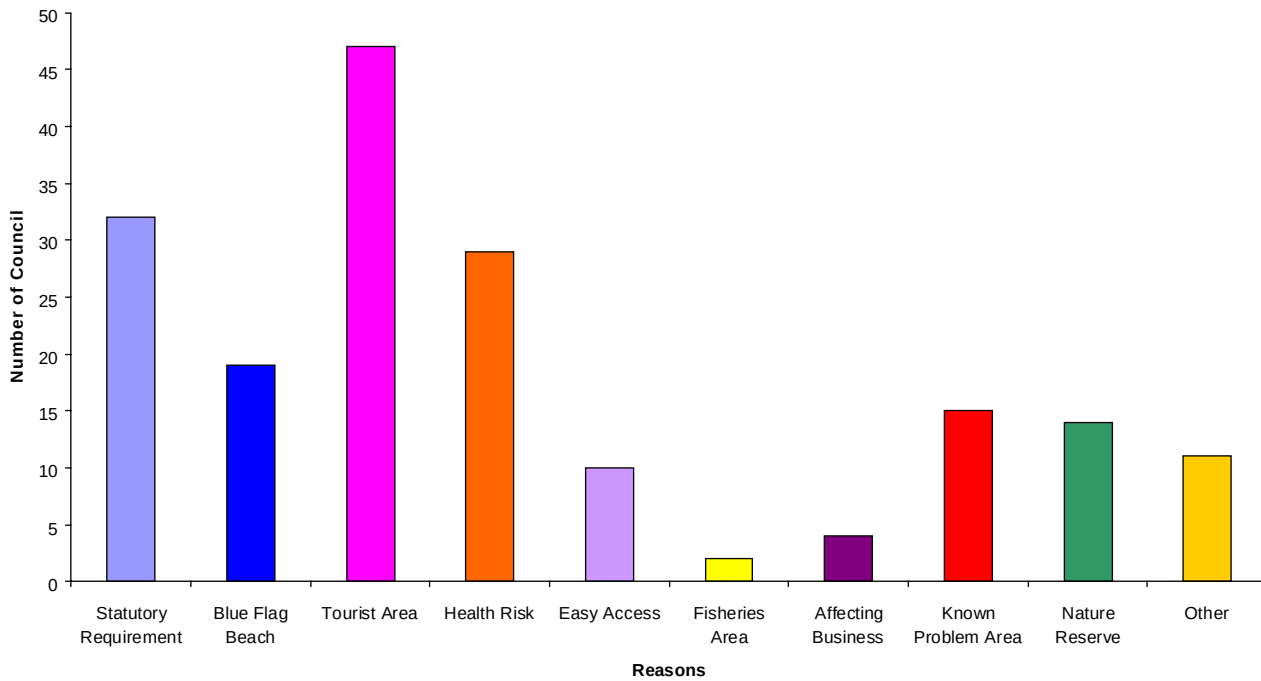


Figure 4.3. Graph outlining the main reasons why Local Authorities in the UK undertake beach cleaning.

Most of the areas cleaned were of high (40%) to medium (34%) public usage, although some beaches that are cleaned may be isolated (6%) or inaccessible to the general public (1%) (figure 4.5). The majority of the beaches are cleaned using manual and mechanical methods (57%) with the remainder (43%) being cleaned using only manual litter-picking (figure 4.6). During the summer season, 41% of beaches are cleaned daily, 22% weekly, 8% monthly and 2% annually. Many other beaches are cleaned as necessary. For example, for a specific event, after bad weather, or if there is a complaint about the state of the beach (figure 4.7).

Type of Beach Cleaned

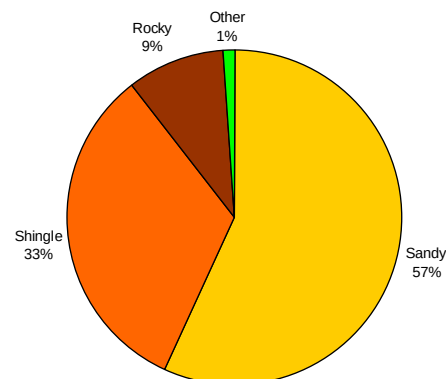


Figure 4.4. Graph showing the percentages of beaches of various types that are cleaned by Local Authorities in the UK.



Plate 4.1. Rocky shores are more difficult to clean: Fife, Scotland

The total cost for the 56 UK Local Authorities to clean up beaches is £2,197,138. The budget allocated for beach cleaning is only £1,675,155. This is because many councils do not have a beach cleaning budget and instead use their emergency funds or street cleaning account. As expected with the majority of beaches being cleaned manually, the main cost is for the wages for the work force (£201,500). Collection of rubbish from the affected sites and transport of workforce to the site cost £87,000 and £47,800

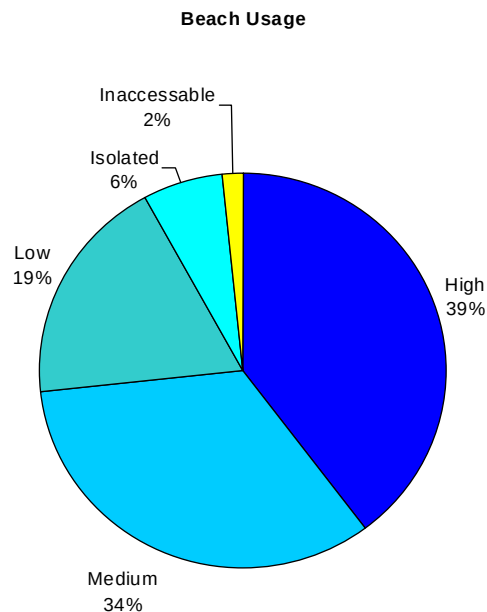


Figure 4.5. Graph showing the percentage of beaches with particular usage, that are cleaned by UK Local Authorities

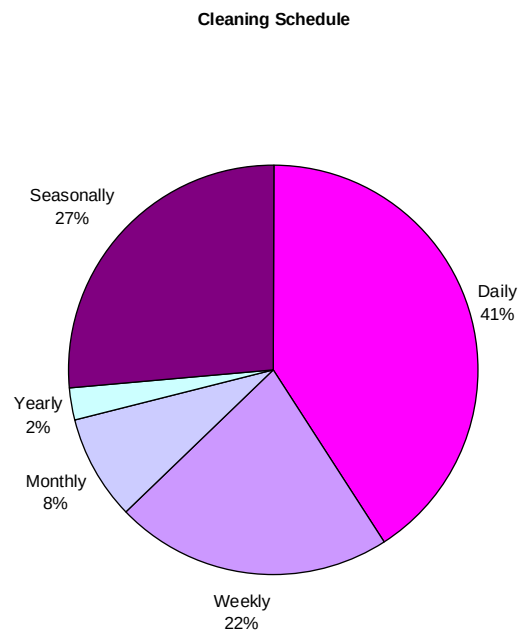


Figure 4.7. Graph showing how often beaches are cleaned by UK Local Authorities

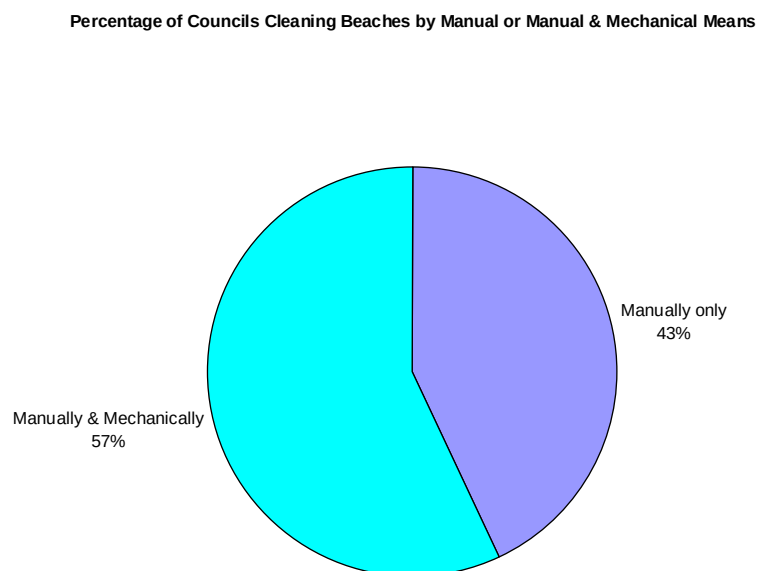


Figure 4.6. Graph showing the percentage of beaches that are cleaned manually or mechanically by UK Local Authorities

respectively. The cost of providing materials such as refuse sacks and gloves amounted to £18,800. The cost of administering beach cleansing operations was £13,300 (figure 4.8).

All of the councils use landfill as their main means of disposal of rubbish from beaches. Twelve councils also use recycling methods and

two councils use incineration to dispose of rubbish. Over 10,000 tonnes of debris from beaches is removed and disposed of each year. The cost of disposal of rubbish is over £114,200. Landfill charges vary from £13-£30 per tonne. Two councils are undertaking trials of seaweed composting (figure 4.9 - overleaf).

Breakdown of Costs for Beach cleaning

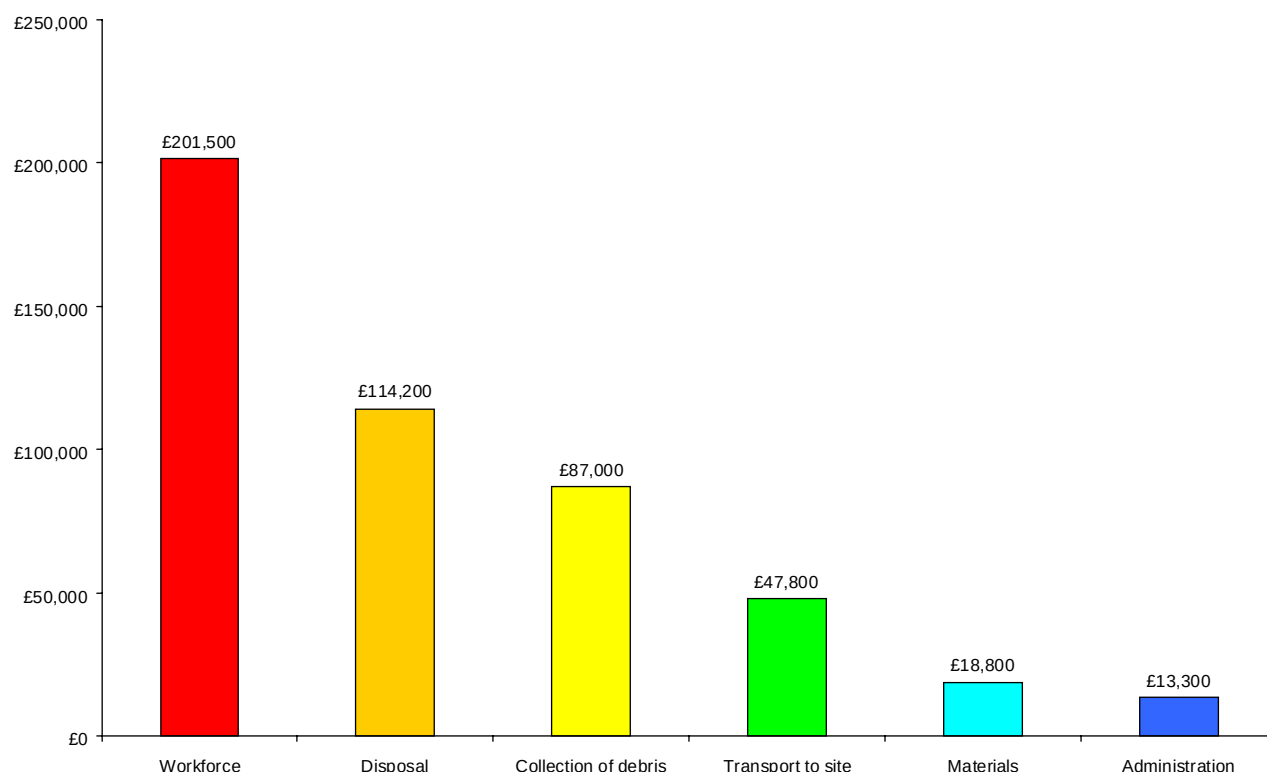


Figure 4.8. Graph showing the break down of the beach cleaning budget spent by UK Local Authorities (where known).

All councils have litter bins near the beaches that are cleaned, 29 councils also have notices. The cost of servicing and maintenance of these anti-litter devices is £127,276.

All 56 councils report that the beaches cleaned are used by tourists and recreational users. Thirty-two Local Authorities report that the fishing industry also use the beach or areas near the coastline that is cleaned (figure 4.10 - overleaf).

Expenditure per head of population for beach cleaning varies between £1.45-£2.18 per person in tourist areas (e.g. Guernsey, Cornwall, Ayrshire); to £0.01-£0.11 in remote areas or areas with heavy industry (E.g. Highland, Borders, Wirral) (table 4.2 - overleaf). The expenditure spent per km of coast cleaned ranges from £50,000 per km in Wyre where a small area is cleaned repeatedly; to £15 per km

in Dunbartonshire where a large area is only cleaned once or twice a year (table 4.3).

Oil Pollution

Of the 72 UK councils responding, 49 have an oil spill contingency plan, however only 12 councils have an oil spill contingency fund. The value of the fund ranges from £1,000 to £10,000 with a total fund for UK councils of £24,610. Thirty-two councils have had a problem with small, unattributable amounts of oil appearing on their coastline. Those local authorities reported over 176 incidences of small oil spillages in 1997. Over £71,000 is spent cleaning up these spillages, three times the value of the fund available. The money comes either from the street/beach cleaning budget or from the individual local authority's general reserves (figure 4.11).

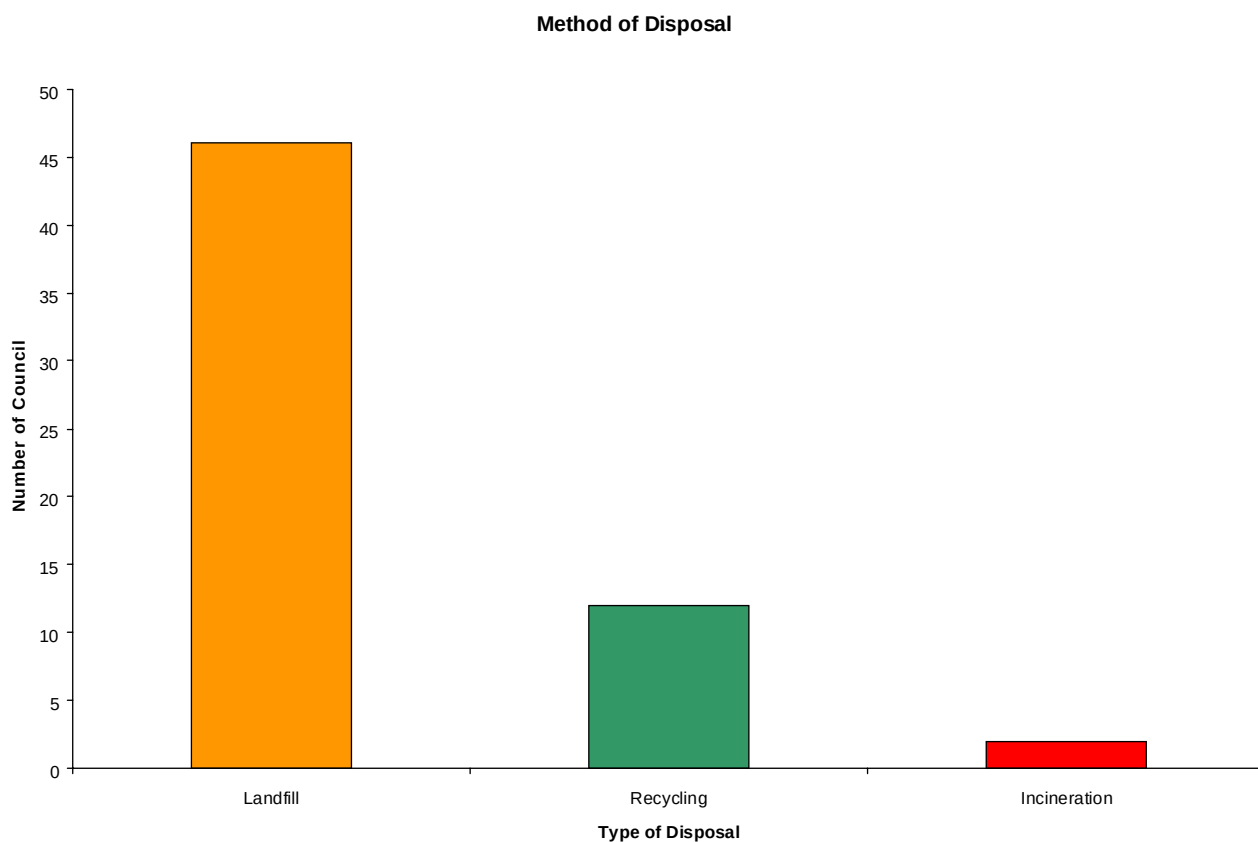


Figure 4.9. Graph showing the method of debris disposal undertaken by UK Local Authorities.

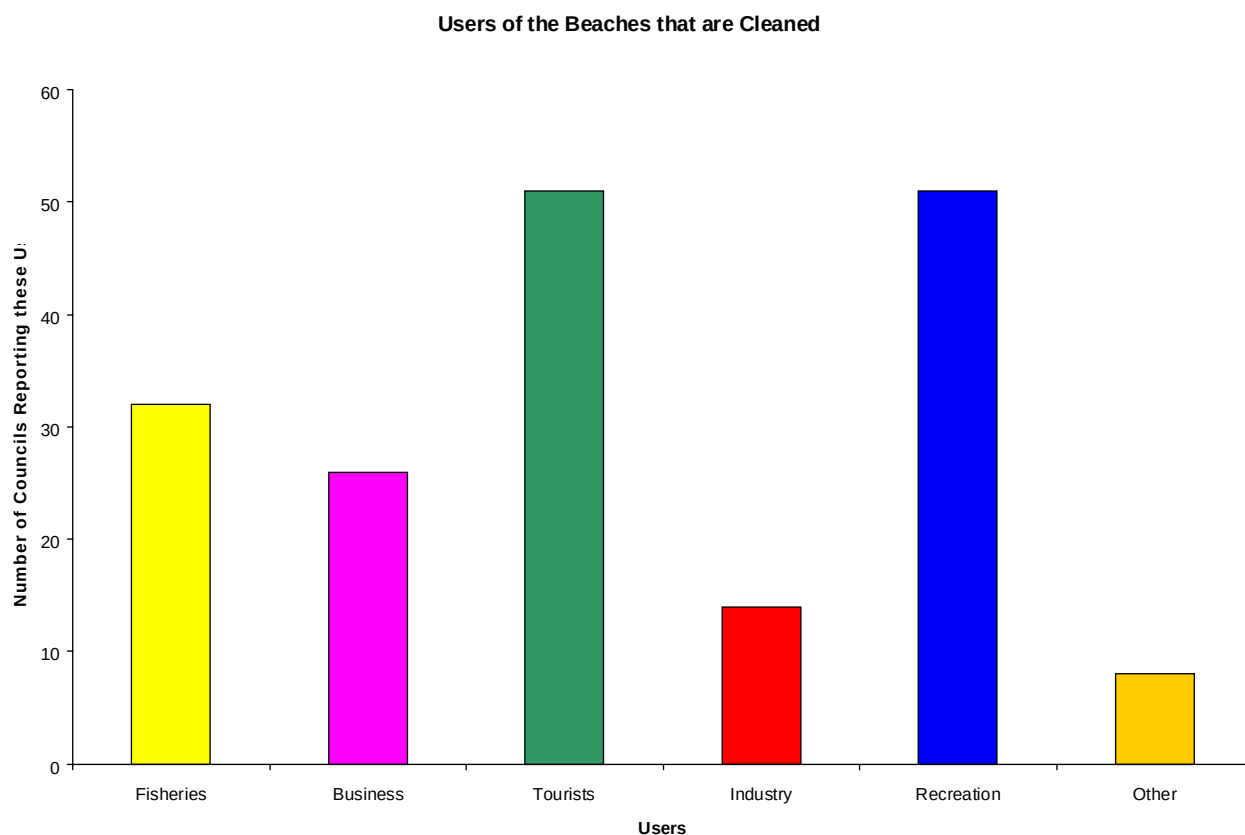


Figure 4.10. Graph showing the main users of the beaches cleaned in the UK.

