

Plastic Pollution



Edited by Justin Healey

ISSUES
IN SOCIETY

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INTRODUCTION

Plastic Pollution is Volume 440 in the 'Issues in Society' series of educational resource books. The aim of this series is to offer current, diverse information about important issues in our world, from an Australian perspective.

KEY ISSUES IN THIS TOPIC

Plastic products and packaging are integral to modern daily life. Plastic is durable, cheap, light and can be flexible or rigid, with multiple uses – however plastic is also making the planet a victim of its own success. Plastic pollution has become an epidemic, afflicting land, waterways, coastlines and oceans. More than 8 million tonnes of plastic enter the world's oceans each year, killing marine life as it breaks down into billions of microplastic pieces, without decomposing. Consumption of plastic has increased exponentially, but while recycling is well established, only a small proportion of plastic is recovered for recycling or energy recovery.

How can we reduce the amount of plastic waste, increase recycling and minimise impacts on the environment? What are governments, industry, retailers and consumers doing to eliminate the use of plastic packaging to reduce landfill waste and ocean pollution?

This book offers confronting facts on the impacts of plastic, but also features strategies aimed at tackling plastic pollution. Now is the time to save our planet from the growing perils of plastic.

SOURCES OF INFORMATION

Titles in the 'Issues in Society' series are individual resource books which provide an overview on a specific subject comprised of facts and opinions.

The information in this resource book is not from any single author, publication or organisation. The unique value of the 'Issues in Society' series lies in its diversity of content and perspectives.

The content comes from a wide variety of sources and includes:

- Newspaper reports and opinion pieces
- Website fact sheets
- Magazine and journal articles
- Statistics and surveys
- Government reports
- Literature from special interest groups

CRITICAL EVALUATION

As the information reproduced in this book is from a number of different sources, readers should always be aware of the origin of the text and whether or not the source is likely to be expressing a particular bias or agenda.

It is hoped that, as you read about the many aspects of the issues explored in this book, you will critically evaluate the information presented. In some cases, it is important that you decide whether you are being presented with facts or opinions. Does the writer give a biased or an unbiased report? If an opinion is being expressed, do you agree with the writer?

EXPLORING ISSUES

The 'Exploring issues' section at the back of this book features a range of ready-to-use worksheets relating to the articles and issues raised in this book. The activities and exercises in these worksheets are suitable for use by students at middle secondary school level and beyond.

FURTHER RESEARCH

This title offers a useful starting point for those who need convenient access to information about the issues involved. However, it is only a starting point. The 'Web links' section at the back of this book contains a list of useful websites which you can access for more reading on the topic.

CHAPTER 1

Plastic waste and marine pollution

THE PERILS OF EVERYDAY PLASTICS

Plastic is everywhere these days, and it's become a real problem. From drink bottles and disposable cutlery to cosmetic product microbeads and tiny particles from synthetic clothing, plastic is clogging our waterways, killing our marine life and damaging our ecosystems and our health, according to this guide from the **University of Queensland**

PLASTIC IN OUR OCEANS

- Each year, more than 8 million tonnes of plastic end up in our oceans – and much of this comes from particles that wash off things like car tyres and synthetic clothing.
- At the rate we're currently throwing out single-use plastics such as bottles, bags and cups, by 2050, our oceans will have more plastic than fish, and around 99% of seabirds will have ingested some form of plastic.
- There are now said to be 5.25 trillion pieces of plastic debris in the ocean, with 46,000 pieces in every square mile. That's why 100,000 marine creatures die from plastic entanglement each year, plus around one million sea birds, and why 700 marine species might go extinct because of plastic.

PLASTIC ON OUR LAND

- We throw out so much plastic every single day, and most of those bags, bottles, packets and more aren't being recycled – they either end up in landfill, littering the environment, harming wildlife or blocking drains and increasing flood risk.
- Plastic doesn't break down – in fact, plastic bags last so long (from 20 to 1,000 years) that there are more of them in the litter stream every year, and in Australia, only 3% of plastic bags are recycled.
- In the US, producing plastic uses 331 billion barrels of petroleum, a chemical that harms the environment by polluting air and water, every year.
- Plastic is made from non-renewable resources: liquid petroleum gases (LPG), natural gas liquids (NGL) and natural gas.

PLASTIC AND OUR HEALTH

- Plastic is working its way into our food chain: research shows that when marine creatures consume plastic, it remains in their system – which means that when we eat fish, we're eating plastic, too.



We throw out so much plastic every single day, and most of those bags, bottles, packets and more aren't being recycled – they either end up in landfill, littering the environment, harming wildlife or blocking drains and increasing flood risk.

- Many of the chemicals that leach from plastics used in cooking and food and drink storage aren't good for us: the worst culprits are bisphenol A (BPA) and phthalates, which are hormone-mimicking endocrine disruptors.

So how can we fix our plastic problem? The good news is that many governments all over the world (including Queensland) have either already implemented, or are planning to implement, plastic bag bans; the UK and US, among other countries, have also banned plastic microbeads.

But what can you do as an individual? Here are five simple steps you can take to reduce your plastic consumption:

- 1. Bring your own bags:** Reusable shopping bags are easy to find, and come in a huge range of colours, styles and sizes. Carry a bag with you wherever you go so you never have to put your purchases in



So how can we fix our plastic problem? The good news is that many governments all over the world have either already implemented, or are planning to implement, plastic bag bans; the UK and US, among other countries, have also banned plastic microbeads.

plastic again!

2. **Bring your own drink containers:** Get your morning brew in a KeepCup and fill a reusable bottle with water so you don't have to opt for single-use cardboard or plastic alternatives when you're on the go.
3. **Store your food in non-plastic containers:** Invest in some beeswax wraps to cover food instead of plastic wrap, and opt for glass or stainless steel containers for your leftovers and school or work lunches.
4. **Buy in bulk:** Cut down on packaging by stocking up on pantry and household essentials in bulk – some organic/natural food and produce stores even let you bring your own containers to fill with goods such as pulses, nuts and grains.
5. **Replace your kitchen and bathroom plastics:** Ditch plastic containers for products such as shampoo, detergent and handwash (buy these in bulk and decant them into glass bottles or jars instead), or

opt for things like soap, shampoo and deodorant bars instead of their plastic-packaged alternatives.

You can also get on board with movements such as Plastic Free July to kickstart your new plastic-free fantastic lifestyle and help save the planet!

University of Queensland (15 March 2018).

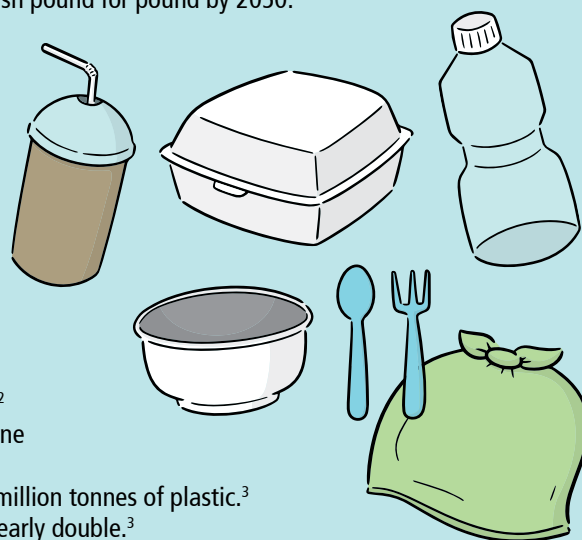
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Plastic pollution: facts and statistics

While plastic has many valuable uses, we have become over-reliant on single-use or disposable plastic – with severe environmental consequences. Facts and figures about the impacts of plastic on the environment include the following:

- 8.3 billion metric tonnes of plastic has been produced since plastic was introduced in the 1950s.¹
- The amount of plastic produced in a year is roughly the same as the entire weight of humanity.¹
- Virtually every piece of plastic that was ever made still exists in some shape or form (with the exception of the small amount that has been incinerated).¹
- 91% of plastic waste isn't recycled. And since most plastics don't biodegrade in any meaningful sense, all that plastic waste could exist for hundreds or even thousands of years.¹
- Nearly two million single-use plastic bags are distributed worldwide every minute.¹
- One million plastic bottles are bought every minute around the world – and that number will top half a trillion by 2021. Less than half of those bottles end up getting recycled.¹
- There is more microplastic in the ocean than there are stars in the Milky Way.¹
- If plastic production isn't curbed, plastic pollution will outweigh fish pound for pound by 2050.¹
- 13 million tonnes of plastic leak into the ocean each year.²
- 17 million barrels of oil are used in plastic production each year.²
- 100,000 marine animals are killed by plastics each year.²
- 90% of bottled water is found to contain plastic particles.²
- 83% of tap water is found to contain plastic particles.²
- 50% of consumer plastics are single-use.²
- 10% of all human-generated waste is plastic.²
- The plastic we throw away could circle the Earth four times in a single year.²
- Disposable plastic items represent 50% of marine litter.²
- 95% of disposable plastic packaging is wasted.²
- Plastic can survive in the environment for up to 500 years.²
- Recycling plastic takes 88% less energy than making new plastic.²
- We can save 1,000-2,000 gallons of gasoline by recycling one tonne of plastics.²
- In 2018 alone, global manufacturers produced an estimated 360 million tonnes of plastic.³
- In the next 10-15 years global plastic production is projected to nearly double.³
- Production is scheduled to reach 500 million tonnes by 2025 and a staggering 619 million tonnes by 2030. Avoiding the worst of these outcomes requires a complete rethinking of the way we produce, use and manage plastic.³
- The most common single-use plastics found in the environment are in order of magnitude: cigarette butts, plastic beverage bottles, plastic bottle caps, food wrappers, plastic grocery bags, plastic lids, straws and stirrers, glass beverage bottles, other plastic bags, and foam take-away containers.³
- The Asia-Pacific Economic Cooperation (APEC) estimated at \$1.3 billion (US) the economic impact of marine plastics on the tourism, fishing and shipping industries in that region alone.³
- In Europe alone, the estimated costs for cleaning shores and beaches reaches \$630 million (US) per year (European Commission, 2015), and studies suggest that the annual economic damage of plastic to the world marine ecosystem is at least \$13 billion (US) (UNEP, 2014).³
- Of the 24 African countries having introduced national bans on plastic bags, more than half (58%) have been implemented between 2014-2017.³
- Up to 1 trillion plastic bags are used each year.³
- Australians used 5.66 billion single-use plastic bags in the 2017 financial year; some of which contributed to the 13 million tonnes of plastic which makes its way into our oceans each year, entangling or being eaten by marine life such as turtles, sea birds and whales.⁴
- Nearly one-third of the plastic packaging we use escapes collection systems, which means that it ends up clogging our city streets and polluting our natural environment. Every year, up to 13 million tonnes of plastic leak into our oceans, where it smothers coral reefs and threatens vulnerable marine wildlife. The plastic that ends up in the oceans can circle the Earth four times in a single year, and it can persist for up to 1,000 years before it fully disintegrates.⁵
- Plastic makes its way into our water supply – and thus into our bodies. Scientists still aren't sure about its harms, but plastics contain a number of chemicals, many of which are toxic or disrupt hormones. Plastics can also serve as a magnet for other pollutants, including dioxins, metals and pesticides.⁵
- Plastic bags can cause big problems when placed in your kerbside recycling bin, most councils around the country do not accept them (note: currently a handful of councils can accept bags and soft plastic in their recycling: Lismore and Ballina in NSW; and, Cockburn, Vincent, City of Fremantle, Town of East Fremantle, Kwinana, Melville, and City of Perth in WA).⁶
- Most supermarkets in Australia do accept plastic shopping bags for recycling; look for the plastic bag recycling collection bin at the front of the store. Torn or damaged reusable 'green bags' that can no longer be reused can also be placed in





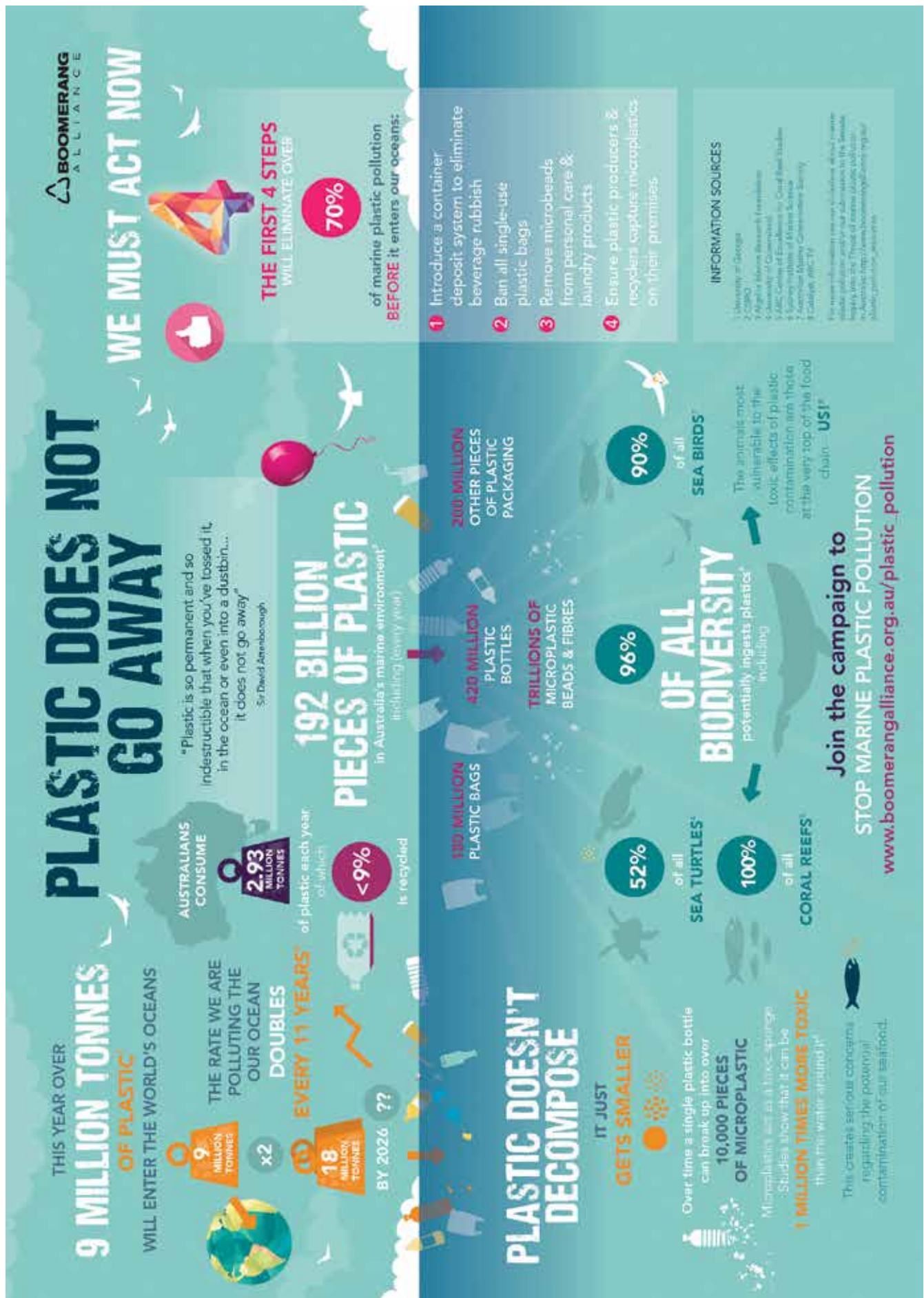
these collection bins.⁶

- Many types of soft plastics (including plastic bags) can now be recycled at selected supermarkets through a scheme run by the REDcycle program. These soft plastics include pasta and rice bags, lolly and biscuit packets, fresh fruit and veggie bags, frozen food bags, magazine and newspaper wrapping, and clean plastic wrap/film.⁶
- 20 million Australians still use over 3.9 billion plastic checkout bags a year. That's 10 million a day!⁶
- A person's use of a plastic checkout bag can be counted in minutes – however long it takes to get from the shops to their homes. However, plastic bags can take between 15-1,000 years to break down in the environment.⁶
- Many marine and terrestrial animals are killed by plastic bags that escape from landfill. The best solution to this problem is to use reusable bags that prevent you using plastic bags in the first place.⁶
- Over 200,000 plastic checkout bags are dumped in landfills every hour.⁶
- Only 3% of Australia's plastic bags are currently being recycled, despite recycling facilities being available at major supermarkets and retail outlets.⁶
- Plastics are used in a wide variety of products and have displaced other materials, such as wood, metal, and glass. It can be formed into polyesters for use in fabrics and textiles, polyvinylidene chloride for food packaging, and polycarbonates for eyeglasses and compact discs, among thousands of other uses.⁷
- The production of plastic requires four basic steps: the acquirement of raw material, synthesizing a basic polymer, compounding the polymer into a usable fraction, and lastly, moulding or shaping the plastic.⁷
- The production of plastic is quite energy-intensive, requiring 62 to 108 mega joules of energy per kilogram based on U.S efficiency averages. Producing silicon can require up to 235 mega joules per kilogram of material.⁷
- In 2016, the global production of plastics reached 335 million metric tonnes, with 60 million metric tonnes produced in Europe alone.⁷
- China is one of the largest producers of plastics in the world, accounting for one quarter of global production. Production of plastics in China will continue to develop and include more efficient companies that produce higher-quality plastics.⁷

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PLASTIC AND HOW IT AFFECTS OUR OCEANS

How big is the problem, what happens once plastic goes into the ocean, and what can we do about it? Genelle Weule reports for **ABC Science**

Plastic is woven into the fabric of our lives

No one in their daily life within a period of 10 minutes isn't touching something that is not made of plastic," said Professor Andrew Holmes, an emeritus professor at the University of Melbourne and a polymer chemist who has developed special plastics for flat screen TVs and solar cells.

It's used in everything from the keyboard or pen you are using, to your glasses or contact lenses, the Teflon on your frying pan, and the banknotes in your wallet. It's in your clothes, phone, car, mattress, and TV screen.

"Plastic can be flexible or rigid, and its lightness also makes it very appealing," said Professor Holmes.

But for all the benefits plastic has given us, disposing of products – particularly those designed to be used only once, such as packaging – has become a major environmental issue.

"The ocean is full of waste because humans have disposed of it carelessly," said Professor Holmes.

So how big is the problem, what happens once plastic goes into the ocean, and what can we do about it?

How much plastic goes into the ocean?

Around 8 million tonnes of plastic went into the ocean in 2010, according to the most comprehensive study of plastic pollution so far.

The international study calculated that 192 nations produced a total of 275 million tonnes of plastic waste.

The largest amount of this waste was produced by China, at 1.32 to 3.52 million tonnes. This was followed

by Indonesia, the Philippines, Sri Lanka and Vietnam.

Australia – which didn't rate in the top 20 polluters – contributed less than 0.01 million tonnes.

But that still added up to 13,888 tonnes of litter per year, a quarter of which finds its way into waterways, according to study co-author Dr Chris Wilcox of CSIRO's Oceans and Atmosphere Flagship.

With global production of plastic increasing exponentially, the amount of plastic finding its way into the ocean is likely to get much bigger.

"About every 11 years the amount of plastic produced doubles," said Dr Wilcox.

"To put that in other words, between now and 2028 we will produce as much plastic as we produced [from the 1950s] until now."

For all the benefits plastic has given us, disposing of products – particularly those designed to be used only once, such as packaging – has become a major environmental issue.

How long does plastic last in the ocean?

Plastic is made to be strong and durable, so it can take a long time to break down.

"Plastics are very hard materials so they are hard to break down unless you can burn them," said Professor Holmes.

"There are some you can get back to original building blocks, but not many."

These include the newer plant-based bioplastics made out of polylactic acid (PLA). But much like traditional petrochemical plastics such as Perspex, PLA-based plastics only break down under very high temperatures.

In the natural environment, the main things that break down plastics are sunlight, oxygen and water.

"The problem is that normal degradation leaves particles that can still be harmful to living things – nanoparticles and microparticles," said Professor Holmes.

"That includes so-called degradable polymers used in some plastic bags, which have starch added to help them fall apart."

The rate at which plastic breaks down depends upon the conditions and the type of plastic.

It breaks down faster if exposed to physical abrasion and sunlight – so it will break down faster in surf zones than if it is buried under sediment in an estuary, Dr Wilcox explained.

"Then there's a lot to do with how thick the plastic is, how dense the plastic is, and does it have UV stabilisers."



For example, dense monofilament fishing line could last for up to 600 years, whereas a thin plastic bag getting bashed around in the surf could last just months.

“But even if that bag breaks down over the course of six months or a year, it might well have had a lot of environmental impact before that,” he said.

Where does the plastic go?

It is really hard to quantify just how much plastic is in the ocean, but the latest figures estimate there are up to 51 trillion particles or 236,000 tonnes.

That may sound like a lot, but in fact it is nowhere near the estimated 8 billion tonnes that went into the oceans in 2010 alone.

Precisely what happens to the ‘missing’ plastic is a puzzle for researchers like Dr Wilcox.

“That says around 40 times the plastic that’s in the ocean is going in every year. So there’s a whole bunch that has to be going somewhere else.”

Plastic is widespread in the open ocean, but is particularly concentrated in the five major ocean gyres – rotating currents of water – in the Pacific, Atlantic and Indian Oceans.

The largest and best-known of these is the Great Garbage Patch in the north Pacific – a concentrated soup of microplastics, or tiny fragments less than 5 millimetres across.

There are two types of plastics that float: polyethylene, which is used to make milk jugs and plastic bags, and polypropylene, which is used for things like bottle caps, straws and dairy containers.

As they travel out to sea plastics get ground down into small, hard cubes, which can be eaten by marine animals.

Plastics are also home to microbes in a phenomenon dubbed the ‘plastisphere’. These microbes may be simply using the plastic to float around the ocean, but there is some evidence they may play a role breaking down the plastic.

Plastics should become more abundant as they break down in size, but recent research found the concentration of the smallest particles, between a few microns and a few millimetres, was much lower than expected.

“It’s not clear what’s going on – whether there’s some kind of sampling problem, or if those things are settling to the bottom of the ocean,” Dr Wilcox said.

Scientists have found evidence of microplastics in deep-sea sediments from the Atlantic Ocean, Mediterranean Sea and Indian Ocean. Some of the missing plastic could also be in coastal regions.

“I think that that is something that people really don’t appreciate. The gyres may have a fair bit of plastic in them, but the coastal margin probably has much more,” said Dr Wilcox.

“Even in Australia, you can tell how far away you are from a city by how much plastic is on the beach and in the water near the beach.”

An analysis of waters around Australia found on average there were around 4,000 microplastic fragments



WHAT IS PLASTIC MADE FROM?

- Plastics is the name we give to a group of substances mostly made from carbon-based molecules arranged in many repeat units (n) in a long chain known as a polymer.
- There are many different types of plastics depending upon what is attached to the carbon.
- Plastic shopping bags, for example, are made from a type of polymer called polyethylene (C₂H₄n) – where each unit in the chain is made up of two hydrogen atoms joined to one carbon atom.
- Most plastics are derived from petroleum, although some newer ones, known as bioplastics, are derived from building blocks produced by microbial fermentation or from corn syrup.
- Chemicals including colourants, foaming agents, plasticisers, antioxidants and flame retardants can be added to different types of plastics to give them specific qualities such as colour, texture, flexibility and durability.

per square kilometre, although some hotspots had concentrations of around 15,000 to 23,000.

