Chapter 2

Overview of marine plastic pollution

2.1 According to the United Nations Environment Programme (UNEP), 'marine litter' refers to any persistent, manufactured or processed solid material disposed of, or abandoned in, the marine and coastal environment. It can consist of items that have been deliberately discarded into rivers and oceans, or on beaches; brought indirectly into the marine environment through sewage, stormwater, winds and rivers; or accidentally lost, including items lost at sea such as fishing gear and cargo.[1]

2.2 The concerns with plastic in marine debris is its vast distribution in the water column, on the seabed and along coastal shorelines, as well as its persistence, and its characteristic of breaking down to smaller and smaller particles. These characteristics set plastics apart from other debris in the oceans with many submitters noting that plastics remain in the environment for decades if not longer.[2] Professor Tony Underwood, added that:

> I think the focus on plastic might be justified because it is persistent in ways that metal, wood and other materials are not. Plastic just gets smaller and smaller, but it does not go away. That is different from metal which eventually, when you throw it in the sea, will be gone. I think there is a good reason why the focus on plastic keeps coming up compared with other debris.[3]

2.3 This chapter canvasses the magnitude of marine plastic pollution, types of marine plastic pollution, sources of plastic pollution in the Australian marine environment, and the extent of marine plastic pollution in Australian waters.

2.4 The committee notes the extensive body of research on marine plastic pollution, and the differing hypotheses, research methods, and findings available. This report utilises research presented to the committee in evidence, and acknowledges any associated limitations. The committee also acknowledges that research continues to be conducted into the threat of marine plastic pollution, and that understanding of the issue continues to evolve.

2.5 In addition, the committee has drawn on the recently released report by the World Economic Forum and the Ellen MacArthur Foundation—*The New Plastics Economy*: *Rethinking the future of plastics*—which explores issues related to the production and use of plastics particularly plastic packaging. The report noted that,

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1 United Nations Environment Programme, *Marine Litter – an analytical overview*, 2005, http://www.unep.org/regionalseas/marinelitter/publications/docs/anl_oview.pdf, (accessed 22 February 2016), p. 3.

2 Dr Eric Woehler, Convenor, Birdlife Tasmania, *Committee Hansard*, 26 February 2016, p. 35.

3 Professor Tony Underwood, *Committee Hansard*, 18 February 2016, p. 6.

while undertaking work to explore the opportunities and challenges for the circular economy[4] across global supply chains, plastic packaging became an area of focus 'due to its omnipresence in daily life all over the globe'. Plastic leaking (escaping) from after-use systems was identified as a key theme. It was stated that the 'evidence of the looming degradation of marine ecosystems by plastics waste, particularly plastic packaging, has made plastics leakage a priority topic'.[5]

Plastics production

2.6 Plastics have existed for just over a century, however, mass production commenced in earnest in the 1950s.[6] Plastics are made from organic polymers including petrochemicals, cellulose, coal, natural gas and salt. The World Economic Forum noted that over 90 per cent of plastics produced are derived from virgin fossil feedstocks which represent about 6 per cent of global oil consumption.[7]

2.7 Polymers are mixed with a complex blend of additives such as stabilisers, plasticisers and pigments. Plastics may also contain unintended substances in the form of impurities and contaminants.[8] Examples of plastics include polyethylene terephthalate (PET or PETE), high-density polyethylene (HDPE), polyvinyl chloride (PVC), polypropylene (PP), polystyrene (PS) and low-density polyethylene (HDPE).

2.8 Generally, plastics are extremely durable. However, the development of 'bio-degradable' and 'degradable' plastics has seen the production of plastic items which degrade more quickly than traditional plastics. Though these items are no longer present in the environment at the macro-level, they continue to exist as microplastics. Degradable and biodegradable plastic is commonly used to produce shopping and garbage bags. Issues associated with the use and classification of biodegradable and degradable plastics are discussed further in Chapter 7.

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4 Today's economic model is generally seen as linear: 'take, make, dispose' and relies on large quantities of cheap, easily accessible materials and energy. The circular economy focuses on preservation and enhancement of natural capital, optimisation of resource yields and fostering of system effectiveness. http://www.ellenmacarthurfoundation.org/circular-economy/overview/characteristics

5 World Economic Forum, *The New Plastics Economy*: *Rethinking the future of plastics*, January 2016, http://www3.weforum.org/docs/WEF_The_New_Plastics_Economy.pdf, (accessed 23 February 2016), p. 6.

6 Vegter AC, Barletta M, Beck C, Borrero J, Burton H, Campbell M, Costa F, Ericksen M, Ericksson C, Estrades A, Gilardi KVK, Hardesty BD, Ivar do Sul JA, Lavers JL, Lazar B, Lebreton L, Nicols WJ, Ribic CA, Ryan PG, Schuyler QA, Smith SDA, Takada H, Townsend KA, Wabnitz CCC, Wilcox C, Young LC, Hamann M, 'Global research priorities to mitigate plastic pollution impacts on marine wildlife', *Endangered Species Research*, 2014, 25: 225–247, http://www.int-res.com/articles/esr_oa/n025p225.pdf.

7 World Economic Forum, *The New Plastics Economy*: *Rethinking the future of plastics*, January 2016, http://www3.weforum.org/docs/WEF_The_New_Plastics_Economy.pdf, (accessed 23 February 2016), p. 7.

8 National Toxic Networks, *Submission 4*, discusses toxicity associated with plastics.

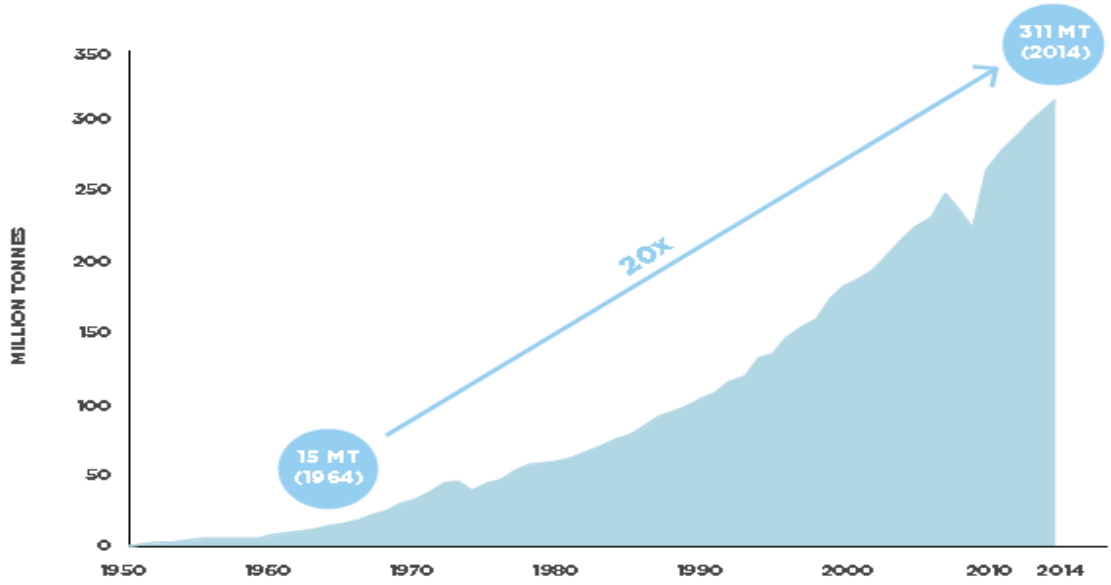
2.9 With most plastic products being lightweight, inexpensive, durable and disposable, they have become an indispensable part of life with the World Economic Forum stating that:

> Plastics have become the ubiquitous workhorse material of the modern economy—combining unrivalled functional properties with low cost. Their use has increased twentyfold in the past half-century and is expected to double again in the next 20 years. Today nearly everyone, everywhere, every day comes into contact with plastics—especially plastic packaging…[9]

2.10 The World Economic Forum went on to note that plastics are increasingly being used across economies in sectors ranging from packaging to construction, transportation, healthcare and electronics. This increasing use is reflected in the rate of increase in global plastic production: in 1964, 15 million tonnes of plastics were produced, in 2014 that had increased to 311 million tonnes. According to the World Economic Forum, plastics production is expected to double again in 20 years, and to almost quadruple by 2050.[10]

2.11 Figure 2.1 provides the growth of production between 1950 and 2014.

Figure 2.1: Growth in global plastics production 1950–2014



Source: World Economic Forum, The New Plastics Economy: Rethinking the future of plastics, January 2016, p. 11.

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9 World Economic Forum, *The New Plastics Economy*: Rethinking the future of plastics, January 2016, http://www3.weforum.org/docs/WEF_The_New_Plastics_Economy.pdf, (accessed 23 February 2016), p. 6.