Expenditure per Head of Population

UK	
Guernsey	£2.18
Anglesey	£2.15
Bournemouth	£2.14
Weymouth & Portland	£1.83
North Cornwall	£1.46
South Ayrshire	£1.45
Coleraine	£1.32
East Lothian	£1.20
Waveney	£0.79
Southend on Sea	£0.78
Wight, Isle of	£0.67
Penwith	£0.58
Suffolk Coastal	£0.54
Sedgemoor	£0.43
Restormel	£0.40
Carrick	£0.39
Argyll & Bute	£0.38
Wexford	£0.34
Down	£0.32
Christchurch	£0.27
Edinburgh	£0.22
Wyre	£0.19
North Devon	£0.17
New Forest	£0.15
Aberdeenshire	£0.14
Fife	£0.11
Wirral	£0.09
Highland	£0.07
Eastleigh	£0.05
Cornwall	£0.03
Borders	£0.02
West Dunbartonshire	£0.02
Falkirk	£0.01
Sweden	
Sotenäs	£13.97
Göteborg	£0.29
Norway	
Fjell	£0.06
Denmark	
Holmsland	£6.16
Thyboron-Harboore	£5.96
Sydthy	£0.90
Hantsholm	£0.81

Table 4.2. Table showing the expenditure per head of population.

Expenditure per km cleaned

UK	
Wyre	£50,000
Weymouth	£39,333
Bournemouth	£29,106
Edinburgh	£19,574
North Devon	£15,000
Southend-on-Sea	£13,402
Coleraine	£7,180
Carrick	£6,458
Jersey	£5,000
South Ayrshire	£4,342
North Cornwall	£4,277
Waveney	£4,221
Guernsey	£4,003
Sedgemoor	£3,712
Wexford	£3,500
East Lothian	£2,500
Christchurch	£2,019
Falkirk	£2,000
Suffolk Coastal	£1,919
Aberdeenshire	£1,875
Wirral	£1,579
North Down	£1,438
Eastleigh	£1,042
Fife	£893
Borders	£200
Cornwall County	£68
Dorset County	£37
West Dunbartonshire	£15
Denmark	
Sydthy	£4,375
Holmsland	£3,300
Thyboron-Harboore	£1,632
Blavandshuk	£1,625
Hanstholm	£500
Germany	
SDN	£69
Norway	
Fjell	£1,100
Sweden	
Göteborg	£1,580
Sotenäs	£1,127
BOSAM	£44

Table 4.3. Table showing the expenditure per km of beach cleaned.

INCIDENCES OF SMALL AMOUNTS OF OIL APPEARING ON THE UK COASTLINE EACH YEAR

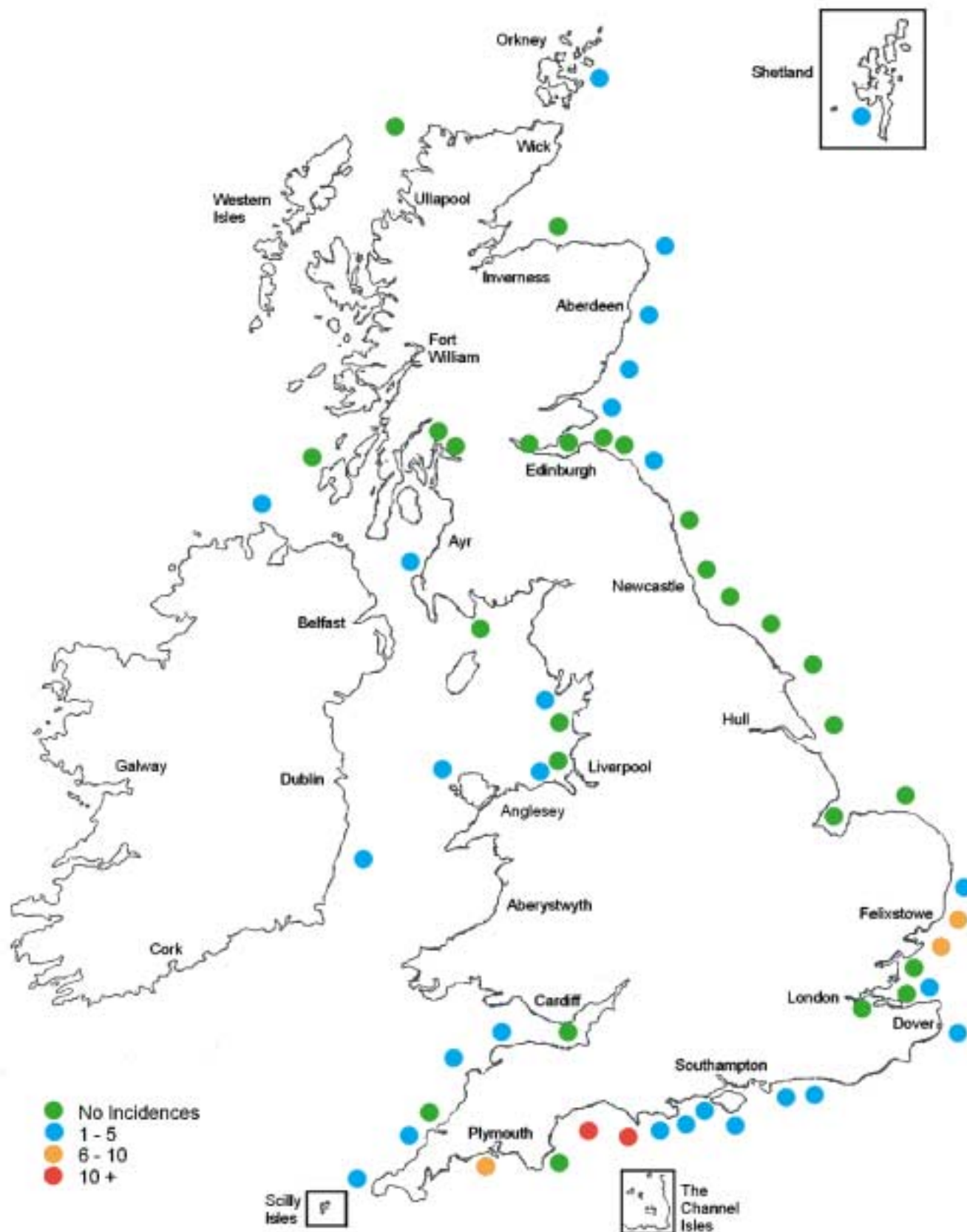


Figure 4.11. Map showing the incidences of small oil spills, tar balls and oiled debris occurring on the UK coastline as reported by UK Local Authorities, 1997-1998.

Discussion

There are many inaccuracies associated with the final figure received for local authorities in the UK. Firstly, money is taken out of other budgets to cover the costs of beach cleaning. The percentage taken from, for example, a street cleaning budget for beaches may not be recorded. Money is also used out of the beach cleaning account for other marine incidents, for example, the disposal and removal of dead whales or the cleanup of oil spills. Finally the costs for cleaning beaches include removal and disposal of all litter on the beach including sewage, tourist dropped items and seaweed.

A survey by ASH Consultants in 1994 also investigated the problems of marine debris and coastal local authorities in Scotland. They reported that many of the District Councils referred to particular problems occurring at times of highest Spring Tides combined with storms, commonest in late Winter and early Autumn.

4.2. UK Voluntary Initiatives

Many councils do not have the additional funds to clean beaches which they are not required to do so by law. Instead, many have set up partly funded organisations within the council that oversee and organise volunteer cleanups of the local area. A high proportion of authorities acknowledged the need for voluntary assistance and this was always reflected in support by the councils in kind. For example by the provision of skips, gloves and bags (See ASH, 1994).

Da Voar Redd Up

The Shetland Amenity Trust started the 'Da Voar Redd Up' in 1988 to combat the increasing problem of marine debris and the bad publicity associated with it. In 1997, 2,450 volunteers (about 10% of the islands population) removed 9,000 bags (equivalent to 45 tonnes) of rubbish from Shetland's beaches and roadsides. Thirty beaches were cleaned over this time. The Trust receives £5,000 from the Council's Reserve Fund to run this cleanup. The estimated cost to

pay manual workers to do the same job would be at least £13,752.

Fife Rubbish Free Zones

Fife Rubbish Free Zones was set up in 1991, to encourage local communities to monitor, clean and protect certain areas from rubbish and flytipping. One third of these sites are coastal and these are cleaned by volunteer groups at special events throughout the year. In 1997, 50 tonnes of debris were removed. The group receives £6,000 a year to organise the clean ups.

The Great Dorset Beach Clean

The Great Dorset Beach Clean is co-ordinated by the 'Dorset Countryside' ranger team of Dorset County Council. Its aims are to raise awareness of the on-going problem of coastal pollution, enable local people to become involved in positive action along their coast, and to remove as much rubbish as possible from the beaches along the Dorset Coast. Each year approximately 7 tonnes of rubbish is removed from beaches by volunteers. The District Councils arrange the collection and disposal of the rubbish.

Viking Shore Trust

The Viking Shore Trust was established in 1993 by a group of local people concerned by the large volume of litter accumulating at the head of Loch Long in Argyll. Arrochar shore was becoming a litter black spot viewed by locals and visitors from around the world. The Trust exists to effect solutions to this problem and to increase general awareness of the marine litter issue. The Trust sponsors community-based groups, environmental organisations and other groups to undertake shore clean-ups.

4.3. Land Ownership and Management Responsibility

Many sites of natural heritage interest exist around the UK and these are designated and safeguarded through mechanisms operated by Scottish Natural Heritage, Countryside Commission for Wales and English Nature.

Other sites are often owned or managed by a variety of organisations (National Trust, RSPB, etc.) who afford their sites custodial protection and management.

Management responsibility for these sites is not always straightforward, especially when addressing the complex range of interactions between activities and the environment and the managing body themselves. A prime example of this is the removal of marine debris from beaches and the provision of facilities (such as litter bins) on certain stretches of coastline, which might be considered the responsibility of site managing bodies or land owners, and not necessarily the local council.

The National Trust for Scotland

The National Trust for Scotland is Scotland's second largest voluntary conservation organisation and cares for a great diversity of properties. Although no surveys on marine debris have been undertaken by the Trust, beach cleans are occasionally undertaken by Trust volunteers. While accepting that marine debris is a problem on some sites, the Trust agrees that the best approach to litter control in general should be preventative.

The National Trust in the Isle of Wight cleans 1.5 miles of sandy coastline daily during the summer season at a cost of £1,600 per annum. They receive a few complaints about rubbish on the beach outwith the season but do not have the resources to continue cleaning throughout the year. In East Anglia, the Trust is dependent upon the availability of volunteers to clean up debris. In Wales, Trust staff undertake cleaning of beaches alongside their other duties and are also helped by volunteers. The shore at the White Cliffs of Dover is cleaned by the National Trust as necessary. This is generally weekly during the tourist season at an average cost of £40 per week.

Local Authorities in Other Countries

The initial survey was extended to include local authorities from Denmark, Sweden, Norway,

Germany and Holland. Members of the organisation, KIMO, were contacted and sent the same questionnaire as used in the UK.

4.4. Denmark

Blavandshuk, Lemvig, Hanstholm and Thyboron-Harboore Kommunes spend 782,000 dkr (approximately £78,200) each year on beach cleaning. Blavandshuk Kommune also enlists schools to help clean ups and pays each class £600 per day. The beaches that are cleaned are all sandy and of high to medium use by the public. They are all owned by the State of Denmark. They are cleaned daily or weekly on a seasonal basis by manual means. Blavandshuk and Hanstholm Kommunes stated that they used manual means to prevent the removal of excess sand. These four Kommunes clean 88 km of beach each year.

After discussions with Esbjerg and Hanstholm Kommunes, it was apparent that oil spills were more of a problem than marine debris. This is because the predominant wind and currents will send any debris further north into the Skagerrak and onto the West Coast of Sweden. All Kommunes reported no occurrences of any sewage debris appearing on their beaches. A comparison with beach cleaning costs in 1987 and 1997 show that the costs of cleaning the same length of beach have increased and in some cases doubled (table 4.4).

4.5. Germany

The Municipalities which were contacted through Schutzgemeinschaft Deutsche Nordseekutse, spend approximately £17,500 per year cleaning 255 km of dyked area using both manual and mechanical means. They remove 450 tonnes of debris from medium to low use areas which are cleaned seasonally as necessary (see table 4.1).

4.6. Sweden

The West Coast of Sweden, particularly the section between Göteborg and the Norwegian border, suffers severely from marine debris and oil. Every summer since 1992, the coast has been cleaned up as a result of co-ordination between

Comparisons of Beach Cleaning costs in Denmark in 1987 and 1997

Kommune	Length(km)		Cost (Dkr)	
	1987	1997	1987	1997
Skagen	62		498,000	
Hirtshals	40		232,000	
Hjorring	9		147,000	
Lokken-Vra	12		147,000	
Pandrup	23		361,489	
Hantsholm	43	10	37,825	50,000
Thisted	15		200,229	
Sydthy	24	24	54,685	105,000
Thyboron-Harboore	20	19	26,950	310,000
Lemvig	19	19	158,000	
Ulfborg-Vemb	13		25,000	
Holmsland	40	40	178,475	330,000
Blabjerg	12		200,000	
Blavandshuk	40	40	300,000	650,000
Fano	11		46,000	
Skarebaek	10		65,000	
Totals	393km	152km	2,677,653 £267,765	1,445,000 £144,500

Table 4.4. Comparisons of beach cleaning costs in Danish Kommunes in 1987 and 1997

the coastal municipalities, the County Employment Board and the County Administration Board. The beach cleanups have been financially possible due to the involvement of the County Employment Board. Beach cleaning is significantly more difficult and more expensive because of the jaggedness of this coastline and wealth of islands. With the reluctance displayed by the Swedish Government when it comes to contributing to paying for beach cleaning; the local authorities, with the help of volunteers and support from the Keep Sweden Tidy Foundation have been obliged to accept responsibility for very substantial costs.

Legislation

The Swedish law which regulates litter from ships is in the first instance the “*Law on Actions Against Water Pollution from Ships*”. This law applies to pollution that has to do with the running of the ship. Although the legislation was

adopted to regulate discharges of ballast water, the law is nevertheless applicable to the concept of ‘*dangerous substance*’ by which is meant ‘*oil, and other substances which if are released into the sea or any other water area are likely to give rise to harmful effects on human health, be harmful to the marine fauna or flora, damage recreational values or disrupt other legitimate utilisation of the sea or other water areas*’.

The 1985 proclamation from the National Maritime Administration contains regulations on solid waste. It is stipulated that discharges of solid waste are prohibited from Swedish or foreign vessels within Sweden’s maritime territory. For the purpose of this proclamation, solid waste is defined as:

- All waste of plastic: for instance ropes, fishing nets of synthetic material and plastic refuse sacks.



Plate 4.2. Beachcomber's retreat: This building is made entirely from debris washed up on the beach, Sotenäs, Sweden.

- Other solid waste: including paper products, rags, glass, metal, bottles, china, battens, boards, clothing, and packaging materials.

"The Law on Prohibition of Dumping of Waste in Water" regulates waste other than that which relates to the running of the ship. Discharging of waste, whether it be in solid, liquid or gaseous form, from ship or other means of transport is prohibited within Sweden's territorial waters. Such dumping is also prohibited from Swedish ships in open sea.

Costs to Swedish Kommunes

The total costs for cleanup operation of beaches on the Bohuslän coast in 1997 were estimated to be at least 10 million Sek (£1,000,000). The costs for the municipalities amounted to 2-3 million Sek (£200,000) (for boat hire, transportation, equipment, disposal). The cost for the County Employment Board to provide 8,000 man working days is approximately 8 million Sek (£800,000). Wage costs for supervision, planning and organisation are not accounted for, since beach cleaning is seen as an integral part of the work done by personnel employed by the municipality or other organisations. From 1998, beach cleaning will be organised by the district councils affected (BOSAM), Vastkuststiftelsen (Foundation for Managing Nature Reserves in West Sweden) and the County Employment Board



Plate 4.3. Type of boat used on the Swedish west coast to collect debris from the numerous islands and rocky outcrops.

In 1992, a complete clean-up of the coast of Bohuslän was carried out for the first time. From north to south, around 200 people, over a period of 6 months, gathered more than 15,000 cubic metres of rubbish at a cost of 21 million Sek (£2.1 million) (table 4.5 overleaf). Between 1992-1997 over 8,000 fish boxes, 7,430 oil cans and enough rubbish to fill 250,000 sacks was removed from the coast of Bohuslän (table 4.6 - overleaf).

The City of Göteborg, Sotenäs and Munkedals Kommunes and the local authority organisation BOSAM spent 4,197,419 Sek (approximately £419,741) cleaning 3,605 km of the West Coast of Sweden. They removed 11,464 bags manually throughout the season. The areas cleaned are predominantly rocky and may be highly used or isolated. The Kommunes pay unemployed people money to clean the coastline for the season

4.7. Holland

In areas of high tourism, the costs of coastal cleaning tend to be high and must be paid out of municipal funds. In the Hague Municipality, they get approximately 15 million tourists each year and spend as much as 1.5-2 million guilders (£500,000) per year on coastal cleaning. In Den Helder, with approximately 1.5 million tourists per year, around 60,000 guilders (£20,000) is spent on cleaning beaches per annum.

Beach Cleaning in Bohuslän 1997					
Municipalities	Number of Days	Number of Sacks	Number of Fish Boxes	Number of Oil Cans	Costs (Sek)
Stromstad	1,000	4,510	500	136	272,826
Tanum	530	3,647	232	476	163,400
Sotenäs	800	4,899	139	261	247,157
Lysekil	893	6,330	237	35	330,600
Uddevalla	560	1,911	9	42	165,000
Munkedal	56	83		15	5,865
Orust	589	2,314	299	575	308,988
Tjorn	279	1,535	100	197	102,477
Stenungsund	761	1,383	19	20	125,474
Kungälv	892	3,000	187	398	200,000
Ockerö	749	2,458	178	18	181,000
Göteborg	776	4,136	120	119	200,000
Total	7,885	36,206	2,020	2,292	2,302,787
					£230,000

Table 4.5. Table showing some of the beach cleaning costs incurred by Local Authorities in the region of Bohuslän, Sweden.

Results from 6 years of beach cleaning in Bohuslän					
Year	Estimated Volume (Cubic Metres)	Number of Sacks	Number of Fish Boxes	Number of Oilcans	Costs per Sack (Sek)
1992	15,500	89,200	2,410		225
1993	5,500	36,071	1,412	2,500	250
1994	6,000	36,210	1,231	733	300
1995	6,000	34,427	1,229	589	320
1996	4,000	22,607	575	1,316	420
1997	6,000	36,206	2,020	2,292	360
Total	43,000	254,721	8,877	7,430	

Table 4.6. Summary of beach cleaning statistics in Bohuslän, Sweden between 1992-1997.

