

## Introduction

The world's lakes, seas and oceans have been, and are being affected by human activity. Only recently has it been realised that they are a finite resource which are vulnerable to growing populations and industrialisation. Sewage discharge, agricultural runoff, toxic waste disposal, oil spillages and overfishing have all adversely affected marine ecosystems. Global warming is implicated in the destruction of coral reefs.

**Marine litter**, also known as **marine debris**, refers to human-made solid waste that ends up in coastal and marine environments. It includes wood, fibres, paper, glass, metal and **plastics**. Objects most commonly discarded worldwide include cigarette butts (most common and not **biodegradable**!), plastic or paper bags, food wrappers/containers, eating utensils, plastic bottles, drink cans and straws, ropes. Plastics are generally not biodegradable.

## Causes

About 80% of marine litter originates from land. People discard litter, deliberately or accidentally, which is carried to the sea by wind or rivers. Rain washes litter off streets into drains. Poorly-maintained waste disposal facilities, rubbish bins and refuse trucks fail to contain the litter which often finds its way to the sea. Ships can lose cargoes and fishing boats can lose nets and equipment by accident or in storms. Tsunamis and hurricanes result in millions of tonnes of marine debris. Warfare and economic collapse generate sunken or abandoned ships, planes and weapons.

## Effects

At an immediate level, litter fouls any environment and lowers its aesthetic value. This affects life quality and can also be a health hazard as litter attracts vermin. Litter at sea has fouled ship propellers and interfered with water intake. Ships abandoned in waterways can affect currents and increase shading – this can alter the ecosystem. As they disintegrate, metals, oil and toxic materials enter the water. Conversely, ships and rigs can be deliberately sunk to create artificial reefs.

Much litter sinks in the ocean where it interferes with coral reefs and can cause injury to animals. The effects on **benthic** organisms have not yet been properly determined. Nets entrap birds, fish and seals. Ingested plastics have blocked animals' tracts leading directly to suffocation and starvation. Large quantities of ingested plastics have given animals a feeling of being full so they cease eating. More subtly, chemicals from plastic have mimicked the effect of hormones such as **estradiol**, possibly disrupting the physiology of animals. Wood, paper and plastics are often coated with polish or preservatives which are released into the water.

Because of its non-biodegradability, plastic is considered the greatest hazard. It is estimated that it makes up 80% of sea waste. One UN estimate puts an average of almost 18,000 plastic pieces of all sizes per square kilometre in the oceans. Plastics are light so they reach the oceans more easily. Once there, they float and are more readily transported by winds and currents to other places or back to shore. Ocean currents have concentrated them in regions of relatively little



Above: The parents of this albatross chick collected these items from the sea and fed them to the chick. This unaltered photograph was taken by Chris Jordan (via U.S. Fish and Wildlife Service Headquarters).

water movement (the Great Pacific Garbage Patch, for example). Larger plastic pieces may become colonised by plants and animals – these organisms can become exotic species if they are carried to a different marine habitat. Plastics are ultimately broken down physically to ever smaller particles. **Microplastics** can form **suspensions** in the water. They are ingested by small animals or are incorporated in plants. Over time they may accumulate in the higher levels of the food chain. Research is ongoing. A consideration is that life may well adapt to the challenge but ecosystems will change as a result, perhaps in adverse ways.

## Remedies

Hundreds of beach clean-ups are organised annually in Ireland by more than 500 groups of volunteers registered with Clean Coast. Litter that is actually in the water is not as easily removed. In some countries, some harbours use **skimmer boats** and on some rivers, trash traps are installed.

Experiments at sea indicate that collection of large quantities of plastic debris is likely to trap and kill fish and other marine animals. Large scale removal of microplastics using any current technology could affect the **microplankton**. A further consideration is that plastic recovered in this way would be practically useless for recycling due to prolonged exposure to ultraviolet radiation. Microorganisms or enzymes from certain animals can degrade some plastics but not in the conditions that are prevalent in the sea.

