Senate Inquiry: The threat of marine plastic pollution in Australia

SUBMISSION TO:
Committee Secretary
Senate Standing Committees on Environment and Communications
PO Box 6100
Parliament House
Canberra ACT 2600

A Manta Ray and Green Sea Turtle in their 'natural environment' off the coast of Oahu Hawaii PHOTOGRAPH BY JOHN JOHNSON, ONEBREATHPHOTO.COM

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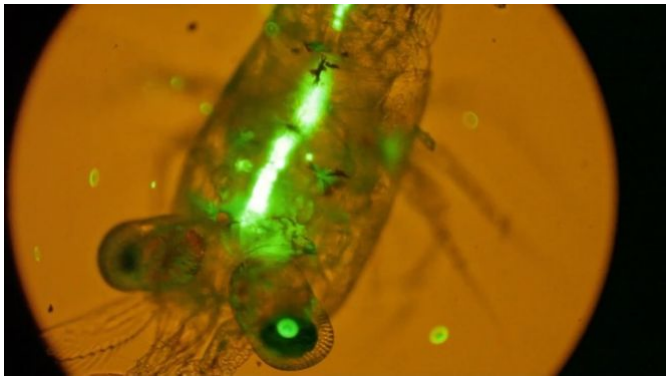
1. Introduction: The threat of marine plastic pollution in Australia and Australian waters:

"There are plastics in your toaster, in the blender and the clock, in the lamp and in the roaster, on the door and in the lock, in the washer and the dryer and the garden tools you lend, in your music amplifier and electric fryer—you have got a plastic friend!"
DuPont: "The Wonderful World of Chemistry" at the 1964 New York World's Fair

In 1964 these words were meant to excite consumers about the new material that would make their life so much easier – 50 years on and we are now understanding how true they were – plastic is everywhere but it certainly isn't our friend.

Plastics have become so pervasive within modern life that in many instances we don't even recognises the goods we use are 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) remains unquantified and is commonly unidentified as a threat in government studies and policy.

Using CSIRO estimates we believe there are around 124.23million pieces of plastic litter along the Australian coastline (3,461 per klm of coastline) and some 34.9billion pieces of microplastics floating in Australia's sovereign waters (our economic exclusion zone less our Antarctic waters).



A Planktonic Copepod ingesting fluorescent nanoplastics

Plastic generates solid waste pollution in every step its lifecycle: manufacture, distribution, use and disposal. Over time this material will be exposed to weather, be abraded, break into smaller pieces and while eventually too small to readily see will persist in our environment as a microplastic (100nm[1] - <5mm diameter) or nanoplastic (less than <100 nm). While there has been much publicity regarding microplastics, nanoscale sized particles are a largely ignored aspect of plastic pollution that represents a major threat as they are of a scale where they can be directly ingested by plankton and consequently are digestible by 97-98% of the food chain – an issue with real consequences for our health and fisheries industry. Professor Tamara Galloway of Exeter University, quotes research estimating that anyone consuming an average amount of seafood would ingest about 11,000 plastic particles a year[2].

Microplastic and Nanoplastic:

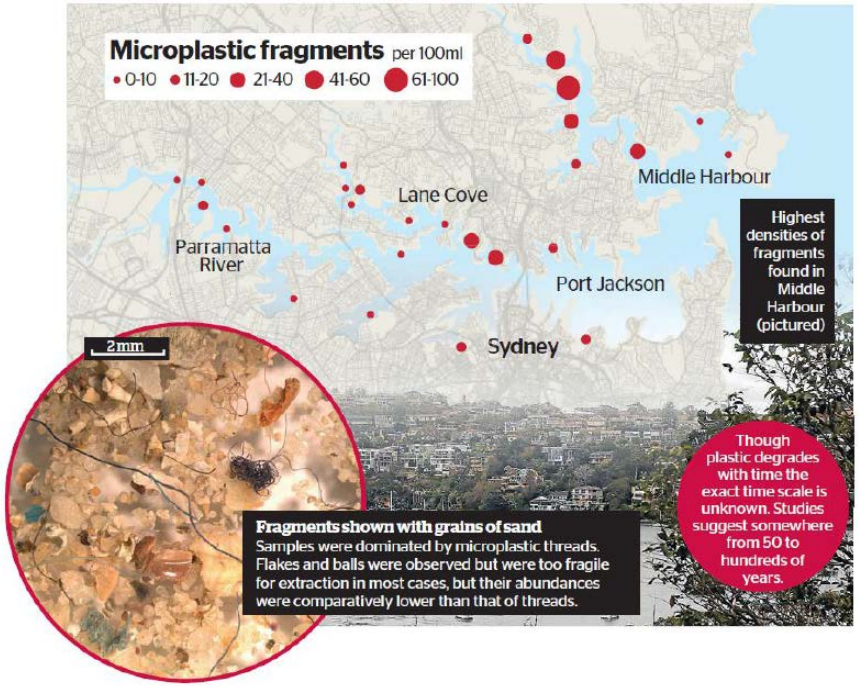
Microplastics are tiny plastic fragments, fibres and granules of less than 5mm in size. The major sources of microplastics include:

- General plastic packaging (e.g. bottles and bags) and products that have been torn or broken down into small pieces of material

[1] nm = nanometre. There are 1,000 nm to a micron and 1million nm to a millmetre. As an example of scale a single human hair is approx. 75,000nm in diameter
[2] http://www.bbc.com/news/science-environment-34414710

- 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

While exact estimates of the amount of microplastics entering our environment are unknown, in 2014, researchers from the Sydney Institute of Marine Science found "alarming" levels of microplastic pollution in Sydney Harbour. Sediment samples taken at 27 sites across the Harbour found concentrations of microplastics ranged from 0-10 to a high of 61-100 particles per 100ml of sediment in Middle Harbour (see left).



Nanoplastics are even smaller particles of plastic pollution. The generation of nanoscale particles is undisputed, but due to the difficulty identifying microscopic sized materials in our oceans has been largely unquantified. Nearly all plastic marine debris will continue to degrade and abrade until they, eventually, reach a nano scale size. However there are a number of key areas where pollution is at a nanoscale at the point they are initially released and these include the synthetic rubber dust released from tyres during their normal use; the release of synthetic fibres during household laundry and cleaning and the release of plastic dust particles during the use and maintenance of plastic products like exterior paint, plastic coatings. Boomerang Alliance believes there is at least 32,000 tonnes of nano scale particles are released in Australia each year – all of which has the potential to reach our marine environment.

Like all plastics, micro and nano scale plastics have significant potential to act as a toxic sponge – sucking up persistent organic pollutants and heavy metals to become a major vector for distributing toxic materials across the environment and importantly into our food chain. Micro and nanoplastics are seen to be a more direct threat than plastics generally as they are readily mistaken for zooplankton and other sources of marine food.

Critically, public policy should be focussed on the original and primary source of marine plastic pollution; yet it is critical to recognise that the policy responses should be focussed primarily on plastic products and packaging and its supply and disposal chains – not on the consequent microplastic by-products.

Two areas where action specific to microplastics (rather than plastics generally) are required are microbeads and nurdles.

While the true extent of marine plastic pollution continues to be better understood there is still a poor understanding of the overall problem. It is becoming increasing apparent that:

- While aspects of plastic pollution in the marine environment are now well understood (i.e. coastal litter, floating plastic debris in the oceans and ghost nets (abandoned and lost fishing gear); there are key aspects of marine plastic pollution still largely unquantified (i.e. nanoplastic fibres and particles, plastic pollution buried in the seabed, the levels of microbeads and nurdles released into our waterways).
- While a global issue, the problem of marine plastic pollution is local – CSIRO and many scientists and NGOs unanimously agree that the overwhelming majority of plastic found along our oceans and coastline was produced domestically.
- The extent and distribution of microplastics in the world's oceans has seen the ingestion of plastic rubbish become one of the primary threats to marine conservation. In the last week, CSIRO has upgraded its estimates to now indicate that they expect that up to 90% of all seabirds have already ingested plastics and that the growth rate of plastic production indicates the problem doubles every 11 years.
- That inaction on marine plastic pollution across all tiers of Australian government has resulted in inadequate policy responses largely driven by badly underestimated estimates of the problem and sensitivity to industry lobbies.
- Government seems reluctant to tackle the primary cause of marine plastic pollution – the terrestrial generation of rubbish that migrates into Australian (and in turn international) waters. Instead they place more emphasis on important but secondary marine debris issues: the generation of rubbish from the maritime industry; entanglement; and the migration of international plastic pollution into our domain.
- The high levels of plastic, and the now well documented potential for plastics to act as a vector for heavy metals and toxic chemicals to enter the food chain, found in the gut of seabirds, means there is a significant threat for the contamination of our fisheries and aquaculture. This presents substantial risks with consuming our seafood and the viability of our maritime industry.

Marine plastic debris now ranks as one of the top tier challenges to government Our submission aims to provide a scan across the scope of marine plastics pollution and to provide more detailed commentary regarding the extent of rubbish entering our waters and, of course, the most practical solutions.