The placement of rubbish bins and the erection of notices is perhaps the most obvious step taken by the Dutch municipalities to control marine debris on tourist beaches. In crowded areas, waste bins are placed as close as 25 metres. This saturation approach works to a certain extent but does not solve the problem. Waste bins fill up in no time and litter ends up dumped under them or nearby. Once a beach is littered, another problem arises as the threshold to littering is reduced. Regular cleaning during the day is usually not possible as access is hampered by the sheer volume of people. In contrast with what you would expect, deposit bottles are discarded in large numbers. In one municipality, waste collectors are reported to have made an extra 2,000 guilders (£670) per person each year from separating out deposit bottles from the rest of the litter (Hutjes and Supit, 1994).

4.8. Conclusions and Recommendations

Marine debris affects all coastal local authorities throughout the study area. However in many cases, marine debris is not seen as an immediate problem and due to lack of resources is often untouched and forgotten about. Local Authorities agree that much of their beach cleaning budget is dedicated towards removing debris from high profile tourist beaches and for keeping any award beaches at a satisfactory standard. Other less popular places, especially rocky shores, are frequently ignored due to the high cost associated with clearing these areas

***Recommendation 1:** Prioritisation in the allocation of available resources has been identified as a key issue for most if not all of the local authorities. This should be improved by defining appropriate litter management standards for individual beaches within the available resource constraints based on consideration of the major factors (statutory designation, level of use, type of use, location, landscape and conservation value, visual sensitivity, public or political expectation etc).*

Returned questionnaires to this study had often been filled in by several different departments. In many cases questions were not answered as it 'was dealt with by another department' or different answers were given for the same question. Many local authorities were unsure of which department was actually responsible for beach cleaning. According to this survey, the department involved could be anything from leisure and recreation, commercial services, environmental services or planning.

***Recommendation 2:** One key officer should be allocated the subject of coastal pollution contact. This would be a secretariat role of keeping all interested staff within the authority informed of what is happening and also act as a point of contact.*

***Recommendation 3:** There is a requirement for new mechanisms for funding beach cleaning programmes which should be related to the 'polluter pays principle'. For example using car park fees, charging waterfront businesses, or tourist taxes.*

All the local authorities questioned stated that they had litter bins present near the beaches that they clean. However councils are still removing over 10,000 tonnes of debris from these areas each year that has not been deposited in the bins. According to Beachwatch 1998, direct littering by recreational beach users contributed to 36.7% of all beach litter. Using this figure, approximately 3,670 tonnes may have been left by tourists or other beach users who had not disposed of their rubbish in the litter bins provided. This suggests that there are

- a) too few litter bins available
- b) the bins are not emptied often enough
- c) the bins are not in easy to find locations, or
- d) the general public are not using these bins

***Recommendation 4:** There should be an investigation into the use of litter bins for disposal of rubbish. In many areas people are*

encouraged to take their rubbish home with them and issued with bags with which to place their rubbish. This practice should be encouraged.

Recommendation 5: *Information notices should include education material about the possible environmental harm that marine debris does and how it affects human activities.*

Recommendation 6: *There should be further research done into the sources of marine debris in particular areas and sources of regularly occurring debris items should be tracked down.*

The manufacturer and sellers of locally sold items (e.g. milk cartons) should be informed of the occurrence of their product as a debris item and can then modify the design to promote recycling or biodegradability.

Recommendation 7: *Local manufacturers and suppliers should be encouraged to promote recycling and responsible disposal. They may be able to include educational slogans on the cartons or encourage wholesalers who sell a lot to the shipping industries to encourage responsible disposal.*

Only half of the UK councils responding have an oil spill contingency plan. Many of the District and Borough councils report that an oil spill would be co-ordinated by the County Council.

Recommendation 8: *All councils should draw up an oil spill contingency plan as part of their emergency plans. The plan should identify key personnel who would be responsible for dealing with any spills. Any oil spill contingency plans held by County Councils should be circulated to the relevant personnel at District level.*

Recommendation 9: *All councils should identify funds for use for dealing with oil spills.*

Although mechanical beach cleaning machines are initially expensive to buy, many local authorities report that they are cheaper and quicker to use on long straight areas of sandy beach. However, there has been research showing how mechanical cleaning can alter the long term dynamics of the beach and may lead to coastal erosion if too much sand is taken away.

Recommendation 10: *There should be an analysis of the economic costs of mechanical beach cleaning versus the environmental damage that it causes.*

The use of volunteer partnerships with councils has encouraged greater pride by local people for their area. One-off cleanups can be very educational and especially popular with children. Schemes such as Da Voar Redd Up in Shetland and the Fife Rubbish Free Zones have helped to combat flytipping as a source of marine debris.

Recommendation 11: *That other councils investigate the possibility of establishing volunteer partnerships as a way of combating marine debris and litter. Not only are volunteer groups able to clean areas that are not cleaned by the council, but they also educate the local population and encourage responsible waste disposal.*

If we compare the expenditure per tonne of debris we see that places which have to clean rocky shores or that have a lot of islands, have to pay substantially more. For example Thyborn-Harboore (Denmark) and Göteborg (Sweden) pay £3,444 and £1,429 respectively, compared to £33 per tonne spent clearing sandy beaches in South Ayrshire (Scotland) (table 4.7).

A large amount of money was spent cleaning beaches in Scotland in 1994 and 1998. Figures taken by Ash 1994 show that East Lothian, Aberdeenshire, Highland and South Ayrshire all spend less on beach cleaning now than in 1994 (table 4.8). Given that standards are now higher and many councils report that the marine debris problem is getting worse, it would seem that less



Plate 4.4. Flat bottomed boat used for collecting debris from the shoreline of Oslofjord

is done. This decrease in budget is due to the general increase in budget constraints which Local Authorities have to face. They prioritise their total budget available to support key services, of which beach cleaning is low on the list.

There is a failure of the existing beach award schemes to accommodate more rural or remote beaches. In these areas, the provision of facilities (e.g. toilets, car parks) and services specified in the award criteria may be neither appropriate nor desirable. Local Authorities in the North of Scotland, and other similar rural locations, do not have the funds to undertake the required water sampling to detect coliforms. They feel that sampling that is often unnecessary as the number of people entering the sea is low due to the colder climate. Although rural communities may not want to advertise their beaches as being award status, they feel that their area may be unintentionally be given a bad reputation as a result of having no beach awards. In reality the area may have several clean and safe beaches which just don't match the infrastructure required by the award schemes.

Recommendation 12: *There should be quantification of the effect of beach award status in influencing choice of destination and overall tourism value.*

Recommendation 13: *Award schemes should be extended to accomodate areas that are*

rural with no supporting infrastructure. The promotional literature could clearly state what amenities are present at each beach and the rate of sampling.

Expenditure per tonne removed

UK

<i>Fife</i>	<i>£660</i>
<i>New Forest</i>	<i>£625</i>
<i>Dorset</i>	<i>£415</i>
<i>Aberdeenshire</i>	<i>£150</i>
<i>Waveney</i>	<i>£59</i>
<i>Cornwall</i>	<i>£54</i>
<i>Wyre</i>	<i>£40</i>
<i>South Ayrshire</i>	<i>£33</i>

Denmark

<i>Thyboron-Harboore</i>	<i>£3,444</i>
<i>Holmsland</i>	<i>£327</i>

Sweden

<i>BOSAM</i>	<i>£1,791</i>
<i>Goteburg</i>	<i>£1,429</i>

Norway

<i>Fjell</i>	<i>£110</i>
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Germany

<i>SDN</i>	<i>£39</i>
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Table 4.7. Expenditure per tonne of debris removed from beaches.

Comparison of Costs of Beach Cleaning between 1994 and 1997/98

Old Council Boundary	New Council Boundary	Cleaning Cost in 1994	Cleaning Cost in 1997/98	Change
East Lothian	East Lothian	£120,000	£100,000	
Banff & Bucan	Aberdeenshire	£65,000	£30,000	
North East Fife	Fife	£20,000	£33,000	
Ross & Cromarty	Highland	£20,000	£15,500	
Argyll & Bute	Argyll & Bute	£30,000	£40,000	
Kyle & Carrick	South Ayrshire	£220,000	£165,000	

Comparison of Beach Cleaning Schedule between 1994 and 1997/98

Old Council Boundary	New Council Boundary	Cleaning Cost in 1994	Cleaning Cost in 1997/98	Change
Aberdeen	Aberdeen	Daily	Daily	
Angus	Angus	Weekly	Weekly	
Argyll & Bute	Argyll & Bute	Daily	Not known	?
Banff & Buchan	Aberdeenshire	Weekly	Not known	?
Caithness	Highland	As necessary	As necessary	
East Lothian	East Lothian	Seasonally	Weekly	
Edinburgh	Edinburgh	Daily	Daily	
Falkirk	Falkirk	Daily	Daily/Weekly	
Kyle & Carrick	South Ayrshire	Daily	Daily/Weekly	
Nairn	Highland	Daily	As necessary	
North East Fife	Fife	Weekly	Weekly	
Ross & Cromarty	Highland	As necessary	As necessary	
Skye & Lochalsh	Highland	As necessary	As necessary	
Stewartry	Dumfries & Galloway	Weekly	Weekly	
KEY				
Decrease			Increase	
				
			Same	

Table 4.8 Comparison of beach cleaning costs spent by Scottish Local Authorities in 1994 and 1997/1998

5. Tourism and Health Related Issues

Coastal recreation and tourism takes many forms, including camping, surfing, angling, diving, sailing and wildlife tourism, amongst others. Tourism is a major source of income and may dominate the local economy in certain regions such as the South West Peninsula of England, West Wales and the West coasts of Scotland, Denmark Sweden and Norway. For example, Weston-Super-Mare in Somerset (UK) has 2.5 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, the beaches are cleaned at least once a day in the summer at a cost of £100,000 (Acland, 1995).

The British Tourist Authority has identified the economic importance of clean beaches estimating that 18 million British people and 3 million overseas tourists take holidays in British seaside resorts (House of Commons Environment Committee, 1990). Annually the UK seaside and maritime leisure industry is worth £8 billion, £6 billion of this relates to seaside holidays with the rest mainly arising from boating (Maritime Technology Foresight Panel, 1996). In 1996, the British public took 24.8 million UK seaside holidays and made over 110 million day visits to the UK coast.

It is generally accepted that Scotland's natural environment is recognised as its most important tourism resource. The coastline is a key part of this resource. Sandy beaches cover 760 km or around 6% of the total coastline length (Ritchie and Mather, 1984). While past visitors to Scotland hold these beaches in high esteem, it has been recognised that there is a lack of awareness in potential visitors of their existence and quality (ASH, 1994).

5.1. UK Tourism

As part of this project, Tourist Authorities throughout the UK and Ireland were asked various questions regarding coastal tourism in their areas.

The questions asked were:

- How many tourists do you get to your area each year?
- Of these, approximately what percentage come specifically to visit the beach or coastline?
- Approximately what income does tourism provide to the local community each year?
- Do any of your beaches have awards? (e.g. Blue flag, seaside awards)
- How many complaints (if any) do you receive each year about the beach/coastline? (e.g. sewage, glass, dog fouling, rubbish)
- Are you aware of any accidents that have been caused by rubbish on the beach? (e.g. cuts from glass)

Responses were received from 20 tourist boards throughout the British Isles. They reported over 140 million visitors to their areas, of which 34.3 million were visiting the area specifically to see the beach or coastline. The percentage visiting the coastline specifically varied from only 4% in Orkney to over 80% in the Isle of Wight, Thanet, North Cornwall and Conwy. Over £5.5 billion is generating from tourism into these

Tourist Authority	Number of Tourists	Percentage going to beach	No. going specifically to beach	Tourist generated income	Approx. income derived from coast users	Beach Awards	No of Complaints	No. of Accidents
Arun	2 million	NK		£233 million		yes	few	yes
Caernarfon	60000	20%	12,000	16%		yes	3	yes
Canterbury	NK	NK	NK	NK		yes	30	yes
Clacton-on-Sea	2.5 million	NK		£10 million		yes	20	yes
Conwy	4 million	80%	3.2 million	£203.9 million	£163 million	5 seaside awards	10	none
Cornwall	4 million	12%	480,000	£800 million	£96 million		NK	NK
Dover	1.5 million	15%	225,000	£80.3 million	£12 million	none	20	yes
Guernsey	473,000	NK	NK	£160 million		8 seaside awards	few	few
Gwynedd	1.5 million	20%	300,000	NK		18 seaside awards & 3 Blue flags	none	none
Jersey	90,000	NK		£284 million		none	6	few
North Cornwall	600,000	80%	480,000	£140 million	£112 million	8 seaside awards	NK	NK
North West	120 million	20%	24 million	£2,673 million	£535 million	none	NK	NK
Northern Ireland	1.5 million	NK		£268 million		5	NK	NK
Orkney	120,000	4%	4,800	£16 million	£0.64 million	none	10	none
Pembrokeshire	1.3 million	60%	783,000	£196 million	£117.6 million	28 seaside awards & 6 blue flags	12	2
Poole	2 million	50%	1 million	£104 million	£52 million	yes	26	none
Seaford	29,338	68%	20,000	£2 million	£1.4 million	yes	3	none
Thanet	1.7 million	90%	1.5 million	£112 million	£101 million	yes	few	yes
Western Isles	100,000	70%	70,000	£13.1 million	£9.2 million	none	10	none
Wight, Isle of	2.6 million	85%	2.2 million	£234 million	£199 million	12 seaside awards	2	few
Totals			34.3 million	£5,529.3 million	£1398.8 million		154	

Table 5.1. Summary of responses obtained from UK Tourist Boards

local economies annually. If we assume that each visitor spends the same regardless of what attraction they are visiting then approximately £1.4 billion is spent whilst visiting coastal attractions. The number of complaints about dog fouling or broken glass or debris on the beaches, is relatively few, with less than 200 being reported annually. There are also few recordings of accidents resulting from marine debris. Most accidents that do occur tend to be glass related (table 5.1f).

A recent survey in association with the Marine Conservation Society (MCS) and Surfers Against Sewage (SAS) carried out questionnaires on water users on location (at a beach) and on the Internet (On line questionnaire) to establish the extent of public awareness of sewage. Over 87% (both beach goers and internet users) believed there was a genuine danger from exposure to sewage. Over 80% believed that the public were being misguided by the Blue Flag and Tidy Britain Beach Awards scheme of beach designation. However over 58% of respondents stated that the knowledge of a favourite area being heavily polluted with sewage has not deterred them from surfing it. When asked if they would pay an extra £30 a year on their water bill to remedy the problem of untreated sewage, over 80% said no.

Out of 76 official complaints registered with the Ayrshire Tourist Board in 1993, six related specifically to beach cleanliness and a further three to the deterioration in the quality of one of the beaches. Research in England on the importance of various beach and seafront characteristics in the visitors' decision to visit a particular site, has shown that beach cleanliness scores highly (Turnstall and Coker, 1992).

People tend to avoid littered beaches (Rees and Pond, 1995) and in extreme cases 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.

5.2. Swedish Tourism

Sotenäs is a small Swedish municipality with a population of only 10,000. However over 94,000 people visit the area producing over £24 million in tourist and business income. Following an oil spill in 1993, it was calculated that this lost the municipality 20% of the tourist income. Due to this substantial loss, the municipality has continued to clean the coast line to prevent a similar decline in tourism due to the presence of marine debris. They calculated that if the decrease in tourism income was only 6-7% then it would not be economically viable to continue cleaning the beaches.

5.3. Public Perception

Many local authorities assert that an area's reputation will be lost through bad press about bathing water quality, littered beaches or inshore oil spills. It is for this reason that some coastal districts choose not to enter beach awards schemes for fear of failing. However it is not known whether a resort's image is dented in its entirety or for any length of time. For example, it has been reported that Blackpool's problems with the quality of its bathing waters has had no apparent impact on the number of visitors to the area (Gilbert, 1995).

A study by Kent County Council (Gilbert, 1995), found some evidence that expectations vary with the public's perception of the locality.

Twelve percent of visitors to the port of Boulogne thought the beach to be unacceptably dirty, but at Wimereux, an upmarket resort to the north, the figure rose to 28% even though the beaches there were far cleaner than at Boulogne. Similarly, visitors to Kent were asked to rank five resorts in terms of bathing water quality. The responses showed that elegant Ramsgate was ranked first whereas downmarket Margate scored fifth, even though Margate's water was far cleaner than that at Ramsgate.

5.4. Health Related Issues

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



Plate 5.1. Syringes found on the Shetland coastline following the grounding of a klondyker.

Entanglement is also problematic, and particularly the entanglement of sports SCUBA divers in mono-filament gill nets. 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.

As part of the study into the economic costs of marine debris, several health authorities throughout the UK were contacted and questioned about the numbers of injuries occurring in their area that were caused by marine debris.

Many of the health authorities contacted reported considerable difficulty in identifying that the illness or injury recorded was caused by marine debris or that it occurred at the coast. Lothian Health Board reported that very

occasionally an accident (e.g. needlestick injury) may be discussed with one of the medical staff but that this was rare. Similarly the Western Isles were not aware of any incidents involving marine debris, however they were aware of canisters and other containers coming ashore that had the potential to cause human accidents.

Ayrshire and Arran Health Board reported that minor injuries (e.g. cuts from glass, broken cans) may be self-treated or dealt with by primary care and not recorded. There had been no reported needlestick injuries occurring on the coastline during the year. Likewise, Highland Health Authority was also unaware of any incidents occurring along its coastline during the past two years.

Surfers Against Sewage (SAS) run a unique medical database of incidents of illness believed to be caused by sewage contaminated seawater. They believe that providing evidence that individuals suffer illness due to the sewage and/or debris being present in the water will seriously tip the scales towards more stringent directives. These will be aimed at protecting the environment and the health of the beach and sea user, rather than at ease of compliance.

They currently hold references to about 862 cases of reported illness which, for ease of presentation have been separated into a number of categories:

1. Ear, nose and throat
2. Gastrointestinal infections
3. Wound infections
4. Eye irritations
5. Skin irritations
6. Chest/respiratory
7. Specific viral (hepatitis, meningitis etc.)
8. Non-specific viral
9. Other

They further analysed these cases by location and split this into 3 categories which are:

1. Designated Bathing Water that “passed” i.e. complied with the mandatory standards for total and faecal coliforms.
2. Designated Bathing Water that “failed” i.e. does not comply with the mandatory standards for total and faecal coliforms.
3. Non-designated beach or bathing water.

72% of the cases on the SAS Medical Database are from beaches that pass the Mandatory Standard for Total and Faecal Coliforms.

5.5. Conclusions and Recommendations

The complaints received from tourists are mainly about dog fouling, glass or sewage related debris. Tourists appear less concerned about general debris. It is difficult to quantify the actual numbers of visitors going specifically to beaches each year.

Recommendation 14: *Further research should be undertaken into the actual numbers of tourists visiting beaches each year.*

Recommendation 15: *Research should be undertaken into the public perception of maritime debris and what the tolerable levels are.*

Recommendation 16: *Designated areas should be dog free and / or dog waste facilities should be readily available.*

Recommendation 17: *Responsible dog ownership should be encouraged.*

Recommendation 18: *Tourist Boards should include responsible waste disposal messages in their brochures.*

Recommendation 19: *In areas of high tourist activity bottle banks should be made available. Notices showing the location of bottle banks should be placed in all local shops and hotels which sell bottled drinks.*

6. Fisheries and Marine Debris

The North Sea and Atlantic coastal waters offer a rich resource for fishermen, many coastal communities around this region having been dependent on fishing for centuries. Fishing remains one of the primary uses of the coastal zone and continues to be an important source of income and employment, especially in areas where other economic opportunities are scarce.

