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HOW DOES PLASTIC DEBRIS IMPACT THE MARINE WILDLIFE AND WHAT IS THE PATHWAY TO CHANGE?

Exploring the many ways plastic debris can pollute the ocean.

IMPACTS ON MARINE WILDLIDEE

Microplastics, entanglement, ingestion and bioaccumulation.

FUTURE WITH PLASTIC

The foreseeable future, pathway to change and alternatives.

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HOW DOES PLASTIC DEBRIS IMPACT MARINE WILD LIFE AND WHAT IS THE PATHWAY TO CHANGE?

Plastic is ubiquitous! From water bottles, bags, clothing, straws, and coffee cups, to toys, DVDs, Styrofoam, plumbing materials, and furniture; inevitably we use these in our everyday lives. Plastic can save human lives; knee and hip joints to plastic heart valves (Precision Engineered Products 2019). However, at the same time it is responsible for causing substantial damage to an entire ecosystem; entangling, suffocating, and killing wildlife. An example is the ocean ecosystem. This environment is beneficial to the planet as well as humans. The National Ocean Service website (2018) states that the ocean provides ingredients for medicine, food, transportation, climate regulation, economic benefit, recreation use and the air we breathe. The ocean produces more than half the world's oxygen, absorbing 50 times more carbon dioxide than the atmosphere. If we do not protect the oceans ecosystem from plastic, the material will continue to have a chemical impact, leaching its' free-floating pollutants that adhere to all surrounding surfaces (Royte 2018).

Figure 1 (Medium 2017)

Where do Microplastics Come From?

Microplastics stem from human pollution. It is cheaper to use plastic than other alternatives. It saves energy and sustains food, increasing shelf life. Plastic packaging is often favoured by manufacturers owing to its resourcefulness and adaptability to alter colour, weight, size, shape, utility, printing, and protection (Plastic Packaging Facts 2021). This accessibility is leading modern societies to revolve their lives around single use cutlery, packaged food, cosmetics, and water bottles. When thinking of plastic pollution; household trash, shopping bags and recyclable plastic come to mind. There is a public misconception that plastic takes thousands of years to decay (Andrews 2019), but few people know that this is not the truth. Plastic will not decompose. It simply breaks down into small plastic pieces sizing less than five millimetres long, otherwise identified as microplastics (Plastic Soup Foundation 2021).

Figure 2 (Daily News Egypt 2018)

Microbeads (tiny pieces of polyethylene plastic) are commonly used in skin cleansers, tooth paste and cleaning products.

Figure 3 (Greenpeace 2016)

Microfibres are synthetic threads that wash off clothes in the washing machine; a single fleece jacket can produce 100,000 microfibres in one wash (NOAA 2018). Both microfibres and microbeads pass through water infiltration systems, entering rivers, great lakes, and the Ocean (Department of Agriculture, Water, and the Environment 2021). The convenience of plastic led to a polluted ocean.

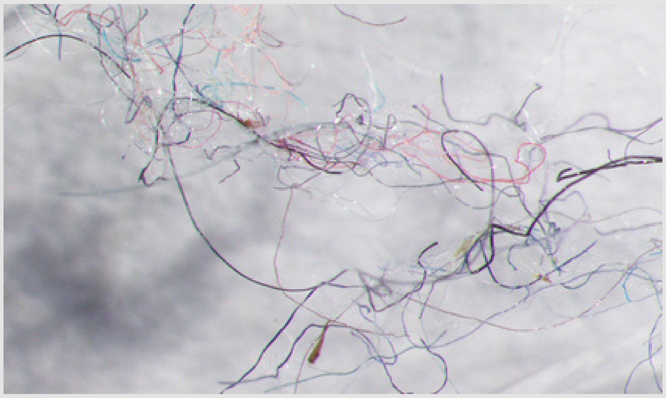

Figure 4 (Vancouver Aquarium 2018)

Impacts on Marine Wildlife

Plastic debris accumulating in the ocean is the main cause of destruction to the ocean ecosystem. It is estimated that 15-51 trillion microplastic particles have accumulated in the ocean (Environmental Audit Committee 2016) since the first documented records, produced in the early 1970s (Wilcox et al 2014, p. 227).

Figure 5 (Phys.org 2020)

However, plastic waste situated on the seafloor will take longer to break down due to the deficiency of oxygen and sunlight (NOAA 2018). The photodegradative process is delayed due to the ocean current. The ocean current creates a continuum of slow circulating gyres. Gyre's support the circulation of ocean waters around the globe.