10 World Economic Forum, *The New Plastics Economy*: *Rethinking the future of plastics*, January 2016, http://www3.weforum.org/docs/WEF_The_New_Plastics_Economy.pdf, (accessed 23 February 2016), p. 7 and p. 10.

2.12 Plastic is produced in most global economies with 85 per cent of production concentrated in three economies: the United States, Europe and Asia. In 2014, for example, 45 per cent of world plastic production took place in Asia (with China accounting for 26 per cent) followed by Europe with a 20 per cent share, and the North American Free Trade Agreement (NAFTA) with a 19 per cent share.[11]

2.13 As noted above, plastics are used in many sectors. However, its use is concentrated in packaging, that is, material designed for immediate disposal. Plastic packaging represents 26 per cent of the total volume of plastic production globally. In 2013, the plastics industry sold 78 million tonnes of plastic packaging with a total value of US$260 billion. Plastic packaging volumes are expected to double within 15 years, and more than quadruple by 2050 to an estimated 318 million tonnes which the World Economic Forum noted is more than the entire plastics industry output today.[12]

2.14 Plastic packaging ranges from water and soft drink bottles to shrink-wrap, rubbish bags and drink cups. Different plastic polymers are used across packaging products for example, PET (polyethylene terephthalate) bottles and PE-LD (polyethylene, low density) food wrap.

Plastic production in Australia

2.15 The Australian plastic production industry produces over 1.2 million tonnes per year, representing approximately 10 per cent of Australian manufacturing activity. The industry also employs 85,000 people.[13] In Australia 1.5 million tonnes of plastic were consumed in the 2012–13 financial year which equates to approximately 65 kilograms of plastic for every man, women and child in Australia.[14] Only 20 per cent is subsequently recycled. In addition, 37 per cent of this plastic was single-use disposable packaging.[15]

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11 Statista, *Distribution of global plastics materials production in 2014, by region* http://www.statista.com/statistics/281126/global-plastics-production-share-of-various-countries-and-regions/ ; World Economic Forum, *The New Plastics Economy*: *Rethinking the future of plastics*, January 2016, http://www3.weforum.org/docs/WEF_The_N Plastics ew_ _Economy.pdf, (accessed 23 February 2016), p. 22; see also paragraph 2.7.

12 World Economic Forum, *The New Plastics Economy*: *Rethinking the future of plastics*, January 2016, http://www3.weforum.org/docs/WEF_The_N Plastics ew_ _Economy.pdf, (accessed 23 February 2016), p. 10.

13 Dr Mark Browne, and co-authors Professor Tony Underwood, Professor Gee Chapman, Professor Emma Johnston, *Submission 21*, p. 1.

14 Associate Professor Mark Osborn, *Submission 16*, p. 2.

15 Reisser J, Shaw J, Wilcox C, Hardesty BD, Proietti M, et al., 'Marine Plastic Pollution in Waters around Australia: Characteristics, Concentrations, and Pathways', 2013, *PLOS ONE*, PLOS ONE 8(11), http://www.plosone.org/article/fetchObject.action?uri=info:doi/10.1371/journal.pone.0080466&representation=PDF (accessed 9 November 2015), p. 1.

The magnitude of marine plastic pollution

2.16 Plastics which enter the oceans can either float on the ocean surface, or sink to the seafloor if they are made of polymers denser than seawaters. Over time, buoyant plastics can drift ashore or they may drift out into the open oceans. Plastics in the open ocean tend to accumulate in convergence zones. These zones include five large-scale gyres of the South and North Pacific, South and North Atlantic and the Indian Ocean.[16] The sizes of these gyres are difficult to determine as they are constantly expanding and moving.[17]

2.17 Reports of marine plastic pollution were first noted in scientific literature in the early 1970s.[18] The Australian Institute of Marine Science (AIMS) commented that 'in northern Australia, marine plastic pollution was first identified as an issue of concern in the 1990s'.[19]

2.18 Since that time, various organisations have reported on the magnitude of marine plastic pollution, but it remains unclear how much plastic is currently in the ocean, and how much is entering each year. For example, in 2005, the UNEP stated that it was estimated that 6.4 million tonnes of marine litter were disposed of in the oceans and seas each year. The UNEP further estimated that over 13,000 pieces of plastic litter were floating on every square kilometre of ocean surface.[20]

2.19 A study published in 2014, commented that the ocean surface water alone contained five trillion plastic pieces.[21] Another study published in 2015 estimated that between 4.8 and 12.7 million metric tonnes of plastic entered the ocean in 2010 from land sources. Most of this plastic was comprised of single-use plastics, designed for immediate disposal.[22]

2.20 In its January 2016 report, the World Economic Forum stated that 'the best research currently available estimates that there are over 150 million tonnes of plastic

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16 Reisser J, *et al*., 'Marine Plastic Pollution in Waters around Australia: Characteristics, Concentrations, and Pathways', 2013, *PLOS ONE*, p. 1, PLOS ONE 8(11), http://www.plosone.org/article/fetchObject.action?uri=info:doi/10.1371/journal.pone.0080466&representation=PDF (accessed 9 November 2015).

17 Surfrider Foundation Australia, *Submission 14*, p. 3.

18 Jambeck, J. A, Andrady, R, Geyer, R, Marayan, M, Perryman, T, Siegler, C, Wilcox C, 'Plastic waste input to the oceans from land', 13 February 2015, *Science*, Volume 347 Issue 6223, http://science.sciencemag.org/content/347/6223/768 (accessed 22 February 2016), p. 1.

19 Australian Institute of Marine Science, *Submission 11*, p. 2.

20 United Nations Environment Programme, *Marine Litter An analytic overview*, 2005, http://www.unep.org/regionalseas/marinelitter/publications/docs/anl_oview.pdf, p. ii.

21 Associate Professor Mark Osborn, *Submission 16*, p. 1.

22 Jambeck, J. A, *et al*, 'Plastic waste input to the oceans from land', 13 February 2015, *Science*, Volume 347 Issue 6223, http://science.sciencemag.org/content/347/6223/768 (accessed 22 February 2016), p. 1.

waste in the oceans today'. In addition, it was stated that the amount of plastic in the world's oceans is forecast to grow to 250 million tonnes in 2025.[23] The World Economic Forum described this amount of plastic entering the marine environment in graphic terms:

> Each year, at least 8 million tonnes of plastics leak into the ocean—which is equivalent to dumping the contents of one garbage truck into the ocean every minute. If no action is taken, this is expected to increase to two per minute by 2030 and four per minute by 2050.[24]

2.21 Forecast growth in the amount of plastic finding its way into the marine environment is based on increased population and economic growth occurring in developing countries as well as continued increases in consumer consumption in developed countries.[25] Dr Britta Denise Hardesty, Senior Research Scientist from the CSIRO, similarly commented that 'the amount of plastic going into the ocean is proportionate to the amount of plastic produced', with the global increase in plastic production corresponding to the increase in the amount of plastic that is entering the ocean.[26]

2.22 The committee notes that in evidence, a note of caution was sounded regarding the predictions of the amount of marine plastic in the marine environment contained in the World Economic Forum paper. Professor Stephen Smith from the National Marine Science Centre, commented that care was required as the predictions were 'over a long temporal scale, but I think it highlights the importance of the problem'. Professor Smith went on to state that if the rate of waste entering the ocean continues, 'then I would support dire predictions'.[27]

2.23 Professor Underwood also noted that there were variances in estimates of the amount of plastics entering the ocean due to lack of knowledge and the lack of clarity about how much plastic there is in the world at any given time, 'because the estimates are not particularly good'.[28]

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23 World Economic Forum, *The New Plastics Economy*: *Rethinking the future of plastics*, January 2016, http://www3.weforum.org/docs/WEF_The_N Plastics ew__Economy.pdf, (accessed 23 February 2016), p. 14.

24 World Economic Forum, *The New Plastics Economy*: *Rethinking the future of plastics*, January 2016, http://www3.weforum.org/docs/WEF_The_N Plastics ew_ _Economy.pdf, (accessed 23 February 2016), p. 7.

25 Jambeck, J. A, *et al.*, 'Plastic waste input to the oceans from land', 13 February 2015, *Science*, Volume 347 Issue 6223, http://science.sciencemag.org/content/347/6223/768 (accessed 22 February 2016), p. 770.