The EU wide recognised, **Fishing For Litter** programme, is designed to reduce the amount of marine litter in our seas by physically removing it and to highlight the importance of good waste management amongst the fleet. Fishing for Litter is a simple idea. Participating vessels are given hardwearing bags to collect marine litter that is caught in their nets during their normal fishing activities and brought ashore for proper disposal.

## Facts & Figures

Marine litter can cause serious economic damage: losses for coastal communities, tourism, shipping and fishing. Potential cost across EU for coastal and beach cleaning was assessed at almost **€630 million per year**, while the cost to the fishing industry could amount to almost €60 million, which would represent approximately 1% of total revenues of the EU fishing fleet (in 2010). Taking into account its accumulation and dissemination, marine litter may be one of the fastest growing threats to the health of the world's oceans.

Since 2005 BIM's **net recycling** programme (in partnership with the industry) has prepared more than 700 tonnes of nets for recycling. BIM has also produced a leaflet on waste prevention and a poster on marine litter detailing the degradation time of various common litter items.

Fishermen in Ireland and the UK have been bringing ashore any litter they pick up with fish catches. This is placed in secure receptacles near the pier for proper disposal. There is also a greater awareness of storing articles securely on board so that they do not become sea litter.

On land, a lot can be achieved by positive action. People can stop littering (prevalent in many parts of the world). Rubbish containers and landfill sites can be maintained so as to prevent litter escaping. Many kinds of marine litter can be incinerated to generate electricity.

## Recycling

Plastics can be recycled but the process is generally expensive and requires proper classification and sorting of the material. Plastic may also be recycled to lower-quality plastic for items such as park seats.

Plastics constitute a major problem. It is undeniable that our modern society depends on them; in some ways our civilisation is defined by them. While we need them, we may reduce our use and recycle them to a degree but the demands of a large world population will mean more of them must be produced – and litter will continue to be a problem. A **circular economy** where devices are repaired and dismantled for their materials at the end of their useful lives may yet be essential. Marine litter is a threat to the ocean ecosystem and it also represents a waste of the planet's resources.

Manufacturers of plastics are working with other stakeholders to find the best solutions. These include reduction, reuse, increased recycling, tough litter abatement laws and well-run municipal waste management systems.

Marine Litter Items	%
Cigarettes/cigarette filters	24.6
Bags (paper & plastic)	9.4
Caps/lids	9.1
Food wrappers/containers	8.9
Cups/plates/forks/knives/spoons	7.2
Beverage bottles (plastic) < 2 L	5.5
Beverage Bottles (glass)	4.8
Beverage cans	4.6
Straws, stirrers	4.4
Rope	2.1
Other items	19.4
<b>Total debris items</b>	<b>100</b>

**BIM** is the Irish State agency responsible for developing the Irish seafood industry. It was established under the Sea Fisheries Act 1952.

BIM's mission is to grow a thriving Irish seafood industry; expand the raw material base, add value and develop efficient supply chains that together deliver on the Government's Food Harvest 2020 targets for seafood and create sustainable jobs

We help to develop the Irish seafood industry by providing:

- technical expertise
- business support
- funding
- training and
- by promoting responsible environmental practices.

The industry contributes about €700 million annually to national income and employs 11,000 people, mainly in coastal counties from Donegal to Louth.

The four main activities in the Irish seafood industry are covered by:

- Fishing – The top fishing ports in Ireland are Killybegs, Castletownbere, Dingle, Dunmore East and Kilmore Quay, but fishing vessels also land into numerous small ports around the coast.
- Fish farming - Aquaculture activity includes growing finfish, such as salmon and trout and shellfish farming, including the cultivation of mussels, oysters and scallops.
- Processing - Seafood companies produce high value products from salmon, whitefish, shellfish and pelagic fish species (e.g. herring, mackerel and horse mackerel) all of which generate substantial export earnings to the sector.
- Marketing - Irish seafood is sold at home (€340 million) and in international markets (Europe, Africa and the Far East) where exports are valued at €375 million.

BIM's clients are fishermen, fish farmers, processors and anyone involved in marketing Irish seafood. But it also works with students, educators, the media, seafood consumers and the general public to spread the word about the quality and potential of the Irish seafood industry.

