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Standing Committee on Environment & Communication Reference Committee  
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Dear Ms McDonald,

**Submission to the Senate Inquiry into the threat of marine plastic pollution in Australia and Australian waters**

Thank you for your letter regarding the Senate inquiry into the threat of marine plastic pollution in Australia and Australian waters. The Australian Institute of Marine Science (AIMS) welcomes the opportunity to contribute to the inquiry.

AIMS is Australia's tropical marine research agency. The Institute is a Publicly-Funded Research Agency with statutory independence granted by the AIMS Act (1972). Our annual budget supports over 220 staff (plus an additional 20 early-career researchers and 80 students) who have access to modern infrastructure including two coastal research vessels and advanced analytical facilities for oceanographic, geochemical, molecular and genetic research. Because of its history of research in the tropics, ready access to a dedicated offshore research vessel, and teams of scientists with expertise in expeditionary, ship-based research, AIMS has established an international reputation in the design and execution of tropical marine monitoring programs, ecosystem biodiversity assessments, environmental risk assessment, and studies on resilience and cumulative impacts.

Recently, AIMS has been working specifically in the area of marine plastic pollution in the following three projects:

- A recently finished project funded by the North Australia Marine Research Alliance, entitled '*Impact of ghost nets on sea turtle populations*' (1). This project aimed to determine the spatial distribution and movements of ghost nets in the Arafura Timor Sea, and identify the demographic composition and origin sea turtle found entangled in those nets.
- A current project funded by the Department of Environment's National Environmental Science Program, entitled '*Identification, impacts, and prioritization of emerging contaminants present in the Great Barrier Reef and Torres Strait marine environments*'. This project aims to examine the risk of emerging contaminants, including microplastics to the Great Barrier Reef (GBR) and Torres Strait marine environments.
- A current project funded by AIMS, entitled '*Prevalence and impacts of microplastics in tropical marine ecosystems*'. This project supports a Visiting Fellow from Portugal to develop collaborative research in the field of microplastics and marine litter.

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**With respect to the Terms of Reference of the Threat of marine plastic pollution in Australia and Australian waters**, AIMS provides below specific comments relating to (i) the review of current research and scientific understanding of plastic pollution in the marine environment; (ii) sources of marine plastic pollution; (iii) the impacts of marine plastic pollution, including impacts on species and ecosystems and fisheries. Our comments relate specifically to the tropical marine waters of Northern Australia.

### **Specific comments**

#### ***(i) the review of current research and scientific understanding of plastic pollution in the marine environment***

Globally, plastic pollution is ubiquitous throughout the marine environment with an estimated 10s-100s of thousands of tons of plastic floating in the world's oceans (2, 3). Marine plastic pollution is also prevalent in the water column, on the seabed and along coastal shorelines (4, 5). These plastics are derived from a wide variety of marine and land-based sources, including (un-)intentional discard from shipping and land disposal via industrial and urban discharges and river run-off (5-8). The timeframe for complete mineralisation of plastic in the marine environment is unknown but estimated to range from months to millenia (6, 8, 9), depending on a combination of environmental factors and the properties of the polymer (5). Such persistence makes plastic pollution of the marine environment a long-term issue, particularly considering the projected exponential increase of plastic production (10).

Marine plastic pollution is generally divided into macro-plastics (e.g. fishing nets, plastic packaging) and micro-plastics (plastic particles <5 mm in diameter) (5, 11). The terms 'primary' and 'secondary' micro-plastics refers to particles being either specifically manufactured for particular applications (e.g. cosmetic products), or produced as a result of fragmentation from larger items. This distinction can be used to pinpoint sources of marine plastic pollution and target measures for mitigation.

For Australia, the '*Background paper for the threat abatement plan for the impacts of marine debris on vertebrate marine life*' (12) provides a recent summary of current research and scientific understanding of harmful marine debris, including marine plastic pollution. In northern Australia, marine plastic pollution was first identified as an issue of concern in the 1990's (13, 14). Since then, an increasing number of reports have documented the abundance and distribution of plastic pollution in the marine environment (15-21), reflecting the exponential increase in global scientific publications about many different aspects of microplastic distribution and behaviour (5). Similarly to international studies, source attribution shows that marine plastic pollution is derived from marine and land-based sources, with relative attribution depending on the location (14-16, 18, 20). This means that measures for the prevention and management of marine plastic pollution will need to be targeted towards a range of industry sectors and be applied across institutional and jurisdictional boundaries (12, 13, 22-24).