26 Dr Britta Denise Hardesty, CSIRO, *Committee Hansard*, 26 February 2016, p. 8.

27 Professor Stephen Smith, *Committee Hansard*, 18 February 2016, p. 2.

28 Professor Tony Underwood, *Committee Hansard*, 18 February 2016, p. 2.

The magnitude of marine plastic pollution in Australian waters

2.24 The committee received evidence of the limited knowledge of the magnitude of marine plastic pollution in Australian waters. The then Department of the Environment, Water, Heritage and the Arts in its 2009 background paper for the Threat Abatement Plan for the impacts of marine debris on vertebrate marine life commented:

> Information and data on the sources, magnitude and impacts of marine debris around Australia has been derived primarily from land-based coastal surveys. This information probably under-represents the actual quantity of marine debris in Australia's marine and coastal environments, as debris may sink, may become buried underground or become entangled underwater on rocky outcrops and reefs, and never float ashore. There is little information available on the magnitude of the debris that is floating in the sea or present on the seabed.[29]

2.25 The background paper went on to state that data available at that time suggested that high concentrations of debris accumulate on parts of the coastline all around Australia. Specific areas where debris had been reported at comparatively high densities included coasts adjacent to urban centres and remote areas of north-western Cape York, Groote Eylandt, northeast Arnhem Land, the far north Great Barrier Reef, parts of South Australia including Anxious Bay, parts of Western Australia, southwest Tasmania, and Australia's sub-Antarctic Islands. Quantities of debris in these areas ranged from more than 400 kg of debris per kilometre along remote parts of the northern Australian coast to 15 kg of debris per kilometre or less on heavily polluted parts of more remote southern Australian coastlines including Australia's sub-Antarctic Islands.[30]

2.26 In 2013, a study on marine plastic pollution in waters around Australia similarly noted that:

> …our current knowledge on plastic contamination in the Australian marine environment is restricted to (1) beach litter cleanups that record mainly the occurrence of relatively large objects…(2) land-based surveys of marine megafauna impacted by marine debris…and (3) inferences based on plastic pollution reports from New Zealand.[31]

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29 Department of the Environment, Water, Heritage and the Arts, *Background Paper for the Threat Abatement Plan for the impacts of marine debris on vertebrate marine life*, May 2009, p. 2.

30 Department of the Environment, Water, Heritage and the Arts, *Background Paper for the Threat Abatement Plan for the impacts of marine debris on vertebrate marine life*, May 2009, p. 2; see also Australian Institute of Marine Science, *Submission 11*, p. 3.

31 Reisser J, *et al.*, 'Marine Plastic Pollution in Waters around Australia: Characteristics, Concentrations, and Pathways', 2013, *PLOS ONE*, PLOS ONE 8(11), http://www.plosone.org/article/fetchObject.action?uri=info:doi/10.1371/journal.pone.0080466&representation=PDF (accessed 9 November 2015), pp. 1–2.

2.27 The 2013 study went on to characterise and estimate the concentration of marine plastics in waters around Australia using surface net tows. It was concluded that a high prevalence of small plastic fragments (less than 5 mm) in Australian waters is consistent with other regions of the world's oceans. Plastic pollution levels were moderate when compared to concentrations in other marine areas. The study found high amounts of plastic close to cities on the east coast, as well as in remote locations including west Tasmania and the North West Shelf.[32]

2.28 AIMS pointed to a number of research projects which reported on the density of marine debris along the northern Australian coast. For example, a 2003 survey of marine debris at Cape Arnhem found that plastic items made up around 74 per cent of all items recorded during a beach marine debris survey.[33]

2.29 Both Clean Up Australia and the Tangaroa Blue Foundation maintain data sets of the debris collected from their clean-up activities. Clean Up Australia commented that:

> Detailed studies of the materials removed on Clean Up Australia Day in 2014 found 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. Dive sites reported 50% of rubbish removed was plastic.[34]

2.30 The Tangaroa Blue Foundation coordinates the Australian Marine Debris Initiative (AMDI). The AMDI objectives include the removal of marine debris from the environment; the collection of scientifically robust and long-term data on what is removed and from where; and tracking the debris back to the source wherever possible. Ms Heidi Taylor, Managing Director of the Tangaroa Blue Foundation, stated that to date, more than 5.4 million marine debris items have been entered into the AMDI database. This debris has been removed from 1,729 sites and the weight of the debris has been totalled at over 500 tonnes. There are 140 categories in the AMDI with the datasets for Western Australia holding information from 2005.[35]

2.31 Other submitters provided evidence of individual clean-ups to highlight the extent of marine plastic pollution. The Waste Management Association Australia, Tasmanian Branch, for example, stated that 'the annual South-West Marine Debris

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32 Reisser J, *et al*., 'Marine Plastic Pollution in Waters around Australia: Characteristics, Concentrations, and Pathways', 2013, *PLOS ONE*, PLOS ONE 8(11), http://www.plosone.org/article/fetchObject.action?uri=info:doi/10.1371/journal.pone.0080466&representation=PDF (accessed 9 November 2015), p. 1.

33 Australian Institute of Marine Science, *Submission 11*, p. 3.

34 Clean Up Australia, *Submission 9*, p. 3.

35 Ms Heidi Taylor, Tangaroa Blue Foundation, *Committee Hansard*, 10 March 2016, pp. 28, 32.

Clean-Up collected 48,000 separate items of litter mostly plastic from five beaches in Tasmania's "pristine wilderness areas" in 2014'.[36]

2.32 Dr Frederieke Kroon, Principal Research Scientist from AIMS also commented on the information sourced from the AMDI and noted that overall, at least 80 per cent of the marine debris collected in beach clean-ups in the Great Barrier Reef and Torres Strait regions is comprised of plastic.[37]

2.33 In addition, Dr Kroon pointed to AIMS's own research projects. Dr Kroon commented that in a field campaign in November 2015, in remote marine environments in North-West Australia, including the Kimberley region and offshore in the Browse and Bonaparte basins, small plastic particles and fibres were detected. Further work is ongoing to better understand the abundance and distribution and, eventually, the sources and fates of these plastic particles in remote regions.[38]

2.34 However, Dr Kroon also noted that while research has been undertaken, it is still unclear as to the magnitude of marine plastic pollution in Australian waters, particularly those of northern Australia. Dr Kroon stated:

> Because the tropical marine environment across Northern Australia is such a large area, we are uncertain about the abundance and distribution of marine plastics. Various studies have been done. There was the CSIRO survey right around Australia and there has been work done on ghost nets in Arnhem Land, in the Gulf of Carpentaria. There has been our own work in the [Great Barrier Reef] and in the Arafura and Timor Seas, in the Kimberley. But we are not getting a general overview of the problem for the whole of Northern Australia and what the long-term effects on the marine ecosystems may be.[39]

2.35 The Tangaroa Blue Foundation also argued that a large amount of plastic debris is hidden, for example, debris is covered by sand in coastal dunes and can be released at a later date through tidal action and storm events. Debris is also trapped in vegetation in estuaries and waterways which can then impact on critical habitats. The Tangaroa Blue Foundation also noted that 'data on the abundance of debris is based on what can be observed and collected and there is no current estimate on the abundance of hidden debris in the coastal or estuarine systems'.[40] Professor Smith told the committee that erosion of coastal environments is 'liberating old plastic from the dunes' and in areas such as Coffs Harbour, items such as bottle tops from 1979 are

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36 Waste Management Association Australia, Tasmanian Branch, *Submission 13*, p. 1.

37 Dr Frederieke Kroon, Australian Institute of Marine Science, *Committee Hansard*, 10 March 2016, p. 15.

38 Dr Frederieke Kroon, Australian Institute of Marine Science,, *Committee Hansard*, 10 March 2016, p. 15.

39 Dr Frederieke Kroon, Australian Institute of Marine Science,, *Committee Hansard*, 10 March 2016, p. 18.

40 Tangaroa Blue Foundation, *Submission 60*, p. 4.

being found.[41] A committee member similarly noted personal observation of '10 feet of stratified plastic on the west coast' of Tasmania.[42]

2.36 A further area where there is a significant gap in knowledge is the plastic pollution abundance in sediments in Australian waters. Associate Professor Mark Osborn commented that this 'compromises our ability to predict the impact of these pollutants upon benthic systems'.[43]

Sources of marine plastic pollution

2.37 Plastics entering the marine environment are generally categorised as either ocean- or land-based. While land-based marine plastic pollution is recognised as the more prevalent, with it generally being considered that 80 per cent of marine plastic pollution comes from land sources, ocean-based sources still account for a significant proportion of marine plastic. The following discussion provides an overview of these two sources of marine plastic pollution. The country of origin of marine plastic is also considered.

Ocean-based marine plastic pollution

2.38 Ocean-based marine plastic pollution is material that is either intentionally or unintentionally dumped or lost overboard from vessels. Vessels include not only merchant ships but also offshore oil and gas platforms.[44]

2.39 Traditionally, ship-sourced garbage was disposed of at sea until the introduction of the International Convention for the Prevention of Pollution from Ships (MARPOL). As at 1 January 2013, MARPOL Annex V prohibits the discharge of all types of garbage into the sea, with very limited exceptions (not related to plastics). In 2014, 144 parties, representing approximately 98 per cent of the world's merchant shipping tonnage, ratified MARPOL Annex V.

