

Plastic pollution in the oceans

Fact Sheet & Teacher's Notes

Lesson 2: Impacts of plastic pollution and possible solutions

Starter

What chain of events led to this bird's death?

Students are shown the photograph taken by a wildlife photographer on Tern Island in Hawaii and are asked to deduce both the cause of death and the chain of events that led to it. The bird's remains were found on an isolated beach far from any source of pollution.

They ought to identify the following geographical factors leading to the bird's death (there may be other, equally valid suggestions):

- Plastic waste carried by sewers / runoff from a distant urban area
- Migration of waste following surface ocean currents (knowledge of ocean currents and the location of the Hawaiian islands could allow some sensible suggestions to be made)
- Breakdown of plastic waste into smaller pellets due to attrition
- Bird mistakes plastic pellets for a food source
- Death follows (there are several possible causes)

Teaching tip

This is a good attention-grabbing way to start the second lesson. Many similar images are available online, for instance:

<http://www.wildencounters.net/w/blog/2009/09/midway-atoll-april-2009/> or

<http://www.doobybrain.com/2008/02/08/vortex-of-trash-in-the-pacific-ocean/>

Below: *Figure 5 Dead Bird* (Flickr Creative Commons)

Source: <http://www.flickr.com/photos/angrysunbird/2293085236/sizes/z/in/pool-17104879@N00/>



The photographer himself makes the following observation: 'This Laysan Albatross chick starved to death because its parents fed it too much plastic flotsam. This plastic flotsam filled the stomach, creating a feeling of being full when it wasn't. The parents collect the

flotsam as it was used by flying fish to lay their eggs on. Some chicks manage to regurgitate the ingested plastic, I found regurgitated fishing gloves and a toothbrush, but often it killed the chicks. We found lighters, bottle caps, toys, pens, markers, toothbrushes and miles of fishing line in dead chicks. I kept the pen from this bird for use as a teaching aid.'

Main activity

(1) The impact of plastic pollution on marine ecosystems, organisms and food chains

Types of plastic pollution

Pollution can have damaging effects on ecosystems and may reduce biodiversity. In recent years, scientists have become increasingly concerned with the impacts of plastic pollution on marine species and food webs. Plastic pollution takes a number of different forms:

- *Large recognisable objects* such as bottles, bottle caps, bags, broken dolls, used biro. If ingested these can be extremely harmful to fish, birds or marine mammals. Other risks attached to these objects include the strangulation or suffocation of birds or animals.
- *Large pellets* or shards of plastic in the early stages of their physical breakdown. Newer fragments have sharp edges, older fragments are more rounded. They may still be brightly coloured which causes some birds and fish to mistake the fragments for their usual food sources such as shrimps.
- *Small pellets* of plastic that have been eroding for a longer period of time. On beaches, these particles may be the same size as grains of sand and not easily detected at first. Small manufactured pellets also enter the ocean directly – these are called ‘nurdles’.
- *Microplastic pellets* are the smallest detectable physical fragments resulting from the physical breakdown of plastic waste. Research has shown that waters around the north-east Atlantic are contaminated by such microscopic fragments of plastic. The abundance of this material has increased significantly over the last 40 years. Smaller than the diameter of a human hair, these tiny debris particles have been formed by the breakdown of everyday items such as plastic bags, bottles and plastic materials used in packaging.
- *Chemicals* are produced by the decomposition of polystyrene in warm waters of around 30°C temperature. Although this chemical weathering is confined to warm tropical waters, ocean currents circulate the resulting chemicals around the planet.

Specification advice

All taught 16-18 courses require students to be able to make some sort of assessment of the impacts of human activity on ecosystems. The depth of information about impacts on marine wildlife offered here might allow students to offer some interesting variety of impacts in their responses.

AQA looks at ‘the relationships between human activity, biodiversity and sustainability’ – the threat posed by plastic to sea birds and rare species such as turtles could be examined. OCR asks for students to look at how ‘human activity poses threats to physical environments in both planned and unintended ways.’

Edexcel specifies the ‘global factors threaten biodiversity’ – and the global scale of this case study certainly pushes the right buttons.

Impacts on marine life

Data on sea birds showing the ingestion of plastic waste as being a cause of death first began to appear in the 1950s. 95% of dead fulmars (a common sea bird) washed ashore in Scotland will have some plastic debris in their gut. Worldwide, 260 species bird and mammal are known to ingest or become entangled in plastic wastes. (Source: Charles Moore)

- Discarded red lids from water bottles are a particular problem– in size and colour they mimic the appearance of the krill shrimp that albatross eat. Autopsies have shown an abundance of red-coloured debris in the gut of dead albatross birds.
- Plastics sometimes undergo chemical decomposition at a molecular level in warm tropical waters. This can result in the release of a chemical called bisphenol A (BPA). Japanese researchers have found that some samples of sea water contain up to 50 ppm of BPA. This can become a problem because BPA functions as an endocrine disruptor (especially for organisms higher up the marine food chain) – impairing reproduction.
- All direct impacts on one marine species will indirectly impact on other species due to the way that marine food webs function.