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.

#### ***(ii) sources of marine plastic pollution***

The '*Background paper for the threat abatement plan for the impacts of marine debris on vertebrate marine life*' (12) provides a recent summary of the origin of harmful marine debris, including marine plastic pollution, in the Australian marine environment.

In northern Australia, a small number of research projects have examined the sources of marine plastic pollution (14-16, 18, 20). The reported results differ with regards to the density of marine debris along the

northern Australian coast, but are mostly consistent with regards to source attribution. Kiessling (13) reports that the amount of debris washing ashore in northern Australia is as high as, if not higher than, any other area in Australia or the South-east Asian region. In contrast, Hardesty et al. (18) report that debris density is relatively low along the north-western, northern, and north-eastern coasts of mainland Australia compared to other sections of the mainland. In the Great Barrier Reef (GBR), land-based, and oceanic and shipping sources have been posited for the marine plastic pollution in offshore waters and on continental islands and sand cays, respectively (14, 18). At Cape Arnhem (NT), plastic items made up around 74% of all items recorded during a beach marine debris survey; approximately 28% were likely to have originated from marine based sources (fishing or shipping operations) (15). The same survey determined that only 14% of the derelict fishing nets were identified as Australian, with the remainder of (South-East) Asian origin (15). A more extensive survey of the NT coast revealed that 87% of all marine debris items found were foreign, and derived mostly from marine industries such as fishing and cargo shipping (16). Oceanographic modelling suggests that derelict fishing nets found along the coastline of Arnhem Land and Gulf of Carpentaria are likely to have originated from the Arafura and Timor Seas (20, 25).

Information on sources of micro-plastics in northern Australia is limited (19, 26). High concentrations of micro-plastics were reported for the east coast of Cape York and near Exmouth and Karratha (26). Along the GBR, relatively low concentrations of micro-plastics were found in waters near Orpheus and Pelorus Islands (19). Both studies identified these micro-plastics primarily as secondary fragments, most likely derived from single-use disposable packaging and fishing equipment (19, 26). In north-east Arnhem-land, marine macro-plastic surveys showed that plastic and rubber are the most common marine debris, not including discarded fishing nets (16). The majority of this marine debris including fishing nets originates from sources outside Australia in particular Indonesia (33.5%) followed by China (29.1%) (16).

### ***(iii) the impacts of marine plastic pollution, including impacts on species and ecosystems and fisheries.***

Many scientific reports have described and reviewed the effects of marine plastic pollution on species, ecosystems and fisheries, with most of these studies (>90%) reporting on the effects of plastics on individual species (28). These studies have described detrimental effects of plastics in single species in both field collections and controlled experimental systems (28).

For the Australian marine environment, the '*Background paper for the threat abatement plan for the impacts of marine debris on vertebrate marine life*' (12) provides a recent summary of the impacts of harmful marine debris, including marine plastic pollution.

#### ***Effects of marine plastic pollution on species***

The size and composition of plastic debris and particles determine the pathways that lead to detrimental effects. For example, marine plastic debris such as derelict fishing gear is comparatively large and can entangle or entrap a wide range of marine species (28, 29). In northern Australia, mortality for a range of species following entanglement has been reported including turtles, dolphins, dugong, sea snakes, sharks, pelicans, and various fish species including barramundi and sharks (13).

Ingestion of smaller particles, including micro-plastics, may block feeding and digestive processes and expose organisms to associated chemical contaminants (8, 30, 31). Plastic ingestion has been documented for a large range of marine species, including detritivores, deposit feeders, planktivores, filter-feeders and suspension-feeders (30), and has been particularly well studied in seabirds (9, 32). Several Australian studies have documented ingestion of plastic particles by marine species, including seabirds on North Stradbroke Island (33), Lord Howe Island (34), and Heron Island (35), turtles from South East Queensland (36), and tropical hard corals in laboratory experiments (19). High levels of ingested plastic in seabird fledglings were associated with increased contaminant loads (34). Based on evidence from overseas studies (30), it is highly likely that plastic ingestion is much more widespread and includes many more marine species in northern Australia than currently documented.