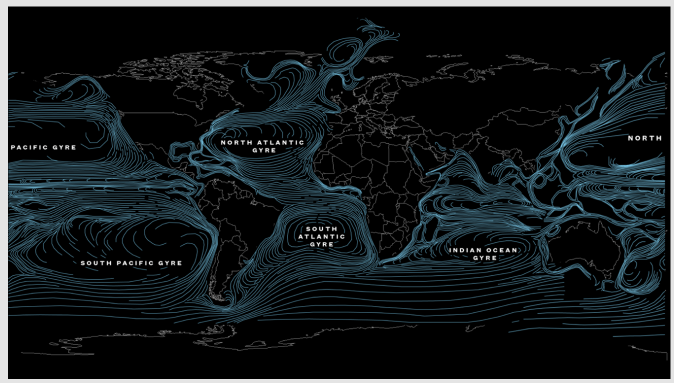

FIgure 6 (Earthdecks 2021)

Today, "microplastics make up 85% of pollution found on shorelines around the world" (NOAA 2018) and has become the greatest pollutant across the globe (Hamlyn 2019, Ivancic 2019) since mass production commenced in the early 1950s (Wilcox et al 2014, p. 225). The National Oceanic and Atmospheric Administration (2018) notes plastic waste situated in the environment becomes brittle, breaking down into microplastics due to wind, waves and the photodegradative effect. The sun's ultraviolet light provides energy for oxygen atoms to integrate within the polymers of plastic, allowing plastic debris to break down into microplastics.

Due to a severely polluted ocean, marine debris is pulled into the large system of circulating currents. There are five major gyres, also known as the trash vortexes (NOAA Ocean Podcast Ep 14 2014). The circulation of plastic pollution concludes at The North Pacific Gyre, a Great Pacific Garbage Patch, virtually the same size as Queensland, covering a 1.6 million-square kilometre area (Keane 2019). This results in plastic being found throughout nearly every part of the ocean, even the seafloor. Debris Free Ocean (2019) state that plastic islands floating along the ocean surface have consequences of sunlight blockage.

Figure 7 (Wordpress 2019)

Plastic Affecting the Marine Food Chain

Autotrophs (small marine organisms) are the base of the marine food chain. They do not consume other organisms and have the highest nutritional value, using photosynthesis to make their own food (National Geographic 2020). Autotrophs require sunlight to synthesise nutrients (glucose and oxygen) from carbon dioxide and water (CO2 + 6H2O > C6H12O6 + 6O2) (Byju's Classes 2019, NOAA 2018)

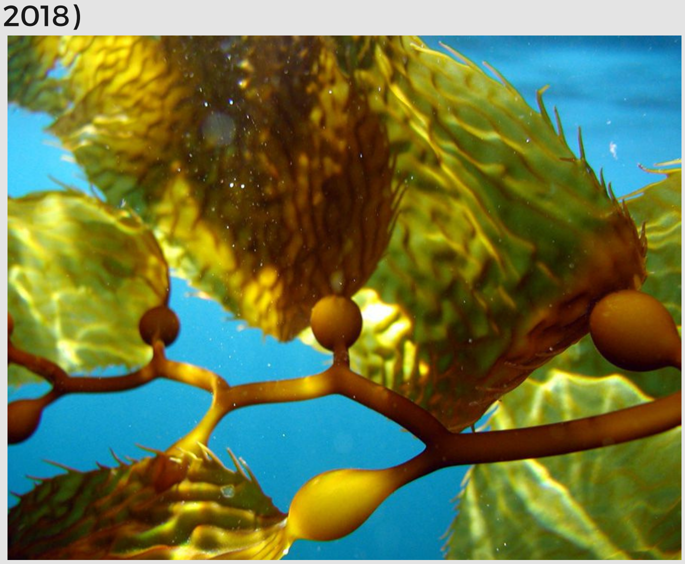

Figure 8 (Schwo, M n.d.)

Plastic islands cause substantial damage to the ocean ecosystem as sunlight cannot reach autotrophs, causing a decrease in their productivity.

Marine wildlife is part of an interconnected food web, therefore, microplastics ingested by one organism can end up accumulating in another during consumption. A build-up of plastic debris can cause blockages to the gills and reproductive organs which all have effects on the food web (Cirino, E 2018, Plastic Soup Foundation 2021). It is theorized that once autotroph output collapses (extinction), other marine organisms further along the food chain will become endangered (Debris Free Ocean 2019). Marine wildlife is already in danger from marine predators, commercial fisheries, and now plastic debris. Biologist Sarah Hamlyn (2019) raises the harms plastic can cause through entanglement, ingestion, bioaccumulation, and changes of habitats.

