BOOMERANG ALLIANCE

TURN BACK THE TOXIC TIDE

THREAT ABATEMENT PLAN: MARINE PLASTIC POLLUTION

DRAFT

DAVE WEST | NOVEMBER 2016

1. The Boomerang Alliance

Boomerang Alliance was established in early 2004, initially to address government's failings to restrict the increasing profligate packaging waste in Australia.

Raising rapidly to become the peak NGO on waste, recycling, litter and marine debris, Boomerang Alliance today represents some 45 community groups and has some 49,000 individual supporters. As a network our messages are promoted through our member groups and typically reach around 200,000 people – and broader peaking at some 2 million individuals that have supported individual campaigns.

Despite very public opposition from parts of the beverage, packaging and retail industry sectors, Boomerang Alliance has a strong track record of success – being widely recognised as the driving force for the:

- Adoption of Container Deposit Systems (CDS) in NT and NSW (with Qld, ACT and WA expected to follow by 2018).
- Plastic Bag Bans in SA, NT, Tasmania and the ACT.
- Federal e-waste product stewardship scheme.
- Strengthened regulations for the management of used tyres.
- Introduction of waste levies in NSW, Victoria, South Australia and Western Australia.
- The adoption of Australia's first National Waste Policy and regular reporting.

In addition to our advocacy, Boomerang Alliance has strong competencies in the waste and recycling arena which has seen us independently review sectors of industry – establishing industry wide standards and undertaking audit processes to ensure their standards in public safety, environmental protection and resource recovery reach high levels.

We also undertake investigations to help stop the widespread illegal waste trade in Australia. We are proud of our record which has seen two public companies suspended from the ASX following Boomerang Alliance complaints. Our evidence has also led to over 120 penalties and prosecutions and exposed over 60 illegal dumping operations including what is believed to be the largest illegal tyre dump in the world in Stawell Victoria over the past 3 years.

Plastic in the marine environment emerged as a key theme soon after Boomerang Alliance's inception in 2004, with the adoption of CDS and a ban on plastic bags: our first two campaigns. Since then we have developed a wealth of information and have come to the belief that the proliferation of plastics in our environment now ranks as a threat of the highest order. Frustrated by years of inertia and bureaucratic bungling, we decided in early 2015 that we needed to layout a comprehensive plan to cut Marine Plastic Pollution, fast. While we don't expect government or industry to simply adopt our plan, we believe it will create momentum and a starting point for Australia to achieve the necessary goal of eliminating 70% of Australian Marine Plastic Pollution by 2020.

Our work is reliant on the donations and support of the public, philanthropists, and responsible business. If you think our work is important and would like to help us ensure that the key aspects of this Threat Abatement Plan are adopted by government, please donate. For more information, go to:
https://boomerangalliance.nationbuilder.com/donation

Acknowledgements

Boomerang Alliance would like to recognise the efforts of those who helped us develop this plan, in particular our staff and volunteers. While there are too many to thank individually, we acknowledge the work and contribution of two outstanding young interns, Leisha Duncan and Andy Gray, who managed our series of blogs and podcasts, identified and developed much of the content herein and co-wrote sections of the plan itself.

Leadership is critical if we are to tackle the rising tide of marine plastic pollution in our oceans and we thank Qld Environment Minister, the Hon Steven Miles, NSW Environment Minister The Hon Mark Speakman and the Senate Environment and Communications Committee of 2016 and The Hon Senator Peter Whish-Wilson for their breakthrough investigations on the impacts of plastic in Australia's Marine Environment.

We would also like to recognise and thank key philanthropic and corporate supporters for our campaigns - The Purves Environmental Fund, The PurryBurry Trust, The Morris Family Foundation, Diversicon, Tomra Systems ASA – and the many individual donations.

There are also many experts and members of the science community whose work has played a fundamental role in influencing our thinking and the actions we recommend, in particular we would like to acknowledge Chris Wilcox and Denise Britta Hardesty from CSIRO, Mark Browne at UNSW and Jennifer Lavers at UTAS whose work continues to inspire us all.

The Boomerang Alliance would additionally like to acknowledge UNEP & Grid Arendal (2016) for the infographics that are used throughout. These graphics assisted significantly by providing a comprehensive visual understanding of marine plastic pollution.

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2. INTRODUCTION

AIMS AND OBJECTIVES

The aim of this Threat Abatement Plan (TAP) is to develop an effective and coordinated approach to ensure the impacts of Marine Plastic Pollution (MPP) in the Australian marine environment is minimised.

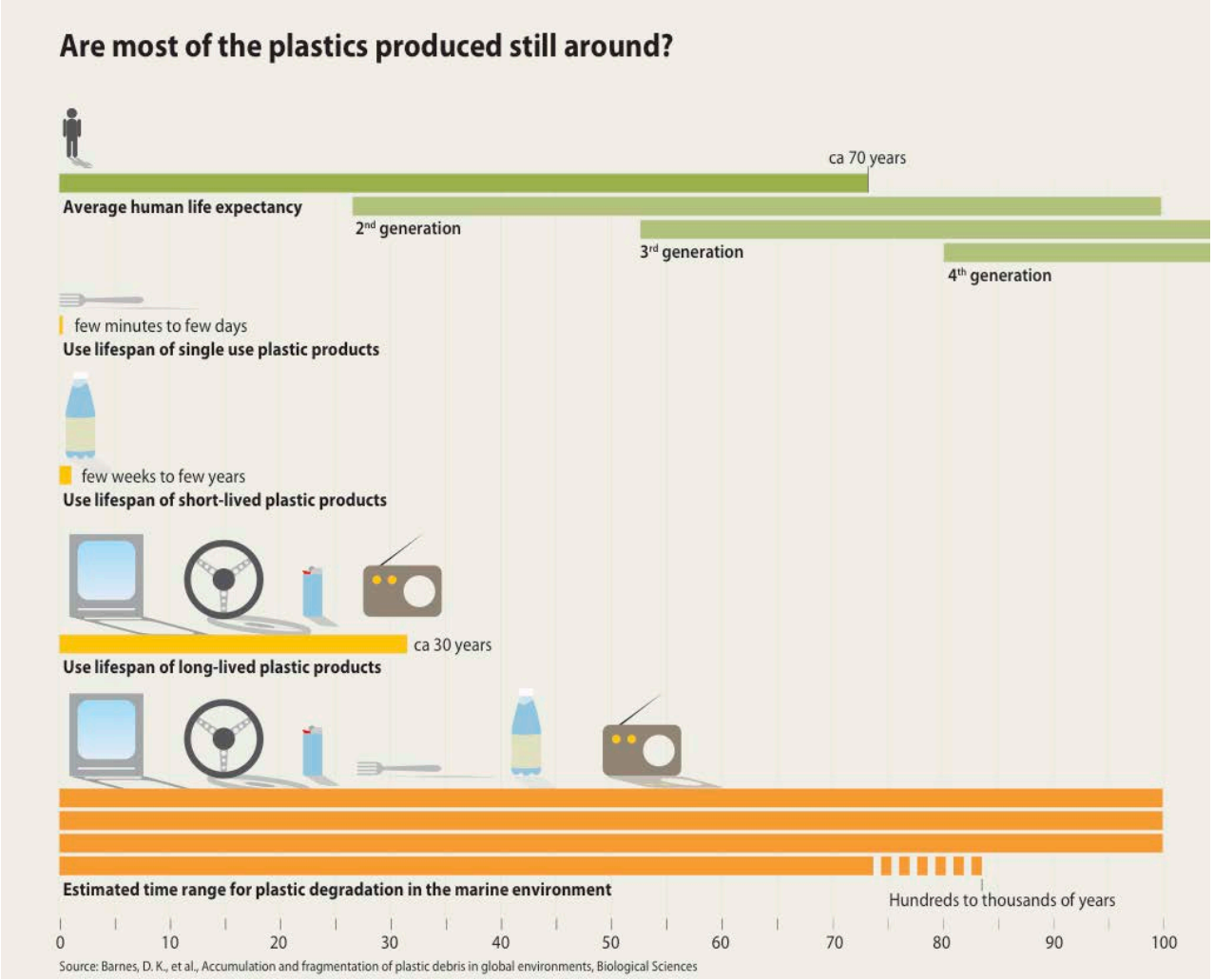
Boomerang Alliance has identified that between 90-130,000 tonnes of the plastic consumed in Australia enters our marine environment annually. This represents 4.3kgs of MPP per capita – by comparison the current global estimate is that around 9 million tonnes of plastic is entering the world's oceans p.a. – i.e. 1.3kgs per capita. To that end, the TAP's primary objective is to make deep cuts in the generation of MPP that will bring us down to (at least) the global per capita level – this establishes our target: to eliminate 70% of all plastics with the potential to enter the marine environment.

To ensure that the damage is minimised, there is an urgent need for action and this plan should be implemented (in full) by 2020 at the latest.

CONTEXT

In 2016, scientists and the community presented extensive evidence supporting urgent action to the Australian Senate's Inquiry into MPP. In April, the Senate released its report titled *Toxic Tide: The Threat of Marine Plastic Pollution in Australia*. The evidence presented showed that "the magnitude of marine plastic pollution in Australia ... is a problem that cannot be ignored and is growing year-on-year."

Describing the devastating impacts of plastic on our sea life and dire predictions of future impacts including concerns about health risks associated with plastic infested seafood, the Report outlines a series of recommendations reflecting our long standing



agenda: including the adoption of Container Deposits, banning plastic bags and microbeads, developing innovative alternatives to plastic packaging, reinstating funding for GhostNets Australia, a national policy for stormwater management, and active government support for research on MPP.

The Report also expressed disappointment "with the apparent lack of action on MPP" and stated "there is a need for increased national leadership on MPP abatement".

We hoped we would see some action after 10 years of bungled investigations and political inertia, but as the months passed - no response from government.

So, it's up to us – again! We've made great progress - both in broad acceptance regarding the problem of MPP and the key solutions which are now largely accepted – but we must pressure our political leaders to stop talking and act!

We think the best way to seize the momentum is by developing our own, community driven, Threat Abatement Plan and we are proud to release this draft for feedback and consultation with key stakeholders.

Our TAP seeks to:

I. Inform stakeholders of the prevalence and impact of plastics on our ocean and shores.

II. Identify the most profligate sources of MPP and identify which plastics cause the greatest problems once in our waterways.

III. Create a framework of action for MPP.

IV. Recommend the actions that we believe are the most effective responses to specific aspects of MPP.

We hope you find our plan informative and welcome your input into its final version.

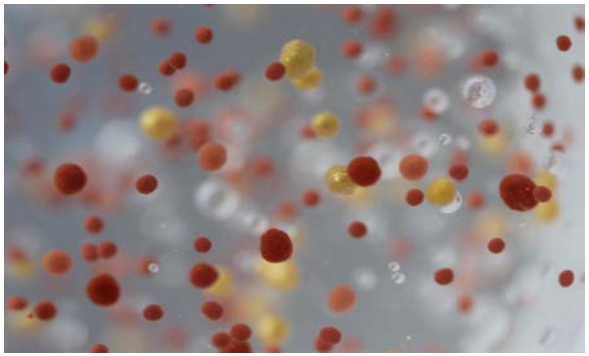
Priority Actions

"We have to keep the momentum going so that we can come together and protect our ocean. Why? Because our ocean is essential for life itself – not just the food, but the oxygen and weather cycles of the planet all depend on the ocean." U.S. Secretary of State, John Kerry - Our Ocean2016

While our recommendations are covered in greater depth later, we believe that the priority actions are:

Product Bans:

Boomerang Alliance calls for the following products to be prohibited for distribution and sale in Australia:



Everyone supports a ban on microbeads in personal care and cleaning products - so why wait 2 more years?

I. All single use plastic bags, but allow the relevant Environment Minister to exempt a specific bag if the producer can demonstrate that they are essential (e.g. medical bags) or present no threat to become MPP.

II. Personal care, cosmetic, and cleaning products (including waxes and polishes) containing synthetic microbeads.

III. Polystyrene packaging for takeaway food and beverage service.

Take Back Schemes:

There is an urgent need to develop 'Take Back' Schemes – where the manufacturer is required to develop specific programs to recover their products (often accompanied by a deposit / refund to incentivise recovery) for the following MPP sources:

I. Packaged beverages are the single largest source of MPP (33% of the total weight of all identified MPP) and a major source of litter (45%) generally. The only effective action to address beverage litter is to adopt a CDS in all Australian states and territories.

II. Rigid plastic takeaway food packaging and disposable cups (not manufactured from polystyrene) require mandatory barcodes and plastic identification symbols to eliminate confusion regarding what can and cannot be recycled. This sector also needs to be included into a form of take back scheme – perhaps as the second step within a CDS.

Advance Disposal Fees:

Advance Disposal Fees (ADF) are a charge imposed on each item at the time of sale so that producers pay for the collection, transport, and reprocessing of the waste. Typically, ADFs are applied to products that can be managed within the existing waste and recycling network or where recovery is impossible, and the revenues are allocated to complementing clean up or recycling programs.

An ADF should be adopted to bring focus and revenues to abatement efforts on the following aspects of MPP:

I. Cigarette Butts – where a charge of just 0.2¢ per cigarette sold would generate $32.4 million p.a. to offset local government and community litter clean-up efforts.
II. Shredder floc is the residual mixed plastics and metal components that are too contaminated for recycling during complex disassembly (cars, white goods, air conditioners, electronics etc.) – and is a cocktail of dangerous chemicals and heavy metals. There is strong potential for this material to be mismanaged during recycling and to enter the marine environment via stormwater and leaching.

   An ADF on producers of these products could be used to develop new systems of resource recovery and to install filtration systems to eliminate the potential for these materials to pollute.
III. Some consideration needs to be given to improve the waste management performance of all maritime industries. Regardless of their level of care, it is a fact that some plastic cargo will be lost at sea and/or spilt during loading and unloading.

   An ADF should be established based on a reasonable estimate of losses and the high costs (over $2,000 per tonne) to recover those losses.

Mandatory Design Requirements

Product Stewardship schemes that specify certain actions of manufacturers and importers to ensure their products are not polluting are a key action that government and industry can adopt to avoid more restrictive regulation.

These design requirements can be used to specify minimum recycled content; identify polymers that are (or are not acceptable); or require technical modification to product standards to address an aspect of MPP. In some ways, the proposed ban of microbeads is actually more accurately a Mandatory Design Requirement (MDR) as they do not ban the product itself they simply require a safe alternative to the plastic microbeads found in cosmetics and cleaning products.

Areas where MDR's should be effectively deployed include:

I. Require all domestic washing machines to be fitted with microfibre filtration systems on the machines outtake; and broader sewerage filtration systems be fitted to all commercial laundry and dry cleaning businesses.

Synthetic Fibres from clothing, manchester and other targets are emerging as a major source of MPP

II. Require all commercial fishing boats operating in Australian waters to only use nets fitted with a GPS tracking device to aid recovery.
III. Regulators should require compliance with Operation Clean Sweep standards (run by BA ally Tangaroa Blue) for all plastics manufacturers and be expanded for application to capture fugitive microplastic losses in plastics recycling, reprocessing and waste management facilities. This initiative should be accompanied by strengthened regulations and a commitment from environmental regulators to enforce existing regulations.

Next Steps

Between now and March 2017, Boomerang Alliance will be seeking to run a series of peak industry forums targeting key stakeholder groups from lifestyle sectors (recreational fisherman, boating enthusiasts, beach activities, etc.) as well as key industry players in plastics manufacturing, waste and recycling, fast moving consumer goods sectors (including the food and grocery industry), retailer groups, fashion houses and community based groups working on litter or marine protection.

We will also seek to meet with all Federal, State and Territory Environment Ministers along with regulatory bodies to discuss our plan and any alternatives they may seek.

To ensure each recommended action will be effective and minimise impacts on the economy and consumer lifestyle, we will produce Summary Regulatory Impact Assessment for each key action - consistent with Australian Best Practice Regulation Standards, allowing government to quickly act on identified priorities.

In April 2017, Boomerang Alliance will summarize the feedback we received and host a conference where we will look to bring together some of the world's leading experts and encourage a rigorous debate aimed at generating a consensus on the necessary actions.

3. About Marine Plastic Pollution

"Plastic is so permanent and so indestructible that when you've tossed it, in the ocean, or in a dustbin… it does not go away" David Attenborough.

What is Marine Plastic Pollution?

Plastics have become so pervasive within modern life that in many instances we often don't recognize them as plastic (e.g. 'synthetic' clothes are 100% plastic, 'rubber tyres' contain twice as much plastic as natural rubber). Similarly, over half the plastic pollution generated annually (and in turn entering our waterways) is commonly unidentified as a threat in government studies and policy. Plastic generates solid waste pollution in every step of its lifecycle: manufacture, distribution, use and disposal. Over time, this material will be exposed to weather, be abraded, and fragment into smaller pieces. While eventually too small to readily see, it will persist in our environment as a microplastic (100nm - <5mm diameter) or nanoplastic (<100 nm).

In effect, this means that any plastics we allow outside of our control becomes a genuine risk of entering the marine environment, where it creates substantial threats to our biodiversity, lifestyle, economy and even our health.

Using CSIRO estimates we believe there are around 358 million pieces of plastic litter along the Australian coastline (on average 3,461 per km of coastline) and some 34.9 billion pieces of plastic floating in Australia's sovereign waters (our economic exclusion zone less our Antarctic waters).

Those estimates do not include microplastics which have been too small to be captured by these initial studies. Shockingly, our preliminary testing from over 100 surveys around the Australian coastline are indicating that there are approximately 60,000 pieces of microplastic along each km of Australian shoreline – indicating that the true extent of MPP may be 17 times higher than CSIRO estimates.

We define marine plastic pollution as being those plastics (of any size or mass): that are found in our marine or estuarine environment; whether intentionally or unintentionally lost from our control; and there is an identified pathway to reach the marine environment.

Types of Marine Plastic Pollution

MPP can be broadly grouped into 4 categories:

1. **Litter** (rubbish thoughtlessly discarded or lost from bins and garbage trucks on collection) is the major point source comprising approximately half of all MPP, including:
   - Around 863 million plastic bottles
   - 200 million other pieces of plastic packaging
   - 275 million plastic bags
   - 10 million plastic products
   - 8 billion+ synthetic cigarette butts

2. **Plastic pollution associated with product use (broadly grouped into two types)**:

2A. Those plastics intentionally designed to release microplastics, such as microbeads which are designed to be flushed down a drain, and tyre dust (14%) generated by the abrasion on roads to create tyre grip.