BIM offers a range of training programmes for the Irish Fishing Industry. Training programmes include: marine engineering, radio, safety and aquaculture. The training programmes are accredited by the Department of Transport, Tourism & Sport & Quality and Qualifications Ireland. BIM has five training centres in Ireland and entry to BIM's training courses is directly to their colleges, as BIM is not part of the CAO system.

For further information visit: **www.bim.ie**

Find this and other lessons on **www.sta.ie**



## Syllabus References

The main syllabus references for the lesson are:

### Leaving Certificate Biology

- Nutrient recycling by organisms; definitions. Outline of carbon and nitrogen cycles
- Human impact on an ecosystem. Pollution; definition, areas of effect, its control. Study the effects of any one pollutant
- Problems associated with waste disposal. Importance of waste minimisation. Role of microorganisms in waste management and pollution control (p. 11)

### Leaving Certificate Geography

- Sustainable economic development so as to control its environmental impact. ... Conflicts that may develop between local and global economic interests. Appropriate national examples; Irish fish stocks, tourism and heritage (p. 26)

**Science and Technology in Action** is also widely used by **Transition Year** classes.

## Learning Outcomes

On completion of this lesson, students should be able to:

- Describe what is meant by 'marine litter', list the main types and describe their sources.
- Outline the effects of marine litter on the marine environment.
- Describe how marine litter is transported in the oceans.
- Outline the effects of marine litter on the fishing industry.
- Describe some initiatives that have been undertaken to limit or remove marine litter.

## General Learning Points

These are additional relevant points which are used to extend knowledge and facilitate discussion.

- Marine litter refers to human-made solid waste that ends up in coastal and marine environments. Much of it contains synthetic materials that are not biodegradable.
- The oceans contain an estimated 18,000 pieces of plastic per square kilometre. Marine litter can stop propellers of ships and block water intake systems.
- Not all litter floats; much of it sinks to the ocean floor and damages the ecosystem.
- Floating items are transported by wind and ocean currents and accumulate in particular places. Skimmer boats are used to remove floating litter around harbours.
- Fishing crews are now helping to remove marine litter and return it to shore for reprocessing.

## Student Activities

1. Make a map of the world showing the ocean currents and the prevailing winds. Estimate where a plastic bag dropped on particular seafront in the world might end up.
2. Make a list of widely-used plastics that are found in marine litter. Which of these could be replaced by biodegradable materials?
3. Fill a large bottle with water from a slow-moving freshwater stream. Place a few pieces of plastic in the water and leave for a few weeks and then record how they have been colonised.
4. Make a poster detailing the adverse effects of marine litter on five different marine animals.
5. Write a story beginning "I was a plastic microbead in Elaine's toothpaste..."
6. Find out what happened to the ship MV Lyubov Orlova.
7. Make a list of ways you could reduce your use of the Earth's resources and reduce the amount of litter you generate.
8. Make a poster outlining either the 'London Dumping Convention' or the 'Honolulu Strategy'.
9. Find out what litter clean-up groups are in your area. What beneficial effects have they had?
10. Make a list of the things in your school which contain plastic and a list of those which do not contain plastic.

## True/False Questions

- |  |     |
|--|-----|
| a) World demand for plastics is greater than its current ability to recycle or safely dispose of it. | T F |
| b) Plastic microbeads are never used in hygienic products or cosmetics.                              | T F |
| c) Cigarette tips are readily biodegradable.   | T F |
| d) Most litter in the world is found at sea.   | T F |
| e) Litter generated in the middle of a continent is no threat to marine life.                        | T F |
| f) Some sea litter has proved to be of archaeological interest.                                      | T F |
| g) Sea turtles have apparently been known to mistake plastic bags for jellyfish prey.                | T F |
| h) Suspensions of plastic microparticles can reduce the light reaching aquatic plants.               | T F |
| i) Objects containing rubber, glass or metal are rarely biodegraded completely.                      | T F |
| j) Dealing with sea litter involves legal, cultural and financial challenges.                        | T F |

Check your answers to these questions on [www.sta.ie](http://www.sta.ie).