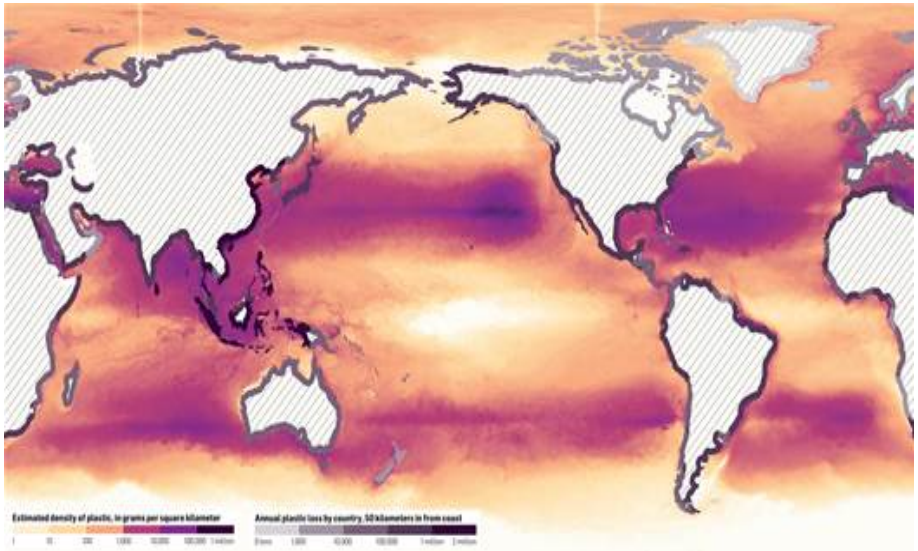
2. The extent of plastics in the marine environment.

2.1 Summary of the Global Situation: In February this year, 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"[3].

In particular the study provides a vital indicator to better understand the likely level of marine plastic pollution being the equivalent to 1.7-4.6% of the total plastic waste produced / consumed within 50klms 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. This plastic debris results in an estimated $13 billion a year in losses from damage to marine ecosystems, including financial losses to fisheries and tourism as well as time spent cleaning beaches.[4]

The graphic to the right depicts the concentrations of plastic found in the world's oceans[5]:



2.2 Australia: The Australian government estimates 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 (see next chapter) - the most recent National Waste Report estimated that the total plastics waste for 2011 indicates that Australia is a major consumer of plastics – estimating that there was 2.188million tonnes of plastic waste generated in Australia[6]. The Annual National Plastics Recycling Surveys undertaken for PACIA and the

[3] "Plastic waste inputs from land into the ocean." Science 13 February 2015
[4] "Global Plastic Production Rises, Recycling Lags" Worldwatch Institute January 2015
[5] Chelsea Rochman, Aquatic Health Program, University of California
[6] National Waste Report Waste Generation and Resource Recovery Data Workbooks

Australian Packaging Covenant are restricted to plastics manufacturing in Australia are well quantified but the amount of plastic manufactured locally is dwarfed by imports of finished plastic goods, plastic packaging imported on other finished goods and plastic sheet and fabrics imported which have not been estimated at all. The Annual Plastics Survey puts plastics consumption at just 1.53million tonnes p.a.

The rate of plastic consumption growth outlined via National Waste Reporting indicates consumption from 2008 (1.71million tonnes) and 2011 establishes an apparent plastic consumption growth rate of 9.3% P.A. This rate of growth is consistent with other estimates, for example Dr Chris Wilcox of CSIRO has reported that the amount of plastic produced doubles every 11 years (equates to 9.09% p.a.). Conversely the Annual Plastics Surveys conducted for PACIA and the APC reports indicate an average annual growth rate of 0.4% which is more indicative of the movement of goods consumed in Australia from local manufacture rather than including imports from Asia .

To identify the extent to which reporting on plastics consumption in Australia may be understated the writer made 2 simple comparisons:

1. Consumption Per Capita with 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)[7]. At 130kgs per capita the level of plastics consumption in Australia would be approx. 3million tonnes P.A.
2. If Australia's share of global GDP (1.04%) reflects our proportion of global consumption in plastic (as it does in most commodities) Australian plastic consumption is 3.11million tonnes p.a.

2.3 Revising Plastic Consumption In Australia: In an effort to better understand Australian plastic consumption, plastic waste generation and the likely levels of marine plastic pollution, Boomerang Alliance has tried to identify the total plastics generated in Australia annually. This is not a simple exercise and is not meant to portray an empiric assessment. Rather it is an effort to identify the aspects of plastics that are not well understood and 'put a stick in the sand' to describe the situation at a high level.

Please note that Boomerang Alliance in no way asserts that these figures are exact, rather it is our best effort to provide ball park estimates based on solid data and international experience. To arrive at a complete picture we used the domestic manufacturing data (turning polymers into products) and then added in estimates of plastics imported (plastics imports not assessed in Australian studies include: complete plastic products imported into Australia (e.g. homewares, furnishings, housewares, pipe); the primary and tertiary packaging on finished goods (e.g. polystyrene on manufactured goods to PET on high end mineral waters); plastics as a component of sophisticated equipment and machinery (e.g. motor vehicles, white goods and electronics) and finally plastic sheet and fabrics imported to finish products locally (e.g. synthetic textiles for the fashion industry) , by using Australian customs and trade data along with industry intelligence.

[7] ANZ Bank "Insights: Global Plastics Industry Market Update" 2008

We identified nearly 3billion tonnes of plastic is consumed in Australia each year. The table to the right breaks down this estimate.

The next critical question is what plastics are likely to end their life in our waterways? Theoretically, the answer is all of them – at every stage of its 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 our marine environment

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

Estimates of Annual Plastic Consumption in Australia	Tonnes P.A.	% of all Plastic
Australian Made Plastic Products[8]	1,008,200	34.08%
Australian Made Plastic Packaging [19]	527,000	17.81%
Plastics Packaging Imported with finished goods[10]	313,000	10.58%
Imported Synthetic Textiles, Fabrics and Carpets[11]	300,000	10.14%
Imported Plastic Products (houseware, furniture, pipes etc.)[12]	290,000	9.80%
Plastics Component of Shredder Floc[13]	266,000	8.99%
Plastic component of tyres[14]	145,350	4.91%
Clean Plastic in machinery (cars, electronics, white goods)[15]	65,000	2.20%
Imported Plastic Bags[16]	21,000	0.71%
Plastic Maritime Waste[17]	10,000	0.34%
Cigarette Butts[18]	7,000	0.24%
Microbeads (all applications)[19]	650	0.03%
Total:	**2,953,200**	**100.00%**

[8] Sourced from the 2013-14 Annual Plastics Recycling Survey
[9] As Above
[10] See http://www.smh.com.au/environment/australian-packaging-industry-falling-short-of-recycling-goal-may-cut-target-20150702-gi39h0
[11] Extrapolated from figures in the 2014 National Waste report and NSW EPA audits of C&I and C&D waste and recycling
[12] Estimated from Australians Customs and ABS data
[13] Calculated from "*End-of-Life Domestic Refrigeration and Air Conditioning Equipment in Australia*" see: https://www.environment.gov.au/protection/national-waste-policy/publications/end-of-life-domestic-rac-equipment-australia
[14] Total tyres based on Hyder End of Life Tyre 2015 Study. Plastic proportion based on Tyre Life BA 2015.
[15] Estimate based on Aust Government Product Stewardship RIS studies
[16] Hyder Consulting Plastic Retail Carry Bag Use 2008
[17] Extrapolated from the 1996 ANZECC Review of marine Debris
[18] Tobacco Institute of Australia
[19] Extrapolated from Norwegian Study "Sources of Microplastic Pollution" 2014

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 PA
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	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[20]	3,5-5,500 Tonnes P.A.
Plastic Products (1MtPA domestic) (290KtPA imported)	Very High: 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	Low	High: 1.5% of production p.a.	Low	5-7,000 Tonnes P.A.

[20] 4.5trillion of the 5.6trillion cigarettes consumed enter the litter stream: "Cigarettes Butts and the Case for an Environmental Policy on Hazardous Cigarette Waste" International Journal of Environmental Research and Public Health May 2009

(300KtPA imported)		• Plastic fibres from household laundry and floor cleaning	• Beachwear is often lost at beaches etc. but is a very small part of the litter stream	
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	150-200 Tonnes PA.
Maritime Industry Waste (10KtPA)	Low	High: • 2,400 TPA of nets lost during operations	High: • 7,600 TPA of plastic waste dumped	10,000 Tonnes PA
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 PA of waste and litter.**	**99-130,000 Tonnes P.A.**

It is important to note that an estimated 99-130,000 tonnes of potential marine plastic pollution is much higher than other estimates – however, Boomerang Alliance could find no Australian studies which identified nano plastic pollution sources (fibres, tyre road dust etc.), nor did any include total estimates for cigarette butts, microbeads and nurdles which represent around a quarter of the total.

The second aspect of marine plastic pollution that remains unquantified by other studies is the amount of material at the bottom of our waterways as opposed to floating material – The World Ocean Review 2010 notes that "70% of litter eventually sinks to the sea floor".