Plastic is widespread in the open ocean, but is particularly concentrated in the five major ocean gyres – rotating currents of water – in the Pacific, Atlantic and Indian Oceans.

The vast majority of the microplastic fragments came from plastic packaging such as cups, bottles, bags, as well as fragments of fishing gear.

Dr Wilcox said coastal pollution was an even greater problem for biodiversity than in the open ocean.

“The number of species in the coastal margin is much higher than out in the gyres.”

What impact does plastic have on marine animals?

Research shows getting entangled in plastic was the biggest issue, said Dr Wilcox.

Animals get wrapped up in monofilament fishing line nets, plastic bags, balloons, and straps.

His research has estimated that between 5,000 and 15,000 sea turtles are entangled each year by derelict fishing gear washing ashore in northern Australia alone.

“Anything that is long or flexible or sheet-like is the worst.”

The second biggest issue is the impact of eating plastic – it is estimated around 90 per cent of seabirds are doing so. These plastics can cause blockages of the gut or perforation of the intestines.

Ingestion of plastic can also cause toxic chemicals such as phthalates – a plasticiser that effects the hormone system – to leach into the animal.

“In our research, we can predict how much plastic is in a seabird’s stomach by measuring how much phthalate is in its fat,” said Dr Wilcox.

So what can we do about it?

“The solution to all this stuff is on land and it has to do with changing our supply chains around packaging, how we use packaging, and how we take care of packaging,” said Dr Wilcox.

The main problem, he said, was how cheap plastic was.

“If plastic had a fee or deposit associated with it we would produce and consume less.”

He said one way of doing this was to introduce container deposit schemes, which had been shown to reduce the amount of drink containers in the environment by 60 per cent.

“That is a big deal, as beverage containers make up 40 per cent of the waste in the environment.”

Consumers could also press retailers to use less plastic packaging, Dr Wilcox said.

“In many cases individuals have been able to drive significant local change by governments and businesses.”

According to Professor Holmes, the world may have to move to fully biodegradable plastics, made out of plants. But these have drawbacks.

“The challenge is, is there enough arable land to produce the building blocks of plastic when we also need to produce food?”



In the meantime, he said, we must recycle anything we can.

“Ideally all plastics should be recyclable, but at present that is not the case.”

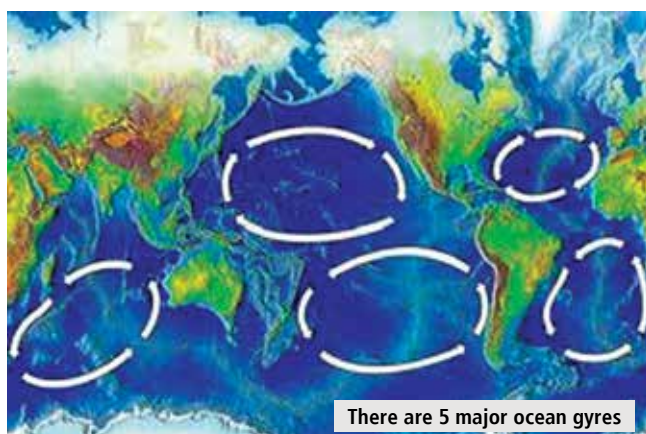
“The plastic waste in the oceans is disastrous for marine and bird life, and the human race has to avoid disposal of this waste in a way that enables it to enter drains, rivers, and eventually the ocean.”

Professor Holmes said plastics that cannot be recycled – such as those used in plastic bags, or expanded polystyrene foam used in coffee cups and packaging around electronic goods – must be responsibly disposed into landfill or by burning.

“The plastic waste in the oceans is disastrous for marine and bird life, and the human race has to avoid disposal of this waste in a way that enables it to enter drains, rivers, and eventually the ocean,” he said.

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Weule, G (27 February 2017). ‘Plastic and how it affects our oceans’, ABC News. Retrieved from www.abc.net.au/news on 31 August 2018.



LIKE DIAMONDS, PLASTICS ARE FOREVER

Every piece of plastic we have ever used is still on the planet today. That means, like diamonds, plastics are forever. The life cycle of plastic is a dangerous one. It starts in our homes, reaches our oceans, harms our ocean wildlife and enters the food chain – our food chain. The good news is that we *can* break this cycle. We can all make our lives and our oceans less plastic.

We can break the cycle!

- Be a conscious consumer! Stop and think about what you buy, and say no to disposable, single-use, unnecessary items.
- Say no to bottled water and plastic bags! Use reusable water bottles and bags.
- Do you get take-away lunch and dinners? Why not take reusable food containers, or dine at the restaurant instead?
- Pick up litter – rubbish travels down the storm drain and into the sea. Every little bit makes a difference.
- Support plastic bag bans and container deposit schemes.
- Spread the word!

Millions of tonnes of rubbish enter the oceans every year. Australians use over 10 million plastic bags a day.

Every piece of plastic we have ever used is still around today!



Up to 80% of rubbish in the oceans comes straight from beaches and stormwater drains. Most of this is plastic.



Plastics never truly go away – they break down from the sun and waves into smaller pieces.



Animals get entangled and eat plastics in the ocean
Animals like turtles, whales and seabirds mistake floating plastic for food. Animals that eat plastic can have intestinal blockages, suffocate and starve.



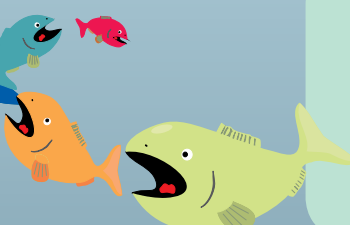
Around 1,500 seals and sea lions become tangled in marine debris and die every year in southern Australia.



Plastics absorb toxins from seawater like PCBs, mercury and pesticides and has 1,000 times more toxic chemicals than in surrounding waters. When ingested, plastics have been found to leach toxic chemicals into seabirds.



Plastics enter the food chain
Plastics enter the bottom of the food chain through zooplankton (small drifting animals), which mistake micro plastics for food. These in turn are eaten by larger animals. In some areas of the ocean, plastic now outweighs zooplankton. Plastics have been found in seabirds, tuna and other fish, seals, turtles and whales.



As plastics move up the food chain, what will this mean for us?



www.marineconservation.org.au



Design by Catfish Creative
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Entangled seal pup: John Gibbons
Plastic pellets in sand: Sandy Brittain, Sustainable Coastlines/Marine Photobank
Albatross chick with plastic debris: Claire Fackler NOAA National Marine Sanctuaries/Marine Photobank

Australian Marine Conservation Society. *Like diamonds, plastics are forever.*
Retrieved from www.marineconservation.org.au on 31 August 2018.

EIGHT MILLION TONNES OF PLASTIC ARE GOING INTO THE OCEAN EACH YEAR

*Wherever it ends up, plastic has enormous potential for destruction. But there are solutions – some simple, and others more challenging, write **Britta Denise Hardesty** and **Chris Wilcox***

You might have heard the oceans are full of plastic, but how full exactly? Around 8 million metric tonnes go into the oceans each year, according to the first rigorous global estimate published in *Science* today.

That's equivalent to 16 shopping bags full of plastic for every metre of coastline (excluding Antarctica). By 2025 we will be putting enough plastic in the ocean (on our most conservative estimates) to cover 5% of the Earth's entire surface in cling film each year.

Around a third of this likely comes from China, and 10% from Indonesia. In fact all but one of the top 20 worst offenders are developing nations, largely due to fast-growing economies but poor waste management systems.

However, people in the United States – coming in at number 20 and producing less than 1% of global waste – produce more than 2.5 kg of

plastic waste each day, more than twice the amount of people in China.

While the news for us, our marine wildlife, seabirds, and fisheries is not good, the research paves the way to improve global waste management and reduce plastic in the waste stream.

Follow the plastic

An international team of experts analysed 192 countries bordering the Atlantic, Pacific and Indian Oceans, and the Mediterranean and Black Seas. By examining the amount of waste produced per person per year in each country, the percentage of that waste that's plastic, and the percentage of that plastic waste that is mismanaged, the team worked out the likely worst offenders for marine plastic waste.

In 2010, 270 million tonnes of plastic was produced around the world. This translated to 275 million tonnes of plastic waste; 99.5 million

tonnes of which was produced by the two billion people living within 50 km of a coastline. Because some durable items such as refrigerators produced in the past are also thrown away, we can find more waste than plastic produced at times.

Of that, somewhere between 4.8 and 12.7 million tonnes found its way into the ocean. Given how light plastic is, this translates to an unimaginably large volume of debris.

While plastic can make its way into oceans from land-locked countries via rivers, these were excluded in the study, meaning the results are likely a conservative estimate.

With our planet still 85 years away from 'peak waste' – and with plastic production skyrocketing around the world – the amount of plastic waste getting into the oceans is likely to increase by an order of magnitude within the next decade.

Our recent survey of the Australian coastline found three-quarters of coastal rubbish is plastic, averaging more than 6 pieces per metre of coastline. Offshore, we found densities from a few thousand pieces of plastic to more than 40,000 pieces per square kilometre in the waters around the continent.

If the top five plastic-polluting countries – China, Indonesia, the Philippines, Vietnam and Sri Lanka – managed to achieve a 50% improvement in their waste management – for example by investing in waste management infrastructure, the total global amount of mismanaged waste would be reduced by around a quarter.



Where is the plastic going?

While we now have a rough figure for the amount of plastic rubbish in the world's oceans, we still know very little about where it all ends up (it isn't all in the infamous 'Pacific Garbage Patch').

Between 6,350 and 245,000 metric tons of plastic waste is estimated to float on the ocean's surface, which raises the all-important question: where does the rest of it end up?

Some, like the plastic microbeads found in many personal care products, ends up in the oceans and sediments where they can be ingested by bottom-dwelling

creatures and filter-feeders.

It's unclear where the rest of the material is. It might be deposited on coastal margins, or maybe it breaks down into fragments so small we can't detect it, or maybe it is in the guts of marine wildlife.

Wherever it ends up, plastic has enormous potential for destruction. Ghost nets and fishing debris snag and drown turtles, seals, and other marine wildlife. In some cases, these interactions have big impacts. For instance, we estimate that around 10,000 turtles have been trapped by derelict nets in Australia's Gulf of Carpentaria region alone.

More than 690 marine species are known to interact with marine litter. Turtles mistake floating plastic for jellyfish, and globally around one-third of all turtles are estimated to have eaten plastic in some form. Likewise seabirds eat everything from plastic toys, nurdles and balloon shreds to foam, fishing floats and glow sticks.

While plastic is prized for its durability and inertness, it also acts as a chemical magnet for environmental pollutants such as metals, fertilisers, and persistent organic pollutants. These are adsorbed onto the plastic. When an animal eats the plastic 'meal', these chemicals make their way into their tissues and – in the case of commercial fish species – can make it onto our dinner plates.

Plastic waste is the scourge of our oceans; killing our wildlife, polluting our beaches, and threatening our food security. But there are solutions – some of which are simple, and some a bit more challenging.

Solutions

If the top five plastic-polluting countries – China, Indonesia, the Philippines, Vietnam and Sri Lanka – managed to achieve a 50% improvement in their waste management – for example by investing in waste management infrastructure, the total global amount of mismanaged waste would be reduced by around a quarter.

Higher-income countries have equal responsibility to reduce the amount of waste produced per



Before the plastic revolution, much of our waste was collected and burned. But the ubiquity, volume, and permanence of plastic waste demands better solutions.

person through measures such as plastic recycling and reuse, and by shifting some of the responsibility for plastic waste back onto the producers.

The simplest and most effective solution might be to make the plastic worth money. Deposits on beverage containers for instance, have proven effective at reducing waste lost into the environment – because the containers, plastic and otherwise, are worth money people don't throw them away, or if they do others pick them up.

Extending this idea to a deposit on all plastics at the beginning of their lifecycle, as raw materials, would incentivise collection by formal waste managers where infrastructure is available, but also by consumers and entrepreneurs seeking income where it is not.

Before the plastic revolution, much of our waste was collected and burned. But the ubiquity, volume, and permanence of plastic waste demands better solutions.

DISCLOSURE STATEMENT

Britta Denise Hardesty has received funding from Shell Australia's Social Investment Program and CSIRO's Oceans and Atmosphere Flagship. Chris Wilcox has received funding from Shell Australia's social investment fund and CSIRO's Oceans and Atmosphere Flagship.

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THE CONVERSATION

Hardesty, BD, and Wilcox, C (13 February 2015). *Eight million tonnes of plastic are going into the ocean each year*. Retrieved from <http://theconversation.com> on 31 August 2018.

MARINE PLASTICS

This **IUCN** issues brief explains the impacts of plastic on our oceans

- Over 300 million tonnes of plastic are produced every year for use in a wide variety of applications.
- At least 8 million tonnes of plastic end up in our oceans every year, and make up 80% of all marine debris from surface waters to deep-sea sediments.
- Marine species ingest or are entangled by plastic debris, which causes severe injuries and deaths.
- Plastic pollution threatens food safety and quality, human health, coastal tourism, and contributes to climate change.
- There is an urgent need to explore the use of existing legally binding international agreements to address marine plastic pollution.
- Recycling and reuse of plastic products, and support for research and innovation to develop new products to replace single-use plastics are also necessary to prevent and reduce plastic pollution.

WHAT IS THE ISSUE?

Plastic is a synthetic organic polymer made from petroleum with properties ideally suited for a wide variety of applications, including packaging, building and construction, household and sports equipment, vehicles, electronics and agriculture. Plastic is cheap, lightweight, strong and malleable. Over 300 million tonnes of plastic are produced every year, half of which is used to design single-use items such as shopping bags, cups and straws.

At least 8 million tonnes of plastic end up in our oceans every year. Floating plastic debris are currently the most abundant items of marine litter. Waste plastic makes up 80% of all marine debris from surface waters to deep-sea sediments. Plastic has been detected on shorelines of all the continents, with more plastic materials found near popular tourist destinations and

densely-populated areas.

The main sources of marine plastic are land-based, from urban and storm runoff, sewer overflows, beach visitors, inadequate waste disposal and management, industrial activities, construction and illegal dumping. Ocean-based plastic originates mainly from the fishing industry, nautical activities and aquaculture.

Under the influence of solar UV radiation, wind, currents and other natural factors, plastic fragments into small particles, termed microplastics (particles smaller than 5mm) or nanoplastics (particles smaller than 100nm).

WHY IS IT IMPORTANT?

Plastic pollution is the most widespread problem affecting the marine environment. It also threatens ocean health, food safety and quality, human health, coastal tourism, and contributes to climate change.

Impacts on marine environment

The most visible and disturbing impacts of marine plastics are the ingestion, suffocation and entanglement of hundreds of marine species. Marine wildlife such as seabirds, whales, fishes and turtles, mistake plastic waste for prey, and most die of starvation as their stomachs are filled with plastic debris. They also suffer from lacerations, infections, reduced ability to swim, and internal injuries. Floating plastics also contribute to the spread of invasive marine organisms and bacteria, which disrupt ecosystems.

At least 8 million tonnes of plastic end up in our oceans every year. Floating plastic debris are currently the most abundant items of marine litter.

Impacts on food and health

Invisible plastic has been identified in tap water, beer, salt and are present in all samples collected in the world's oceans, including the Arctic. Several chemicals used in the production of plastic materials are known to be carcinogenic and to interfere with the body's endocrine system, causing developmental, reproductive, neurological, and immune disorders in both humans and wildlife.

Toxic contaminants also accumulate on the surface of plastic materials as a result of prolonged exposure to seawater. When marine organisms ingest plastic debris, these contaminants enter their digestive systems, and over time accumulate in the food web. The transfer of contaminants between marine species and humans through consumption of seafood has been identified as a health hazard, but has not yet been adequately researched.

CONSIDERED SOURCES

YEARLY WORLD CONSUMPTION AND TYPE OF LOSS

SOURCES	WORLD CONSUMPTION KTONS/YEAR OF PLASTIC	INTENTIONAL LOSS	REFERENCES
 PLASTIC PELLETS	257,000	NO	Plastics Europe (2007)
 SYNTHETIC TEXTILES	42,534	NO	FAO/ICAC (2013)
 TYRES	6,431	NO	ETRma (2010)
 ROAD MARKINGS	588	NO	Grand View Research, Inc. (2016)
 MARINE COATINGS	452	NO	Coatings world (2012)
 PERSONAL CARE PRODUCTS	42	YES	Leslie, H.A. (2015)

Microplastic sources based on global consumption of plastics of just over 300 million tonnes. Credit: IUCN 2017, p.1.

Impacts on climate change

Plastic, which is a petroleum product, also contributes to global warming. If plastic waste is incinerated, it releases carbon dioxide into the atmosphere, thereby increasing carbon emissions.

Impacts on tourism

Plastic waste damages the aesthetic value of tourist destinations, leading to decreased tourism-related incomes and major economic costs related to the cleaning and maintenance of the sites.

WHAT CAN BE DONE?

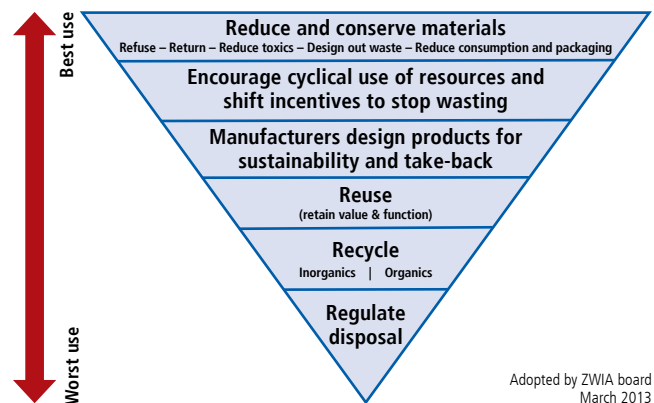
Global concern and public awareness regarding the impact of plastic on the marine environment are currently increasing. The United Nations Environment Program (UNEP) considers plastic marine debris and its ability to transport harmful substances as one of the main emerging issues affecting the environment. At the 2015 G7 summit in Bavaria, Germany, the risks of microplastics were acknowledged in the Leaders' Declaration.

Legal efforts have been made at the international and national levels to address marine pollution. The most important are the 1972 *Convention on the Prevention of Marine Pollution by Dumping Wastes and Other Matter* (or the London Convention), the 1996 *Protocol to the London Convention* (the London Protocol), and the 1978 *Protocol to the International Convention for the Prevention of Pollution from Ships* (MARPOL). However, compliance with these laws is still poor, partly due to limited financial resources to enforce them. Existing international legally-binding instruments should be further explored to address plastic pollution.

Recycling and reuse of plastic materials are the most effective actions available to reduce the environmental impacts of open landfills and open-air burning that are often practised to manage domestic waste. Sufficient



Zero Waste Hierarchy



Adopted by ZWIA board
March 2013

Waste Hierarchy, according to the Zero Waste International Alliance.
Credit: Zero Waste International.

litter and recycling bins can be placed in cities, and on beaches in coastal areas to accelerate the prevention and reduction of plastic pollution.

The main sources of marine plastic are land-based, from urban and storm runoff, sewer overflows, beach visitors, inadequate waste disposal and management, industrial activities, construction and illegal dumping. Ocean-based plastic originates mainly from the fishing industry, nautical activities and aquaculture.

Governments, research institutions and industries also need to work collaboratively redesigning products, and rethink their usage and disposal, in order to reduce microplastics waste from pellets, synthetic textiles and tyres. This will require solutions which go beyond waste management, to consider the whole lifecycle of plastic products, from product design to infrastructure and household use.

To effectively address the issue of marine plastics, research and innovation should be supported. Knowledge of the full extent of plastic pollution and its impacts would provide policy-makers, manufacturers and consumers with scientific evidence needed to spearhead appropriate technological, behavioural and policy solutions. It would also accelerate the conceptualisation of new technology, materials or products to replace plastics.

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MARINE POLLUTION

FACT SHEET COURTESY OF THE UNITED NATIONS OCEAN CONFERENCE

MARINE DEBRIS

- More than 8 million tonnes of plastic enter the oceans each year, equal to dumping a garbage truck of plastic every minute. As much as 80 per cent of all litter in our oceans is made of plastic.
- As many as 51 trillion microplastic particles – 500 times more than the stars in our galaxy – litter our oceans and seas, seriously threatening marine wildlife.
- Marine debris is harming more than 800 species. 40 per cent of marine mammals and 44 per cent of seabird species are affected by marine debris ingestion.
- According to some estimates, at the rate we are dumping items such as plastic bottles, bags and cups after a single use, by 2050 oceans will carry more plastic mass than fish, and an estimated 99 per cent of seabirds will have ingested plastic.
- Plastic waste kills up to 1 million sea birds, 100,000 sea mammals, marine turtles and countless fish each year. Plastic remains in our ecosystem for years, harming thousands of sea creatures every day.
- Abandoned, lost or otherwise discarded fishing gear in the oceans makes up around 10 per cent (640,000 tonnes) of all marine litter. This gear

continues to catch fish through so-called ‘ghost fishing’, and also traps turtles, seabirds and marine mammals.

LAND-BASED ACTIVITIES

- 80 per cent of all pollution in seas and oceans comes from land-based activities.
- Nitrogen loads to oceans roughly tripled from pre-industrial times due to fertiliser, manure and wastewater. The global economic damage of nitrogen pollution is estimated at \$200-800 billion per year.
- In many parts of the world, (urban) sewage flows untreated, or under-treated, into the ocean.
- Pollution and eutrophication (excessive nutrients in water) are also caused by run-off from the land, which cause dense plant growth and the death of animal life. The five large marine ecosystems most at risk from coastal eutrophication are: Bay of Bengal, East China Sea, Gulf of Mexico, North Brazil Shelf and South China Sea.
- Increased nutrient loading from human activities, combined with the impacts of climate change and other environmental change has resulted in an increase in the frequency, magnitude, and duration of harmful algal blooms worldwide. These algal blooms can contaminate seafood with toxins, and impact ecosystem structure and function, recreational activities, fisheries, tourism and coastal property values.
- Nutrient over-enrichment from agricultural, municipal and industrial sources contributes to the so-called ‘dead zones’ – hypoxic regions that exhibit oxygen levels that are too low to support many aquatic organisms including commercially desirable species. The extent and duration of ‘dead zones’ is also increasing worldwide.

OIL SPILLS

- Oil tankers transport some 2,900 million tonnes of crude oil and oil products every year around the world by sea. In addition to large tanker incidents, small oil spills happens every day, due to drilling incidents or leaking motors, and cause the death of birds, marine mammals, algae, fish and shellfish. Oil spills remain a concern, though actual spills have decreased steadily for several decades.

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United Nations. *Marine pollution*. Retrieved from <http://sustainabledevelopment.un.org> on 31 August 2018.



Great Pacific Garbage Patch plastic pollution

DWARFS PREVIOUS ESTIMATES AND IS 'GROWING EXPONENTIALLY'

New findings show that the Great Pacific Garbage Patch, a rotating soup of plastic in the north Pacific Ocean, contains up to 16 times more waste than previous surveys were able to detect. An **ABC Science** report by Nick Kilvert

A team of scientists has conducted what they say is the most comprehensive study to date of the patch's size and the debris floating in it.