## Examination Questions

### Leaving Certificate Biology (OL) 2016, Q. 11 c

Humans can have many effects on an ecosystem, e.g. pollution.

- Explain the term pollution.
- Give one effect of a named pollutant in agriculture, industry or the home.
- Give one specific way of controlling the pollution referred to in (ii) above.
- Give one example of good waste management from agriculture, fisheries or forestry.
- Give two ways to minimise domestic waste.

### Leaving Certificate Biology (OL) 2011, Q. 2

- What is meant by pollution?
- Name one human activity that causes pollution.
- State two problems associated with waste disposal in Ireland.
- List two ways of minimising waste.
- Give one example of the use of microorganisms in waste management.

### Leaving Certificate Geography (HL) 2014, Q. 9 A

Examine the data showing the total waste generated by households and businesses in selected EU countries in 2004 and 2012. (*Amended from Eurostat*)

(i) Using graph paper, draw a suitable graph to illustrate this data.	Countries in 2004 and 2012 (Mt)		
	Year	2004	2012
(ii) Explain briefly one reason why a charge is usually applied for the disposal of waste.	Ireland	24.5	20.0
	Denmark	12.5	16.0
	Czech Republic	29.0	23.0

### Leaving Certificate Geography (HL) 2011, Q. 8 c

Pollution does not recognise boundaries and therefore can impact on the environment locally, nationally or internationally.

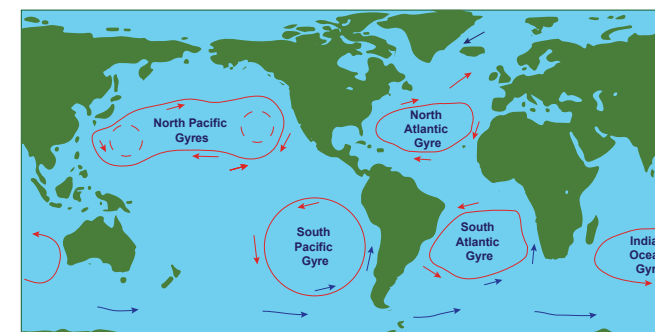
Examine the above statement with reference to example(s) that you have studied.

### Junior Certificate Science (HL) 2011, Q. 4 h

Some plastics are made from starch, vegetable oil etc., and are called bioplastics. Others are made from petroleum with additives. Suggest an advantage of bioplastics over petroleum-based biodegradable plastics.

## Did You Know?

- Ocean gyres are circular currents that flow around a calm central area. Marine debris, often carried from very distant places, tends to accumulate in these areas. There are a number of these 'garbage patches' in the world's oceans, the Great Pacific Garbage Patches between America and Japan being the most famous.



## Biographical Notes

### Alexander Parkes (1813 – 1890)

Alexander Parkes was the son of a Birmingham lock manufacturer. Extremely talented, he worked in industry from an early age. His research in electroplating led him to develop a method of removing silver from lead and also a superior method of silver plating.

Much of his work was with rubber; he found a way of waterproofing fabrics with a thin rubber coating and developed a means of vulcanising rubber. He also worked on rubber recycling. In an effort to develop building materials that could be moulded while hot but would be solid when cold, he synthesised the first man-made plastic ('celluloid') in 1855 from cellulose nitrate and other organic compounds. People saw the first kitchen utensils at the London Exhibition in 1862. However, his process was expensive and the plastics were prone to cracking and catching fire. The age of cheap plastics had yet to come. Celluloid is in fact biodegradable.

## Revise The Terms

Can you recall the meaning of the following terms? Revising terminology is a powerful aid to recall and retention.

Absorption, adsorption, benthic, biodegradable, biodegradable plastics, bioplastics, circular economy, estradiol, marine debris, marine litter, microplankton, microplastics, PCB, plastics, skimmer boats, suspensions.

Check the Glossary of terms for this lesson on [www.sta.ie](http://www.sta.ie)