2.40 While MARPOL Annex V now prohibits the disposal of waste generated on vessels, some ship operators illegally dump garbage while at sea. It is estimated that 20 per cent of marine debris originates from the shipping sector.[45] Ocean-based debris includes sewage, food scraps, oil and grease, animal carcasses, and cargo residues. Ocean-based plastic waste includes packaging, bottles, plastic parts of e-waste,

41 Professor Stephen Smith, *Committee Hansard*, 18 February 2016, p. 22.

42 Senator Peter Whish-Wilson, *Committee Hansard*, 18 February 2016, p. 22.

43 Associate Professor Mark Osborn, *Submission 16*, p. 3.

44 Vegter, AC, *et al.*, 'Global research priorities to mitigate plastic pollution impacts on marine wildlife', *Endangered Species Research*, 25: 225–247, 2014 http://www.int-res.com/articles/esr_oa/n025p225.pdf, p. 233.

45 Australian Maritime Safety Authority, *Submission 68*, p. 1.

synthetic ropes, fishing nets ('ghost nets'), floats, monofilament lines, and strapping or wrapping associated with ships' stores and cargo.[46]

Abandoned or lost fishing gear

2.41 Of particular concern in Australian waters is abandoned, lost or otherwise discarded fishing gear (ALDFG). This includes plastic nets, lines, and crab and lobster pots from both commercial and non-commercial fishing operations. ALDFG is known to pose a threat to a range of marine fauna with nets, lines, bait bags, and traps entangling marine fauna and, in some cases, being ingested by marine fauna. ALDFG can also damage underwater habitats such as coral reefs and benthic zones.

2.42 'Ghost fishing' occurs when ALDFG is no longer under the control of a fisher or fishing operation and continues to trap and kill fish, marine mammals, crustacea, turtles and birds. ALDFG can continue to ghost fish for many years once it has been lost.

2.43 Each year around 640,000 tonnes of fishing gear are lost or thrown overboard around the world. In Australia's Gulf of Carpentaria, so-called 'ghost nets' are found in densities reaching up to three tonnes per kilometre, which are some of the highest rates in the world. It is estimated that the majority of nets come from fisheries in neighbouring countries, though approximately 4 per cent of ghost nets originate in Australia.[47]

2.44 The Northern Territory Seafood Council stated that lost or discarded fishing gear from fishing activities by foreign fishing operations is of increasing concern to industry. In particular, enormous nets of predominantly Taiwanese manufacture and longline gear used by numerous fisheries to the north of Australia, or by illegal fishers in Australian waters, are pushed by the prevailing winds and currents into Australian waters.[48] The CSIRO identified that most ghost nets enter the Gulf of Carpentaria from the northwest and move in a clockwise direction.[49] The concerns with ghost nets are discussed further in Chapter 5.

2.45 In addition, the debris from recreational fishers was identified as a source of marine plastic pollution. Mr Brad Warren, Executive Chair of OceanWatch Australia told the committee that Australia has approximately five million recreational fishers, many of whom are using nylon lines, plastic lures and plastic bait bags. Many of these

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46 Australian Maritime Safety Authority, *Submission 68*, p. 2.

47 Hardesty BD and Wilcox C, 'Ghostnets fish on: marine rubbish threatens northern Australian turtles', 31 January 2013, *The Conversation*, https://theconversation.com/ghostnets-fish-on-marine-rubbish-threatens-northern-australian-turtles-11585, (accessed 24 February 2016).

48 Northern Territory Seafood Council, *Submission 63*, p. 3.

49 Hardesty BD and Wilcox C, 'Ghostnets fish on: marine rubbish threatens northern Australian turtles', 31 January 2013, *The Conversation*, https://theconversation.com/ghostnets-fish-on-marine-rubbish-threatens-northern-australian-turtles-11585, (accessed 24 February 2016).

items are lost or disposed of at sea.[50] Mr Warren also noted the ready commercial availability of crab traps which when lost or abandoned, break down and the nylon netting becomes an entanglement risk for marine fauna. The plastic then further breaks down into microplastics.[51]

2.46 Professor Smith also noted a very recent survey that suggested highly accessible sections of estuaries in areas of high population density—such as the Gold Coast seaway—support very high loads of benthic debris which is dominated by fishing-related items, most notably monofilament line.[52]

Land-based marine pollution

2.47 Land-based marine pollution originates from urban and industrial waste sites, sewage outlets, stormwater, litter transported by systems, and litter discarded by beach users. The most widely cited figure for the proportion of marine plastic originating from land-based sources is 80 per cent. However, it has been argued that 'this figure is not well substantiated and does not inform the total mass of debris entering the marine environment from land-based sources'.[53]

2.48 A study published in 2015 by an international team of experts aimed to estimate the amount of plastic entering the ocean from waste generated on land by linking worldwide data on solid waste, population density and economic status. The study estimated that 2.5 billion metric tonnes (MT) of municipal waste were generated in 2010 by 6.4 billion people living in 192 coastal countries. Approximately 11 per cent (275 million MT) of the waste generated was plastic. The study scaled this figure according to the population living within 50 kilometres of the coastline and estimated that 99.5 million MT of plastic waste were generated in coastal regions. Of this amount, 31.9 million MT were classified as mismanaged resulting in an estimated 4.8 million to 12.7 million MT entering the ocean in 2010.[54]

2.49 Similarly, the CSIRO indicated that the vast majority of marine debris entering Australian waters is land-based and generated locally.[55] In 2011, Dr Hardesty and Dr Chris Wilcox from the CSIRO released *Understanding the types, sources and at-sea distribution of marine debris in Australian waters* which found that:

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50 Mr Brad Warren, OceanWatch Australia, *Committee Hansard*, 18 February 2016, p. 61.

51 Mr Brad Warren, OceanWatch Australia, *Committee Hansard*, 18 February 2016, p. 63.

52 Professor Stephen Smith, *Submission 27*, p. 5.

53 Jambeck, J. A, *et al.*, 'Plastic waste input to the oceans from land', 13 February 2015, *Science*, Volume 347 Issue 6223, http://science.sciencemag.org/content/347/6223/768 (accessed 22 February 2016), p. 768.

54 Jambeck, J. A, *et al.*, 'Plastic waste input to the oceans from land', 13 February 2015, *Science*, Volume 347 Issue 6223, http://science.sciencemag.org/content/347/6223/768 (accessed 22 February 2016), p. 770.

55 Dr Britta Denise Hardesty, CSIRO, *Committee Hansard*, 26 February 2016, p. 1.

> Overall domestic sources are probably an important contributor to marine debris in Australia, with debris released in areas of intense human activity reaching even distant locations along our coastline and in offshore areas.[56]

2.50 While the study found that there is a contribution from international sources in some areas, Australia is likely to be responsible for plastic pollution found in the region. It stated that:

> Australia is probably a net exporter of debris to some neighbouring marine regions and surrounding countries. In particular debris from the densely populated east coast is likely transported toward New Zealand and into the southwestern Pacific. Debris from the north and west coasts is likely transported north-westward toward Indonesia and into the north-eastern Indian Ocean.[57]

2.51 The study found that in remote areas, the debris had a higher composition of refuse from marine industries such as fishing and shipping. However, in regions near urban areas however there was more debris from coastal inputs. The study concluded that 'overall, the results suggested that control of domestic inputs may be the critical issue, whether they are from economic activities offshore or from coastal sources'.[58]

2.52 More recently, the CSIRO led a major national study documenting the state of marine debris in Australia. The study included coastal and offshore surveys around the continent, analysis of the impacts of this debris on marine wildlife, and an evaluation of the likelihood of domestic and foreign sources. It also investigated the effectiveness of council, regional, and state policies in reducing the amount of debris entering the marine environment.[59] This study again suggested that most marine debris in the Australian region is domestic. It was found that debris in the marine environment appears to increase with the local population. The data also suggested that areas that have a high population in the region, but relatively isolated coast, tend to have high amounts of debris, consistent with illegal dumping.[60]

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56 Hardesty, B D, and Wilcox, C. *Understanding the types, sources and at-sea distribution of marine debris in Australian waters,* 2011, CSIRO, http://secure.environment.gov.au/coasts/pollution/marine-debris/publications/pubs/marine-debris-sources.pdf, (accessed 9 November 2015), p. 20.

57 Hardesty, B D, and Wilcox, C. *Understanding the types, sources and at-sea distribution of marine debris in Australian waters,* 2011, CSIRO, http://secure.environment.gov.au/coasts/pollution/marine-debris/publications/pubs/marine-debris-sources.pdf, (accessed 9 November 2015), p. 20.