6.1. Commercial Fishing

Fishing vessels, along with the fish farming industry are perhaps the main sources of discarded fishing net, line, rope, crab pots, floats, fish feed bags, polystyrene blocks and fish boxes (Dixon and Dixon, 1983). In turn, the fishermen are finding an increasing amount of plastic debris amongst their catch, which not only takes time to remove, but plastic bottles and old net can themselves damage freshly caught fish and therefore are not welcome. Moreover, there have been cases whereby plastic has blocked cooling systems causing engines to overheat. In some areas around the UK, such as the Bristol Channel, the problem has reached such a state whereby fishermen, when removing plastic items entangled in their nets, voluntarily place them in plastic bin liners for disposal by the local council at their base ports (Earll and Gilbert, 1996).

Lart (1995) notes that much of what is known about the impact of litter on fishing activities is based on anecdotal evidence. His report recognised that the two major types of litter interfering with fishing gear were plastics and sewage related debris. Williams *et al* (1993) state that litter found in an offshore fishing bank caused a serious economic loss to fishermen in Swansea Bay, although 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 but no attempts have been made to quantify the extent of the problem.

Olin *et al* (1995) claim that dumping of

chemicals, including mustard gas, routinely affects local fishermen off the coast of Bohuslän in West Sweden and that catches have to be discarded when ordnance gets stuck in nets. Similarly there is anecdotal evidence suggesting that fishermen in the Firth of Clyde and North Channel often net munitions (Edwards, 1995). Stevenson (1998) reports there are cases of fishermen trawling up incendiary bombs in their nets from the area around Beaufort's Dyke which caused fires and explosions on board. The UK Ministry of Defence has confirmed that they have paid compensation to vessel owners whose nets were destroyed due to these munitions.

Problems with propeller foulings, blocked intake pipes and damaged drive shafts have been reported in the North Sea, Alaska and the East Coast of North America (Dixon and Dixon, 1981; EPA, 1989). Two studies done in the Bering Sea and the Gulf of Alaska mention that between 40% and 60% of bottom trawls collected plastic and metal debris (Feder *et al.*, 1978; Jewett, 1976).

Inshore fishing is particularly important for Orkney, Shetland and the West Coast of Scotland, where the majority of small vessels are based. Scotland's fishing industry handled 71% of all UK fish landings into the UK in 1994, with a market value of some £279.3 million, and Scotland's major fish market – Peterhead – is the largest in Western Europe. The fishing industry is also a vital source of employment in Scotland. It is estimated that there are over 8,500 people directly employed as fishermen,

with a further 13,000 employed onshore in fishing related activity. Many of these people live around the coastline of Scotland.

6.1.1. The Shetland Fishing Industry

After discussions with the Shetland Fishermen's Association, a questionnaire was designed and mailed to all of its members through their monthly mail shot. In this way, the project was openly endorsed by the association and the fishermen were more likely to respond. The fishermen were then sent a covering letter explaining the project and a simple questionnaire to establish if the fishing industry in Shetland did in fact have a problem with marine debris. The initial questions asked were:

“Have you experienced problems with marine debris accumulating in your nets during hauls?”

“Has your catch or nets ever been contaminated with the contents of containers lost at sea? (e.g. oil, pesticides, detergents)”

“Have your nets ever collected or snagged on rubbish from the seabed? (e.g. wire lines, oil industry debris)”

Of the 25 that responded, 92% had accumulated marine debris in their nets; 69% had their catch contaminated and 92% had snagged their nets on debris on the seabed. Many also mentioned problems with fouled propellers and blocked intake pipes (figure 6.1 - overleaf).

A second, more detailed questionnaire was then designed for each individual respondent to assess the cost that each vessel faced due to marine debris.

“Have you experienced problems with marine debris accumulating in your nets during hauls?”

The results indicated that plastics, old nets, wire, paint tins, oil and grease containers were frequently caught in nets. On average, 1-2 hours

per week were spent clearing this debris from the nets (table 6.1 - overleaf). Five boats also reported a restricted catch because of debris. Information was also gained on the worst areas for debris in Shetland. These included the entrances to the two main ports, Lerwick and Scalloway, and areas where klondyker activity was high. In some cases the debris problem is so bad that fishermen change location and avoid some areas altogether. One fishermen stated *‘Certain parts of Ronas Voe...the seabed is covered in plastic of every variety you care to name and it is a waste of time towing on it for that reason’*. Responsibility for the dumping of marine debris was attributed to klondykers, fish farming and in particular the oil industry. Only one fisherman mentioned that *‘this can not always be oil related as fishing vessels lose gear as well’*.

“Has your catch or nets ever been contaminated with the contents of containers lost at sea? (e.g. oil, pesticides, detergents)”

A catch could be contaminated by oil filters, paint or grease. One fisherman reported *“we picked up a drum with about 4 gallons of green deck paint which destroyed 20 boxes of fish and took us about 4 hours to clean the boat winch.”* Another commented: *“Oil filters: these are about the worst you can get; as when you empty the fish out of your gear, there is still oil coming out of the filters: this has the effect of contaminating your fish which means you have to dump your catch.”* The loss of contaminated fish was estimated by the fishermen to be worth between £300-£2,000 each time (table 6.2 - overleaf). Also associated with any contamination is the additional time taken to clean the boat and equipment of the contaminant which can take from 4 to 15 hours. For example, one vessel reported that on several occasions *“a whole shot has had to be dumped due to oil, tar or oily rags coming up in the nets. The hoppers and handling system have had to be scrubbed clean of oil.”*

INCIDENCES OF MARINE DEBRIS AND OIL IN THE SEAS AROUND SHETLAND AND ITS EFFECTS ON THE COMMERCIAL FISHING INDUSTRY

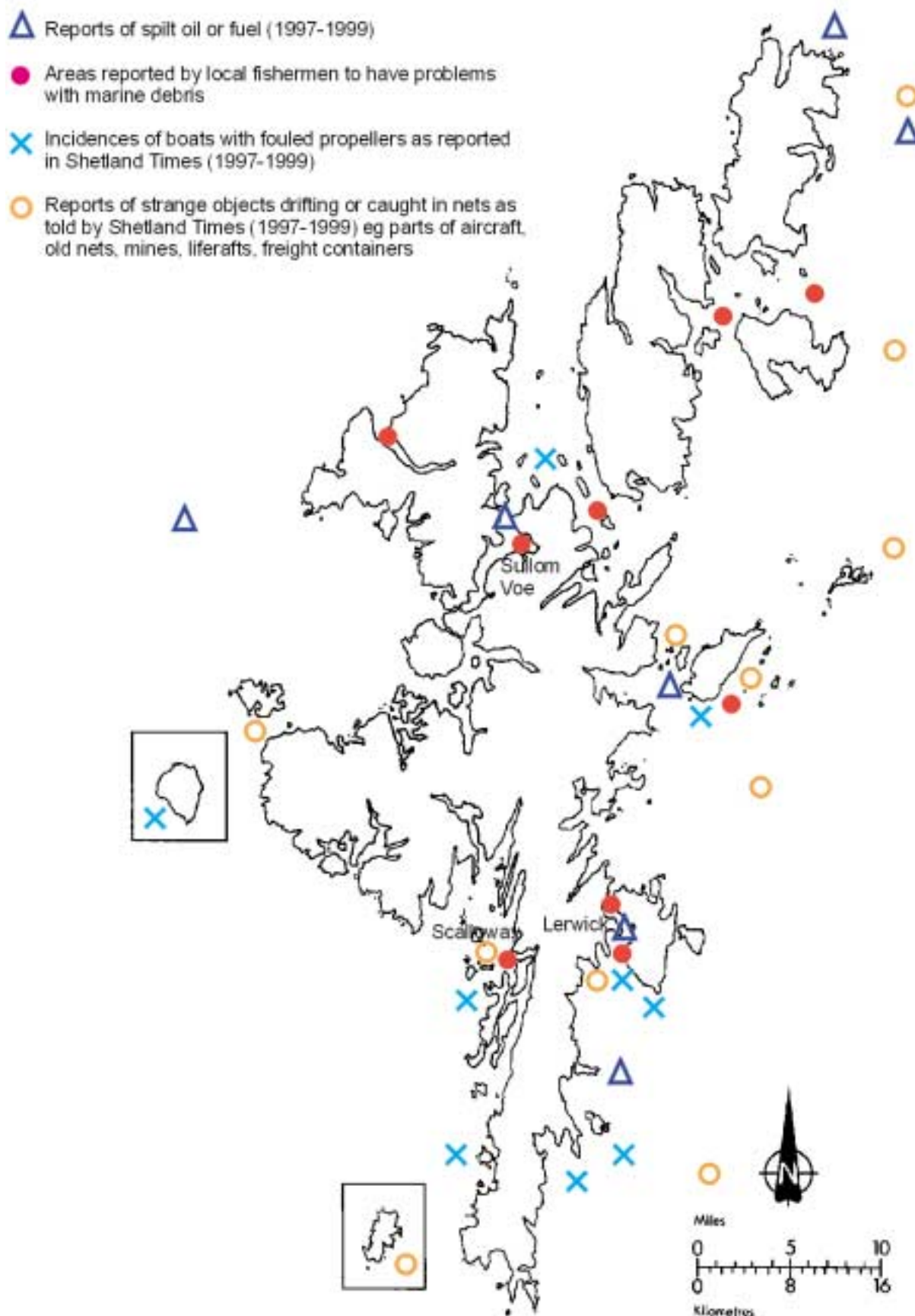


Figure 6.1. Map of Shetland, showing the problem areas for marine debris, as reported by Shetland fishermen and the occurrences of oil, fouled propellers and other floating objects as reported by the Shetland Times, 1997-1999.

Type of marine debris that accumulates in nets How long does it take to clear nets?

Vessel	Type of marine debris that accumulates in nets	How long does it take to clear nets?	Worst time of year	Worst areas	Has your catch been restricted
1	wires	4 hours/month		Colgrave Sound	yes
2	fishing gear, wires, domestic debris, polythene, containers	1 hour/week	summer	North & South of Lerwick	yes
3	wires, nets, paint tins		any	Oil pipe lines, Sullom Voe	yes
4		2 hours/week	winter		yes
5		2 hours/week		Oil areas	yes
6	nets, wire	1 hour per time	any	Scalloway	yes
7	containers, oil filters, paint tins			Colgrave Sound, Yell Sound	
8	plastic			Ronas Voe	
9	paint tins, oil drums				

Table 6.1. Summary of results from Shetland fishermen showing the types of debris accumulating in their nets, 1998.

	Value of fish that has been contaminated	Loss of fishing time due to contamination
1	£2,000	12-15 hours
2	£1,000	
3	£300	4 hours

Table 6.2. Table showing the costs of contamination of fish from marine debris as reported by Shetland fishermen, 1998.



Plate 6.1. Metal oil drum: This could cause contamination if caught in a fishing net.



Plate 6.2. Plastic strapping bands: These regularly foul propellers.

“Have your nets ever collected or snagged on rubbish from the seabed? (e.g. wire lines, oil industry debris)”

Various large items of debris were collected in the nets from the seabed. These included wire, old nets, shackles, paint tins, oil industry debris and even fish farm equipment. One vessel commented that *“Heavy wires caught in net cause danger to crew and are difficult to extract from net, thus wasting time. They require storage on deck until land is reached to off load making working difficult.”* The costs associated with repairing the nets damaged from snagging on debris on the seabed, ranged from £2,000 to over £10,000. The time lost due to this could be anything from 2 hours to 2 months depending on the severity of the incident. In extreme cases, the entire gear could be lost due to snagging on debris on the seabed and this could cost over £15,000 to replace. This would not be covered by insurance and only in one case was any unemployment benefit claimed.

Fouled propellers were generally caused by old netting or plastic strapping bands. The cost of hiring a diver to untangle this was anything from £50 to £300 per incident and up to a day could be lost due to this. In one case, an additional £100+ was spent having a vessel’s gearbox inspected to see if any damage had been done due to the entanglement (table 6.4 - overleaf).

Fishermen were also asked to estimate the value of one hour of their time. Responses indicated a range of £30-£120 per hour (average £67). Using this average figure the figure below shows what each boat would lose each year:

£3,500-£7,000	due to lost time clearing nets of debris
£250-£1,000	cleaning equipment and nets of contaminants
£100-£10,000+	due to time lost fixing nets
£60-£500	due to time lost with fouled propeller
£2,000-£10,000+	to repair nets
£50-£300	to un-foul propeller
£100	for gear box inspection
£6,000-£30,000	assuming only one incident per year and working only 40 hours per week

Using these figures we can estimate the total cost of marine debris for the Shetland fishing fleet of 164 boats. (Assuming that all the boats incur all the costs tabled above)

	Type of debris collected from seabed	Have your nets been damaged by snagging	Cost to repair them	Time lost due to repairs
1	Not Known	yes		Not Known
2	nets,wire,pieces of ships, bits of aeroplanes, coal, flares, tins, wartime shells, metal	yes	£500-£1000	5-6 days
3	nets, wire, pieces of ships	yes	£2,000	6 hours
4		yes	£5,000	2 months
5	wires, iron, nets	yes	£2,000	5 hours/week
6	wire, fish farm items	yes		2 hours
7	wire, nets	yes		Not Known

Table 6.3. Table showing the types of debris collected from the seabed as reported by the Shetland fishermen, 1998.

	Cost to unfoul propeller	Time lost due to fouling	Claim insurance?	Claim income support	Cost of one hour of lost fishing
1					£45
2	£300	1 day	no	no	£80-£120
3	£60	1 day			£100
4			no	yes	£50
5			no	no	£58
6					£30

Table 6.4. Table showing the costs of fouled propellers as reported by Shetland fishermen, 1998.

Percentage of fleet affected	Average Cost
10%	£ 98,400 - £ 492,000
25%	£246,000 - £1,230,000
50%	£492,000 - £2,460,000
100%	£984,000 - £4,920,000

6.1.2. The Esbjerg Fishing Fleet

The Fishing Association of Esbjerg stated that its members had very few problems with marine debris, as the fleet was mostly pelagic and trawled mid water; whereas marine debris appears to affect inshore fishermen and trawlers. Out of 100 boats there was only one reported incidence of a fouled propeller. Further investigation of this problem is required in Denmark.

6.1.3. The West Coast of Sweden Fishing Fleet

A preliminary survey was conducted on the West coast of Sweden by Stahre (1998, pers comm.) which investigated the costs associated with marine debris and the fishing industry in the Bohus region of Sweden. The following preliminary results from a small survey sample were found:

Fouled propeller	2,400,000 Sek	£240,000
Blocked intake pipes	280,000 Sek	£28,000
Damaged nets	700,000 Sek	£70,000
Destroyed catch	2,820,000 Sek	£282,000
Reduced catch	?	?
Total Cost	6,200,000+ Sek	£620,000+

These results show the estimated total cost to the fishermen of Bohus over one year.

6.1.4. The Oslofjord Fishing Fleet

The Oslo Fjord Fishermen's Association also stated problems with fouled propellers and fouled nets. A damaged trawl costs 45-50,000 nkr (£5,000) to replace and this is covered by insurance. Further work is required in this area.

6.1.5. Other Examples

Results from censuses at four principal harbours along the Gulf of Mexico showed that there was concern that relatively few fishermen were willing to admit that they disposed of material at sea. However, most fishermen indicated that they had considerable experience with plastic marine debris, usually observing plastics floating about in the ocean (Pearce, 1992).

Other damages involve collisions with floating debris (Takehama, 1990). Using insurance statistics, Takehama (1990) showed that, for 1985, the total number of accidents were:

69% collisions
18% engine trouble
13% entanglement

A study by Nash (1992) showed that the impacts of waste on fishing methods were all viewed as negative by fishermen. All motorboat users reported waste being caught in their propellers. Twenty-nine percent mentioned changing location or not fishing at all if too much waste was seen floating. Changing location may or may not entail a smaller fish yield but more time and energy may be necessary to reach the same yield. Wallace (1990), in her mail survey evaluating the awareness of the debris problems off the Eastern coast of the USA, found that over 45% of the commercial fishing sector has had its propellers caught in plastic, 30% has had its gear fouled and 35% has had its cooling systems clogged by plastic.

6.1.6. Waste generated by the Fishing Industry

A report by NORD (1996) investigated the waste handling practices of Faroese fishing vessels. The waste quantities were determined from crew interviews and from calculated quantities of packings from the domestic waste. The total quantity of domestic waste is estimated to be 0.5kg/person/day. On ships that were at sea for up to two weeks, the waste quantities were expected not to exceed 70-90kg (i.e. 7-9 normal

Vessel		Food Wastes	Packing	Net & yarn	Wire	Other	Oil Waste
Trawlers	Single lengths of trips max. 2 weeks	10-20 kg per trip	20-70 kg per trip	25 kg per trip	200 m per trip	Shackles etc. Gloves: 10-20 pairs per trip	2-4 tons per year
	Pair 'Shallow' water	10-20 kg per trip	20-70 kg per trip	25 kg per trip	100-150 m per trip	Shackles etc. Gloves: 15-20 pairs per trip	2-4 tons per year
	Single 'deep' water	10-20 kg per trip	50-70 kg per trip	50-400 kg per trip	300-600 m per trip	Shackles etc. Gloves: 15-20 pairs per trip	2-4 tons per year
Trawlers	Cod; salted, retail packed & frozen	300-400 kg per trip	600-1,500 kg per trip	1,500 kg per trip	1,200-1,500 m per trip	Steel balls, shackles etc. 6-8 tons Gloves: 100-200 pairs per trip	2-4 tons per year
	Shrimp	200-300 kg per trip	600-1,000 kg per trip	1,500 kg per trip	1,200-1,500 m per trip	Steel balls, shackles etc. 6-8 tons Gloves, rags etc.	2-4 tons per year
Long-line	Length of trips max. 3 months	10-20 kg per trip	600-800 kg per trip	Minimal	—	Gloves: 10-20 pairs per trip. Rags etc.	1-2 tons per year
	Length of trips max. 2 weeks	10-20 kg per trip	20-70 kg per trip	Minimal	—	Gloves, rags, etc.	1-2 tons per year
Net	Length of trips max. 2 weeks	10-20 kg per trip	20-70 kg per trip	5-15 bags per trip	—	Gloves: 10-20 pairs per trip. Rags etc.	1-2 tons per year
Line	Length of trips max. 2 weeks	10-20 kg per trip	20-70 kg per trip	Minimal	—		
Small Boats	1-2 days	Minimal	Minimal	Minimal	—		

Table 6.5. The estimated amounts of waste generated by Faroese fishing vessels as compiled by NORD, 1996

garbage bags). On ships whose trips last for up to 4 months, the total waste quantity would reach approximately 1,500-2000kg, corresponding to a volume of 75-100m³. Such quantities will present a storage problem unless compacted, in which case the volume will be reduced to a maximum of 15-20m³.

The study found that deep-sea trawlers may purchase between 1,314–2,848kg of net, 12,141-16,000m of wire and 537-641 kg of nylon yarn to repair nets. There was general agreement that nets should not be thrown into the sea. However this was done on a few ships and the net was weighed down with heavy objects such as wire or shackles. There was also widespread agreement that wire, shackles and other steel objects would cause no harm if thrown in the sea. Common statements were *‘wire and other steel rust away in no time’* and *‘discarded wire is never seen again’*.

6.2. Aquaculture / Fishfarming

Aquaculture has been one of the most significant new industries to emerge in Scotland, particularly in the Highlands and Islands, over the past 25 years. The aquaculture industry is mainly concentrated in the sealochs of the west coast, the Western Isles and the sheltered voes and inlets of Orkney and Shetland. Since the early 1980s, Atlantic salmon farm production in Scotland has developed rapidly with 119 companies, employing a total of 1226 workers and producing a total of 64,066 tonnes of salmon in 1994. The Scottish Industry faces severe competition particularly from Norway and its economic future is of central importance to many remote coastal communities.

Litter arising from the fishfarming industry has until recently been under direct control of individual managers. However, a new incentive is now in place which may go some way towards combating this particular source of pollution. This is the Quality Assurance Scheme run by Food Certification, Scotland which will ensure

twice yearly inspection of farm sites and included in the quality criteria is the need for an effective waste disposal system at each site.