2B. Plastics that are unintentionally released into the environment during their use. The largest single source here is thought to be the release of synthetic fibres during washing and commercial laundering (10-12%) and includes plastic products that are exposed to weather over the long term (plastic exterior paints, powder coatings etc.). Through UV exposure and abrasion, these produce plastic fragments and fine plastic dusts that are released into the environment and find their way into our oceans (another 4%).

3. **Mismanagement of plastic within the commercial and industrial sectors** is another major source of Plastic Pollution, with fugitive waste escaping waste and recycling facilities (6%), and plastics facilities failing to capture raw materials (nurdles) lost in spills (4%), being the major sources.

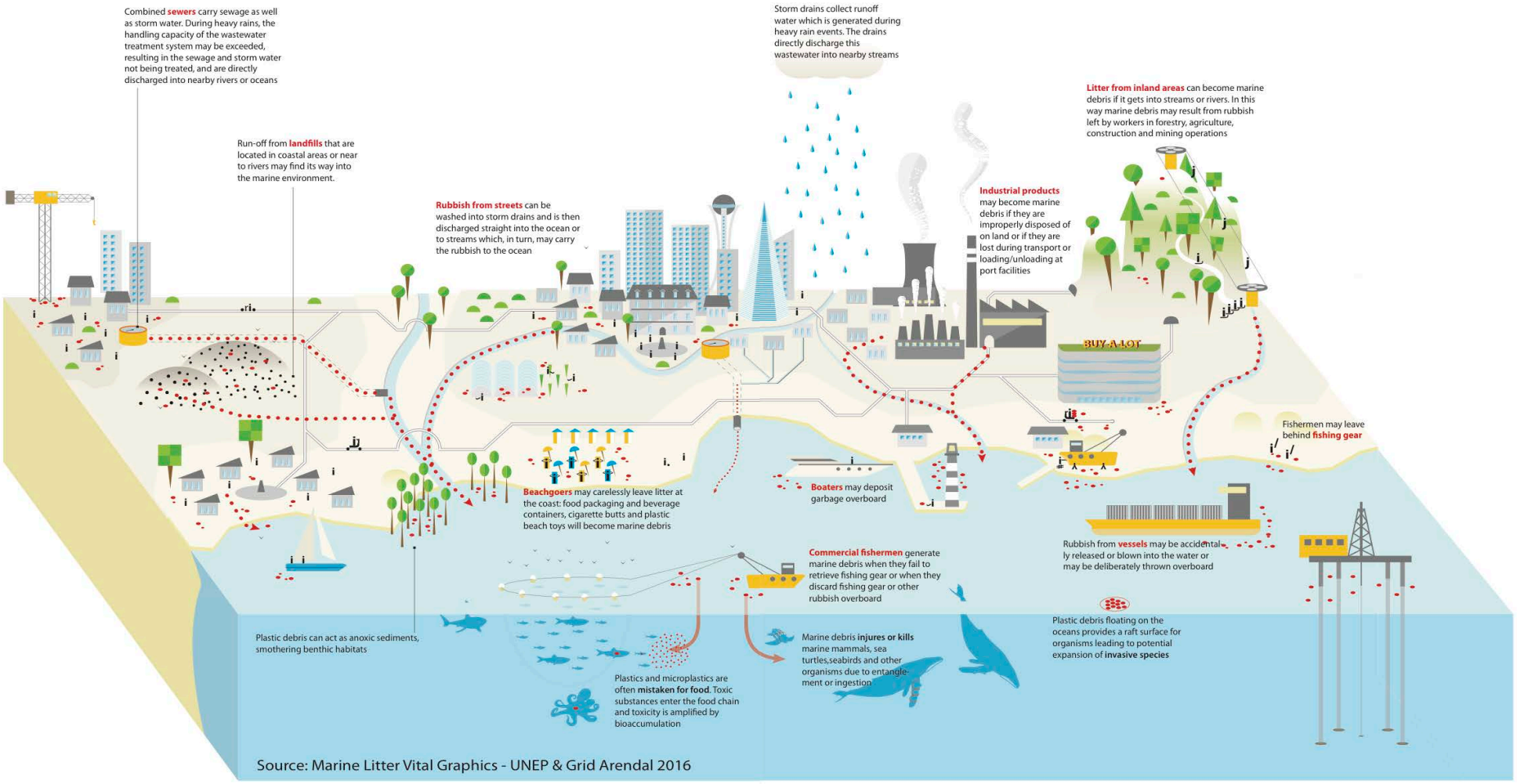
4. **Mismanaged waste in maritime industries**, where Ghost Nets, lost cargo in shipping, and the dumping of waste overboard contributing around 5% of all MPP.

How Plastics Reach our Oceans

It's easy to assume that the majority of plastic found in our oceans came from dumping at sea or via the various maritime industries – but this is untrue! There is a strong consensus that around 80% of the plastic found on our coast and in our waters, is being generated from land. Similarly, developing nations with limited waste management systems are often blamed; and while our neighbours, like us, certainly need to do more - there is an equally strong consensus that not only is the clear majority of plastic found in our waters locally generated, but that we are most probably a nett exporter of MPP (i.e. more Australian MPP leaves our waters than arrives from international waters).

A diagram outlining the way plastics enter our waters can be found on the following page.

Plastic debris in the ocean: a multiplicity of sources and pathways



Source: Marine Litter Vital Graphics - UNEP & Grid Arendal 2016

4. Prevalence of Plastic in the Marine Environment

It is important to note that no estimate regarding the amount of plastic in our oceans or entering our marine environment is particularly accurate as it is virtually impossible to physically monitor the consumption, disposal and recovery of all plastics.

Equally, it is critical to establish a broad estimate of both the total and types of plastic entering our waterways to understand the scale of potential impacts and develop the most effective abatement strategies.

To that end, Boomerang Alliance has devoted significant time reviewing published estimates of MPP domestically and internationally. We found that Australian estimates of total plastic waste and litter were consistently understated and that many sources of MPP identified in leading international studies (particularly microplastics) had been omitted.

Outlined below are our best estimates; using existing data, correcting known errors and where no estimates have been made, extrapolations using best practice international approaches.

Boomerang Alliance does not suggest this estimate is empiric, rather it is an attempt to quantify the scale of the problem in meaningful terms – we recommend that the scope and scale of MPP should be a priority for Australian Government but this cannot remain an excuse for inaction, as it has for the past 10 years.

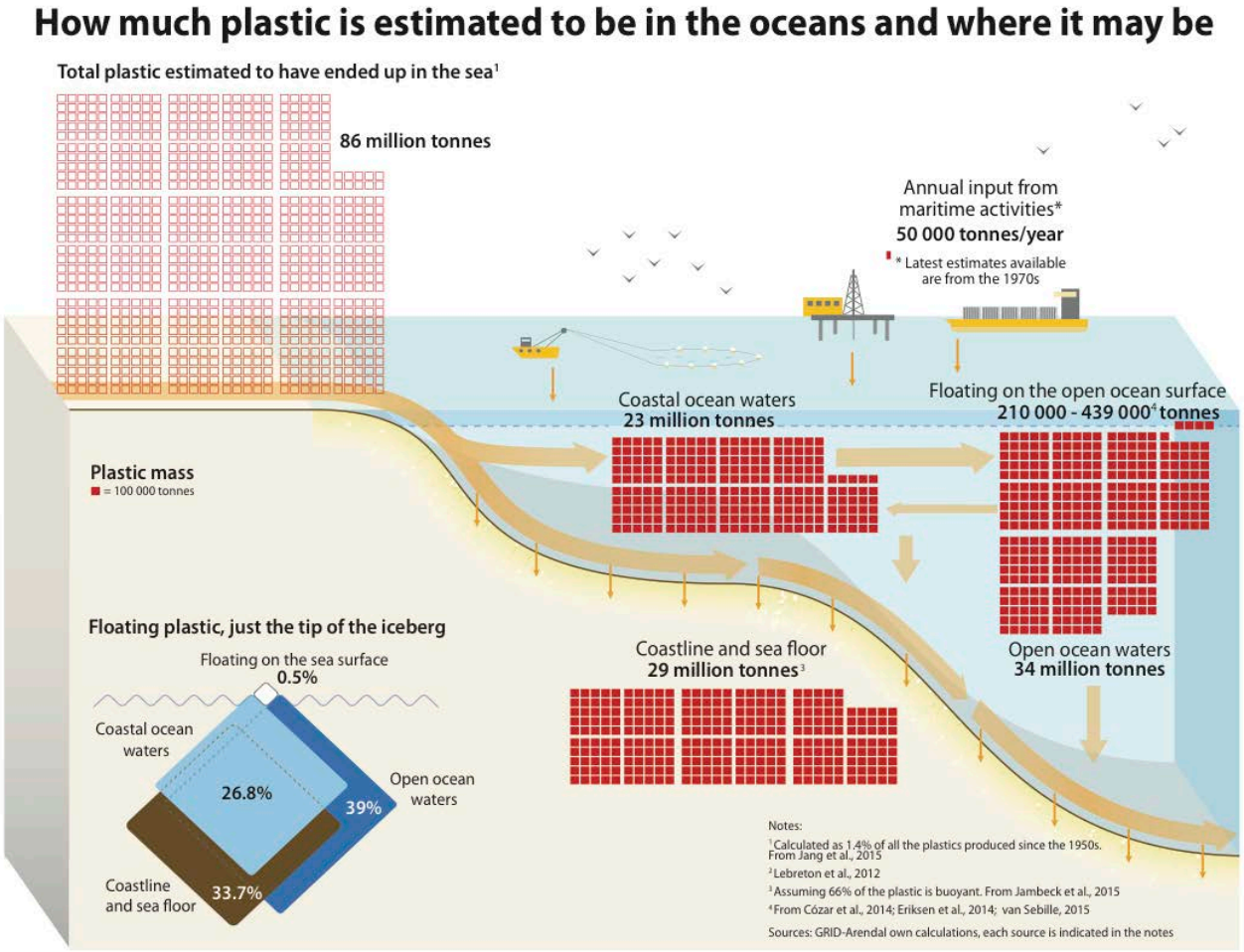
Globally

In February 2015, Science Magazine reported that the amount of plastic entering the world's oceans "will be close to 9.1 million tonnes of plastic, and by 2025, the annual cumulative output of plastic into the world's oceans will be around 155 million tonnes"[1].

This study provides a vital indicator to better understand the likely level of MPP - being the equivalent to 1.7-4.6% of the total plastic waste produced / consumed within 50kms of the coastline.

Another study published in PLOS One December 2014 estimated that in total, more than 5.25 trillion plastic particles weighing 268,940 tonnes are estimated to be floating in Earth's oceans[2].

The graphic below depicts the concentrations of plastic found in the world's oceans.



Plastic in Australia

The Australian government's estimates on plastic are limited to:

I. ***National Waste Reports:*** which estimate the amount of plastic recycled and a broad estimate of what proportion of landfill is plastic, rather than a quantified study of plastic consumption and the pathways until the end of an item's life.

II. ***Industry based reports:*** which capture the amount of plastic product made in Australia but do not consider the other significant components of plastic production and consumption in Australia – imported plastic finished products; plastic packaging on finished goods; the plastic components of complex manufactured goods imported into Australia (e.g. white goods, electronics, motor vehicles and parts).

The Australian Government's efforts to quantify our waste streams are notoriously understated - the most recent National Waste Report estimated that the total plastics waste generation in Australia for 2011 was 2.188 million tonnes, indicating we are a major consumer of plastic[3].

The Annual National Plastics Recycling Surveys undertaken for PACIA and the Australian Packaging Covenant are restricted to plastics manufactured in Australia – which are well quantified, but plastics manufactured in Australia is dwarfed by imports of finished plastic goods, plastic packaging imported on other finished goods and plastic sheet and fabrics, which have not been estimated at all. After over a decade of government resistance, last year Boomerang Alliance finally forced government to review reported consumption of plastic packaging to include plastic packaging imported on finished goods – causing the estimate to skyrocket from 572,400 tonnes in 2014-15 to 944,300 tonnes p.a. (a 64% increase).

The annual plastics survey put total plastics consumption at just 1.53 million tonnes p.a. but it has the same omissions in terms of imports, and it does not extend to synthetic textiles - severely distorting government estimates and regulatory investigations.

Boomerang Alliance reviewed Customs data to identify the amount of plastics imported into Australia and added in omitted categories like synthetic textiles, tyres, etc. to suggest revised estimates of plastic consumption:

Plastic Consumption in Australia	Tonnes
Australian Made Plastic Products[3]	1,008,200
Australian Made Plastic Packaging[4]	527,000
Plastics Packaging Imports[5]	313,000
Imported Synthetic Textiles [6]	300,000
Imported Plastic Products[7]	290,000
Plastics Components in Machinery[8]	331,000
Plastic Component of Tyres[9]	145,350
Imported Plastic Bags[10]	21,000
Plastic Maritime Waste [11]	10,000
Cigarette Butts[12]	7,000
Microbeads (all applications)[13]	650
Total:	**2,953,200**

As a further check, to identify the extent to which reporting on plastics consumption in Australia may be understated, the writer made two simple comparisons:

I. Comparing plastic consumption per capita to other affluent developed economies. The estimated total plastic consumption reported via National Waste Reports is very low compared to other affluent societies – 97kgs per capita when compared to North America (139kgs/capita) or Western Europe (136kgs/capita)[14]. At 130kgs per capita the level of plastics consumption in Australia would be approx. 3 million tonnes p.a.

II. If Australia's share of global GDP (1.04%) reflects our proportion of global consumption in plastic (as it does in many commodities), Australian plastic consumption is 3.11 million tonnes p.a.

Based on these reviews, there is evidence that plastics consumption is more likely to be around 3 million tonnes p.a., rather than 1.7-2.2 million tonnes estimated by government. While this estimate is far greater than previous efforts by both government and industry, they are conservative and likely to be understated because:

I. Revised plastics packaging import estimates made by the APC, have not revised PET consumption.
II. Synthetic Fibres cover much of the traditional uses (clothing, manchester, fabric, carpet) but exclude the import of the textile as an input for Australian fashion and textiles.
III. Estimates for imported plastic products are limited to large industrial sectors.
IV. Plastic component estimates are limited to motor vehicles and white goods.
V. Waste reporting is dated (2011) as are estimates of maritime waste (2008).

Boomerang Alliance has not sought to adjust these estimates further as the revisions included herein bring Australian consumption in line with international positions.

In Australian Marine Environments

The next critical question is which plastics have the potential to end their life in our waterways? Theoretically, the answer is all of them – at every stage of its manufacture, distribution, use and disposal, plastic creates pollution and, over time, the lightweight and often buoyant nature of plastics means (without intervention) they can be transported via wind and stormwater into our marine environment.

The baseline estimate of the number of pieces of plastic found in our marine environment are:

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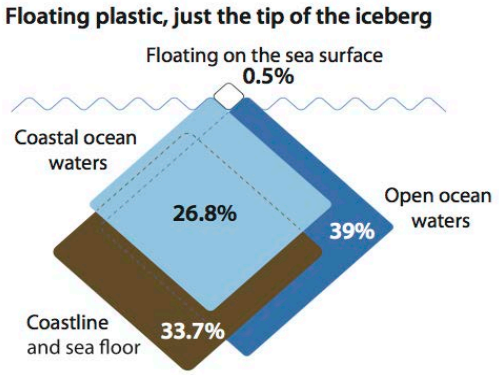
192 billion pieces of plastic in the Australian marine environment, comprising:
** 358 million pieces on the coastline[15];*
** 34.9 billion pieces floating in our sovereign waters (excluding our Antarctic territory[16]); &*
157 billion pieces that have sunk[17].

Importantly, we also need to recognise that these estimates are limited by the quality of information received. Global and Australian estimates are very much based on extrapolation of plastic production, which is a reasonable baseline in a global context, but with little manufacturing in Australia, consumption (which is almost double Australian production) is a far more reliable baseline.

The graphic found to the right visually represents the distribution of plastics found in the marine environment and highlights that the highly visible component of MPP (the plastic floating on our ocean surface) are very much the tip of the iceberg – representing just 0.5% of all MPP. If these ratios are used to project from estimates of plastic floating on our ocean surface, the amount of plastic likely to be infesting Australia's waterways skyrockets.



This graphic from UNEP's "Marine Litter Vital Graphics" shows that the plastic found floating on our ocean's surface and coastline are dwarfed by the amount of plastic found floating in the sub-surface water column and sea bed.

To determine the threat (i.e. the likelihood of different plastics entering the marine environment) Boomerang Alliance sought to identify the way different plastic pollution sources reach our waters. Once again, the purpose of this exercise is to provide a broad estimate, not an empiric assessment.

Boomerang Alliance has identified that, conservatively, between 90-130,000 tonnes of plastic has the potential to reach the marine environment – which represents between 3.3-4.4% of the plastic consumed in Australia – consistent with international estimates that between 2-4% of plastics enter the marine environment. The estimate is at the higher end because other estimates omit nano scale plastics such as synthetic fibres, microbeads, and tyre dusts, representing some 30,000 tonnes p.a.

A table detailing each of the major plastic sources and our estimates of their potential to reach the marine environment during their manufacture, use and disposal can be found in the appendices to this document.

Of course, the key issue in assessing the threat of MPP is volume not weight - given that plastics are so lightweight; that across polymers there are different plastic densities; and the fact that the surface areas of these plastics determines the degree that plastics suck up toxic chemicals they encounter. To ensure we prioritize those plastic products and packaging, Boomerang Alliance looked at volume to weight ratios of each grouping before recommending actions. Our best estimate of the major sources of MPP are outlined in the table below:

Source of MPP	% (weight)	% (volume)
Beverage Litter	33%	38%
Plastic Bag Litter	2%	4%
Cigarette Butts	3%	3%
Other Litter	9%	12%
Microbeads	2%	2%
Tyre Dust	18%	14%
Use of Plastic (Wear & Tear)	4%	2%
Fugitive Plastic (manufacturing, waste & recycling facilities)	13%	10%
Synthetic Fibres	11%	10%
Maritime Waste	7%	5%
Total	100%	100%

Microplastic - Size Matters

While all plastic debris is dangerous to the environment, the threat escalates 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 0.004 µm (a

human hair is around 18 µm), and invisible to the naked eye. The biggest are 5mm in diameter.