Further, the primary source for previous estimates based on ocean trawls and coastal 'litter' surveys which, in effect, reflect the amount of marine plastic pollution nett of recovery / abatement efforts. Reflecting the extent of an existing problem without reflecting pollution control efforts (and their costs) has the potential to lead to poor policy decisions.

2.4 Abatement: A short note on the idea that we can recover plastic pollution after it has entered the environment – to all practical purposes we can't! The costs to trap all stormwater, have all public places with convenient / effective rubbish bins and to have the necessary filtration systems to screen micro plastics is astronomical.

2.5 Threat Characteristics: Having identified the scale of potential marine plastic pollution, Boomerang Alliance next sought to describe the risks factors presented by different plastic polymers / sources and the difficulties in capturing different types of plastic pollution (either at the source or downstream).

Some plastic pollution presents greater risks to the marine environment and biodiversity than others. Key considerations for this include:

Size: The smaller the particles of plastic the more likely they are to be ingested immediately. At the nano scale (fibres, dusts, microbeads) the pollution is at a scale where it can be ingested by as much as 98% of marine biodiversity.

Shape: The shape and construction of different plastic items can also increase its impact on biodiversity. Plastic bags resemble jellyfish in our oceans and as a result, turtles often ingest bags. Ghost Nets (lost fishing nets and equipment) present a significant entanglement threat to marine species.

Toxicity: While all plastics have some toxic issues, particular polymers are more toxic (PVC, Polystyrene, Polycarbonate, Synthetic Rubber).

Contamination: Plastics are a particular threat because of their ability to absorb toxics and other contaminants. A number of polymers are noted as being more absorbent than others (HDPE and LDPE). Similarly the source of plastic pollution can often mean the material is heavily contaminated when it enters the marine environment (plastic lost from waste facilities, plastics found in complex equipment, used cigarette butts).

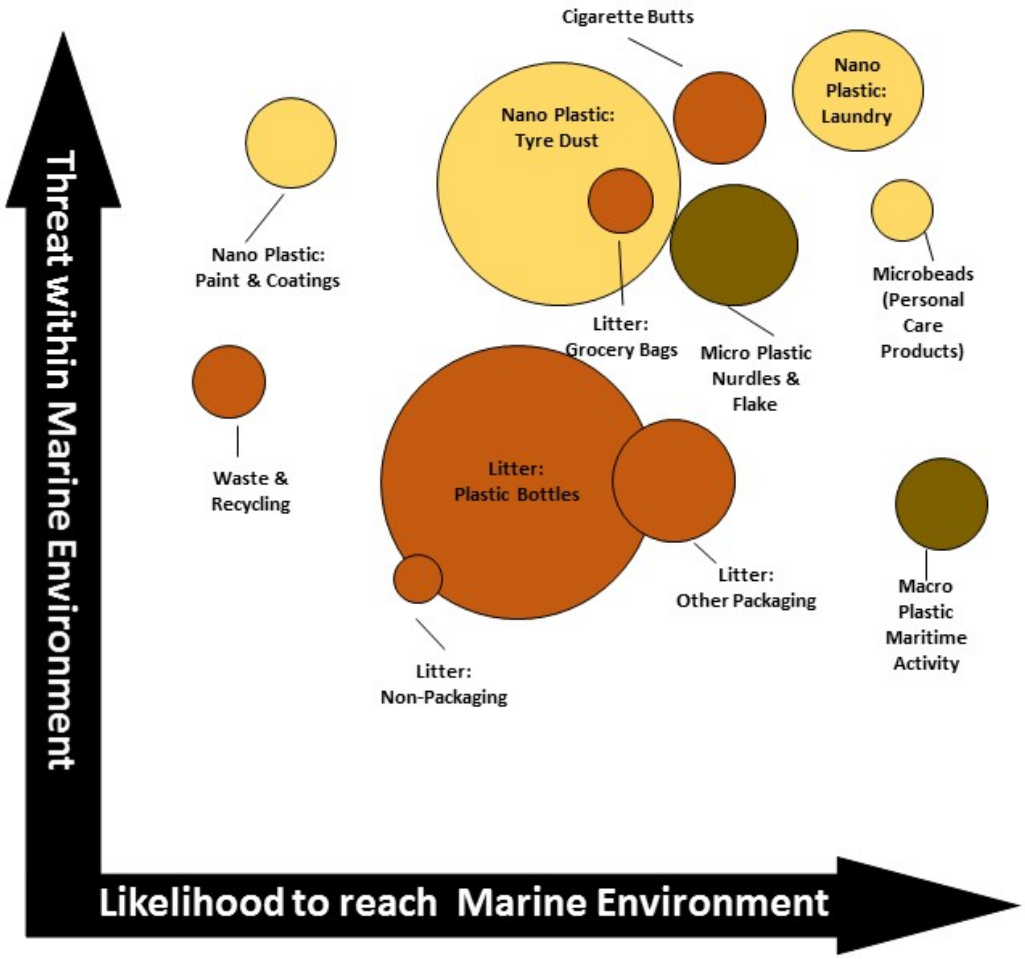
2.6 Likelihood to enter the Marine Environment: Finally, we looked at the likelihood of different sources being captured by existing policy strategies and abatement approaches. Factors considered in this assessment included:

Size: Whether traps, filters etc are able to capture the source of plastic pollution – all sources that are at a micro or nano size during use are unable to be trapped.

Location: The place that plastic pollution is generated will directly affect the likelihood that the pollution enters our waterways (maritime plastics obviously all enter our oceans, beverage containers are often consumed in and around recreational waterways most microbeads are consumed during washing processes and directly access the marine environment via sewer systems).

Mobility: Very light weight plastics are often caught by the wind and reach the marine environment quickly (plastic bags, dusts and fibres) or are particularly buoyant and rapidly pass through the stormwater system (plastic bottles, polystyrene foams, LDPE, HDPE PP).

The bubble chart to the right provides a visible representation of the threats of different plastics. The bigger the bubble the larger the pollution source, the higher the bubble is positioned the greater the threat and the further to the right the greater the likelihood the material will enter the marine environment. In the next section, we discuss the threats in greater detail.



4. Major Threats

In this section we have tried to describe the issues with specific plastics and their lifecycle stages that most impact the marine environment.

4.1 Plastics Manufacturing & Distribution:

Nurdles are pre-production microplastic pellets (and flake) that are used to make plastic products. Nurdles, typically enter the environment by escaping the boundaries of the plastic extruder or recycler factories, and are washed into waterways via the nearest stormwater drain, or are lost during transport. This is an offence in every state in Australia - however it has not come to the attention of regulators and may be seen as difficult to enforce.[21]

Many reasons exist to explain the abundance of pellets in the environment, including unsound practices within factories with regard to cleaning spill-over, but more important is perhaps the lack of mitigation methods that are designed to prevent such incursion to the environment from the factory floor. Factories hose their buildings and workshop floors down at night, resulting in pellets washing into drains — a documented practice at several major factories in our cities.

There is no filter on surrounding stormwater drains, so once they are in gutters or drainage areas, they are washed into stormwater outlets easily, resulting in entry to the river systems. Further, when transporting the resin pellets, hopper cars and trucks are not required to have lids on containers of pellets.

Little is being done to eliminate this threat; despite the fact that it is already an offence in every Australian jurisdiction to allow the discharge of pollutants from their site into the stormwater system.

Over several years, Tangaroa Blue carried out a number of studies concerning the prevalence of nurdles along our beaches and coasts. It undertook sampling across 41 broad geographical locations including river systems in Brisbane, Sydney, Melbourne, Perth and Adelaide and found concentrations as high as 6,000 nurdles per square metre of beach.[22]

4.2 Pollution Generated During the Use of Plastic Products

Microbeads are are polyethylene (but can be also be made of polypropylene (PP), polyethylene terephthalate (PET), polymethyl methacrylate (PMMA) and nylon) microspheres that are widely used in cosmetics as exfoliating agents, personal care products (e.g. toothpaste and nail polish),

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[21] Queensland's Plastic Pollution Crisis: Container Deposit & Other Solutions (June 2015) The Boomerang Alliance, p13. https://d3n8a8pro7vhmx.cloudfront.net/boomerangalliance/pages/65/attachments/original/1434695777/CDSOLUTIONS_QLD.pdf?1434695777

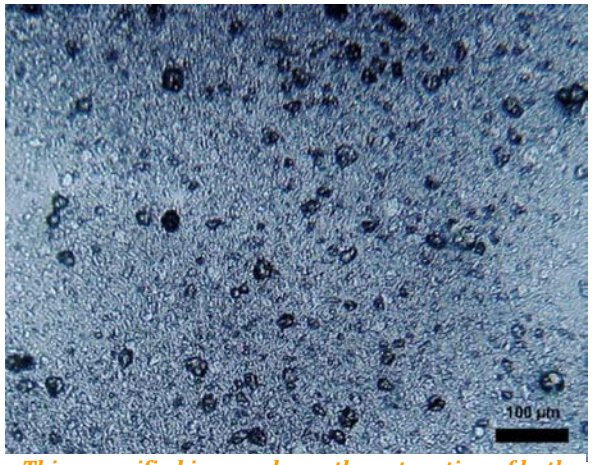
[22] A Review of Plastic Resin Pellet Distribution Throughout Australia and Mitigation Methods for Reducing Spill-Over into the Marine Environment (August 2013) Tangaroa Blue Foundation; Plastic Resin Pellets Information (September 2012) Tangaroa Blue Foundation, http://www.tangaroablue.org/resources/reports/category/13-plastic-resin-pellet-information.html

laundry detergents as well as biomedical and health science research, microscopy techniques, fluid visualization and fluid flow analysis, and process troubleshooting.