6.2.1. The Shetland Fish Farming Industry

Using the same methodology as for the Shetland fishermen, Shetland Salmon Farmers Association was first approached for initial discussions about the project. Following this an introductory letter and questionnaire was sent out to firms in Shetland. The initial questions asked were:

- Does marine debris accumulate in your salmon cages?
- Have your nets or salmon stock suffered contamination from marine pollution? (e.g. oil, pesticides)
- Has there been any damage to your boats or other equipment due to marine debris? (e.g. anchor fouling, entangled propellers)

In general, salmon farmers agreed that marine debris was less of a problem to them than to the commercial fishermen in the area. Of those responding (15), only six firms reported litter accumulating in cages and three reported stock or net contamination (figure 6.2). Netting, rope and wood was found inside the cages and on average 1 hour per month was spent clearing this debris. One firm reported an *“ongoing problem of fishing net debris and rope tangling in surface fixtures”* and *“occasional problems with wooden spars and pallet fragments tangling in nets”*.

The main problem was that of propeller entanglement or blocked intake pipes. One salmon farmer commented that it was difficult to estimate the time lost due to fouled propellers or blocked intake pipes but there was *“much need to be vigilant to avoid plastic bags and net from fouling intakes as this can be costly”*. The average cost of hiring a diver to un-foul a propeller was £150. However up to

SALMON FARMS AFFECTED BY MARINE DEBRIS IN SHETLAND

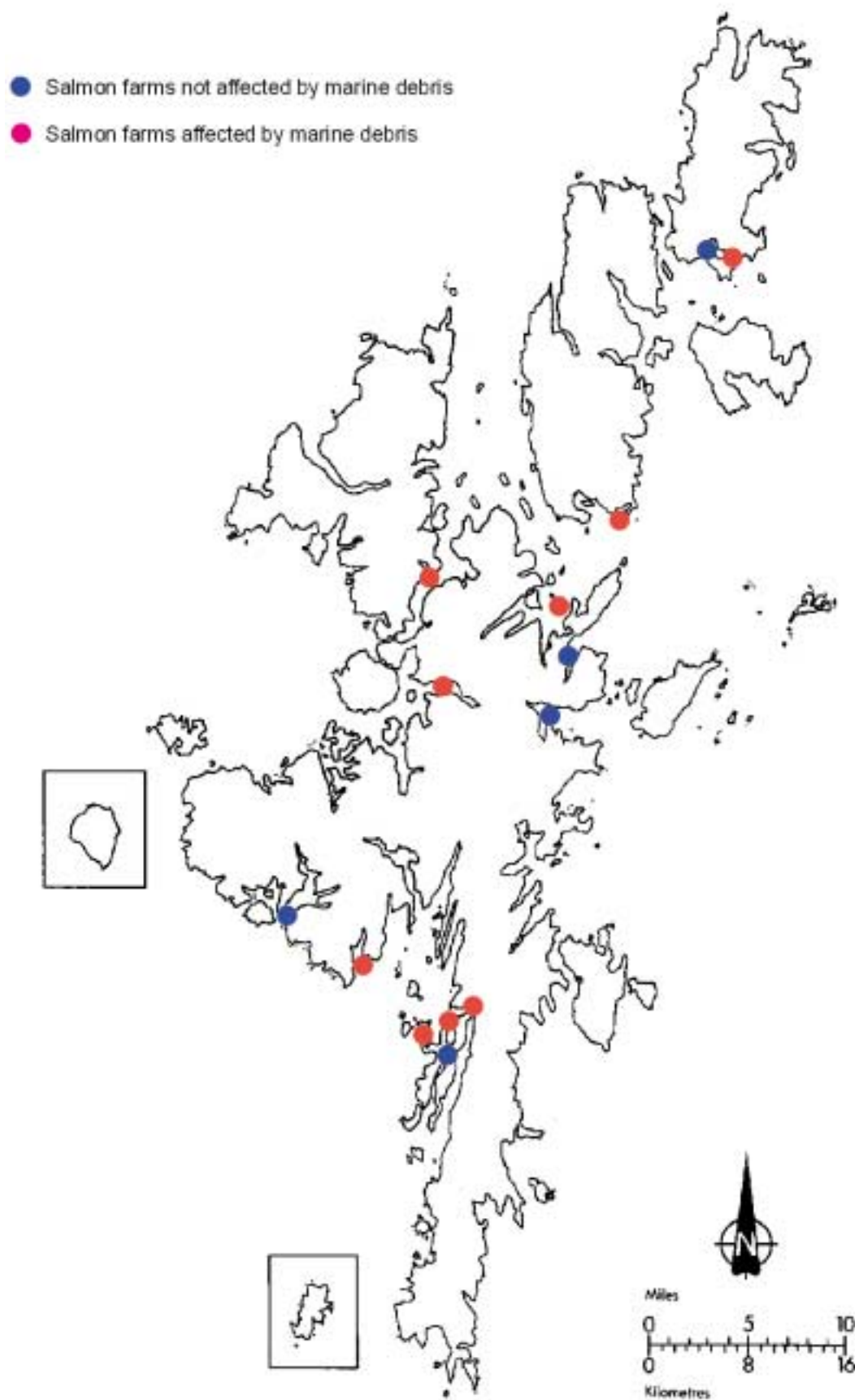


Figure 6.2. Map of Shetland showing the locations of responding salmon farms which have been affected by marine debris.

£1200 could be paid if the propeller needed to be repaired or replaced. For example, one firm reported damaging an outboard motor propeller on a plastic box which was floating in the water. The loss of one hour was estimated to be worth up to £80.

6.2.2. Fish Farming in the UK and Ireland

Of the salmon farms that had been contacted in Ullapool, Skye and Northern Ireland; only one farm reported accumulation of debris in their cages. A firm in Northern Ireland noted that *“although we get occasional debris accumulation at the cages, this is more often that not removed by the strong currents that prevail”*. None of the farms had suffered any contamination from pollution and had not had any problems with fouled propellers.

6.3. Conclusions and Recommendations

Discarded nets and ropes continue to be a problem both on beaches and to the fishing industry. There is still a lack of concern about marine debris by the fishing industry. Although it is regularly affected by old nets and ropes, it refuses to admit that the industry itself may be the cause of this debris. The industry still prefers to blame the oil industry with one fisherman reporting that he could *“Cope with discarded nets from other fishing boats but something should be done about the oil industry debris”*.

Recommendation 20: Education about the effects of marine debris to the fishing industry and the environment should be included in fisheries and seamanship courses. (e.g. skipper's ticket etc.).

Recommendation 21: Waste management education should be made mandatory in all maritime courses.

Recommendation 22: The practicalities and cost of net recycling should be investigated.

Recommendation 23: Net reuse should be investigated. For example: the secondary use

of nets to cover bin bags to prevent seagulls tearing them open. In America nets have been used as decorations in bars and restaurants.

A year and a half pilot program was conducted in the Port of Newport, Oregon (1987-1988) in an effort to understand the means by which compliance with the anticipated marine debris laws could be accomplished in a fishing port. This program involved an advisory committee made up of commercial and recreational fishing interests, the port and marina operators, the refuse company, Coastguard and State and local enforcement officers and other community members. Fishermen's involvement in the program led to peer pressure, industry pride, and competition to bring back all their refuse. The program encouraged recycling as a way to increase the services available to fishermen and to lower recycling costs. Even if items could not be recycled, many items were reused by others. For example, nets were in great demand for decoration, baseball backstops and gardening, while fishing 'troll' line wire made great picture framing wire. Fishermen also liked the recycling bins as they often found items that were useful when they were making boat repairs.

Recommendation 24: Fishermen should be encouraged to bring all their rubbish ashore and any additional rubbish that accumulates in their nets. This could be promoted by allowing a reduction in port fees for vessels returning all their wastes.

Recommendation 25: Fishermen and other sea goers should attempt, where possible, to reduce the amount of packaging taken to sea.

Recommendation 26: Maritime suppliers should be encouraged to provide supplies that have minimal packaging.

Fish boxes are still a big problem both discarded on beaches and floating in harbours. Some fishing companies pay a return fee for the return of discarded fish boxes.

Recommendation 27: *There should be an universal deposit scheme set up to encourage the return of all fish boxes.*

In many areas Klondykers have been seen to be the cause of substantial amounts of debris.

Recommendation 28: *Harbour Authorities should provide literature to these and other foreign vessels explaining the legislation in force and resultant penalties when debris is disposed of improperly and the procedure for the disposal of various wastes.*

Recommendation 29: *Fish farmers should also be encouraged to bring in waste seen floating in their cages.*

Recommendation 30: *Fish farmers should be encouraged to take additional care when*

disposing of their own waste (e.g. feed bags).

Many fishing boats complained of contamination from oil filters or oily rags.

Recommendation 31: *This problem should be publicised throughout the industry so that more boats are aware of the problem and take better care of items used when changing oil themselves.*

Plastic strapping bands are also a severe problem on beaches and in the water. They are also a key factor in the entanglement of animals and birds.

Recommendation 32: *An investigation should be made into making plastic strapping bands bio- or plastic-degradable such as six-pack ring holders.*

7. The Shipping Industry and Marine Debris

The waters around the UK coast include some of the world's busiest sea lanes. At any one time there are 5,000 ships operating in the North Sea. Indeed, there are few areas of its coastal waters without significant shipping traffic. Of the pollution incidents that are caused by shipping, media attention tends to focus on major oil spills such as the Braer (1993) and the Sea Empress (199). However the majority of marine pollution from shipping is actually caused by the day to day operation of merchant ships, fishing vessels and leisure craft.

7.1. Harbour Authorities

Despite the regulations prohibiting disposal of debris and oil at sea, harbours still suffer from accumulation of debris within their boundaries and vessels using these areas are still at risk of fouling their propellers or anchors due to debris. In order to assess how marine debris and oil affects the running of harbours various port authorities were contacted initially throughout the UK and Ireland.

Questionnaires were sent to 95 harbours around the coast of UK and Ireland. The harbours varied in size and use from small fishing harbours to large commercial container ports. Of these, 42 harbour authorities responded.

Each harbour authority was asked the following questions:

1. Whether the users of your harbour have had any incidents with marine debris (e.g. entangled propellers, fouled anchors, blocked intake pipes) and if so, the average number of incidents occurring each year?
2. Any additional costs that you as a harbour authority have had due to marine debris (e.g. manual removal of debris, hire of divers, additional dredging)?
3. Whether you have recurring problems with a particular type of debris (e.g. fishing nets, paint tins)?

7.1.1. Fouled Propellers and Anchors Fouled propellers

Of the harbour authorities responding, 82%

reported incidents of vessels fouling their propellers with marine debris (table 7.1). Over 180 incidents involving fouled propellers were reported by the harbour authorities to have occurred during 1998 (figure 7.1). Most foulings were as a result of old fishing nets or rope, although fish boxes and old tyres (which have been used for fenders) also caused many entanglements. Incidents of this type were most frequent in busy fishing ports such as Peterhead^(SCO) and Macduff^(SCO). Removal of debris from propellers was usually undertaken using diving services at a cost of between £100 and £400 per incident. Assuming the average cost per incident as £280, the reported number of 182 foulings per year costs UK harbour users £50,960. This figure is in reality much higher as many harbours did not have figures for the number of propeller entanglements happening each year. In other cases the entanglement required the vessel to be lifted out by crane. The Harbour Master of Swansea Port^(ENG) reported that during lifting operations, vessels can sometimes be damaged, resulting in an associated cost of £4,000.

Many harbours reported that their own pilot boats or tugs had been affected by fouled propellers and noted that there is potentially a risk of delays to vessels entering the harbours due to a loss of this service while the propeller is cleared. For example, Barry Harbour in Wales, reported that they expected two days downtime a year as a consequence of removing items from the propeller shafts of their pilot cutter. As well

INCIDENCES OF PROPELLER FOULING EACH YEAR IN HARBOURS

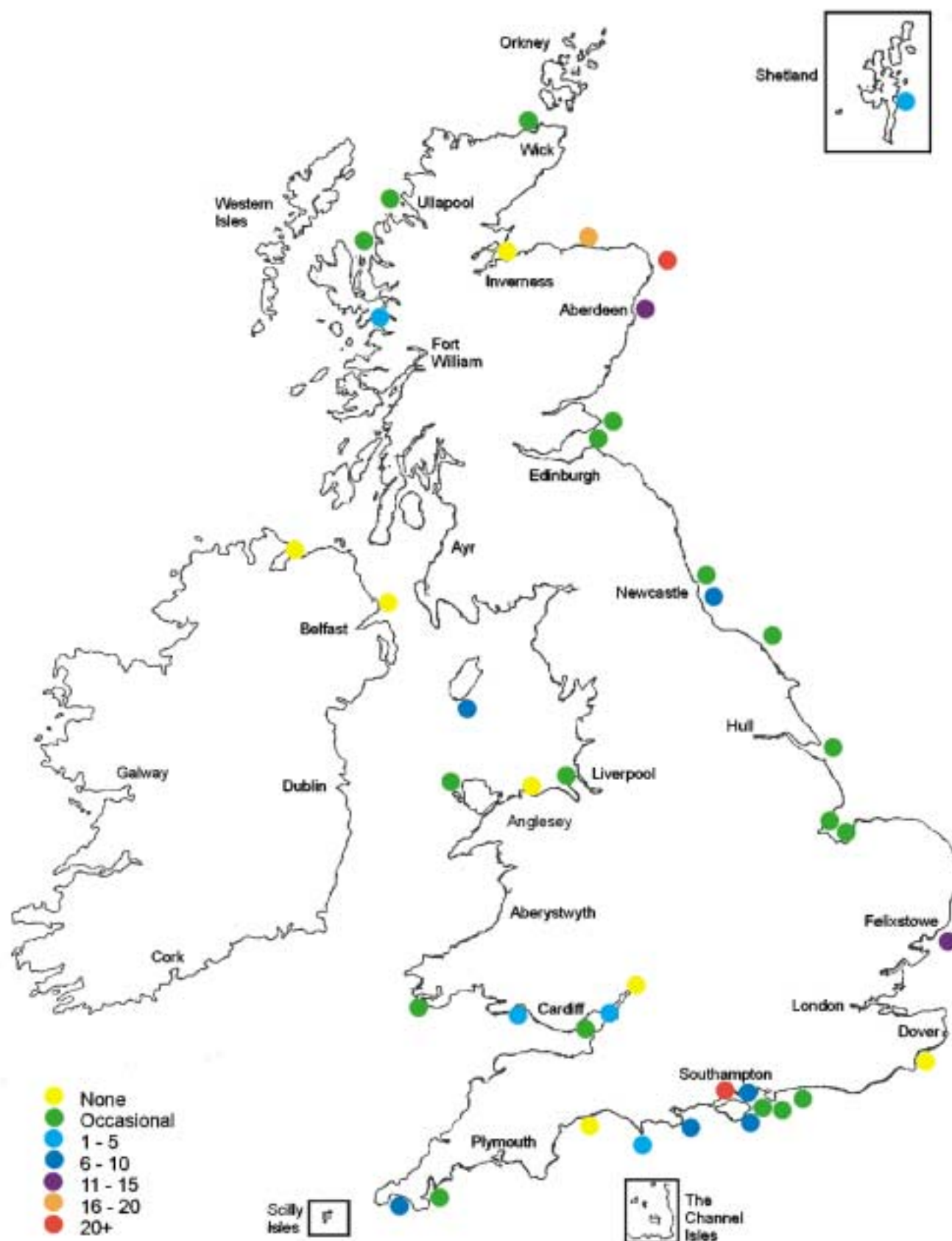


Figure 7.1. Map of UK showing the locations of harbours that have reported occurrences of fouled propellers

Harbour	No. of fouled propellers	What are the propellers fouled with?	Clearance method	Cost of Diver per incident
Aberdeen	10	Net, tyres, fish boxes		
Anstruther	Occasionally			
Boston	Occasionally			
Brightling sea	0			
Bristol	3	Ropes, plastic bags	Diver	£400
Cardiff	Occasionally	Rope, net	Crane/diver	
Carrick	Occasionally			
Chichester	Occasionally	Rope, net, bags		
Conwy	0			
Cowes	5			
Dartmouth	0			
Douglas	6	Nets	Diver	
Felixstowe	12	Rope		£300
Gairloch	Occasionally	Nets		
Garston	1			
Gloucester	0			
Hamble	6			
Hartlepool	1	Wood		
Holyhead	Occasionally	Rope		
Hull	Occasionally	Rope		
Invergordon	0			
King's Lynn	0			
Kinlochbervie	Occasionally			
Larne	0			
Lerwick	10	Net, rope, fish boxes	Diver	
Littlehampton	Occasionally	Rope		
Londonderry	0			
Macduff	20	Net, rope	Diver	
Montrose	1		Diver	
Penzance	10			
Peterhead	52	Net, rope		
Pittenweem	Occasionally			
Poole	6		Diver	£300
Port Talbot	3			
Portsmouth	Occasionally			
Scrabster	2	Tyres		
Seaham	4	Net, tyres	Crane	
Southampton	24	Net, rope	Diver	£300
Sunderland	Occasionally	Plastic sheeting		
Swansea	3	Net, rope	Crane	
Tenby	Occasionally	Rope		
Uig	3		Diver	£100
Weymouth	Occasionally			
Whitby	Occasionally			
TOTAL	182			

Table 7.1. Table showing details of the occurrences of fouled propellers in UK Harbours.

as the cost of hiring a crane or divers, an additional cost is incurred as they have to hire a replacement craft to cover .

In Felixstowe^(ENG), two companies providing towage and port operation services, have suffered propeller damage due to contact with wood. This costs £5,000 every 2 – 3 years for propeller refurbishment. They also reported that fishing line can be an extreme nuisance when it wraps itself around the prop shaft and into the stern seal. Several harbour authorities stated that many incidents were not reported to them and that the individual vessels dealt with the problem themselves.

Fouled Anchors

Captain Philip McParlin, whilst working as the Harbour Master in Killybegs, County Donegal, illustrated the problem of fouled anchors by describing how a 130m reefer ship at anchor was unable to put to sea when the weather turned bad because of an anchor fouled with warp. After an anxious night, the weather moderated and the vessel was able to slip the warp. Because of this debris, a serious accident was only narrowly avoided.

7.1.2. Clearance of Debris from Harbours Seabed Debris

In 1995, Uig Harbour, Isle of Skye^(SCO), employed a team of divers to remove debris from the fishing berth. Over 120 tyres, 12 lengths of wire and five 1 tonne boulders were removed, filling two skips. Additional waste included, clam dredges, trawl doors and creels. Divers are hired annually in Scrabster Harbour^(SCO) to conduct a bottom clearing exercise whereby they recover old tyres from the sea bed. This costs the Harbour Trust between £1,500-£1,700 each year (table 7.2 - overleaf).

On two occasions Pittenweem Harbour, Fife^(SCO) had to remove a tangle of seaweed and ropes from the main channel at a cost of £300 each

occasion. The Hamble Harbour^(ENG) has also on occasion had to hire divers to survey and remove debris. The Port of Invergordon^(SCO) removes anchors and industrial units dropped from rigs in port for repair, however the cost of this is borne by the rig owners (figures 7.2 and 7.3 - overleaf).

Floating Debris

Aberdeen Harbour^(SCO) is patrolled daily by its work boat and any floating debris is removed. It reports that plastic fish boxes are a particular problem as they have a neutral buoyancy and often lie just below the surface which is the ideal height for fouling propellers or bow thrusters. Its Operations Department collects debris from the quaysides or the water and takes it to approved landfill sites. This costs the Harbour in the region of £15,000 per year. Scrabster Harbour Trust^(SCO) also reported a large problem with plastic fish boxes being blown or deliberately dropped overboard. Their pilot launch may be away 3 or 4 times a week collecting them. The Port of Seaham^(ENG) reported that tyres and fishing nets had to be removed from the harbour entrance during the salmon season.