"When things get that small, it targets up to 96% of all biodiversity, invertebrates, to potentially start ingesting them. They can enter the bloodstream through the gut, and then they can circulate in the bloodstream directly entering cells and tissues of these animals." Professor Emma Johnston, Sydney Institute of Marine Science[18]

The major sources of microplastics include:

- General plastic packaging (e.g. bottles and bags) and products that have fragmented into small pieces
- Nurdles – which are pellets and flakes of plastic resin used in plastics extrusion and manufacture
- Microbeads – tiny plastic pellets used in a range of products as abrasives. In particular, there is growing concern about the use of microbeads in personal care and laundry products.
- Synthetic fibres that are released from clothing made from plastics (polyester, nylon, rayon etc.)
- Tyre Dust – the tiny fragments of synthetic rubber left on the road through wear and tear.

There are two types of microplastic pollution:

I. **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.

II. **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.

It is important to address microplastics specifically when developing any Threat Abatement Plan to manage dangerous marine debris. Size matters when dealing with MPP – most obviously the smaller the piece of plastic, the more difficult it becomes to capture at the end of its use - with filtration systems needing to screen items with a diameter less than a human hair. Similarly, while common macro litter items like drink bottles, plastic bags and polystyrene 'peanuts' may survive within the marine environment 'forever', they begin to fragment into microplastics within weeks of entering our waterways.

How Much Microplastic?

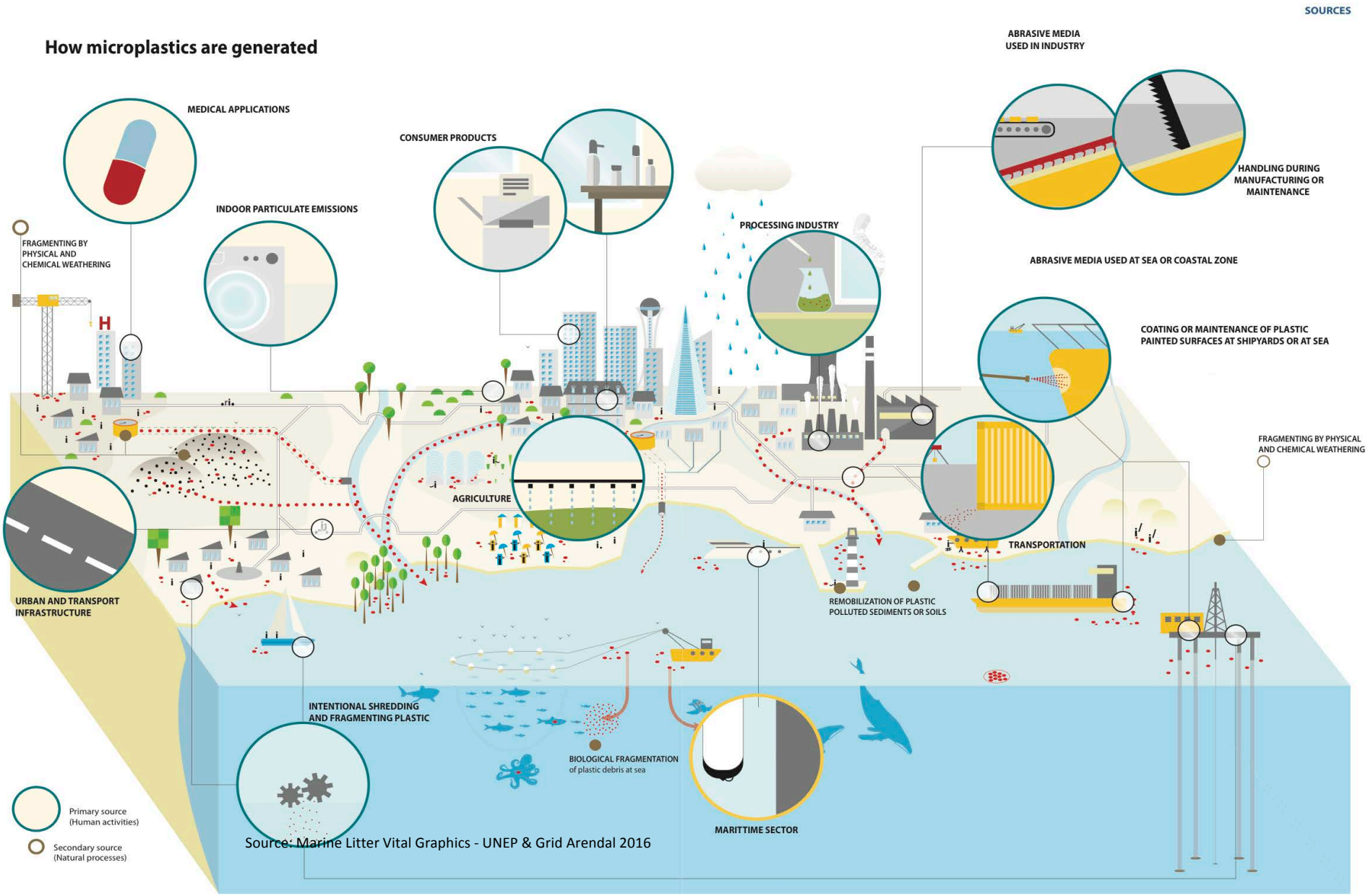
While there is a significant level of uncertainty regarding the amount of microplastic pollution found in the environment, Boomerang Alliance estimates that between 90-130,000 tonnes / p.a. of plastic enters the ocean from Australian sources of which some 35,000 tonnes / p.a. are believed to be primary microplastics.

These materials include:

- synthetic rubber dust our tyres leave on the road during use (potentially 23-24,000 tonnes p.a.)
- loss of plastic productions pellets (nurdles) during plastic manufacture (potentially as much as 5,000 tonnes p.a.)
- synthetic textile fibres lost during laundry (5-7,000 tonnes p.a.)
- the discharge of microbeads used in personal care and home cleaning (650 tonnes p.a.).

It is difficult to estimate how much of secondary microplastics are found in our environment as the overwhelming majority of this type of microplastic is macro litter items that have fragmented; but other secondary microplastics include most fugitive losses at waste and recycling facilities (10,000 tonnes p.a.) and wear and tear while plastic is 'in use' (4,000 tonnes p.a.)

Examples of some of the types of microplastic that are proliferating our oceans



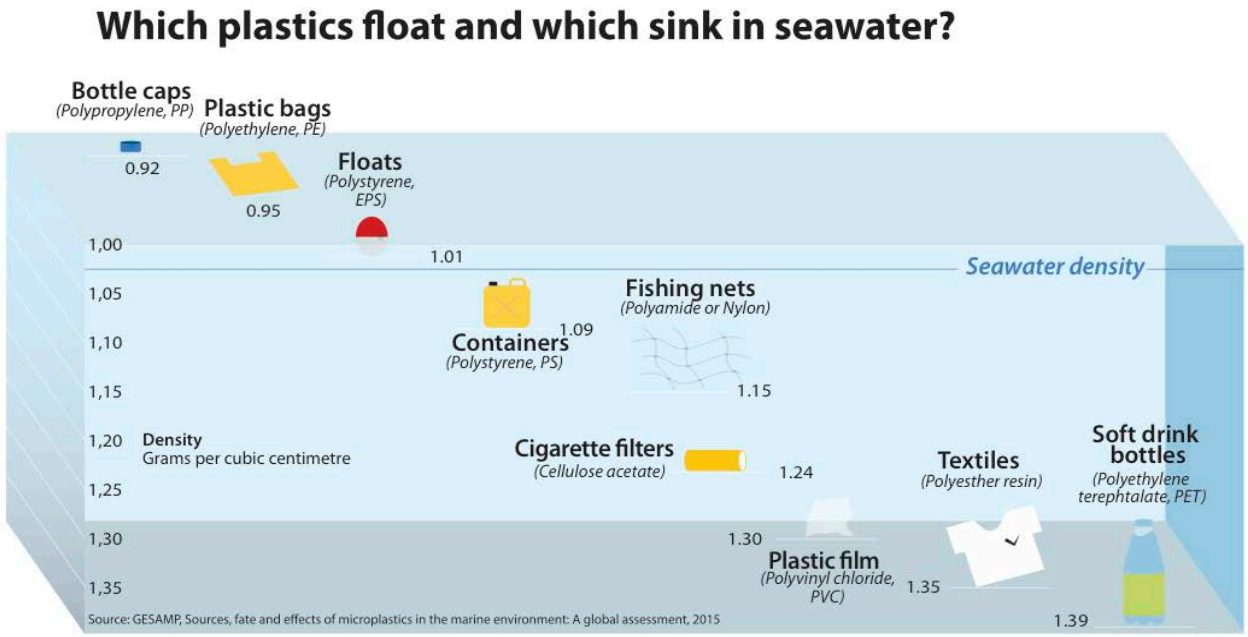
Source: Marine Litter Vital Graphics - UNEP & Grid Arendal 2016

5. Good Plastic vs Bad Plastic?

Over and above decisions regarding plastic products that should be a priority for action, it is also important to consider the type of plastic polymer used for products and packaging as their properties can also create different risks. Many plastics that are ideal materials for 'durables' due to their long life, are a disaster when used, as they commonly are for packaging that is used for seconds before being thrown away. Similarly, some polymers are popular because they are so flexible in their applications and they are often used inappropriately. For example, polystyrene is often used in takeaway food containers because it is a low cost material that is easy to use without any consideration of the fact that when exposed to heat polystyrene leaches the deadly chemical styrene.

Manufacturers and retailers are not to blame here; you cannot expect thousands of small businesses across Australia to have the knowledge of chemistry to understand the risks. Rather the responsibility lies with government who somehow think it is poor policy to 'discriminate' between different packaging types – a ridiculous notion given the very point of environmental regulation is to create a bias away from materials that have a negative impact on our environment. It is critical government (through regulation or working with the Australian Packaging Covenant) provide guidance regarding the least harmful materials for use in various packaging applications and what can (and cannot) be readily recycled by existing infrastructure.

As a broad guide, Boomerang Alliance has prepared the following short summary of the various plastic labels and their 'toxic risks' as they are understood.



1. Polyethylene Terephthalate

PET or PETE stands for polyethylene terephthalate.

PET is commonly used in:

- soft drink and water bottles
- cosmetics
- household cleaners
- juice
- salad dressings
- oil
- condiments and sauce containers
- synthetic (polyester) clothing

Health Concerns

Studies have found levels of antimony (a toxic chemical) leaching from water bottles that have been placed in heat for a prolonged time. Although PET does not contain BPA or phthalates, it is always best to make sure that your water bottles are not temperature abused. PET plastic should not be reused as cleaning detergents and high temperatures can cause chemicals to leach out of the plastic.

In the Marine Environment

PET has a higher specific gravity (which means it is a dense material) than water and consequently do not float – therefore PET products like plastic water bottles will not float and will sink to the seabed and are impossible to then recover.

2. High-Density Polyethylene

High-density polyethylene (HDPE) is a polyethylene thermoplastic made from petroleum. HDPE is hard, opaque and can withstand high temperatures.

HDPE is commonly used in:

- plastic toys
- outdoor furniture
- milk bottles
- heavier weight plastic bags like those used in departments and fashion stores

Health Concerns

No known health concerns.

In the Marine Environment

Like PET, HDPE has a high specific gravity and will sink to the seabed once in the marine environment.

Laboratory testing has shown that HDPE consistently soaked up Persistent Organic Pollutants (POPs) at concentrations an order of magnitude higher than other plastics such as PETE.

3. Polyvinyl Chloride

Polyvinyl chloride (PVC) is a thermoplastic polymer. Using phthalates (a plasticizer), it can be made softer and more flexible.

Common applications for PVC include:

- cordial bottles
- building materials (vinyl flooring and bench tops, PVC pipe)
- car interiors
- cling wrap
- pool toys and other inflatable structures
- clothing (vinyl)

Health Concerns

PVC is one of the toxic plastics that should be avoided – creating dangerous pollution in its manufacture, use and disposal.

The U.S. Center for Health, Environment & Justice describes PVC as "one of the most environmentally hazardous consumer materials ever produced[19]."

Roughly 30% of the world's supply of chlorine is used in the manufacture of PVC - when chlorine is used in industrial processes to make PVC plastic, or products made with PVC are burned as trash, a dangerous by-product called dioxin is formed. Dioxin is a known human carcinogen.

PVC is also dangerous while it is being used, as chemical 'plasticizers' added to make some plastics soft and flexible break down and are released during normal use. One example is that 'new car smell', which is actually the smell of toxic off gassing. The most common of these plasticizers, diethyl hexyl phthalate (DEHP), is a suspected carcinogen.

In the Marine Environment

The dangerous chemicals and additives used in PVC present similar threats to the health concerns above.

4. Low-density polyethylene

Low-density polyethylene (LDPE) is a thermoplastic made from petroleum. It can be translucent or opaque. It is flexible and tough, but fragments easily.

LDPE is commonly used in

- aseptic packaging and liquid paperboard e.g. juice and milk cartons and disposable coffee cups (as the waterproof inner and outer layer)
- most single use plastic grocery bags
- some packaging material

Health Concerns

No known health concerns.

In the Marine Environment

LDPE has a low specific gravity and will sink to the seabed once in the marine environment.

Laboratory testing has shown that LDPE consistently soaked up POPs at concentrations an order of magnitude higher than other plastics such as PETE.

5. Polypropylene

Polypropylene (PP) is a thermoplastic polymer. It is strong, tough, has a high resistance to heat and acts as a barrier to moisture.

In 2008, researchers in Canada found that quaternary ammonium biocides and oleamide were leaking from polypropylene laboratory equipment, affecting experimental results.

Where is Polypropylene found?

- synthetic ropes and nets
- yogurt & margarine tubs
- plastic cups & baby bottles
- kitchenware & microwavable plastic containers
- plastic tubing
- Plant pots

Health Concerns

Most PP is labelled as microwavable safe and dishwasher safe - however, please note microwavable/dishwasher safe only means that the plastic will not warp when heated. It does not imply that it is a healthy practice.

In the Marine Environment

Polypropylene has a slightly lower specific gravity than water and thus much of it floats. Like HDPE and LDPE, in laboratory testing, Polypropylene has been known to adsorb toxins, including PCBs at much higher levels than other polymers.

6. Polystyrene

Polystyrene (PS) is a petroleum-based plastic. It can either be hard or used in the form of Styrofoam.

Polystyrene is commonly used in containers for food and drinks.

The styrene monomer (from which polystyrene is made) is a suspected cancer agent. Styrene oligomers in polystyrene containers used for food packaging have been found to migrate into the food. There are concerns that when heated polystyrene food packaging may release styrene and other chemicals. Some sources suggest that packaging of such foods containing carotene (Vitamin A) or cooking oils must be avoided.

Where is Polystyrene found?
Polystyrene is widely used in packaging materials and insulation. Some common items include:

- disposable cutlery
- clam Shells (foam packaging used by restaurants and cafes for hot food takeaway containers)
- CD and DVD cases
- foam cups (juice, milkshakes etc).

Health Concerns
According to the Foundation for Achievements in Science and Education fact sheet, long term exposure to small quantities of styrene can cause neurotoxic (fatigue, nervousness, difficulty sleeping), haematological (low platelet and haemoglobin values), cytogenetic (chromosomal and lymphatic abnormalities), and carcinogenic effects.

Styrene is classified as a possible human carcinogen by the US EPA and by the International Agency for Research on Cancer.

In the Marine Environment

Polystyrene is probably the most problematic plastic in the marine environment due to the combination of its toxic properties and the fact that in soft and foam formats it quickly fragments into tiny individual beads that are readily mistaken for potential food.

Further, the lightweight nature of polystyrene and its rapid fragmentation also means it is difficult to control at waste and recycling facilities, increasing its likelihood to enter the marine environment.

Polystyrene beads are escaping waste and recycling facilities far too often, like this site in Victoria

7. Other plastics (varies)

Plastic #7 can be a little tricky as it stands for “Other” and covers a wide range of plastics including plastics such as acrylic, nylon, polycarbonate, and polylactic acid (a bioplastic), and multilayer combinations of different plastics- which may or may not contain harmful chemicals like BPA.

Of relevance to the TAP are:

Polycarbonate is derived from BPA.

Where is Polycarbonate found?

- electrical wiring
- CD/DVD cases
- baby bottles
- 3 and 5 gallon reusable bottles (make litres)
- Non-breakable glasses, crockery and cutlery

Health Concerns
Polycarbonate is derived from BPA, which has been found to be an endocrine disruptor.

In the Marine Environment

Acrylic and Nylon - which are common synthetics used in textiles, have been identified as some of the most common fibres found in ocean sediment.

Bioplastic Alternatives

"The reality is (bio-plastic) are simply fragmenting plastic packaging into 'bite size' pieces of plastic that are readily consumed by marine wildlife."

Dr Kathy Townsend, Qld University

Many companies are introducing bioplastic packaging, like this 'Plant Bottle' from Coca Cola without considering whether it is an actual solution to litter and marine plastic pollution or simply greenwash.

The range of materials that are commonly known as bioplastics represent a suite of alternatives, and within this report, we use the term 'bioplastics' as an umbrella term for those alternative plastics known as degradable, biodegradable (in landfill), oxo-biodegradable, and compostable plastics. Put simply, so-called 'bioplastics' are a substitute for fossil fuel based plastics – yet that does not mean that they produce any benefit in reducing the MPP problem.

Many bio based plastics have been around for years and we probably do not even recognise them as different from the common Polymers marked with a 1-7 Plastic Identification Code. For example, Rayon, a common synthetic found in clothing is typically made from a wood derived cellulose and cellophane is typically sourced from wood or cotton. Similarly, polyester can be sourced from non-fossil fuels – yet none offer any benefit in dealing with MPP.

The key to the adoption of a bioplastic as a substitute for more conventional polymers found in the marine environment is biodegradability and more particularly, the extent that a plastic will biodegrade in the natural environment.

A material may be labelled 'biodegradable' if it conforms to certain national or regional standards. These apply to industrial composters, not to domestic compost heaps or discarded litter in the ocean. Equally important is how long it takes for biodegradation to take place – which is controlled by environmental factors as well as the properties of the polymer.

At every stage of plastic's life, there is the potential for an impact to occur, whether as a large object or a nano-sized particle.