Microbeads are commercially available in particle sizes from 10 µm to 1000 µm (1mm). Low melting temperature and fast phase transitions make this material especially suitable for creating porous structures in ceramics and other materials.

Although useful, microbeads pose an environmental hazard when disposed of in waste water, as they pass through sewage treatment plants without being filtered out. Their use and disposal create plastic particle pollution of our waterways, coastline and oceans.

Reports have shown that even if using sophisticated (and expensive) processes for settling solids in sewage that may remove up to 99% of microbeads from the final effluent that is pumped into our waterways, these processes would still create a major source of pollution. For example, if just 1% of microbeads escape capture in the sewerage treatment plants across the San Francisco Bay area, some 471 million microbeads would be released every single day. Screening systems in Australian sewer capture very few microbeads.



This magnified image shows the saturation of both microplastic and nanoplastic material found in toothpaste. The larger 'dots' are a microbead size, the smaller nanoplastic sized.

While the extent of the problem in Australia remains unknown, a single tube of deep facial cleanser[23] can contain 350,000 microbeads, demonstrating that the level of microbead pollution is substantial. Microbeads can play a constructive and vital aspect of many products, but justification for the use and necessity of microbeads in consumer goods is problematic.

The use of microbeads should be banned in cosmetics, personal care products, laundry detergents and cleaning products and paint.

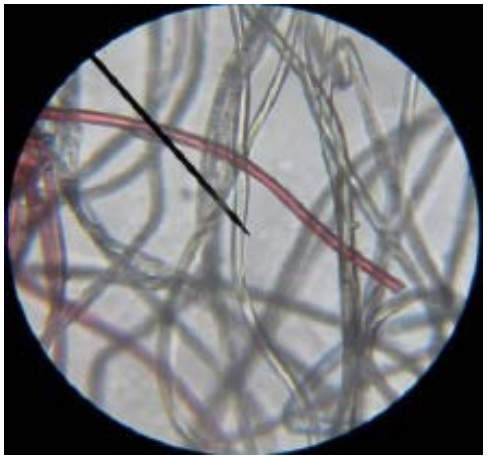
Nanoplastics and Synthetic Dusts:

It has often been suggested that plastic particles in the <100nm size range (nanoplastics) may be entering the marine environment in significant volumes. As a general principle the smaller an item the greater its threat to both human health and biodiversity as it more readily enters the bloodstream.

The amount of nanoparticles entering the environment, and specifically the marine environment is probably the least quantified area of study. However, the range of activities which use synthetic materials, the known volumes of synthetic dusts created in sectors that have been studied (e.g. tyre dust) and the ease with which they can access the marine environment indicates they are a very significant component.

[23] U.S. NGO "Sum of Us" estimate that Neutrogena's "Deep Clean" facial cleanser contains over 350,000 microbeads in each tube alone

The only study that has sought to consider nanoplastic fibres and synthetic dusts (which are more correctly grouped at the nano rather than micro size) in any detail is the Norwegian study (Sources of Microplastic Pollution in the Marine Environment) which has been included as an appendix for reference purposes.



A magnified image of nano sized plastic fibres generated from clothes washing

The largest source of nanoplastic sized emissions is thought to be abrasion from tyres and brake pads, -a accounting for about 10-20% of all plastic pollution and is an aspect that can be readily quantified based on previous studies around the impact of these dusts on air borne health issues like Asthma. As a simple calculation it is thought that around 9kgs of these dusts are produced per 25,000 klms travelled. Based on our road use this equates to over 20,000 tonnes of vehicle nanoplastic generation annually.

While there is far less certainty the second largest category of nanoplastic generation is thought to be dust and particles from plastic based paint and coatings when applied, weathered or maintained both on buildings, structures, ships and yachts. This category could represent as much as 5% of all plastic pollution.

The following are a number of examples (from Norway) of how plastic coatings and paint generate plastic pollution in the marine environment:

Example 1: A road bridge crossing the water. The total surface area of the bridge covered with paint *is 11,000 m^2 . Assuming a 2 mm thick layer of paint, a total of 22,000 litres of paint solids would have been added to the bridge surface. It was presumably dumped in the fjord during renovation and sandblasting some ten years ago, because the seabed locally below the bridge is very contaminated by PCB, a usual content and hence tracer of old paints used on metal construction. If polymer binder is 50% of this solid content, and at a specific gravity of 1.2, about 13 tonnes of particulate polymer, would have been emitted. In this case the paint was presumably chlorinated rubber with PCB as a plasticiser.*

Example 2: Oil drill unit maintained while on sea. A total renovation of the above waterline painted surfaces was done while the 250 meter long vessel was staying on the water, dockside. All removed paint was spilled; nothing collected or declared as hazardous waste. Assuming a blasted surface area of 2,000m^2 (patchy removal only), and applied 8,000ltr of new topcoat with 30% of this spilled, about 2 tonnes of polymer particles in the paint, much of it in micrometre range, would have been emitted. In this case the new topcoat contained polysiloxanes.

Example 3: Power station renovations. Renovations and sandblasting of old hydropower stations and hydropower water pipelines have emitted large amount of sandblasting media contaminated with the removed paint in the terrain many places in Norway. As the hydropower stations are often located near waterways, there is potential for direct spill to rivers and the sea. In a particular case the coating contained PCBs, and paint particles were flushed into the fjord where cod ate it and got heavily contaminated. Paint particles were found inside the cod stomachs.

Of significant (but largely unquantified) interest is the volumes of fibres potentially entering our environment which are generated through washing synthetic fabrics and home cleaning. The Norwegian study considered that the potential order of magnitude when compared to microbead production was thought to be of a significantly higher than estimates of microbeads emitted from personal care products.

A UK study in 2011 sought to quantify the extent of clothes washing as source of plastic pollution found that some 200 nano plastic fibres are produced per litre of laundry effluent[24] - using this emissions factor there are around 4,500 tonnes of plastic fibres released each year in Australia.

4.3 Potential Marine plastic Pollution at the End of Product Life

Litter: Litter is the greatest source of visible plastic in the marine environment (around 75% of the total litter stream[25]), with the CSIRO's recent research into marine debris formalising the fact that "most (marine debris) is from Australian sources, not the high seas, with debris concentrated near cities".

A short summary of some of the research by our key partners and allies is as follows:

1. **Clean up Australia**

Clean Up Australia has led the debate and action on litter and marine pollution in Australia for over 25 years. Its founder and Executive Chairman, Ian Kiernan AO, efforts are well known – he is both a past Australian of the Year and is one of the 100 Australians regarded as a National Living Treasure. Over the past 25 years Clean Up Australia Day has seen Australians volunteer some 27.2million hours to recover over 288,650 tonnes of rubbish across the country. Their perspective on what makes up the rubbish stream (litter) in Australia highlights a number of relevant considerations to this inquiry:

- Plastic rubbish is the most common material volunteers recover – representing well over 30% of all materials collected.
- Over the past 5 years, beverage related rubbish (bottles, cans, lids, straws etc.) represent 36.92% of all items collected on Clean Up Australia Day (and 30.2% of all plastic).
- Over the 21 years that Clean Up Australia has been collating data from Clean Up Australia Day we have seen beverage litter growing consistently. In 2013 it reached the point where beverage rubbish replaced cigarette butts as the most common product we collect. A trend that has continued through 2014 and 2015.
- Detailed studies of the materials collected on Clean Up Australia Day in 2009 and 2010 highlighted that while plastics were significant in every type of site, the proportion of plastic materials recovered at beach and waterways was some 20% more than the amount found at other sites[26]. This highlights the strong potential for plastics to migrate into our waterways via wind and stormwater systems.