Using a combination of drag netting and visual surveys from boats and an aeroplane, they estimated the patch is 1.6 million square kilometres in area – almost the same size as Queensland.

Packed into this area is more than 78,000 tonnes of plastic, the researchers report in the journal *Scientific Reports*.

Most of the mass was made up of pieces larger than 5 centimetres. While microplastics, which account for about 8 per cent of the mass, made up a bulk of the estimated 1.8 trillion pieces of plastic floating in the patch.

Lead researcher Laurent Lebreton said the garbage patch was growing exponentially and was boosted by debris washed out to sea during the Japanese tsunami in 2011.

"We show that plastic concentration has been increasing exponentially since the 1970s for different reasons," said Dr Lebreton, an oceanographer at the Ocean Cleanup Foundation in the Netherlands.

"We found about 30 per cent of the identifiable objects were likely coming from Japan.

"We correlated that with our model and we looked at estimates from the Japanese Government in terms of how much they think was washed to sea that day ... and we predict that about 10-20 per cent of the materials post-2011 in the larger size class came from the tsunami."

Previous sampling, which estimated the patch contained around 4,800 tonnes of garbage, had primarily involved dragging funnel nets behind vessels to collect surface debris.

But Dr Lebreton said that this method excludes larger debris that cannot be collected by the nets, and that boat surveys can only cover a limited area.

"We saw that the surface area sampled by our trawls was not really large enough to be representative of the contribution of the bigger debris," he said.



They estimated the patch is 1.6 million square kilometres in area – almost the same size as Queensland.

"[So] we decided ... to conduct an aerial expedition above the patch. We collected about 7,000 images [from the plane] and that helped us to calculate the contribution of larger debris such as ghost nets."

Clean-up operation needs to target source

By including the larger debris sizes in their study, the researchers knew they'd come up with a bigger figure than previous studies, but they were still surprised by just how much mass the larger debris contributed.

"I wasn't expecting to find that 92 per cent of the mass would be [larger plastics]," Mr Lebreton said.

Almost half the larger debris they identified was commercial fishing gear including nets and fish aggregation devices – nets and other structure set adrift intentionally by fishers to attract fish.

Research scientist Dr Denise Hardesty from the CSIRO said it wasn't surprising the survey produced a much larger size estimate of the garbage patch, given the different research methods used.

"When you're comparing aerial surveys that are looking at ghost nets with estimates that are all focused on

KEY POINTS

- Surveys of the Great Pacific Garbage Patch conducted in 2015 and 2016 estimate 78,400 tonnes of plastic waste are packed into an area almost the size of Queensland.
- This figure is much greater than previous estimates and has increased exponentially since the 1970s.
- Scientists were surprised to find that most of the mass was made up of larger pieces, such as fishing debris.

Almost half the larger debris they identified was commercial fishing gear including nets and fish aggregation devices – nets and other structure set adrift intentionally by fishers to attract fish.

floating plastics we're not really making the exact same comparison," said Dr Hardesty, who was not involved in the study.

"Ghost nets will weigh so much more than all those little tiny bits and pieces and fragments."

But she says that the new research is still cause for concern.

"Whether you're focusing on count or mass, I think it is alarming and we all recognise that this is an increasing global project and it's going to take local solutions as well as hopefully global governance to help resolve the issues," she said.

"We need to deal with this before it enters the ocean

rather than when it's out in the middle of the ocean."

Plastic circulating in the garbage patch does eventually get 'kicked out' and washes up on coastline, Dr Hardesty said.

But right now we are feeding waste in at a much higher rate than it can be expelled.

"There's an increasing source that's coming from our coast. And yes shipping and fisheries waste is also contributing, but the lion's share of mismanaged waste is coming from land," she said.

The Ocean Cleanup Foundation said they would use the research to develop technologies that, they claim, would be able to "clean up 50 per cent of the Great Pacific Garbage Patch in five years".

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Kilvert, N (23 March 2018). 'Great Pacific Garbage Patch plastic pollution dwarfs previous estimates and is 'growing exponentially'', ABC News. Retrieved from www.abc.net.au/news on 31 August 2018.

Great Pacific Garbage Patch

- The Great Pacific Garbage Patch (GPGP) is the largest of the five offshore plastic accumulation zones in the world's oceans. It is located halfway between Hawaii and California.
- This vast dump of plastic waste swirling in the Pacific Ocean is currently bigger than France, Spain and Germany combined, and growing at an exponential rate.
- The Ocean Cleanup project says eight million tonnes of plastics enter the oceans every year, much of which has accumulated in five giant garbage patches around the planet.
- The GPGP cannot be walked upon and cannot be seen from space, as is often claimed.
- The patch was discovered in 1997 by yachtsman Charles Moore, and named by Curtis Ebbesmeyer, a Seattle oceanographer known for his expertise in tracking ocean currents and the movement of cargo lost overboard.
- The estimated 1.8 trillion plastic pieces floating in the patch is equivalent to 250 pieces of debris for every human in the world.
- Microplastics make up 94% of the estimated 1.8 trillion pieces of plastic in the patch; but that only amounts to 8% of the total tonnage. Surprisingly, it was discovered that, of the 79,000 metric tonnes of plastic in the patch, most of it is abandoned fishing gear, and not plastic bottles or packaging.
- While the overall size of the patch does not appear to be changing, it is the mass of the trash within the patch which is accumulating and growing denser.
- The patch is currently the target of a \$32 million cleanup campaign launched by a Dutch teenager, Boyan Slat, now 23, and head of the Ocean Cleanup organization he founded.
- A comprehensive new study by Slat's team of scientists concluded that the 79,000 tonnes was 4-16 times larger than has been previously estimated for the patch. The study also found that fishing nets account for 46% of the debris, with the majority of the remainder composed of other fishing industry gear including ropes, oyster spacers, eel traps, crates and baskets. Scientists estimate that 20% of the debris is from the 2011 Japanese tsunami.
- 'Ghost nets', a term coined to describe purposely discarded or accidentally lost netting, drift through the ocean, entangling whales, seals, and turtles. An estimated 100,000 marine animals are strangled, suffocated, or injured by plastics every year.
- Marine debris expert Marcus Eriksen, co-founder of the 5 Gyres Institute, cautions that the new study is based on only limited surveys, making it difficult to accurately estimate the complete size of the patch. He notes that the data are significant in showing such a high accumulation of fishing gear.
- Much of the plastic is likely to have originated from Pacific countries, however it could be coming from anywhere, riding the globe's ocean currents.
- The Ocean Cleanup proposes using passive floating structures localised in the ocean gyres, where marine debris tend to accumulate. These structures will create an artificial coastline, and utilize the ocean currents to concentrate the marine debris, so it can be collected. Since the original proposal in October 2012, there have been multiple changes to the designs, among those whether the system is anchored or floating, the method for collecting the debris and the dimensions of the system.

Compiled by The Spinney Press.

THE TRASH VORTEX

AN ARTICLE FROM GREENPEACE INTERNATIONAL

You could save a turtle's life by using less plastic and making sure your garbage is properly managed. In the North Pacific is an area the size of Turkey of floating plastic rubbish. It is rubbish from the land that is polluting our oceans, choking and trapping millions of fish and animals. We can keep plastic trash out of our ocean and save ocean life.

Take a walk along almost any beach anywhere in the world and washed ashore will almost certainly be either plastic bags and bottles, or containers. Perhaps plastic drums or expanded polystyrene packing. All too often there are polyurethane foam pieces, pieces of polypropylene fishing net and discarded lengths of rope. Together with traffic cones, disposable lighters, tyres and even toothbrushes, this plastic trash has been casually thrown away on land or at sea and has been carried ashore by wind and tide.

One of the things that makes plastic so heavily used domestically and commercially – its durability – also makes it a major problem for our oceans, and will continue to do so for generations. Around 100 million tonnes of plastic are produced each year, of which about 10 million tonnes ends in the sea. About 80% of it comes from land.

The larger items are the visible signs of a much bigger problem. At sea and on shore under the influence of sunlight, wave action and mechanical abrasion these larger items slowly break up into smaller pieces. Plastic doesn't break down like natural materials – it doesn't go away, it just goes from being a floating bottle to tiny plastic particles that are easily eaten by fish and other marine species or simply spread even further afield. A single one-litre bottle could break down into enough small fragments to put one on every mile of beach in the entire world.

Small plastic pellets aren't just the result of natural erosion. Cargo ships are increasingly carrying packing cases using small plastic pellets as stuffing and these are liberally dispersed across the oceans when drum loads or even container loads are lost at sea. The pellets are frequently found during beach clean-ups, but also at sea in areas where winds and currents are weak.

THE 'TRASH VORTEX'

The North Pacific sub-tropical gyre covers a large area of the Pacific, in which the water circulates clockwise in a slow spiral. Winds are light and the currents tend to push any floating material into the low energy centre of the gyre. There are few islands on which some of the floating material beaches. So most of it stays there in the gyre, in astounding quantities – estimated at six kilos of plastic for every kilo of plankton.

The 'Trash Vortex', also known as the 'Eastern Garbage Patch', is an area equivalent in size to Texas, or



Turkey, or Afghanistan, that slowly rotates our rubbish in a never-ending rotation.

Some of the larger items are consumed by seabirds and other animals, which mistake them for prey. Many seabirds and their chicks have been found dead, their stomachs filled with bottle tops, lighters and balloons.

A turtle found dead in Hawaii had over a thousand pieces of plastic in its stomach and intestines. It has been estimated that over a million seabirds and one hundred thousand marine mammals and sea turtles are killed each year by either eating or getting tangled in six-pack plastic can holders, and discarded netting, fishing lines and other bits of discarded plastic.

Chemical sponge

Plastics can also act as a sort of 'chemical sponge', concentrating many of the most damaging of the pollutants found in the world's oceans: the persistent organic pollutants (POPs). So any animal eating these pieces of plastic debris will also be taking in highly toxic pollutants.

Ocean hitchhikers

Bits of floating plastic can also provide easy transport for plants and animals to move into oceans beyond their normal habitat – these alien species often causing major problems by disturbing the natural balance of the ecosystem.

The North Pacific gyre is one of five major ocean gyres. The Sargasso Sea is a well-known slow circulation area in the Atlantic, and research there has also demonstrated high concentrations of plastic particles present in the water – it's own Trash Vortex. The Sargasso Sea is home to a rich selection of marine life including fish, turtles and whales and is the breeding ground of the European eel. The Sargasso Sea one of the areas identified by Greenpeace that should be protected as an ocean sanctuary.

© Greenpeace International. *The trash vortex*. Retrieved from www.greenpeace.org on 31 August 2018.

MICROPLASTICS

Boomerang Alliance is calling for more regulation on microplastics as part of its campaign to cut 70% of the Australian plastic entering our oceans and waterways by 2020. Authored by Dave West.



The rising tide of plastic pollution in our rivers and oceans is causing increasing worldwide concern. Did you know that the CSIRO recently completed a survey, which found that “three quarters of the rubbish along Australia’s coast is plastic”? Most it comes from Australian sources, not the high seas, with debris concentrated near cities.

While all plastic debris is dangerous to the environment, the threats escalate as plastic fragments into increasingly small pieces and enters the marine food

chain – and, in turn, our diet. These microplastic pieces can be as small as 0.004µm (a human hair is around 18µm), and invisible to the naked eye. The biggest are 5mm in diameter.

These tiny microplastic particles are often mistaken as food, and the latest research suggests that they are being ingested at very high levels.

Microplastics pollute our oceans and cause harm

- Microplastics are tiny fragments, pellets or fibres of plastics with a size of $\leq 5\text{mm}$. Most are smaller than a grain of sand and invisible to the naked eye.¹
- Microplastics are the most abundant form of solid-waste pollution and have been found in all oceans, on all continents and even in the deep sea where their concentration is now four times higher than in coastal waters.¹
- When plastic debris degrades into smaller fragments it releases toxic additives such as plasticizers, dyes, flame retardants or bisphenol A (BPA) into the water.¹
- Many cosmetics such as face scrubs and body washes, as well as toothpastes contain microbeads as abrasive scrubbers. These tiny plastic particles cannot be filtered out by sewage plants and are washed into rivers and oceans.¹
- Plastic resin pellets are the raw material in the manufacture of plastic products. At the factories and during transport they are often spilled in large numbers and end up in the ocean where they are a major contributor to marine debris and almost impossible to clean up.¹
- An average consumer discards 2.4mg of microplastics daily.¹
- Four billion minute fibres could be littering each square kilometre of some of the world’s deep seas.¹
- Every time a synthetic garment is washed, it releases about 1900 microplastic fibres that bypass sewage filters and end up in the ocean.¹
- Fragments of plastic debris, microbeads, synthetic fibres and plastic resin pellets form a plastic soup. In addition to the toxins that are released by degrading plastics, microplastics also adsorb chemicals from seawater such as pesticides and detergents on their surface, making them highly toxic particles. When eaten by plankton, crabs, mussels or small fish these chemicals enter the food chain, leach into the tissues of the animals and can accumulate. Predators and eventually humans could then ingest high levels of toxins, possibly causing cancer or damage to the nervous system and several organs.¹
- Plastic debris/litter and microplastics are ubiquitous in the ocean, occurring on remote shorelines, in coastal waters, on the seabed of the deep ocean and floating on the sea surface; the quantity observed floating in the open ocean in mid-ocean gyres appears to represent a small fraction of the total input.²
- There is a clear need to move towards a more circular economic model for the plastic production cycle, to minimise waste generation; this can be summarised as Reduce (raw material use) – Redesign (design products for re-use or recycling) – Remove (single-use plastics when practical) – Re-use (alternative uses or for refurbishment) – Recycle (to avoid plastics going to waste) – Recover (re-synthesise fuels, carefully controlled incineration for energy production).²
- There are many land- and sea-based sources of plastic debris and microplastics, with significant regional differences in the relative importance of different sources and pathways to the ocean.²
- ‘Leakage’ of plastics into the ocean can occur at all stages of the production-use-disposal cycle, especially due to inadequate wastewater and solid waste collection and management; the amount of marine plastic is so far poorly quantified.²
- Marine plastics have a social, economic and ecological impact – marine litter has been shown to have significant ecological impacts, causing welfare and conservation concerns, especially for threatened or endangered species; social impacts can include injury and death; and economic losses in several sectors can be substantial.²
- Microplastics in seafood do not currently appear to represent a human health risk, although many uncertainties remain.²
- Improving waste collection and management presents the most urgent solution to reducing plastic inputs, especially in developing economies.²

SOURCES

1. Tangaroa Blue, *Microplastics* fact sheet, by Angelika Volz.
2. UNEP (2016). *Marine plastic debris and microplastics – Global lessons and research to inspire action and guide policy change*. United Nations Environment Programme, Nairobi. © United Nations Environment Programme (UNEP), 2016.

Compiled by The Spinney Press.

MICROBEADS

- Microbeads are small, solid, manufactured plastic particles that are less than 5mm and don't degrade or dissolve in water.
- Plastic microbeads are added as ingredients to a range of products, including rinse-off cosmetics, personal care and cleaning products, for a variety of purposes: as an abrasive or exfoliant, a bulking agent, for controlled timed release of active ingredients, and to prolong shelf life. They are also a relatively cheap ingredient.
- Microbeads may be found in some products, including toothpaste, sunscreen, facial scrubs, body wash, cosmetics such as foundation and blush, and other care products.
- If you are concerned about microbeads in your products, look for the following ingredients on the label: Polyethylene (PE), Polyethylene terephthalate (PET), Nylon (PA), Polypropylene (PP), Polymethyl methacrylate (PMMA).
- Microbeads are not captured by most wastewater treatment systems; if they are washed down drains after use, they can end up in rivers, lakes and oceans.
- Once in water, microbeads can have a damaging effect on marine life, the environment and human health. This is due to their composition, ability to adsorb toxins and potential to transfer up the marine food chain.
- These tiny plastics persist in the environment as they are almost impossible to remove. The best way to reduce their impact is to prevent them from entering the environment.
- In late 2017, the Department of the Environment and Energy commissioned an independent assessment of personal care and cosmetic products sold in supermarkets and pharmacies which found that of approximately 4,400 supermarket, pharmacy and cosmetic store products inspected, 94% were microbead-free. No shampoos, conditioners, body washes or hand cleaners were found to contain microbeads, indicating that the phase-out in these products may be successful.
- The Department of the Environment and Energy is working with industry and state/territory governments to ensure a voluntary phase-out of microbeads from personal care and cosmetic products, focussing on microbeads in rinse-off products.
- The Australian Government is expected to examine options to broaden the phase-out to other products in order to eliminate remaining microbeads from the Australian market.

SOURCE

Department of the Environment and Energy (10 September 2018), *Plastic microbeads*. Retrieved from www.environment.gov.au on 31 August 2018.

One recent study from the Great Barrier Reef found that “corals ate plastic at rates only slightly lower than their normal rate of feeding on marine plankton”; another study by CSIRO has found that “90% of seabirds around the world have ingested plastic”; and even plankton (the basis of the marine food chain) has been observed ingesting plastic.

The prevalence of microplastic being ingested by our sea life is a major concern which has rapidly become one of the major threats to marine biodiversity. Not only does this plastic cause starvation and poison species with the chemicals contained within the plastic itself, but microplastics are also known to be a toxic sponge sucking up any dangerous chemicals found in the surrounding ocean.

A 2001 study by Japanese researchers found that plastic production pellets (the raw materials of plastic manufacturing) collected from coastal Japanese waters had accumulated toxins at concentrations up to a million times that found in the surrounding seawater.

So it really is time for all of us to act on microplastic pollution.

There are two types of microplastic pollution:

- **Primary microplastics** which are tiny pieces of manufactured plastic-like microbeads for use in facial cleansers, cosmetics, toothpaste, detergents and polishes and to some degree in medicine as vectors for drugs. They also include ‘nurdles’, the small plastic resin balls that are used to make all plastic products.
- **Secondary microplastics** are the tiny plastic pieces

that are derived from the breakup of larger plastic debris like bags and bottles. Over time, physical, biological and chemical processes can reduce the structural integrity of plastic debris resulting in fragmentation.

We don't yet understand the full impact of microplastics on marine ecosystems and the potential for longer term risks to human health but there is an emerging body of science demonstrating that the chemicals that accumulate in these plastics enters our food chain, with one scientist estimating “that people who consume average amounts of seafood are ingesting approximately 11,000 particles of plastic every year”.

As part of its campaign to cut 70% of the Australian plastic entering our oceans and waterways by 2020, Boomerang Alliance is calling for:

- An immediate ban on the use of microbeads in cosmetics, personal care and household cleaning products
- For our environmental regulators to enforce the existing laws prohibiting plastics manufacturers from allowing their resin pellets to escape their sites
- For responsible plastics manufacturers to join Operation Clean Sweep (www.opcleansweep.org.au) run in Australia by Boomerang Alliance ally Tangaroa Blue.

West, D. *Microplastics*. Retrieved from www.boomerangalliance.org.au on 31 August 2018.

CHAPTER 2

Tackling plastic pollution

Communities unite against plastic pollution on World Environment Day

WORLD ENVIRONMENT DAY CAMPAIGN NEWS FROM **UN ENVIRONMENT**

5 JUNE 2018, NEW DELHI – Communities around the world came together today for the single largest annual celebration of our environment – World Environment Day

This year, under the theme of ‘Beat Plastic Pollution’, people were encouraged to take a critical look at their own relation to single-use plastic, and make real efforts to break their dependency on disposable plastic.

World Environment Day marks the culmination of a global campaign from the United Nations to raise awareness and inspire action on plastic pollution. As global hosts, India did more than raise awareness. With an announcement to eliminate all single-use plastic in the country by 2022, India has effectively set the pace in the global race to beat plastic pollution. This unprecedented and ambitious move against disposable plastic will drastically stem the flow of plastics from 1.3 billion people and business in the fastest growing economy in the world.

“I am proud to see what is taking place this World Environment Day. It is incredibly encouraging to see

communities everywhere take responsibility for the tide of plastic pollution that is threatening our ecosystems,” said Erik Solheim, head of UN Environment.

“From clean-ups on every continent to far-reaching policy agreements, this World Environment Day has made a great difference in how we view the production, consumption, and discharge of single-use plastics.”

With a focus on the future, UN Environment also launched a groundbreaking report: *Single-use Plastics: A roadmap for Sustainability*. The report is an unprecedented global outlook on efforts to beat plastic pollution, providing analyses of case studies from more than 60 countries to present the world’s first comprehensive study of the global movement to beat plastic pollution.

GOVERNMENT ACTION TO TACKLE PLASTIC POLLUTION

Governments around the world are stepping up to the challenge of tackling the tide of plastic pollution, implementing measures to mitigate future impacts on their nations. Indian Prime minister Narendra Modi made the bold commitment to eliminate all single-use



plastics in the country by 2022, in an unprecedented ambitious measure to beat plastic pollution.

Spurred by the World Environment Day momentum, plastic bags have also been announced to become banned in Chile, Botswana, and Peru, while Nigeria will set up recycling plants across the country. Brazil will announce a new national plan on plastics and Wales will commit to being the first 'refill nation'. Across all continents, 50 countries have now joined the UN's Clean Seas campaign against marine litter.

PRIVATE SECTOR STEPS UP

From businesses, NGOs and major sports bodies, private sector leaders are making bold commitments to join the movement against single-use plastics, including the International Olympic Committee; WWF International; Roland Garros; Federation International de Motocyclisme; the India Premier League; LG Electronics; Volvo; and Infosys, to name a few.

On June 4th, the International Olympic Committee announced the support of seven major sports bodies and 20 national federations who will be acting to take disposable plastic out of their sports, making it the biggest ever commitment from the sports community on this issue.

GOING VIRAL

With thousands of citizen-organised events around the globe, the call to #beatplasticpollution has created a viral moment.

Hailed as the 'new ice bucket challenge', the hashtag trended on Twitter, Instagram, and Facebook, mobilising thousands of people online. From everyday consumers to some of the most famous names in Hollywood and Bollywood, thousands pledged to stop using disposable plastic items.

"Our world is swamped by harmful plastic waste. Every year more than 8 tonnes end up in the oceans," UN Secretary-General António Guterres said in a video message on the day. "On World Environment Day, the message is simple: reject single-use plastic. Refuse what you can't reuse. Together we can chart a path to a cleaner, greener world."

A GLOBAL MOVEMENT

World Environment Day was, above all, a global celebration of our collective connection with nature. On every continent, communities came together to highlight their vision of a sustainable future.

In North America, at the Ocean Heroes Bootcamp, youth leaders joined UN Goodwill Ambassador Adrian Grenier, leaders and local citizens to highlight their commitments to a pollution-free planet. Clean-ups of parks, riverfronts, beaches, and cities brought people together against plastic pollution in Vancouver, New Orleans, and Washington DC, while at UN headquarters in New York a green fair and high-level dialogue highlighted sustainable lifestyle solutions to the diplomatic community.

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Governments around the world are stepping up to the challenge of tackling the tide of plastic pollution.