There is considerable debate as to the extent to which plastics intended to be biodegradable do actually biodegrade in the natural environment. This extends to the peer-reviewed scientific literature, but is most intense between organisations that have a vested interest in the results. For example, the producers of different types of plastics, additive chemicals intended to promote degradation and those involved in the waste management and recycling sectors.

Unfortunately, to date bioplastics are not truly biodegradable, and at best will only break down through multi-million-dollar industrial composting facilities commonly referred to as bio-reactors; or need micro-organisms, such as bacteria, fungi, and algae; or require specific controls over factors like temperature, moisture, oxygen, and pH[2021].

Because bioplastics have been designed to biodegrade in these complex terrestrial conditions - which are not replicated in marine environments - any level of natural biodegradation of bioplastics is much slower.

Like conventional plastic, bioplastics can contain heavy metals and fragment in a similar manner to traditional plastic – while claimed to be a primary benefit - bioplastics have little to no benefit to reducing litter or MPP.

"The adoption of plastic products labelled as 'biodegradable' will not bring about a significant decrease in the quantity of plastic entering the ocean or the risk of physical and chemical impacts on the marine environment."

UNEP Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities 2015

6. The Impacts & Threats

Once plastic is released into the marine environment it becomes almost impossible to recover and has a vast range of impacts that threaten biodiversity, lifestyle, economy and even our health.

Toxicity

There is a lot of misinformation concerning the toxicity of plastics and it is important to note that this is a complex issue. The very nature of plastics means there are toxicity impacts associated with their manufacture, use and disposal, but that does not necessarily mean all plastics represent a risk to your personal health or that of the environment.

The key issue to understand is the circumstances where plastic is likely to release toxic chemicals and where the wrong type of plastic is selected for an application. For example, PET (polyethylene terephthalate) most commonly used in plastic drink bottles, is generally known as one of the so-called 'safe plastics', but PET packaging contains the chemical antimony which Australia's National Pollutant Inventory describes as having "toxic properties like that of arsenic"[22]. Under normal circumstances the amount of antimony that could be released from PET packaging is very low but when heated via a microwave or in your dishwasher, antimony and other chemicals can be released (which is why PET is unsuitable for re-use as food or beverage packaging).

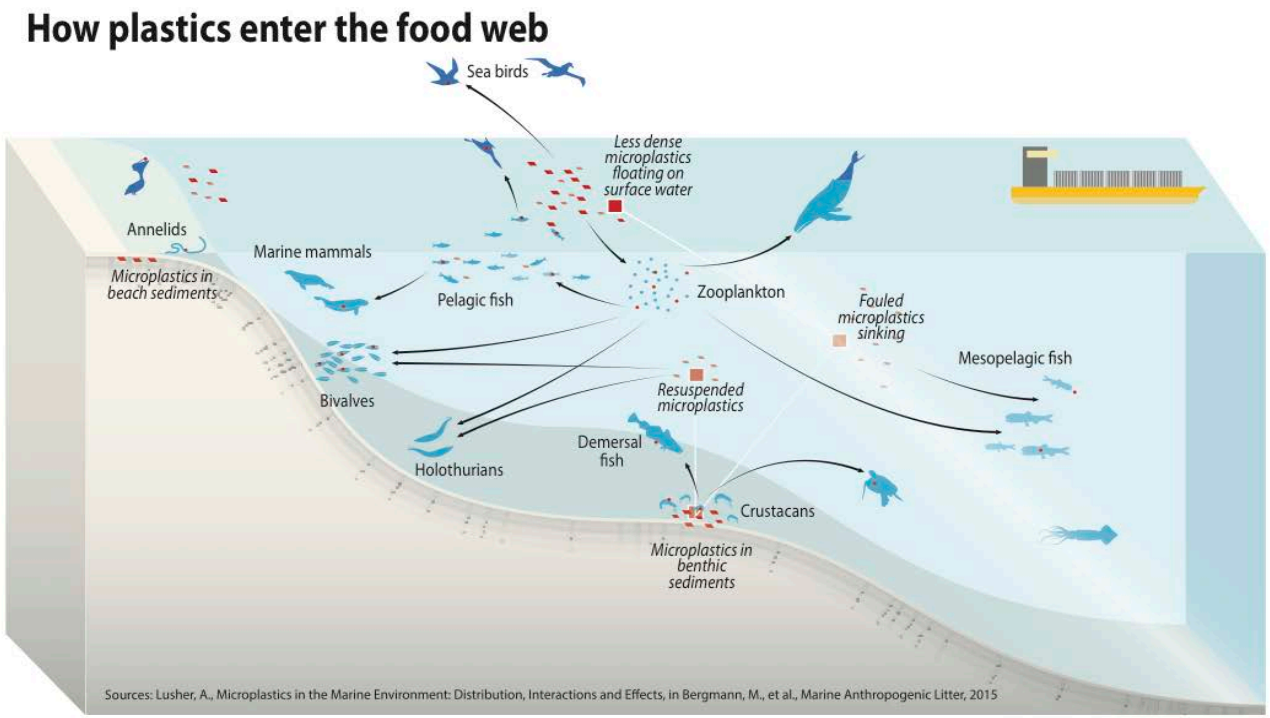
In addition to the level of toxicity within specific polymers there are also additives and the level of adsorption of surrounding chemicals displayed by different plastics that must be considered.

Additives

Base polymers often have a range of other chemicals added to them – softeners, flame-retardants, antioxidants and anti-bacterial agents to achieve properties desired for the final product. Many of these additives increase the toxicity of the plastic itself. For example, a brominated flame retardant is applied to nearly all synthetic textiles used in clothing, soft furnishings, and mattresses.

Brominated chemicals are under increasing criticism for their use in household furnishings and where children would encounter them. Many believe that Polybrominated Diphenyl Ethers (PBDE) could have harmful effects on humans and animals. Increasing concern has prompted several European countries to follow the precautionary principle (which is more commonly applied in Europe), to introduce bans. PBDEs are known to be lipophilic and bioaccumulative and testing has identified PBDEs in people all over the world.

Some brominated flame-retardants were identified as persistent, bioaccumulative, and toxic to both humans and the environment and were suspected of causing neurobehavioral effects and endocrine disruption[23]. One target group is fire fighters who are exposed to brominated fire retardants during fire-fighting operations and are suffering cancer rates that far exceed the general public's.



With very low recycling rates and the high volumes of plastic entering our oceans, there is little question that brominated flame retardants are being released into the environment.

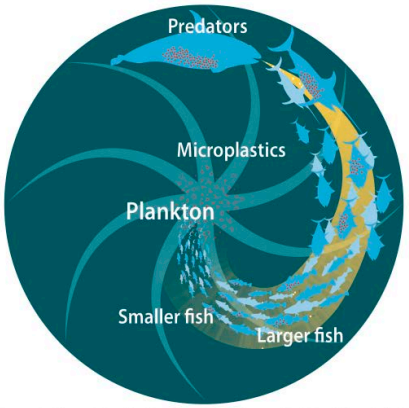
Sorption of Other Pollutants

Plastics are a particular threat because of their ability to adsorb toxins and other contaminants. Studies have shown that plastic found in our oceans (particularly microplastics) 'suck up' so many dangerous Persistent Organic Pollutants like the banned insecticide DDT and polychlorinated biphenyl (PCBs) that they were found to be up to 1 million times more toxic than the ocean surrounding them[24].

Ironically, many of the plastic polymers considered to have lower levels of toxicity in their base are also those plastics with a much higher sorption rate (e.g. HDPE and LDPE) and consequently when found in the marine environment are often as toxic as other polymers.

Biodiversity

Plastic bioaccumulation in the food web



Source: Rochman, C., M., The Complex Mixture, Fate and Toxicity of Chemicals Associated with Plastic Debris in the Marine Environment, in Marine Anthropogenic Litter, 2015

Estimates of the impact of plastic on biodiversity are hardly precise, as it is a very complicated process to monitor the diverse range of species. However, it is well documented that plastic litter causes physical harm to marine mammals, fish and invertebrates and death by entanglement, asphyxiation or blockage of organs are common[25][26]. It is also known that plastic particles tend to accumulate, are persistent, bioaccumulating and adhere toxic contaminants such as PCBs, DDT and PBDEs[27][28].

Marine Biologist Dr Kathy Townsend from the Moreton Bay Research Station, University of QLD, confirms that approximately 30% of the turtles she autopsies have plastics, including plastic bags, in their intestinal tract. Marine turtles are particularly vulnerable to floating debris as some species of marine turtles are thought to mistake plastic bags and other similar items for jellyfish prey.

Impacts of plastics in the marine environment on our biodiversity include:

- Starvation of species due to the ingestion of large amounts of plastic
- Entanglement and injury from plastic rubbish
- Increased toxicity from ingestion
- Biological invasion of alien species.

Migration of Invasive Species

Human activities have resulted in many species being transported from their native habitats to regions where they are not native. Known as biological invasion, the impacts of introducing a new species into an ecological community can be devastating for the ecosystem concerned.

Biological invasions have been identified as one of the greatest threats to global biodiversity, and the introduction of invasive species is accepted as one of the greatest causes of species loss.

Natural debris floating in the oceans have always provided "rafts" as a pathway for certain marine species to travel to new ecosystems. However, the introduction of vast quantities of plastic debris into our oceans has massively increased the amount of raft material and consequently increased opportunities for the dispersal of alien marine organisms into new habitats. Organisms ranging from algae to iguanas have been observed to raft on rubbish in the marine environment. Plastic encrusted with marine organisms have been found in the Pacific, Atlantic, Caribbean and Mediterranean Seas.

Australia's unique environments have a history of catastrophes from impacts associated with invasive species – Rabbits, Mice, Foxes and the Prickly Pear are just some of the terrestrial examples, but you may not realize that over 250 marine pests have invaded our waters – many hitching a ride via shipping, floating rafts of debris, and more recently plastics.

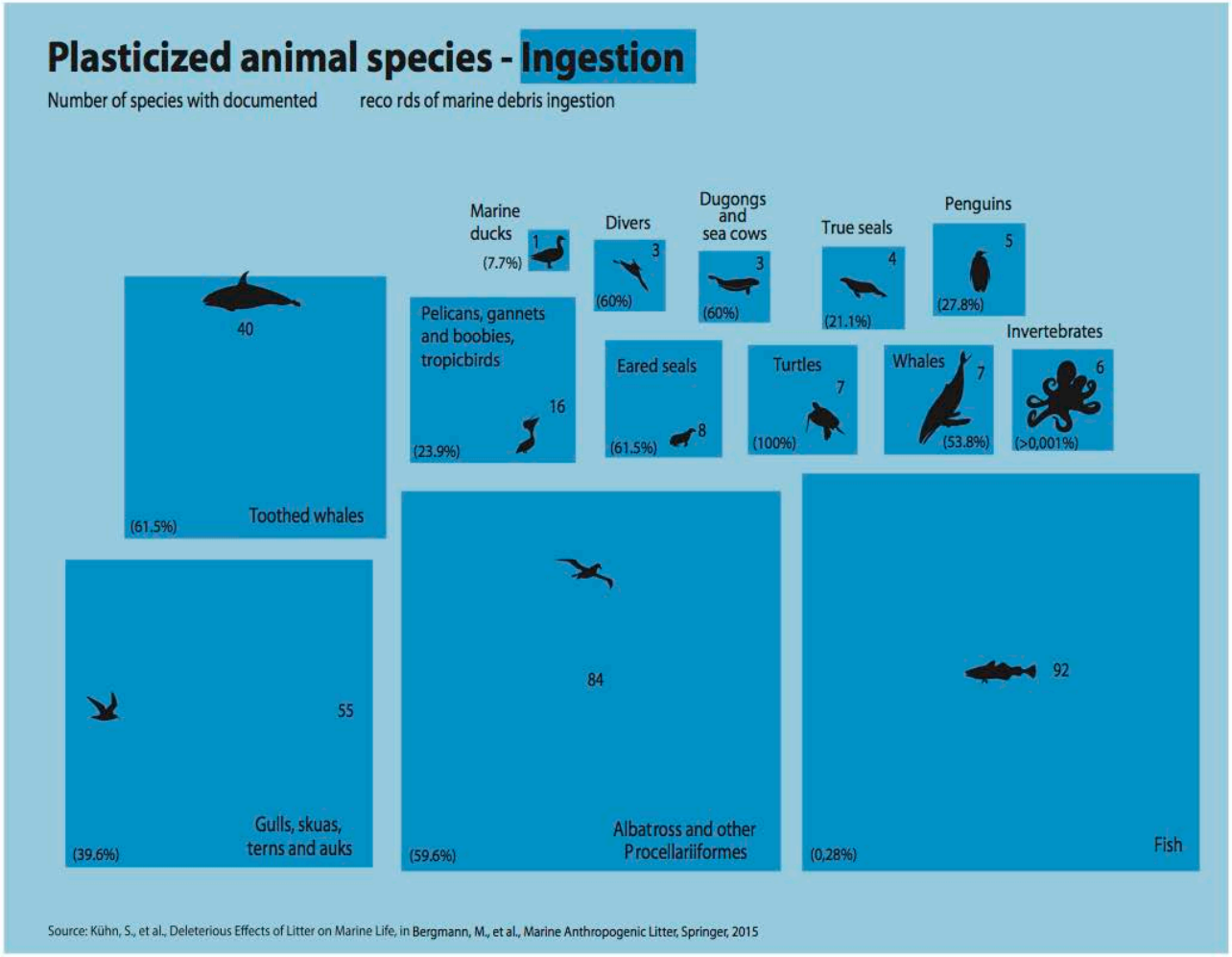
Ingestion

Late last year, the CSIRO upgraded its estimates to indicate that up to 90% of all seabirds have already ingested plastics and that the growth rate of plastic production indicates the amount doubles every 11 years[29].

The Great Barrier Reef Outlook Report 2014 has identified marine debris and plastics as a major threat to the health of the reef[30]. It was found that between 2008 and 2014, 683,000 items of marine debris were recovered within the Marine Park. According to a recent study by the ARC Centre of

Excellence for Coral Reef Studies, corals digest microbeads at about the same rate as normal food[31]. As demonstrated by the large amounts of plastic found in their guts, corals are unable to expel these fragments. Eventually, corals will starve and die when their stomachs become filled with plastic.

Moreover, the CSIRO has suggested that by 2050, "95% of all sea birds will have plastics in their gut"[32]. It is estimated that globally, over 1 million sea birds and over 100,000 mammals die every year as a result of plastic. These creatures die through ingestion mistaking it as food or from entanglement in plastic items. Consumed debris may starve animals by preventing ingestion of food, reducing absorption of nutrients, mechanical blockage or impairment of the digestive system resulting in internal wounds and ulceration. These physical impacts and internal ulcerations are likely to cause lower survival rates of chicks when parents regurgitate plastics as food.



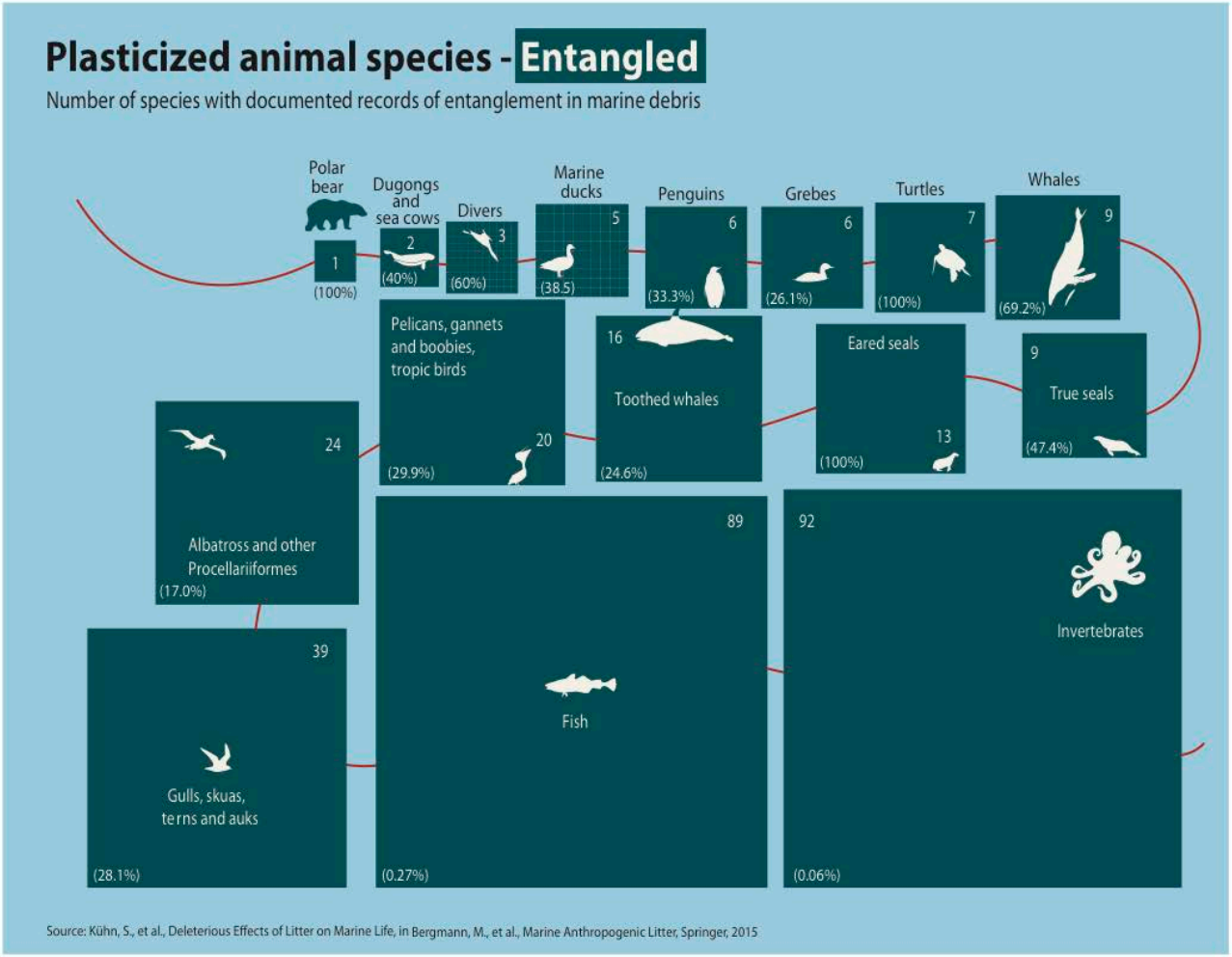
Microplastics in particular, have larger surface to volume ratios than other debris, potentially facilitating contaminant exchange and have been shown to be ingested by a range of organisms. Particles, including microplastics have recently been found in the circulatory systems and other tissues of filter feeding organisms (i.e. organisms low down in the food chain) such as blue mussels following experimental exposure. These particles caused typical inflammatory responses.