[24] See Accumulation of Microplastic on Shorelines Worldwide: Sources and Sinks. Environmental Science & Technology

[25] Britta Denise Hardesty, Senior Research Scientist for CSIRO: 'We found about three-quarters of the rubbish along the coast is plastic.' http://www.csiro.au/en/News/News-releases/2014/Plastic-on-the-coasts-is-ours

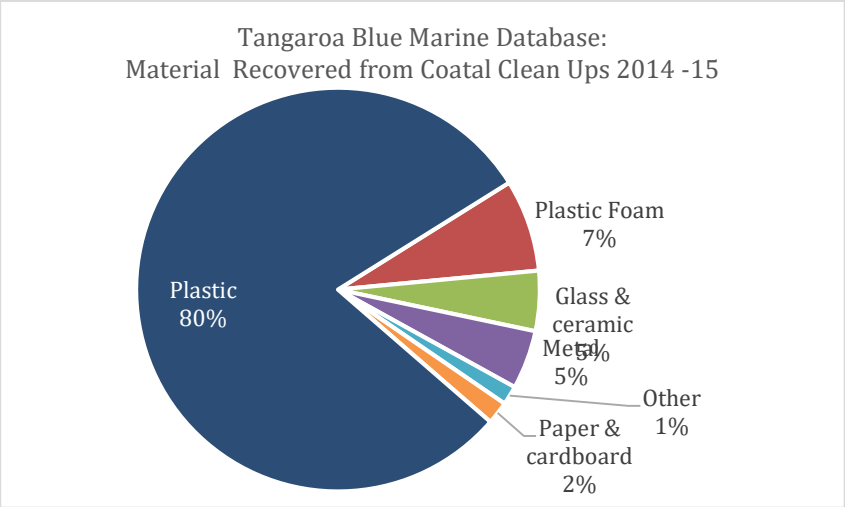
[26] NB We removed schools as a site for this analysis as they often have policies of not selling products in glass packaging and have social policies that alter the patterns of beverage consumption.

2. Tangaroa Blue

Another Boomerang Alliance partner, Tangaroa Blue are the leading organization coordinating coastal clean ups around Australia and collating information on the amount and source of the debris they recover.

Over the past 2 years, the Tangaroa Blue database has captured the efforts of some 2,200 clean ups involving over 55,000 volunteer hours and recovering some 2million pieces of coastal litter.

Like Clean Up Australia, their report highlights that the vast majority of coastal litter is plastic. The graph summarizes the main materials their volunteers recover.



3. Project AWARE

Project AWARE are a group of divers who have focussed their efforts on the bottom of the ocean. Their project '**Dive Against Debris'** is a citizen science program to specifically yield data about the types and quantities of marine debris found *underwater*.

In Australia, over 450 scuba divers have taken part in Dive Against Debris surveys at various locations across the country – removing and reporting the marine debris items encountered. With 150 million metric tons of mismanaged plastic conservatively estimated to make its way into the world's ocean by 2025, it sadly comes as no surprise that plastic items are consistently the top items encountered and removed from Australian waters – plastic items accounting for almost 60% of all items reported. The majority of these plastic items are: plastic bags, plastic bottles and fishing line.

Priority Aspects of the Plastics Litter Stream:

<u>Plastic Bottles:</u>

The single largest point of plastic litter and marine debris is beverage sector waste, with plastic bottles, along with lids, straws, cups etc. representing around half of the material (by volume) found in the litter stream and some 60% of all plastic rubbish recovered along our beaches and waterways.

Using the data outlined in the Packaging Decision Regulation Impact Statement (DRIS) released in March 2014 it is estimated that some 17.4billion bottles and cans are consumed in Australia each year – of which some 7.8billion bottles are plastic. After adjusting the DRIS figures to

reflect the understated consumption reported in July of this year[27] (which increases the number of plastic bottles consumed to 11.4billion p.a.) the recovery and recycling of plastic bottles is a poor 37% - meaning some 7.3billion plastic bottles are littered or landfilled each year.

Any effort to restrict plastic marine pollution is doomed to failure without strong and decisive steps to address bottles and cans. CSIRO Marine Scientist Dr Brita Denise Hardesty summarises the rationale for this simply:

"The waste associated with the beverage industry comprises a third and in some estimates a half of the marine debris we find globally".

When asked whether any jurisdictions were earning a 'gold star' in tackling marine debris, Dr Hardesty said "… we do not find full plastic bottles, or cans in South Australia. I would likely attribute that to the container deposit scheme that they have."[28]

The most common polymers used by the beverage sector are PET (soft drinks, water, milk sports and energy drinks), HDPE (milk, flavoured milk, juice, lids) and LDPE (Liquid Paper Board Cartons, Tetrapack). HDPE and LDPE absorb much greater concentrations of contaminants than other plastics like PET and absorbs contaminants for longer periods (up to 44 months) than other plastics[29].

Single use plastic bags

Research by Clean Up Australia in 2009 estimated that over 3.9billion single use plastic supermarket bags are consumed each year,[30] and the Australian Government believes that around 2% (up to 80million) of these single use bags enter the litter stream each year.

This number is likely to be understated because:

- Like other plastic packaging there is significant importation not captured by existing data as it is often imported in smaller quantities via convenience retailers or consigned in a mixed shipment of various goods and supplies.
- A common source of plastic bag litter are bags captured via the waste and recycling stream, but then escape processing facilities and landfills.
- In 2009 the Sydney Morning Herald claimed that plastic bag usage could be 30% greater than reported, information sourced from confidential industry data.[31]

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[27] http://www.smh.com.au/environment/australian-packaging-industry-falling-short-of-recycling-goal-may-cut-target-20150702-gi39h0. & 'The Australian Packaging Covenant's Recycling Black Hole', Jeff Angel (Boomerang Alliance) 06/15. http://www.boomerangalliance.org.au/apc_recycling_black_hole

[28] "Plastic Oceans", ABC: Catalyst, 09/12. http://www.abc.net.au/catalyst/stories/3583576.htm

[29] "Long-Term Field Measurement of Sorption of Organic Contaminants to 5 Types of Plastic Pellets: Implications for Marine Debris"

[30] Plastic Bags Fact Sheet: Say NO to Plastic Bags, Clean Up Australia (July 2009) http://www.cleanup.org.au/PDF/au/cua_plastic_bags_fact_sheet.pdf; "The Facts on Plastic Bags", Boomerang Alliance, 08/15. http://www.boomerangalliance.org.au/the_facts_on_plastic_bags

[31] "The Facts on Plastic Bags", Boomerang Alliance, 08/15. http://www.boomerangalliance.org.au/the_facts_on_plastic_bags

By factoring these considerations it is reasonable to expect that consumption is over 5 billion single use plastic carry bags a year and the amount of plastic bags entering the litter stream each year is likely to be as high as 150million bags p.a. (3-4%).

While (even with the adjusted estimated above) single use bags do not represent a major part of the plastics consumed in Australia each year, plastic bags should be a priority for government action on marine debris because:

1. The lightweight nature of disposable plastic bags indicate they quickly migrate into the environment after use.
2. Plastic bags resemble jellyfish in the marine environment and consequently are one of the most commonly consumed sources of plastics.
3. Turtles, in particular, target jellyfish as a primary food source; and at least 6 species of sea turtles are listed a threatened species under the *Environmental Protection and Biodiversity Conservation Act 1999*.
4. The soft films that plastic bags are made from also present a significant risk (known as bubble butt) where the digestive system of marine species (particularly turtles) becomes blocked - trapping the gases produced by digestion and inhibiting their ability to dive for food[32].
5. HDPE and LDPE are 2 common polymers used for plastic shopping bags. These polymers absorb much greater concentrations of contaminants than other plastics like PET and absorbs contaminants for longer periods (up to 44 months) than other plastics[33].

Landfill, Transfer Stations and Recycling

There are substantial issues associated with the waste management industry and potential marine plastic pollution – during destruction many products will produce microscopic fibres that when broken up in an outdoor environment are likely to see thousands of fibres released into the environment to eventually reach a waterway. Examples include:

- Around 20% of a mattress is made up of synthetic and natural fibres and foams and some 1.6million mattresses re disposed of each year. Only 1 facility (The Ideas Company) disassembles mattresses with a system to contain dust and fibres. At just 1% loss of fibres the potential marine plastic pollution threat represents over 1,000 tonnes p.a. A similar level of nanoplastic fibre release is evident across the hard waste stream.
- When tyres are shredded or crumbed in a facility without dust capture (less than 10% of facilities have dust capture systems) they generate significant synthetic rubber dust. We estimate that some 1,500 tonnes of this highly toxic material escapes Australian facilities each year.

Further, at active landfills, air drift is a key challenge. Air drift is defined as plastics taken by the wind to the nearby environment. Even though the landfills have tried to reduce the problem and have made some clean ups, plastic waste around landfills and also former landfills can be

[32] http://ecowatch.com/2013/08/06/the-danger-of-plastic-bags-to-marine-life/
[33] "Long-Term Field Measurement of Sorption of Organic Contaminants to 5 Types of Plastic Pellets: Implications for Marine Debris"

regarded as a source for microplastics the light weight nature of plastics means that they are often caught by wind (or washed off site during rain).

Plastic bags are a well-known example of this, with government studies identifying that some 20-30million bags escape waste facilities each year[34].

Other plastics that are identified as escaping waste facilities include: polystyrene and other plastic foams and plastic films.

The Norwegian Study "Sources of microplastic pollution in the marine environment" suggests that several plastic types can be degraded and abraded more rapidly and to a larger extent in landfills than earlier believed. Total leachate volume from 88 Norwegian landfills in 2007 was reported as 9,100,000 M^3/year.