7.1.3. Other Incidents

Whitby^(ENG) Harbour Master reported that his yacht pontoon had been damaged by large debris. King's Lynn^(ENG) Harbour operates enclosed docks that occasionally can be fouled by debris. In some cases divers may be called out to investigate. The Port of Sunderland^(ENG) also reported that debris affects its impounded dock system. The debris congregates behind the dock gates and the Port spends a considerable amount of time removing and disposing of the debris so that the gates can be opened at tide time.

Felixstowe^(ENG) Port Authority noted that not all incidents were caused by marine debris with some being caused by the vessel's own staff and equipment.

Harbour	Clearance of Debris	Cost	Type of Debris	Other costs
Aberdeen	1x per day	£2,500	Fish Boxes, tyres	Dredging
Anstruther	90 hours/year		Containers, rope, fishboxes	
Boston	Unknown			
Brightling sea	None			
Bristol	Unknown			
Cardiff	Unknown	£1,500	Ropes, tyres, nets	Old Boats Sinking
Carrick	Unknown			
Chichester	Unknown		Wood, litter	
Conwy	None			
Cowes	Unknown			
Dartmouth	None	£500		
Douglas	Unknown		Nets, ropes	
Felixstowe	Unknown			
Gairloch	Unknown		Oil drums	
Garston	50 hours/year		Wood, plastic sheeting	
Gloucester	None	£500		
Hamble	Unknown		Wood, bags	
Hartlepool	4x per year		Wood	
Holyhead	None			
Hull	Unknown			
Invergordon	Occasionally	£720	Wood	Hire of Divers
King's Lynn	Unknown		Wood	
Kinlochbervie	1x per month		Tyres	
Larne	None			
Lerwick	20 hours/year		Nets, fish boxes	
Littlehampton	3 hours/month	£1,000	Wood, trolleys	Dredging
Londonderry	None			
Macduff	Unknown			Dredging
Montrose	Unknown		Rope, nets, plastic sheeting	
Penzance	Annually		Plastic	Hire of Divers
Peterhead	3 hours/day	£2000+	Nets, ropes, fish boxes	Dredging & Divers
Pittenweem	90 hours/year		Containers, rope, fishboxes	Hire of Divers
Poole	1x per week		Litter	
Port Talbot	Unknown			
Portsmouth	Occasionally		Containers	
Scrabster	4x per week	£500	Fish boxes, nets, bottles	Hire of Divers
Seaham	Unknown		Nets, tyres	
Southampton	Unknown			
Sunderland	3 hours/week		Plastic bags, sheeting	
Swansea	Unknown			
Tenby	Unknown			Hire of Divers
Uig	Unknown		Strapping bands	
Weymouth	3x per year			
Whitby	Unknown		Wood	

Table 7.2. Table showing details of the removal of marine debris from UK Harbours, 1999

TYPES OF DEBRIS FOUND IN HARBOURS AND MARINAS

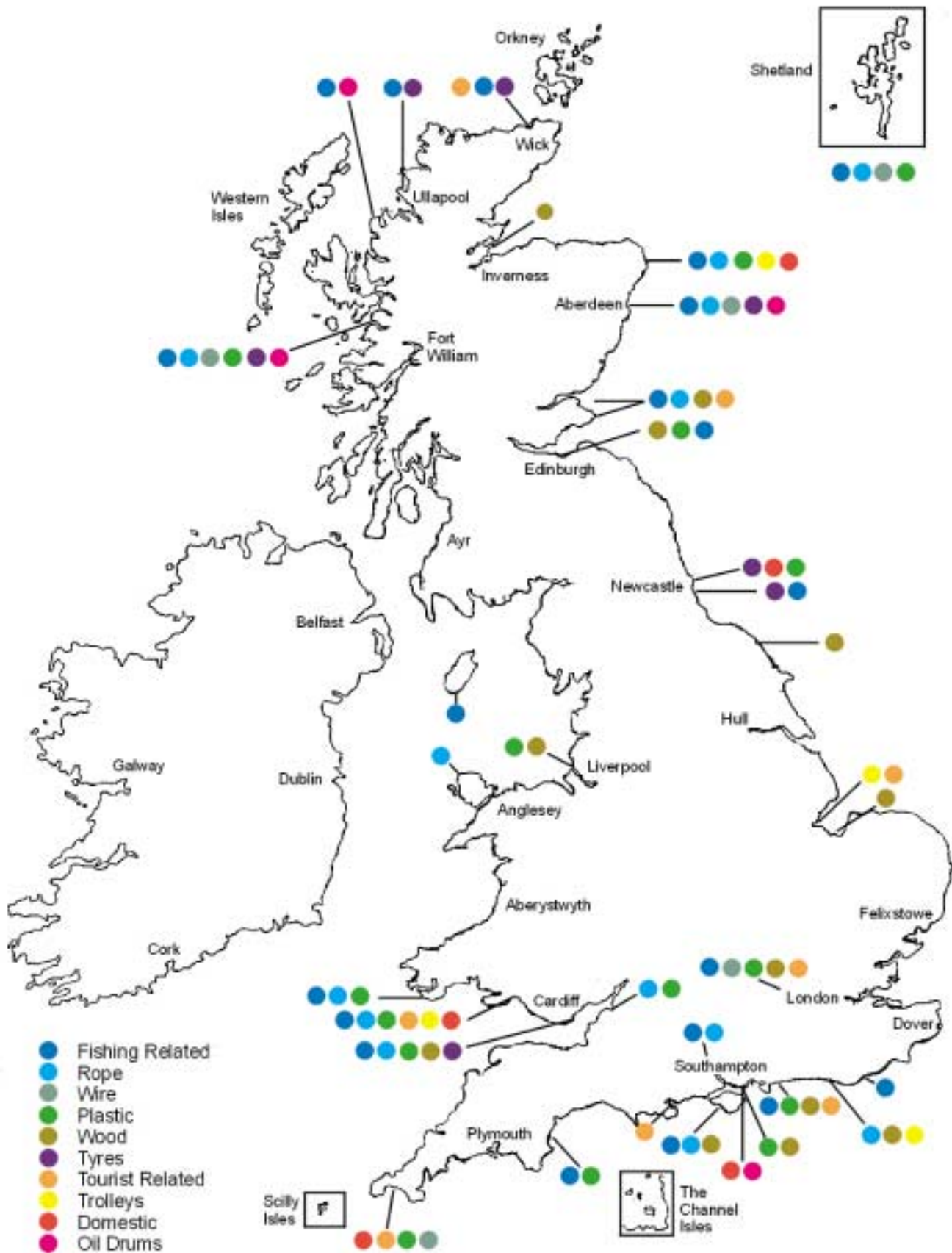


Figure 7.2. Map of UK showing the types of debris that are repeated found in various UK harbours.

REMOVAL OF DEBRIS FROM HARBOURS: COSTS AND TIME

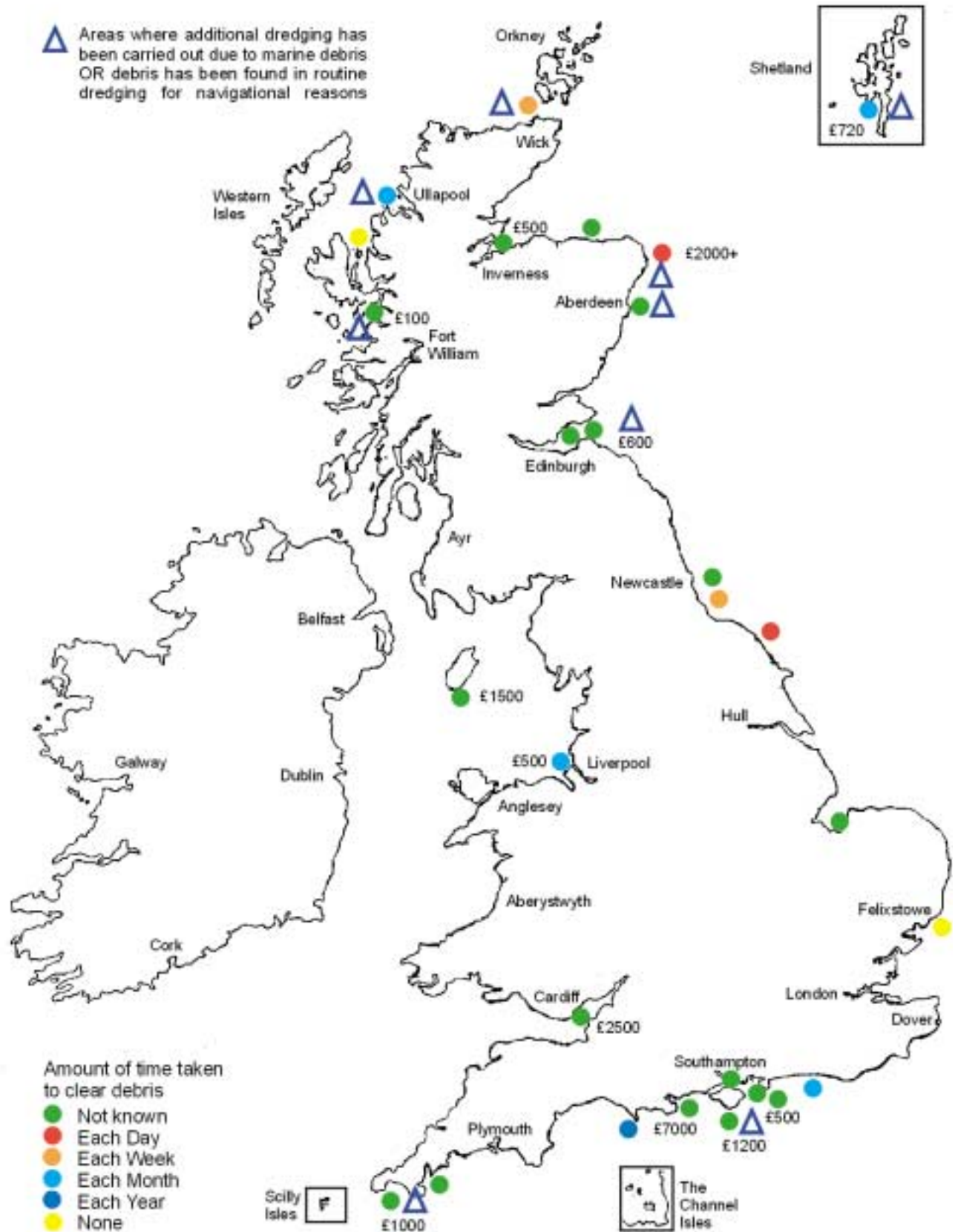


Figure 7.3. Map of UK showing the amount spent by various UK harbours to remove marine debris.

7.2. Examples from Specific Ports

7.2.1. Lerwick Harbour Trust

Lerwick in Shetland^(SCO), is a major North Sea port with 3,700 vessels visiting the harbour in 1996. The Harbour Trust cleans the internal harbour manually as necessary with a cost of £720 per year. In addition to this, the harbour is dredged annually to remove old wires and other debris that have become a navigation hazard. Problems encountered in the harbour include fouled propellers and anchors and blocked intake pipes. For example, the oil tanker 'Alanda Orient' had its propeller fouled by a net and the cruise liner 'Crystal Harmony' fouled its anchor on an old wire and was delayed by four hours. If a boat is hindered by marine debris, it may require the harbour tugs for a tow or to lift anchors. This can cost between £108-£308 per hour.

7.2.2. Esbjerg Harbour

Esbjerg Harbour Authority^(DEN) also reported problems with fouled propellers and they dredge the harbour annually to remove old wires. The harbour separates garbage into recyclables and collects old nets for incineration. The cost of removing the garbage for the fishing area of the port was 573,000dkr (£57,300) in 1996.

7.2.3. Göteborg Harbour

Göteborg Harbour has set up 10 'environment stations' around the port to encourage vessels to dispose of items such as oil, batteries, fluorescent bulbs and waste rags correctly. They



Plate 7.1. Environmental recycling station, Göteborg Harbour, Sweden

also separate combustible (e.g. general garbage) from non-combustible (e.g. wire). Waste paper and iron are also recycled. In 1997 the port began environmental training for all staff and all employees were given the opportunity to state their view on environmental aspects of the port.

7.3. Waste Generated by the Shipping Industry

A study commissioned by the UK Marine Safety Agency (now Maritime and Coastguard Agency) assessed the amounts of waste generated by North Sea vessels and the disposal procedures for such wastes (ERT, 1995). The study found that waste handling throughout the shipping industry of the North Sea tends to vary from country to country and from port to port. Some vessels may operate to fixed schedules and only visit a few major ports during their travels. Some operators had taken a proactive approach and operate waste segregation schemes and recycling of certain wastes. However this is not the case throughout the entire shipping industry and there are many operators who do not have prearranged waste disposal facilities for when they arrive in port, either because they do not operate to fixed schedules or may not know their next destination.

The study found that galley and domestic wastes from the shipping industry in the North Sea ranged from less than 1kg/person/day to 4kg/person/day. Another study by Norske Veritas (1994) estimates the amount of domestic waste produced to be between 1.4kg/person/day for freighters up to 2.1kg/person/day for passenger vessels. The 1kg/day figure is similar to the amounts of domestic waste generated onshore in the UK. It is estimated that plastic materials constitute approximately 20% of the waste (ORCA, 1994). In 1995, port facilities were highly variable both for oils and garbage, with the onus on vessel operators and managers to ensure safe or adequate disposal of operation wastes. Information and awareness relating to the handling of wastes on vessels is regarded as

variable, with some companies having highly detailed systems and others essentially nothing.

7.4. Port Waste Management Planning, UK

In January 1998, a new regime for port waste reception facilities came into force. Its aim is to ensure that ships' wastes can be discharged in ports as quickly, simply and cheaply as possible. This removes any excuse for illegal discharges at sea. It also will ensure the necessary change in culture in terms of waste management, away from the users of the port to the port management to promote a more proactive approach.

The MARPOL convention simply requires States to ensure the provision of waste reception facilities which are 'adequate' and which do not cause undue delay to the ships that use them. The UK Government believes that the facilities should meet the needs of their users and of the environment. Ports should attempt to remove as far as possible any disincentives towards their use. In particular, facilities should:

- Cater for all types of waste which are usually landed at the port
- Be conveniently located and easy to find
- Be easy to use
- Be reasonably priced, or preferably not subject to a direct charge for use
- Be periodically reviewed to ensure that they remain adequate

In his report into marine pollution, Lord Donaldson (1994) argued that the costs of using the facilities should be recovered through an indirect means which could not be evaded, such as port and harbour dues. This would ensure that vessels which do not use waste reception facilities in order to avoid paying, would be forced, for the first time, to pay for waste reception facilities through general dues. However, research has shown that some ship operators place much more importance on the

time it takes to use a facility, rather than its immediate cost.

7.4.1. Peterhead Harbours^(SCO)

The Harbour Authority estimated the following skip contents:

Vessel waste	10%
Wire	5%
Fishing nets	25%
Plastic	15%
Paper	15%
Wooden Pallets	5%
Paint tins	5%
Unauthorised House rubbish	20%

Consideration was given to recycling but it was decided to be impractical because of the mixture of wastes involved. There was initial reluctance by a minority of fishing vessels to pay per landing but all agreed after discussions.

Costs and provisions of facilities to Harbour Authority

Costs of skips, including landfill	£31,000 pa
Costs of drum disposal	£ 1,000 pa
Cost of waste oil disposal	free
Labour 2 men cleaning quays & collecting waste	£20,000 pa
Total costs of facilities provided by harbour	£52,000 pa
Charge to each fishing vessel per landing	£3

(It was considered that the small charge to fishing vessels would be an incentive to land waste. However, the charge does not cover the costs to the Harbour Authority.)

The waste plan was publicised by displaying it around the harbour and notices were also given to all cargo ships via their agents. Every fishing vessel has tally books with details on the reverse of the correct method for disposal of waste.

7.4.2. Aberdeen Harbour^(SCO)

A copy of Aberdeen's Waste Management Plan is given to all regular vessels using the port and

to all local agents or owners. As part of this plan, nineteen 8m³ skips are placed at convenient sites around the harbour. This service is free to the port user but costs the harbour around £55,000 per year to operate. The domestic waste from P & O Ferries is segregated from paper, wood and scrap metal.

7.5. Education and Improvements

Marine debris, in particular fishing debris, used to be a serious problem for Kinlochbervie^(SCO) Harbour. Through an education program the local fishermen are becoming better at disposing of their waste in the skips provided and only the odd tyre has to be retrieved now.

Since the introduction of skips through the Penzance Harbour^(ENG) Waste Management Plan, the harbour has seen a decrease in the amount of plastic that is disposed of improperly.

The estimated net loss in the Bering Sea and the Gulf of Alaska during 1980-83 was 35-65 nets lost by 300-325 trawlers (Low *et al.*, 1985). Merrel (1980), estimated that 1,635 tonnes of fishing gear was lost off Alaska and 135,000 tonnes per year lost world-wide.

Disposal of nets is a major problem world wide, in that there are many countries without national infrastructures for recycling them. However, fishermen in Alaska and Washington have developed a regional infrastructure for recycling their nets. Over 680 tonnes of gillnet webbing is recycled annually. It is sold to Taiwan and Hong Kong for use in bicycle seats, electronics and appliances parts, kitchen utensils and other items (F.I.S.H. Habitat Education Program, 1994).

7.6. UK Marinas

In general, there appear to be more reports of fouled propellers to marina managers than to

harbour masters. This may be because the marina may directly be asked for assistance to remove the debris whereas in a harbour a boat owner may go to an outside firm. There is a corresponding link between the increase of recreational vessels and the reported increase of propeller foulings. For example, Torquay Marina^(ENG) expects 40 visiting boats a night in the summer in addition to the 500 boats which are resident there. It has on average 4 incidents of propeller fouling a week which is actually only a small percentage of the boats using its facilities.

Newhaven Marina^(ENG) reported that its users generally fouled their propellers while operating close inshore. While Port Edgar Marina^(SCO) noted that there was an ever-present risk of propeller fouling on the Firth of Forth, mainly due to broken plastic sheets, dropped by contractors working on either of the two Forth Bridges. Halcon Marine, Essex^(ENG) also report that plastic is an ever-increasing hazard for prop fouling and blocked intake pipes. Torquay Marina^(ENG) report that its cleaning schedule has been reduced due to better waste management from boat owners. In 1985 it used to have to clean the marina daily and now it only requires weekly cleaning (Figure 7.4 and Table 7.3 - across and overleaf).



Plate 7.2. Marina in Oslofjord, Norway

INCIDENCES OF PROPELLER FOULING EACH YEAR IN MARINAS



Figure 7.4. Map of UK showing the locations of incidences of propeller fouling as reported by UK marinas.

Marina	No. of Propellers Fouled	Clearance of Debris	Cost	Type of Debris
Barry Yacht Club	occasional			Plastic Bags, Wood, Seaweed
Cowes Yacht Haven	12			Ropes, nets and wood
Halcon Marine, Essex	12	1hour/week		wood, litter
Maryport Marina, Cumbria		6hours/day		Containers, litter
Newhaven Marina, E. Sussex	occasional			Nets
Port Edgar, Edinburgh	occasional			Plastic, wood, nets
Suffolk Yacht Harbour	10	50hours/year		
Swansea Marina	occasional	daily	£10,000	Containers, litter, wood
Torquay	200+	weekly		Fishing Debris

Table 7.3. Table showing details of the occurrences of marine debris in UK marinas, 1999.

7.7. Rescue services

7.7.1. RNLI and UK Coastguard services

The Royal National Lifeboat Institution (RNLI) is a registered charity which exists to save lives at sea. It provides, on call, the 24-hour service necessary to cover search and rescue requirements out to 50 miles from the coast of the United Kingdom and the Republic of Ireland. There are 219 lifeboat stations and an active fleet of 296 lifeboats.