The Department of the Environment and Energy collected data in Australian waters over three and a half decades (1974-2008), discovering that 77 marine wildlife species were found to be impacted by plastic through entanglement or ingestion (Australian Government 2009). However, at the present-day, plastic marine debris affects more than 700 species worldwide (Two oceans Aquarium 2019).

Bioaccumulation

Plastic pollution is not only harmful to marine wildlife via entanglement and ingestion but through bioaccumulation. Plastic has a chemical impact, leaching free-floating pollutants into surrounding waters (Royte 2018). The physical and chemical make-up of plastic accumulates other toxins from the ocean. These toxins are often bioaccumulating toxins, meaning if they were ingested by an animal, they may become bioavailable, remaining in that animals' tissues (Hamlyn 2019). Pesticides, lead, mercury, BPA, and phthalates are examples of some bioaccumulating toxins contained in plastic and consumed by marine wildlife (Andrews 2019). Scientists are currently researching if bioavailable toxins found in animal tissue have the ability to be biomagnified through ingestion higher in the food chain, suggesting these toxins terminate at our dinner plates through seafood consumption (Hamlyn 2019).

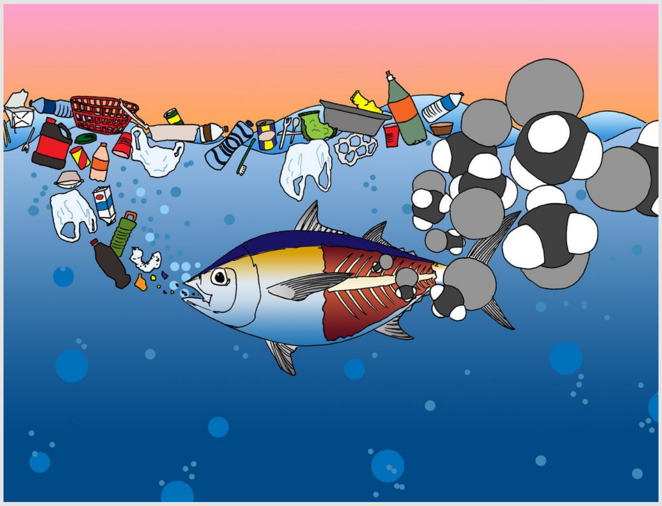

Figure 9 (Vivian, L 2020)

Entanglement

Sarah Hamlyn, a staff Biologist at the Research & Restoration Marine Laboratory observed and analyzed plastic debris in Florida Keys. Her findings in this coastal area include food wrappers, flipflops, plastic bottles and microplastics which have become caught and entangled within other plastics such as fishing line, rope, broken crab traps, bait bags, buckets, Styrofoam buoys and eskys.

Figure 10 (Kassenberg, C n.d.)

Plastic will smother important habitats alongside coastal communities creating anoxic seawater (seawater without oxygen) and trapping countless marine organisms. Plastic debris burying oyster beds, shallow seagrass areas, and beach habitation used by wading and migratory birds are some of the many impacts that plastic entanglement can have on the ocean ecosystem (Hamlyn 2019).

Animals' necks often become stuck in plastic ring packaging which restricts blood flow, causing serious injury (Ivancic 2019). As a result, 100,000 sea turtles and birds are killed annually by plastic due to entanglement and ingestion (Andrews 2019). Ultimately, entanglement of marine wildlife can lead to abnormal shell development, starvation, and drowning, causing immediate harm and transience of some marine species (Debris Free Ocean 2019).

Ingestion

Plastic swallowed by animals does not need to be large in quantity to cause serious damage (Wilcox et al. 2014). Results from necropsy have showed animals' (fish, mammals, and birds) stomachs to be filled with plastic (Hamlyn 2019).

Figure 11 (SOTT 2018)

Plastic marine debris such as bags and microplastics, are often perceived as food to marine wildlife (Price 2018). Nevertheless, ingesting plastic is the leading cause in cases of starvation (Hamlyn 2019). Plastic accumulates in the stomach preventing the animal from getting enough nutrients whilst also reducing space for food in the gizzard and stomach (Debris Free Ocean 2019 (Ivancic 2019). The consumed material can cause punctured organs and obstruction to the digestive tract (Price 2018). Sea turtles commonly mistake plastic bags for jelly fish and the bags obstruct the turtle's mouth and digestive system (Ivancic 2019). Eventually animals' ingesting an artificial diet of plastic debris will lead to malnutrition and sooner or later, mortality.