Shredder Floc: The disassembly and shredding of complex equipment such as motor vehicles, e-waste, white goods creates large amounts of waste known as 'shredder floc' a mixed and heavily contaminated material that is thought to be around 38% plastic: For example shredded car dashboards, stuffing from car seats and insulation from fridges and freezers. These residuals have no market for recycling. Dust emissions to air reported for 5 sites in the European WEE (e-waste) emissions database and have varied between 2, 5 and 8 tonnes per year over a 10 years period. This dust is primarily particulate from coatings as well as plastic foams and plastic articles within this waste (that is, microplastics). These dusts can be contaminated with heavy metals and Persistent Organic Pollutants (POP) like brominated flame retardants but are at levels where they do not need to be registered.

Around 700,000 tonnes of shredder floc is produced in Australia annually – at 38% the plastics component represents some 266,000 tonnes of highly toxic plastic pollution.

Maritime Industry Waste and Dumping: Derelict fishing gear – known as "ghost nets" – poses a particular threat to marine wildlife. These are nets which have torn away and been lost during fishing activities, or old and damaged nets that have been deliberately discarded overboard. The nets can remain adrift in the sea and continue to function for years. They pose a threat to fish, turtles, dolphins and other creatures, which can become trapped in the nets and die. The tangled mass then snags other nets, fishing lines and debris, so that over time, the ghost nets become "rafts", which can grow to hundreds of metres in diameter. Some of these nets sink to the sea floor, where they can cause considerable environmental damage. Propelled by currents, they can tear up corals and damage other habitats such as sponge reefs.

CSIRO has estimated that each year around 640,000 tonnes of fishing gear is lost or thrown overboard by the fisheries around the world. These "ghostnets" drift through the oceans and can continue fishing for many years. They kill huge numbers of marine mammals, sea turtles and sea birds, and cause significant loss of biodiversity. Ghostnets are a particular problem in the Gulf of Carpentaria where CSIRO has identified that ghostnets wash ashore at densities reaching up to 3 tonnes/km, which is amongst among the highest concentrations found in the world.

[34] Environment Protection and Heritage Council, Plastic Shopping Bags in Australia. National Plastic Bags Working Group Report to the National Packing Covenant Council, 6 December 2002

A 1996 ANZECC review estimated that of debris generated by marine activities and vessels across Australian waters each year[35] it found:

- around 13,800 tonnes of waste were generated aboard ships
- around 2 400 tonnes of fishing gear were lost or discarded, and
- up to 6 500 tonnes of waste per year are lost or discarded overboard.

Boomerang Alliance has arrived at an estimated 10,000 tonnes of this material that is plastic – 100% of lost fishing gear and around a third of the other waste.

Entanglement in Ghostnets n the Gulf is known to kill sharks, crocodiles, and dugongs, as well as other fish and invertebrates. But it is turtles that are most at threat. Australia is home to six of the world's seven threatened species of marine turtle. During a recent cleanup of ghostnets on beaches in the Gulf, 80% of animals recorded in nets were marine turtles, including Olive Ridley, Hawksbill, Green and Flatback turtles. Getting tangled in ghostnets is one of the most common causes of death for marine turtles in Australia.

Improved stewardship within the plastics and waste industries

Before any new policy or action is taken to address nurdles it is important to recognise that it is already an offense to dump waste down the stormwater system in every Australian jurisdiction. The only reason this problem exists is due to a poor effort to enforce regulations and inform the industry that it is expected to ensure nurdles do not migrate from their facilities or transport systems.

Further, government support and incentives to underpin a voluntary plan for improved stewardship within the plastics industry that minimises the impact of plastics extrusion and resin manufacture. This should include:

- That any plastic packaging or product has the maximum practicable recycled content;
- Embodies sustainable packaging design principles; &
- Has onsite management system to capture nurdles.

[35] Summary sourced from 2010 National Waste Report

5. Australia's regulatory environment is a primary cause of our growing problem:

Boomerang Alliance is the lead NGO on issues of waste, recycling and litter in Australia, with some 32 allies working collaboratively on better understanding the extent and impact of rubbish in Australia and developing practical and effective solutions.

Packaging and plastic waste have been a priority for the Boomerang Alliance since our formation in 2004. While we have only recently formalised a campaign on the issue of marine plastic pollution we have identified the threat of plastic and other packaging rubbish on our marine biodiversity since our inception.

A consistent and frustrating issue associated with any work on waste, litter or marine debris in Australia is government and stewardship programs to understate the problem by:

- estimating consumption levels at well below their true amounts;
- publishing untested industry data that dramatically exaggerates the recovery and recycling performance in key products and materials;
- failing to develop the knowledge and understanding of both the impacts and cost of waste related pollution and /or failing to properly quantify the benefits of recycling.

This is particularly evident in the identification of marine pollution threats of plastics during the development of product stewardship programs. We suggest the Inquiry review past Commonwealth RIS publications for: plastic bags; packaging impacts; end of life tyres; mobile phones, and e-waste – all major sources of plastic in Australia and none attempted to examine marine impacts in any detail nor do the Cost Benefit Analysis required within these processes place any cost on marine plastic pollution.

The result is a consistent pattern where any efforts to co-ordinate a national policy approach is either a complete failure or the adoption of voluntary programs where polluters receive substantial financial advantage over market leaders and other early adopters.

If this trend continues there is little hope that we will be able to address the rapidly growing problem of marine plastic pollution – after all if governments fail to identify the problem or place a cost on the pollution or underestimate it (leaving the field open for negative industry lobbying) - why would Cabinets consider taking action?

Examples:

Packaging: In the 2004, 2010 and 2015 Boomerang Alliance intervened in the reviews of the Australian Packaging Covenant to highlight that the packaging recycling sector's performance was a fiction. While our feedback was initially rejected and we were forced to expose these inadequacies in the media we have been proven right in our assertions that:

- Plastics packaging estimates of consumption and recycling were distorted by a failure to capture the amount of packaging imported via finished goods. Subsequently, earlier this year a whistle blower leaked internal documents that showed that the Covenant was aware

that plastics packaging consumption was 50% more than claimed and recycling rates for plastic packaging were in fact 29% not the 44% claimed.

- In 2010 we discovered glass recycling figures were being badly distorted by including glass that was recovered but was not of a quality to be recycled. The result showed that some 500,000 tonnes of glass had been stockpiled with no apparent market. Subsequent investigations at a state level have shown that the difference between the claimed recycling rates is dramatic. In Victoria, some 76% of glass is recovered via kerbside and other recycling streams but only 48% of this material is subsequently recycled. Using Victoria's data it became evident that around 280,000 tonnes of so called recycled glass is actually not recycled.

This practice has been evident for years and played a fundamental role in distorting cost benefit analysis undertaken to consider adopting a national container deposit scheme.

Tyres: When tyres were being considered for the adoption of a co-regulatory product stewardship, in 2009 the Australian Government rejected the Regulatory Impact Statement, declaring the problem was solved as some 76% of tyres were now being exported to Vietnam. Despite spending some 5 years 'investigating' the problem - the regulators failed to consider the devastating impacts of tyres that were being improperly stored in Australia and so badly estimated the amount of end of life tyres generated in Australia that the claimed RIS generation of waste tyres in Australia of 30million units (240,000 tonnes p.a.) in 2009 has been revised 3 times since and it is now concluded that 4 years later estimated consumption is 51 million units (433,500 tonnes p.a.).

The regulators also failed to identify the serious impacts of the (then) current practices. For example:

- The incidence of fires involving tyres has been a major issue in Australia – with NSW records alone showing that in NSW alone there have been 322 fires involving tyres between 2008 – 2013;
- That the overwhelming majority of tyres exported from Australia to Vietnam were in fact smuggled across the Chinese border; &
- That internationally one of the largest source of plastic synthetics entering our oceans is, in fact the rubber scraped off tyres as they travel across our roads. For example a study in Norway[36] demonstrates that (other than terrestrial litter) some 6,500 tonnes of synthetic rubber powders are washed from their roads into the ocean.

Plastic Bags: Despite a strong commitment from then Commonwealth Environment Minister, The Hon. Peter Garrett, a 2007 meeting of State, Territory and the Commonwealth Environment Ministers fell into acrimonious debate on how the best address the problem. The previous voluntary retailer program initiated to address the overwhelming plastic bag use in Australia ended in 2005. In the following year plastic bag use increased by 17% between 2006 and 2007.[37]

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[36] Sources of marine microplastic-pollution to the marine environment. See http://www.miljodirektoratet.no/Documents/publikasjoner/M321/M321.pdf

[37] "The Facts on Plastic Bags", Boomerang Alliance, 08/15. http://www.boomerangalliance.org.au/the_facts_on_plastic_bags. NSW Parliament 2013, 'Plastic bags: an update'

Conclusions: It is difficult to reach a conclusion that shifting product stewardship programs from a state level to a coordinated national approach has delivered any benefit. Rather it seems to have stymied progress.

It is unacceptable to the community and industry that it typically takes over 5 years for the Commonwealth to design and consider whether to develop a product stewardship program and another 5 years to implement.