Volunteers in Nairobi, Kenya rolled up their sleeves for a massive clean-up in Kibera, Africa's biggest informal settlement, taking the first steps to restoring what was once a sprawling lake in the middle of the neighbourhood. In Kenya's western city of Kisumu, sustainable retail was spotlighted with an elegant fashion show while the official national event in Mombasa saw policymakers discuss the future of PET in a national sustainable plastic framework.

In Europe, celebrations kicked off last week with a heroic swim across Geneva's lake Léman, featuring volunteers dragging balloons symbolising the weight of plastic waste produced per person in different European countries, and tourists visiting Brussels got to celebrate World Environment Day with the iconic statue of 'Manneken Pis', dressed up for the occasion.

Asia turned its focus on art to highlight the issue of plastic pollution, with 12 large-scale art installations prominently featured in a dozen cities across Asia Pacific. From traditional statues, to whimsical creations and abstract spheres made from plastics, the exhibits drew attention to the quintessentially international problem of plastic waste.

Across Latin America, clean-ups happened all over the continent, from the Galapagos Island in Ecuador to the Sea of Cortez in Mexico. Finally, Honduras committed to fighting marine litter by joining UN Environment's CleanSeas program.

For news and stories about World Environment Day celebrations, as well as more information about Plastic Pollution, visit: www.worldenvironmentday.global

United Nations Environment Programme (UNEP) (5 June 2018). *Communities unite against plastic pollution on World Environment Day*. Retrieved from www.worldenvironmentday.global on 31 August 2018.

NEW REPORT OFFERS GLOBAL OUTLOOK ON EFFORTS TO BEAT PLASTIC POLLUTION

*A new report from **UN Environment** finds a surging momentum in global efforts to address plastic pollution. The first-of-its-kind accounting finds governments are increasing the pace of implementation and the scope of action to curb the use of single-use plastics*

- A new report by UN Environment examines the state of plastic pollution in 2018.
- The report offers the first comprehensive global assessment of government action against plastic pollution.
- The analysis features best practices and lessons learned from case studies on single-use bans, levies and other forms of government intervention.
- UN experts suggest a ten-step roadmap for policymakers.

In what is framed as the first comprehensive review of the 'state of plastics', UN Environment has assembled experiences and assessments of the various measures and regulations to beat plastic pollution in a report: *Single-use Plastics: A roadmap for Sustainability*.

"Plastic isn't the problem. It's what we do with it."

Erik Solheim, Head of UN Environment



This global outlook, developed in cooperation with the Indian Government and the Ministry of Environment, Forest and Climate Change, presents case studies from more than 60 countries. The report analyzes the complex relationships in our plastics economy and offers an approach to rethink how the world produces, uses and manages single-use plastics.

Among the recommendations are specific actions policymakers can take to improve waste management, promote eco-friendly alternatives, educate consumers, enable voluntary reduction strategies and successfully implement bans or levies on the use and sale of single-use plastics.

The report was launched in New Delhi today by Indian Prime Minister Narendra Modi, and Head of UN Environment Erik Solheim on the occasion of World Environment Day.

"The assessment shows that action can be painless and profitable – with huge gains for people and the planet that help avert the costly downstream costs of pollution," said Erik Solheim Head of UN Environment, in the report's foreword.

"Plastic isn't the problem. It's what we do with it."

Among the key findings, the report states that government levies and bans – where properly planned and enforced – have been among the most effective strategies to limit overuse of disposable plastic products.

However, the report goes on to cite the fundamental need for broader cooperation from business and private sector stakeholders, offering a roadmap for upstream solutions, including extended producer responsibility and incentives for adoption of a more circular economy approach to plastic production and consumption.

The report recognizes that single-use plastic waste generation and waste management practices differ across regions. While no single measure against pollution will be equally effective everywhere, the authors outline 10 universal steps for policymakers to tackle the issue in their communities.

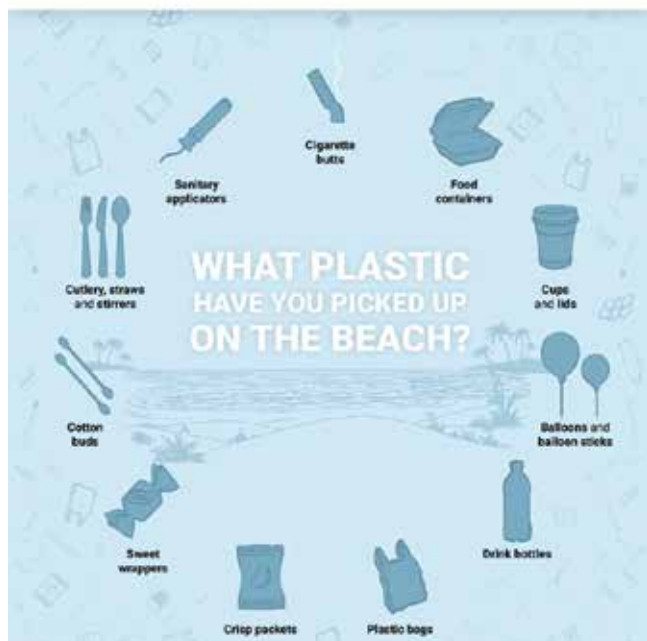
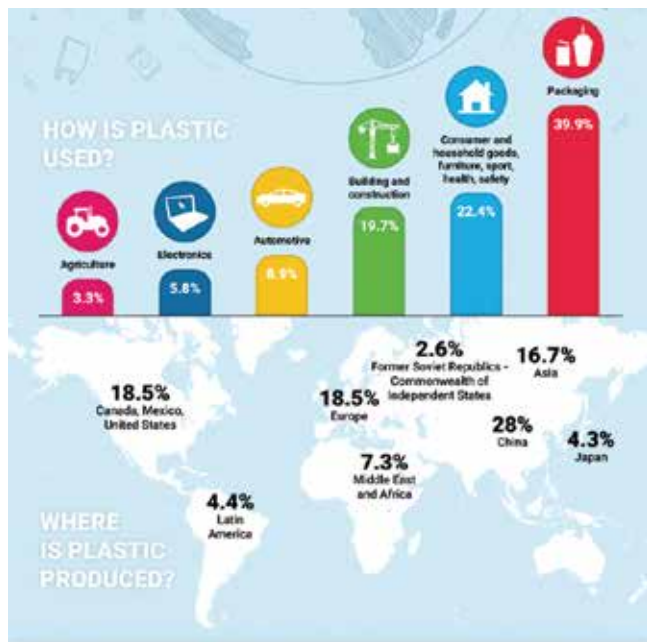
Under the theme: 'Beat Plastic Pollution', World Environment Day 2018 is issuing a call to action to individuals, governments, the public and the private sector to examine joint solutions to reduce the heavy burden of plastic pollution on our natural places, our wildlife and our own health.

UN Environment (5 June 2018). *New report offers global outlook on efforts to beat plastic pollution*. Retrieved from <http://worldenvironmentday.global> on 31 August 2018.

IF YOU CAN'T REUSE IT, REFUSE IT

THIS INFOGRAPHIC FROM THE WORLD ENVIRONMENT DAY CAMPAIGN WAS REPRODUCED COURTESY OF **UN ENVIRONMENT**

Plastic pollution has become an epidemic. Every year, we throw away enough plastic to circle the Earth four times. Much of that waste doesn't make it into a landfill, but instead ends up in our oceans, where it's responsible for killing one million seabirds and 100,000 marine mammals every year. For the good of the planet, it's time to rethink how we use plastic. Read on to get the facts and learn how you can beat plastic pollution.



UN Environment (16 February 2018). *Infographic: If you can't reuse it, refuse it*. Retrieved from <http://worldenvironmentday.global> on 31 August 2018.

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MARINE DEBRIS: WHAT IS AUSTRALIA DOING?

THE DEPARTMENT OF THE ENVIRONMENT AND ENERGY EXPLAINS THE FEDERAL GOVERNMENT'S COMMITMENTS TO TACKLING THE PROBLEM OF MARINE WASTE

WHAT IS MARINE DEBRIS?

Marine debris (or marine litter) is defined as any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment (UN Environment Program, 2009).

COMMON ITEMS OF MARINE DEBRIS INCLUDE

Plastic bottles	Fishing nets	Food packaging
Crates	Cigarette butts	Gloves
Buckets	Rope	Fishing gear
Packing materials	Light globes	Plastic bags
Plastic microbeads		

HOW DOES MARINE DEBRIS AFFECT THREATENED SPECIES?

Marine debris is harmful to marine life including to protected species of birds, sharks, turtles and marine mammals. Marine debris may cause injury or death through drowning, injury through entanglement and internal injuries, or starvation following ingestion.

Entanglement

Turtles, marine mammals and sea birds can be severely injured or die from entanglement in marine debris, causing restricted mobility, starvation, infection, amputation, drowning and smothering.

Seabirds entangled in fishing lines, fragments of fishing nets, plastic packing straps or other marine debris may lose their ability to move quickly through the water, reducing their ability to catch prey and avoid predators; or they may suffer constricted circulation, leading to asphyxiation and death.

Fishing line debris, nets and ropes cut into the skin of marine mammals or turtles, leading to infection or the amputation of flippers, tails or flukes.

Ingestion

Marine species can confuse plastics including bags, rubber, balloons and confectionery wrappers with prey and swallow them. This debris can cause a blockage in the digestive system.

Turtles are known to eat plastic bags, confusing them with jellyfish, their common prey.

Sea birds eat polystyrene balls and plastic buoys, confusing them with fish eggs and crustaceans, and whales are also known to eat plastic debris.

KEY THREATENING PROCESS

'Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine

debris' has been listed as a key threatening process under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

EPBC Act Key threatening process – Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris
www.environment.gov.au/cgi-bin/sprat/public/publicshowkeythreat.pl?id=14

THREAT ABATEMENT PLAN

In June 2009, the Australian Government made the Threat Abatement Plan for the Impacts of Marine Debris on Vertebrate Marine Life (the Plan) under the *Environment Protection and Biodiversity Conservation Act* following consultation with stakeholders including industry, conservation groups, state, territory and local governments.

The Plan was developed in response to the Natural Resource Management (NRM) Ministerial Council's *A National Approach to Addressing Marine Biodiversity Decline*, which recognises marine pollution as a significant threat to the health of listed species.

It provides a framework with timeframes and actions to ensure a coordinated national approach on the issues, and will:

- Review existing policies, codes of practice, conventions and activities to determine their effectiveness
- Coordinate abatement strategies identified in separate marine animal recovery plans, such as the Marine Turtle Recovery Plan and the Grey Nurse Recovery Plan, and
- Examine the effectiveness of joint agreements with other nations to address the issues of marine debris and its impact on wildlife, and assess the need for new ones.

The Australian Government is working in close co-operation with state and territory governments to implement the Plan. A five-year review on progress under the Plan is scheduled to take place.

Threat abatement plan for the impacts of marine debris on vertebrate marine life (and Background paper)

www.environment.gov.au/biodiversity/threatened/publications/tap/marine-debris-2018

Marine debris resulting from the legal disposal of garbage at sea is excluded from the key threatening process. Under the *International Convention for the Prevention of Pollution from Ships*, overboard disposal of food, paper, glass, metal and crockery (but not plastics) is permitted from vessels more than 12 nautical miles from land.

GREAT BARRIER REEF

The Reef 2050 Plan was released by the Australian and Queensland governments in March 2015 and is the overarching framework for protecting and managing the reef. It includes actions to protect the marine environment and wildlife from harmful material and debris. As part of this plan and during the International Year of the Reef 2018, the Australian Government is investing half a billion dollars in the health and resilience of the reef. This includes funds allocated towards increasing community engagement in reef protection through activities such as coastal clean-up days and awareness raising activities.

- Reef 2050 Plan, www.environment.gov.au/marine/gbr/long-term-sustainability-plan
- The Reef Trust and investments, www.environment.gov.au/marine/gbr/reef-trust

OTHER ACTIVITIES

National waste policy

The reef plan complements the Government's National Waste Policy (www.environment.gov.au/protection/waste-resource-recovery/national-waste-policy) and existing activities to mitigate the impacts of marine debris – such as state/federal projects through the Standing Council on Environment and Water that address litter at its source, by reducing waste, increasing recycling and encouraging industry to take responsibility for their products.

The Australian Packaging Covenant (www.environment.gov.au/protection/waste-resource-recovery/plastics-and-packaging/packaging-covenant) is an example of a successful product stewardship scheme where governments and industry have worked together to reduce the environmental impacts of packaging.

Individual state and territory governments are also taking specific actions to address plastic waste and litter (www.environment.gov.au/protection/waste-resource-recovery/plastics-and-packaging).

Regional action

The plan includes a number of regional and international actions that the Government is pursuing beyond our borders.

The Australian Government has an ongoing, active regional engagement on marine debris and litter including through the Coral Triangle Initiative, the Coordinating Body on the Seas of East Asia (COBSEA) and the Marine Resources Conservation Working Group of Asia Pacific Economic Cooperation (APEC).

As a part of this, the Government contributes to regional efforts to improve knowledge, prevention and responses to marine debris. This has included leading an APEC project Understanding the Economic Benefits and Costs of Controlling Marine Debris in the APEC Region.

International engagement

The Government maintains an active presence and

participation in fora including the United Nations General Assembly (UNGA) and the United Nations Environment Programme (UNEP). UNEP coordinates the Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities and also recently completed a survey of international marine debris impacts and activities, *Marine Litter: A Global Challenge* (UNEP, April 2009).

HOW CAN I GET INVOLVED?

There are lots of ways you can make a contribution to reducing marine debris.

- Ensure that when you enjoy the marine environment you responsibly dispose of your rubbish to stop it becoming marine debris – use available facilities and be aware of best-practice guidelines
- Participate in clean-up activities
- Contribute to our collective understanding of this issue by assisting organisations undertaking activities such as coastal clean-ups and surveys that record marine debris, and
- Consume wisely and help to reduce demand for materials that are possible sources of marine debris.

Where can I find out more?

Below is a range of publications and websites available on marine debris, with material ranging from local to national, regional and international. While not an exhaustive list, the links below provide a starting point to find out more.

Your local government and community websites may be another useful source of information on local activities and events.

PUBLICATIONS

Australian

- Dhimurru turtle entanglement report – *Research on the impact of marine debris on marine turtle survival*





and behaviour: North east Arnhem Land, Northern Territory, Australia – Dhimurru turtle entanglement report – April 2009, www.environment.gov.au/resource/research-impact-marine-debris-marine-turtle-survival-and-behaviour-north-east-arnhem-land

- *Finding solutions: Derelict Fishing Gear and Other Marine Debris in Northern Australia* – 2003, <https://parksaustralia.gov.au/marine/management/resources/scientific-publications/finding-solutions-derelict-fishing-gear-and-other-marine-debris-northern-australia/>
- Litter Management In Australia, Environment Protection and Heritage Council, 2008, www.nepc.gov.au/system/files/resources/020c2577-eac9-0494-493c-d1ce2b4442e5/files/wastemgt-rpt-litter-management-australia-200811.pdf
- *A national approach to biodiversity decline* – Report to the Natural Resource Management Ministerial Council – July 2005, www.environment.gov.au/biodiversity/publications/national-approach-biodiversity-decline-australia
- *RecFishing Research Best Practice in Recreational Fishing*, <http://frdc.com.au/Partners/National-Priorities-and-Subprograms/Recfishing-Research>
- *Understanding the types, sources and at-sea distribution of marine debris in Australian waters* – 2011, www.environment.gov.au/marine/publications/understanding-distribution-marine-debris-australia

International

- *Abandoned, lost or otherwise discarded fishing gear* (UNEP), www.fao.org/docrep/011/i0620e/i0620e000.htm
- *Marine Litter: A Global Challenge* (UNEP), <http://wedocs.unep.org/handle/20.500.11822/7787>

- The Net Kit (WWF), www.wwf.org.au/publications/the_net_kit/

WEBSITES

Australia

- Coastcare, www.landcareaustralia.org.au/coastcare
- CSIRO Marine Debris, www.csiro.au/en/Research/OandA/Areas/Marine-resources-and-industries/Marine-debris
- Northern Territory Marine Debris Monitoring Program
- Australian Maritime Safety Authority, www.amsa.gov.au/marine-environment
- Marine Debris in the Great Barrier Reef, www.gbrmpa.gov.au/learn-about-the-reef/resources-by-theme
- Marine Debris in the Australian Antarctic Territory, www.antarctica.gov.au/environment/pollution-and-waste
- Clean Up Australia: www.cleanup.org.au
- Keep Australia Beautiful, www.kab.org.au
- Carpentaria Gulf Nets Programme, www.ghostnets.com.au
- Project AWARE Marine Debris Page, www.projectaware.org
- Port Waste Reception Facilities, www.amsa.gov.au/waste-reception-facilities-australian-ports
- RecFishing Research Best Practice Guidelines, www.recfishingresearch.com.au
- Surfrider Foundation Australia, www.surfrider.org.au
- Tangaroa Blue Foundation, www.tangaroablue.org
- WWF Australia – Marine Debris Program, www.wwf.org.au/what-we-do/oceans

Regional

- APEC, www.apec.org
- COBSEA, www.cobsea.org/activities/activities_strategic_pollution.html
- SPREP, www.sprep.org/publications/stop-solid-waste-is-it-too-late

Global

- Clean Up the World, www.cleanuptheworld.org
- NOAA Marine Debris Program, marinedebris.noaa.gov
- Surfrider Foundation, www.surfrider.org
- UNEP Regional Seas Programme, www.unenvironment.org/explore-topics/oceans-seas/what-we-do/working-regional-seas

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Department of the Environment and Energy. *Marine debris*. Retrieved from www.environment.gov.au on 31 August 2018.

AUSTRALIAN PLASTICS RECYCLING SURVEY – NATIONAL REPORT

The 2016-17 annual survey from the **Department of the Environment and Energy** provides an overview of the consumption, flow, recovery and recycling of plastics in Australia, the state of reprocessing markets and assists in informing the status of product stewardship commitments in relation to plastic products. Following is the executive summary from the survey report

KEY FINDINGS

- A total of 3,513,100 tonnes of plastics were consumed in Australia in 2016-17.
- A total of 293,900 tonnes of plastics were recycled in 2016-17, which is a fall of 10 per cent from 2015-16 recovery. Including tyres, total plastics recovery was 415,200 tonnes.
- In 2016-17 the national plastics recycling rate was 11.8 per cent.
- Of the 415,200 tonnes of plastics collected for recycling, 180,100 tonnes (43.4 per cent) was reprocessed in Australia and 235,100 tonnes (56.6 per cent) was exported for reprocessing. Local reprocessing was flat from 2015-16, with export for reprocessing falling by 20 per cent.

In 2017, the Department of the Environment and Energy, and Queensland, Western Australian, Victorian and NSW state agencies commissioned the annual *Australian Plastics Recycling Survey* (APRS) to capture the consumption and

recycling of plastics in Australia during the 2016-17 financial year.

This information is collected through a detailed survey of Australian reprocessors, Australian resin manufacturers and importers, and extensive interrogation of Austr-

alian Customs data, sourced from the Department of Foreign Affairs and Trade (DFAT). Green Industries SA performs its own survey of South Australian plastics reprocessors and material recovery facility operators, and the data from that survey is incorporated into this report.

The 2017 survey has been conducted by the partnership of Envisage Works and Sustainable Resource Use (SRU), and the survey results are aggregated and analysed within this report. This research started in 1997 and has been undertaken annually since 2000.

For the first time this year's survey includes consumption and recycling of tyres nationally. As an add-on task to the main time-series APRS study this year, an assessment of national consumption of plastic retail carry bags in 2016-17 has been undertaken, with a focus on single-use bags.

The survey provides a comprehensive picture of the consumption, flow, recovery and recycling of plastics in Australia, the state of reprocessing markets and assists in informing the status of product stewardship commitments in relation to plastic products. The survey is a valuable tool for promotion, knowledge of the industry and forward planning, including informing and tracking policies and programs to further improve plastics resource efficiency over whole of life.

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Department of the Environment and Energy
(1 May 2018). *2016-17 Australian plastics recycling survey – national report*, p.1.
Retrieved from www.environment.gov.au
on 31 August 2018.

Figure E-1 – Annual Australian plastics recycling 2000 to 2016-17

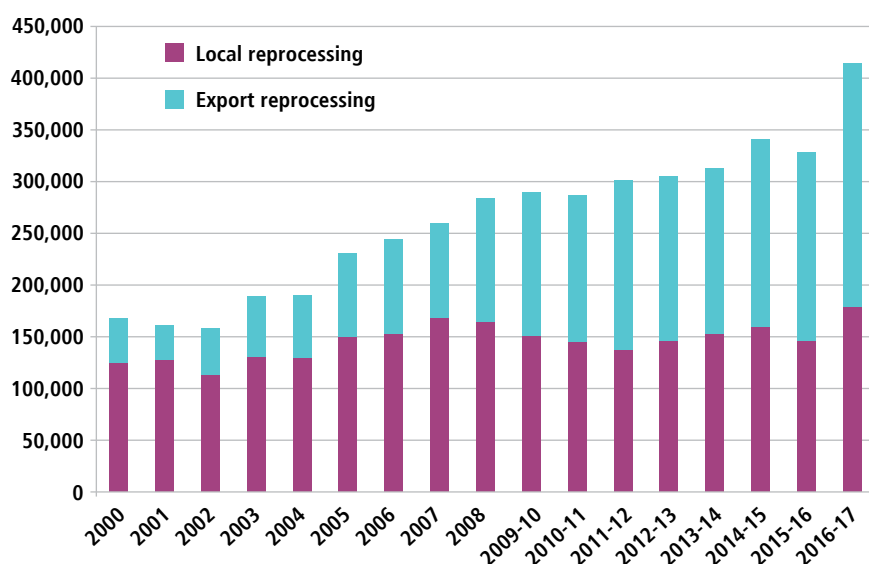
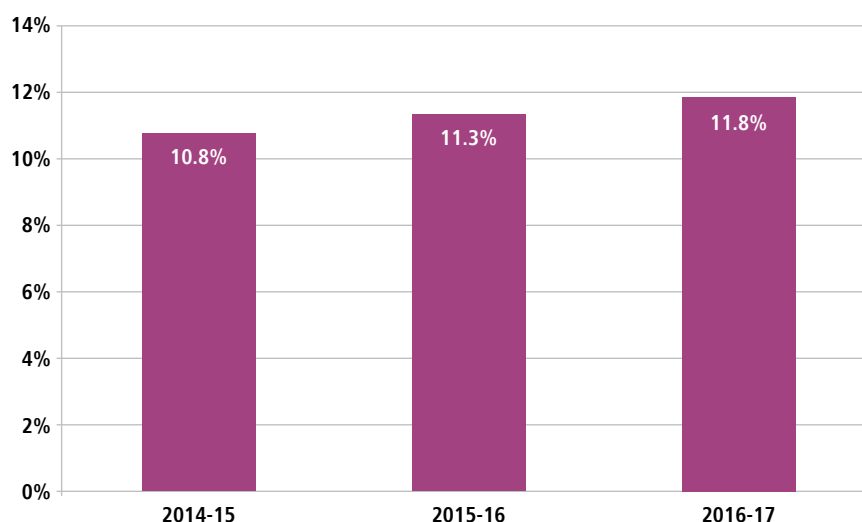


Figure E-2 – Annual Australian plastics recycling rates 2014-15 to 2016-17



GOVERNMENT ACTION ON PLASTICS AND PACKAGING

THE **DEPARTMENT OF THE ENVIRONMENT AND ENERGY** DETAILS THE AUSTRALIAN GOVERNMENT'S LATEST EFFORTS TO REDUCE PLASTIC AND PACKAGING WASTE

At the Meeting of Environment Ministers on 27 April 2018, environment ministers announced that a voluntary phase-out of microbeads is on track – with 94 per cent of cosmetic and personal care products now microbead free. Ministers announced that they remain committed to eliminating the final six per cent, and examining options to broaden the phase-out to other products.