58 Hardesty, B D, and Wilcox, C. *Understanding the types, sources and at-sea distribution of marine debris in Australian waters,* 2011, CSIRO, http://secure.environment.gov.au/coasts/pollution/marine-debris/publications/pubs/marine-debris-sources.pdf, (accessed 9 November 2015), p. 20.

59 CSIRO, *Submission 7,* p. 4.

60 CSIRO, *Submission 7,* Appendix 3, 'Input to Department of Environment Threat Abatement Plan', p. 16.

2.53 Professor Smith also stated that the source of marine plastic pollution is likely to be highly site dependent and linked to adjacent human activities. He explained that this can vary considerably over even relatively small spatial scales.[61] For example, on Rottnest Island:

> …a proportion of debris on beaches adjacent to visitor accommodation results from *in situ* deposition from beach-goers. In contrast, debris on beaches on the western side of the island is dominated by fragmented plastics, much of which can be traced to commercial fishing activities in the region.[62]

2.54 The Tangaroa Blue Foundation similarly commented that there are very significant regional differences in the proportion of ocean- and land-based debris for coastal sites due to a range of factors including population density, prevailing wind and current regimes and regional onshore and offshore activity such as industry, shipping and commercial fishing.[63]

2.55 The Adelaide and Mount Lofty Ranges Natural Resources Management Board also noted that in an assessment of 38 study sites in South Australia, those sites open to open oceans exhibited higher litter counts associated with recreational, commercial and boating related activities. The study found that sites in the metropolitan region showed the highest rate of consumer associated plastics.[64]

Urban litter in Australia

2.56 Urban litter includes lost or abandoned plastic items, items which fall out of rubbish bins due to overfilling or windy weather, and plastic debris which is inadequately secured during transportation. It can include balloons, plastic bags, single-use consumer items such as straws and food packaging, and cigarette butts.

2.57 The movement of plastic pollution from urban areas to the marine environment can occur in a variety of ways. However, a significant contributor is the stormwater system which often delivers directly to coastal areas, or to rivers which ultimately deliver to coastal areas.[65]

2.58 Professor Smith explained that the sequence of urban debris moving into the marine environment via the stormwater system is well recognised and that a number of mitigation measures have been put in place in most urbanised areas. These

61 Professor Stephen Smith, *Submission 27*, p. 5.

62 Professor Stephen Smith, *Submission 27*, p. 5; see also, Professor Stephen Smith, *Committee Hansard*, 18 February 2016, p.11.

63 Tangaroa Blue Foundation, *Submission 60*, p. 3.

64 Adelaide and Mount Lofty Ranges Natural Resources Management Board, *Submission 20*, p. 6.

65 Parks Victoria, *Submission 79*, p. 8.

measures include gross pollutant traps (GPTs) and education campaigns such as signs on drains.[66]

2.59 The committee received evidence highlighting the volumes of urban litter recovered in clean-up activities, in both the marine environment and in stormwater systems:

- the 1997 *Stormwater Gross Pollutants Industry Report* by the Cooperative Research Centre for Catchment found that over 12,000 tonnes per annum of packaging litter had entered Port Phillip Bay;[67]
- the South East Queensland Healthy Waterways Rubbish Report indicated that it collects over 250,000 items of litter each year from 210 kilometres of waterways with the most common item collected being plastic bottles followed by food packaging;[68]
- Liverpool City Council submitted that it removed 1.2 cubic tonnes of gross pollutants including plastics from 114 GPTs in the 2013–14 financial year. In addition, 99.4 tonnes of rubbish, including large quantities of plastic were removed from the Georges River Catchment in 2014–15. The Council also noted that in 2014–15, a total of 606 cubic metres of rubbish and litter were removed from riparian, creek and waterway areas;[69] and
- Georges River Combined Councils' Committee stated that between 25,000 and 50,000 plastics bottles are removed from the river annually.[70]

2.60 While it has been long held that most marine pollution is land-based, it has also been argued that 'this figure is not well substantiated and does not inform the total mass of debris entering the marine environment from land-based sources'.[71] Professor Smith stated that recent studies are challenging the assumption that 80 per cent of marine debris is sourced from adjacent terrestrial environments.[72] For example, Professor Smith presented to the committee the results of a study involving the collection of 632 bottles by volunteers in coastal areas, which found that 43 per cent were Chinese and South East Asian brands. The study found that very few of the bottles (6 per cent) had any indication that they had been in the water very long—this

66 Professor Stephen Smith, *Submission 27*, p. 5.

67 Total Environment Centre, *Submission 1*, p. 1.

68 Wildlife Preservation Society of Queensland, *Submission 5*, p.

69 Liverpool City Council, *Submission 61*, p. 3.

70 Georges River Combined Councils' Committee, *Submission 17*, p. 1.

71 Jambeck, J. A, *et al.*, 'Plastic waste input to the oceans from land', 13 February 2015, *Science*, Volume 347 Issue 6223, http://science.sciencemag.org/content/347/6223/768 (accessed 22 February 2016), p. 768.

72 Professor Stephen Smith, *Submission 27*, p. 4.

would preclude them from having originated from overseas. Professor Smith hypothesised that these bottles may have been disposed of from passing ships.[73]

Country of origin of marine plastic pollution

2.61 Marine plastic pollution in Australian waters also originates from international sources. Ocean currents can transport debris over long distances. The World Economic Forum commented that according to the best available data, Asia accounts for more than 80 per cent of the total leakage of plastic into the ocean.[74] The CSIRO also noted that China and Indonesia were particularly significant sources of plastic pollution.[75]

2.62 The CSIRO study found that there is a contribution from international sources in some areas of Australia, particularly the north-eastern Coral Sea, Arafura Sea, southern Indian Ocean and Southern Ocean.[76] For example, large abandoned fishing nets in the Gulf of Carpentaria likely originate from overseas.[77]

2.63 The committee also received evidence from the Northern Territory Seafood Council based on anecdotal evidence from professional fishers, data from Marine Ranger groups and other coastal clean-ups of remote northern beaches. The Council submitted that much of the rubbish in remote northern areas is drifting into Australian waters and onto reefs and beaches from:

- fishing activities to the north of the Australian Fishing Zone (AFZ),
- illegal foreign fishing activities inside the AFZ; and
- international shipping transiting through northern waters.[78]

2.64 Similarly, OceanWatch Australia also submitted that 'the contribution from overseas sources is potentially significant and underestimated'. The submission noted that observation of microplastic debris, identification of parent material, and Australian consumption rates would indicate 'potential for significant international sources'. OceanWatch Australia went on to highlight that 'in the case of plastic bottles,

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73 Professor Stephen Smith, *Committee Hansard*, 18 February 2016, pp. 10–11.

74 World Economic Forum, *The New Plastics Economy*: *Rethinking the future of plastics*, January 2016, http://www3.weforum.org/docs/WEF_The_New_Plastics_Economy.pdf, (accessed 23 February 2016), p. 22.

75 CSIRO, *Submission 7*, Appendix 3, 'Input to Department of Environment Threat Abatement Plan', p. 21.

76 Hardesty, B D, and Wilcox, C. *Understanding the types, sources and at-sea distribution of marine debris in Australian waters*, 2011, CSIRO, http://secure.environment.gov.au/coasts/pollution/marine-debris/publications/pubs/marine-debris-sources.pdf, (accessed 9 November 2015), p. 20; see also paragraph 2.44.

77 CSIRO, *Submission 7*, p. 4.

78 Northern Territory Seafood Council, *Submission 63*, p. 2.

further evidence can be found in barcodes where the trademark of product registration originates from countries in the Pacific and Southern East Asia'.[79]

2.65 OceanWatch Australia stated that:

> There seems a reluctance to acknowledge and address the contribution of plastic waste from international sources. The current domestic environmental policy focus and funding mechanisms seek to tackle the problem through monitoring and cleanups within Australian boundaries. Little effort that we are aware of is applied within potential source countries.[80]

2.66 Professor Smith stated that 'a key problem in determining the source of all items is that fragmented plastics are often the most numerous and there is no simple way to determine their source'.[81] Professor Underwood similarly told the committee that there is 'insufficient research' to answer the question of where marine plastic pollution is sourced.[82]

The products and materials that represent the major sources of marine plastic pollution

2.67 Plastic debris found in the marine environment is either larger debris (macroplastic) or small particles (microplastic). The following provides an overview of these types of marine plastic pollution.

Macroplastics

2.68 Macroplastics are composed of a wide variety of industrial, commercial and consumer items. As noted above, plastic packaging makes up 26 per cent of plastic production. As a consequence, plastic packaging, which is designed to be disposed of after a single use and has low rates of recycling, makes up a large proportion of marine plastic pollution. Of particular concern are beverage containers and single-use plastic bags.