Constitutional and Mutual Recognition Act provisions to protect cross border trade (which are important) have also became an issue to allowing states to quickly protect their environment – despite a succession of ministers seeing important state waste initiatives being stalled there has been no effort to develop a timely and effective process that allows states and territories to protect the environment.

Recommended Action on the Commonwealth Role in Product Stewardship:

1. Develop mechanisms that ensure cross border issues are considered but allows a timely and practical approach to dealing with their priority waste issues.
2. Review the current process for investigating national product stewardship approaches that reflect important 'best practice regulation' processes but ensure our waste and litter problems are addressed, including wider public benefits.
3. Develop national tools and resources that allow for the impacts of pollution and benefits of recycling are able to be assessed in a timely manner.
4. Ensure the department stops accepting uncontested data from polluters (who clearly have a vested interest in ensuring the problems are understated) as the basis of regulatory assessment processes.

6. The impacts of marine plastic pollution, including impacts on species and ecosystems, fisheries, small business, and human health

The nature of plastics causes a number of complications within our biodiversity:

- Starvation of species due to the ingestion of large amounts of plastic;
- The manner in which plastics absorb toxic chemicals;
- Entanglement and injury from plastic rubbish;
- Indirect impacts across the food chain as a result bio magnification of plastic related pollution via the eating of plastic contaminated species

It is well documented (GESAMP 2010, UNEP 2014) that plastic litter causes physical harm to marine mammals, fish and invertebrates and instances of death by entanglement, asphyxiation or blockage of organs are common. It is also known that plastic particles tend to accumulate persistent, bioaccumulating and toxic contaminants such as PCBs, DDT and PBDEs (e.g. Ivar du Sol and & Costa 2014, Ogata et al. 2009).

In particular, microplastics have larger surface to volume ratios, potentially facilitating contaminant exchange and have been shown to be ingested by a range of organisms (GESAMP 2010). While recent modelling studies show that the flux of contaminants associated with micro-plastics to remote areas is small compared with that from oceanic and especially longdistance atmospheric transport processes, the problem is that plastics with their accumulated contaminant load are directly ingestible by organisms (GESAMP 2014).

Particles, including microplastics have recently been found in the circulatory systems and other tissues of filter feeding organisms such as the blue mussels following experimental exposure, i.e. in organisms low down in the food-chain. These particles caused typical inflammatory responses (GESAMP 2014). Very small (nano-size) microplastics have been shown to cross cell membranes, under laboratory conditions, causing tissue damage (GESAMP 2014). 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 to their physical presence or both, still remains to be answered. Microplastics have larger surface to volume ratios, potentially facilitating contaminant exchange and have been shown to be ingested by a range of organisms making contaminant transfer more likely.

Within marine food webs, plastic debris commonly serves as both a transport medium and a potential source of toxic chemicals such as polychlorinated biphenyls (PCBs), endocrine-active substances and chemicals similar to DDT (often used as an agricultural insecticide). These chemicals are known to compromise immunity and cause infertility, even at very low levels.[38]

The Great Barrier Reef Outlook Report 2014 has identified marine debris and plastics as a major threat to the health of the reef. It was found that in the time period of 2008 to 2014, 683,000 items of marine debris were recovered within the marine park. According to a recent study by

[38] Queensland's Plastic Pollution Crisis: Container Deposit & Other Solutions (June 2015) The Boomerang Alliance, p7.
https://d3n8a8pro7vhmx.cloudfront.net/boomerangalliance/pages/65/attachments/original/1434695777/CDSOLUTIONS_QLD.pdf?1434695777

the ARC Centre of Excellence for Coral Reef Studies, corals digest micro-beads at about the same rate as normal food.[39] As demonstrated by the large amounts of plastic found in their guts, corals are unable to expel of these fragments. Eventually, corals will starve and die when their stomachs become filled with plastics.

In addition to the manner in which plastics act as a toxic sponge is the fact that microplastics are so small that they have the huge potential to affect virtually all marine life. "When things get that small, it opens it up for 96 per cent of the world's biodiversity, which are invertebrates, to potentially start ingesting them. They can enter the bloodstream through the gut, and then they can circulate in the bloodstream, they can directly enter cells and tissues of these animals" says researcher Professor Emma Johnston, from the Sydney Institute of Marine Science.

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 with a further 6% killed due to entanglement.[40] Marine turtles are particularly vulnerable to floating debris as some species of marine turtles are thought to mistake plastic bags and other items for jellyfish prey.

Moreover, the CSIRO has suggested that by 2050, “95% of all sea birds will have plastics in their gut.”[41] It is estimated that globally over 1 million sea birds and over 100,000 mammals die every year as a result of plastics. These creatures die through ingestion of plastics they mistake as food or from entanglement in plastic items. Ingested 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. When plastics are regurgitated as food to chicks by their parents, physical impacts and internal ulcerations are likely to lower survival rates.

Additionally, a significant number of dead whales and dolphins have been found to ingest sufficient plastics to have caused fatal blockages. In August 2000, an eight metre Bryde’s whale died soon after becoming stranded on a Cairns beach.[42] An autopsy found that the whale’s stomach was tightly packed with 6M^2 of plastic, including many plastic check-out bags. Such obstructions in animals can cause severe pain, distress and death.

[39] Microplastic ingestion by scleractinian corals by N.M. Hall, K.L.E. Berry, L. Rintoul, M.O. Hoogenboom is published in the journal Marine Biology. DOI 10.1007/s00227-015-2619 https://research.jcu.edu.au/tropwater/publications/Halletal2015.pdf

[40] ‘Effects on Wildlife’, Planet Ark: Plastic Bag Reduction, 12/11. http://plasticbags.planetark.org/about/wildlife.cfm

[41] Sources, Distribution and Fate of Marine Debris: CSIRO study. http://www.csiro.au/en/Research/OandA/Areas/Marine-resources-and-industries/Marine-debris

[42] ‘Effects on Wildlife’, Planet Ark: Plastic Bag Reduction, 12/11. http://plasticbags.planetark.org/about/wildlife.cfm

7. Listen to the Community:

While we have seen constant debate on the most effective way to address marine plastic pollution and rubbish generally over the past 10 years, the public has a very clear view on the problem. The following Omnipoll (the new name for Newspoll) was commissioned by Boomerang Alliance to conduct a poll which included the question ***"Are you concerned about the impacts of plastic packaging on the environment?"*** in July this year. The results highlight the high levels of concern the community has about plastics packaging:

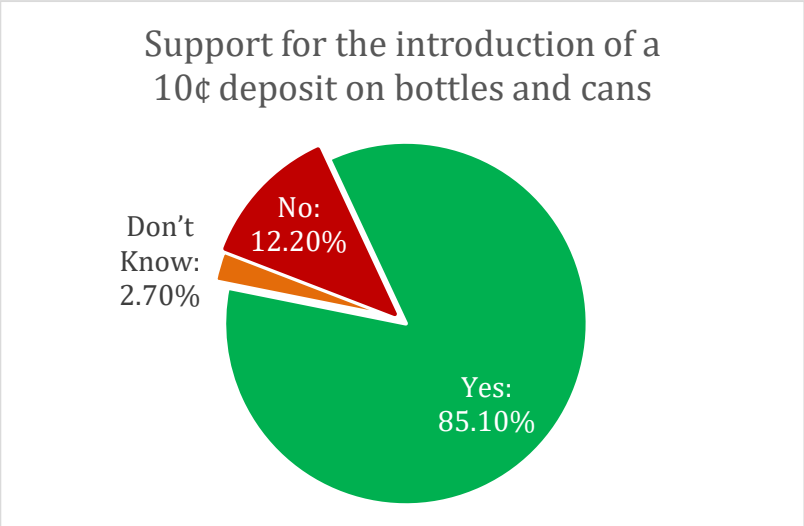
	National 1266	Male 629	Female 637	Grocery Buyer – 1096	NSW 369	QLD 212	SA/NT 159
WTD Resp	14746	7370	7376	13163	4929	2945	1205
Yes %	69	67	72	72	72	73	75
No %	20	21	18	19	15	17	15
Unsure %	11	12	10	9	13	9	10

Market research by Newspoll (again for the Boomerang Alliance) has consistently shown very high levels of support for a CDS over a 10 year period. The polls make it clear that there is a cost yet consistently poll 85+%. The most recent results (Feb 2015) are found below:

*Question: Thinking now about recycling and litter. **South Australia** currently has a deposit and refund scheme, where 10 cents is added to the cost of bottled and canned drinks. The 10 cents is **refunded**, when people return empty bottles and cans to recycling collection depots.*

*The **New South Wales** government is set to introduce a container deposit system using reverse vending machines which automatically separate glass, metal and plastic containers and provide the deposit refund.*

Do you personally think the (State) government should or should not introduce a deposit and refund scheme for bottles and cans, in (state).