Ministers also endorsed a target of 100 per cent of Australian packaging being recyclable, compostable or reusable by 2025, to be delivered by the Australian Packaging Covenant Organisation.

WHY IS IT IMPORTANT TO REDUCE PLASTIC AND PACKAGING WASTE?

Plastic products and packaging are integral to modern daily life. Plastic has multiple uses and provides light, innovative materials that solve a variety of challenges. It can be produced for a relatively low cost compared with other materials, but is often designed for short-term or single use.

Consumption of plastic has increased exponentially. While plastic and packaging recycling in Australia is well-established, only 14 per cent of plastic is recovered for recycling or energy recovery.

The Australian Government, along with states and territories and industry, is working to reduce

PLASTIC BAGS

STATE OR TERRITORY	BANS SINGLE-USE NON-BIODEGRADABLE PLASTIC BAGS
<i>Australian Capital Territory</i>	Yes
<i>New South Wales</i>	None proposed
<i>Northern Territory</i>	Yes
<i>Queensland</i>	Yes
<i>South Australia</i>	Yes
<i>Tasmania</i>	Yes
<i>Victoria</i>	By the end of 2019
<i>Western Australia</i>	Yes

the amount of plastic waste, increase recycling and minimise the impact on the environment. This includes supporting industry to design more sustainable solutions and recover materials before they enter the environment to reduce waste and litter.

WHAT IS THE DEPARTMENT'S ROLE?

- We administer the Australian Packaging Covenant to reduce the environmental impacts of consumer packaging and optimise resource recovery.



PLASTIC BOTTLES AND CONTAINERS

STATE OR TERRITORY	CONTAINER DEPOSIT SCHEMES
<i>Australian Capital Territory</i>	Yes
<i>New South Wales</i>	Yes
<i>Northern Territory</i>	Yes
<i>Queensland</i>	Yes
<i>South Australia</i>	Yes
<i>Tasmania</i>	Under consideration
<i>Victoria</i>	None proposed
<i>Western Australia</i>	Expected in early 2020

- We develop plans and guidelines to prevent plastic waste from entering the oceans.
- We work with state, territory and local governments, as well as industry, to support and encourage the reduction of plastic waste and litter.

OUR STANDARDS, INSTRUMENTS AND GUIDELINES

- *Australian Packaging Covenant*
www.environment.gov.au/protection/waste-resource-recovery/plastics-and-packaging/packaging-covenant
- *National Environment Protection (Used Packaging Materials) Measure 2011*
www.nepc.gov.au/nepms/used-packaging
- *Threat Abatement Plan for the Impacts of Marine Debris on Vertebrate Marine Life*
www.environment.gov.au/biodiversity/threatened/publications/tap/marine-debris-2018

Packaging

The Australian Government partners with other jurisdictions and industries to reduce the environmental impacts of packaging through the Australian Packaging Covenant. The Covenant requires companies to come up with ways to design more recyclable, compostable or reusable packaging.

- www.environment.gov.au/protection/waste-resource-recovery/plastics-and-packaging/packaging-covenant

Plastic marine debris

The Australian Government takes the problem of plastic waste and its impacts on the environment and wildlife seriously, and works with other governments to address ocean pollution.

As part of these efforts, the Government has developed the *Threat Abatement Plan for the Impacts of Marine Debris on Vertebrate Marine Life*. The plan aims to prevent waste from entering the oceans and becoming marine debris. The Government has also allocated money in the 2018-19 Budget for rubbish removal in the Great Barrier Reef.



- www.environment.gov.au/marine/marine-pollution/marine-debris

Plastic microbeads

The Government is working with industry, who have taken positive steps, to ensure a voluntary phase-out of microbeads from personal care and cosmetic products.

- www.environment.gov.au/protection/waste-resource-recovery/plastics-and-packaging/plastic-microbeads

Plastic bags

Most state and territory governments have banned single-use lightweight plastic bags. In addition, governments led by Queensland are working to voluntarily phase-out the use of heavy duty plastic bags. States' actions on plastic bags are being supported by Australia's major supermarkets, which are no longer using single-use plastic bags. The Government will keep working with state governments and businesses to support these initiatives.

Plastic bottles and containers

States and territories are implementing legislation and container deposit schemes that specifically address their bottle waste and litter issues (*see table, this page*). By giving people money if they return containers to be recycled, they are helping to keep plastic out of the environment and landfill.

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Department of the Environment and Energy. *Plastics and packaging*. Retrieved from www.environment.gov.au on 9 October 2018.

2025 NATIONAL PACKAGING TARGETS – IS IT ENOUGH?

POSTED BY JAYNE PARAMORE ON BEHALF OF THE **BOOMERANG ALLIANCE**

Business, industry and the not-for-profit sector joined the Australian Packaging Covenant Organisation* (APCO) to mark the official announcement of the federal government's targets for managing the growing mountain of plastic waste and pollution generated by the packaging industry.

The announcement from our newly-minted federal environment minister, Melissa Price, comes in the wake of a 'perfect storm' of indisputable evidence highlighting the global damage being caused by plastic entering the environment which has reached a deafening crescendo over the past twelve months. The issue has been further compounded by China's ban on imported plastic waste imposed in January which has shone a bright light on Australia's inadequate capacity to manage its own plastic footprint.

The new 2025 targets have been established to support commitments made at the meeting of state and federal environment ministers in April 2018.

The four key targets are that:

- 100% of all Australia's packaging will be reusable, recyclable or compostable by 2025 or earlier
- 70% of Australia's plastic packaging will be recycled or composted by 2025
- 30% average recycled content will be included across all packaging by 2025
- Problematic and unnecessary single-use plastic packaging will be phased out through design, innovation or introduction of alternatives.

Boomerang Alliance welcomes any commitment from the federal and state governments to ramp up action on addressing this emerging environmental disaster, but the question remains as to whether the targets are sufficiently ambitious to have a significant impact quickly enough to protect our marine environment and wildlife.

In the wake of the Chinese ban on imported plastic waste, it has become painfully apparent in recent months that Australia, alongside many other developed economies, must seek the means to deal with plastic waste domestically, to avoid sending increasing quan-

The growing backlog of problematic and single-use plastic waste currently building up in Australia is highlighting not only the excessive amount of virgin materials that are used for plastic packaging but also the limitations of our current recycling capacity to process the material.



tities of plastic to landfill, or worse still, to be used as a feed stock for waste-to-energy projects.

The growing backlog of problematic and single-use plastic waste currently building up in Australia is highlighting not only the excessive amount of virgin materials that are used for plastic packaging but also the limitations of our current recycling capacity to process the material.

Boomerang Alliance would like to see higher targets in shorter time frames, accompanied by the necessary incentives by government to build a viable circular economy for plastics.

Creating that circular economy however, does not merely rely on the capacity to recycle plastics but also on there being sufficient demand for recycled materials. While the objective for 70% of Australia's plastic packaging to be recycled or composted by 2025 is admirable, an average of 30% recycled content across all packaging in the same time period falls short of closing the loop on plastics within the system, particularly given that the term 'all packaging' acts as a catch-all for other materials including paper and cardboard.

The voluntary nature of these targets is another area of concern, given the widely demonstrated shortcomings of voluntary product stewardship models. As we have recently seen in NSW and Victoria, retailers back-flipped on their self-declared plastic bag bans, highlighting the ease with which voluntary models are abandoned – this freedom to opt-out did not exist in those states with legislated bans. By making the targets mandatory, the playing field is immediately levelled and provides greater certainty to all players in the circular economy, increasing the potential for industry investment to capture and recycle materials that will be needed to supply a guaranteed demand.

At the same meeting, the minister also officially launched APCO's new Australasian Recycling Label (ARL) and the accompanying PREP Design tool, aimed at supporting the achievement of the 2025 targets.

The ARL has been designed to provide consumers with clear guidelines on how to handle packaging when they come to dispose of it at home, in an attempt reduce contamination in the household recycling bin and increase recycling rates.

Alongside this, the PREP design tool equips manufacturers and packaging designers with information about the domestic recyclability of their chosen packaging materials, in the hope that packaging will be developed with better recyclability profiles at the point of design.

The development of the APCO tools will go some way to helping eliminate problem plastics – such as carbon black – that are widely used in packaging, but which cannot currently be recycled in Australia. Under the current model however, the tools are only available to APCO members and their uptake is on a voluntary basis, which further calls into question the ability to reach the stated objectives in the timeframe outlined.

Certainly, the objectives outlined by the environ-

2025 national packaging waste targets

1. 100% of all Australia's packaging will be reusable, recyclable or compostable by 2025 or earlier
2. 70% of Australia's plastic packaging will be recycled or composted by 2025
3. 30% average recycled content will be included across all packaging by 2025
4. Problematic and unnecessary single-use plastic packaging will be phased out through design, innovation or introduction of alternatives.

The 2025 National Packaging Waste Targets build on commitments made by Commonwealth, state and territory environment ministers and the president of the Australian Local Government Association in April 2018 to set a sustainable path for Australia's recyclable waste.

Leaders from packaging, retail, logistics, manufacturing, recycling and waste management businesses have pledged to better manage packaging waste.

Companies and organisations supporting the pledge include Aldi, ALGA, Amcor, Australia Post, Boomerang Alliance, Chep, Close the Loop, Coca-Cola Amatil, Coles, Detmold, Goodman Fielder, Lion, Metcash, Nestlé, Orora, Pact Group, Planet Ark, Redcycle, Simplot, Suez, Tetra Pak, Unilever, Veolia, Visy and Woolworths.

ment minister this week represent a welcome step in the right direction but it must be acknowledged that is only one part of a larger jigsaw.

It must be accompanied by, among other things, improved processes for materials reclaim and processing, enhancement of Australia's domestic recycling capacity, adoption of strong circular economy principles, demand creation for recycled materials through enforceable mandatory content requirements and broader Extended Producer Responsibility obligations across the entire packaging sector.

Only with a holistic approach to the plastic packaging question and strong government action to drive change, will we begin to see meaningful inroads being made into preventing plastic pollution from entering the environment and continuing to compromise the health of our ocean and its vulnerable wildlife.

*** The Australian Packaging Covenant Organisation is the co-regulatory, not-for-profit organisation established to deliver the commitments of Australian Packaging Covenant.**

The Covenant was created as a National Environment Protection Measure under the National Environment Protection Council Act 1994. The Covenant sits alongside state and territory regulation frameworks.

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End labelling confusion: Australasian Recycling Label



PLANET ARK IS WORKING WITH SOME OF AUSTRALIA AND NEW ZEALAND'S LEADING BUSINESSES TO REDUCE CONFUSION ABOUT RECYCLING

The Australasian Recycling Label is an evidence-based system that provides you with easy to understand recycling information when you need it most, in those few seconds when you are deciding what bin the package goes in.

The Australasian Recycling Label removes confusion, saves you time and reduces waste.

ABOUT THE LABEL

The Australasian Recycling Label is designed to be easy to understand. It shows what needs to be done with each piece of a package to dispose of it in the best way. You will find this label on the packaging of participating brands.



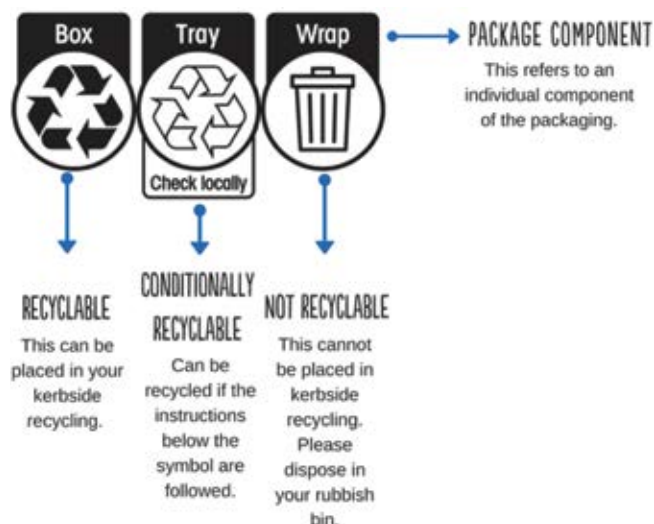
HOW TO INTERPRET THE LABEL?

The example below shows the Australasian Recycling Label as you might find on a box of chocolates.

The box is cardboard and is therefore recyclable in your kerbside recycling.

The tray is made from a material that is accepted in kerbside recycling by many but not all councils. You need to check with your local council to confirm.

To check local recycling options for these conditionally recyclable items go to [RecyclingNearYou.com.au](https://www.recyclingnearyou.com.au).



The conditionally recyclable label can also have many instructions that help to ensure the material will be recycled when put into the kerbside recycling bin e.g. aluminium foil may have an instruction tab advising to 'scrunch into ball'.

The wrap is not recyclable so should be placed in your rubbish bin.

The Australasian Recycling Label removes confusion, saves you time and reduces waste.

WHY DO WE NEED IT?

While our research has shown that Australians are good recyclers, we have also found that the majority of people are confused about recycling of common items. This can be caused by misleading or incorrect labelling on packaging and means that, even with the best intentions, we may be sending precious recyclable materials to landfill.

That's why we created the Australasian Recycling Label, to help people make informed decisions and ensure our recycling efforts are resulting in maximum resource recovery.

Thanks to a partnership with the Australian Packaging Covenant Organisation (APCO), the Australasian Recycling Label has just entered an exciting new phase. This development will allow more companies to adopt the Australasian Recycling Label, more products with the label to hit the shelves and, most importantly, more resources being recovered.

Leading organisations including Australia Post, Blackmores, Nestlé, Officeworks, Unilever and Woolworths have already pledged their commitment to using the label and as such are actively working towards reducing the amount of waste going to landfill in Australia.

Planet Ark. *End labelling confusion: Australasian Recycling Label*. Retrieved from <https://planetark.org> on 10 October 2018.

The new 100% recyclable packaging target is no use if our waste isn't actually recycled

On its own, the ambitious new target for recycling packaging is not enough, because it doesn't guarantee that recyclable or reusable items will definitely be recycled or reused, writes Atiq Zaman

Commonwealth, state and territory environment ministers last week agreed on an ambitious target that 100% of Australian packaging be recyclable, compostable or reusable by 2025. This is no doubt sensible, given the turmoil sparked by China's crackdown on waste imports.

Having a 100% target is fantastic. But this does not mean that all of the waste we generate in 2025 will necessarily find its way to one of these destinations.

For one thing, the definitions of different waste categories vary by state and territory, so there is no commonly accepted working definition of what constitutes 'recyclable, compostable or reusable'.

In practice, these terms depend largely on the infrastructure available. Single-use plastic bags are a good example of a product that is

technically recyclable but which is not accepted in most councils' kerbside recycling collection. That's because they are often contaminated with food waste and many councils lack the machinery to process them.

On its own, the new 100% target is not enough, because it doesn't guarantee that recyclable or reusable items will definitely be recycled or reused. To really make a difference, we also need policies and market incentives to ensure that these things end up where we want them to.

Driving recycling

We can see this principle in action by looking at the issue of drink containers. Glass and plastic bottles are already 100% recyclable, yet there is a stark difference in recycling rates between states that do have

container deposit schemes, and those that don't.

In South Australia, which has had container deposit legislation for more than 40 years, almost 80% of drink bottles are recycled. But in Western Australia, where similar legislation is only at the discussion stage, the rate is just 65%.

Despite the Australian Bureau of Statistics' attempt at a National Waste Account in 2013, little nationwide data are available, thanks to a lack of a consistent reporting framework across different jurisdictions.

Plastic not fantastic

In sectors where not all waste is fully recyclable, the problem is more complex still. Of the seven categories of plastic packaging, only three are economically viable to recycle: PET (soft drink bottles); HDPE (milk bottles); and PVC (shampoo bottles).

The other four – LDPE (garbage bags); PP (microwaveable cookware); PS (foam hot drink cups); and other plastics – are less economically viable and so are recycled at much lower rates.

While these plastics will still be allowed under the new target as they are technically recyclable, the new target might prompt a switch to less problematic materials.

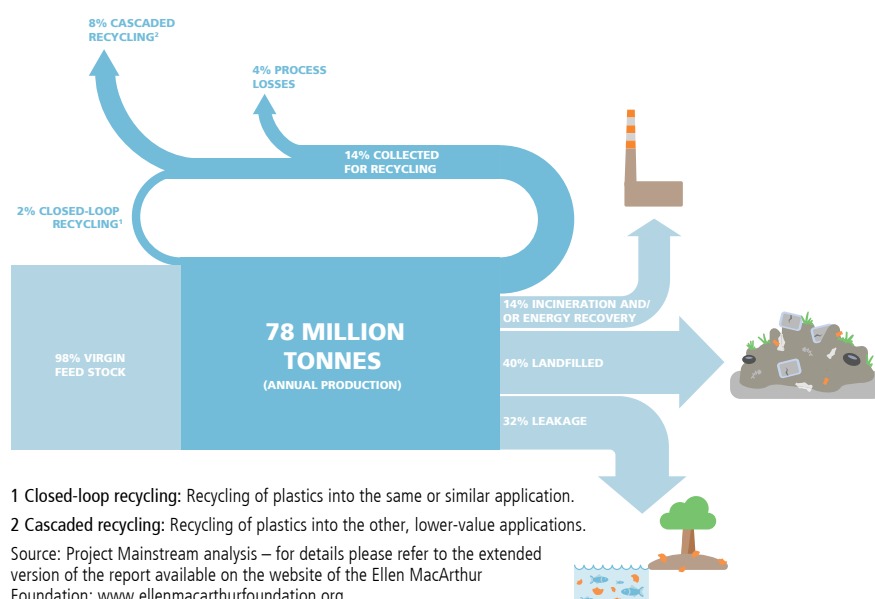
Globally, around 78 million tonnes of plastic is used every year, but only 14% is collected for recycling, while 14% is incinerated and the remaining 72% ends up in landfill or as litter in the environment.

The problems are no less vexing for other types of waste. With market rates for many types of recyclable paper having dropped to zero in the wake of China's import restrictions, it will be hard to see how some products will be recycled at all, if left purely to economic forces.

Retailers may have to embrace

Of the seven categories of plastic packaging, only three are economically viable to recycle: PET (soft drink bottles); HDPE (milk bottles); and PVC (shampoo bottles). The other four – LDPE (garbage bags); PP (microwaveable cookware); PS (foam hot drink cups); and other plastics – are less economically viable and so are recycled at much lower rates.

GLOBAL FLOWS OF PLASTIC PACKAGING MATERIALS IN 2013



more innovative solutions to improve the quality of recycling waste, such as reverse vending machines, which accept items such as aluminium cans and plastic or glass bottles – as long as they are cleaned and sorted. However, without creating a local waste market or government incentives, we cannot expect retailers to buy their packaging back.

And this is before we even consider the complexities of composting and reuse. Compostable waste as a whole is already facing problems due to a high contamination rate, and lack of separate bin for recycling organic waste in many local councils. Reuse, meanwhile, needs us to tackle the eternal problem of people's perceptions and behaviour about using old packaging again.

Will some kinds of packaging disappear?

Under the product stewardship initiative, which calls on producers and retailers to take care of the

waste produced after consumption of goods, it seems more likely that some materials will simply be phased out of the product supply chain altogether.

The impending plastic bag bans in several states and leading supermarkets offers a chance to replace them not with heavier, more durable plastic, but with biodegradable, renewable and eco-friendly natural materials such as hemp.

In turn, this would boost hemp production (alongside the legalisation of hemp-based medicine and food products in Australia). This could lead to the opportunity for manufacturing industry to produce environmentally-friendly, biodegradable plastics.

Hemp-based biodegradable plastic would significantly safeguard the environment, even if we failed to achieve a 100% recycling of biodegradable plastic packaging.

Similarly, glass or aluminium might be used instead of plastic, and

are more easily recycled.

Even more innovatively, we might even see the arrival of edible packaging derived from the milk protein casein, formed into film rather like plastic cling wrap, which can be used to package foods such as butter or cheese.

We need a better target

We've established that it's not enough simply to set a target of making 100% of our waste recyclable, compostable or reusable. To really feel the benefits we need a follow-on target, such as actually recycling 100% of our packaging by 2030.

For this to work, we would need three things:

- Legislation, regulations or incentives for manufacturers to develop new packaging types;
- An increase in public participation rates in recycling; and
- The development of a strong domestic market for recyclable materials.

Finally, we should remember that waste prevention is better than waste management.

Everyone – from governments, to manufacturers, to retailers, to consumers – should focus first on generating less waste in the first place. Then the fiendish problem of what to do with our waste will be all the smaller.

DISCLOSURE STATEMENT

Atiq Zaman does not work for, consult, own shares in or receive funding from any company or organisation that would benefit from this article, and has disclosed no relevant affiliations beyond his academic appointment.

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THE CONVERSATION

Zaman, A (4 May 2018). *The new 100% recyclable packaging target is no use if our waste isn't actually recycled*. Retrieved from <http://theconversation.com> on 31 August 2018.

We should remember that waste prevention is better than waste management. Everyone – from governments, to manufacturers, to retailers, to consumers – should focus first on generating less waste in the first place.

Government pledge to make packaging reusable, combustible or recyclable by 2025

- In recent years, Australia has exported about a third of its recyclable waste to China because of limited domestic processing facilities.
- However, on 1 January 2018, China stopped accepting 24 categories of foreign solid waste, disrupting the export of material out of Australia each year.
- Australia is one of over 100 countries hit hard by China's new restrictions, affecting around 1.3 million tonnes of its recyclable waste. This accounts for 4% of Australia's recyclable waste, but 35% of recyclable plastics and 30% of recyclable paper and cardboard.
- Since the ban, recycled waste has been stockpiled in warehouses around certain local councils across the nation, which have grappled with higher service costs after the Chinese waste import ban.
- In April 2018, the Federal Government struck a deal with states and territories to address Australia's mounting waste burden.
- Ministers agreed to the ambitious target that 100% of Australian packaging be recyclable, compostable or reusable by 2025 or earlier to cut down on the amount of waste we produce.
- Building incinerators to convert waste into energy and phasing out unrecyclable packaging in less than five years were core foundations of the voluntary deal.
- The Greens, Labor and other groups believe more can be done to phase out use of plastic, and have concerns about the viability of waste-to-energy.
- Generating energy from waste that is unable to be recycled is common in other countries, particularly in Europe.

Compiled by The Spinney Press.