Figure 12 (Globetrender 2020)

The Foreseeable Future With Plastic

The ocean is just as valuable to humans as it is for every other living organism on Earth. The ocean provides ingredients for medicine, food, transportation, climate regulation, economic benefit, recreation use and the air we breathe, producing more than half the world's oxygen, absorbing 50 times more carbon dioxide than the atmosphere (NOAA 2018). Depending on human consumption and the inaction of human control, it has been estimated by 2025-2050 there will be more plastic in the ocean than fish (Keane 2019, Kilvert 2019). If this is the case, many marine species becoming endangered or extinct would be the reality of an artificially polluted ocean. With the surge of marine debris and microplastics, mass extinction across the entire ocean ecosystem is inevitable due to inaction of the world's population. It could be hypothesized that if the ocean were to have more plastic waste than fish by 2050, it will reduce the percentage of clean oxygen and absorption of carbon dioxide via the ocean. Nonetheless, change will happen if global authorities use regulation to implement education on negative impacts of plastic pollution, providing proper knowledge on recycling (Ivancic 2019). A global measure includes cooperative regulation with annual clean-ups, raising awareness and advocating for water supplies as well as environmentally conscious waste disposal in developing countries. These are steps towards the right direction to find better alternatives (Hamlyn 2019).

Figure 13 (DIVE magazine 2019)

Pathway To Change

Australian federal, state and territory leaders have agreed and begun implementing the National Waste Policy Action ban. This ban ensures a nation-wide phase out of single-use plastics (lightweight plastics, bags, straws, utensils, microbeads, and polystyrene consumer good containers) by 2025. Additionally, the Australian government plans to crack down on lightweight plastics including plastic misleadingly marketed as 'degradable' (Global Citizen 2021). As of March 1st, 2021, South Australia historically commenced this ban, starting with single-use plastics (straws, drink stirrers, and cutlery). The state is committed to extending the ban to polystyrene consumer goods containers and oxo-degradable plastics as of the 1st March 2022 (Australian Marine Conservation Society 2021). This shows that there is a pathway to change in Australia.

Alternatives

Manufacturers have become heavily reliant on plastic as it can be used to keep food fresh, an example is grocers use polyethene shrink wrap as it helps the cucumbers to retain moisture (Tullo A 2016, vol. 94 no. 41). Renee Cho (2017) explains bioplastic manufactured products are labelled as 'non-biodegradable', 'biodegradable' or 'compostable', however, if not recycled appropriately, bioplastic can be equally toxic compared to traditional petroleum based raw materials. Longer-lasting durable materials, safer for the environment include stainless steel, glass, platinum silicone, beeswax-coated cloth, natural fibre cloth, wood, bamboo, pottery/ceramics, paper, and cardboard.

Figure 14 (Kickstarter 2020)

Natural packaging such as mushroom, seaweed-based, pressed hay and banana leaves are almost fully compostable alternatives available on the market. (Earth Easy 2020). Living a plastic-free lifestyle helps in modelling sustainable living for the community and promotes a plastic-free future.

Figure 15 (Wilson, M 2019)

Summary

The key findings were substantiated by a wide range of creditable primary and secondary sources. The research validated the outcome and resolution, leading to a refined question, and result of a reliable outcome; answering "How does plastic debris impact the marine wildlife and what is the pathway to change?" In conclusion, plastic debris impacts the marine wildlife due to the small size and ability to infiltrate into the food chain. Plastic debris impacts over 700 marine species through entanglement, ingestion, bioaccumulation, and changes of habitat (Hamlyn 2019, Ivancic 2019, Two Oceans Aquarium 2019). Plastic will obstruct animals 'nasal passage and digestive system, will puncture organs, cause abnormal shell development, suffocate animals through entanglement and smothering of habitat (Hamlyn 2019, Ivancic 2019, Price 2018). Plastic replaces nutrients in natural food as it is replaced artificially by plastic pollutants.

Plastic debris accumulates in the animals' stomach, shrinking their desire to eat and obstructing their digestive system, resulting in starvation and suffocation (Ivancic 2019, Hamlyn 2019). Plastic also impacts the food chains most vital organisms, blocking sunlight to the most vital organisms (Autotrophs). (Debris Free Ocean 2019, National Geographic 2020, NOAA 2018).

Pathway to change is possible through regulations, implanting laws banning single-use plastics (Ivancic 2019) and wealthier countries to help fund clean water systems and drinking taps in developing countries to reduce the need of plastic water bottles (Hamlyn 2019). The root problem is raising awareness and encouraging corporations to manufacture better eco-friendly alternatives and influence appropriate household recycling. Senior Science teacher in South Australia, Helena Ivancic, states that these actions will 'allow marine ecosystems to recover and regenerate, becoming as biodiverse once again' (Ivancic 2019).

Figure 16 (Green Schools Alliance 2018)

Figure 17 (IDDRI 2020)

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