In 1998, RNLI lifeboats attended over 200 incidents around the British Isles where the casualty suffered a fouled propeller (figure 7.5). The rescues were divided equally between commercial fishing vessels and pleasure craft (figure 7.6 - overleaf). HM Coastguard, which co-ordinates the rescues, recorded that the highest numbers of all incidents were recorded in the south east and south west during the summer months, and the majority of those related to maritime leisure activities. This is verified by data from the RNLI which shows increases in rescues to recreational vessels with

fouled propellers during the summer months (figure 7.7 - overleaf).

Eleven percent of fouled propeller rescues were to vessels in life threatening situations and 53 lives were saved (figure 7.8). Other rescues were undertaken to people and vessels in danger, but were not life-threatening (22%), and to vessels that were in no danger but in order to prevent future additional incidents (67%).

In 1999, it will cost £81 million to run the RNLI. The direct costs of launching a lifeboat are relatively small and consist of crew allowances and fuel. The average cost of launching a lifeboat is about £5,800 for an all weather lifeboat and £2,200 for an inflatable inshore lifeboat. This includes the running costs of a lifeboat station i.e. stores, lifeboat maintenance, and station maintenance, but does not include the substantial cost of depreciation of the lifeboat. Therefore to undertake 230 rescues a year to vessels with fouled propellers costs between £506,000 to £1,334,000 each year.

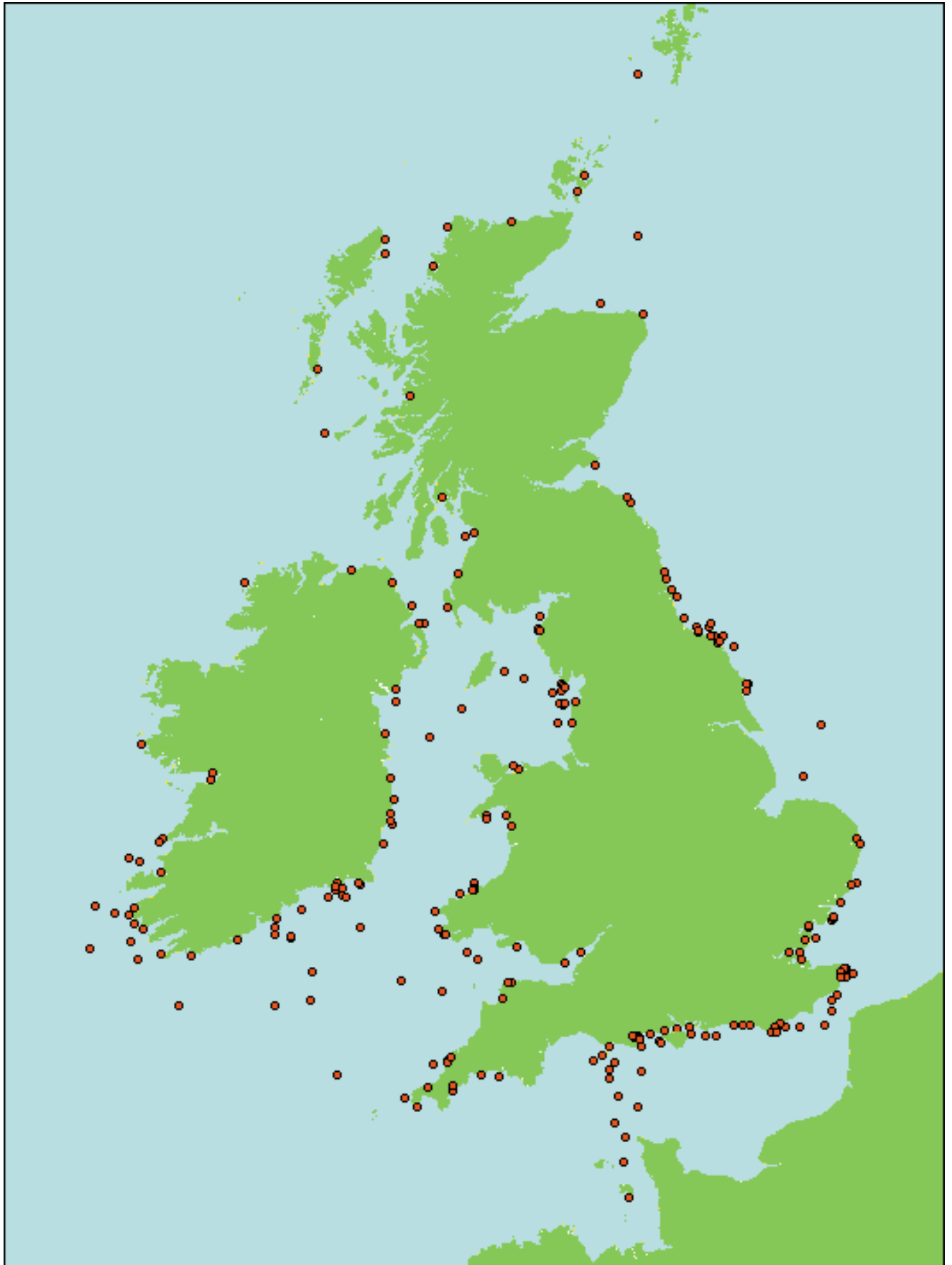


Figure 7.5. Map of UK showing the locations of vessels attended to by the RNLI suffering a fouled propeller, 1998 (source: RNLI).

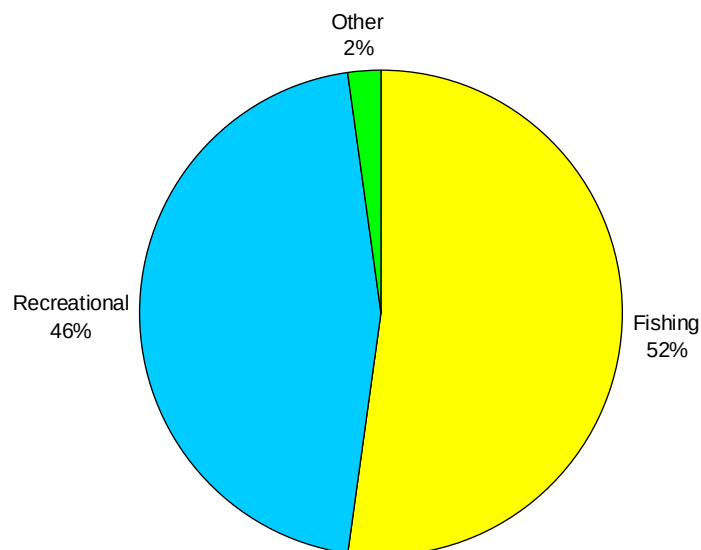


Figure 7.6. Graph showing the type of vessel affected by a fouled propeller that were rescued by the RNLI during 1998.

RNLI rescues during 1998 to various vessel types

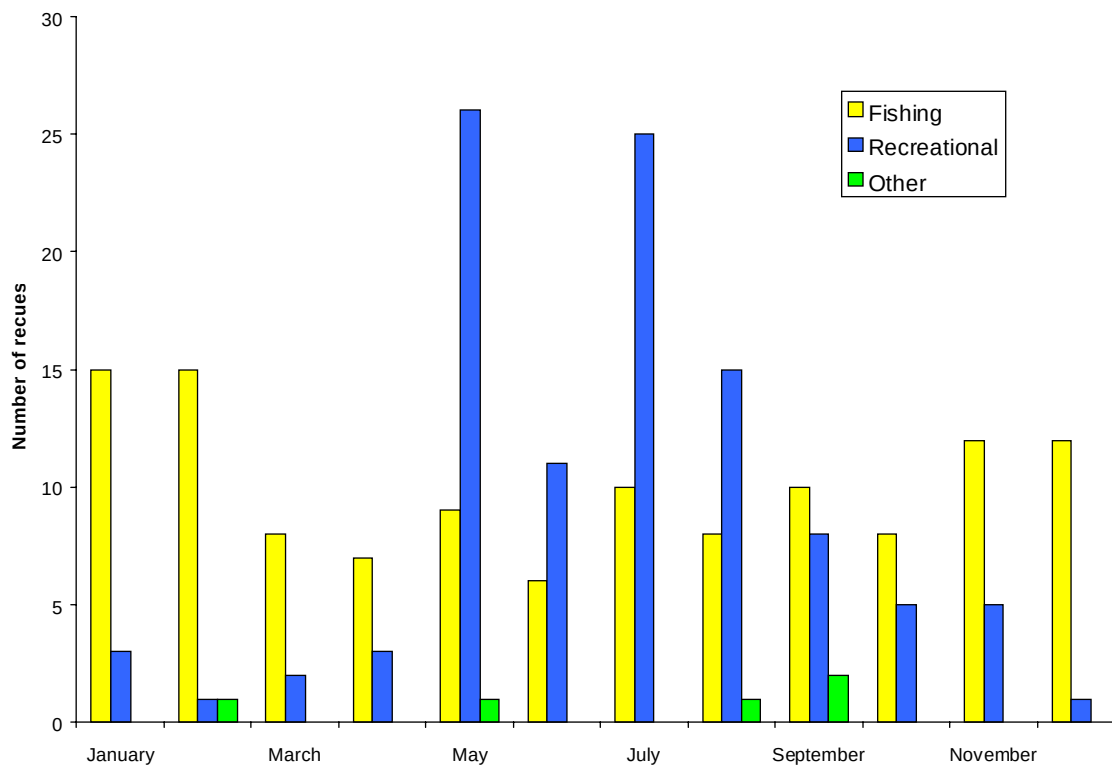


Figure 7.7. Graph showing the number of RNLI rescues to various vessel types each month in 1998.

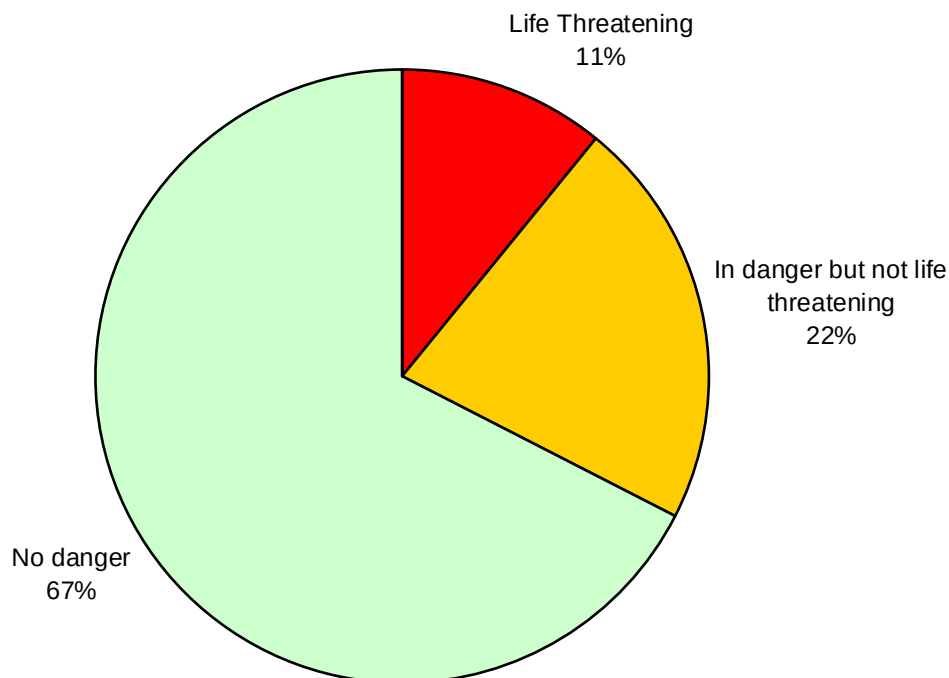


Fig 7.8. Graph showing the percentages of rescues undertaken by the RNLI to vessels with fouled propellers that were: life threatening, in danger or in no danger, 1998

Shetland Coastguard currently rescues at least 5 vessels a year with fouled propellers. However, there are other reports that appear in the local newspaper, of vessels being towed into harbour by fellow mariners because of fouled propellers (see table). For example, a fishing boat with a fouled propeller may be towed for several hours by a fellow fishing boat. This costs both vessels lost fishing time. There are no figures available to define what percentage of propeller foulings on fishing vessels are from their own gear or from marine debris.

7.7.2. Stromstad Coastguard

Stromstad Coastguard, Sweden also reported rescuing vessels with fouled propellers. In one case, a fishing boat had become entangled in towing cables which took two divers one hour's labour to cut through the wire before untangling it. The launching of rescue services to deal with an incident caused by marine debris could put at risk other more severe casualties.

7.8. Conclusions and Recommendations

Harbours

Summary of costs:

£100-£400	to clear each fouled propeller
£4,000	potential vessel damage
£5,000	propeller refurbishment
£300-£1,700	additional dredging
up to £15,000	removal of debris

up to £26,100 PER HARBOUR

Harbour Authorities reported over 180 incidences of fouled propellers. This figure does not include incidences that occur outside the harbour limits of many of the foulings that

occur to the smaller vessels that may contact diving firms directly. As with foulings to fishing vessels, the main items causing propeller foulings in harbours are: old nets, ropes, fish boxes and tyres. The presence of these items floating within a busy harbour area can cause considerable problems to navigation.

Recommendation 33: Harbour Authorities should encourage vessel owners to dispose of old nets, ropes and other rubbish at the quayside.

Recommendation 34: A new campaign, such as the UK Maritime and Coastguard Agency's 'Sea Sense', should be launched to highlight the harm marine debris can do to the environment and the shipping industry.

Recommendation 35: Recycling areas should be set up in each port (if practical), with additional collection points as necessary. Göteborg Harbour Authority has set up a number of recycling points in old transport containers. These are used to collect old batteries, oil, tyres and fluorescent light tubes.

Many harbours do not publicise their facilities widely enough. They also do not promote the problems of marine debris in their area or ways to prevent this.

Recommendation 36: Information boards should be present in all harbours. These boards could not only provide information about reception facilities, but could show the number of propeller foulings that occur locally. This, along with information showing the number of times the local lifeboat has had to rescue boats with fouled propellers would ensure that marine debris was continually seen as a local problem as opposed to someone else's problem. In many cases, vessel owners only stop irresponsible rubbish disposal at sea when it affects them or someone they know.

With a high percentage of plastics washing up on beaches, an effort should be made to reduce

the amount of plastics, in particular packaging materials, from going on to vessels.

Recommendation 37: Harbour Authorities should work together with local wholesalers to minimise packaging on ships' stores.

Recommendation 38: Vessel operators should attempt to minimise the amount of waste they produce through source reduction. They should dispose of any waste produced in compliance with MARPOL and local regulations. They should make the necessary alterations to their on-board waste storage areas to allow for garbage separation if practical.

Recommendation 39: Owners should petition their local Harbour Authorities for better waste reception facilities. Vessels should advise ports in advance if they need assistance with disposal of larger items such as nets or wires.

Recommendation 40: National Governments should make port waste management plans mandatory if they have not already done so.

Recommendation 41: Shipyards should ensure that all new vessels are designed to incorporate convenient garbage storage spaces and, where appropriate, garbage treatment technologies such as compactors.

Recommendation 42: Governments should help ports establish and maintain garbage reception facilities.

US Coastguard data suggests that on average, there is an 80% chance of not having to pay a fine if you are caught disposing of rubbish illegally.

Recommendation 43: Governments should strengthen the powers of MARPOL and other anti-polluting legislation by insisting that a minimum fine is enforced on every offender.

One Harbour Master replying to this survey, stated that he had traced oil containers that were continually being found on a local beach, to be those that had been purchased locally by local boats.

Recommendation 44: Investigation should be made into the possibility of tagging and tracing larger items. Therefore an illegally disposed tagged oil drum could be traced back to the vessel that bought it and the vessel fined.

Recommendation 45: Marinas should also encourage their users to practise better waste management techniques. They should also publicise their facilities and try to promote waste recycling.

Many of their users may not be able to separate their waste due to space constrictions.

Recommendation 46: Consideration should be given when designing waste reception facilities at marinas to encourage recycling. For example, day-or weekend sailors should be encouraged to separate out their glass and aluminium for recycling.

8. Agriculture and Marine Debris

8.1. Shetland Agriculture

In Shetland, marine debris littering fields and coastal roadsides is common due to the prevalence of strong winds. There are over 1,500 crofters and farmers in Shetland and it was deemed impossible to contact them all. Instead, after discussions with the National Farmers Union, Shetland Agricultural Association and the farming development officer of the Shetland Islands Council, it was decided to target a smaller select group. The sample was drawn up by the Shetland Agricultural Association to represent all locations in Shetland, different sizes of farms and by willingness of response of the individuals. Again, each crofter was asked five initial questions to ascertain whether they had experienced a problem with marine debris. The questions were:

- Is any of your land adjacent to the coast?
- Does marine debris get blown onto your land? (E.g. plastic bags, sheeting)
- Have any of your animals become entangled with marine debris?
- Have any of your animals become ill due to ingestion of marine debris?
- Has any of your machinery been damaged by marine debris?

The 30 that responded 86% had land adjacent to the coast. Of these, 96% had experienced marine debris, such as nets, plastic bags and containers blowing onto their land, 36% had incurred problems with their animals becoming entangled in net, rope or plastic strapping, and 20% had animals which had become ill due to ingesting plastic. Only one crofter had incurred problems with marine debris damaging farm machinery (figure 8.1).

The crofters who did have marine debris blowing onto their land spent from 1 hour per year to 3 hours a month removing it. One crofter who spent an hour a month removing marine debris commented that he “*would need to spend much more time if we were to keep the place clean*”. A range of 1-16 bags of rubbish were removed and in one case 3 trailer loads. The debris generally blown onto agricultural land included

plastic containers, plastic bags, polystyrene, nets and rope. One crofter on the east coast of Shetland, reported that his croft was “*vulnerable to debris from shipwrecks because of our location*”. Another commented that they “*try to pick up any rubbish whenever we are at the shore*” to prevent it blowing onto his land.



Plate 8.1. Marine debris collecting at a fence on farmland adjacent to the sea in Shetland.