PLASTIC RECYCLING FACT SHEET

THIS FACT SHEET WAS REPRODUCED COURTESY OF **CLEAN UP AUSTRALIA**

Plastics are the most common rubbish item found on Clean Up Australia Day, representing over 33% of all rubbish collected over the past 10 years⁷. This includes drink containers, confectionary packets and water bottles, all of which pose a huge threat to wildlife and our environment. Recycling plastic saves energy, valuable resources and helps to protect our environment. **Clean Up Australia** explains

THE PROBLEM WITH PLASTICS

Plastics are polymers, chains of molecules produced by smaller molecules called monomers. There are many different types of plastics depending on their molecular make up and shape.

To help identify the different plastics, a Plastic Identification Code is stamped on the final product to indicate what type of resin it contains¹. The code is displayed as a number inside a triangle of chasing arrows.



IMPACT ON THE ENVIRONMENT

Greenhouse gases

Fossil fuels such as natural gas, oil and coal are used in the production process of plastic, emitting dangerous greenhouse gases and toxic chemicals. As plastic decomposes gases are produced, particularly methane. Methane traps up to 100 times more heat than carbon dioxide, making the comparatively smaller amount of methane still 19 times greater a problem for climate change over a 5-year period².

Natural resources

Plastics are made from non-renewable resources that, once depleted, cannot be replaced³.

Persistence in the environment

Most plastic is not biodegradable and will survive in the environment for hundreds of years. Rather than biodegrading, plastic photodegrades, breaking down into smaller and smaller pieces. Plastic is also lightweight and moisture-resistant, meaning it can float easily in air and water, and travel long distances.

Landfill space

Australians use 1.3 million tonnes of plastic each year. We are great recyclers, with 46% of waste recycled each year⁴, however, this means that over half of our waste still ends up in landfill causing serious problems for the environment.

Threat to marine life

Every year more than 6 million tonnes of rubbish is dumped into the world's oceans. 80% of this waste is

DID YOU KNOW?

- The energy saved by recycling one plastic drink bottle will power a computer for 25 minutes.⁸
- Making products from recycled plastics instead of virgin materials reduces water usage by 90%, carbon dioxide by 2.5 tonnes and energy consumption by two-thirds.⁸
- A variety of plastics can be returned to your supermarket for recycling.^{9,10}
- For safety reasons, staff at recycling centres won't open plastic bags – please avoid recycling using a plastic bag otherwise items will end up as general landfill.
- The rings from bottle necks and six-pack holders need to be cut when you dispose of them to reduce harm to animals.
- Tie the tops of plastic bags up when disposing of them to prevent them blowing away.
- It takes 25 two-litre plastic bottles to make an adult fleece jacket.¹¹
- Buying products that have had a previous life, or have been made from parts which have been (or can be) recycled is a great way of reducing energy and water use and waste.¹²

plastic, with an estimated 46,000 pieces of plastic per square mile of ocean⁵. Plastic waste including plastic bags, food packaging, and abandoned fishing nets can be deadly to marine life.

Turtles, whales, and sea birds mistake rubbish for food or get entangled in it, causing painful injuries or even death. It is estimated that marine rubbish, mostly plastic, is killing more than a million seabirds and 100,000 mammals every year.⁵

THE SOLUTION

The best way to limit the plastic waste that you create and to prevent rubbish from going to landfill is to avoid, reduce, reuse and recycle.

Plastics are increasingly used in our every day life, thus recycling is more important than ever to reduce waste. Identifying the type of plastic is essential because each type of plastic is recycled differently.

IDENTIFYING PLASTICS

The Plastic Identification Code is stamped on all plastic products to identify the type of resin used.

On the next page are listed some common products you will find for each type of plastic.

What kind of plastic is kerbside recyclable?

Not all plastics are the same and your local council may only be able to recycle certain types through your kerbside recycling program.

In most areas, plastics labelled 1, 2, and 3 can be recycled, although many councils are now extending their recycling programs to include those labelled 4 through 7. Check with your council for details.



PET (Polyethylene terephthalate)
– soft drink and fruit juice bottles



HDPE (High-density polyethylene)
– milk bottles or shampoo containers



PVC (Polyvinyl chloride or plasticised polyvinyl chloride) – cordial, juice or squeeze bottles



LDPE (Low density polyethylene)
– garbage bags and bins



PP (Polypropylene) – ice cream containers, take-away food containers and lunch boxes



PS (Polystyrene) – yoghurt containers, plastic cutlery, foam hot drink cups



Other – all other plastics, including acrylic and nylon¹

Contamination of recyclables is a problem because it raises the costs for collectors, recyclers and the community.

Make sure you are aware about what plastics can be recycled and only put these in your recycling bins. To prepare plastics for recycling, rinse residue from bottles and containers, remove lids and squash bottles.

What is not kerbside recyclable?

Plastic bags, bin liners, and cling wrap are not recyclable. These plastics can get stuck in the sorting equipment in recycling facilities, causing it to stop or break. Often bottle tops and lids cannot be recycled with the bottle

as they may be made of a different type of plastic.

Polystyrene foam is generally not recyclable. This includes the spongy black foam trays that meat is often packaged in at supermarkets. It also includes some take-away containers and hot drink cups. Other items that cannot be recycled in the normal recycling bins from your council are disposable nappies and syringes².

Remember, if you are unsure about what is kerbside recyclable check with your local council. Non-kerbside recyclable plastic bags can still be recycled at some local supermarkets.

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Plastics you can and can't recycle

Every type of plastic is actually recyclable, and at least 20% of what we currently dispose of in our garbage bins could go into recycling bins, according to Planet Ark. However, it is important to understand not all items can be recycled via your kerbside bin. Check with your local council about what they accept, as each area has different recycling systems and sorting processes.

Plastic you can put in your kerbside recycling bin

Kerbside recycling is primarily for hard plastics, which include:

- Biscuit trays
- Bottles (e.g. milk, soft drink)
- Cake trays (plastic)
- Cleaning product bottles
- Compact disc cases (without discs)
- Containers (e.g. ice cream and margarine)
- Deodorant sticks (roll-on)
- Detergent bottles
- Fruit and vegetable punnets
- Hard plastic packaging
- Medicine bottles
- Plant pots (small)
- Plastic six-pack holders (cut to reduce harm to sea animals)
- Plastic toys (without batteries)
- Shampoo/conditioner bottles
- Soap pump bottles
- Take-away food containers
- Vitamin bottles
- Yoghurt containers.

Notes: All plastic drink bottles can go into recycling bins, however it is recommended removing lids and putting them in the garbage, as bottle lids are too small to be picked up by the recycling plants' sorting machines. Also, when the lid is left on, liquid may remain inside the bottle and weigh down the sorting machines; pressure can also build up and when compacted into bales, they may explode, then break the bale and be rebounded or rejected.

Plastic trays such as meat trays or soft food trays differ across councils. Rigid hard plastic trays can be recycled while soft polystyrene trays cannot, which means many councils reject both.

Plastic you can't put in your kerbside recycling bin

- Cling wrap
- Disposable nappies
- Frozen food bags
- Garden hoses
- Plastic bags and sachets
- Plastic dinnerware (disposable plates, cutlery)
- Plastic straws
- Polystyrene
- Rope
- Toothbrushes (non-electric); toothpaste tubes and dental floss containers can be recycled, although the only national scheme accepting these items is TerraCycle.

Plastic bags

- All 'scrunchable' plastic including shopping bags, plastic food packaging, fruit netting and dry cleaning bags can be recycled – but most often not via your household recycling bin (they get caught in conveyor belts). Only a handful of regional councils will accept these soft plastics.
- According to Planet Ark, the best method is to bundle all your plastic bags into one bag and take it to a REDcycle bin located in many metropolitan and large regional supermarkets. These plastic bags are then recycled into plastic school furniture.

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Compiled by The Spinney Press.

PLASTIC BAGS FACT SHEET

Say NO to plastic bags. Plastic bags are everywhere, and while they are convenient, they cause significant environmental damage all over the world. Every year Australians consume more than 4 billion supermarket plastic bags. Of these, just 3 per cent are recycled and the rest end up in our environment or in landfill.

Clean Up Australia explains



THE PROBLEM WITH PLASTIC BAGS

TYPES OF PLASTIC BAGS

HDPE bags

High-density polyethylene 'singlet' bags are the thinner bags used by over 80% of retailers, but predominately in supermarkets. These bags are easily recycled, yet rarely are.

LDPE bags

Low-density polyethylene bags are the much thicker bags used by boutiques and department stores. These bags are recyclable, although there are few collection points.

ENVIRONMENTAL IMPACT OF PLASTIC BAGS

A plastic bag on the beach, in a tree or blowing down the street is a very unattractive, yet common sight. Moreover, because plastic bags don't go away, they just break up into smaller and smaller pieces of plastic, the number of plastic bags in the environment continues to accumulate, with 80 million littered per year.¹

Plastic bags are lightweight and moisture-resistant, which means that they float easily in air and water, often travelling long distances.

Threat to marine life

Every year over 6 million tonnes of rubbish is dumped into the world's oceans, 80% of which is plastic, and a

DID YOU KNOW?

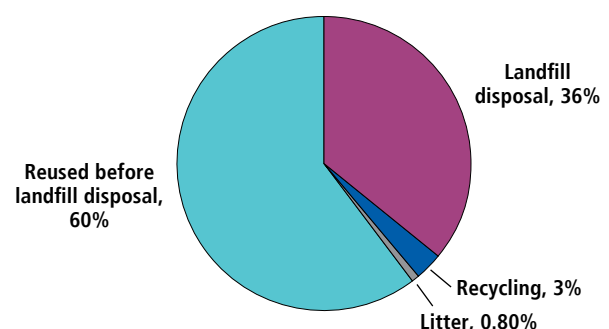
- Plastic bags can be returned to your supermarket for recycling but only 3% are currently recycled.¹
- So called 'biodegradable' bags actually cause greater widespread pollution than regular plastic bags.¹
- Australians currently use 4 billion plastic bags annually, which means over 10 million new bags are used every day.²
- The energy consumed in the life cycle of one plastic bag is estimated to be equivalent to 13.8 millilitres of crude oil, or about a teaspoonful.⁶
- Australians throw away about 7,150 recyclable plastic bags a minute, with 429,000 recyclable plastic supermarket bags dumped into landfill every hour.
- States/territories in Australia (excluding NSW) have either banned or committed to implement a ban in the near future.⁵
- Plastic bags can become serial killers. Once a bag is ingested, the animal dies and decomposes, releasing the bag back into the environment to kill again.⁴

further 10% of this being plastic bags.⁵ With an estimated 46,000 pieces for every square mile of ocean, plastic is responsible for killing 1 million sea birds and over 100,000 sea mammals each year.³ Turtles, whales and sea birds mistake rubbish for food or get entangled in it, resulting in painful injuries, or even death.

Landfill space

Australians dispose of an estimated 4 billion plastic bags, or 20,700 tonnes of plastic, that can be recycled¹. Even plastic bags that are reused as bin bags end up in municipal waste streams and will never be recycled, filling our already limited landfill space.

DISPOSAL OF PLASTIC BAGS¹



Greenhouse gases

When gas, oil and coal are used to produce plastic bags, they emit dangerous greenhouse gases. Large amounts of plastic end up in landfill, also a significant source of greenhouse gases.

Clean-up costs

It is estimated that it costs governments, businesses and community groups over \$4 million per annum to clean up littered plastic shopping bags.²



Biodegradable, degradable and compostable plastic bags

Recycling plastic bags reduces waste to landfill, saves non-renewable petroleum-based resources, reduces litter on land and in waterways and threats to wildlife, and saves energy required for producing new plastic bags

Recycling standard types of plastic shopping bags

Lightweight, checkout-style bags are most commonly found in supermarkets and take-away stores, and are made from high-density polyethylene or HDPE. The heavier, tougher plastic bags supplied by boutiques and department stores are made from low-density polyethylene or LDPE.

Some councils now accept plastic bags in their kerbside recycling bins. Check with your council first if they accept plastic bags, otherwise keep them out of the recycling bins as they can get caught up in the processing machinery and contaminate other recycling streams. Most supermarkets have a bin at the front of the store (such as REDcycle) which accepts single-use plastic shopping bags for recycling; they also sell reusable 'green bags'.

As companies move to get rid of single-use plastic bags and bans on microbeads are coming into force, new biodegradable or compostable plastic products offer an alternative. BUT, while a degradable or compostable plastic item may deteriorate slightly faster than a conventional product, the conditions must be right. Concerns include the terminology itself, the lack of appropriate recycling or composting infrastructure, and the toxicity of degradable plastics.

Understanding what to do with some types of plastic bags can be confusing as some are labelled 'biodegradable', 'degradable', and 'compostable'. In fact, these types of bags cannot be recycled.

Biodegradable bags

These bags are made from plant-based materials (e.g. corn and wheat starch). In the presence of oxygen these bags will break down – however, in the anaerobic (oxygen-free) environment of landfill, the bags cannot biodegrade.

Degradable bags

Made from petroleum products containing metal compounds to accelerate breakdown. Oxygen, ultra-violet light and/or heat weaken degradable plastic bags until they fragment into smaller pieces. This breaking down process may take up to 5 years to occur; a proportion will end up in our waterways and the ocean. These bags cannot be composted.

Compostable bags

This term generally refers to biodegradable bags that will biodegrade within 6 months, if composted.

Reusable, non-plastic bags best

The speed of biodegradation of these different types of bags can vary greatly, depending on the original material and whether the plastic ends up in a commercial composting facility, a backyard compost heap, or the ocean. Differences in materials, labelling and capabilities of composting facilities make it difficult for the waste system to function properly.

Best practice is to avoid plastic bags altogether. Whenever possible, refuse and reuse plastic bags. When shopping, always take reusable, non-plastic bags with you.

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Compiled by The Spinney Press.

THE SOLUTION

Say NO to plastic bags campaign

Clean Up Australia is committed to getting rid of light-weight plastic shopping bags. "Say NO to Plastic Bags" brings individuals, the community, businesses, government and environmental groups together to Refuse, Reuse and Recycle plastic bags.

Because plastic bags don't go away, they just break up into smaller and smaller pieces of plastic, the number of plastic bags in the environment continues to accumulate, with 80 million littered per year.

WHAT YOU CAN DO TODAY

Refuse

- If you are buying only a few items, consider carrying them.
- When shopping, take re-useable alternatives like 'green bags', bags made out of long-lasting washable non-plastics, or baskets with you.
- Make sure that you keep these bags in the car or put your car keys in your reusable bags at home so you don't forget them.
- Consolidate purchases into one bag rather than getting a new bag in each store.
- Remember, the thicker bags are not easily recyclable so avoid taking them, where possible.

Reduce

- Count the number of plastic bags that you use and aim to reduce that number each week.
- Avoid putting items with handles into a bag, e.g. dog food or nappies.
- Avoid using small plastic bags as bin liners. Simply put the household rubbish straight into the bin, lay it out with newspaper first and rinse afterwards, use the rinse water in your garden.

Reuse

- If you can't avoid a plastic bag, reuse it to freeze food, store clothing or while walking your dog.
- Keep a spare reusable shopping bag in your handbag or wallet. A Choice 2010 survey found 62% respondents use reusable bags for shopping.⁷

Recycle

- Find a local supermarket that offers recycling facilities for plastic bags.
- Return your plastic bags with the driver if your shopping is delivered.
- Ensure that your bags are free from contamination (food scraps or receipts), to aid the recycling process.
- Ask your local council if they have plans to include plastic bags in kerbside recycling.
- Remember not to put your regular recycling in plastic bags, as this disrupts the recycling process and it will end up in landfill instead.

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PLASTIC BOTTLES AND CONTAINERS

RECYCLING TIPS FROM PLANET ARK

Plastic bottles and containers are made from natural resources such as crude oil, natural gas and coal. Most plastic is not biodegradable and will persist in the environment for hundreds of years.

If your workplace or business has large quantities of plastic bottles and containers to recycle, visit [Business Recycling.com.au](https://www.businessrecycling.com.au) to find suitable collection or pick-up service options.

CONFUSION WITH RECYCLING PLASTIC CONTAINERS

A triangle with a number (1 to 7) inside stamped on a plastic container or bottle is actually a Plastic Identification Code.



This code identifies the type of plastic the product is – not if it can be recycled. People often confuse the

‘plastic identification code’ for the general recycling symbol (mobius loop), which involves three chasing arrows.



ABOUT PLASTIC LIDS

Please check with your council for any specific local advice around recycling plastic lids. In general, we advise the following:

- Ensure the plastic bottle is empty, and crush the bottle if possible. The lid may then be screwed lightly back onto the bottle and placed in the recycling bin
- Most plastic lids and neck rings are not the same type of plastic as the container but they can be easily separated in many processing facilities.
- Plastic lids on their own are too small for current recycling technology to sort, so do not place them loose in the recycling bin.

Planet Ark. *Plastic Bottles and Containers.*

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SAY NO TO BOTTLED WATER

Bottled water is increasingly popular in Australia. However, plastic bottles generate an enormous amount of waste that is ending up in landfill, or even worse, in our environment. According to reports from volunteers, one in ten items found on **Clean Up Australia Day** is related to plastic drinking bottles.

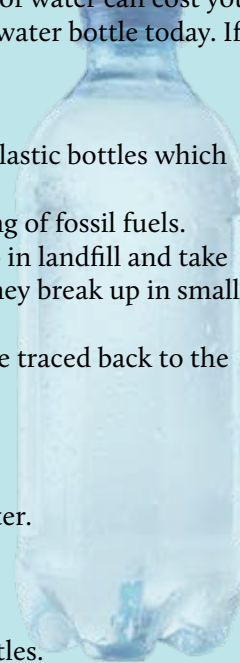
By avoiding bottled water and refilling your own bottle you can help conserve virgin resources and protect our pristine nature. Another great side effect is saving money. One bottle of water can cost you around \$2.50 versus only a few cents per litre for tap water. So start refilling your water bottle today. If you don't have one, visit our online store.

ENVIRONMENTAL IMPACTS

- **In production:** Most bottled water is packaged in PET (polyethylene terephthalate) plastic bottles which are derived from crude oil. It can take up to 3L of water to produce 1L of water.
- **In transportation:** Transportation of bottled water around the world requires burning of fossil fuels.
- **In landfill and the litter stream:** Although plastic bottles are recyclable, many end up in landfill and take up to 1,000 years to break down. When littered they often end up in the sea where they break up in small pieces, killing marine life that mistake them for food.
- And after all, bottled water is expensive. Over 90% of the cost of a water bottle can be traced back to the bottle, lid and label. You can save all that money by drinking tap water.

WHAT CAN YOU DO?

- The best thing to do is to avoid bottled water.
- Install a tap filter if you are concerned about the taste or quality of your local tap water.
- Buy a reusable bottle.
- Pick up and recycle any plastic bottles you find as rubbish.
- Support the campaign for Container Deposit Legislation
- Ask your local council to install water fountains to allow people to refill reusable bottles.
- Read our fact sheet (www.cleanup.org.au/fact-sheets) on bottled water to learn more about it, why to avoid it, and what you can do to reduce your environmental impact.



Clean Up Australia Ltd. *Say No to Bottled Water.* Retrieved from www.cleanup.org.au on 31 August 2018.

PLASTIC FREE JULY ACTION PICKER

My Challenge Choices (Getting started)



⊘ WHAT TO AVOID	✓ HOW TO AVOID IT	YOUR IMPACT Ocean/Landfill/Global warming	✓ YES, I'LL DO THIS
Fill the yellow bin with plastics for 'recycling'	Avoid as much plastic packaging as you can	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<input type="checkbox"/>
Pre-packed fruit and veg	Choose loose products (skip the little plastic bag or put in a reusable bag)	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<input type="checkbox"/>
Lightweight plastic bags	Remember your reusable shopping bags or use a cardboard box	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<input type="checkbox"/>
Personal care products containing plastic microbeads	Check the products you buy for microbeads (polyethylene, polypropylene, nylon) visit beatthemicrobead.org	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<input type="checkbox"/>
Bottled cleaning products	Opt for refills, bulk store products or make your own alternatives. Choose glass or cardboard packaging	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<input type="checkbox"/>
Bagged dry foods	Buy from a bulk store (fill your reusable container) or opt for cardboard boxed product	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<input type="checkbox"/>
Pre-packed meat or fish	Shop at the deli counter or butcher or fishmonger for paper wrapped cuts or BYO reusable container	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<input type="checkbox"/>
Takeaway drink straws	Refuse plastic straws (or opt for a paper straw if they have them). BYO reusable straw	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<input type="checkbox"/>
Takeaway coffee cups	Bring your reusable cup or sit and enjoy a real cup	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<input type="checkbox"/>
Takeaway utensils and containers	Support vendors offering compostable alternatives (bamboo or card), BYO reusables or sit and enjoy 'dine-in'	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<input type="checkbox"/>
Bottled water	Fill a reusable bottle from the tap	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<input type="checkbox"/>
Bottled soft drinks	Reduce the amount (helps your health), or make your own with a sodastream or choose glass bottles (and recycle)	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<input type="checkbox"/>
Bin liners (or 'reusing' plastic shopping bags)	Have a sealed container for 'wet' scraps and compost or freeze until bin day. Line the kitchen bin with paper	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<input type="checkbox"/>
Scooping your pet poo in plastic bags	Buy cornstarch based compostable bags online or at a pet suppliers or consider a dedicated pet poo composting system at home	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<input type="checkbox"/>
Milk containers (plastic)	Choose waxed card or glass bottled brands (depending on your local glass recycling). Make your own nutmilk	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<input type="checkbox"/>
Plastic food wrap for leftovers and sandwiches	Use a reusable lunch box to store food, store food in containers or use beeswax wraps	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<input type="checkbox"/>
Littering: cigarette butts, balloons	Dispose of cigarette butts in the bin (they are plastic and wash into the ocean environment) Avoid releasing balloons (what goes up, must come down)	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<input type="checkbox"/>
Ignoring other people's litter	Pick up that plastic bag blowing in the street, empty food containers, straws etc.	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<input type="checkbox"/>



