Chapter 3

The effects of marine plastic pollution

3.1 While public perception of the effects of plastic in the oceans has been formed by images of turtles and other marine fauna entangled in fishing lines and plastic debris, the effects of marine plastic pollution are more widespread, can be less visible and many are only now being identified. There also remain significant gaps in knowledge about the effects of marine plastic pollution including the population level impacts of ingestion, the effects on human health of plastics in the food chain, and the frequency and potential effects of invasive species via marine debris, as well as the effects of microplastics.

3.2 As the Australian Institute of Marine Science (AIMS) concluded:

> The risks of marine plastic pollution to marine life, ecosystems and fisheries are uncertain, and understanding them requires detailed information on: (i) the likelihood of exposure to plastics and (ii) the direct and indirect effects of the plastics. At present it is not possible to rank the risks posed by marine plastic pollution in the marine environment (internationally or nationally) against more comprehensively studied pressures such as climate change or land-based pollution.[1]

3.3 This chapter provides an overview of the effects of plastic pollution on marine fauna (including ingestion and entanglement), human health, fisheries and shipping, and ecosystems. It also identifies areas where more research is required.

Effects of plastic pollution on marine fauna

3.4 The committee received considerable evidence on the impact of plastic pollution on marine fauna. This evidence included research from leading Australian academics, government agencies and community organisations. The evidence indicated that plastic pollution affects marine fauna and flora through:

- ingestion;
- entanglement;
- the transport and bioaccumulation of harmful chemicals; and
- the transport of invasive species.

Ingestion

3.5 Plastic ingestion has been documented in a large range of marine species—the committee received evidence that over 200 species of marine animal are recorded as

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

having ingested manufactured polymers.[2] Dr Kathy Townsend told the committee that 'on a global scale Australia has been recognised as a hot spot for marine debris ingestion for both seabirds and sea turtles'.[3] AIMS added that, based on evidence from overseas studies, 'it is highly likely that plastic ingestion is much more widespread and includes many more marine species in northern Australia than currently documented'.[4]

3.6 Studies indicate that plastic bags, cling film, food wrappers and balloons are most commonly consumed by turtles, while seabirds consume degraded hard plastics sourced from take away containers, single-use plastics and discarded consumer products.[5] Dr Townsend explained that balloons are attractive to both seabirds and turtles because they look similar to squid and jellyfish. Red and orange balloons are particularly appealing to marine fauna as they are similar colours to traditional prey species.[6] Dr Hardesty added that matter adhering to the surface of plastic, such as roe, may make objects attractive to seabirds.[7]

3.7 The committee received evidence that plastic ingested by animals is known to 'physically block their digestive tracts, alter feeding behaviour and dietary inputs'.[8] Plastic debris may also lacerate the mouth and digestive tract causing serious injury to the animal. This may also result in a greater susceptibility to predators and disease, and a decreased ability to breed and rear young.[9]

3.8 However, the committee was also informed that the ability to assign actual cause of death to plastic ingestion is 'exceptionally small.' Dr Britta Denise Hardesty, CSIRO, explained that differentiation between causality and correlation is 'really important' and that unless gut perforation or blockage is identified, cause of death can be difficult to identify. Dr Hardesty also commented that CSIRO is undertaking work to try to estimate how much plastic is required to kill a turtle or a seabird.[10]

3.9 The following discussion provides an overview of evidence received in relation to ingestion of plastics by turtles, seabirds, cetaceans and corals and zooplankton.

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2 Dr Kathy Townsend and Dr Qamar Schuyler, *Submission 141*, p. 1; see also Humane Society International, *Submission 22*, p. 2.

3 Dr Kathy Townsend, *Committee Hansard*, 10 March 2016, p. 1.

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

5 Dr Kathy Townsend and Dr Qamar Schuyler, *Submission 141*, p. 1.

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

7 Dr Britta Denise Hardesty, CSIRO, *Committee Hansard*, 26 February 2016, p. 10.

8 Dr Mark Browne, and co-authors Professor Tony Underwood, Professor Gee Chapman, Professor Emma Johnston, *Submission 21*, p. 3.

9 Humane Society International, *Submission 22*, p. 2.

10 Dr Britta Denise Hardesty, CSIRO, *Committee Hansard*, 26 February 2016, p. 9.

Turtles

3.10 The committee received a range of evidence on the ingestion of marine plastic pollution by turtles. In particular, the types of plastic consumed, the species particularly susceptible to plastic consumption, and the rates of death and injury as a result.

3.11 Dr Townsend stated that ingestion by turtles has been increasing historically, with ingestion rates of over 60 per cent in some species of sea turtles since 1980. It is also estimated that over 50 per cent of the world's sea turtles have ingested marine debris worldwide as the population stands now.[11]

3.12 Studies indicate that certain species are more likely to ingest plastic, with oceanic leatherback turtles and green turtles being at the greatest risk of both lethal and sub-lethal effects of ingesting plastic debris.[12] Dr Townsend indicated that younger turtles, at both the 'lost years-stage' and at the 'benthic-stage', are particularly prone to plastic ingestion.[13] Research has found that smaller, oceanic-stage turtles are more likely to ingest plastic debris than coastal foragers, and carnivorous species are less likely to ingest debris than herbivores or gelatinovores (jellyfish eaters). The CSIRO also found that benthic-stage turtles favour soft clear plastic, possibly because it resembles jellyfish.[14]

3.13 The CSIRO in collaboration with the University of Queensland, and the Imperial College, London, identified that turtles are selective of materials and prefer to ingest items 'that are flexible, and different in colour from the background debris in the ocean'.[15] Dr Townsend also told the committee that:

> …studies have shown that for turtles, for instance, things such as plastic bags, cling film, food wrappers and balloons are the most commonly consumed plastic debris, regardless of life stage.[16]

3.14 Once plastic has been ingested by a turtle, the animals have difficulty in ridding themselves of this debris—many turtles have downward facing spines in their throats which prevent the regurgitation of plastic. The plastic subsequently remains in

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11 Dr Kathy Townsend, *Committee Hansard*, 10 March 2016, p. 1; see also CSIRO, *Submission 7*, Appendix 3, 'Input to Department of Environment Threat Abatement Plan', p. 24.

