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Senate Standing Committees on Environment and Communications
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Senate Inquiry into The Threat of Marine Plastic Pollution in Australia

Introduction

The National Toxics Network Inc. (NTN) welcomes the opportunity to make a submission to the inquiry. NTN was formed in 1993 as a community-based charity. NTN provides a central repository of technical expertise and educational materials to individuals and organisations across Australia in relation to toxic chemical pollutants and their impacts on environmental health.

NTN is the Australian NGO focal point for the International Persistent Organic Pollutants Elimination Network (IPEN) and works towards the full implementation of the *Stockholm Convention on Persistent Organic Pollutants* (POPs) and other global chemical conventions and agreements to which Australia is a signatory. These conventions have tangible outcomes in terms of reducing levels of identified toxic pollutants circulating in the environment such as CFCs and mercury.

NTN committee members have been involved in a range of national government advisory bodies including the Hazardous Waste Reference Group, the Stockholm Stakeholders Reference Group, the National Industrial Chemicals Notification Assessment Scheme (NICNAS) Community Engagement Forum and Strategic Consultative Committee and Australian Pesticides and Veterinary Medicines Authority advisory committees. In this capacity, NTN represents community concerns and engages in complex discussions about policy and regulatory options for mitigating toxic pollutants impacting our environment is vital.

Terms of Reference

As NTN's expertise is in the area of toxic chemical pollution reduction, we are limiting our submission to address these aspects only. We are aware that other environment organisations, such as the Total Environment Centre, are making submissions that will detail information about the extent, sources and solutions for plastic pollution in Australia.

For specific information on the impacts of plastic pollution on Australian marine life we suggest you ensure the Senate Committee hears evidence from Australian Seabird Rescue <http://seabirdrescue.org/marine-plastic-debris>

Contaminants in Plastics

The UN Environment Program in its Yearbook for 2011 described marine plastics as a 'new toxic time bomb'. It said that in addition to entangling wildlife, or being mistaken for food, floating plastics served to accumulate and concentrate chemicals such as polychlorinated biphenols (PCBs) and the pesticide DDT.

By 2011, the annual global demand for plastics had significantly increased and stood at about 245 million tonnes. It is estimated that land-based sources, including beach litter, contribute about 80% of the plastic debris in the marine environment.¹

Of particular concern is the occurrence of smaller pieces of plastic debris including those not visible to the naked eye, referred to as microplastics finding their way into the world's oceans. Engineered plastic nanoparticles derived from post-consumer waste as well as from microplastics via degradation pose a specific challenge to the ecosystem.

Several broad classes of plastics are used in packaging including:

Polyethylene (PE), Polypropylene (PP), Polystyrene (PS), Poly(ethylene terephthalate) (PET); and Poly(vinyl chloride) (PVC).

Toxicity associated with plastics can be attributed to one or more of the following factors:

(a) Residual monomers from manufacture present in the plastic or toxic additives used in compounding of plastic can leach out of the plastic, eg bis-phenol (BPA) and phthalate plasticizers.

(b) Toxicity of some intermediates from partial degradation of plastics. For instance, burning polystyrene can yield styrene and other aromatics and a partially burnt plastic may contain significant levels of styrene and other aromatics.

(c) The persistent organic pollutants (POPs) present in seawater are slowly absorbed and concentrated in the microplastic fragments.

POPs that occur universally in seawater at very low concentrations are picked up by microplastics via partitioning. It is the hydrophobicity of POPs that facilitate their concentration in the microplastic litter at a level that is several orders of magnitude higher than that in seawater. These contaminated plastics when ingested by marine species presents a credible route by which POPs can enter the marine food web.²

In 2001, Mato *et al*³ noted that plastic pellets were widely distributed through the world's oceans along with plastic wastes. The origin of pellets varies and some will have spent longer in the ocean than others, hence, some pellets have higher concentrations of POPs than others. These pellets may have come from, or spent time circulating in, more heavily polluted areas before eventually being beached.

Mato *et al* noted polypropylene (PP) resin pellets accumulate pollutants including nonylphenols, DDE and PCB, which can be up to one million times more concentrated on the surface of the pellets than in the ambient seawater. PCBs and DDE adsorb to polypropylene (PP) resin pellets from seawater, steadily increasing concentration over time. PCBs and DDE were found to accumulate in plastic pellets in concentrations up to 105-106 times higher than surrounding seawater. As PP resin pellets are made of saturated hydrocarbon units, their surfaces are nonpolar and adsorb hydrophobic pollutants such as PCBs and DDE through hydrophobic sorption. Another source of pollutants are the plastic additives and degradation products such as nonylphenol.⁴

¹ Andrady, L., Microplastics in the marine environment, *Marine Pollution Bulletin* 62 (2011) 1596–1605

² *ibid*

³ Mato, Isobe, Takada, Kahnehiro, Ohtake, and Kaminuma. Plastic Resin Pellets as a Transport Medium for Toxic Chemicals in the Marine Environment *Environ. Sci. Technol.* 2001, 35, 318-324)
<http://www.mindfully.org/Plastic/Pellets-Transport-Medium.htm>