Microplastics have also been shown to cross cell membranes under laboratory conditions, causing tissue damage[33]. These plastics and their contaminant load then bioaccumulate and can pass along the food chain.

Whether the presence of acid conditions or surface active digestive substances in the guts of such marine organisms can desorb and release contaminants in significant quantities to cause such effects, or whether such a response is via their physical presence or both, still remains to be answered.

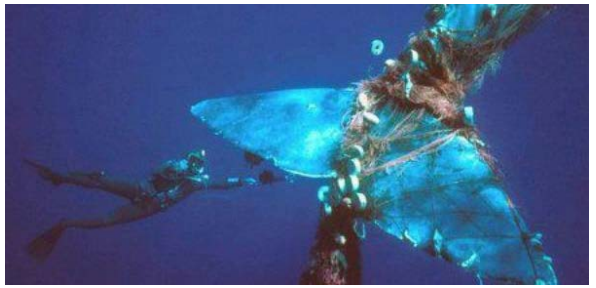
Entanglement

Entanglement in debris is a more obvious and proven risk to marine life, compared to other impacts of litter which are still subject to debate. More than 30,000 cases of entanglement (in 243 species) have been reported[34]. Entanglement can cause a quick or a slow death through drowning, starvation, strangulation or cuts and injury that cause infection[35]. Much of the damage to organisms is caused by discarded fishing equipment – so-called "ghost fishing". It is a problem that affects predominantly higher taxa organisms: whales, turtles, seals, dolphins, dugongs, sharks and large fish. For example, studies examining scarring on whales from the Gulf of Maine indicate that more than 80 per cent of right whales and 50 per cent of humpback whales have experienced entanglement in fishing gear[3637].



While entanglement with large debris is well-documented, it is also important to recognize that smaller litter items like plastic bags and hi-cones (the plastic can holders used for 6 packs of beer) are also a significant point of harm – becoming wrapped around our sea life causing them to become entangled and drown or starve to death.

A July 2015 paper jointly published by CSIRO and the Ocean Conservancy noted that, "There were substantial differences among debris types in severity for entanglement. Fishing related items (buoys and rope, monofilament, nets) were the items that caused the most damage, given that an animal interacted with them. However, close behind these three items were balloons and plastic bags[39].



Health Risks

"People who consume average amounts of seafood are ingesting approximately 11,000 particles of plastic every year."

Dr Iglesias-Rodriguez, National Oceanography Centre - University of Southampton

There is growing concern that plastic ingestion by marine species is contaminating our seafood.

A 2016 report by Greenpeace International "Plastic in Seafood" showed that across 10 international studies, on average, 27.1% of seafood was found to contain plastic[40].

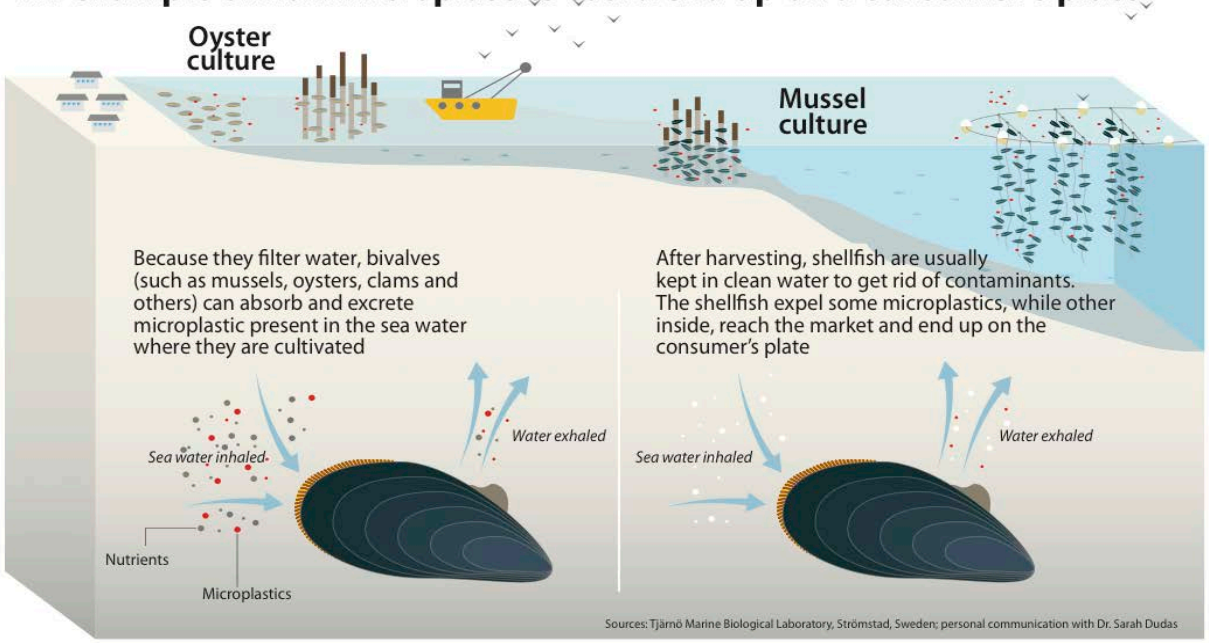
While there needs to be further research, these findings create a huge threat to our long-term health. We need to understand both the direct impacts of plastic ingestion - but potentially more threatening- also understand the impacts of both the toxic chemicals contained within the plastics themselves and the chemicals sucked up while in the ocean.

We do not 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 are entering our food chain[41]. These have the potential to cause a range of health problems including cancers, cellular mutation, and birth defects.

Studies looking at the transfer of microplastics within the food chain include the following:

- In a lab experiment, microplastics were found to have translocated from the gastrointestinal tract in mullet to its liver tissue.
- A feeding experiment using streaked shearwater chicks fed the birds with polyethylene resin pellets collected from Kasai seaside park in Tokyo Bay. The birds were also fed wild fish. Polychlorinated biphenyls (PCBs) were detected in the fish fed to the chicks, because the fish ingest PCBs through their prey.
- A laboratory experiment investigated transfer of microplastics through three steps in a food chain (three trophic levels) and looked at the effect of microplastics on the top fish predator. When compared to control fish, the microplastics-fed fish spent a longer time feeding, were less active, spent more time together in a shoal and expended less time and energy exploring the tank.
- Blue mussels contaminated with microplastics were fed to common crab. Some microplastics were seen in the crabs 21 days following ingestion of the contaminated mussels, which suggests that microplastics could transfer in the food web from prey to predator.
- Common mussels are filter feeders that have been shown to retain microplastics, which accumulated in the gut and translocated to the circulatory system within three days and remained in the mussel for more than 48 days.
- Norwegian lobster caught in the Clyde Sea were kept in tanks and fed plastic-seeded fish. Twenty-

An example of how microplastics could end up on a consumer's plate



four hours later, every lobster had plastics in their stomach.

- In a lab experiment, mysid shrimp were fed microplastic-contaminated zooplankton. The shrimp ingested the microplastics, suggesting the transfer through the food web by predators that ingest contaminated prey.

Economic

The UNEP (2014) Report, "Valuing Plastics: The Business Case for Measuring, Managing and Disclosing Plastic Use in the Consumer Goods Industry", estimated that 10 to 20 million tonnes of plastic is finding its way into the world's oceans each year, costing approximately AUD$17 billion p.a. in environmental damage to marine ecosystems[25]. This includes estimated financial losses incurred by fisheries and tourism as well as time spent cleaning up beaches.

Even more staggering is the total natural capital cost of plastic used in the consumer goods industry, estimated to be more than AUD$99 billion p.a., with the largest contributors being food (25%), non-durable household goods (20%), soft drinks (13%), and retail (8%)[25].

To the right is a chart from the report identifying the estimated costs of each major industrial sector's contribution to MPP and the proportion those sectors' products and packaging represent in terms of natural capital[25].

In 2009, Asia-Pacific Economic Cooperation (APEC) estimated that the direct costs to the tourism, fishing and shipping industries was AUD$1.7 billion – which in today's monetary terms represents over AUD$2.25 billion[42]. The breakdown of this estimate is as follows: AUD$473 million to the fishing industry, AUD$362 million to shipping and AUD$808 million to marine tourism.

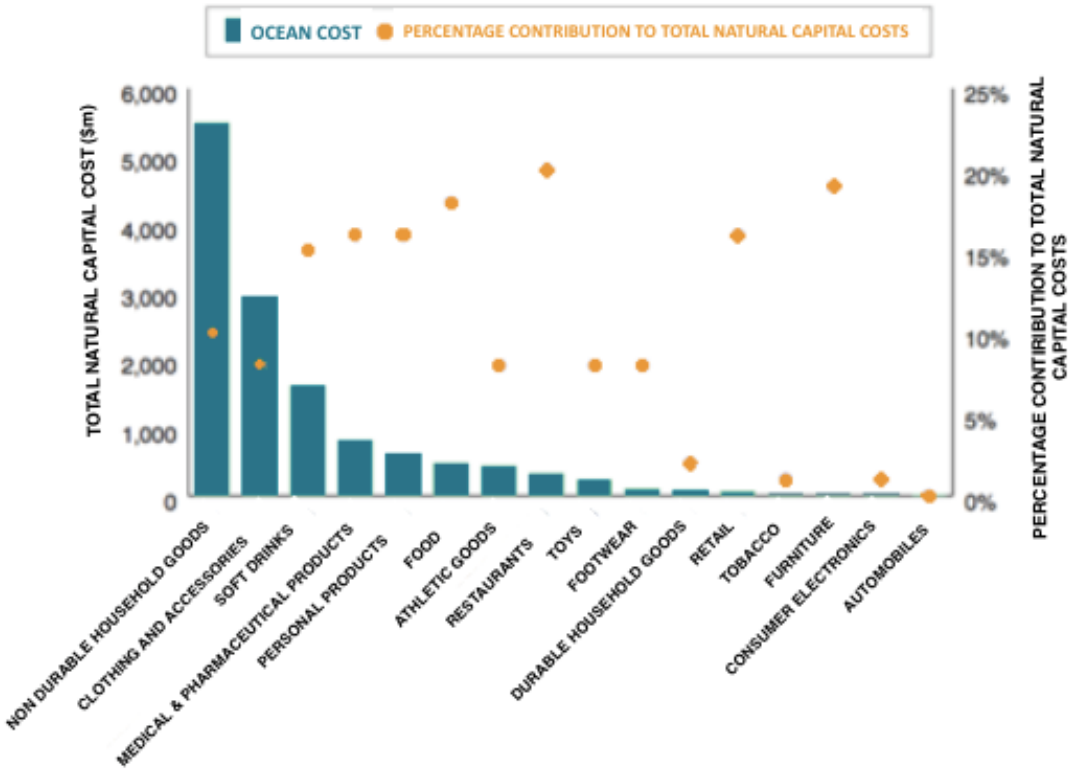
With tourism a major driver of the Australian economy, along with a strong fisheries sector - it is vital that any future studies consider the destructive forces of litter on the Great Barrier Reef (and other reefs), beaches, fisheries, and marine mammals.

Aesthetic and Lifestyle

Although not at the forefront of many reports, the economic impact on aesthetic and lifestyle is noted as a significant economic impact, and is commonly ignored by our governments. A recent Scottish analysis (conducted to consider whether Scotland should adopt a container deposit system[43]), estimated that in addition to the direct benefits of CDS in terms of reducing litter (by 17%) it would also provide indirect savings through litter reductions:

"The indirect costs of litter are thought to be considerably higher than the direct (clean-up) costs. The study identified 5 key areas in which litter

TOTAL NATURAL CAPITAL COST OF PLASTIC IN THE OCEAN ($) AND PERCENTAGE CONTRIBUTION TO TOTAL NATURAL CAPITAL COST PER SECTOR



created a significant indirect cost along with an estimate of the potential loss;

(1) Property values – AUD$165 million loss;

(2) Mental health – AUD$87 million loss;

(3) Crime – AUD$37 million loss;

(4) Neighbourhood litter disamenity – AUD$120 to 1.27 billion loss;

(5) Beach litter disamenity – AUD$82 to 165 million loss."

While the relative values contained in these studies could be debated, it makes the point clearly that the impacts of litter on society represent far more than the direct costs of cleaning it up. Other indirect benefits associated with the reduction of litter identified by the Scottish Report and Keep America Beautiful (2009[44]) include; indirect economic impacts of litter (like the potential spread of disease), litter injuries (particularly glass), and where high levels of litter are found – a loss of business revenue and falling property values for residences - as other significant impacts.

Property Values

One example of how litter impacts on the wider economy was developed in the USA by the National Association of Home Builders (NAHB), who built a hedonic pricing model based on data from a large survey conducted by the U.S. Census Bureau[45]. The NAHB model deconstructed the price of a home into selected components, so that estimated factors were developed for each price-influencing variable while addressing problems of nonlinearity. Based on this model, NAHB determined that the presence of litter tended to reduce the value of property in that neighbourhood by about 7.4%. If just 5% of 1.6 million homes in Greater Sydney neighbourhoods are adversely affected by litter, the potential economic impact on housing in Sydney is $11.8 million.

Keep America Beautiful tested the validity of the NAHB model by surveying 600 homeowners across 30 states and found that 93% of all homeowners believed that a littered neighbourhood would decrease their home's value and would also personally deter them from purchasing a home in an area that was considered 'unkempt[44]'.

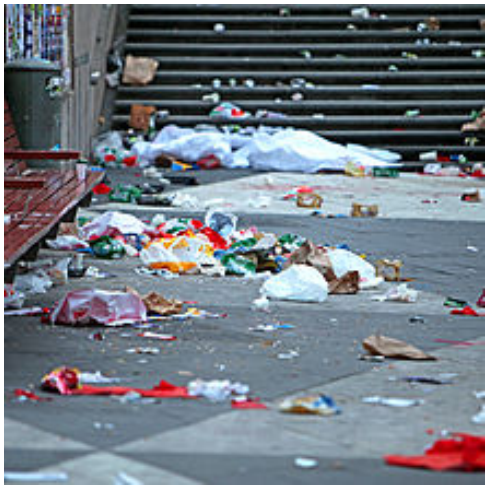
Cost of Managing Litter

Another major area of cost to the community is in the bill to clean up our mess –local authorities bear most of the cost of cleaning up litter from beaches, maintaining litter traps and bins etc., which in NSW alone represents a staggering $132 million p.a.[46]

The Boomerang Alliance believes that significant omissions have been made in calculating the cost of litter. This is based both on the amount of litter and a range of, to date, unaccounted costs that have been considered in other assessments.

Commonwealth Government analysis has estimated the cost of litter as $35 million p.a. The studies then attribute the cost of reducing packaging litter at $501 per tonne, then later discount the benefit of reducing this amount to around 40% of that figure[47]. These estimates do not reflect the actual expenditure on litter reduction, but are a very inadequate analysis:

- The cost of operating gross pollutant (litter) traps and street sweeping services is captured – but omits the cost of servicing municipal rubbish and the substantial capital investment in trucks, bins and traps.
- Allocates a value of just $7.67 per hour to formalised community litter clean ups of some 15-17,000 tonnes p.a. when more typically volunteer labour is costed at over $20 per hour.
- Excludes the significant overall costs to litter ENGOs like CleanUp Australia and Keep Australia Beautiful - including the costs of volunteer recruitment, event promotion, provision of bags and gloves etc., and administration and fundraising.
- Omits costs and volunteer labour for more informal clean up events run by organisations such as Responsible Runners, Tangaroa Blue, Take 3, Two Hands Project, Project Aware, etc. These clean ups represent at least as many hours as the formal events captured in governments study.
- Excludes State and Commonwealth grants and programs for litter management and illegal dumping. In NSW alone, government spending is some $15 million p.a.
- Fails to identify the state and local government costs to manage litter on beaches, national parks, crown and state lands, schools and colleges.



- Omits business expenditure to sweep car parks, malls, shopping centres and hard stand areas and retailer, hospitality and accommodation services to maintain a clean frontage around their premises.
- Omits the cost to every household to remove litter from their property and its boundaries. While small on a house by house basis, the overall cost of home owners and occupiers cleaning up litter on the property and fence line is significant. Using a similar measure to the participation and volunteer costs ($7.67/hour) identified for the Packaging CRIS, the impact of each of the 5.86 million free standing Australian homes spending just 10 minutes a month collecting litter would represent an annual cost of over $89.9 million p.a.

By way of a comparison, Boomerang Alliance compared the estimated cost (per capita) to manage litter in the U.S.A. using the detailed study undertaken by Keep America Beautiful (KAB) in 2009 which tracks the more complete range of litter costs including the private sector[44]. Keep America Beautiful identified a total cost (in 2008) of $US11.5 billion p.a. ($14 billion AUD) and highlights that, in fact, private sector costs dwarf those of the government sector - which are the sole focus of previous studies.

This highlights the very poor effort government has made to even identify where litter costs are experienced, let alone the scale of these costs.