12 CSIRO, *Submission 7*, p. 5.

13 'Lost years stage' turtles are younger turtles which float on the open ocean feeding on the first one to two metres of the surface. 'Benthic stage' turtles are slightly older juveniles which live in the benthic zones, feeding primarily from the ocean floor. See Dr Kathy Townsend, *Committee Hansard*, 10 March 2016, p. 6.

14 CSIRO, *Submission 7*, Appendix 2, 'Executive Summary "Understanding the effects of marine debris on wildlife: Final report to Earthwatch Australia"', p. 10.

15 CSIRO, *Submission 7*, Appendix 3, 'Input to Department of Environment Threat Abatement Plan', p. 24.

16 Dr Kathy Townsend, *Committee Hansard*, 10 March 2016, p. 1.

the stomach where it blocks the digestion of food. In addition, plastic products often decompose within the turtle and produce gas which remains trapped inside the animal. These gases cause the turtle to float on the surface of the water, which can lead to starvation, and the inability to hide from predators.[17]

3.15 According to the Wildlife Preservation Society of Queensland, recent studies by the Queensland National Parks and Wildlife Service found that 'over 70% of loggerhead turtles found dead in Queensland waters have ingested plastic'. In addition, 30 per cent of sea turtle deaths in Moreton Bay can be attributed to the ingestion of plastic pollution.[18]

3.16 The committee received evidence from a number of organisations that provide rescue services for injured marine animals. For example, the Coolum and North Shore Coast Care explained that within its organisation there are a number of volunteers responsible for monitoring the nesting of endangered loggerhead and green sea turtles, and who attend turtle strandings. It further stated that sea turtles generally only strand when they are very ill or dead. It noted that in the past three years, there have been a total of 134 strandings, with 71 deceased animals found.[19] Necropsies were undertaken on a number of these deceased turtles at the University of Queensland Research Station. Data published by this facility in 2012 indicated that '33% of the sea turtles necropsied from the Brisbane and Sunshine Coast areas had ingested plastic debris'.[20] Similarly, the Great Barrier Reef Marine Park Authority commented that plastics make up 90 per cent of the marine debris ingested by marine turtles in Queensland.[21]

3.17 The Australian Seabird Rescue also noted that a database recording marine turtle strandings on the coast of northern New South Wales recorded a total of 142 strandings between 2001–2007. It indicated that of these strandings, 18 turtles were listed as having ingested plastic.[22]

3.18 However, the CSIRO stated that it is difficult to quantify the impact of ingestion in turtles, and as a result, it is currently working to analyse the relationship between ingestion and mortality. Preliminary results indicate that there is a 'positive relationship' between the two, and the CSIRO is currently collaborating with researchers at the University of Tasmania to estimate mortality rates.[23]

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17 Clean Up Australia, *Submission 9*, p. 10. See also Ms Kathrina Southwell, Australian Seabird Rescue, *Committee Hansard*, 10 March 2016, p. 23.

18 Wildlife Preservation Society of Queensland, *Submission 5*, p. 3.

19 Coolum and North Shore Coast Care, *Submission 56*, p. 3.

20 Coolum and North Shore Coast Care, *Submission 56*, p. 4.

21 Great Barrier Reef Marine Park, *Submission 29*, p. 1.

22 Australian Seabird Rescue Inc., *Submission 80*, p. 2.

23 CSIRO, *Submission 7*, Appendix 3, 'Input to Department of Environment Threat Abatement Plan', p. 24.

Seabirds and shorebirds

Seabirds

3.19 Seabirds live their lives in the open ocean and most only return to land to breed. Dr Hardesty commented that seabirds 'are truly pelagic…We consider seabirds as the canary in the coalmine, if you will, in the oceans. It is a really good indicator of ocean health'.[24]

3.20 The committee received extensive evidence on the ingestion of marine plastic by seabirds. This evidence included the effect of plastic ingestion on both adult and juvenile birds, the rate of plastic consumption, and the future direction of research in this field.[25]

3.21 Seabirds ingest a variety of items, with Dr Townsend informing the committee that seabirds largely consume 'balloons and degraded hard plastics, usually sourced from things like takeaway containers, water bottles and other single-use plastics and discarded consumer products'.[26] Other submitters also provide evidence of the types of plastic debris found in seabirds. For example, Dr Hardesty reported seeing toothbrushes, bottle caps and even glass bottles with metal lids inside albatross.[27] Dr Heidi Auman, submitted findings from her research and stated:

> 98% of Laysan albatross chicks from Midway Atoll National Wildlife Refuge contained marine plastic debris in their stomachs. Most of this could be measured in multiple handfuls and included: shards of unidentified plastic, bottle caps, Styrofoam, beads, fishing line, buttons, chequers, disposable cigarette lighters (up to six per bird), toys, PVC pipe and other PVC fragments, golf tees, dish washing gloves, highlighter pens, medical waste and light sticks. Non-plastic items included neoprene O-rings, rubber pieces, and a lightbulb. Naturally killed chicks had significantly greater masses of plastic and had significantly lighter body masses and lower fat indices than injured but otherwise healthy chicks.[28]

3.22 In addition, research shows that chicks of some species are being fed plastic while in the nest. Mr Ian Hutton commented that studies showed 79 per cent of flesh-footed shearwater chicks contained some ingested plastic, fed to them by their parents who picked this debris up while foraging over the Tasman Sea.[29]

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24 Dr Britta Denise Hardesty, CSIRO, *Committee Hansard*, 26 February 2016, p. 5.

25 See for example CSIRO, *Submission 7*, Mr Ian Hutton, *Submission 69*, Dr Kathy Townsend and Dr Qamar Schuyler, *Submission 141*, Australian Seabird Rescue, *Submission 80*.

