Landfill-on-sea

Old plastic rubbish doesn't die – it just gets tossed away in far-off places that we rarely get to see. **Daisy Dumas** assesses its impact on the world's largest floating landfill – the Great Pacific Garbage Patch

A challenge. Try, if you can, to spend at least five minutes without the company of plastic sometime today. I'm warning you, it won't be easy.

We sit on it, wash in it, eat from it, drink from it, look through it, play with it and pay with it. It is more than likely that there is some residing inside you. Plastics are literally everywhere.

What was once seen as the durable, lightweight, cheap and easily manufactured answer to our needs and desires has now become an unwelcome ubiquity. We are only just beginning to understand the extent of damage caused by the uncontrolled, unparalleled and unexamined over-production of plastics.

In the quest to produce a material that transports and stores effectively, we have unwittingly created a range of products made from a substance that is totally at odds with the environment. And having conquered the land, plastics are now taking over the planet's greatest oceans.

The doldrums

The Central Pacific Gyre is the largest uniform ocean realm on the planet, stretching over a vast 10 million square miles. Subtropical highs cause the slow, clockwork rotation of the ocean, where a devastatingly calm core gently wanders with the currents.

Once synonymous with a sailor's nemesis, the area has taken on a rather more sinister role as a site for the world's plastic trash. Trapped in these calm seas, a toxic dump of floating seaborne plastic waste swirls and grows, constantly accumulating substance.

At twice the size of France, this phenomenon was dubbed the Great Pacific Garbage Patch (GPGP) by leading flotsam expert Curtis Ebbesmeyer, and is perhaps the single largest body of pollution in the world; an aggregation of year upon year of discarded plastic entering the Pacific Ocean. In this place plastic waste can rotate and linger for over 16 years, its origin a multitude of shorelines, neighbouring waters and ocean vessels.

The doldrums have always been an area where flotsam collected. Until the recent past, biodegradation has taken care of integrating much of this largely natural waste into the marine ecosystem. Nowadays, however, 90 per cent of all marine debris is anything but natural. It is, instead, plastic. Defying even the most rapacious and stubborn bacteria, plastics slowly photo-degrade to a molecular level, at which point further degradation can only be achieved by burning.

Between 70 and 80 per cent of the debris collecting in the Garbage Patch is post-consumer waste from the land, mostly swept into the marine ecosystem by storms and wind. Much of the remaining plastic is an unintended consequence of the mass-fishing industry, as vast trawling nets, broken buoys and mile upon mile of plastic cord and twine intermingle with plastic bottles, toys, trainers and cigarette lighters. A smaller but nonetheless significant fraction of the debris is pre-consumer, often in the form of 'nurdles' – pre-manufacture pellets.

Given the nebulous nature of the GPGP, its rate of growth is hard to determine. 'I think it is growing faster than we can predict. At the moment it is enlarging at an exponential rate, increasing by a factor of 10 each year,' says Captain Charles Moore, Founder of the Algalita Marine Research Foundation in California, who in 2006 found that in some areas of the GPGP, the ratio of plastic to plankton measured six to one. 'It is likely to be 100 times worse in six years' time and similar to rates found off the coast of Japan, where much of the waste originates.'

Hideshige Takada, an environmental geochemist at Tokyo University, who is studying the problem off Japan's coastline, has measured a three-fold increase in plastic particulate pollution between 1989 and 1999, and tenfold increases in the past two to three years.

Today, particulate pollution in the GPGP is at least as high as 100,000 pieces per square mile.

Facts in the water

The remote Midway Atoll lies at the north-eastern tip of the Hawaiian archipelago. Far from man, far from manufacturing plants and far from the prodigious demands of modern culture, Midway should, by definition, exemplify a storybook desert island.

It is anything but. Surrounded by the GPGP, Midway could be mistaken for a landfill site. Its beaches are littered with the harsh reality of extreme pollution, as carcasses jostle with coke bottles and clumps of fishing nets lie discarded like seaweed. An important albatross rookery, 40 per cent of fledglings hatched on Midway never leave the island, instead dying from starvation.

Captain Moore's gruesome photo library bears

A rubbish diet? The contents of an albatross's stomach

The six-pack stomach ideal – not so healthy for sea turtles

A tiny trumpetfish caught in a net of human waste

Plastic facts

Almost every aspect of our lives is touched by plastics, so much so that:

- In 1979, the manufacture of plastic overtook that of steel.
- Today we use 20 times more plastic than we did 50 years ago.
- Each year, 100 million tonnes of plastic are used worldwide.
- We each dispose of 185lb of plastic every year.

So, is biodegradable plastic the answer? In short, no. While bio plastics have an application in modern life (especially in farming), they are limited in their effect. They require high temperatures, a very specific pH and high levels of light to decompose, but such conditions rarely occur in natural environments, let alone sea, where there are lower temperatures and levels of sunlight. In an ocean environment, as in a landfill, biodegradable plastic will remain intact, causing damage to wildlife and ecosystems for many years.

macabre testimony to the first-hand effects of seaborne plastic. Decomposed albatross bodies, their bloated stomachs exposing horrific last meals of lids, nurdles and cigarette lighters, compete for space beside unrecognisable turtles, their shells disgustingly disfigured from a life with six-pack beer holders lodged tight around their middles.

Whether it be an algae-sifting whale or a fish-eating seal, small pieces of plastic are mistaken for food at all levels of the chain. Algalita researchers have seen styrofoam cups with bites taken out of them because they have the same texture as food. Indeed, recent media coverage of washed-up rubber ducks from a massive dump in the Pacific over a decade ago show telltale bite marks to their necks and abdomens. Nurdles of all colours and sizes fool jellyfish, birds and fish into ingesting them, blocking digestive and respiratory tracts and competing with scant nutrients for a place in their stomachs. Microplastics have even come to be known as 'plastic plankton' – a befitting but twisted name to billions of indiscriminate filter feeders.