⁴ Mato, Isobe, Takada, Kahnehiro, Ohtake, and Kaminuma. Plastic Resin Pellets as a Transport Medium for Toxic Chemicals in the Marine Environment *Environ. Sci. Technol.* 2001, 35, 318-324)
<http://www.mindfully.org/Plastic/Pellets-Transport-Medium.htm>

Microplastics represent an increasing source of anthropogenic contamination in aquatic environments, and are also entering estuaries, which are amongst the most productive aquatic systems.⁵

Ivar do Sul *et al* (2014) concluded that the occurrence of microplastics in the marine environment has substantially increased with microplastic debris being observed within every marine habitat. All marine organism groups are at a great risk of interacting with microplastics and the ingestion of microplastics has been documented for vertebrate and invertebrate marine species.⁶

Chemical Impacts

The high accumulation potential of POPs and other persistent bioaccumulative toxins such as nonylphenol means that plastic resin pellets serve both as a global transport medium and a source of toxic chemicals in the marine environment. Some of the chemicals found in PP resin pellets are endocrine disruptors (eg nonylphenol, phthalates).⁷ Endocrine disrupting effects can be triggered at very low concentrations and exhibit non-monotonic (non linear) dose responses. Ingestion of pellets with low concentrations of POPs by marine organisms is expected to present a problem for marine organisms.

Mortality due to plastic ingestion is now common in seabirds, marine mammals and sea turtles but the extent to which the ingestion of hazardous chemical components attributes to wildlife deaths is not readily available.

Rochman *et al* (2013)⁸ examined the effects of chronic dietary exposure to environmentally relevant concentrations of low-density polyethylene plastic on the Japanese medaka (*Oryzias latipes*), a common model fish species. They found that polyethylene ingestion may contribute towards the bioaccumulation of potentially hazardous substances in fish, and the exposed fish also tended to experience adverse health effects in the liver. The toxicity seems to be a consequence of both the absorbed pollutants and plastic material. The fish showed signs of hepatic stress, more so in fish that were exposed to marine-treated plastic (deployed in an urban bay), rather than to virgin (pre-production) plastic.

Researchers from the University of Tasmania examined the toxic effects of seabirds ingesting marine plastic pollution and population decline. Lavers *et al* (2014)⁹ examined the toxic effects of trace metals caused by the ingestion of plastics in flesh-footed shearwaters (*Puffins carneipes*). The study found that the proportion of the shearwater population ingesting plastic increased from 79% in 2005 to 2007 to 90% in 2011. Between 6 and 22% of plastic pieces remained inside fledglings after their stomachs were sampled. The study found body condition is negatively influenced by the amount of ingested plastic, and that the shearwater contaminant load is positively related to the amount of ingested plastic. The study went on to find that the flesh-footed shearwater had the highest percentage of their total population with ingested plastics, higher than any marine vertebrate.

Large amounts of plastic are also being recovered from flesh-footed shearwaters on Lord Howe Island. In the latest survey, one bird's stomach contained more than 200

⁵ A. Bakir *et al*. Transport of persistent organic pollutants by microplastics in estuarine conditions, *Estuarine, Coastal and Shelf Science* 140 (2014)

⁶ J.A. Ivar do Sul, M.F. Costa The present and future of microplastic pollution in the marine environment *Environmental Pollution* 185 (2014)

⁷ Mato, Isobe, Takada, Kahnehiro, Ohtake, and Kaminuma. Plastic Resin Pellets as a Transport Medium for Toxic Chemicals in the Marine Environment *Environ. Sci. Technol.* 2001, 35, 318-324)
<http://www.mindfully.org/Plastic/Pellets-Transport-Medium.htm>

⁸ Chelsea M. Rochman, Eunha Hoh, Tomofumi Kurobe & Swee J., Ingested plastic transfers hazardous chemicals to fish and induces hepatic stress, *Scientific Reports* 3, Article number: 3263 (2013)

⁹ Lavers, J., Bond A., Hutton I. (2014). Plastic ingestion by Flesh-footed Shearwaters (*Puffinus carneipes*): Implications for fledgling body condition and the accumulation of plastic-derived chemicals. *Environmental Pollution* (187), pp. 124-129.

pieces and others held more than 50.¹⁰ The sharp-edged fragments tear internal organs and toxic substances bind to the plastic. Mercury, which is toxic to birds at four parts per million (ppm), was found in the shearwaters at up to 30,000 ppm, according to Dr Lavers.

Levels of the Pollutants in Plastic Resin Pellets

Mato *et al* (2001) detected significant amounts of PCBs, DDE, and nonylphenols (NP) in polypropylene (PP) resin pellets collected from four Japanese coasts. Concentrations of PCBs (4-117 ng/g), DDE (0.16-3.1 ng/g), and NP (0.13-16 µg/g) varied among the sampling sites. The NP contents in the PP resin pellets were 2 orders of magnitude higher than those found in Tokyo Bay sediment (0.1-0.6 µg/g).