Main activity

(2) What solutions exist?

The size and scale of this problem makes it an enormous challenge. Action needs to be co-ordinated amongst the world's producers of plastics as well as consumers in every country on the planet. There is an important role for government at varying scales in helping to regulate consumer and producer behaviour.

The key problem seems to be the worldwide under-valuing of plastic waste - and a lack of incentives either for consumers to recycle, or for manufacturers to make greater efforts to ensure that their products can be easily recycled / reused. An attitudinal shift is needed to reduce global society's current 'linear' use of oil, wherein 8% of world oil production goes into plastics each year - one third of which is subsequently thrown away. Recycling of *all* plastics would replace this unsustainable linear usage model with a sustainable system.

Actions to bring about behavioural change need to target both producer and consumer groups. The following range of initiatives can be studied by students as a starting-point for looking into this issue. The initiatives shown vary in their scope, size and potential ability to bring about effective change on a global scale.

Follow-up activity

Students can make their own investigations into these or other initiatives aimed at tackling the plastic pollution problem & the world's oceans. For instance, the Plastics 2020 strategy can be explored at:
<http://plastics2020challenge.com/>

As an additional exercise, they can draw a table that contrasts the strengths and weaknesses of different strategies. Important themes to consider include: overall effectiveness, likely take-up rates and whether the initiative is local or truly global in scope.

<p>Business-led initiatives</p>	<ul style="list-style-type: none"> • Direct ways of tackling the problem may lie with the plastics industry itself. Peter Davis, Director-General of the British Plastics Federation, recently spoke to the Royal Geographical Society (with Institute of British Geographers) about the Plastics 2020 challenge – a new UK initiative dedicated to diverting a greater volume of used plastics waste out of landfill and into recycling facilities. However, this action relates to just one country – and there are a growing number of big polluters all around the globe. Also, any initiative, no matter how ambitious, cannot undo the damage already done. • Retail businesses in the UK and other countries have recently begun to deter the use of throwaway plastic bags by using a range of incentives. In the UK, much of the early impetus came from a BBC camerawoman, Rebecca Hosking, a nature documentary maker who has seen first-hand the devastating effects of plastic carrier bags on marine life. In Hawaii, she witnessed scores of animals and birds being choked to death by the plastic bags which had washed ashore. She spearheaded a campaign amongst retailers in her home town of Modbury that then spread nationally.
<p>Regulation</p>	<ul style="list-style-type: none"> • Government restrictions on use of throwaway plastic bags now exist in China and Bangladesh, where the use of thin (<0.025mm thickness) plastic bags has been prohibited at the highest level. These small bags have been blocking watercourses and sewers in these two nations, greatly exacerbating flooding, especially during the monsoon season. Densely populated Taiwan, which is running out of landfill space, has not only banned bags but has also stopped fast food restaurants and supermarkets issuing plastic knives, forks and cups. Like Hong Kong, the Taiwanese government also makes supermarkets charge for bags.
<p>Awareness-raising exercises</p>	<ul style="list-style-type: none"> • ‘Plastiki’ is an innovative sailing vessel built with 12,500 used plastic bottles for buoyancy. David de Rothschild, founder of Adventure Ecology, established its mission: to sail across the Pacific Ocean and through the garbage patch – and to catch the eye of the global media, raising awareness of the pollution problem. From March to July 2010, David and a crew of five undertook the expedition. • ‘Plastic bag’ is a short film by American director Ramin Bahrani. It traces the epic, existential journey of a plastic bag (voiced by Werner Herzog) searching for its lost ‘maker’ (the woman who took it home from the store and eventually discarded it). One review describes it as follows: ‘Along the way, it encounters strange creatures, experiences love in the sky, grieves the loss of its beloved maker, and tries to grasp its purpose in the

world. In the end, the wayward plastic bag wafts its way to the ocean, into the tides, and out into the Pacific Ocean trash vortex — a promised nirvana where it will settle among its own kind and gradually let the memories of its maker slip away. It is a heavy subject—existential angst—and in the form of plastic bag’s personification, definitely absurd. But for the most part the film takes itself and its concept seriously, albeit with occasional breaks for wry humour. The result is a film that is a success as education and entertainment, that musters a startling amount of pathos from its subject and a surprising amount of empathy from its audience.’ The epic music (especially so in the closing sequence) is written and performed by members of cult Icelandic band Sigur Ros. <http://deagosto.com/2010/04/16/plastic-bag/>

Plenary

‘Resource, not rubbish’

Discarded plastic is actually a wasted resource, not rubbish. This is the view of people working within the plastics and recycling industries.

What is needed is a change in mind-set amongst producers and consumers that leads to all plastics waste - and not just some of it - being recycled or even re-used (does a plastic bottle really need to be melted down in order to produce the raw material for new bottles to be manufactured from? Can a better system of bottle re-use not be devised?)

Teaching tip

You can research more background to this important global perspective at:

<http://www.resourcesnotwaste.org/>

In groups, students should briefly discuss what measures they think need to be taken if we are to improve society's recycling rates for plastic waste.