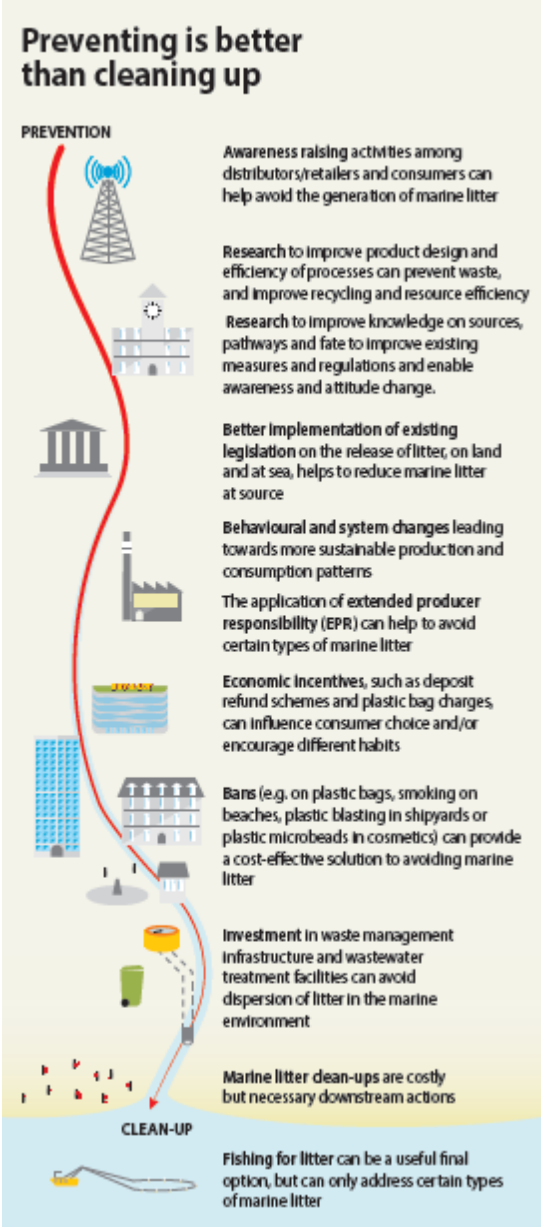
The Keep America Beautiful report concludes that the national cost of litter management in the USA (in 2008) was AUD $47.02 per capita, making a mockery of Australian Government estimates representing a cost of just $1.78 per capita.

By using the KAB US study and the recent NSW study into litter costs for the adoption of a CDS we have extrapolated a more realistic estimate of the cost of litter in Australia as:

Sector	US ($mill) Estimate	Aust. ($mill) Equivalent
State and Fed Gov't	$477	$32
Local Gov't	$1,293	$354
Business	$11,974	$799.52
Schools	$317	$21.17
Clean up Groups	N/A	$15.80
Volunteers	N/A	$15.80
Total	**$14,061**	**$1,238**

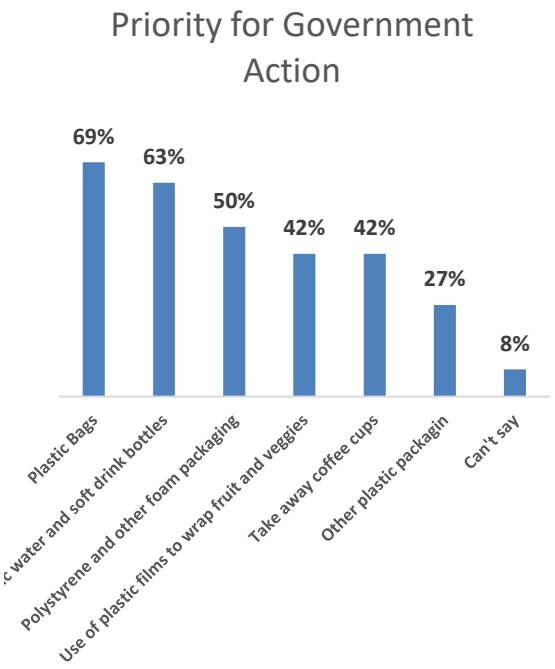
This shows that government estimates understate the extent of our litter and MPP problems. More importantly, how can we expect our political leaders to put forward the case for action, when our bureaucracies posit pollution cost estimates that miss over 95% of the costs?

It is notable that if litter costs had been accurately projected we, in all likelihood, would have adopted a plastic bag ban as early as 2004 and a CDS in 2007. Because of this incompetence some 300,000 tonnes of plastic pollution have entered our seas.



7. Community Expectations

In preparing this TAP, BA in late 2015 commissioned Omnipol to ask what people felt were the priority actions on plastics – unsurprisingly 2 out of 3 people nominated action on plastic bags amongst their priorities, with plastic bottles and polystyrene packaging high on the list.



To further our understanding of general perceptions and attitude of the community towards MPP, the Boomerang Alliance developed a series of polls to engage our supporters as we produced our blog series on MPP.

We received fantastic feedback from community members across the board - with 5000 responses from both community and BA members. These responses have allowed us to solidify that the Boomerang Alliance's priority actions reflect the interests of the community as well as address some of the misconceptions surrounding MPP that are evident within the community.

We asked the community what three plastic products they thought required priority government intervention. Their responses were:

Plastic Product	Percent
All single-use plastic bags	67.8%
Personal care and domestic cleaning products containing microbeads	43.7%
Plastic beverage containers	34%
Disposable plastic and composite cups (coffee cups, juice cups, milkshake containers, etc.)	23.5%
Single-use plastic grocery bags	17.8%
Rigid plastic takeaway food containers (Polystyrene clam shells, Polypropylene, etc.)	17.8%
Banning a suite of miscellaneous plastic pests (Helium balloons, plastic straws)	16.9%
Stronger penalties and enforcement on littering (particularly cigarette butts)	14.9%
Planning requirements to provide waste infrastructure and management plans to stop litter generation from urban waterfront commercial activities and major tourist attractions	12.6%
Prohibiting the loss of plastic resin pellets and flake across the plastic manufacturing chain	10.9%
Requiring mandatory and effective filtration of all washing machines to capture synthetic fibres	10.9%
Stronger regulation on maritime waste for shipping in Australian waters	10.6%
Funding research to stop the incidence of ghost nets	10.0%
Penalties for waste and recycling facilities that allow residual plastics to escape their control	4.9%
Plastic garbage bags and kitchen tidy bags	2.5%

As we expected, the three highest percentile responses represent the issues with high media profiles - Bags, Bottles, Microbeads. What is interesting is the support for action on the second order sources of MPP. Miscellaneous plastic items such as balloon clips, and straws as well as takeaway food packaging outweighed action on regulation and enforcement of existing laws covering maritime and industrial waste, as well as the introduction of filters on washing machines to capture synthetic fibres.

It is of interest to note that there was a higher proportion (67.8%) of people who believe that all single-use plastic bags should be a priority for government intervention, compared to only 17.8% who nominated the plastic bags bans implemented in SA, NT, ACT and Tasmania where bans are limited to light weight single-use plastic grocery bags.

We then asked respondents if they believe the following plastic products or packaging should be banned. We then provided the option for respondents to suggest what they also felt required bans:

	Yes	No	Unsure
Microbeads	96.1%	0.6%	3.3%
Plastic 6-pack ring holder	95.8%	1%	3.1%
Single-use plastic shopping bags	93.4%	2.3%	4.4%
Polystyrene food and drink packaging	92.6%	1.5%	6%
Plastic lollipop/ice-cream sticks	91.7%	2.2%	6.1%
Single use plastic straws	84.8%	6%	9.2%
All single use plastic bags	80.9%	6.5%	12.7%
Helium balloons	70.9%	7.7%	21.4%

Within the option to suggest additional items, there was a large response of people wanting bans on a variety of single-use items. Two of the more noticeable items were plastic cutlery, and takeaway coffee cups. Clingwrap, balloons, straws and coffee capsules were also mentioned quite frequently throughout the responses.

However, most notable was the extensive call for a ban on plastic packaging, including general supermarket items (e.g. individually wrapped biscuits, chip packets), toy packaging, and the infamous fruit and vegetable packaging which was mentioned most frequently. This included the individually wrapped fruit and vegetables, and also the plastic containers used for fresh produce.

"All unnecessary plastic packaging needs to be phased out as soon as possible"

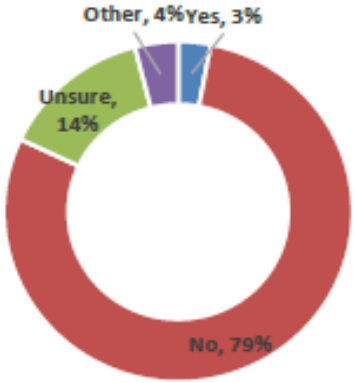
What is interesting about the feedback, is if we look at the sources of plastic pollution in Australia it is clear that while there are calls for action on a number of 'miscellaneous plastic items', they only represent 9% of pollution compared to 18% of pollution that comes from synthetic fibres (9%) and nurdles (9%) - both of which can be addressed with relative ease. One of the most difficult things to overcome when implementing a threat abatement plan, is competing with notions of MPP that have been popularised through the media, while other major sources such as synthetic fibres and nurdles which have been ignored in government reporting are not well understood. While it is easy to be swept up by graphic imagery of the impacts of certain plastic items (e.g. straws and turtles) we must resist putting populist issues ahead of major threats and so we have taken a pragmatic approach that addresses the most problematic and profligate sources of MPP first.

The next phase of questioning concerned government intervention on MPP. We asked: "*Do you agree with the Governments conclusion that the amount of litter polluting our streets, parks, beaches and waterways is reducing?"*

More than three-quarters of respondents disagreed with the Government's conclusion that litter is reducing, while only 3% agreed.

Many respondents expressed their concerns and own observations stating the amount of litter has not decreased.

Do you agree that the amount of litter is reducing?

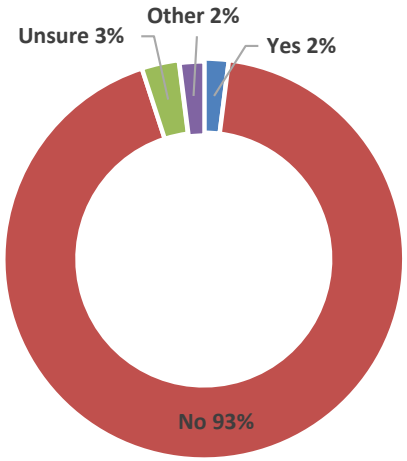


"I still collect a bag full of plastic every day on my walk through the local park. Same park every day, same short walk, same bag full of plastic."

We next asked the community: *"Do you believe litter numbers will go down without any Government intervention?*

Unsurprisingly, a significant majority (93%) of respondents believe that without government intervention, litter numbers will not decrease.

Is government intervention required?

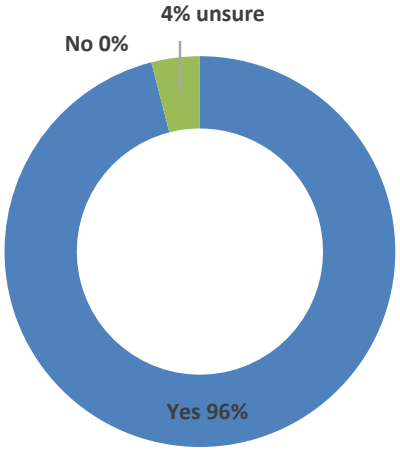


"Governments should provide incentives to industry to encourage sustainable, re-usable products, not based on plastics and other similar ingredients which ultimately damage our environment, as well as to provide re-usable packaging"

Our polls also show that respondents believe action should be a priority with governments adopting the precautionary principle as a matter of necessity.

This is reflected by the 96% of respondents who said that the Australian Government should adopt the precautionary principle when developing policy to eliminate microplastics.

Should the Precautionary Principle be adppted?



8. Priority Actions

While it is critical that we develop an effective Threat Abatement Plan to deal with the toxic tide of MPP that is proliferating our oceans and waterways, we also need to account for today's politics and economics. Some may wish to eliminate all plastics, believing it would have a beneficial impact on our marine environment and sea life – but it would also see the amount of food waste skyrocket and dangerous alternatives may be introduced.

When intelligently used and integrated into waste minimisation and recycling programs, plastics deliver some big benefits.

To that end, Boomerang Alliance has identified both those plastics that are the most profligate within marine environments and/or are the plastic polymers and products that are the most problematic (i.e. most likely to be ingested, or toxic, or cause entanglement issues) as the priorities for government intervention.

Potential to Reach our Oceans

What plastics are likely to end their life in our waterways? Theoretically, the answer is all of them – at every stage of their manufacture, distribution, use and disposal, plastics create pollution and over time the lightweight and often buoyant nature of plastics means (without intervention) all or some will be transported via wind and stormwater into the marine environment. To determine the threat (i.e. the likelihood of different types of plastics entering the marine environment) we sought to identify the way different plastic pollution sources reach our waters. Once again the purpose of the chart is to provide a broad estimate not an empiric assessment.

The bubble chart provides a visible representation of the threats of different plastic products and packaging. The bigger the bubble, the larger the pollution source and the higher the bubble is positioned - the greater the threat. The further to the right, the greater the likelihood the material will enter the marine environment.

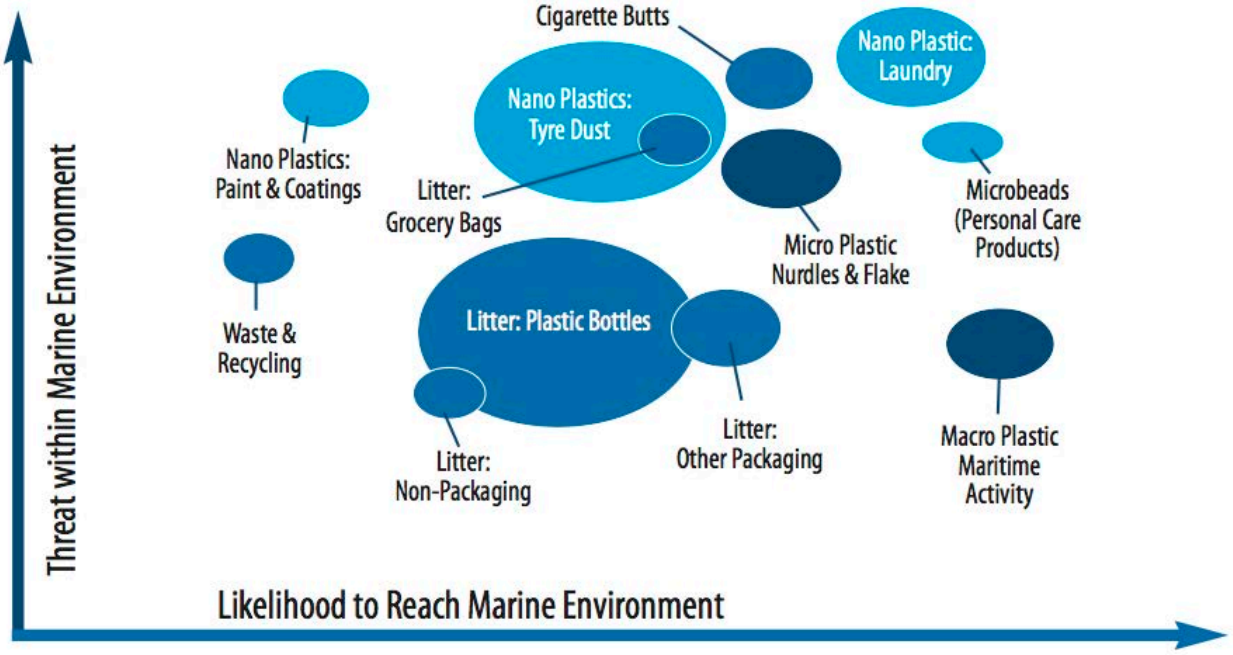
Our approach was then to identify both those plastic products and packaging that represent the largest sources (the most profligate) and those products that, once in the marine environment, are the most problematic in terms of their impact. This informs our priorities for action – whether that be via a product ban (e.g. single use plastic bags), the introduction of an Extended Producer Responsibility (EPR) Scheme (e.g. Container Deposit Schemes), or to use traditional regulations, (often termed command and control approaches) to require plastics manufacturers to ensure that their raw materials are not spilt and swept into the stormwater drain.

The Most Profligate

(The biggest sources of MPP)

I. **Plastic Bottles:** By far beverage containers are the single largest component of the litter stream and CSIRO has identified that between 35 – 50% of all plastics found along our shorelines are sourced from the beverage sector. We estimate that (by weight) plastic beverage containers represent 33% of all MPP (and 38% of the total volume).

II. **Tyre Dust:** Surprisingly to many, tyre dust – the tiny specks of synthetic rubber that are abraded and



left on our roads to ensure safe handling and braking - are most likely the second largest source of MPP (18% of the total weight) with 100% of this material eventually washed down our stormwater drains and into our seas.

III. **Synthetic Fibres** lost from clothing and textiles during washing are thought to be a major source of MPP. BA estimates they represent between 10% of all MPP and the largest source of primary microplastic entering our oceans.

IV. **Maritime Industry Waste** (ghost nets, discarded fishing gear, lost cargo and maritime dumping) represents around 11% (by weight) of all MPP.

V. **Other Plastic Packaging** represents around 12%of littered plastics – the clear majority of which (64%) is packaging best defined as plastic food and drink containers (polystyrene clam shells, PP & PET rigid plastic containers and disposable cups).

The Most Problematic

(i.e. most likely to directly impact marine biodiversity once they enter the marine environment)

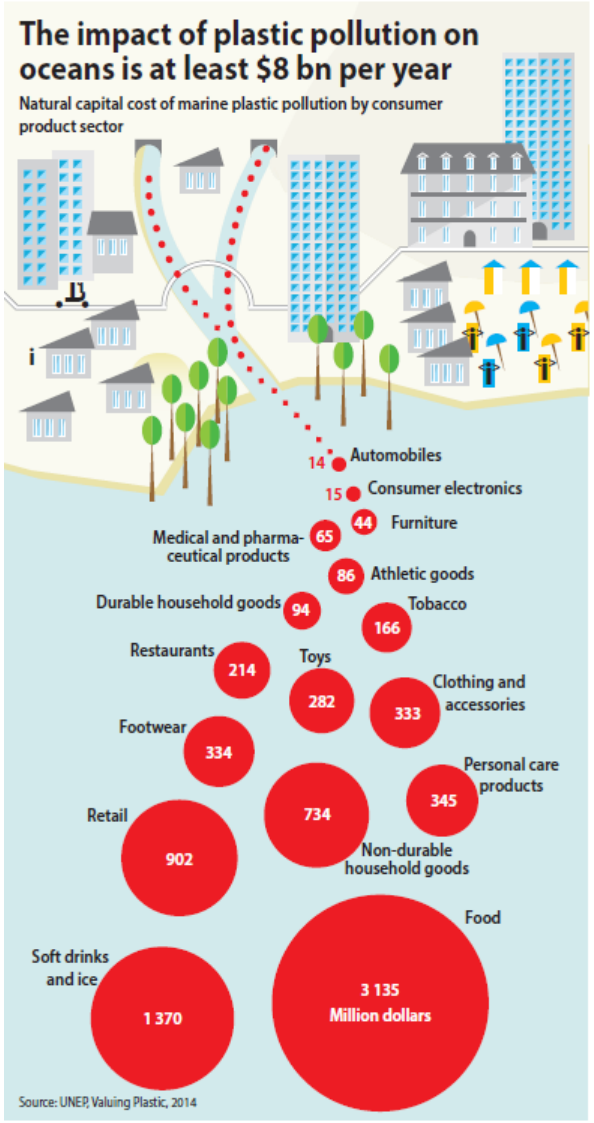
I. **Plastic Bags:** While plastic bags are estimated to represent just 1-2% (by weight – 4% by volume) of all MPP they are one of the most problematic sources. Firstly, they are shown to be immediately targeted by species that mistake them for their food sources (e.g. jellyfish); secondly they fragment quickly due to their lightweight nature; and thirdly are often identified within entanglement threats
(getting caught around marine mammals, turtles and sea birds).