Whether marine plastic entanglement and ingestion ultimately result in reduced reproductive fitness and population size is difficult to determine. Regardless, marine plastic pollution should be considered as one of the many threats to marine species and thus contributing to the overall cumulative impacts. This is particularly the case for species that are already threatened, vulnerable, endangered, or critically endangered (8, 28), such as the olive ridley sea turtle population on the western Cape York (1).

#### *Effects of marine plastic pollution on ecosystems*

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 (37). Pollution by marine plastic, such as fishing gear and household items, causes damage to sessile fauna and loss of benthic faunal cover (29, 38-40). Along tropical coastal shorelines, marine plastic pollution (>10 cm diameter) caused significant differences in species assemblages of meiofauna, diatoms and macrofauna (41). Of particular concern is the potential for dispersal on marine plastic debris of pathogens (44) and invasive species (45). The increasing amounts of floating marine plastic pollution suggests that rafting will continue to be an important dispersal mechanism for marine organisms (28, 42), including in Australian marine waters (43). Through ingestion, bio-magnification of microplastics (and associated contaminants) could occur up the marine food chain, potentially representing a significant and understudied global issue (37).

#### *Effects of marine plastic pollution on fisheries*

The effects of marine plastic pollution on fisheries have not been well studied globally, and we are not aware of any Australian studies. The few studies available report that derelict fishing traps in coastal ecosystems can cause reductions of up to 5% in annual fisheries catches (29, 46). The economic impacts of lost fishing gear, damage to fishing gear, and reduced catch rates varies from fisheries to fisheries (29), but can result in annual losses of ~\$1M AUS in individual fisheries (46). Ingestion of microplastics has been documented in wild-caught fisheries species (30, 47-49), and accumulation of chemical contaminants from marine plastics in fish has been reported in laboratory studies (50, 51). The potential flow-on effects on fisheries sustainability and human health, however, are currently unknown.

Overall, despite a number of relevant studies internationally, the exposure and effects of plastics in tropical marine systems are both largely unknown (28). In particular, limited studies have been conducted on the effects of plastic pollution on marine organisms, ecosystems and fisheries in northern Australia, including those of the GBR.

**As with many pressures on marine systems, our knowledge of the nature and extent, and impacts, of plastic/microplastic pollution remain poorly understood. However, there is growing evidence that we do have a problem with plastics at local and global scales, and at a time when many coastal and oceanic ecosystems (and species) are in decline, adding to the cumulative risks is a concern.**

We trust that these comments are helpful to the work of the inquiry and would be happy to elaborate further on any issues if this would be of further assistance.