26 Dr Kathy Townsend, *Committee Hansard*, 10 March 2016, p. 1.

27 Dr Britta Denise Hardesty, CSIRO, *Committee Hansard*, 26 February 2016, p. 10.

28 Dr Heidi Auman, *Submission 190*, p. 1.

29 Mr Ian Hutton, *Submission 69*, p. 1.

3.23 In 2014, the CSIRO published the results of a global risk analysis of seabirds and marine debris ingestion for nearly 200 species. It was found that 43 per cent of seabirds and 65 per cent of individuals within a species have plastic in their gut.[30] The CSIRO predicted that 95 per cent of the world's seabirds will have ingested plastic by 2050 due to the steady increase in plastics production.[31]

3.24 The committee received evidence that the Tasman Sea, between Australia and New Zealand and the Southern Ocean, has been identified as a 'hotspot' for the potential impact of plastic ingestion by seabirds.[32] For example, a study conducted by the CSIRO identified that 67 per cent of short-tailed shearwaters (*Puffinus tenuirostris*) were found to have ingested marine plastic pollution. The study found that juvenile birds were more likely to ingest plastic than adults, and that juveniles consumed larger amounts.[33]

3.25 Dr Jennifer Lavers, who conducts research with Mr Hutton into the flesh-footed shearwater (*Puffinus carneipes*) populations on Lord Howe Island, told the committee that since 2005 there has been a gradual increase in the amount of plastic and also the proportion of the population ingesting plastics. Mr Hutton added that in one instance, 274 pieces of plastic were retrieved from a deceased bird. Mr Hutton stated that this was a record and represented '14 per cent of the body weight' of the bird.[34] Mr Hutton went on to note that this 'is the equivalent of a human carrying a pillowcase full of plastic in...[their] stomach'.[35]

3.26 The committee was interested to hear that plastic items retrieved from the stomachs of seabirds on Lord Howe Island were able to be identified as items originating from Australia rather than from overseas sources. In particular, Mr Hutton told the committee that bottle lids, balloon clips, and caps from milk cartons, marked with identifiable Australian brands are regularly retrieved from the stomachs of birds.[36]

3.27 Dr Lavers told the committee that seabirds such as the shearwaters on Lord Howe Island have been found severely emaciated as a result of ingesting large amounts of plastic. In addition, the ingestion of plastic has also been found to affect

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30 CSIRO, *Submission 7*, Appendix 2, 'Executive Summary "Understanding the effects of marine debris on wildlife: Final report to Earthwatch Australia"', p. 11.

31 CSIRO, *Submission 7*, p. 5.

32 CSIRO, *Submission 7*, Appendix 2, 'Executive Summary "Understanding the effects of marine debris on wildlife: Final report to Earthwatch Australia"', p. 11.

33 CSIRO, *Submission 7*, Appendix 2, 'Executive Summary "Understanding the effects of marine debris on wildlife: Final report to Earthwatch Australia"', p. 11.

34 Mr Ian Hutton, *Committee Hansard*, 18 February 2016, p. 21.

35 Mr Ian Hutton, *Committee Hansard*, 18 February 2016, p. 22.

36 Mr Ian Hutton, *Committee Hansard*, 18 February 2016, p. 13.

the growth and development of juvenile birds. Dr Lavers told the committee that on Lord Howe Island researchers:

> …very regularly find very severely emaciated birds, so the plastic has been linked with very significantly reduced body mass and also stunted wing growth. These are birds that are attempting to make their first flight out to sea with wings that are half the length of what they should be at that age. You can imagine that their survivability is, as a result of that, very low.[37]

3.28 Dr Lavers also noted that despite research being available on the impact of plastic ingestion on individual birds, there is a 'key research gap' in understanding the 'population level impact'.[38] Dr Lavers did however provide the committee with 'a very rough estimate' that the juvenile survival rate of shearwaters is reduced by 'approximately 11 per cent'.[39]

3.29 The key research gap in understanding the effect of marine plastic ingestion at the population level has been widely recognised by the scientific community. Dr Hardesty noted that while there were many papers and stories on individual species, there was a need to commence addressing the population level impacts.[40] Similarly, Professor Tony Underwood, stated that modelling of populations is not being undertaken and pointed to the work on the petrels in Europe. While sampling is carried out to measure the amount of plastic ingested, there is no improvement in understanding or any assessment of the risk to a species.[41]

3.30 Dr Hardesty went on to comment that the CSIRO has developed a method to allow assessment at the population level for seabirds. This is a non-invasive method for measuring the amount of plastic in a seabird which examines the oil secreted from a seabird's preening gland.[42] This method can be applied at the 'individual, population and species levels and it has no observed detrimental impacts'.[43] Dr Hardesty described this research as an opportunity to address the issue of marine plastic pollution 'holistically'.[44]

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37 Dr Jennifer Lavers, *Committee Hansard*, 18 February 2016, p. 18.

38 Dr Jennifer Lavers, *Committee Hansard*, 18 February 2016, p. 19.

39 Dr Jennifer Lavers, *Committee Hansard*, 18 February 2016, p. 18.

40 Dr Britta Denise Hardesty, CSIRO, *Committee Hansard*, 26 February 2016, p. 10.

41 Professor Tony Underwood, *Committee Hansard*, 18 February 2016, p. 19.

42 CSIRO, *Submission 7*, Appendix 3, 'Input to Department of Environment Threat Abatement Plan', p. 20.

43 CSIRO, *Submission 7*, Appendix 2, 'Executive Summary "Understanding the effects of marine debris on wildlife: Final report to Earthwatch Australia"', p. 11.

44 Dr Britta Denise Hardesty, CSIRO, *Committee Hansard*, 26 February 2016, p. 10; see also ANSTO, *Submission 191*.

Shorebirds

3.31 Shorebirds, also known as waders, inhabit coastal margins around the world. Resident shorebirds in Australia include the Hooded Plover and Pied Oystercatchers. Approximately 60 species of migratory shorebirds visit Australia including Sandpipers and Stints.[45] Shorebirds forage on coastlines around the world, both rocky and sandy foreshores. Many species are visual foragers, that is, they visually locate their prey on or in the sediments and beachcast seaweeds and grasses before ingestion.[46]

3.32 As with seabirds, concerns were raised about the ingestion of plastics by shorebirds. The submission from Birdlife Australia focused on the potential threat to resident and migratory shorebirds from the ingestion of microplastics and the associated absorbed chemicals. Dr Eric Woehler, Convenor, Birdlife Tasmania, argued that:

> …every single shorebird that feeds on Australia's foreshore or coastal areas would potentially be at risk from ingesting microplastics. It is clear from the literature around the world that these microplastics are not just confined to marine environments; they are also found in freshwater and estuarine environments. These foreshore areas—estuarine, freshwater and marine—are all used by migratory and resident shorebirds in Australia.[47]

3.33 In particular, Birdlife Australia submitted that shorebirds may face threats from marine microplastics through the ingestion of the particles themselves that can remain in their stomachs and potentially accumulate over time, and from the ingested microplastics that are likely to have absorbed persistent organic pollutants and metals that can be transferred to the shorebirds' body tissues.[48]

3.34 The effects of microplastics in the marine environment are canvassed in more detail in the following discussion.

Cetaceans

3.35 The committee received evidence that ingestion of plastic by cetaceans, including dolphins and whales, can cause death and injury, particularly when plastic causes fatal blockages in the animals' digestive tracts. Plastic products may also lacerate digestive tracts or cause rupturing, which leads to the death of the animal.