II. **Cigarette Butts:** In total cigarette butts represent around 5% (by weight – 3% by volume) of all MPP and are virtually impossible to deal with once they enter the marine environment where they quickly break down into nano scale synthetic fibres.

III. **Microbeads:** used in cosmetics, personal care, detergents and synthetic waxes and polishes are also a relatively small source of MPP (less than 2% by weight or volume), yet when washed into our sewer systems, it is ensured 100% of microbeads will enter our oceans. Microbeads closely resemble fish eggs and are often targeted by marine species and are so small (ranging in size from 0.0004 to 1.24 mm) that organisms that form the base of the food chain can ingest them, e.g. plankton and corals.

IV. **Plastic Nurdles:** the resin pellets and flakes used to manufacture plastic products, which are often lost during transport, and handling and washed into our stormwater drains, are often mistaken for fish eggs.

V. **Polystyrene Food Packaging:** which fragments into individual beads quickly (increasing the likelihood of ingestion), are made from one of the most toxic monomers – styrene. There are concerns that when heated, polystyrene food packaging has been shown to release styrene and other chemicals, while other sources suggest that packaging of such foods containing carotene (Vitamin A) or cooking oils must be avoided.



The Plastic Products and packaging we all consume come at a cost of $10.5billion ($8billion USD)

9. RESEARCH

"Research and, particularly, conservation based research is chronically underfunded… we need funding on par with things like climate change and sea level rise, because that is the challenge that we are facing. It needs to be put in that same tier." Dr Jennifer Lavers, Institute for Marine and Antarctic Studies - UTAS

As canvassed throughout this publication, there remains much that is unknown about the properties of plastics within the marine environment and its impacts and effects.

The urgency and need to prioritise further research was highlighted by the 2016 Senate Report '*Toxic Tide – The Threat of Marine Plastics*' which was of the view that "there is a need for greater sound, peer-reviewed research on the effects of marine plastic pollution and for this research to inform future government policy." (Nevertheless, the Committee proposed immediate policy measures).

Leading academics and NGO's have been critical of the lack of support for research on MPP, with several witnesses testifying before the Senate that very little of the research they conduct on MPP is funded by the Australian Government.

"Mr Ian Hutton explained that he funds his own research through his private business and occasional small grants from the Lord Howe Island Board."

"Professor Stephen Smith commented that most his funding was provided through NSW government agencies, and in-kind from Earthwatch Institute."

"Dr Lavers told the committee that her research is largely funded through philanthropy with some grants from not-for-profit organisations"

Globally, government is scrambling to fill the gaps with essential research. For example:

- Norway recently announced that it would provide AUD$1.56 million to support the United Nations Environment Programme on marine litter.
- Belgium, France, Germany, Ireland, Italy, The Netherlands, Norway, Portugal, Spain, and Sweden formed The Joint Programming Initiative Healthy and Productive Seas and Oceans (JPI Oceans) and committed AUD$10.6 million into research on microplastics in the ocean
- UNEP announced AUD$7.9 million over the next two years for global and regional marine litter work.
- Ellen MacArthur Foundation announced a AUD$13.2 million three-year New Plastics Economy initiative to build momentum towards a global plastics system that works.

By comparison, Australia's commitment to developing sound research into the sources, impacts and mitigation of MPP has been poor. In total the Australian Government's funding between 2005 and 2015 (10 years) was just $284,500.

Australian funded research projects should include:

- The sources of MPP and pathways for plastic pollution to reach the marine environment.
- The effects of MPP, particularly microplastics, on marine fauna and ecosystems.
- Identify effective mitigation and prevention strategies to stop plastic debris from entering the marine environment.
- The potential threats of MPP and associated chemicals to impact the viability of our seafood industry and more importantly long term associated health risks.

NATIONAL MARINE DEBRIS DATABASE

The Senate Committee recommended "the implementation and support for a nationally consistent marine debris database should be priority for the Australian Government."

The value of a national database has been recognised, and the Tangaroa Blue Foundation has received funding from the Australian Government to support upgrades to the AMDI – but to date there is no recurrent funding to ensure that this (and other) important initiatives are maintained.

RESEARCH MUST NOT IMPEDE ACTION

Too often, Australian policy development is stymied by the need for research becoming an excuse for inaction, when there is sufficient knowledge for the precautionary principle to be adopted.

Again, the Senate Report into MPP heard from leading academics working on MPP stating that the government should balance the need for further research with the need for urgent action to reduce sources of marine plastic pollution.

"With ocean plastic pollution, I think operating under the precautionary principle is a reasonable principle to take. We know enough to be able to make good, informed recommendations and management decisions. We know that we find fewer plastic bags on coastlines during clean-ups when you move away from urban centres. We know that we find fewer beverage containers when picking up litter - when you are in South Australia." Dr Denise Britta Hardesty - CSIRO

10. Recommended Actions

Aspect	Action		Responsibility	By
1. Leadership	**1.1**	Australian Government should urgently seek to work with our neighbouring countries to develop improved standards to manage plastic waste and MPP, with a focus on improving international agreements (Law of the Sea, MARPOL etc) in eliminating MPP and forming regional agreements to tackle specific regional issues (e.g. Ghost Nets, Regional Dumping at sea, strategies to address potential biological invasions associated with MPP, assistance to implement MARPOL, aid from developed nations for developing neighbours).	Australian Minister for Foreign Affairs	6/'17
	1.2	The Australian Government, in collaboration with state, territory and local government must deliver an effective MPP Threat Abatement Plan (TAP). The TAP should set hard targets for mitigation and abatement of plastics found in our environment along with specific milestones. The TAP should be sufficient to eliminate at least 70% of plastic with the potential of reaching the marine environment.	Australian Environment Minister	12/'17
	1.3	MPP should be placed on the COAG Agenda for the first meeting in 2017, with Ministers to agree on their approach to tackling MPP and the key priorities they will focus on. The meeting should endorse the need for coordinated national action and need for a TAP.	Australian Environment Minister	6/'17
	1.4	Australian Government and each state and territory should recognise the threat presented by the growing amounts of plastic in our marine environment and announce that the reduction of MPP is a priority of the highest order.	Federal, State and Territory Environment Ministers	11/'16
	1.5	MPP should be a priority for all state, territory and federal governments. Accordingly, MPP should become a permanent standing item for discussion at a meeting of environment ministers at least twice each year.	Australian Environment Minister	11/'16
	1.6	A working group, under the auspices of the meeting of environment ministers, be established by the beginning of 2017 to address specific matters related to MPP and to discuss progress of the TAP on a quarterly basis.	Australian Environment Minister	11/'16
	1.7	Each state and territory should instruct its environment agency to develop a strategy to reduce MPP through strengthened regulation and improved enforcement of regulations relating to the manufacture, distribution, recycling and disposal of plastic and synthetics.	Federal, State and Territory Environment Ministers	3/'17
2. Research	**2.1**	Australian Government will provide at least $2.5million p.a. for a minimum of 5 years in funding and active cross-departmental support research covering: I. the effects of marine plastic pollution in Australian waters, including: • the extent of marine plastic pollution; • the sources of marine plastic pollution; • to identify the extent of ghost nets in Australian waters, and to identify means to prevent the loss of fishing gear; • the effects on ecosystems particularly in the Great Barrier Reef.	Australian Minister for Industry, Innovation and Science	7/'17

		II. the threat posed by microplastic pollution, including research to: • identify the extent of microplastic pollution; • evaluate the effects of microplastic pollution on marine fauna; • evaluate the effects of microplastic pollution on ecosystems; and • identify mitigation measures; and III. the threat posed by marine plastic pollution, particularly microplastic, on human health.		
	2.2	State and Territory Governments should (jointly) match Federal Government Research funding on a dollar for dollar basis.	State & Territory Environment Ministers	7/'17
	2.3	The Australian Packaging Covenant Industry Association and key APC Industry Associations with material interests in the plastic production and consumption cycle (PACIA, the AFGC, ACOR, Packaging Council of Australia etc.) should match Federal Government research funding. This research should focus on the development of innovative solutions to mitigate plastic pollution, eliminate litter, and explore alternatives to plastic packaging.	Australian Packaging Covenant Council	7/'17
	2.4	Australian Governments should work closely with Clean Up Australia, Tangaroa Blue and CSIRO amongst others to establish a national marine plastic pollution database by July 2017 to identify and track plastic litter, marine debris and microplastics along our shores and waters.	Australian Department of Environment and Energy	7/'17
	2.5	Improving data collection and citizen science is a critical aspect to better understand the extent, nature and impact of MPP. Federal Government should provide long term funding to both Tangaroa Blue and Clean Up Australia to improve the data capture and collation tools along with adequate administrative resources to manage the database.	Australian Department of Environment and Energy	7/'17
3. Capacity	**3.1**	The ongoing growth in community education, citizen science, policy development and clean-up efforts have become essential aspects to address MPP; yet the lead organisations coordinating these activities receive no specific support for their work: Australian Government should extend GVEHO Grants, specifically for their MPP work (which attracts additional housing and administrative costs to their general purposes) towards those ENGOs that lead specific aspects of the combat to tackle MPP. They include: GhostNets Australia (Ghost Nets), Clean Up Australia (Community Clean Up efforts), Tangaroa Blue (Marine Debris), Boomerang Alliance (Policy and coordination of responses to gov't policy), Australian Marine Conservation Society (Marine Biodiversity).	Australian Environment Minister	7/'17
	3.2	It is important that there is a community group responsible for coordinating community response at a state level. State and Territory Governments should identify that organisation and provide appropriate administration grants to support their work.	State & Territory Environment Ministers	7/'17
	3.3	All coastal councils should urgently seek to provide financial and administrative support to local beach and coastal clean-up groups operating in their municipalities.	Local Government	4/'17

	3.4	Action on MPP is undermined by misinformation about plastics and marine plastic pollution and a lack of coordinated community and school education regarding the issue. State and Territory Governments should seek to develop a suite of information regarding what plastic products can and cannot be recycled, MPP sources and impacts and simple actions households can take to reduce their plastic pollution footprint.	State & Territory Environment Ministers	4/'17
	3.5	The Commonwealth, Qld, Tasmania, NT, and WA Environment Departments have inadequate staff in waste policy and enforcement to be able to address waste and recycling, let alone addressing specific aspects of MPP. All relevant Ministers should look to immediately increase their Departments capacity through a specific budget to address MPP, its sources and abatement.	Relevant Environment Ministers	7/'17
4. Plastic Pollution by Maritime Industry	**4.1**	The Australian Government should: • Develop innovative technologies for the tagging of fishing gear and support the introduction of these technologies by the Australian-based fishing industry, and by fishing industries in regional countries; • undertake a review of current government arrangements to detect and remove ghost nets (both in Northern Australia and Tasmania); • develop a nationally consistent strategy to ensure that ghost nets are recovered in the Australian Fishing Zone, and coastal waters.	Australian Minister for Agriculture and Water Resources	7/'18
	4.2	Federal, State and Territory Environment Ministers should form a working group to develop an ADF style Product Stewardship scheme for the SE Asian / Oceanic Region across the maritime industry to ensure all nations within our region can target the recovery of lost cargo, fishing gear and waste at sea.	Federal, State and Territory Environment Ministers	7/'17
	4.3	Australian cruise operators should develop a template operations manual for the management of on-board waste. This should include managing passenger litter and the prohibition to sell products in plastic packaging or wrapped in plastic film.	Australian Cruise Association and other tourism industry bodies	4/'17
	4.4	State and Territory Governments should introduce legislation to ensure that details of waste reception facilities for ships are included in port environment plans.	State Port Authorities	7/'17
	4.5	Introduce regulations requiring all ships to maintain logs books recording lost fishing gear.	Australian Maritime Safety Authority	12/'17
5. Producer Responsibility Schemes	**5.1**	All Australian states and territories to have commenced Container Deposit Systems before the end of 2020.	Qld, ACT, Vic, Tas and WA Environment Ministers	7/'18
	5.2	At their first meeting of 2017, Federal, State and Territory Ministers should form a working group to investigate the introduction of a take back scheme for plastic takeaway food packaging and disposable cups.	Federal, State and Territory Environment Ministers	7/'17
	5.3	Federal, State and Territory Ministers should form a working group to investigate the introduction of an Advance Disposal Fee on cigarette butts to fund community and local government litter clean-up efforts.	Federal, State and Territory Environment Ministers	7/'18

6. Product Bans	**6.1**	Introduce A ban on all single use plastic bags.	Federal, State and Territory Environment Ministers	11/'16
	6.2	There is urgent need to provide a regulatory underpinning for the Federal Government phase out to prohibit the importation, manufacture, distribution or sale of personal care, cosmetic and household cleaning products containing microbeads.	Australian Environment Minister	11/'16
	6.3	Polystyrene Packaging is a significant problem in the marine environment, combined with a 'precautionary approach' regarding concerns over polystyrene's potential to leach styrene into food means that takeaway food packaging and disposable cups should be prohibited for importation, manufacture, distribution or sale in Australia.	All Federal, State and Territory Environment Ministers	7/'17
	6.4	There are a range of secondary sources of MPP that are unnecessary and can be readily replaced by non-polluting alternatives. The prohibition of these products and packaging has minimal industry impacts and should be banned. They are: • Helium filled balloons • Disposable plastic straws (though LPB straws are acceptable) • Hi Cones (plastic 6-pack ring holders) • Ice cream and lollipop sticks (which can be readily substituted for timber or other biodegradable products)	All Federal, State and Territory Environment Ministers	7/'18
7. Mandatory Product Design Requirements	**7.1**	Require all domestic washing machines to be fitted with microfibre filtration systems on the machines outtake; and broader sewerage filtration systems be fitted to all commercial laundry and dry cleaning businesses.	All Federal, State and Territory Environment Ministers	12/'17
	7.2	Plastics manufacturing, recycling and waste facilities should require an environmental license issued by Environmental Regulators. These licenses should require compliance with Operation Clean Sweep standards (ran by BA Ally Tangaroa Blue) for all plastics manufacturers and be expanded for application to capture fugitive microplastic losses in plastics recycling, reprocessing and waste management facilities. This initiative should be accompanied by strengthened regulations and a commitment from environmental regulators to enforce existing regulations.	All Federal, State and Territory Environment Ministers	4/'17
	7.3	A major source of MPP is packaging, which includes the much-neglected tertiary packaging (packaging used for shipping). The use of polystyrene 'peanuts' for padding in shipping cartons and plastic foam sheets is unnecessary and can be readily replaced with alternative biodegradable packaging made from bagasse or other organic sources. The APC should trial a voluntary effort but if 70% of this type of plastic packaging has not been eliminated within 3 years it should be replaced by a regulatory scheme in late 2020.	Australian Packaging Covenant Council	12/'17
8. Regulation	**8.1**	The loss of plastics during waste management and recycling is a major source of MPP in Australia that is both unnecessary and unlawful. Waste and recycling facilities are obliged to ensure they maintain of all waste that comes into their control and they must ensure they have adequate infrastructure to capture: light weight plastic bags and films; residual	All Federal, State and Territory Environment Regulators	4/'17

		microplastics; & tiny plastic fibres and dusts generated during shredding need exhaust systems to stop them escaping the premises. All state environment regulators need to take immediate action to enforce existing laws and stop this unnecessary pollution.		
	8.2	Like the waste and recycling industry, plastics manufacturers are obliged to ensure any waste they generate is controlled within their site until it is collected by a waste company. The loss of plastic resin pellets (nurdles) and flake (the recycling based substitute for pellets) are far too common and are readily avoided. All state environment regulators need to take immediate action to enforce existing laws and stop this unnecessary pollution.	All Federal, State and Territory Environment Regulators	4/'17
9. Product Standards	**9.1**	Introduce product standards for all plastic packaging and products manufactured or imported for use in Australia. This standard should require the product or packaging to display a Plastic Identification Symbol and a bar code. Where packaging is a composite material that includes plastic it should be required to clearly outline what those materials are (to aid recycling) and a level of standardisation adopted so that Material Recovery Facilities (MRF) can separate materials with confidence.	All Federal, State and Territory Environment Ministers	12/'18
	9.2	The Australian Packaging Covenant (APC) Council, in Partnership with PACIA should authorise work to develop a standard on what is recyclable in Australia. This should be based on a survey of local government and defined by those materials that are currently collected by most MSW kerbside recycling services. Standards should provide guidance to packaging manufacturers on design requirements to ensure recyclability and labelling. The use of recycling symbols should be better policed.	Australian Packaging Covenant Council	12/'18
10. Planning	**10.1**	State Planning Authorities should develop a 'planning for plastics program', using a tool like the NSW 'Basix" program. This should require large commercial and industrial projects to outline how they will minimise the use of disposable plastic, the infrastructure to capture fugitive plastic waste and management regimes for the handling of plastic waste and litter. Sectors that should address plastic waste and litter in development applications include: • Waste and recycling facilities; • Plastics manufacturing, extrusion and injection moulding facilities; • Large accommodation, resorts, tourist attractions, theme parks located within 1klm of the coastline or an estuary; • Take away, cafes, restaurants and hotels; • Waterfront precincts like Southbank (Vic), Darling Harbour (NSW), Cavill Mall (Qld), etc. • Shipping terminals, Ports, and Marinas • Construction sites • Major sporting venues and events.	All State and Territory Planning Ministers.	7/'19

11. Potential Reductions:

We need to assess the potential of the recommended actions in order to reach the established goal of cutting MPP by 70%, over and above its current known volumes.