2.69 The Tangaroa Blue Foundation provided information on the top ranking 10 items found in clean-ups around Australia. The first eight are plastic and four of these relate directly to the packaging.

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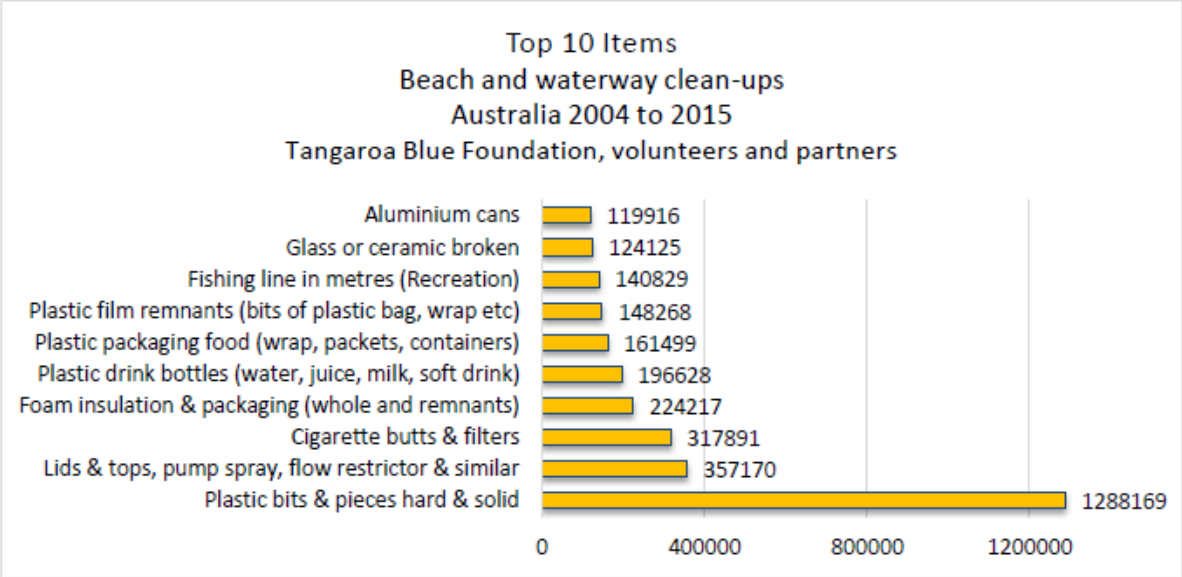
79 OceanWatch Australia, *Submission 75*, p. 3.

80 OceanWatch Australia, *Submission 75*, p. 3.

81 Professor Stephen Smith, *Submission 27*, p. 4.

82 Professor Tony Underwood, *Committee Hansard*, 18 February 2016, p. 10.

Figure 2.2: Top 10 items from Australian beaches and waterways



Source: Tangaroa Blue Foundation, Submission 60, p. 4.

2.70 Dr Hardesty noted that approximately 40 per cent of all litter found in coastal areas is from the beverage industry. Dr Hardesty went on to state that one bottle can break down into dozens of small pieces.[83] Clean Up Australia similarly noted that the prevalence of beverage rubbish, including plastic bottles, has now replaced cigarette butts as the most common product group removed during clean-ups.[84]

2.71 Clean Up Australia estimated in 2009 that over 3.9 billion single-use plastic bags are consumed each year with the Australian Government believing that around 2 per cent of these bags enter the litter stream each year. The Total Environment Centre argued that these estimates were understated. It told the committee that 'it is reasonable to expect that consumption is over 5 million p.a. and the amount of bags entering the litter stream each year is likely to be at least 100 million bags p.a.'.[85]

2.72 The committee also received evidence that balloons which have either been accidentally lost or deliberately released, contribute significantly to plastic pollution which is ingested by marine fauna.[86] Dr Kathy Townsend from the University of Queensland told the committee that:

> …people have quite a cartoon idea of what happens to balloons when they release them—they just disappear and never come back down again. Of course that is not the case at all. They go up to the stratosphere, they shred and then they drop again. They do not drop in front of your feet, so you do

83 Dr Britta Denise Hardesty, CSIRO, *Committee Hansard*, 26 February 2016, p. 2.

84 Clean Up Australia, *Submission 9*, p. 3.

85 Total Environment Centre, *Submission 1*, p. 6.

86 This is discussed further in Chapter 3.

> not see them. Any of those massed balloon releases at any of those sorts of events will eventually come down somewhere.[87]

2.73 New South Wales outlawed the mass release of balloons in 1999, and the maximum that can be released in a single event is 19.[88] Similarly, the Sunshine Council banned the intentional release of helium balloons in 2011.[89]

2.74 However, the committee received evidence that even small numbers of balloons can still travel significant distances and enter the marine environment. For example, Ms Karyn Jones submitted:

> In February 2014, I found a bunch of 14 balloons, with only 5 remaining inflated. The bunch had been released from Albury the previous afternoon, and had travelled over 300 kilometres to a beach south of Bermagui (this was confirmed by both Albury City Council and the Bureau of Meteorology). This shows how far helium filled balloons can travel in a short period of time, from far inland to the marine environment. It also shows how "up to 20" balloons is ludicrous.[90]

2.75 Evidence on the distance balloons can travel was also provided by the Capricorn Conservation Council which stated that 'balloon[s] distributed, ironically at the 2012 Gladstone EcoFest by Curtis Island LNG a company were found washed up on Keppel bay beaches 85 kilometres north west'.[91]

2.76 Dr Townsend explained that typically balloons are made from two kinds of plastic polymer—latex-type polymers or foil-type polymers. Latex-type polymers typically degrade much more quickly than other kinds of plastic, however immersion in water has been found to slow this process. Foil-type polymers are essentially the same material as traditional, lightweight plastic bags, and degrade at similar rates.[92]

2.77 Dr Townsend told the committee that researchers have found 'pretty much fully intact balloons' in the intestines of marine fauna, and that the gastrointestinal pH is not sufficient to increase degradation. Dr Townsend also explained that balloons may also be ingested while attached to ribbons or other pieces of plastic which prevent the item from passing through the animal's digestive system.[93]

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87 Dr Kathy Townsend, *Committee Hansard*, 10 March 2016, p. 2.

88 Section 146E of the *Protection of the Environment Act 1999* (NSW)

89 Sunshine Coast Council, Fact Sheet – Helium Balloons, cms.sunshinecoast.qld.gov.au/addfiles/documents/laws_regulations/scc_local_laws_2011/fs_helium_balloons.pdf, (accessed 18 March 2016).

90 Ms Karyn Jones, *Submission 117*, p. 1.

91 Capricorn Conservation Council, *Submission 32*, p. 1.

92 Dr Kathy Townsend, *Committee Hansard*, 10 March 2016, p. 2.

93 Dr Kathy Townsend, *Committee Hansard*, 10 March 2016, p. 3.

Microplastics

2.78 Microplastics are tiny plastic fragments, fibres and granules of less than five millimetres in size.[94] There are four major sources of microplastic in the marine environment:

- intentionally produced items;
- inherent by-products of other products or activities;
- emitted through accident or unintentional spill; and
- macroplastic degradation.

2.79 The committee received evidence that in Australia, sewage and stormwater systems provide important pathways for microplastics to move into the marine environment. In addition, sewage and other domestic waste is often added to soils to improve nutrients and reduce water-loss. This process contaminates soil with microplastics which eventually enter the marine environment through sediment movement.[95]

Intentionally produced items

2.80 Microbeads are commercially produced in particle sizes from 10 microns (μm) to 1000 μm (1 mm). They are generally made from polyethylene and have a range of commercial uses.[96] Microbeads are used in products as abrasives including exfoliating personal care products (PCP) such as face and body wash and toothpaste while other PCP use microbeads for bulking or slip effect such as shaving foam, lipstick, mascara or sunscreen. The Total Environment Centre stated that 'a single tube of deep facial cleanser can contain 350,000 microbeads'.[97]

2.81 Clean Up Australia submitted that researchers at Plymouth University conducted a study of facial scrubs which list plastics as an ingredient. The study subjected the scrubs to vacuum filtration to obtain the plastic particles and subsequent analysis using electron microscopy found that each 150 ml of the products could contain between 137,000 and 2.8 million microparticles of plastic.[98]

94 Australian Institute of Marine Science, *Submission 11*, p. 2.

95 Dr Mark Browne, and co-authors Professor Tony Underwood, Professor Gee Chapman, Professor Emma Johnston, *Submission 21*, pp. 1–2.