3.36 An example of the ingestion of plastic by a whale, was provided by the Boomerang Alliance: in August 2000, an eight metre Bryde's whale died soon after stranding on a beach in Cairns. A subsequent necropsy found that its stomach

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45 Birdlife Australia, *Submission 76*, pp. 8–11.

46 Birdlife Australia, *Submission 76*, p. 13.

47 Dr Eric Woehler, Convenor, Birdlife Tasmania, 26 February 2016, p. 33.

48 Birdlife Australia, *Submission 76*, p. 13.

contained six square metres of plastic, including a large number of lightweight single-use plastic bags.[49]

3.37 However, Professor Underwood cautioned the committee against assuming that ingestion of plastic caused death in every case of whale stranding. Professor Underwood told the committee that 'very few…cases were autopsied' so there is very little evidence of the 'biological consequences' of plastic ingestion.[50]

3.38 Dr Hardesty similarly told the committee that researching the consequences of ingestion and entanglement on cetaceans was deemed important by the Australian Government as they 'are really good indicators of ocean health'. However, this work has not occurred yet.[51]

Corals and zooplankton

3.39 The committee received evidence that in addition to large marine animals, research indicates that corals and zooplankton also ingest marine plastic pollution.

3.40 A number of submissions stated that the ingestion of microplastics poses a threat to coral reefs. For example, Clean Up Australia submitted that corals are non-selective feeders and readily consume microbeads and microplastics that are present in seawater. Clean Up Australia went on to note that a study conducted by the Australian Research Council Centre of Excellence for Coral Reef Studies discovered that corals digest microplastics at almost the same rate as normal food, and are unable to expel them from their digestive systems. There is concern that eventually, corals will starve and die as their digestive cavities are filled with plastic.[52] Further research is being undertaken to determine the impact plastic has on coral physiology and health, as well as its impact on other marine organisms.[53]

3.41 Research is also being conducted into the trophic (that is, from prey to predator) transfer of plastics, and accumulated chemicals through the ingestion of zooplankton. Birdlife Australia submitted that studies have found microplastics present in planktivorous fish, which are fish that feed on zooplankton.[54]

3.42 Birdlife Australia also stated that limited evidence from a small number of studies has shown bioaccumulation of microplastics in seals from ingestion of fish

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49 Boomerang Alliance, *Submission 77*, p. 25.

50 Professor Tony Underwood, *Committee Hansard*, 18 February 2016, pp. 22–23.

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

52 Clean Up Australia, *Submission 9*, p. 10. See also http://www.coralcoe.org.au/news/great-barrier-reef-corals-eat-plastic.

53 James Cook University, 'Great Barrier Reef corals eat plastic', *Media release*, 2015, https://www.jcu.edu.au/news/releases/news-archive2/news-and-media1111111111111111115

54 Birdlife Australia, *Submission 76*, p. 11.

which have fed on zooplankton. However, the studies were not able to demonstrate whether the zooplankton or the fish had ingested the plastic.[55]

Entanglement

3.43 Evidence was presented to the committee on the threat of entanglement posed by marine plastic pollution. Marine fauna entanglement in marine plastic pollution includes entanglement in abandoned fishing gear such as nets and lines, plastic bags, packing straps, ropes, clothing and diving gear, and six-pack rings.

3.44 Entanglement can cause restricted mobility, scoliosis, starvation, smothering and wounding, which in turns leads to infections, amputation of limbs, and death. Entanglement can also reduce the ability to avoid predators.

3.45 Entanglement is a world-wide problem. Dr Townsend told the committee that:

> Worldwide, at least 143 species of marine animals have been entangled in marine debris, including most of the world's sea turtles. Locally, in Moreton Bay, we have estimated that between six and seven per cent of the animals are being entangled in marine debris. This plastic marine debris source for entanglements is coming mainly from the fishing industry, both commercial and recreational.[56]

3.46 However, it has been noted by researchers that, to date, there is scant data overall to provide a global estimate of the number of animals which have become entangled. Vegter *et al.* observed that most reports are either restricted to opportunistic observations of animals or are from heavily visited coastal regions. The researchers concluded that 'we likely observe only a small fraction of entangled or injured wildlife', thus actual or total rates of wildlife entanglement are not known.[57]

3.47 The committee received evidence that seabirds, turtles, whales, dolphins, dugongs, sea snakes, sharks, fish, crabs and crocodiles and numerous other species are killed and maimed through entanglement.[58] Eco Barge Clean Seas detailed an incident where a large, male green sea turtle weighing 120 kg was found stranded on Whitehaven Beach in the Whitsunday Islands. The animal was found with a 'completely amputated front left flipper and wounds on the rear of its body.' It is assumed that these injuries were sustained as a result of fishing line entanglement due to the depth and cleanliness of the cuts. Eco Barge Clean Seas stated that it is likely the animal either tried to rid itself of the fishing line or the line became entangled in coral and the animal was forced to pull itself free in order to return to the surface to

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55 Birdlife Australia, *Submission 76*, p. 12.

56 Dr Kathy Townsend, *Committee Hansard*, 10 March 2016, p. 1.

57 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

58 Australian Institute for Marine Science, *Submission 11*, p. 3;

breathe. Eco Barge noted that the turtle was mature, of breeding age, in peak condition and had 'probably migrated hundreds of kilometres to reach the Whitsundays to breed, instead becoming permanently maimed by lost fishing gear'.[59]

3.48 The committee also received a number of submissions from organisations and individuals who have rescued marine fauna entangled in plastic pollution.[60] For example, the Australian Seabird Rescue stated that:

> Over 40% of the sea turtles that come into care at Australian Seabird Rescue in Ballina are affected by plastic ingestion and/or entanglement, many of these animals die…We have found in any estuary, 20% of pelicans are injured by fishing line (made of plastic). Last year we had a Green Sea Turtle (that was otherwise healthy) that had to be euthanised due to a plastic bag wrapping tight around its flipper.[61]