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Plastic Pollution

Issues in Society | Volume 440

PLASTIC-FREE TIPS

A HANDY LIST OF SUSTAINABLE ALTERNATIVES TO USING PLASTIC

- **Bags** – bring your own re-usable shopping bags to the supermarket or shops, preferably of the environmentally-friendly, non-plastic kind (canvas, cotton); or use your arms (for limited items), or a cardboard box instead.
- **Bin liners** – line your bin with several layers of newspaper.
- **Bottles** – avoid plastic water bottles which are incredibly wasteful and expensive; take your own drink bottle when you are out and about. Water comes out of the tap for free – so why pay for it?
- **Bread** – buy fresh bread in paper bags, or use your own cotton bread bag.
- **Bulk food stores** – shop in bulk at plastic-free grocery stores like wholefoods shops and co-ops, for your health and the environment. Products from bulk bins include nuts, dried fruit, flour, legumes, coffee, rice, oats etc.
- **Cigarettes** – cigarette butt filters are made from cellulose acetate, a non-biodegradable plastic. They can shed microfibres and once used, give off high levels of toxins, including nicotine. Cigarette butts are a significant pollutant in the ocean and are the most commonly recovered item in beach clean-ups.
- **Cleaning products** – make your own cleaning products (surface cleaners, dishwashing liquid, bathroom cleaners) with products you can buy in bulk, and usually in cardboard; most ingredients will already be in your cupboard (recipes online).
- **Clothing (synthetic)** – outdoor gear, leggings, fleeces and jumpers made from acrylic and polyester, polyamide, spandex and nylon shed up to 700,000 microfibres with each wash. Microfibres are difficult to filter out in water; these fibres are now being found in tap water in many countries. Instead, choose to wear natural fibres like cotton, bamboo and wool.
- **Coffee cups** – take your own keep-cup or thermos and avoid styrofoam and plastic-lined cardboard waste.
- **Coffee pods** – avoid the mixed plastic and aluminium variety, use only the 100% aluminium type which can be returned to some stores for recycling; or use compostable pod options.
- **Cooking** – make your own plastic packaging-free food basics and snacks, such as DIY nut milks, crackers, yoghurt, muffins, muesli bars, bliss balls and ginger beer (recipes online).
- **Cups (take-away)** – paper cups are lined with polyethylene which breaks up into tiny pieces if the cup is littered or composted. Mixed materials need to be handled by a specialist recycling facility. Bring a refillable mug/keep-cup.
- **Cutlery** – avoid the white plastic single-use option that is offered when you buy take-away, bring your own reusable non-plastic cutlery (and plates) when possible.
- **Deli/butcher for cheese and meat** – use your own container and buy direct from the deli and/or butcher to avoid pre-packaged goods usually sold in plastic or styrofoam trays. Ask the deli worker/butcher/fishmonger to wrap meats in paper if you don't have your own containers.
- **Farmers' markets** – visit your local farmers' market, where you can buy farm-fresh produce with no plastic packaging that's come straight from the farm to you.
- **Food (snacks)** – avoid food in pre-portioned packaging and purchase in bulk instead; instead of buying multiple mini packs of biscuits, chips, yoghurt etc for school/work snacks, use a large single packet/tub and portion it into containers.
- **Food (take-away)** – at food courts, take your own container and refuse the plastic cutlery in favour of your own.
- **Food storage** – use saved glass jars and bottles for purchasing bulk food and storing leftovers; store leftovers in a bowl with a plate over the top instead of using plastic wrap; use existing plastic containers in the cupboard until they wear out; store vegetables in reused plastic bags, wrapped in damp tea towels or glass containers; wrap sandwiches in fabric or paper; keep herbs in a slightly damp tea towel in a glass container; wrap cheese in an old linen tea towel; freeze leftovers in heat-proof glass containers; use a clean shower cap to cover bowls; when freezing meat or seafood, wrap it in baking paper, then aluminium foil, instead of plastic.
- **Fruit and vegetables packaging** – avoid buying pre-packed or pre-weighed fruits and vegetables; instead choose them from the loose section and put them straight into the fruit basket or fridge when you get home. Some stores and co-ops also deliver cardboard boxes of fruit and vegetables.
- **Gifts** – avoid buying plastic gifts – offer an experience (restaurant voucher, meals, movie tickets etc); donate to charity; give a book; wrap gifts without plastic tape; learn the Japanese art of *furoshiki* (wrapping with fabric); reuse gift bags/wrapping paper you have received; make your gifts (such as homemade soap or try a plastic-free cooking recipe).
- **Glass packaging** – purchase items stored in glass, not plastic.
- **Glitter** – most glitter is made from PET or polyvinyl chloride film (PVC) and is very hard to dispose of; instead, get biodegradable cellulose film glitter, made from eucalyptus trees.
- **Grow your own** – grow your own herbs and salad leaves at home; enjoy fresh greens when you want and avoid the ones from supermarkets which come wrapped in plastic.
- **Lighters** – don't buy disposable plastic lighters; purchase matches or a refillable lighter that can be reused.
- **Milk** – look for milk in refillable glass bottles.
- **Nappies** – avoid disposable nappies (which take around 150 years to decompose); use cloth nappies instead. As you will need to use extra products for sanitising and washing cloth nappies, choose non-toxic laundry powders in a cardboard box that have less impact on the planet than plastic nappies.
- **Paint** – plastic dust from the thermoplastic paints used for road markings, ships and houses is found across the surface of the oceans. However, not all paints contain plastics – look for paints that use linseed oil or latex as binders.

- **Pasta** – make your own, buy in bulk, or look for cardboard-packaged pasta.
- **Personal care products** – swap your plastic toothbrush for a bamboo one; make your own toothpaste (recipes online); make your own deodorant (recipes online); use wooden/bamboo hairbrushes instead of plastic ones; use solid bar shampoo (not in a plastic bottle); for women, instead of tampons use a menstrual cup to reduce your plastic waste; use an electric shaver and avoid non-recyclable/non-biodegradable disposable razors; use naturally scented non-aerosol air fresheners or scented candles, incense or essential oils instead; avoid face soaps, body washes and toothpastes which contain microbeads.
- **Pet care** – purchase pet food which comes in paper bags; take your own containers to the butcher and seafood supplier for bones, fish, etc; make your own homemade treats for your cat or dog (recipes online); instead of plastic doggy poo bags, use folded up newspaper, paper bags or a 'pooper scooper'.
- **Plastic film wrap** – swap plastic film (which is non-recyclable and non-re-useable) for beeswax wraps (reusable wax-lined cloths) or storage containers that are both microwave- and freezer-safe.
- **Plates** – avoid using disposable plastic cups, plates, and cutlery. Use your own glasses and ceramic plates and wash them. If you must use disposable items, opt for biodegradable ones made from corn starch or paper, and compost afterwards.
- **Refills** – rather than buying a new product each time, buy refills for your cleaning, laundry and liquid soap supplies.
- **Straws** – refuse plastic straws; use your lips, paper straws or invest in a reusable straw (stainless steel, bamboo or glass).
- **Tea bags** – many teabags are not entirely biodegradable as they contain a polypropylene skeleton. That skeleton then breaks into tiny pieces when the paper breaks down in the compost or soil. Check if your teabag brew is plastic-free or switch to loose-leaf tea.
- **Toilet paper** – purchase toilet paper wrapped in paper.
- **Toys** – recycle old broken plastic children's toys, or if not broken donate them to a local op shop, daycare centre, toy library or kindergarten instead.
- **Travelling** – take your own reusable drink container (even on a plane); pack your own snacks; use your own earphones (not the disposable ones on planes); take your own personal hygiene products (don't use the small plastic bottles in hotels); pack a couple of light reusable bags for souvenirs or anything else you might purchase when you are away.
- **Wet wipes** – baby wipes, hand wipes and make-up removing wipes are typically made from polyester, polyethylene and polypropylene (or a mixture of those plastics and natural fibres). They block sewers, and the plastic doesn't break down. They are also a source of plastic fibres. An all-cotton flannel is the eco-friendly choice.

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Compiled by The Spinney Press.



SIX AWESOME PROGRAMS TACKLING OCEAN PLASTICS

OCEANWATCH AUSTRALIA LISTS A NUMBER OF INNOVATIVE WAYS TO TACKLE THE PLASTIC PROBLEM

Ocean plastics are the grown-up version of microplastics – small plastic particles in the environment that are generally smaller than 1 mm (0.039 in) down to the micrometer range. This plague of epic proportions is not a giant pile of garbage that you might see at the tip it, is an invisible cancer of the oceans and scourge of the food chain ... now for the good news! Here are 6 awesome programs tackling the problem and some ways you can help too!

1. AUSTRALIAN MARINE DEBRIS INITIATIVE

www.tangaroablue.org/amdi/amdi-program.html

Brainchild of Tangaroa Blue's Heidi Taylor, AMDI was created, as an on-ground network of volunteers, communities and organisations that contribute data from rubbish collected during beach and river clean-up events to the AMDI Database, and then work on solutions to stop the flow of litter at the source. This means that not only are they just picking up the never-ending flow of rubbish, the AMDI helps communities look after their coastal environment by providing resources and support programs, and collaborates with industry and government to create change on a large scale.

Heidi's (AMDI) program is taking fighting ocean plastics to the next level with this long-term data collection to stop rubbish where it starts. We think this is an epic task and she is definitely an eco-warrior.

2. SEA BIN AUSTRALIA

www.youtube.com/watch?v=tiy7WQYQyhY

Best mates Andrew Turton and Pete Ceglinski spent much of their childhood in the ocean and, after becoming frustrated at the amount of rubbish floating around, quit their jobs to come up with a sustainable solution – an automated rubbish bin for marina docks called the Seabin that many hope could help reduce ocean pollution.

With the help of Western Australian seed investors Shark Mitigation Systems, the duo designed a prototype of the bin in Perth before taking it to market in Mallorca in Spain, a marina capital of Europe.

3. OCEAN CLEANUP SYSTEM

www.youtube.com/watch?v=HxD6mf7B144

Boyan Slat, a 22-year old Dutch diving enthusiast who founded the Ocean Cleanup Project, has become an unlikely hero in the fight against ocean plastics.

The Ocean Cleanup proposes a larger-scale, passive method of removing marine debris in or near the ocean gyres by means of 100-kilometre (62 mi) long networks of floating barriers, anchored to the ocean floor.

These V-shaped barrier networks are designed to interact with natural ocean currents, funneling plastic

debris towards a central point where the plastic can be extracted by a platform and stored for transportation and recycling.

The Ocean Cleanup calls this barrier technology the Ocean Cleanup Array which has since grown into a multinational project aimed at cleansing the world's ocean of an estimated 5trn-plus pieces of plastic debris.

4. TWO HANDS PROJECT

www.twohandsproject.org

Two Hands Project is a collaborative approach to dealing with plastic pollution: take 30 Minutes and Two Hands to clean up your world anytime, anywhere.

Two Hands embodies the spirit of the huge national/international clean-up days but asks what you can do with your two hands in 30 minutes, at a location near you, on any day of the year. Two Hands is taking it all back to grass roots, looking at what you can do to care for the place(s) that are near to you or important to you, anytime that you want. They have ongoing events scheduled every month that you can check out their website above.

5. MR TRASH WHEEL

<http://baltimorewaterfront.com/healthy-harbor/mr-trash-wheel-live-feed/>

Baltimore USA Inner Harbour Water Wheel, or 'Mr Trash Wheel' to locals, harnesses the power of water and sunlight to collect debris flowing down the Jones Falls River.

The river's current turns the wheel, which lifts trash and debris from the water and deposits it into a dumpster barge. When the water current is too slow, a solar panel array provides additional power to keep the machine running. Full dumpsters are towed away by boat, and a new dumpster is put in place. Pretty simple, right?

Beyond that, some experts have called it the only 'truly feasible' concept to harvest debris from waterways. Click above to check out a live feed of the trash wheel in action.

6. ADVENTURE SCIENCE

www.adventurescientists.org/microplastics.html

Adventure Science allows you to help them study the sources, composition and distribution of microplastics pollution while you paddle, backpack or mountain bike. The three-year marine study is currently in preparation for publication and beginning in January 2017. If your next adventure takes you to a lake, a remote river, or glacier-fed stream we need your outdoor skills and water samples!

OceanWatch Australia. *6 awesome programs tackling ocean plastics.*
Retrieved from www.oceanwatch.org.au on 31 August 2018.

BIG AUSTRALIA'S RUBBISH FUTURE DOES NOT HAVE TO GO TO WASTE

Would the concept of waste become obsolete if our garbage had value?

Nick Kilvert reports for **ABC Science**

Imagine if you could get paid for the things you put in your rubbish, and countries competed to import waste. Waste is an environmental issue as well as a resource issue, and as Australia approaches 2050 and a population of 40 million, resources will be more valuable than ever.

Will we look back on single-use products as 21st century madness? That depends on the policy decisions we put in place today, and whether we can transition to a circular economy.

BURN BABY BURN?

The idea of countries importing and even competing for waste seems like a huge paradigm shift, but in some places it is already the norm.

It has been a decade since Sweden all but banned rubbish going to landfill. Now the Swedes claim to reuse or recycle as much as 98 per cent of their waste.

Half of that is turned back into materials such as plastics and aluminium for reuse, and the rest is used to feed sophisticated incineration systems that have

been developed to provide electricity and heating to Swedish households.

The incinerators are strictly monitored to adhere to Sweden's rigid emissions standards, according to Ali Abbas from the University of Sydney (USyd).

According to the 2016 *Avfall Sverige (Swedish Waste Management) Report*, the Swedes recovered three megawatt-hours of energy per tonne of waste burnt. That is enough to power about 900 Australian homes for an hour, according to the Clean Energy Authority.

While the average Australian sends more than one tonne of waste to landfill each year, the average Swedish household sends around three kilograms.

In 2015, Sweden imported 2.3 million tonnes of waste from Norway, the UK, Ireland and elsewhere to fuel its incinerators.

In short, it has created a system that is reliant on waste as a fuel source.

If Australia was to follow Sweden's lead, by 2050 we would be sending virtually no waste to landfill. We may even be mining landfill for fuel to feed our own incinerators.

However, incinerating our waste would do absolutely nothing to alleviate Australia's reliance on, and consumption of virgin materials and would move us no closer to a circular economy.

Instead, creating a dependence on rubbish as a fuel source can in its worst form create a perverse incentive to produce more waste.

RECYCLING STATION ON EVERY STREET, 3D PRINTER IN EVERY HOME

What if trucks no longer came to your house to collect your bins, but you had to take your waste to a reprocessing facility at the end of your street?

And instead of dumping your waste and forgetting it, you reprocessed it on the spot and were paid for the raw material or took it home to feed into your 3D printer?

Researchers at the University of New South Wales (UNSW) are developing the technology to make this possible.

They have created micro-recycling factories capable of producing 3D-printer feedstock from plastics, and metal alloys from electronic waste.

The factories are small enough to be mobile, and are modular, meaning they can be tailored to reprocess specific types of waste.

"Microfactories are really designed to generate local solutions," Veena Sahajwalla from UNSW said.

Being able to generate 3D-printer feedstock is

Will we look back on single-use products as 21st century madness? That depends on the policy decisions we put in place today, and whether we can transition to a circular economy.



significant. Although the technology is in its infancy, clothing, tools, cutlery, crockery, computer and car parts, prosthetic limbs, drones, telescopes, and even weapons have been produced using 3D printers.

The capacity to make the products we need in our own homes from readily available resources offers almost total autonomy from external manufacturing.

It diminishes the need for international shipping, and repositions landfill as a valuable resource.

“The ability to produce materials and goods and products that we all need effectively is the foundation of modern society,” Professor Sahajwalla said.

“So to me that is the ultimate empowerment – to be locally producing [materials] yourself.”

UNLOCKING BARRELS OF CRUDE OIL FROM LANDFILL PLASTIC

Will we mine today’s landfill for 3D printing stock in the future? Maybe, but there could be competition from other resource sectors.

The best estimates say that we have reached or soon will reach peak oil – when the rate of oil extraction peaks and then enters terminal decline as reserves diminish.

The British Plastics Federation estimates 4 per cent of our global oil consumption goes into making plastic each year. A European Union report estimates that will rise to 20 per cent by 2050.

But researchers are developing depolymerisation technology – a technique for returning plastic to its chemical components, including extracting oil for fuel.

A study published in the *International Journal of Energy and Environmental Engineering* last year found that plastic was able to be converted into a low-emission alternative to motor fuel using catalytic depolymerisation.

And there are literally billions of barrels of oil locked up in plastics in landfill.

BINS? WHERE WE’RE GOING WE DON’T NEED BINS

Speak to any recycling industry experts, sustainability researchers and developers, and at some point they will mention the circular economy.

In the waste hierarchy, recycling is good but reuse is better. In a circular economy, there is no such thing as single-use products; resources circulate, and nothing goes to landfill.

Although it sounds like far-fetched idealism, San Francisco is already a long way down the path to achieving its stated goal of being circular – a zero waste city by 2020.

In San Francisco, styrofoam and polystyrene have been banned in nearly all forms including food and take-away containers, coffee cups, eskies, and packaging. Plastic bags have been banned since 2007. Domestic recycling and composting are mandatory.

Australian construction and demolition sent more than 7 million kilograms of waste to landfill in 2014-15.

Although the technology is in its infancy, clothing, tools, cutlery, crockery, computer and car parts, prosthetic limbs, drones, telescopes, and even weapons have been produced using 3D printers.

In contrast, San Francisco has introduced strict civil and criminal penalties to curb the city’s construction waste stream.

“Construction and demolition – debris material removed from a project must be reused or recycled,” the Department of the Environment (SFDE) guidelines state. “No construction and demolition debris can be taken to landfill or put in the garbage.”

This system puts the responsibility onto industry to conserve resources, but the key to achieving a circular economy starts before the product leaves the shelf, according to Professor Abbas.

“In a circular economy, we need to focus on the first step, which is product design,” Professor Abbas said.

Designing products to be used multiple times, and giving them monetary value, is key to stopping them ending up in landfill. If a bottle is worth a dollar to us and we have 20 of them, there’s a good chance they’ll be returned.

The German Pfand (deposit) system already uses this principle. Plastic bottles are designed to be used up to 25 times, glass bottles up to 50 times. They are returned to collection points for a deposit, cleaned, sterilised and circulated back into use.

In San Francisco, where officials claim to be 80 per cent of the way to achieving zero waste, the SFDE says it can get to 90 per cent by focussing on product design and extended producer responsibility.

“The San Francisco Department of the Environment will [work with producers to] design better products [where producers] take responsibility for the entire life cycle of a product including take-back and recycling,” it said.

Australians produced 64 million tonnes, or 2.7 tonnes per person of waste in 2014-15, according to the *National Waste Report*. Most of that was from construction and demolition and commercial and industrial sources.

With a projected population of 40 million people in 2050 that would rise to over 100 million tonnes. It is an abstract figure, but we know it is big. On a finite Earth, it logically cannot increase forever.

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Kilvert, N (17 March 2018). ‘Big Australia’s rubbish future does not have to go to waste’ (Updated 30 May 2018), *ABC News*. Retrieved from www.abc.net.au/news on 31 August 2018.

How plastics made from plants could be the answer to the world's waste problem

Treating plastic waste as a resource rather than as a problem is an important change that needs to happen over the coming decades, writes **James Comerford**

Plastics are incredibly useful materials with extremely diverse properties, allowing a multitude of different applications that benefit our lives.

Bottles and forks aside, in the medical field alone plastics have been used for artificial heart valves, medical implants and devices, controlled drug release, specialist surfaces and coatings that repel water, organic batteries – the list is endless.

But, with marine plastic debris estimated to reach 250m tonnes by 2025, governments across the globe are starting to think about how to overcome this significant problem.

A fundamental part of this issue is that non-sustainable, single-use plastics account for up to 40% of global plastic production. This equates to around 128m tonnes. The vast majority of these plastics have low recycling rates and do not biodegrade in an acceptable time span – polypropylene can take millennia to break down properly.

Worse still, if these plastics find their way into the

marine environment, the motion of the sea along with sunlight can cause the plastics to fracture into small particulates called 'microplastics'.

The presence of macro and microplastics in our oceans has been shown to have a detrimental effect on marine life. But the potential effect on human health is much less well understood.

A ban on the production of cosmetics and personal care products containing plastic microbeads came into effect at the beginning of the year. Though realistically, this only accounts for an estimated 680 tonnes of microplastics per year in the UK.

THE PROBLEM WITH PLASTICS

It is clear then that plastic waste is a complicated problem – spanning economics, sustainability, social pressures and recycling infrastructure in both developed and developing countries. But while it's widely known that plastics can be an issue for the environment, what isn't often known is that the persistence of plastics in the environment is actually closely linked to how they are made.

The overwhelming majority of plastics are made using oil-based materials, meaning that, by their chemical nature, many plastics have no oxygen content. This makes them very hydrophobic (water-hating) and, as such, it is very difficult for common bacteria or enzymes to break them down if they enter the environment.

Treating plastic waste as a resource rather than as a problem is an important change that needs to happen over the coming decades. This will help to preserve our remaining chemical materials, as well as protect our environment.



Over the past few decades, there has been increased awareness of our dependence on a limited oil supply and this has driven research into alternative, sustainable sources of chemicals. In particular, the concept of using bio-based materials as a resource rather than oil-based materials has really gained momentum. Sustainable bio-based material can be waste crops, waste wood, waste food – in fact, any waste biological matter.

Most importantly, these natural, bio-based materials can easily be broken down into smaller chemical building blocks – called ‘platform molecules’ – which in turn, can be used to make other useful chemicals, including plastics.

NATURE’S BUILDING BLOCKS

Using these platform molecules, the Green Chemistry Centre of Excellence at the University of York, has been working with the plastics industry to create a new generation of bio-based polyesters. These are often used to make fibres for clothing, as well as films and containers for liquids and foods. The resulting materials are entirely plant-based, recyclable and – importantly – fully biodegradable.

Aside from sustainability, the huge benefit of using biomass as a resource is the high quantity of oxygen that is incorporated into nature’s chemical structures (cellulose, glucose etc). By using bio-based materials to make bio-based plastics, the oxygen content is kept in the material. The hope is that by having a high oxygen content, the bio-based plastics will have high, but controlled biodegradability. This means that the bio-based plastic can totally and safely break down into benign starting materials.

But although this new generation of sustainable plastics is a huge step forward, and a compostable plastic is of huge benefit, this is by no means the end goal for all bio-based plastics.

CIRCULAR ECONOMY

The circular economy is all about keeping resources in a constant loop, reusing and recycling them as many times as possible. This helps to minimise waste and reduce the need for brand new resources.

Treating plastic waste as a resource rather than as a problem is an important change that needs to happen over the coming decades. This will help to preserve our remaining chemical materials, as well as protect our environment.

Plastics are a fundamental part of modern society and they are here to stay. Ultimately, society has to move away from oil-based products towards sustainable bio-based alternatives. But regardless of whether a plastic is oil-based or plant-based, the biggest impact you can have on the life cycle of a plastic product is to reuse and recycle it.

As a consumer, this means you have a choice and the power to make a positive impact. Find out where your nearest plastic waste recycling point is and look

Plastics are a fundamental part of modern society and they are here to stay. Ultimately, society has to move away from oil-based products towards sustainable bio-based alternatives. But regardless of whether a plastic is oil-based or plant-based, the biggest impact you can have on the life cycle of a plastic product is to reuse and recycle it.



to promote home collection and the proper recycling of all types of plastic waste.

So next time you use the last of the ketchup, help to preserve our resources by making sure your plastic waste stays in the recycling loop.

DISCLOSURE STATEMENT

James William Comerford receives funding from Innovate UK Industrial Biotechnology Catalyst Grant; BBSRC (2016 – 2019) BB/N023595/1 (Project: enzymic polymerisation, characterisation and market evaluation of a set of novel bioplastic co-polymers derived from renewable resources). Biome Bioplastics is one of the consortium members associated with this project as well as a financial contributor.

James William Comerford is Postdoctoral Research Associate, University of York.

THE CONVERSATION

Comerford, JW (23 February 2018). *How plastics made from plants could be the answer to the world's waste problem*. Retrieved from <http://theconversation.com> on 31 August 2018.

HOW PLASTIC-EATING BACTERIA ACTUALLY WORK – A CHEMIST EXPLAINS

Emily Flashman explains how scientists are in the early stages of developing environmentally-friendly recycling by using bacteria

The plastic bottles we throw away today will be around for hundreds of years. It's one of the key reasons why the mounting plastic pollution problem, which is having a deadly effect on marine life, is so serious.