96 Total Environment Centre, *Submission 1*, p. 8.

97 Total Environment Centre, *Submission 1*, p. 8.

98 Clean Up Australia, *Submission 9*, p. 10.

2.82 Industrial products intentionally utilising microplastics include plastic blasting grit, speciality products used in oil and gas exploration and printing, and medical products such as dentistry polish.[99]

2.83 The Total Environment Centre noted that microbeads disposed of in waste water are not filtered out in treatment plants. Even with the use of sophisticated processes for the settling of solids in sewage, which could remove large amounts of microbeads from effluent, microbeads would still cause extensive pollution. The Total Environment Centre noted that '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'.[100]

Microplastic by-product

2.84 Microplastic by-product includes dust from cutting and polishing plastic items, maintaining painted metal constructions such as bridges and buildings, and high pressure washing of painted items. It also includes household and commercial building dust created through weathering and abrasion of plastic items and carpet, building maintenance, and clothing fibres loosened during laundering.

2.85 When synthetic fabrics are laundered, fabric threads are often lost. The washing machine wastewater containing these fabric fibres then enters the sewage network and is subsequently discharged into the marine environment via treatment plants. A single garment can produce >1900 fibres per wash with polyester (67 per cent) and acrylic (17 per cent) the dominant fibres found in wastewater.[101] These fibres are too small to be filtered during processing.

2.86 Road dust contains microplastic by-product from tyre friction, road paint and polymer modified bitumen. In addition, waste handling by-products often include plastic particles from the shredding and fragmenting of plastic waste such as mattresses, bottles and plastic bags.[102] European studies have identified that passenger vehicles have an emission rate of 0.1 gram of tyre dust per vehicle kilometre travelled. Commercial vehicles and trucks have more extensive tyre loss.[103] For example, the Norwegian Environment Agency estimated that 4,500 tonnes of road dust were

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99 Norwegian Environment Agency, *Sources of microplastic-pollution to the marine environment*, 4 December 2014, http://www.miljodirektoratet.no/Documents/publikasjoner/M321/M321.pdf, (accessed 23 February 2016), p. 12.

100 Total Environment Centre, *Submission 1*, p. 8.

101 Sydney Coastal Councils Group Inc., *Submission 8*, p. 3.

102 Norwegian Environment Agency, *Sources of microplastic-pollution to the marine environment*, 4 December 2014, http://www.miljodirektoratet.no/Documents/publikasjoner/M321/M321.pdf, (accessed 23 February 2016), pp. 13–14.

103 Norwegian Environment Agency, *Sources of microplastic-pollution to the marine environment*, 4 December 2014, http://www.miljodirektoratet.no/Documents/publikasjoner/M321/M321.pdf, (accessed 23 February 2016), p. 40.

produced per annum based on the number of road users, and the types of vehicles used. The Boomerang Alliance estimated that between 23–24,000 tonnes per annum of tyre dust are potentially entering the marine environment in Australia.[104]

2.87 European studies also identified that road paint, and polymers used to strengthen bitumen are released into the marine environment through urban runoff and stormwater systems. The Norwegian Environment Agency estimates that 320 tonnes of road paint per annum were lost through wear and tear.[105]

2.88 The processing of plastic products in waste-handling facilities and recycling facilities can lead to the loss of microplastic dust into the air. For example, Mr Dave West, National Policy Director and Founder, Boomerang Alliance told the committee that recent studies in Victoria found that mattress recycling facilities were losing twenty percent of the product in dust generated by shredding. Windborne microplastics from waste-handling and recycling facilities are also likely to end up in the marine environment either directly, or through transportation in the stormwater system. [106]

Unintentional release

2.89 Microplastics unintentionally released into the marine environment include pre-production plastic pellets (nurdles) being washed into stormwater drains near plastic extruder or recycling factories. The Surfrider Foundation Australia commented that studies of the presence of nurdles in five states found concentrations as high as 6000 nurdles per square metre of beach.[107]

2.90 The Total Environment Centre noted that there are a number of causes for the prevalence of nurdles found in the marine environment. These include factories having unsound spill-over cleaning practices, and a lack of mitigation measures to prevent the loss of nurdles into the environment from the factory floor. In particular, factories hose their buildings and workshop floors down at night, resulting in pellets washing into drains. In addition, hopper cars and trucks transporting nurdles are not required to have lids on their containers which can result in spills.[108]

2.91 Stormwater drains are often unfiltered or do not have sufficient filtering, and are unable to prevent the movement of nurdles into the stormwater system. The Total

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104 Boomerang Alliance, *Submission 6*, p. 9. The Boomerang Alliance acknowledged that to date there are no Australian studies conducted into sources such as tyre dust, and this figure represents an estimate.

105 Norwegian Environment Agency, *Sources of microplastic-pollution to the marine environment*, 4 December 2014, http://www.miljodirektoratet.no/Documents/publikasjoner/M321/M321.pdf, (accessed 23 February 2016), p. 40.

106 Mr Dave West, Boomerang Alliance, *Committee Hansard*, 18 February 2016, p. 53.

107 Surfrider Foundation Australia, *Submission 14*, p. 5.

108 Total Environment Centre, *Submission 1*, p. 8.

Environment Centre explained that the Tangaroa Blue Foundation has carried out a number of studies examining the prevalence of nurdles on Australian beaches. In particular, Tangaroa Blue 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.[109]

2.92 Similarly, research conducted around Brisbane has found pellets located within the Brisbane River both upstream and downstream from Brisbane's main industrial and manufacturing areas highlighting the strong possibility of domestic release.[110]

Degradation of macroplastics

2.93 Microplastics are also formed through the degradation of macroplastic items both within the marine environment, and on land. Plastic degrades through oxidation, UV exposure, wave action, and animal and insect digestion and nesting. Macroplastics are also shredded by boat and ship propellers, and released when plastic contaminated sediment is dredged. Birdlife Australia cited a study published in 2012 which reported that individual burrowing isopods (invertebrates) can generate thousands of microplastic particles by boring into styrofoam floats used in jetties, docks and aquaculture facilities. The study found that floats from aquaculture facilities and docks were heavily damaged by thousands of isopods and their burrows and concluded that:

> …one isopod creates thousands of microplastic particles when excavating a burrow; colonies can expel millions of particles.[111]

2.94 A number of witnesses told the committee that so-called 'biodegradable plastics' are particularly prone to breaking into smaller and smaller particles. For example, Ms Terri-Anne Johnson from Clean Up Australia highlighted biodegradable plastic bags which 'break down into smaller and smaller strips of plastic'.[112]

Rates of microplastic pollution in Australia

2.95 While it is generally considered that microplastic pollution is pervasive, few studies have quantified the amount of microplastics in Australian waters. However, AIMS noted a further study undertaken in 2014 where researchers from the Sydney Institute of Marine Science conducted a survey of Sydney Harbour which found 'alarming' levels of microplastic pollution.[113] Sediment samples taken at 27 sites

109 Total Environment Centre, *Submission 1*, pp. 8–9.

110 Total Environment Centre, *Submission 1*, p. 8.

111 Birdlife Australia, *Submission 76*, p. 6.

112 Ms Terri-Anne Johnson, Clean Up Australia, *Committee Hansard*, 18 February 2016, p. 34.

113 Australian Institute of Marine Science, *Submission 11*, p. 3.

across the Harbour found concentrations of microplastics ranged from 0–10 to a high of 61–100 particles per 100 square millimetres of sediment in Middle Harbour.[114]

The cost of marine plastic pollution

2.96 Dr Britta Denise Hardesty, CSIRO, commented that 'the cost of littering and debris to fisheries, small business and human health remain poorly understood, and littering costs to local government due to remediation and tourism losses are substantial'.[115] In answer to the committee's questions concerning the estimates of the damage from marine debris on Australia's tourism, fishing and shipping, the Department of the Environment added that it did not have any estimates nor did other Commonwealth agencies including the Great Barrier Reef Marine Park Authority, the Australian Maritime Safety Authority and the Australian Fisheries Management Authority.[116]

2.97 One source of evidence on the cost of marine plastic pollution is the recently released report by the World Economic Forum which commented that the externalities related to the use of plastics and plastic packaging are concentrated in three areas:

- degradation of natural systems as a result of leakage, especially in the ocean;
- greenhouse gas emissions resulting from production and after-use incineration; and
- health and environmental impacts from substances of concern.

2.98 The World Economic Forum cited a 2014 study by the UNEP which estimated the total natural capital cost of plastics in the consumer goods industry at $75 billion, of which $40 billion was related to plastic packaging.[117] The UNEP study pointed to the significant impact of ocean plastic on maritime natural capital. It was estimated that the annual damage of plastics to marine ecosystems is at least US$13 billion per year. The Asia-Pacific Economic Cooperation (APEC) also estimated that the cost of marine plastic pollution to the tourism, fishing and shipping industries was US$1.3 billion in that region.[118]

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114 Total Environment Centre, *Submission 1*, p. 7.