3.49 Ms Kathrina Southwell, Managing Director of the Australian Seabird Rescue, told the committee that over the past 25 years, pelicans entangled in fishing line have been the most common species rescued, and rehabilitated.[62] However, Ms Southwell noted that many birds 'have to be euthanised because they may have a limb missing…so they cannot survive in the wild'.[63]

3.50 An area of concern is the entanglement of animals in discarded nets. This is a particular problem in northern Australian waters. The CSIRO and Ghostnets Australia have undertaken work in the Gulf of Carpentaria. From their analysis of approximately 9,000 nets intercepted in the Gulf of Carpentaria, it was estimated that at least 15,000 turtles had been entangled. The study examined the types of nets present in the Gulf of Carpentaria and found that large gills nets have particularly high catch rates of turtles. The study also concluded that given the number of nets that wash ashore in the region, the estimated number of entangled turtles can be extended to approximately 20,000 turtles.[64]

3.51 Dr Kroon, AIMS, commented on a study which examined the impact of ghost nets on sea-turtle populations. The aim of that project was to determine the spatial distribution and movement of ghost nets in the Arafura Timor Sea and to identify the demographic composition and origin of sea turtles found entangled in those nets. It was found that derelict fishing gear enters the Arafura Timor Sea from the north, or it is discarded locally, and that a particular type of net made of thin twine of medium-

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59 Eco Barge Clean Seas Inc. *Submission 13*, p. 3.

60 See for example, Eco Barge Clean Seas Inc., *Submission 13*, Mr Mick Morley, *Submission 164*, Wild Bird Rescues Gold Coast, *Submission 110*.

61 Australian Seabird Rescue, *Submission 80*, p. 4.

62 Ms Kathrina Southwell, Australian Seabird Rescue, *Committee Hansard*, 10 March 2016, p. 25.

63 Ms Kathrina Southwell, Australian Seabird Rescue, *Committee Hansard*, 10 March 2016, p. 24.

64 CSIRO, *Submission 7,* Appendix 3,' Input to Department of Environment Threat Abatement Plan', p. 14.

size, the so-called GR24 nets, are more prone to inflict harm to marine biodiversity than other types of nets. The majority of the entangled turtles, olive ridley sea turtles, found in washed up nets come from the Tiwi, McClure and West Papua regions—so from outside of Australia in part.[65]

3.52 The CSIRO also stated that entanglement of pinniped (seals and sea lions) species in plastic pollution is common. Research has found that the majority of pinniped entanglements in Victoria involved plastic twine or rope, and seals become entangled in green items more than in any other colour. Research also indicates that in general, young seals are entangled in greater numbers than adults.[66]

3.53 Research into entanglements with lost, abandoned or derelict fishing gear was considered to be a priority in the paper published by Vegter *el al.* as links to entanglement in derelict fishing gear 'could have considerable financial, environmental and safety implications for fisheries management, as the amount of fishing gear lost to the ocean is estimated to be 640,000 tonnes per year.[67]

Chemical accumulation and plastic-sourced chemicals

3.54 Submitters raised concerns with the potential toxic impacts of marine plastic pollution.[68] Evidence was provided to the committee that marine plastic pollution serves as both a transport medium for accumulated chemicals present in seawater, and is a source of toxic chemicals. The chemicals include pesticides such as DDT, polychlorinated biphenyls, and endocrine-active substances.[69]

3.55 According to the National Toxics Network, toxicity associated with plastics can be attributed to one or more of the following factors:

- residual monomers from the manufacturing process present in the plastic or toxic additives used in the compounding of plastic, leaching out of the plastic;
- partial degradation of certain plastics; and

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65 Dr Frederieke Kroon, Australian Institute of Marine Science, *Committee Hansard*, 10 March 2015, p. 15.

66 CSIRO, *Submission 7*, Appendix 2, 'Executive Summary "Understanding the effects of marine debris on wildlife: Final report to Earthwatch Australia"', p. 11.

67 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

68 Surfrider Foundation Australia, *Submission 14*, p. 4; OceanWatch Australia, *Submission 75*, p. 4.

69 National Toxics Network, *Submission 4*, p. 1.

- persistent organic pollutants[70] (POPs) present in seawater being absorbed and concentrated in microplastic fragments.[71]

3.56 POPs, which are almost universally present at very low concentration levels in seawater, are absorbed, usually by microplastic fragments. Large volumes of POPs can be absorbed by plastic, and scientists have found polypropylene pellets with up to one million times more concentrated levels of POPs than the surrounding seawater.[72]

3.57 The committee received evidence that 'microplastics have large surface area to volume ratios, thus absorbing large…quantities of chemicals, which can make them extremely toxic'.[73] The National Toxic Network commented that ingestion of pellets with even low concentrations of POPs by marine organisms is likely to present a threat to health. However, information on the extent to which ingestion of particular chemical components contributes to organism mortality, is not readily available.[74]

3.58 Some studies have been conducted on chronic dietary exposure to low-density polyethylene plastic. These studies found that ingestion may contribute towards the bioaccumulation[75] of potentially hazardous substances in fish, which can affect the health of the liver.[76] These chemicals are also known to compromise immunity and cause infertility in animals, even at very low levels.[77]

3.59 The committee also received evidence that toxic chemicals can be transferred into 'the tissues of marine worms and freshwater fish reducing functions strongly linked to health biodiversity'. In addition, ingestion of microplastics can compromise the immune systems of animals.[78] Dr Hardesty told the committee that some plastics, and the chemicals that adhere to them, act as 'hormone mimics' and that

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70 Persistent organic pollutants are organic compounds that are resistant to environmental degradation, and are known to bioaccumulate. Most persistent organic pollutants are currently or were in the past used as pesticides, solvents, pharmaceuticals and industrial chemicals. For more information see https://www.environment.gov.au/protection/chemicals-management/pops.

71 National Toxics Network, *Submission 4*, p. 2.

72 National Toxics Network, *Submission 4*, p. 2.

73 Dr Mark Browne, and co-authors Professor Tony Underwood, Professor Gee Chapman, Professor Emma Johnston, *Submission 21*, p. 2.

74 National Toxics Network, *Submission 4*, p. 3.

75 Bioaccumulation refers to the accumulation of substances such as pesticides, or other chemicals in an organism. It occurs when an organism absorbs a toxic substance at a rate faster than that at which the substance is lost.

76 Rochman C.M, Hoh E, Kurobe T, Swee J, 'Ingested plastic transfers hazardous chemicals to fish and induces hepatic stress', 2013, *Scientific Reports*, 3:3263. See National Toxics Network, *Submission 4*, p. 3.