The debris also collected on fences, which were damaged due to extra strain on them. One crofter commented that his fences had not needed repairing so far “*but rubbish is slowly weakening them*”. The damaged fences could cost £50 a time to repair each section. The rubbish also collects in drainage ditches which

CROFTS AND FARMLAND AFFECTED BY MARINE DEBRIS

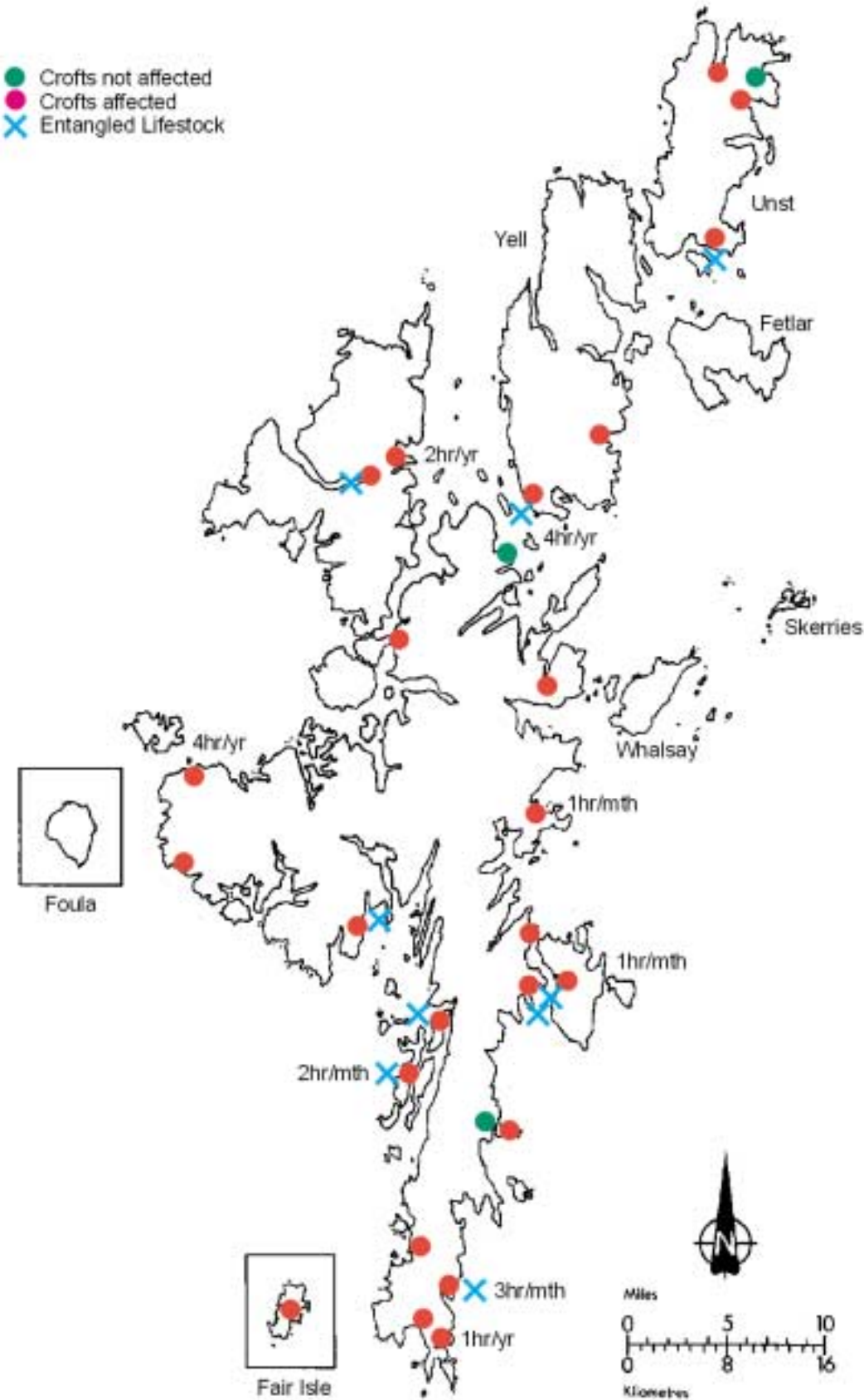


Figure 8.1. Map of Shetland showing the areas of farmland that are affected by marine debris and the number of hours required to remove the debris.

require clearance more often costing £8-45 per metre.

Between 1 and 5 animals from each croft may be entangled in debris a year. They are generally entangled in netting, rope or plastic strapping bands. It may take up to 30 minutes to free the animal and can in some cases lead to a cut leg or even the loss of a foot. One crofter noted that the injury was not normally serious but depended on how soon the entanglement was noticed. Another crofter had incurred additional vets bills as a result of this entanglement at a cost of £30. One of the local veterinary practices reported no problems associated with marine debris and the farm livestock they had treated.

The crofters estimated an hour of their time to be between £4-£12 per hour (average £7.40 per hour). The UK Agricultural Wages Board suggests an hourly rate of between £4.26 for standard workers to £7.35 for those with qualifications. Given that responses were from the croft owners themselves we will assume that their average wage is £7.40 per hour. Using this figure, each croft would lose approximately each year:

£7 - £260	due to time spent clearing land
£1 - £20	due to time spent freeing entangled animals
£8 - £45	due to time spent clearing debris from ditches
£ 30	additional vets bills
£ 50	to replace damaged fences
£400	Max. total for each croft
£600,000	Max. total for all crofts in Shetland

Other problems that are faced by the agricultural community, are the loss of seaweed as a fertiliser due to the increased levels of plastics entangled in them. This also restricts the feeding

area for animals put onto beaches during the winter to gain extra nutrition from the seaweed. An assessment of costs was not possible. A potential problem, highlighted by the survey which requires further investigation, is the possibility of small pieces of plastic becoming stuck in the fleece of sheep. Toxins from the plastic may leach into the wool and affect the quality of the wool. Another problem that was highlighted, was glass containers blown into fields containing grass that is subsequently cut for silage. The crofter that mentioned it was fortunate to notice the glass in time and disposed of the contaminated trailer loads of silage.



Plate 8.2. Cattle on the beach, Oslofjord, Norway.

Recommendations

Coastal farmers, particularly in exposed areas, can be adversely affected by marine debris. In many areas, this requires continual removal of debris from their land to protect their livestock.

Recommendation 47: *Farmers should be encouraged to take additional care when disposing of silage bags etc when near the coast.*

Recommendation 48: *Farmers should report to local authorities, other land owners or the relevant regulating body, occurrences of badly littered beaches.*

9. Power Generation

The intakes of coastal power stations are covered with screens as a matter of routine. 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 trees, pallets, driftwood, tyres, discarded bicycles and oil drums (Environment Agency, 1998). 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. Biofouling is rarely a problem as the screens are self-cleaning and water velocities are usually high. A typical 2,000 megawatt power station usually comprises four turbines which are each serviced by a drum filter. The major items trapped are fish and seaweed, and the siting of the intake is usually carefully considered at the design stage to minimise impacts from marine outfalls. At certain times of the year, sprat and herring shoals can cause particular problems, as can detached seaweed. In addition to fish and seaweed, anthropogenic litter also gets caught by the fine screens and typical litter items include plastics, sewage related debris and other litter items similar to those found on beaches. Obviously the high flow rates entering power station intakes concentrate this litter.

Given the need for smooth continuous operation, power stations' intakes are fitted with sophisticated litter control mechanisms, and a routine maintenance schedule is assumed. According to an investigation by the Environment Agency 1998, litter clearance from intakes can vary from one skip load per day to a skip load per hour, depending upon season and recent weather conditions. 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 be necessary to close down the turbine or entire power station to remove blockages. Closures, though rare, are extremely expensive to power generators due to loss of production.

9.1. UK Power Stations

As part of this study into the economic costs of marine debris, a sample survey was conducted and several power stations throughout the UK were contacted and questioned about the effects of debris with their operations.

Aberthaw, a coastal power station in the Bristol Channel^(ENG), has three units which circulate 220,000 gallons per minute through a static drum screen filter fitted to the discharges of the pumps. The screens, operating under full load, require cleaning every six weeks, at which time they contain sufficient debris to fill a 9 tonne skip. This debris consists of plastic, polythene and small quantities of wood. Occasionally, polythene gets into the pump glands and causes them to leak.

Over the cleaning interval, with the screens gradually blocking, deterioration is observed in the pump's performance which costs the station approximately £500 per week (£26,000 per year). Cleaning of the screens costs £5,000 per unit. Pump gland problems cost £800 to repair and £1,400 in increased works per event. It is estimated that this would occur twice a year.

Longannet power station on the Firth of Forth^(SCO), reports that the quantities of debris removed varies with time of year and the tides.

The outer screens are cleared monthly, while the inner screens are continually cleaned by water jets that wash the debris into a basket arrangement. The annual quantity of waste from the screens in 1997/98 was approximately 456 tonnes. The debris included natural items such as leaves, seaweed and fish as well as debris from human activities. It is estimated that approximately 20-25% of this waste is from the latter source (114 tonnes). Debris from human activities takes the form of barrels of various industrial liquids (part full or empty), material from sewer discharges, plastic bottles and other general litter.

Waste disposal for the above quantity was approximately £14,000, therefore between £2,800 and £3,500 was due to 'unnatural' debris. The station manager commented that they would be required to clean and maintain these screens whether there was such debris present or not, since they need to prevent fish, seaweed etc blocking the intake or entering their cooling water system. The station may find small savings on manpower time if less of the larger 'unnatural' items were present.

Torness Power Station near Dunbar^(SCO), has had to remove debris from the outer and inner screens three times each day. Thirty tonnes of debris is removed each day at a cost of £50,000 per year. Fawley Power Station, Southampton^(ENG) rarely has to clear debris from the outer screens and only has to clean the inner screens once per day if the sea water pumps are running. For a run during the day, a basket of debris equal to approximately one cubic metre would be collected. Most of this debris consists of floating weed and costs £100 to dispose of five days' worth of debris.

Wylfa power station, Anglesey^(WAL), also reported that the clearance of the drum screens was very dependent on the prevailing weather conditions. Experience has shown that the worst combination is a north or north-westerly wind, low water and an incoming tide. In extreme

circumstances, there could be station personnel clearing debris (usually seaweed) from the drum screens continuously for 24 hours. Under normal conditions the daily volume of debris is not large and is approximately less than 1 cubic metre. Wylfa does not have a problem with any particular item of debris with seaweed being the major difficulty.

The power station in Lerwick, Shetland^(SCO), has two sets of screens in the power station which run for approximately one hour each day. The debris is cleared at this time and takes 10 minutes for each screen (122 hours per year). On average the quantity of debris amounts to one tonne annually. The debris consists of seaweed, mussels, plastic, fishing ropes, nets and bottles. They also report that it would be difficult to associate a cost with this debris as they are required to remove the seaweed and mussels even if there was no debris.

Chapelcross Nuclear Power Station near Dumfries^(SCO) takes its cooling water from the River Annan and thus the amount of debris appearing is less than at more coastal sites. The screens are inspected on a weekly basis and any accumulated weed or algae is removed if necessary. Debris from man's activities on the river does not appear to be a problem. Sizewell A Nuclear Power Station, Suffolk^(ENG) draws its water supply from just above the sea bed and thus rarely experiences large amounts of debris. Nevertheless, the inner screens are cleaned continually by a spray of water and the outer screens are cleaned every six months unless there is a specific requirement to clean more often. The debris that is found consists of fragments of rope and other plastic items. The power station at Killingholme, near Immingham^(ENG), abstracts its water via submerged pipelines and does not suffer from surface debris. They are also not aware of any losses or costs as a result of submerged debris.

9.2. Non-Electricity Seawater Intakes

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 many sectors of industry may be sited with close proximity to ports and therefore abstract water containing a higher concentration of litter. They may not be fitted with such sophisticated litter trapping mechanisms and abstract water at substantially lower velocities than power stations.

A questionnaire survey of marine abstractors listed on National Rivers Authority Public registers (now the Environment Agency) found that 5 out of 22 respondents encountered no problems with marine litter, 10 considered that litter caused problems rarely (less than 25% of the time), and 6 considered it as an occasional problem (25-50% of the time) (see Environment Agency, 1998). Only one considered marine litter a very regular problem (more than 75% of the time). General litter (e.g. cans, bottles, packaging) was found in all cases, with gross litter (e.g. items larger than 30cm) being reported in addition by 7 respondents. One respondent, who abstracts continuously, collects approximately 10 kg of general litter every day from automatic screens. The perceived source in this case is mainly from ships berthed in the dock.

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 additional 80 shifts per year for litter-related clearance activities.

9.3. Conclusions and Recommendations

Power stations may have problems with marine debris blocking their inner and outer screens of their cooling water systems. The extent to which they are affected is determined by their location, the location of their water inlets and in some cases, by the weather. In general, power stations with water inlets far out on the sea bed are less affected by marine debris than those with inlets in shallower water or near the water surface. Having water inlets on the sea bed reduces the amount of floating debris that may get drawn into the system.

The amount of debris removed from screens ranges from less than 100 tonnes annually to over 10,000 tonnes. The debris consists mainly of plastic and rope fragments although in some cases large containers may be present. All the power stations reported large amounts of seaweed and other natural substances becoming caught in the screens. Clearance of debris may cost up to £50,000 per year with additional costs for pump gland problems and deterioration in pump performance.

Recommendation 49: *Electricity companies whose water intake pipes are affected by marine debris should pressure governments to reduce the amount of marine debris in the sea.*

Recommendations

Local Authorities

1. Local authorities should define appropriate litter management standards for individual beaches.
2. Local Authorities should allocate a key officer within the Authority to oversee and plan beach cleaning issues.
3. Local Authorities should investigate new mechanisms to finance beach cleaning.
4. There should be an investigation into the use of litter bins for disposal of rubbish at beaches and other alternatives should be considered.
5. Tourist information notices should also contain environmental information for the area with reference to the problems of marine debris and the locations of litter bins etc.
6. There should be an investigation into the types and sources of marine debris for the particular area so that preventive measures can be aimed at the main polluters.
7. Local manufacturers and suppliers should be encouraged to promote recycling and responsible disposal.
8. All Local Authorities should have in place an Oil Spill Contingency Plan.
9. All Local Authorities should identify funds in advance that could be used for emergency cleaning up of oil and other substances.
10. There should be further research into the environmental costs of mechanical beach cleaning versus its cleaning efficiency.
11. All Local Authorities should investigate the practicality of establishing volunteer partnerships within the community that can assist with beach cleaning, promote responsible waste disposal and widen environmental education.
12. There should be quantification of the effect of beach award status in influencing choice of destination and overall tourism value.
13. Award schemes should be redesigned to take into account the nature of remote natural beaches found in rural areas.

Tourism and Health

14. Further research should be undertaken into the actual numbers of tourists visiting beaches each year.
15. Further research should be undertaken into the public perception of marine debris and the acceptable levels of litter on beaches.
16. Dogs should not be banned from beaches but instead designated areas should be set up.
17. Responsible dog ownership should be encouraged
18. Tourist Boards should include responsible waste disposal messages in their brochures.
19. Locations of recycling areas and litter bins should be publicised through local shops, amusements and accommodation.

Fishing

20. There should be more education about the effects of marine debris to the fishing industry.
21. Waste management education should be made mandatory in all maritime courses.
22. The practicalities and cost efficiency of net recycling should be investigated.
23. Net and rope reuse should be investigated.
24. There should be incentives to encourage fishermen to bring all rubbish ashore.
25. The amount of packaging taken out to sea should be reduced.
26. Maritime suppliers should be encouraged to provide supplies with minimal packaging for vessels.
27. There should be an universal deposit scheme set up to encourage the return of all fish boxes.
28. Harbour Authorities should provide literature for foreign fishing vessels which explains the legislation and location of waste disposal areas.
29. Fish farmers should be encouraged to bring in waste floating in or near their cages.
30. Fish farmers should be encouraged to take additional care when disposing of their wastes.
31. Vessel crews and owners should take particular care when changing oil filters.
32. There should be investigation into whether plastic strapping bands can be made degradable to reduce the numbers of animals and propellers becoming entangled each year.

Harbours/ marinas

33. Harbour Authorities should encourage vessel owners to dispose of old nets, rope and other rubbish properly.
34. A new international maritime anti-littering campaign should be launched and should focus on the potential problems that marine debris causes the shipping industry.
35. Recycling should be encouraged within the harbour area with the provision of recycling areas for bottles, batteries, cans, tyres, etc.
36. Information boards containing locations of disposal areas, incidences of propeller foulings and other maritime information should be present in all harbours.
37. Harbour Authorities should encourage vessel operators to minimise the amount of packaging taken on board.
38. Vessel operators should reduce the amount of waste produced through source reduction.
39. Vessel owners should petition Harbour Authorities, if necessary, to provide better waste reception facilities.
40. National governments should make Port Waste Management Plans mandatory if they have not already done so.
41. Shipyards should ensure that all new vessels are designed to incorporate convenient garbage storage spaces and, if practical, garbage compactors or incinerators.
42. Governments should help ports establish and maintain garbage reception facilities.
43. Governments should strengthen the powers of MARPOL by insisting that a minimum fine is enforced on all offenders.
44. There should be an investigation into the tagging and tracking of larger items such as oil drums.
45. Marinas should also encourage their users to practise better waste management techniques.
46. Consideration should be given when designing waste reception facilities at marinas to encourage recycling.

Agriculture

- 47. Farmers should be encouraged to take additional care when disposing of silage bags etc when near the coast.
- 48. Farmers should report to local authorities, other land owners or the relevant regulating body, occurrences of badly littered beaches.

Power Generation

- 49. Electricity companies whose water intake pipes are affected by marine debris should pressure governments to reduce the amount of marine debris in the sea.

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Acronyms

DETR	Department of the Environment, Transport and The Regions (England and Wales)
EA	Environment Agency (England and Wales)
EPA	Environmental Protection Act, 1990 (UK)
FEEE	Foundation of Environmental Education in Europe
KIMO	Kommunenenes Internasjonale Miljøorganisasjon
KSB	Keep Scotland Beautiful (Scotland)
IMO	International Maritime Organisation
MARPOL	International Convention for the Prevention of Pollution from Ships 1973,1978
MCA	Maritime and Coastguard Agency (UK)
MCS	Marine Conservation Society (UK)
NOAA	National Oceanic and Atmospheric Administration (USA)
NORD	Nordic Council of Ministers
OSPAR	Convention for the Protection of the Marine Environment, North-East Atlantic
RNLI	Royal National Lifeboat Institution (UK)
SAS	Surfers Against Sewage (UK)
SEPA	Scottish Environmental Protection Agency (Scotland)
TBG	Tidy Britain Group

Glossary

Beach:

Whole of the area from the edge of the coast to 10m below water level at the lowest tide. Beaches may be composed of mud, sand, gravel, boulders and or rock ledges.

Croft:

Small farm or agricultural holding found in the Highlands and Islands of Scotland

Fishing Gear:

Any physical item or combination of items that is placed in the water for the intended purpose of capturing living marine or aquatic organisms.

Marine Debris:

Solid materials of human origin that are discarded at sea or reach the sea through waterways or through domestic and industrial outfalls (National Academy of Sciences, 1975)

Port/Harbour:

Any landing area for vessels; e.g. port, harbour, marina, dock.

Port Reception Facility:

Any receptacle maintained by or at a port, to receive garbage generated on vessels; e.g. bins, skips.

Vessel:

Any water craft or structure that carries humans; e.g. yacht, ferries, container ships, oil platforms

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KOMMUNENES INTERNASJONALE MILJØORGANISASJON

LOCAL AUTHORITY INTERNATIONAL ENVIRONMENTAL ORGANISATION

KIMO is an international association of Local Authorities and associated organisations which was formally founded in Esbjerg, Denmark, in August 1990 to work towards cleaning up pollution in the North Sea. They realised that any action taken to clean up the North Sea could only be effective if it was co-ordinated on an international basis and decided to contact some other local authorities to form a nucleus of an international group. In 1994 it changed its remit to also include the Irish Sea, North East Atlantic and the Arctic Seas.

From a modest localised start KIMO has grown in size and in terms of its aims and objectives. It now has over 100 members in the UK, Norway, Sweden, Denmark, Faeroes, The Netherlands and the Republic of Ireland with associate members in Germany.

"KIMO's primary objectives are cleaning up of existing pollution in Northern Seas and coastal waters, preventing future pollution, working to preserve and enhance them and leaving them in a fit and healthy state for the well-being of future generations."

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Impacts of Marine Debris and Oil: Economic and Social Costs to Coastal Communities

The problem of marine litter and oil deposited on coasts is common for coastal local communities and other organisations throughout the world. A wide range of studies and surveys employing many different methodologies have been undertaken over the years to assess the problem. These have attempted to address the problems of collecting data on the volumes, types, origin and other factors relating to marine litter and oil. There is much less research and data available about the economic and social impacts of these substances. The purpose of the project was to undertake a pilot study to investigate the cost of marine debris and oil to coastal communities and organisations. Examples include: death or injury of commercial marine life, interference with maritime traffic by damage to ship's propulsion, and the costs of cleaning, collection and disposal of marine debris and oil. The project undertook to look at these and other factors and to produce a report which would attempt to identify the financial and social costs.

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Impacts of Marine Debris and Oil

Economic & Social Costs to Coastal Communities



Karen Hall



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