To that end, we have reviewed what sources of MPP are impacted by the proposed actions and their potential to reduce the volume of MPP entering our waterways which are identified on the table to the right (see the column marked 'Potential')

Recognising that some aspects of the TAP deliberately overlap and others are somewhat intangible in terms of direct MPP reductions (e.g. leadership, research etc.) we then rationalised and discounted the potential reduction to form a 'target' reduction level.

As a result, we believe our TAP can readily achieve the target of a 70% reduction in MPP by 2020.

As the next step, we will prepare a summary Regulatory Impact Statement for each proposed action that requires any change to our environmental laws (whether state of federal) to be tabled at the proposed conference in March / April 2017. This process will also allow us to better detail the reduction potential while also identifying any barriers and the possible impacts on business.

Recommended Action	**Relevance To**			**MPP Reduction**	
	Ref #	Sources Covered:	% of MPP	Potential	Target
Leadership	1.1 - 1.7	All MPP	100%	100%	Nil
Research - General	2.1 - 2.5	All MPP	100%	10%	Nil
Research - Innovation & Alternatives	2.3	All Plastic Packaging	50%	15%	3%
Research - Abatement	2.1, 2.3	All Plastic Litter and Debris	59%	10%	2%
Capacity	3.1 - 3.5	All Plastic Litter and Debris	59%	20%	3%
Maritime Industry	4.1 - 4.5	Maritime Industry Waste and Ghost Nets	5%	5%	2%
CDS	5.1	Beverage Related Litter	38%	35%	30%
Take Back for Takeaway	5.2	Rigid Food Containers, Takeaway Cups	4%	3.50%	2.5%
Cigarette Butt ADF	5.3	Cigarette Butts	3%	2%	1%
Ban Single Use Plastic Bags	6.1	Plastic Bags	4%	4%	4%
Ban use of Plastic Microbeads	6.2	Microbeads	2%	2%	2%
Ban Polystyrene Food Packaging	6.3	Polystyrene Food Packaging	4%	3%	2%
Secondary Plastic Bans	6.4	Straws, Balloons, Lollipop Sticks	1%	<1%	<1%
Washing Machine Filtration	7.1	Synthetic Fibres	10%	9%	6%
Environmental Licensing	7.2	Fugitive Plastic - Waste & Recycling	8%	5%	2%
	7.2	Fugitive Plastic - Manufacture	2%	2%	1%
Packaging Covenant MDR	7.3	Plastic 'Tertiary' Packaging		10%	5%
Better Regulation & Enforcement	8.1	Fugitive Plastic - Waste & Recycling	8%	8%	2%
	8.2	Fugitive Plastic - Manufacture	2%	2%	1%
Mandatory Plastic Stds	9.1	All Plastic Packaging	50%	25%	2%
Plastic Recycling Standards	9.2	All Plastic Packaging	50%	25%	2%
Planning for Plastic	10.1	All Plastic Litter	54%	27%	2%
Total MPP Reductions:					**75%**

12. Appendix A: Potential for Plastics used in Australia to Reach the Marine Environment

Plastics Category	Pollution Pathways			Potential Marine Pollution (T/PA)
	Manufacture	Use	Disposal	
Beverage Related Plastic (240KtPA domestic) (120KtPA imported)	Medium: 1% of domestic production • Nurdle Loss in domestic production and transport.	Low • Short Life Span	Very High: 5-10% of all production • Beverage packaging is a primary litter source (50% of all plastic) • Often consumed in locations accessible to where marine environments (beaches, boating parks etc.)	20-38,000 Tonnes P.A.
Other Consumer Packaging (237KtPA domestic) (143KtPA imported)	Medium: 1% of domestic production • Nurdle Loss in domestic production and transport.	Low • Short Life Span	Medium: 2-4% of production •Significant source of Litter (around 10% of all plastic litter)	10-18,000 Tonnes P.A.
Tertiary & Other Packaging (50KtPA domestic) (50KtPA imported)	Medium: 1% of domestic production • Nurdle Loss in domestic production and transport.	Medium: 1% of all production • Polystyrene foams and wrap damage during handling and transport	Medium: 2-4% of production • Windblown losses • Illegal dumping of industrial containers	4-6,000 Tonnes P.A.
Plastic Bags (imported) (17kPA lightweight) (7KtPA heavier Weight)	Low	Low	High: 3-4% of production • Commonly littered (2%) • Lightweight bags windblown from landfill (1-2%)	500-1,000 Tonnes P.A.
Cigarette Butts (7KtPA mostly domestic)	Low	Low	Very High • Up to 80% of butts enter the litter stream[48]	3,5-5,500 Tonnes P.A.
Plastic Products (1MtPA domestic) (290KtPA imported)	Medium: 1% of domestic production • Nurdle Loss in domestic production and transport.	Medium: 0.5% of production • Abrasion and Degradation in furnishings, paint, powder coatings etc.	Low • Less than 1% of plastic litter	13–18,000 Tonnes P.A.
Synthetic Textiles & Fabric (300KtPA imported)	Low	High: 1.5% of production p.a. • Plastic fibres from household laundry and floor cleaning	Low • Beachwear is often lost at beaches etc. but is a very small part of the litter stream	5-7,000 Tonnes P.A.

Synthetic Rubber Tyre Dust (145KtPA imported)	Low	Very High: 16% of production • 0.1gram of rubber dust is released per klms travelled by car	High: 1% of domestic recycling and W2E •Around 1% of a shredded or crumbed tyre is likely to escape the site via wind/ water	23-24,000 Tonnes P.A.
Microbeads: (650TPA)	Low	Very High: 100% of production for use in personal care products • All microbeads in personal care products and washing powders enter the ocean	N/A	650 Tonnes P.A.
Maritime Industry Waste (10KtPA)	Low	High: • 2,400 T P.A. of nets lost during operations	High: •7,600 TPA of plastic waste dumped	10,000 Tonnes P.A.
TOTAL POTENTIAL MARINE POLLUTION:	• 15,270 Tonnes P.A. of Nurdles if loss is just 1% of production	•32,000 Tonnes P.A. of micro plastic and nano sized dusts and fibres. •2,500 Tonnes P.A. of Ghost Nets	• 37-79,000 Tonnes P.A. of waste and litter.	89-130,000 Tonnes P.A.

13. Appendix B: The Senate Inquiry Recommendations on MPP

RECOMMENDATION 1

Any future Australian Government policies on mitigating the threat from marine plastic be underpinned by sound, peer-reviewed research.

RECOMMENDATION 2

The Australian Government actively support research into the effects of marine plastic pollution in Australian waters, including research to more fully evaluate:

- the extent of marine plastic pollution;
- the sources of marine plastic pollution;
- the effects at the population level; and
- the effects on ecosystems particularly in the Great Barrier Reef.

RECOMMENDATION 3

The Australian Government actively support research into the threat posed by microplastic pollution, including research to:

- identify the extent of microplastic pollution;
- evaluate the effects of microplastic pollution on marine fauna;
- evaluate the effects of microplastic pollution on ecosystems; and
- identify mitigation measures.

RECOMMENDATION 4

The Australian Government actively support research into the threat posed by marine plastic pollution, particularly microplastic, on human health.

RECOMMENDATION 5

The Australian Government undertake work to identify and establish the costs of externalities associated with marine plastic pollution.

RECOMMENDATION 6

That industry contributes further funding of scientific research through the Australian Packaging Covenant.

That this funding be provided for research which particularly addresses the effect of marine plastic pollution on marine fauna, and human health from ingestion as well as research to identify mitigation strategies.

RECOMMENDATION 7

The Australian Government consult with stakeholders, including the Tangaroa Blue Foundation, CSIRO and relevant scientists, to explore mechanisms to establish a national marine pollution database.

RECOMMENDATION 8

The Australian Government place marine plastic pollution on the Council of Australian Governments' agenda for urgent consideration. In recognition of the level of threat associated with plastic pollution in Australia's marine environment, and the need for a comprehensive and coordinated response, the committee recommends that the Australian Government establish a working group, under the auspices of the meeting of environment ministers, to address specific matters related to marine plastic pollution.

RECOMMENDATION 9

The Australian Government explore opportunities for increased regional leadership and direct support on the issue of marine plastic pollution, including projects focused on ghost net recovery.

RECOMMENDATION 10

The Australian Government pursue mechanisms to improve support and coordination of clean-up activities through the meeting of environment ministers working group to ensure that the most effective outcomes of these activities are achieved.

RECOMMENDATION 11

The Australian Government:

- support CSIRO research to identify the extent of ghost nets in Australian waters, and to identify means to prevent the loss of fishing gear;
- support the development of innovative technologies for the tagging of fishing gear and support the introduction of these technologies by the Australian-based fishing industry, and by fishing industries in regional countries;
- undertake a review of current Commonwealth arrangements to detect and remove ghost nets;
- develop a nationally consistent strategy through the meeting of environment ministers working group to ensure that ghost nets are collected in a timely manner in the Australian Fishing Zone, and coastal waters.

RECOMMENDATION 12

The Australian Government reinstate funding for GhostNets Australia to allow it to continue its work to identify and retrieve ghost nets.

RECOMMENDATION 13

The Australian Government, through the meeting of environment ministers working group, encourage all jurisdictions to support the implementation of targeted education campaigns which aim to change consumer behaviour in relation to the use of plastics, and to provide consumers with information regarding alternatives to traditional plastic.

RECOMMENDATION 14

The Australian Government implement the recommendations from the Senate Environment and Communications References Committee inquiry into stormwater management in Australia, in particular:

- Recommendation 1—the development and implementation of a national policy framework for stormwater management (a National Stormwater Initiative); and
- Recommendation 4—the consideration of new funding models and financial incentives that would facilitate improved stormwater management outcomes in an economically efficient way.

RECOMMENDATION 15

The Australian Government, through the meeting of environment ministers working group, actively encourage the states and territories, which have not already done so, to consider the most effective methods to address marine plastic pollution in their jurisdictions. These should include implementation of container deposit schemes and other anti-littering mitigation strategies.

RECOMMENDATION 16

If all states and territories have not introduced container deposit scheme legislation by 2020, the Australian Government revisit the issue with the view to developing legislation for those jurisdictions which are yet to implement container deposit schemes.

The largest single source of MPP is beverage containers. CDS is the single largest action to cut MPP

RECOMMENDATION 17

The revised Australian Packaging Covenant include improved reporting and compliance by industry.

RECOMMENDATION 18

The Australian Government, through the meeting of environment ministers working group, engage with states and territories to improve enforcement of the Australian Packaging Covenant.

RECOMMENDATION 19

The Department of the Environment give consideration to recognising the role of product stewardship in the Threat Abatement Plan by including reference to the Australian Packaging Covenant.

RECOMMENDATION 20

The review of the Australian Packaging Covenant include support for the development innovative packing solutions that offer alternatives to plastics.

RECOMMENDATION 21

The Australian Government support states and territories in banning the use of single-use lightweight plastic bags. In doing so, the Australia Government should ensure that alternatives do not result in other pollutants entering the environment.

RECOMMENDATION 22

The Australian Government move to immediately ban the importation and production of personal care products containing microbeads.

RECOMMENDATION 23

The Australian Government, through the meeting of environment ministers working group, identify measures, including regulatory measures, already available to prevent plastics entering the marine environment and ensure that they are being implemented effectively in all jurisdictions. In particular, the committee recommends that more effective enforcement of environmental laws in relation to preventing nurdles entering the waste management system be pursued.

14. Appendix C: 10 Principles of Product Stewardship

Producer Responsibility and Shared Commitments

Producers are required to design, manage, and finance programs for the safe and environmentally responsible manufacture, distribution, sale, use and end-of-life management of their products and packaging. Programs need to cover an entire sector's products, as opposed to individual approaches.

A Level Playing Field

Stewardship inevitably comes at a cost and it is difficult for a company to be a responsible steward if forced to compete with rogue traders gaining a price advantage over legitimate business by schemes being voluntary or exploiting loopholes or avoiding other regulatory costs associated with their industry. To this end, it is the obligation of federal and state government agencies to ensure a level playing field.

Internalised Costs

All end of life costs should be included in a product's cost. This places the financial burden of managing environmental impacts from manufacture, use and end of life management on consumers rather than a tax based model where individuals who do not consume a product share the cost. In the medium term this creates incentive for manufacturers to redesign their products to reduce their impacts on the community and environment.

Transparency and Integrity

Effective product stewardship requires producers and operators across the supply chain to commit to high levels of transparency and integrity, including:

- Any charges to manage the stewardship program;
- Details of the scheme operation and results;
- Disclosure of how products are managed at the end of their life (and who manages this);
- Publication of meeting minutes on a website; and
- Any rules or policies that restrain trade to ensure compliance with the scheme.

Accountable

Producer Responsibility Organisations (PRO), must ensure they remain credible by being publicly accountable and transparent. This requires: clear goals and targets being regularly published; periodic reporting on progress; plans for the future; audited and published annual accounts. The PRO should also have a public complaints process and a credible process for dealing with them in a prompt timeframe.

Governance and Decision Making

Product stewardship Schemes need to ensure equitable representation from the supply chain as they often over-represent polluters who then use the PRO to manipulate market outcomes or 'green wash' efforts and results. No-one 'in trade' should have access to confidential information regarding sales, pricing or market segmentation information.

Government Independence

Government should not participate in the running of product stewardship schemes or be represented on the governance bodies of a scheme. It is critical they remain impartial rather than become co-opted. Government should:

- ensure that the governance structures are to a high standard and facilitate representation within the governance structure;
- conduct independent reviews and regular broad consultation to ensure stakeholders have opportunities to air and consider any grievances;
- ensure all claims are honest;
- audit whether the scheme is meeting its targets and community expectations.

Under no circumstance should government extinguish its right to further regulate or impose penalties on participants - where necessary - as this is an abdication of its responsibility to protect the public interest.

Results Orientated and Fact Based

Obviously, the success or failure of any producer responsibility scheme is based on genuine results. It is paramount that any stewardship scheme has clear time bound targets that reflect the public's expectations and protection of the environment; and regular milestones (quarterly) reporting to allow success to be reviewed in a timely manner.

Knowledgeable

Responsible stewards and PROs should clearly understand the potential environmental, health and safety risks of their products and actions. In addition, they should know how others participants in the product's lifecycle impact risk. The biggest burden for developing knowledge of a product's hazards falls on the manufacturer because it defines the product's content and potential to cause damage.

Independently Verified

It is well established that the community is sceptical of both industry and government claims regarding environmental health and community safety. To this end it is important that any claims be independently verified by a credible third party who has no financial connections or equity with any members of the scheme itself.

15. Appendix D: Glossary of Terms

Abatement
The act or state of abating or the state of being abated; reduction; decrease; alleviation; mitigation.

Advanced Disposal Frees
A charge imposed on each item at the time of sale so producers pay for the collection, transport and reprocessing of the waste.

Australia's Economic Exclusion Zone
This area is made up of 8.2 million square kilometres off Australia and its remote offshore territories, and 2 million square kilometres off the Australian Antarctic Territory. It extends to a distance of not more than 200 nautical miles from the territorial sea baseline.

Bioaccumulation
The accumulation of a substance, such as a toxic chemical in various tissues of a living organism.

Biodegradable/Biodegradation
Biological processes of organic matter, which is completely or partially converted to water, CO_2/methane, energy and new biomass by microorganisms (bacteria and fungi).

Biological Invasion
The introduction of an invasive or exotic species to a non-native location.

Bioplastics
A type of biodegradable plastic derived from biological substances rather than petroleum.

Compostable Plastic
Capable of being biodegraded at elevated temperatures in soil under specified conditions and time scales, usually only encountered in an industrial composter (standards apply).

Container Deposit Scheme
Monetary deposit on beverage containers (conditional to legislation) at the point of sale. When the container is returned to an authorized redemption centre, or to the original seller in some jurisdictions, the deposit is partly or fully refunded to the redeemer.

Degradable/Degradation
The partial or complete breakdown of a polymer as a result of e.g. UV radiation, oxygen attack, biological attack. This implies alteration of the properties such as discolouration, surface cracking and fragmentation.

Flame-retardants
A compound used in cloth and plastic material to raise the ignition point of the material, making is resistant to fire.

Ghost Fishing
The continued trapping and killing of marine life by discarded fishing nets floating at sea.

Ghost Nets
A commercial fishing net that has been abandoned and then accidentally entangles marine life.

Hedonic Pricing
A method used to estimate economic values for ecosystem or environmental services that directly affect market prices.

Mandatory Design Requirement
Prescription of the requirements for the construction, design and labelling requirements particular products.

Microbeads
Microbeads are tiny plastic microspheres added to a range of products as a gentle abrasive in personal care (exfoliants, body washes toothpaste, etc.) and household cleaning (detergents, waxes, and polishes) and are also used in health science research, microscopy techniques, fluid visualization and fluid flow analysis, and process troubleshooting.

Microplastics
Fragmented pieces of plastic that can be as small as 0.004μm(100nm) and as large as 5mm in diameter.

Nanoplastics
A plastic particle < 100mm

Natural Capital
Natural capital is the term used to describe the renewable and non-renewable natural resources that companies rely on to produce goods and deliver services.

Nurdles
Nurdles are pre-production microplastic pellets that are moulds for the particular product)y are melted into the

Oxo-degradable
Containing a pro-oxidant that induces degradation under favourable conditions. Complete breakdown of the polymers and biodegradation still have to be proven.

Persistent Organic Pollutants
A hazardous organic chemical compound that is resistant to biodegradation and thus remains in the environment for a long period of time.

The Precautionary Principle
The theory that if the effects of a product or action are unknown, then the product should not be used, or the action should not be taken. Also, used to describe a strategy to cope with possible risks where scientific understanding is incomplete.

Primary Microplastics
Tiny pieces of manufactured plastics. For example, microbeads, and nurdles.

Secondary Microplastics
Tiny plastic pieces that are derived from the breakup of larger plastic debris. For example, plastic bags, and bottles.

Shredder Floc
Residual mixed plastics and metal components that are too contaminated for recycling during complex disassembly (cars, white goods, air conditioners, electronics, etc.).

Softeners
Any admixture to a substance for promoting or increasing its softness, smoothness or plasticity.

Sorption
The process in which one substance takes up or holds another; adsorption or absorption.

Synthetic Fibres
Any of various man-made textile fibres including usually those made from natural materials (such as rayon and acetate from cellulose or regenerated protein fibres from zein or casein) as well as fully synthetic fibres (such as nylon or acrylic fibres).

16. Appendix E: References

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