8. The Solutions:

The last detailed analysis of the material recovered on Clean Up Australia Day (2010) and other groups strongly indicates the priority for action which in turn is reflected by the advocacy of the Boomerang Alliance and its 32 allies – which calls for 3 key steps:

- Eliminate over 80% of all beverage container rubbish (which represent 30.2% of all plastic rubbish) by encouraging states to adopt a Container Deposit Scheme (ultimately harmonising into a national CDS);
- Ban Single Use Shopping Bags (14.4% of all plastic rubbish);
- Eliminate primary microplastics (plastic pieces represent around 20%) by:
    - banning the use of microbeads in laundry, cosmetics and personal care products: &
    - Enforcing existing regulations where plastics producers and transporters allow nurdles (plastic resin pellets) to escape their control.

Step 1 – Container Refunds

Any effort to restrict plastic marine pollution is doomed to failure without strong and decisive steps to address bottles and cans. CSIRO Marine Scientist Dr Brita Denise Hardesty summarises the rationale for this simply:

"The waste associated with the beverage industry comprises a third and in some estimates a half of the marine debris we find globally".

The tried and proven approach used most effectively across the globe is a container deposit system (CDS). A CDS targets the largest single source of marine pollution, conservatively tripling the recycling rates for all bottles and cans (expected recycling rates would be around 85%), but also introduces a number of benefits that will assist in targeting other rubbish. These include:

1. Attracts private capital to establish many thousands of convenient collection points across the country. Much of this infrastructure will also be used to recover other problem wastes.
2. Provides the financial incentives and injects the funding needed into clean-up efforts; &
3. Educates people about how to recycle and develops the habit of returning material rather than simply throwing it away.

Historically, kerbside recycling became widely established across Australia in the 1980s, when the major newspaper and magazine publishers came together to form the Publishers National Environment Bureau (PNEB) and announced a scheme to financially underpin the viability of paper recovery via kerbside recycling (paper and cardboard are the dominant material recovered vis kerbside)– this provided a level of certainty for local government and privately owned recyclers to invest billions of dollars in recycling facilities, trucks and sorting operations.

CDS plays a similar role to tackle the most problematic aspect of the waste stream – providing both the collection infrastructure and interface with consumers to address away from home consumption i.e. hospitality outlets, public venues and recreational consumption – where recycling rates are very low (often less than 10%).

Discussions with coordinating bodies trying to address a range of problem waste have highlighted that one of the major barriers to good resource recovery is operating enough collection facilities to collect their waste at the end of its life. Existing, but struggling, product stewardship programs for TVs, computers, used paint, light globes, batteries and used chemical containers are just a few industry sectors who have expressed a strong interest in utilizing CDS collection infrastructure to increase their programs recovery rates.

Further, by placing a 'bounty' in the most commonly littered item – bottles and cans, Australians will start to value waste and become more educated about the problems of waste and recycling. Once the habit of visiting a CDS collection point is established, it becomes simple to expand the range of materials in an organized, systematic and cost effective manner.

CDS' have been adopted in over 40 jurisdictions around the world and 5 Australian jurisdictions (SA, NT have schemes and now NSW, ACT and Qld are finalizing investigations to implement CDS), Yet a series of investigations about beverage containers and packaging continue to reach poorly understood conclusions. Put simply a container deposit system does not represent a big cost – drink container waste and litter is a big problem! Based on estimates described in the Commonwealth Government Regulatory Impact Statement, released in 2014, the nett economic cost of adopting a CDS would be $3.57billion over a 25-year period – which sounds expensive but represents just 1¢ per container sold on a product that is sold for between $2.00-$4.00.

The second argument used to deter government is the notion that a CDS will somehow hurt kerbside recycling – untrue. In an effort to understand the true impact of a CDS on kerbside recycling, NSW Local Government commissioned leading waste experts Mike Ritchie and Associates in 2012. The report concludes that "By adopting a CDS, Councils across Australia could save between $69-183 million p.a."[43]

As further evidence of the cost effectiveness of CDS schemes, a 2010 study by PricewaterhouseCoopers (PWC) undertook the most comprehensive study into the most effective ways to recover used beverage containers. The study looked at systems across Europe, North America, Japan and Australia – using a multi-criteria analysis including economic, social and ecological outcomes PWC compared how well different methods of beverage container collection worked[44]. The results put paid to the debate regarding container deposits systems and provides proof that the beverage industries scare tactics had little basis in fact.

A summary of PWC's conclusions are outlined in the table below:

PWC Indicator: ☑☑ = Strongly Positive Impact ☑ = Positive Impact ⊖ = No Impact ☒ = Negative Impact

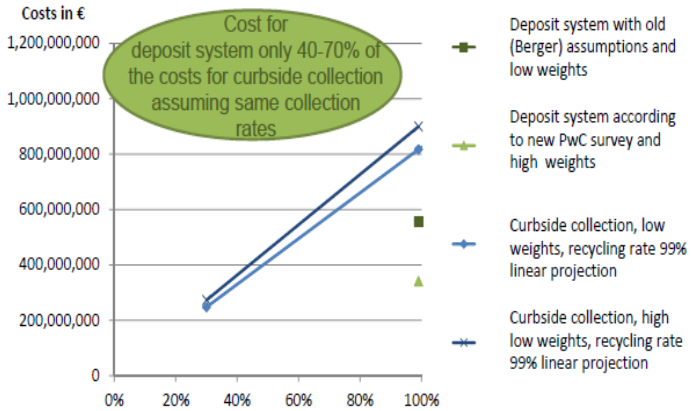
[43] See: http://www.lgnsw.org.au/files/imce-uploads/90/LGSA%20CDS%20Impact%20Study%20100812a.pdf
[44] See: http://www.duh.de/fileadmin/user_upload/download/Projektinformation/Kreislaufwirtschaft/PwC-Study_reading_version.pdf

Impact Area	CDS (Single Use)	Kerbside
Beverage Recovery Rates	☑	⊖
Littering Reductions	☑☑	☒
Resource Consumption	☑	⊖
Waste to Landfill	☑	⊖
Opportunities for Container Re-Use	⊖	☒
Overall System Costs	⊖	⊖
Revenues earned by scheme (to offset scheme costs)	☑☑	⊖
Stability of Collection System	☑	☒
Cost of schemes on Government	☑☑	☒
Impact on Beverage Pricing	⊖	⊖

Key Findings of the PWC Report include:

- Deposit Systems are more sustainable than kerbside collection of beverage containers
- Deposit Systems for beverage containers enable higher collection rates and better recycling
- One way deposit systems are not necessarily more expensive than kerbside collection
- Deposit Systems are more cost effective than kerbside collection
- Deposit Systems and kerbside collection can co-exist very well.

"If the return and recycling rates of the systems are included in the assessment, a mandatory deposit system can be viewed as being more cost efficient."



Recommended Action on Plastic Bottles: With 5 of Australia's 8 jurisdictions moving to a CDS and Western Australia's policy position continuing to be for the adoption of a National CDS it's time for the Commonwealth to show some leadership and take long overdue action (but not delay action on the introduction of a CDS noting the NSW commitment for 1 July 2017)

Step 2: Banning single use plastic bags & microbeads

Complimenting action on beverage containers comes the need to directly address two sources of plastics that are known to have the most immediate and direct impact on marine conservation: single use plastic bags and microbeads.

Single use plastic shopping bags: Plastics are made from non-renewable natural resources such as crude oil, gas and coal. According to the 2002 Nolan ITU Report for Environment Australia on Plastic Shopping Bags - Analysis of Levies and Environmental Impacts; just 8.7 plastic checkout bags contain enough embodied petroleum energy to drive a car 1 kilometre.

Plastic bags have been around for 30 years now. It is estimated world wide that 1 trillion bags are used and discarded every year.

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Microbeads are small polyethylene beads less than 1mm in diameter that are widely used in cosmetics, skin care and personal care industries usually used as exfoliating agents. Recent advances in understanding that these microbeads act as sponge absorbing toxics, other contaminants, and the extent that marine species are mistakenly targeting microplastics as a food source has seen the use of this frivolous product become a substantial environmental concern.

Plastic Bag and Microbeads Recommendation: The threats that plastic bags and microbeads present to the World Heritage listed Great Barrier Reef, spectacular coastal environments and marine species are substantial. Consequently, the consequences of inaction on bags and microbeads represent a failure of public policy to meet its duties and obligations under the obligations under the EPBC Act which identifies ingestion and entanglement by marine debris as a key threatening process to endangered marine life. The Commonwealth needs to take immediate action to ban both single use lightweight plastic bags and microbeads.

Step 3: Improved stewardship within the plastics and Waste Management Industry

Before any new policy or action is taken to address nurdles and/or plastic pollution escaping waste facilities it is important to recognise that it is already an offense in every Australian jurisdiction to allow waste to escape the site and/or dump waste down the stormwater system. The only reason this problem exists is due to a poor effort to enforce regulations and inform the industry that it is expected to ensure nurdles do not migrate from their facilities or transport systems.

Plastics and Waste Management Industry Recommendation: Government support and incentives to underpin a voluntary plan for improved stewardship within the plastics and waste management industries that minimises the impact of plastics extrusion and resin manufacture. This should include:

- That any plastic packaging or product has the maximum practicable recycled content;
- Embodies sustainable packaging design principles; &
- Has onsite management system to capture waste and nurdles.