But scientists recently discovered a strain of bacteria that can literally eat the plastic used to make bottles, and have now improved it to make it work faster. The effects are modest – it's not a complete solution to plastic pollution – but it does show how bacteria could help create more environmentally-friendly recycling.

Plastics are complex polymers, meaning they are long, repeating chains of molecules that don't dissolve in water. The strength of these chains makes plastic very durable and means it takes a very long time to decompose naturally. If they could be broken down into their smaller, soluble chemical units, then these building blocks could be harvested and recycled to form new plastics in a closed-loop system.

In 2016, scientists from Japan tested different bacteria from a bottle recycling plant and found that *Ideonella sakaiensis* 201-F6 could digest the plastic used to make single-use drinks bottles, polyethylene terephthalate (PET). It works by secreting an enzyme (a type of protein that can speed up chemical reactions) known as PETase. This splits certain chemical bonds (esters) in PET, leaving smaller molecules that the bacteria can absorb, using the carbon in them as a food source.

Scientists recently discovered a strain of bacteria that can literally eat the plastic used to make bottles, and have now improved it to make it work faster ... it does show how bacteria could help create more environmentally-friendly recycling.

Although other bacterial enzymes were already known to slowly digest PET, the new enzyme had apparently evolved specifically for this job. This suggests it might be faster and more efficient and so have the potential for use in bio-recycling.

As a result, several teams have been trying to understand exactly how PETase works by studying its structure. In the past 12 months, groups from Korea, China and the UK, US and Brazil have all published work showing the structure of the enzyme at high resolution and analysing its mechanisms.

These papers show that the part of the PETase protein that performs the chemical digestion is physically tailored to bind to PET surfaces and works at 30°C, making it suitable for recycling in bio-reactors. Two of the

teams also showed that by subtly changing the enzyme's chemical properties so it interacted with PET differently made it work more quickly than the natural PETase.

Using enzymes from bacteria in bio-reactors to break down plastic for recycling is still easier said than done. The physical properties of plastics make them very difficult for enzymes to interact with. The PET used in drinks bottles has a semi-crystalline structure, which means the plastic molecules are tightly packed and difficult for the enzyme to get to. The latest study shows that the enhanced enzyme probably worked well because the part of the molecule that is involved in the reaction is very accessible, making it easy for the enzyme to attack even the buried PET molecules.

MODEST IMPROVEMENTS

The improvements to the PETase activity were not dramatic, and we are nowhere near a solution to our plastic crisis. But this research helps us understand how this promising enzyme breaks down PET and hints at how we could make it work faster by manipulating its active parts.

It is relatively unusual to be able to engineer enzymes to work better than they have evolved through nature. Perhaps this achievement reflects the fact that the bacteria that use PETase are only recently evolved to survive on this man-made plastic. This could give scientists an exciting opportunity to overtake evolution by engineering optimised forms of PETase.

There is one worry, though. While any modified bacteria used in bioreactors are likely to be highly controlled, the fact that it evolved to degrade and consume plastic in the first place suggests this material we rely on so heavily may not be as durable as we thought.

If more bacteria began eating plastic in the wild then products and structures designed to last many years could come under threat. The plastics industry would face the serious challenge of preventing its products becoming contaminated with hungry micro-organisms.

Lessons from antibiotics teach us we are slow to outwit bacteria. But perhaps studies such as these will give us a head start.

DISCLOSURE STATEMENT

Emily Flashman receives funding from the Biotechnology and Biological Sciences Research Council.

Emily Flashman is Research Fellow in Enzymology, University of Oxford.

THE CONVERSATION

Flashman, E (19 April 2018). *How plastic-eating bacteria actually work – a chemist explains*. Retrieved from <http://theconversation.com> on 31 August 2018.

If we can't recycle it, why not turn our waste plastic into fuel?

MUXINA KONAROVA ASKS: COULD THIS BE TURNED INTO FUEL, INSTEAD OF JUST MORE PLASTIC?

Australia's recycling crisis needs us to look into waste management options beyond just recycling and landfilling. Some of our waste, like paper or organic matter, can be composted. Some, like glass, metal and rigid plastics, can be recycled. But we have no immediate solution for non-recyclable plastic waste except landfill.

At a meeting last month, federal and state environment ministers endorsed an ambitious target to make all Australian packaging recyclable, compostable or reusable by 2025. But the ministers also showed support for processes to turn our waste into energy, although they did not specifically discuss plastic waste as an energy source.

The 100% goal could easily be achieved if all packaging were made of paper or wood-based materials. But realistically, plastic will continue to dominate our packaging, especially for food, because it is moisture-proof, airtight, and hygienic.

Most rigid plastic products can only be recycled a few times before they lose their original properties and become non-recyclable. Even in European countries with strict waste management strategies, only 31% of plastic waste is recycled.

Worldwide plastic production is predicted to increase by 3.8% every year until 2030. Flexible, non-recyclable plastic materials are used in an increasing range of applications like packaging, 3D printing, and construction.

We need to expand our range of options for keeping this plastic waste out of landfill. One potential approach is 'plastic to energy', which unlocks the chemical energy stored in waste plastic and uses it to create fuel.

HOW PLASTIC TO ENERGY WORKS

Plastic is made from refined crude oil. Its price and production are dictated by the petrochemical industry and the availability of oil. As oil is a finite natural resource, the most sustainable option would be to reduce crude-oil consumption by recycling the plastic and recovering as much of the raw material as possible.

There are two types of recycling: mechanical and chemical. Mechanical recycling involves sorting, cleaning and shredding plastic to make pellets, which can then be fashioned into other products. This approach works very well if plastic wastes are sorted according to their chemical composition.

Chemical recycling, in contrast, turns the plastic into an energy carrier or feedstock for fuels. There are two different processes by which this can be done: gasification and pyrolysis.



Gasification involves heating the waste plastic with air or steam, to produce a valuable industrial gas mixture called 'synthesis gas', or syngas. This can then be used to produce diesel and petrol, or burned directly in boilers to generate electricity.

Most rigid plastic products can only be recycled a few times before they lose their original properties and become non-recyclable. Even in European countries with strict waste management strategies, only 31% of plastic waste is recycled.

In pyrolysis, plastic waste is heated in the absence of oxygen, which produces mixture of oil similar to crude oil. This can be further refined into transportation fuels.

Gasification and pyrolysis are completely different processes to simply incinerating the plastic. The main goal of incineration is simply to destroy the waste, thus keeping it out of landfill. The heat released from incineration might be used to produce steam to drive a turbine and generate electricity, but this is only a by-product.

Gasification and pyrolysis can produce electricity or fuels, and provide more flexible ways of storing energy than incineration. They also have much lower emissions of sulfur and nitrogen oxides than incineration.

Currently, incineration plants are viewed as an alternative energy supply source and a modern way of driving a circular economy, particularly in Japan, South Korea and China, where land is valuable and energy resources are scarce. In other countries, although waste incineration is common practice, the debate around human health impacts, supply issues and fuel trade incentives remains unresolved.



CAN AUSTRALIA EMBRACE PLASTIC TO WASTE?

Gasification of plastic waste needs significant initial financing. It requires pre-treatment, clean-up facilities, gas separation units, and advanced control systems. Pyrolysis units, on the other hand, can be modular and be installed to process as little as 10,000 tonnes per year – a relatively small amount in waste management terms. Plastic pyrolysis plants have already been built in the UK, Japan and the United States.

We need to expand our range of options for keeping this plastic waste out of landfill. One potential approach is ‘plastic to energy’, which unlocks the chemical energy stored in waste plastic and uses it to create fuel.

As pyrolysis and gasification technologies can only process plastics, many councils do not see major advantages in using them. But by taking only a specific waste stream, they encourage better waste sorting and help to reduce the flow of mixed waste and plastic litter.

Australia has invested a serious amount of funding into research, particularly in waste conversion. It has a solid industrialised infrastructure and a highly skilled workforce. The current recycling crisis offers an opportunity to explore some innovative ways of turning our waste into valuable products.

There are direct job opportunities in plastic conversion plants, and indirect jobs around installation, maintenance and distribution of energy and fuels. We might even see jobs in R&D to explore other waste conversion technologies.

In the meantime, the plastic we send to landfill is damaging our environment and harming wildlife. That needs to change, and Australia should consider plastic waste-to-energy as part of that change.

DISCLOSURE STATEMENT

Muxina Konarova receives funding from Advanced Qld Fellowship Scheme and ARENA (Emerging Renewables).

Muxina Konarova is Advanced Queensland Research Fellow, The University of Queensland.

THE CONVERSATION

Konarova, M (14 May 2018). *If we can't recycle it, why not turn our waste plastic into fuel?* Retrieved from <http://theconversation.com> on 31 August 2018.

EXPLORING ISSUES

WORKSHEETS AND ACTIVITIES

The Exploring Issues section comprises a range of ready-to-use worksheets featuring activities which relate to facts and views raised in this book.

The exercises presented in these worksheets are suitable for use by students at middle secondary school level and beyond. Some of the activities may be explored either individually or as a group.

As the information in this book is compiled from a number of different sources, readers are prompted to consider the origin of the text and to critically evaluate the questions presented.

Is the information cited from a primary or secondary source? Are you being presented with facts or opinions?

Is there any evidence of a particular bias or agenda? What are your own views after having explored the issues?

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Brainstorm, individually or as a group, to find out what you know about plastic pollution.

1. What is plastic, and what are some different types of plastics?

2. What are microbeads, and how are they damaging to the environment?

3. What is 'single-use plastic', and what are some examples?

4. What does the term 'marine debris' refer to, and how does it impact marine life?

5. Explain the differences between plastic bags labelled as 'biodegradable', 'degradable' and 'compostable'.



Complete the following activities on a separate sheet of paper if more space is required.

Make a list below of ALL the plastics you can think of that you use in your daily life. Think of everything that may contain plastic, including your phone, clothing, product bottles, wrappings, containers, etc. Once you have a comprehensive list, study it and extract all the 'single-use' plastics you have identified to create a second list.

Once you have compiled your two plastics lists, explain the ways you can potentially address plastic pollution with all of your listed items by applying the following four (4) recycling principles
– Refuse, Reduce, Reuse and Recycle.

LIST OF PLASTICS YOU USE – ALL AND SINGLE-USE

PLASTICS YOU CAN **REFUSE**

PLASTICS YOU CAN **REDUCE**

PLASTICS YOU CAN **REUSE**

PLASTICS YOU CAN **RECYCLE** IN YOUR COUNCIL AREA



- 1. Kerbside recycling is primarily used for hard plastics. Which of the following are considered hard plastics? (select any that apply)**
 - a. Plastic shopping bags
 - b. Fruit punnets
 - c. Water bottles
 - d. Shampoo bottles
 - e. Cling wrap
 - f. Ice cream containers
- 2. Approximately how much water does it take to produce one litre of bottled water?**
 - a. 500ml
 - b. 750ml
 - c. 1 litre
 - d. 1.5 litres
 - e. 2 litres
 - f. 3 litres
- 3. What is the estimated size of the world's largest plastic ocean gyre, the Great Pacific Garbage Patch?**
 - a. 0.6 square km
 - b. 1.6 square km
 - c. 16 square km
 - d. 160 square km
 - e. 1.6 thousand square km
 - f. 1.6 million square km
- 4. What is the percentage endorsed by state and federal environment ministers (April 2018) as the target for packaging to be reusable, recyclable or compostable by 2025 or earlier?**
 - a. 10%
 - b. 25%
 - c. 50%
 - d. 75%
 - e. 90%
 - f. 100%
- 5. To identify different plastics, a Plastics Identification Code is stamped on the final product to indicate what type of resin it contains. Match the following codes with the correct plastic and product types.**

a. Code 1	1. PP (e.g. ice cream containers, take-away food containers, lunch boxes)
b. Code 2	2. HDPE (e.g. milk bottles, shampoo containers)
c. Code 3	3. PS (e.g. yoghurt containers, plastic cutlery, foam hot drink cups)
d. Code 4	4. LDPE (e.g. garbage bags, plastic bins)
e. Code 5	5. Other (e.g. all other plastics, including acrylic and nylon)
f. Code 6	6. PET (e.g. soft drink/fruit juice bottles)
g. Code 7	7. PVC (e.g. cordial, juice or squeeze bottles)

$$1 = b, c, d, t; 2 = t; 3 = t; 4 = t; 5 = t; -a = 6, b = 2, c = 7, d = 4, e = 1, t = 3, g = 5.$$

- Each year, more than 8 million tonnes of plastic end up in our oceans (University of Queensland, *The perils of everyday plastics*). (p.1)
- At the rate we're currently throwing out single-use plastics such as bottles, bags and cups, by 2050, our oceans will have more plastic than fish (*ibid*). (p.1)
- 8.3 billion metric tonnes of plastic has been produced since plastic was introduced in the 1950s (Earth Day 2018: End Plastic Pollution, *10 shocking facts About plastic pollution*). (p.3)
- There is more microplastic in the ocean than there are stars in the Milky Way (*ibid*). (p.3)
- 100,000 marine animals are killed by plastics each year (World Environment Day, *Beat plastic pollution*). (p.3)
- The most common single-use plastics found in the environment are in order of magnitude: cigarette butts, plastic beverage bottles, plastic bottle caps, food wrappers, plastic grocery bags, plastic lids, straws and stirrers, glass beverage bottles, other plastic bags, and foam take-away containers (World Environment Day, press release). (p.3)
- Only 3% of Australia's plastic bags are currently being recycled, despite recycling facilities being available at major supermarkets and retail outlets (World Environment Day, *Beat Plastic Pollution: If you can't reuse it, refuse it*). (p.4)
- Over time a single plastic bottle can break up into over 10,000 pieces of microplastic (Angel, J, *Plastic does not go away*). (p.5)
- No one in their daily life within a period of 10 minutes isn't touching something that is not made of plastic (Weule, G, *Plastic and how it affects our oceans*). (p.6)
- Plastic is particularly concentrated in the 5 major ocean gyres in the Pacific, Atlantic and Indian Oceans. The largest and best known of these is the Great Garbage Patch in the north Pacific – a concentrated soup of microplastics, or tiny fragments less than 5mm across (*ibid*). (p.7)
- An analysis of waters around Australia found on average there were around 4,000 microplastic fragments per square km, although some hotspots had concentrations of around 15,000 to 23,000. The vast majority of the microplastic fragments came from plastic packaging such as cups, bottles, bags, as well as fragments of fishing gear (*ibid*). (p.7)
- Animals get wrapped up in monofilament fishing line nets, plastic bags, balloons, and straps. Research has estimated that between 5,000 and 15,000 sea turtles are entangled each year by derelict fishing gear washing ashore in northern Australia alone (*ibid*). (p.8)
- Plastic pollution threatens ocean health, food safety and quality, human health, coastal tourism, and contributes to climate change (IUCN, *Marine plastics*). (p.12)
- Marine debris is harming more than 800 species. 40% of marine mammals and 44% of seabird species are affected by marine debris ingestion (UN, *Marine pollution*). (p.14)
- Abandoned, lost or otherwise discarded fishing gear in the oceans makes up around 10% (640,000 tonnes) of all marine litter (*ibid*). (p.14)
- It is estimated the Great Pacific Garbage Patch is 1.6 million square km in area – almost the same size as Queensland (Kilvert, N, *Great Pacific Garbage Patch plastic pollution dwarfs previous estimates and is 'growing exponentially'*). (p.15)
- Plastics can act as a sort of 'chemical sponge', concentrating many of the most damaging of the pollutants found in the world's oceans: the persistent organic pollutants (POPs). So any animal eating these pieces of plastic debris will also be taking in highly toxic pollutants (Greenpeace International, *The trash vortex*). (p.17)
- One recent study from the Great Barrier Reef found that "corals ate plastic at rates only slightly lower than their normal rate of feeding on marine plankton." (West, D, *Microplastics*). (pp. 18-19)
- A 2001 study by Japanese researchers found that plastic production pellets (the raw materials of plastic manufacturing) collected from coastal Japanese waters had accumulated toxins at concentrations up to a million times that found in the surrounding seawater (*ibid*). (p.19)
- Every year, we throw away enough plastic to circle the Earth four times (UN Environment, *Infographic: If you can't reuse it, refuse it*). (p.23)
- Of the 415,200 tonnes of plastics collected for recycling, 180,100 tonnes (43.4%) was reprocessed in Australia and 235,100 tonnes (56.6%) was exported for reprocessing (Department of the Environment and Energy, *2016-17 Australian plastics recycling survey – national report*). (p.27)
- Commonwealth, state and territory environment ministers have agreed on an ambitious target that 100% of Australian packaging be recyclable, compostable or reusable by 2025 (Zaman, A, *The new 100% recyclable packaging target is no use if our waste isn't actually recycled*). (p.33)
- Of the 7 categories of plastic packaging, only 3 are economically viable to recycle: PET (soft drink bottles); HDPE (milk bottles); and PVC (shampoo bottles) (*ibid*). (p.33)
- It is estimated that it costs governments, businesses and community groups over \$4 million per annum to clean up littered plastic shopping bags (Clean Up Australia Ltd, *Plastic bags fact sheet*). (p.38)
- Most bottled water is packaged in PET plastic bottles which are derived from crude oil. It can take up to 3L of water to produce 1L of water (Clean Up Australia Ltd, *Say no to bottled water*). (p.41)
- Over 90% of the cost of a water bottle can be traced back to the bottle, lid and label (*ibid*). (p.41)
- It has been a decade since Sweden all but banned rubbish going to landfill. Now the Swedes claim to reuse or recycle as much as 98% of their waste (Kilvert, N, *Big Australia's rubbish future does not have to go to waste*). (p.46)
- Scientists recently discovered a strain of bacteria that can literally eat the plastic used to make bottles, and have now improved it to make it work faster (Flashman, E, *How plastic-eating bacteria actually work – a chemist explains*). (p.50)

Circular economy

The circular economy is all about keeping resources in a constant loop, reusing and recycling them as many times as possible, in order to minimise waste and reduce the need for brand new resources. Treating plastic waste as a resource rather than a problem is an important change that needs to happen going forward to preserve our remaining chemical materials and protect the environment.

Great Pacific Garbage Patch

Largest of the five offshore plastic accumulation zones in the world's oceans. It is located halfway between Hawaii and California. This vast dump of plastic waste swirling in the Pacific Ocean is currently bigger than France, Spain and Germany combined, and growing exponentially.

Marine debris

Marine debris (or marine litter) is defined as any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment. As much as 80 per cent of all litter in our oceans is made of plastic, seriously threatening marine wildlife.

Microbeads

Plastic microbeads are added as ingredients to a range of products, including rinse-off cosmetics, personal care and cleaning products, for a variety of purposes: as an abrasive or exfoliant, a bulking agent, for controlled timed release of active ingredients, and to prolong shelf life. Microbeads may be found in these products: toothpaste, sunscreen, facial scrubs, body wash, cosmetics and other care products.

Microplastics

Most plastics do not biodegrade, but instead photodegrade, slowly breaking down into small fragments known as microplastics. Microplastics are tiny fragments, pellets or fibres of plastics which are smaller than 5mm. Most are smaller than a grain of sand and invisible to the naked eye. Microplastics are the most abundant form of solid-waste pollution and have been found in all oceans, on all continents and even in the deep sea where their concentration is four times higher than in coastal waters.

Plastic

Lightweight, hygienic and resistant material which can be moulded in a variety of ways and utilised in a wide range of applications. The two main categories of plastics are: *thermoplastics* (Polyethylene Terephthalate (PET), Polypropylene (PE), Low Density Polyethylene (LDPE), High Density Polyethylene (HDPE), Polystyrene (PS), Expanded polystyrene (EPS), Polyvinyl chloride (PVC), Polycarbonate, Polypropylene (PP); Polylactic acid (PLA) and Polyhydroxyalkanoates (PHA)); and *thermosets* (Polyurethane (PUR), Phenolic resins, Epoxy resins, Silicone, Vinyl ester, Acrylic resins, Ureaformaldehyde (UF) resins).

Plastic bags

There are two main types of plastic bags: HDPE bags – high-density polyethylene ‘singlet’ bags are the thinner bags used by over 80% of retailers, but predominately in supermarkets. These bags are easily recycled, yet rarely

are; and LDPE bags – low-density polyethylene bags are the much thicker bags used by boutiques and department stores. These bags are recyclable, although there are few collection points. As companies move to eliminate single-use plastic bags, new plastic bag products offer an alternative, however understanding how to dispose of some types of plastic bags can be confusing as some are labelled ‘biodegradable’, ‘degradable’, and ‘compostable’. While a degradable or compostable plastic item may deteriorate slightly faster than a conventional product, the conditions must be right. In fact, these types of bags cannot be recycled.

Plastic bottles and containers

Plastic bottles and containers are made from natural resources such as crude oil, natural gas and coal. Most plastic is not biodegradable and will persist in the environment for hundreds of years. A triangle with a number (1 to 7) inside stamped on a plastic container or bottle is actually a Plastic Identification Code. This code identifies the type of plastic the product is – not if it can be recycled. People often confuse the ‘plastic identification code’ for the general recycling symbol (mobius loop), which involves three chasing arrows.

Recycling

In most council areas, plastics labelled 1, 2 and 3 can be recycled via kerbside recycling bins, although some councils are now extending their recycling programs to include those labelled 4 through 7. Contamination of recyclables is a problem because it raises the costs for collectors, recyclers and community. Make sure you are aware about what plastics can be recycled and only put these in your recycling bins. To prepare plastics for recycling, rinse residue from bottles and containers, remove lids and squash bottles. Only three of the seven plastic categories are economically viable to recycle: PET (soft drink bottles), HDPE (milk bottles) and PVC (shampoo bottles). The other four – LDPE (garbage bags); PP (microwaveable cookware); PS (foam hot drink cups); and other plastics – are less economically viable and consequently recycled at much lower rates.

Single-use plastics

Also referred to as disposable plastics, these are used for plastic packaging and include items intended to be used only once before they are thrown away or recycled. These include grocery bags, food packaging, bottles, straws, containers, cups and cutlery.

Thermoplastics

Family of plastics that can be melted when heated and hardened when cooled. These characteristics are reversible, i.e. can be reheated, reshaped and frozen repeatedly.

Thermosets

Family of plastics that undergo a chemical change when heated, creating a three-dimensional network. After being heated and formed, thermosets cannot be re-melted and reformed.

Websites with further information on the topic

Australian Geographic www.australiangeographic.com.au
 Australian Marine Conservation Society www.marineconservation.org.au
 Boomerang Alliance www.boomerangalliance.org.au
 Clean Up Australia www.cleanup.org.au
 Department of the Environment and Energy www.environment.gov.au
 Earth Day www.earthday.org
 Greenpeace Australia Pacific www.greenpeace.org.au
 Planet Ark <http://planetark.org>
 Plastic Free July <http://www.plasticfreejuly.org>
 Plastic Free Sea <http://plasticfreesea.com.au>
 Plastic Oceans Foundation www.plasticoceans.org
 Plastic Pollution Coalition www.plasticpollutioncoalition.org
 Recycling Near You <http://recyclingnearyou.com.au>
 Sea Life Trust www.sealifetrust.org.au
 Sustainability Victoria www.sustainability.vic.gov.au
 Tangaroa Blue – marine debris initiative www.tangaroablue.org
 World Environment Day (5 June) <http://worldenvironmentday.global>

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