77 Total Environment Centre, *Submission 1*, p. 9

78 Dr Mark Browne, and co-authors Professor Tony Underwood, Professor Gee Chapman, Professor Emma Johnston, *Submission 21*, p. 2.

'intergenerational transfer' (from a mother to a foetus) of some of the chemicals that are absorbed onto the plastic or that are the constituent components of the plastics themselves, can occur.[79]

3.60 However, a number of witnesses commented that there 'is little known about the long-term consequences' of exposure to plastics and accumulated pollutants.[80] Dr Lavers commented that chemical pollution from plastic ingestion is 'still poorly understood' and noted that plastic 'acts as a vector for a whole suite of pollutants, everything from metals to PCBs [polychlorinated biphenyl]'.[81] Dr Lavers went on to explain that:

> …chemical pollution is much less visible and therefore much more difficult to monitor. I think we are, at this stage, really truly underestimating the true impact of the chemical pollution that is associated with plastics, that morbidity effect. They are not necessarily dying, but perhaps they are not living as long; they are not reproducing as frequently. All of those kinds of impacts are so likely to occur, but right now we just do not have the quantitative data to back some of those statements up.[82]

Effects of microplastics

3.61 Evidence indicated that microplastics are now distributed throughout the oceans, including remote areas, and, as discussed above, are ingested by marine animals.

3.62 There is increasing concern with the effects of microplastics which enter the marine environment. These concerns are not limited to the scientific community; the committee received submissions from many organisations and individuals which identified microplastics as a major issue. For example, Parks Victoria commented:

> A growing concern for park managers is the presence of microplastics and particularly plastic nurdles in many park locations across the state, including remote areas such as Wilsons Promontory…While the full impacts of these materials are not well understood they have potential to cause significant harm to feeding chicks, and being widely distributed in the environment pose a particular risk to seabird colonies.[83]

79 Dr Britta Denise Hardesty, CSIRO, *Committee Hansard*, 26 February 2016, p. 6.

80 Dr Mark Browne, and co-authors Professor Tony Underwood, Professor Gee Chapman, Professor Emma Johnston, *Submission 21*, p. 2. See also Professor Mark Osborne, *Submission 16*, p. 3; Humane Society International, *Submission 22*, p. 2.

81 Dr Jennifer Lavers, *Committee Hansard*, 18 February 2016, p. 17.

82 Dr Jennifer Lavers, *Committee Hansard*, 18 February 2016, p. 18.

83 Parks Victoria, *Submission 79*,

3.63 Birdlife Australia also provided extensive evidence of its concerns about the effects of microplastics on shorebirds. Dr Woehler commented:

> We know, full well, the complexity of marine food webs, and we know from the work on the invertebrate sampling that has been done around the world that many of the food species that are consumed by shorebirds in Australia have been shown to ingest plastics. So it is a reasonable hypothesis or prediction to make that these birds would also be susceptible to ingesting the plastic through their food.[84]

3.64 Despite these significant concerns, Dr Woehler stated that there was no research on the impacts of microplastics on shorebirds:

> We believed that we would find a substantial volume of scientific literature detailing the ingestion of microplastics by shorebirds—as coastal, intertidal feeders—around the world, particularly in Europe and North America. But, unfortunately, we were unable to locate a single scientific study from anywhere in the world. Such a gap is remarkable and highly significant. The absence of such studies reinforces that there is still much to learn from our environment, particularly the marine environment.[85]

3.65 Dr Woehler went on to comment that Birdlife Australia considered that 'ingested microplastics and the absorbed chemicals associated with them are an unrecognised threat to resident and migratory shorebirds in Australia and elsewhere around the world'.[86] Birdlife Australia requested that the Commonwealth support directed scientific research into the interactions between shorebirds and microplastics in Australia.[87]

3.66 Dr Kroon also provided evidence on research being funded by AIMS which focuses on microplastics in zooplankton samples which were collected in the Great Barrier Reef and off Scott Reef. Plastic particles and fibres have been found in these samples. As the samples date back to 1997, they can be used to assess the presence and abundance of microplastics over time in these regions. In addition, during a field campaign in November 2015, in north-west Australia, AIMS detected small plastic particles and fibres in remote marine environments, including the Kimberley region and offshore in the Browse and Bonaparte basins. Further work will be undertaken to better understand the abundance and distribution and, eventually, the sources and fates of these plastic particles in the remote regions.[88]

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84 Dr Eric Woehler, Birdlife Tasmania, 26 February 2016, p. 34.

85 Dr Eric Woehler, Birdlife Tasmania, *Committee Hansard*, 26 February 2016, p. 33.

86 Dr Eric Woehler, Birdlife Tasmania, *Committee Hansard*, 26 February 2016, p. 33.

87 Birdlife Australia, *Submission 76*, p. 14.

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

3.67 Dr Mark Browne provided the committee with a number of areas where further research in relation to microplastic pollution was required, including rates of accumulation, and whether population growth of organisms is being slowed. Dr Browne added in terms of the 'unknown consequences we could be underestimating that—and that is because of a failure to put adequate research dollars behind these types of things'.[89]

3.68 The committee notes that during the consultation meetings for the revised threat abatement plan, microplastics were identified as an emerging issue. The Department of the Environment indicated that it was generally considered that the impact of microplastics needs to be better understood.[90] The threat abatement plan is discussed in detail in Chapter 4.

Possible effects of microplastics on human health

3.69 Many submitters voiced concerns about the possible effects of microplastics on humans. In response, the committee noted recent research and also sought advice from the scientists who appeared to give evidence on whether the human consumption of seafood results in the ingestion of microplastics carried by marine fauna, and what impact this may have on human health.

3.70 Studies have concluded that humans may ingest microplastics through the consumption of seafood. A study conducted on Belgian mussels identified that approximately 300 plastic particles (or 1.5 µg) would be consumed in a 300 g serving of mussels.[91] Similarly, another study estimated that in a 100 g serving of oysters, 50 particles would be consumed.[92]

3.71 It is possible that intestinal uptake of microplastics may occur in humans following the ingestion of contaminated seafood, however this may depend on the size of the plastic particles. Dr Browne told the committee that there was once an assumption that ingested plastic would simply pass through the digestive system. However there is now 'abundant evidence that when…microplastics are inhaled or ingested they pass from the point of entry into the circulatory system'.[93]

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89 Dr Mark Browne, *Committee Hansard*, 18 February 2016, p. 7.