The figures speak for themselves – Greenpeace estimates that one million birds and 100,000 marine mammals die in the Garbage Patch each year. Individual species are quite literally on the brink of extinction, the onset of which can be attributed solely to plastic interference.

'We have counted more than 100,000 Laysan Albatross deaths in a single year and it won't be long until species become extinct – there is a whole list of endangered species and it is getting longer,' says Moore. The species Captain Moore worries about most is the Hawaiian Monk Seal, which he says 'faces certain extinction if things don't change'.

It is not for lack of effort. But without removing plastic from oceans, or halting their entry into the marine environment in the first place, rescuers are fighting a losing battle. 'It is tragic... It is so sad to see hard working animal rescue centres treat animals and release them, only to find them washed up in nets a few months later,' says Moore.

Toxic sponges

Quite apart from physical implications, the biological impact is enormous. Not only can larger plastic objects entrap, entangle and entwine pelagic wildlife, they also act as floating islands and play a role in the colonisation of potentially poisonous new habitats. Man-made toxins freely migrate both in and out of plastics, and small plastic particles with high surface areas have the ability to absorb and transport a million times the concentration of hydrophobic toxic chemicals (such as DDT and PCBs) than that of ambient water.

Perhaps most disturbingly, plastics have the capacity to leach out the chemical compounds associated with their production. So much so that the US Food and Drug Administration used to term plastics 'indirect food

additives'. Plastics expert Paul Goettlich of mindfully.org is a harsh critic of the current regulatory structures (or lack thereof) for dealing with the production of plastics and their chemical components. Despite what we are led to believe, he explains, 'the [plastic production] process is never 100 per cent perfect. Logically then, there are always toxicants available for migration into the many things they contact' – whether these points of contact be seawater, fish, birds or mammals.

Ironically, where man has failed to clear these fine-grained toxic sponges from the oceans, nature has erroneously stepped in. As Moore puts it '...an astronomical number of vectors for some of the most toxic pollutants known are being released into an ecosystem dominated by the most efficient natural vacuum cleaners nature ever invented – the jellies and salps living in the ocean. After those organisms ingest the toxins, they are eaten in turn by fish, and so the poisons pass into the food web that leads, in some cases, to human beings.'

The most common group of such chemicals are proven endocrine disrupters. These substances interfere with the function of natural hormones, the most dangerous manifestations of which are reproductive disorders and cancer. On land, studies show that reproductive problems in sentinel species such as amphibians and birds – species that reflect the health of their ecosystem – are giving us all the warning signs we need, whilst the toxic effects of PCBs in humans is well-documented, going back to work-related exposure in the 1930s.

The plastic goods market is expanding at a far faster rate than the infrastructure to deal with waste plastic. Perhaps unsurprisingly, it may be that the lack of action can be traced to the relative economic dead-end posed by the problem. As Captain Moore puts it: 'There is no economic resource that would directly benefit from this process. We haven't yet learned how to factor the health of the environment into our economic paradigm. We need to get to work on this calculus quickly, because a stock market crash will pale in comparison to an ecological crash on an oceanic scale.'

Short of filtering every drop of the planet's water, there is little we can do to turn the tide on the GPGP. Workable solutions must lie in reducing our need and desire for plastic and its subsequent entry into the environment, but plastic consumption in Western Europe alone is currently increasing by four per cent each year.

Not in my back ocean

Though the Central Pacific may seem a million miles away, the GPGP is likely to exemplify the future of many marine areas. According to Richard Thompson of the University of Plymouth, while scales and densities differ, plastic pollution in Europe has increased sharply over the past 40 years. 'Locally, we find that patches of debris vary over time and depend on wind and tidal conditions. Concentrations of debris are found, but at smaller scales of resolution than the Garbage Patch. It is entirely possible that an accumulation similar to that could occur.'

So, where can we expect to see the next Garbage Patch forming? 'It is not so much about specific debris sink-holes,' Thompson warns. 'It is the fact that debris can collect in any number of hotspots around the world.'

Given that 40 per cent of the world's oceans are subtropical gyres, not to mention the many smaller ebbs and flows of sea currents, potential 'hotspots' are worryingly abundant.

Dive below the surface of the problem, and it becomes clear that there is yet another dimension to consider. A comprehensive study in Europe by Galgani *et al*, in 2000, recorded plastic debris during 27 oceanographic cruises and using submersibles down to 2,700m. The truth lurking in the depths was that some areas were contaminated with more than 100,000 items per square kilometre.

> 'A stock market crash will pale in comparison to an ecological crash on an oceanic scale'

There is no prospect of plastic particulate pollution going away quickly. Rather, two trends are likely to increase. Firstly, fne-grained, smaller plastic particles will proliferate through photodegradation. Although the potential environmental impact of smaller debris and 'plastic plankton' is relatively unknown, Algalita recently won a research grant, allowing the team to begin work on the effects of microplastics on zooplankton.

Secondly, seabed, deep-sea plastics will accumulate as larger objects are fouled and worn, altering their density and sinking. The UN estimates that 70 per cent of all seaborne plastic will eventually sink, sequestered to the depths of oceans where a toxic graveyard will fester.

As Bill MacDonald of Algalita says, 'People don't understand that what they do can affect the environment thousands of miles away.'

Perhaps they won't need to. The grim reality is that a plastic garbage patch may soon be coming to the waters near you.

Daisy Dumas is a freelance journalist

Captain Charles Moore of the Algalita Marine Research Foundation hauls deadly nets from the sea off the coast of Hawaii