Yours sincerely

John Gunn  
CEO

## References

1. Jensen MP, *et al.* (2013) Defining olive ridley turtle *Lepidochelys olivacea* management units in Australia and assessing the potential impact of mortality in ghost nets. *Endangered Species Research* 21(3):241-253.
2. Eriksen M, *et al.* (2014) Plastic Pollution in the World's Oceans: More than 5 Trillion Plastic Pieces Weighing over 250,000 Tons Afloat at Sea. *PLoS One* 9(12):e111913.
3. Cozar A, *et al.* (2014) Plastic debris in the open ocean. *Proc Natl Acad Sci U S A* 111(28):10239-10244.
4. Vieira RP, *et al.* (2015) Lost fishing gear and litter at Gorringe Bank (NE Atlantic). *J Sea Res* 100:91-98.
5. GESAMP (2015) Sources, fate and effects of microplastics in the marine environment: a global assessment. ed Kershaw PJ (IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP/UNDP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection, London, U.K.), p 96.
6. Barnes DK, Galgani F, Thompson RC, & Barlaz M (2009) Accumulation and fragmentation of plastic debris in global environments. *Philos Trans R Soc Lond B Biol Sci* 364(1526):1985-1998.
7. Cole M, Lindeque P, Halsband C, & Galloway TS (2011) Microplastics as contaminants in the marine environment: a review. *Mar Pollut Bull* 62(12):2588-2597.
8. Derraik JGB (2002) The pollution of the marine environment by plastic debris: a review. *Mar Pollut Bull* 44.
9. Azzarello MY & Vanvleet ES (1987) Marine birds and plastic pollution. *Mar Ecol Prog Ser* 37(2-3):295-303.
10. Lebreton LCM, Greer SD, & Borrero JC (2012) Numerical modelling of floating debris in the world's oceans. *Mar Pollut Bull* 64(3):653-661.
11. Masura J, Baker JE, Foster G, & Arthur C (2015) Laboratory methods for the analysis of microplastics in the marine environment: recommendations for quantifying synthetic particles in waters and sediments. (NOAA Marine Debris Division, Silver Spring, U.S.A.).
12. Department of the Environment W, Heritage and the Arts, (2009) Background paper for the threat abatement plan for the impacts of marine debris on vertebrate marine life. (Australian Government Department of the Environment, Water, Heritage and the Arts,, Canberra, Australia), p 42.
13. Kiessling I (2003) Finding solutions. Derelict fishing gear and other marine debris in Northern Australia. (National Oceans Office, Hobart, Australia), p 58.
14. Haynes D (1997) Marine debris on continental islands and sand cays in the far northern section of the Great Barrier Reef Marine Park, Australia. *Mar Pollut Bull* 34(4):276-279.
15. Kiessling I & Hamilton C (2003) Marine Debris at Cape Arnhem Northern Territory, Australia: WWF Report Northeast Arnhem Land Marine Debris Survey 2001. (WWF Australia, Sydney, Australia), p 26.
16. White D (2006) Marine Debris in Northern Territory Waters 2004. (WWF Australia, Sydney, Australia), p 38.
17. Ceccarelli DM (2009) Impacts of plastic debris on Australian marine wildlife. Report for the Department of the Environment, Water, Heritage and the Arts. (C&R Consulting, Thuringowa, Australia), p 83.
18. Hardesty BD, Wilcox C, Lawson TJ, Lansdell M, & T/ vdV (2014) Understanding the effects of marine debris on wildlife. (CSIRO, Hobart, Australia), p 364.
19. Hall NM, Berry KLE, Rintoul L, & Hoogenboom MO (2015) Microplastic ingestion by scleractinian corals. *Mar Biol* 162(3):725-732.
20. Griffin D (2008) Pilot investigation of the origins and pathways of marine debris found in the northern Australian marine environment. (CSIRO, Hobart, Australia), p 42.

21. Department of the Environment and Heritage (2001) Coringa-Herald National Nature Reserve & Lihou Reef National Nature Reserve Management Plan. (Department of the Environment and Heritage,, Canberra, Australia), p 68.
22. ANZECC (1996) Working together to reduce impacts from shipping operations: ANZECC Strategy to Protect the Marine Environment. The Australian Marine Debris Status Review. (Australian and New Zealand Environment and Conservation Council, Canberra, Australia), p 135.
23. ANZECC (1995) Maritime Accidents and Pollution: Impacts on the Marine Environment from Shipping Operations. Paper for public comment. (Australian and New Zealand Environment and Conservation Council, Canberra, Australia).
24. Department of the Environment W, Heritage and the Arts, (2009) Threat abatement plan for the impacts of marine debris on vertebrate marine life. (Department of the Environment, Water, Heritage and the Arts, Canberra, Australia), p 16.
25. Dethmers K, *et al.* (????) Derelict fishing gear in a transitional marine system. Origin of sea turtles in ghost nets.
26. Reisser J, *et al.* (2013) Marine plastic pollution in waters around Australia: characteristics, concentrations, and pathways. *PLoS One* 8(11):e80466.
27. Drysdale V, White PJ, Wise P, & Roeger S (2009) Research on the impact of marine debris on marine turtle survival and behaviour: North East Arnhem Land, Northern Territory, Australia. (Dhimurru Aboriginal Corporation, Nhulunbuy, Australia), p 31.
28. Gall SC & Thompson RC (2015) The impact of debris on marine life. *Mar Pollut Bull* 92(1-2):170-179.
29. Arthur C, Sutton-Grier AE, Murphy P, & Bamford H (2014) Out of sight but not out of mind: harmful effects of derelict traps in selected U.S. coastal waters. *Mar Pollut Bull* 86(1-2):19-28.
30. Wright SL, Thompson RC, & Galloway TS (2013) The physical impacts of microplastics on marine organisms: a review. *Environ Pollut* 178:483-492.
31. Teuten EL, *et al.* (2009) Transport and release of chemicals from plastics to the environment and to wildlife. *Philosophical Transactions of the Royal Society B-Biological Sciences* 364(1526):2027-2045.
32. Spear LB, Ainley DG, & Ribic CA (1995) Incidence of plastic in seabirds from the Tropical Pacific, 1984-1991. Relation with distribution of species, sex, age, season, year and body-weight. *Mar Environ Res* 40(2):123-146.
33. Acampora H, Schuyler QA, Townsend KA, & Hardesty BD (2014) Comparing plastic ingestion in juvenile and adult stranded short-tailed shearwaters (*Puffinus tenuirostris*) in eastern Australia. *Mar Pollut Bull* 78(1-2):63-68.
34. Lavers JL, Bond AL, & Hutton I (2014) Plastic ingestion by Flesh-footed Shearwaters (*Puffinus carneipes*): Implications for fledgling body condition and the accumulation of plastic-derived chemicals. *Environ Pollut* 187:124-129.
35. Verlis KM, Campbell ML, & Wilson SP (2013) Ingestion of marine debris plastic by the wedge-tailed shearwater *Ardenna pacifica* in the Great Barrier Reef, Australia. *Mar Pollut Bull* 72(1):244-249.
36. Schuyler QA, Wilcox C, Townsend K, Hardesty BD, & Marshall NJ (2014) Mistaken identity? Visual similarities of marine debris to natural prey items of sea turtles. *BMC Ecol* 14.
37. Browne MA, *et al.* (2015) Linking effects of anthropogenic debris to ecological impacts. *Proceedings of the Royal Society B-Biological Sciences* 282(1807).
38. Chiappone M, Dienes H, Swanson DW, & Miller SL (2005) Impacts of lost fishing gear on coral reef sessile invertebrates in the Florida Keys National Marine Sanctuary. *Biol Conserv* 121(2):221-230.
39. Lewis CF, Slade SL, Maxwell KE, & Matthews TR (2009) Lobster trap impact on coral reefs: effects of wind-driven trap movement. *N Z J Mar Freshwat Res* 43(1):271-282.