90 Mr Stephen Oxley, Department of the Environment, *Committee Hansard*, 26 February 2016, p. 12.

91 See Bouwmeester H, Hollman PCH, Peters RJB, 'Potential Health Impact of Environmentally Released Micro- and Nanoplastics in the Human Food Production Chain: Experiences from Nanotoxicology', *Environmental science and technology*, 49(15), 2015, pp. 8932–9847.

92 See Van Cauwenberghe L and Janssen CR, 'Microplastics in bivalves cultured for human consumption', *Environmental Pollution,* 193, 2014, pp. 65–70.

93 Dr Mark Browne, *Committee Hansard*, 18 February 2016, p. 6.

3.72 There is also evidence that once in the circulatory system, microplastics can be stored for a long time.[94] In humans, particles between 0.16 µm and 150 µm have been found to translocate through the intestinal wall, mainly through lymphatic tissue.[95] Dr Browne commented that medical research into drug delivery systems has shown that the smaller the particle, the greater the rates of transfer.[96] Dr Browne also explained that the effects of the movement of microplastics into the circulatory system of animals can include 'inflammation, fibrosis, breaks in DNA, sometimes mortality and sometimes reduction in feeding behaviour'.[97]

3.73 Further evidence was provided by Dr Hardesty who stated that laboratory experiments which involved fish being fed microplastic found there were 'cellular and tissue level disruptions'. Dr Hardesty explained that a 'difference in cell growth means a cancer'.[98] Though scientific research has identified that translocation of microplastics in humans can occur, there is no current data available on the associated toxicity of such translocation. Dr Hardesty noted that the effect of microplastic ingestion on human health is a difficult issue to understand and added:

> I would say that there is not definitive, peer-reviewed, published literature that can address each of those steps all the- way up through to, and including, human health. The reason for that is that you would need to do a whole series of controlled experiments to be able to state these things definitively, to some extent, and there are ethical considerations around doing such experiments.[99]

3.74 The committee also received evidence that chemicals accumulated on the surface of microplastics, and chemicals used in the production of plastic may cause adverse health effects in humans. As previously discussed, these chemicals include substances such as phthalates and bisphenol A (BPA). These chemicals are classified as endocrine disrupting compounds (EDCs), and the human health implications of such chemicals have been well established. Research has linked EDCs to cancer, male

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94 Dr Mark Browne, and co-authors Professor Tony Underwood, Professor Gee Chapman, Professor Emma Johnston, *Submission 21*, p. 3.

95 See Hussain N, Jaitley V, and Florence AT, 'Recent advances in the understanding of uptake of microparticulates across the gastrointestinal lymphatics', *Advanced Drug Delivery Reviews*, 50, 2001, pp. 107–142 in Van Cauwenberghe L and Janssen CR, 'Microplastics in bivalves cultured for human consumption', *Environmental Pollution*, 193, 2014, pp. 65-70.

96 Dr Mark Browne, *Committee Hansard*, 18 February 2016, p. 11.

97 Dr Mark Browne, *Committee Hansard*, 18 February 2016, p. 6.

98 Dr Britta Denise Hardesty, CSIRO, *Committee Hansard*, 26 February 2016, p. 4.

99 Dr Britta Denise Hardesty, CSIRO, *Committee Hansard*, 26 February 2016, p. 3; see also Dr Mariann Lloyd-Smith, National Toxics Network, *Committee Hansard*, 10 March 2016, p. 10.

and female reproductive issues, adrenal and thyroid disorder, neurodevelopmental issues in children, and disrupted immune function.[100]

3.75 A number of chemicals used in fabrics such as fire retardants, and stain and water repellents such as perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) are also of concern.[101] These chemicals have suspected causal links to cancer; and affect thyroid function, reproductive health, and neurodevelopment.[102] These chemicals may affect both marine fauna, and subsequently humans, when microplastic fabric fibres are consumed in the marine environment.

3.76 It should again be noted, however, that research on the human health implications of ingesting marine fauna which have consumed these fibres has not been conducted.

Impact on fisheries and shipping

3.77 The committee received evidence that marine plastic pollution has an impact on fisheries and shipping sectors through ghost fishing, creating navigational hazards, and providing a transport medium for invasive species. However, evidence also noted that the impact is difficult to assess and quantify.

3.78 AIMS stated that plastic pollution such as abandoned, lost and otherwise discarded fishing gear (ALDFG) can affect the economic outcomes of fisheries. In particular, studies have found that abandoned fishing traps in coastal regions can cause a reduction in annual fisheries catches of up to 5 per cent.[103] AIMS explained that though the economic impacts of ALDFG can vary from fishery to fishery, it is estimated that it 'can result in annual losses of approximately $1M AUS in individual fisheries'.[104]

3.79 Research presented to the committee also indicated that floating plastic pollution may facilitate 'recruitment and survival' of species such as 'barnacles, bryozoans, seasquirts, hydrozoans, sponges and bivalves'. This may in turn allow for

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100 See Talsness CE, Andrade AJ, Kuriyama SN, Taylor JA, and vom Saal FS, 'Components of plastic: experimental studies in animals and relevance for human health', *Philosophical Transactions of the Royal Society of London B: Biological Sciences,* 364(1526), 2009, pp. 2079-2096; Eds. Bergman A, Heindel JJ, Jobling S, Kidd KA and Zoeller RT, *State of the science of endocrine disrupting chemicals 2012,* United Nations Environment Programme and the World Health Organization, 2013.

101 Dr Mariann Lloyd-Smith, National Toxics Network, *Committee Hansard,* 10 March 2016, p. 13.

102 See Talsness CE, Andrade AJ, Kuriyama SN, Taylor JA, and vom Saal FS, 'Components of plastic: experimental studies in animals and relevance for human health', *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, 364(1526), 2009, pp. 2079-2096.