115 Dr Britta Denise Hardesty, CSIRO, *Committee Hansard*, 26 February 2016, p. 1.

116 Department of the Environment, *Answer to questions on notice No. 5*, 26 February 2016.

117 World Economic Forum, *The New Plastics Economy*: *Rethinking the future of plastics*, January 2016, http://www3.weforum.org/docs/WEF_The_New_Plastics_Economy.pdf, (accessed 23 February 2016), p. 13.

118 World Economic Forum, *The New Plastics Economy*: *Rethinking the future of plastics*, January 2016, http://www3.weforum.org/docs/WEF_The_New_Plastics_Economy.pdf, (accessed 23 February 2016), p. 14.

2.99 The World Economic Forum commented specifically on the costs of plastic packaging and stated:

> A staggering 32% of plastic packaging escapes collection systems, generating significant economic costs by reducing the productivity of vital natural systems such as the ocean and clogging urban infrastructure. The cost of such after-use externalities for plastic packaging, plus the cost associated with greenhouse gas emissions from its production, has been estimated conservatively by UNEP at $40 billion—exceeding the plastic packaging industry's profit pool.[119]

2.100 In addition, the World Economic Forum noted that as a consequence of low recycling rates, 95 per cent of plastic packaging material value (US$80–120 billion) is lost to the economy after a short first use.[120]

2.101 A further matter raised in submissions was the cost of clean-ups by volunteers. Clean Up Australia submitted that cost of community effort to reduce marine plastic pollution is undervalued. Clean Up Australia estimated that the cost of holding Clean Up Australia Day was $35.216 million per annum. This was based on the value of volunteers (1,052,536 volunteer hours at an average wage rate of $31.11 per hour), pro bono services (including local government rubbish collection services) of at least $1 million as well as event related expenditure and management and administration costs.[121] Similarly, the value of volunteer efforts to clean up the Georges River were estimated to be $2.8 million over four years.[122]

2.102 The cost of removing litter, including plastic debris, were provided to the committee. For example, in 2012–13, the Victorian Government spent $80 million in removing litter, including the removal of over 7,800 tonnes of litter from Melbourne waterways.[123]

2.103 The committee notes that, in addition to the direct economic costs, there are also potential adverse impacts on human livelihoods and health, food chains and other essential economic and societal systems.

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119 World Economic Forum, *The New Plastics Economy*: *Rethinking the future of plastics*, January 2016, http://www3.weforum.org/docs/WEF_The_New_Plastics_Economy.pdf, (accessed 23 February 2016), p. 10.

120 World Economic Forum, *The New Plastics Economy*: *Rethinking the future of plastics*, January 2016, http://www3.weforum.org/docs/WEF_The_New_Plastics_Economy.pdf, (accessed 23 February 2016), p. 10.

121 Clean Up Australia, *Submission 9*, p. 5.

122 Georges River Combined Councils' Committee, *Submission 17*, p. 4.

123 Associate Professor Mark Osborn, *Submission 16*, p. 2.

International initiatives on marine pollution

2.104 A range of global initiatives have been developed to ensure international cooperation in reducing the rates of marine pollution, and in reducing the harm associated with such pollution. These initiatives include The Honolulu Strategy, the Honolulu Commitment and the Global Partnership on Marine Litter. The United Nations Environment Assembly and UNEP have both also noted marine plastic as an issue of concern.

The Honolulu Strategy

2.105 In 2011, the US National Oceanic and Atmospheric Administration co-hosted the Fifth International Marine Debris Conference in conjunction with the United Nations Environment Programme. The conference resulted in the development of the Honolulu Strategy which is a framework for the global effort to reduce the impacts of marine debris.

2.106 The Honolulu Strategy Goals are:

- reduced amount and impact of land-based sources of marine debris introduced into the sea;
- reduced amount and impact of sea-based sources of marine debris (including solid waste, lost cargo, ALDFG, and abandoned vessels) introduced into the sea;
- reduced amount and impact of accumulated marine debris on shorelines, in benthic habitats, and in pelagic waters.[124]

2.107 In addition to the Honolulu Strategy, the Honolulu Commitment was also developed. This is a 12 point pledge to which international organisations, governments, non-government organisations and citizens are encouraged to commit. The pledge includes making choices to reduce waste, facilitating initiatives that turn waste into a resource in an environmentally sustainable manner, developing global, regional, national and local targets to reduce marine debris.[125]

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124 United Nations Environment Programme and the National Oceanic and Atmospheric Administration, *The Honolulu Strategy*, p. 2, http://marinedebris.noaa.gov/sites/default/files/publications-files/Honolulu_Strategy.pdf, (accessed 22 March 2016).

125 The Fifth International Marine Debris Conference, *The Honolulu Commitment* , http://www.unep.org/pdf/PressReleases/Honolulu_Commitment-FINAL.pdf, (accessed 22 March 2016), p. 2.

Global Partnership on Marine Litter

2.108 The Global Partnership on Marine Litter (GPML) was launched at the Rio+20 meeting in Brazil in 2012. It is a voluntary open-ended partnership for international agencies, governments, businesses, academia, local authorities, nongovernmental organisations and individuals.

2.109 The launch of the GPML complemented paragraph 163 of the Rio outcome document, *The Future We Want*, which noted with concern that the health of oceans and marine biodiversity are negatively affected by marine pollution, including marine debris, especially plastic and committed to take action to reduce the incidence and impacts of such pollution on marine ecosystems.

2.110 The GPML seeks:

- to reduce the impacts of marine litter worldwide on economies, ecosystems, animal welfare and human health;
- to enhance international cooperation and coordination through the promotion and implementation of the Honolulu Strategy and the Honolulu Commitment;
- to promote knowledge management, information sharing and monitoring of progress on the implementation of the Honolulu Strategy;
- to promote resource efficiency and economic development through waste prevention e.g. the 4Rs (reduce, re-use, recycle and re-design), and by recovering valuable material and/or energy from waste;
- increase awareness on sources of marine litter, their fate and impacts; and
- to assess emerging issues related to the fate and potential influence of marine litter, including (micro) plastics uptake in the food web and associated transfer of pollutants, and conservation and welfare of marine fauna.[126]

UN Environment Assembly and the UN Environment Programme

2.111 The UN General Assembly addressed the issue of marine litter in November 2005 and a resolution was passed. Following the resolution, a series of consultations occurred in cooperation with a number of UN agencies, and it was decided that the United Nations Environment Programme should take the lead in developing global and regional activities on marine litter.[127]

2.112 In June 2014, governments attending the first UN Environment Assembly noted with concern the impacts of plastics and microplastics on the marine environment, fisheries, tourism and development. They called for strengthened action,

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126 Global Partnership on Marine Litter, *Factsheet*, http://unep.org/gpa/documents/gpml/GPMLFactsheet.pdf

127 United Nations Environment Programme, http://www.unep.org/regionalseas/marinelitter/about/mandate/default.asp

in particular by addressing such materials at the source. A resolution was adopted calling for the strengthening of information exchange mechanisms, requesting UNEP to present scientific assessments on microplastics for consideration by the next session of the Assembly.[128]

Committee comment

2.113 The committee acknowledges both the magnitude, and the pervasiveness of marine plastic pollution. Evidence clearly demonstrates that this is an issue of global concern with vast quantities of plastic entering the marine environment on a daily basis. The committee understands that calculating the exact rates of plastic pollution into the future is difficult, but is of the view that estimates of current rates of pollution are sufficiently high as to warrant immediate action. The committee also accepts that marine plastic pollution in the Australian marine environment is difficult to quantify, but that amounts recovered through clean-up activities would point to the problem being significant.

2.114 Marine plastic pollution originates from both land- and ocean-based sources, and as such mitigation strategies must be designed to address both. There is evidence that in the Australian context, there are both domestic and international sources—these include urban litter, garbage from shipping, and abandoned fishing gear from international fishing operations. The committee was presented with comprehensive evidence of the enormous volume of single-use plastic packaging associated with the food and beverage industry found in marine plastic pollution.

2.115 Plastic, unless it is removed from the marine environment, will continue to exist, albeit in increasingly smaller sizes. The committee notes with concern the evidence provided on the threat posed by microplastics. In particular, the inability to easily measure the rates of microplastic pollution, the wide variety of microplastic sources, and the impossibility of removing microplastics from the marine environment through clean-up activities.

2.116 The committee accepts the evidence that plastic has a number of externalities, such as the degradation of natural systems including the marine environment, and costs to government and community. The committee is of the view that these externalities must be further explored in order to fully understand the costs associated with marine plastic pollution in Australia

128 Global Partnership on Marine Litter, *Marine Litter – The Issue*, http://unep.org/gpa/gpml/issue.asp