40. Richards ZT & Beger M (2011) A quantification of the standing stock of macro-debris in Majuro lagoon and its effect on hard coral communities. *Mar Pollut Bull* 62(8):1693-1701.
41. Uneputty P & Evans SM (1997) The impact of plastic debris on the biota of tidal flats in Ambon Bay (eastern Indonesia). *Mar Environ Res* 44(3):233-242.
42. Thiel M & Gutow L (2004) The ecology of rafting in the marine environment - I - The floating substrata. *Oceanography and Marine Biology: An Annual Review, Vol 42*, Oceanography and Marine Biology, eds Gibson RN, Atkinson RJA, & Gordon JDM, Vol 42, pp 181-263.
43. Reisser J, *et al.* (2014) Millimeter-sized marine plastics: a new pelagic habitat for microorganisms and invertebrates. *PLoS One* 9(6):e100289.
44. Zettler ER, Mincer TJ, & Amaral-Zettler LA (2013) Life in the "plastisphere": microbial communities on plastic marine debris. *Environ Sci Technol* 47(13):7137-7146.
45. Barnes DKA (2002) Biodiversity - Invasions by marine life on plastic debris. *Nature* 416(6883):808-809.
46. Antonelis K, Huppert D, Velasquez D, & June J (2011) Dungeness Crab Mortality Due to Lost Traps and a Cost-Benefit Analysis of Trap Removal in Washington State Waters of the Salish Sea. *N Am J Fish Manage* 31(5):880-893.
47. Avio CG, Gorbi S, & Regoli F (2015) Experimental development of a new protocol for extraction and characterization of microplastics in fish tissues: First observations in commercial species from Adriatic Sea. *Mar Environ Res*.
48. Collard F, Parmentier E, & Das K (2014) Microplastics contamination in two planktivorous and commercial fish species. in *SETAC Europe 24th Annual Meeting* (SETAC Europe, Basel, Switzerland).
49. Possatto FE, Barletta M, Costa MF, do Sul JA, & Dantas DV (2011) Plastic debris ingestion by marine catfish: an unexpected fisheries impact. *Mar Pollut Bull* 62(5):1098-1102.
50. Rochman CM, Hoh E, Kurobe T, & Teh SJ (2013) Ingested plastic transfers hazardous chemicals to fish and induces hepatic stress. *Scientific Reports* 3:3263.
51. Hamlin HJ, Marciano K, & Downs CA (2015) Migration of nonylphenol from food-grade plastic is toxic to the coral reef fish species *Pseudochromis fridmani*. *Chemosphere* epub.