103 Australian Institute of Marine Science, *Submission 11*, p. 4.

104 Australian Institute of Marine Science, *Submission 11*, p. 4.

these species to be transported to, and then invade new ecosystems.[105] For example, the Northern Territory Seafood Council noted that in 2013, the Asian green mussel (an invasive marine pest), was found on a ghost net collected by Dhimurru Rangers on Bremer Island off Nhulunbuy.[106]

3.80 Invasive marine pests can lead to an increase in operating costs associated with biofouling on vessels and infrastructure. Invasive species also compete for space and resources with native species, and can affect aquaculture operations.[107] However, the submission from Dr Browne *et al.* particularly noted that while there are confirmed reports of species travelling on marine plastic pollution, 'there are no confirmed cases of the establishment of an invasive species through this vector alone'.[108]

3.81 It was noted by Vegter *et al.* that relatively few published articles have focused on rafting of introduced species on plastic debris. The researchers identified a need for additional research in how plastic pollution contributes to the transfer of non-native species was identified.[109]

3.82 The committee also received evidence that large abandoned ghost nets can pose a navigational hazard to fishing vessels and other shipping, when they are present in shipping lanes.[110]

3.83 The Northern Territory Seafood Council commented on the potential impact of microplastics on fisheries. The Council stated that there is potential for microplastics entering the food chain but there is currently little understanding of the impact on species that consume and accumulate microplastics, including humans. Of concern is the potential in the future to microplastic contamination 'to affect the reputation of NT seafood, currently marketed as coming from pristine remote waters'.[111]

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105 Dr Mark Browne, and co-authors Professor Tony Underwood, Professor Gee Chapman, Professor Emma Johnston, *Submission 21*, pp. 2–3.

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

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

108 Dr Mark Browne, and co-authors Professor Tony Underwood, Professor Gee Chapman, Professor Emma Johnston, *Submission 21*, pp. 2–3.

109 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

110 Northern Territory Seafood Council, *Submission 63*, p. 3. See also, Mr Toby Stone, Australian Maritime Safety Authority, *Committee Hansard*, 26 February 2016, p. 26.

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

Impact of marine plastic on ecosystems

3.84 Marine ecosystems can be affected by marine plastic pollution through changes of habitat and species assemblages, dispersal of marine organisms, introduction of invasive species, and alteration of marine food webs. Damage to sessile fauna and loss of benthic faunal cover can be caused by pollution by marine plastic, such as fishing gear and household items. It has also been found that along tropical coastal shorelines, marine plastic pollution has caused significant differences in species assemblages of meiofauna, diatoms and macrofauna. Of particular concern is the potential for dispersal on marine plastic debris of pathogens and invasive species.[112]

3.85 Submitters pointed to concerns about the impact of marine plastic on the Great Barrier Reef and noted that the Great Barrier Reef Outlook Report 2014 and the Great Barrier Reef Long Term Sustainability Report 2015 have identified marine debris as a major threatening process to the long-term health and sustainability of the reef. The Outlook Report states that:

> Marine debris, including that delivered through land-based run-off, continues to affect the ecosystem and is of particular concern for species of conservation concern. Many of the Region's heritage values, including its outstanding universal value, are vulnerable to land-based run-off through its effects on the ecosystem. In addition, water quality declines and marine debris are likely to be diminishing the Region's natural beauty.[113]

3.86 AIMS has conducted a qualitative risk assessment of nine different categories of emerging contaminants, including marine plastic pollution, for the Great Barrier Reef and Torres Strait marine ecosystems. Dr Kroon, AIMS, commented that 'as far as the overall outcomes of the risk assessment are concerned, marine plastics and microplastics pose one of the highest risks, if not the highest, depending on the region, of all nine different categories of emerging contaminants assessed'.[114]

3.87 However, Dr Kroon commented that as the tropical marine environment across Northern Australia is such a large area, there is uncertainty about the abundance and distribution of marine plastics. While work has been undertaken in some areas, such as the Great Barrier Reef and the Gulf of Carpentaria, there is a lack of a general overview of the problem for the whole of Northern Australia and what the long-term effects on the marine ecosystems may be.[115]

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112 Australian Institute of Marine Science, *Submission 11*, p. 4.

113 Cited in Wildlife Preservation Society of Queensland, *Submission 5*, p. 3.

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

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

3.88 Other submitters also acknowledged that much remains to be learnt about the effects of marine plastic pollution on ecosystems. Dr Mark Browne *et al.* noted that there is little available research which has investigated whether plastic debris is actually impacting organisms at the population or species level. The submission went on to state:

> The consensus of these reviews is that (i) there is evidence of ecological impacts from plastic marine debris, but over the next 5–10 years the quantity and quality of research requires improvement to allow the risk and relative importance of ecological impacts of plastic marine debris to be determined with precision; (ii) sufficient evidence exists for decision-makers to begin to mitigate problematic plastic debris now, to avoid risk of irreversible harm...[116]

3.89 Similarly, Dr Kroon told the committee that:

> The difficulty with plastic is that it is so variable—there are so many different chemical compositions, particle sizes and shapes. It is not like a standard toxin, where you can compare the risk or toxicity across many different organisms. Marine plastic pollution ranges from microplastics to fishing nets. How do you compare the risk of one versus the other? That is one of the big research questions, one of the big knowledge gaps that we have. That would also progress us towards an answer as to what the ecological impacts of marine plastics are. We know that, for individual organisms, the ingestion of plastic material or entanglement in a fishing net can be detrimental or lethal. But at a population level, for most organisms or species, we do not have a good handle on what it means for population viability.[117]

Committee view

3.90 Marine plastic pollution is known to pose a serious threat to marine fauna. The committee accepts that the ingestion of, and entanglement in marine plastic pollution are known to cause death, and injuries including limb amputation, starvation, intestinal rupture, and scoliosis. The committee was concerned by the evidence that hundreds of species of fauna including birds, turtles, cetaceans, pinnipeds and corals have been negatively affected by ingestion and entanglement. The committee was also concerned by the statistics indicating that thousands of individual animals have died as a result of marine plastic pollution, particularly through entanglement with abandoned fishing gear.

3.91 However, the committee also accepts that there remain a number of key knowledge gaps in understanding the threat of marine plastic pollution. In particular, the effect at the population and ecosystem levels, and the threat posed by ingestion of

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116 Dr Mark Browne and co-authors Professor Tony Underwood, Professor Gee Chapman, Professor Emma Johnston, *Submission 21*, pp 4–5.

117 Dr Frederieke Kroon, Australian Institute of Marine Science, *Committee Hansard*, 10 March 2016, p. 16.

microplastics by marine fauna. In addition, there is concern that trophic transfer of microplastics may have a negative impact on human health through the consumption of contaminated seafood.

3.92 The committee is of the view that there is an urgent need for research to be conducted in order to remedy these knowledge gaps.