Rios *et al* (2007) reports the main plastic components of the samples of marine debris were polypropylene and polyethylene. Thermoplastic resin pellets samples were taken from the North Pacific Gyre, and selected sites in California, Hawaii, and from Guadalupe Island, Mexico had total concentration of PCBs ranged from 27 to 980 ng/g; DDTs from 22 to 7100 ng/g and PAHs from 39 to 1200 ng/g, and aliphatic hydrocarbons from 1.1 to 8600 lg/g. PAHs and DDT and its metabolites were found in all the plastic samples.¹¹

In 2007, plastic resin pellets collected at Foul Bay Western Australia returned positive results for persistent organic pollutants (POPs),¹² including:

- Polychlorinated biphenyls (PCBs) at 20 ng/g-pellet; highly toxic, chlorinated, industrial chemicals and proven endocrine disruptors
- Dichlorodiphenyltrichloroethane (DDT) and its breakdown products at 9 ng/g-pellet ; an organochlorine insecticide now banned in many countries because of serious health effects in animals and proven endocrine disruptor
- Polycyclic Aromatic Hydrocarbons (PAHs) at 0.4 ng/g-pellet ; toxic combustion products, some PAHs are endocrine disruptors
- Hopanes - used as an indicator of petroleum pollution
- Hexachlorocyclohexane (HCH) <0.2 ng/g-pellet - organochlorine insecticide and rodenticide and known endocrine disruptor

Levels of these chemicals found on the Foul Bay pellets are given in Table 1.

Chemical	Foul Bay Test Result	Range of levels recorded by International Pellet Watch to Date
PCBs	20 ng/g-pellet*	7 to 486 ng/g-pellet
DDT	9 ng/g-pellet	3 to 323 ng/g-pellet
PAHs	0.4 ng/g-pellet	0.2 to 15 ng/g-pellet
Hopanes	14 ng/g-pellet	2 to 49 ng/g-pellet
HCH	<0.2 ng/g-pellet	0.1 to 37 ng/g-pellet

Based on the results, the International Pellet Watch categorises Foul Bay as a ‘clean’ beach in terms of persistent organic pollutants as compared with other sites so far tested around the world.

¹⁰ <http://www.smh.com.au/environment/conservation/deadly-diet-of-marine-plastic-kills-seabirds-20110513-1emff.html>

¹¹ L.M. Rios et al. Persistent organic pollutants carried by synthetic polymers in the ocean environment, *Marine Pollution Bulletin* 54 (2007) 1230–1237

¹² <http://www.tangaroablue.org/amdi/campaigns/59-pellet-alert-project/204-persistent-organic-pollutants-on-plastic-resin-pellets-from-foul-bay-western-australia.html>

Hirai *et al* (2011)¹³ analyzed plastic fragments (<10 mm) from the open ocean and from remote and urban beaches. They measured PCBs, PAHs, DDT and its metabolites, polybrominated diphenyl ethers (PBDEs), alkylphenols and bisphenol A at concentrations from 1 to 10,000 ng/g. They noted concentrations showed large piece-to-piece variability and concluded PCBs were most probably derived from legacy pollution while PAHs showed a petrogenic signature, suggesting the sorption of PAHs from oil slick. Nonylphenol, bisphenol A, and PBDEs came mainly from additives and were detected at high concentrations in some fragments both from remote and urban beaches and the open ocean. Regarding PCBs and PAHs, higher concentrations were observed in plastic fragments from urban beaches. Hence, risks associated with these hydrophobic pollutants are higher in urban beaches than remote beaches and the open ocean.

Solutions

NTN is aware of the long history of Government inquiries into plastic pollution and the various voluntary industry schemes introduced over the years that have utterly failed to address plastic pollution and associated toxic chemical pollution. Meanwhile, the community outcry for something meaningful to be done to address marine plastic pollution is growing louder and louder and will not go away.

1) NTN supports strong and immediate regulatory action by Government to stop the source of marine plastic pollution, which is land-based plastic pollution. We support an immediate ban on plastic bags, and microbeads and the introduction of container deposit systems to address plastic beverage litter.

2) Regulators must enforce existing laws that prohibit the release of nurdles into the environment and work with the plastics industry to ensure appropriate measures are in place to minimize their impacts in the production of plastics.

3) The POPs pollutants finding their way into oceans also need to be addressed. To that end, the Australian Government needs to immediately ratify all new POPs chemicals listed on the *Stockholm Convention on Persistent Organic Pollutants*, which include brominated flame-retardants (BFRs) associated with marine plastic pollution.

4) The Government must address the inadequate regulation of industrial chemicals in Australia. There are over 38,000 industrial chemicals listed on the Australian Inventory of Chemical Substances (AICS), of which less than 3,000 have been assessed for their health and environmental impacts. Life-cycle assessments of industrial chemicals, including those contained in products, must be undertaken otherwise the problem will never be addressed. Australia needs an industrial chemical regulator that has the powers to enforce its recommendations for risk reduction as well as the power to ban industrial chemicals where the risks to the environment and human health are too great and cannot be managed.

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¹³ H. Hirai et al. Organic micropollutants in marine plastics debris from the open ocean and remote and urban beaches, *Marine Pollution Bulletin* 62 (2011) 1683–1692