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EFFECTS OF PLASTICS DEBRIS ON SPECIES OF THE MARINE ENVIRONMENT: AN ANALYSIS OF THE PROBLEM

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Abstract: **The last three decades has seen an alarming global raise in the use of plastics and other synthetic products emanating from new uses for these products, increase in manufacturing rates making them available to more people thus, translating to a rise in plastic pollution and the amount of plastic debris entering the marine environment. The adverse consequences of plastic pollutants on marine species and environment was investigated and reviewed by collating data from published relevant literature. Data was collated from review of related literature. Findings from the desk reviewed literature depicts that, about 8 million metric tons of plastic debris end up in the ocean with projected estimated of increase 8-fold by 2025. Plastic debris effects on marine species include causing changes in their reproductive and behavioural characteristics, entanglement, and maiming by large pieces of debris on nearly all sea turtle species, 45% of all mammals and 21% of all sea bird species. The challenge of plastic debris is manifold, e.g. increased volume of plastic and other synthetic debris that ends up in the marine environment, are pollutants harmful to marine wildlife species, they affect the health of man on land because plastic debris can also be ingested through fish and other species harvested from polluted waters and influences human health through injuries from debris or indirectly by chemicals or toxins in the water. Sustainable and cost-effective measure must be adopted by corporations and individuals to negate these side effects such as adoption of usable and biodegradable packing, increased public awareness to prevent littering, and preventing the generation of single-use products.**

Keywords: **Plastic debris, Pollution Marine environment, Marine species.**

1. INTRODUCTION

The accumulation of plastic products in the environment that adversely affects wildlife, wildlife habitat and humans is termed Plastic Pollution. Pollutants from plastics are categorised into micro, meso or macro debris depending on size. The qualities of plastic products: durable, inexpensive, versatile and lightweight, have led to an increased demand globally resulting in high levels of production consumption and concomitant waste generation (Moore, 2008). However, plastics are resistant to the natural processes of degradation due to their chemical structure and generally degrade in about 500-1000 years all culminating in high levels of plastic pollutants in the environment (Moore, 2008).

Plastic production may only be a century old but the past 50 year have seen a staggering 6.3 billion tonnes of plastic produced and in 2013 and estimated 299 million tonnes of plastic was produced, up 4% from 2012 confirming a rising trend in the production of plastic products. According to a report by global industry analyst in 2016, plastic consumption is expected to reach 320 million tons by 2020(Beachapedia.org, 2018). Plastic pollution has adverse effects on land, but

no other ecosystem is more affected than the marine environment. Plastic debris poses severe harm to marine wildlife either by ingestion of microplastic, entanglement by macro plastic products and interference with their bodily processes through mutations by chemical toxins secreted and absorbed by plastic products (Beachapedia.org, 2018).

A study conducted by a scientific working group at UC Santa Barbara's National centre for ecological analysis and Synthesis(NCEAS), calculated the amount of plastic waste from land into the ocean. Yearly, 8 million tons of plastics enter the ocean, equivalent to 5 plastic bags filled with plastic for every square foot of coastline in the world (Seltenrich, 2016). The same study estimated that by 2025 the annual input from land to the ocean will be 16 million tons or 10 plastic bags filled with plastic per square foot of coastline. The cumulatively estimated input of plastic from land to the ocean from 2015 to 2025 is 40 million tons-100 plastic bags of plastic per square foot of coastline in the world (Seltenrich, 2016). Therefore, the study sought to investigate the impact of plastic pollution on the ocean and marine wildlife, by specifically: i. determining the degree of plastic pollution that enters the ocean, ii. examining the effects of plastic pollution on species of the marine ecosystem and iii. exploring viable and efficient means to curb the problem.

2. LITERARY REVIEW

2.1. The degree of plastic pollution that enters the ocean

Plastic debris (litter) is any manufactured or processed plastic material that enters the ocean environment from any source (mostly from land). Plastic debris is one of the world's most problematic pollution problems due to the vast amount of plastic production and long shelf-life affecting oceans and smaller bodies of water (Sheavly and Register, 2007). Although Ocean dumping has been occurring for centuries, drastic improvement in manufacturing has brought about a change in the type of marine debris dumped into the ocean. Decades ago, the pollutants consisted mostly of biodegradable, organic material but now synthetic products are much more abundant. The long-shelf of plastic debris along with the high buoyancy allows it to float and travel thousands of miles affecting wildlife and the ecosystem for prolonged periods (Sheavly and Register, 2007). A 2014 study by the 5 Gyres estimated that 5.25 trillion plastic particles weighing some 269,000 tons are floating on the surface of the sea (Seltenrich, 2016). The same study identified that the main source of debris come from consumer packaging (food wrappers, beverage containers, cigarettes and related smoking materials), fishing gear and transporting vessels.

The United Nations Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) concluded that land-based sources account for up to 80% of the world's marine debris (Sheavly and Register, 2007). Plastic manufacturing and consumption are at an all time high, more plastic has been produced in the past ten years than the whole last century, 50% of plastic used once is cast-away, the plastic thrown away each is enough to circle the earth four times, only 5% of used plastic is recycled, the average consumer throws away an estimated 185 pounds of plastic per year, plastic accounts for 15% of all waste, Plastic attribute to approximately 90 percent of all trash floating on the ocean's surface, with 46,000 pieces of plastic per square mile(EcoWatch, 2018).

Forty Percent of the worlds ocean surfaces is covered by billions of pounds of plastic found in swirling convergences. The largest convergence is the Great Pacific Garbage Patch, a collection of marine debris in the north Pacific Ocean twice the size of Texas, with plastic fragments outnumbering marine life seven to one (Society, 2018).

The Great Pacific Garbage Patch extends from the West Coast of North America to Japan. The patch includes the Western Garbage Patch, located near Japan, and the Eastern Garbage Patch, located between the U.S. states of Hawaii and California(Fig.1) (Society, 2018).

These cyclones of debris are connected by the North Pacific Subtropical Convergence Zone, located a few hundred kilometres north of Hawaii. A convergence zone is a point at which warm water from the South Pacific meets up with cooler water from the Arctic. This zone transfers debris from one patch to another (Society, 2018).

The Great Pacific Garbage Patch is constrained by the North Pacific Subtropical Gyre. An ocean gyre is a system of circular ocean currents formed by the Earth's wind patterns and the forces created by the rotation of the planet. The zone in the centre of a gyre remains calm and stable. The circular motion of the gyre attracts debris into this calm centre, where it becomes stuck. The volume of debris in the Great Pacific Garbage Patch amasses because much of it is not biodegradable. Marine biologists recently discovered that an estimated 70% of marine debris sinks to the bottom of

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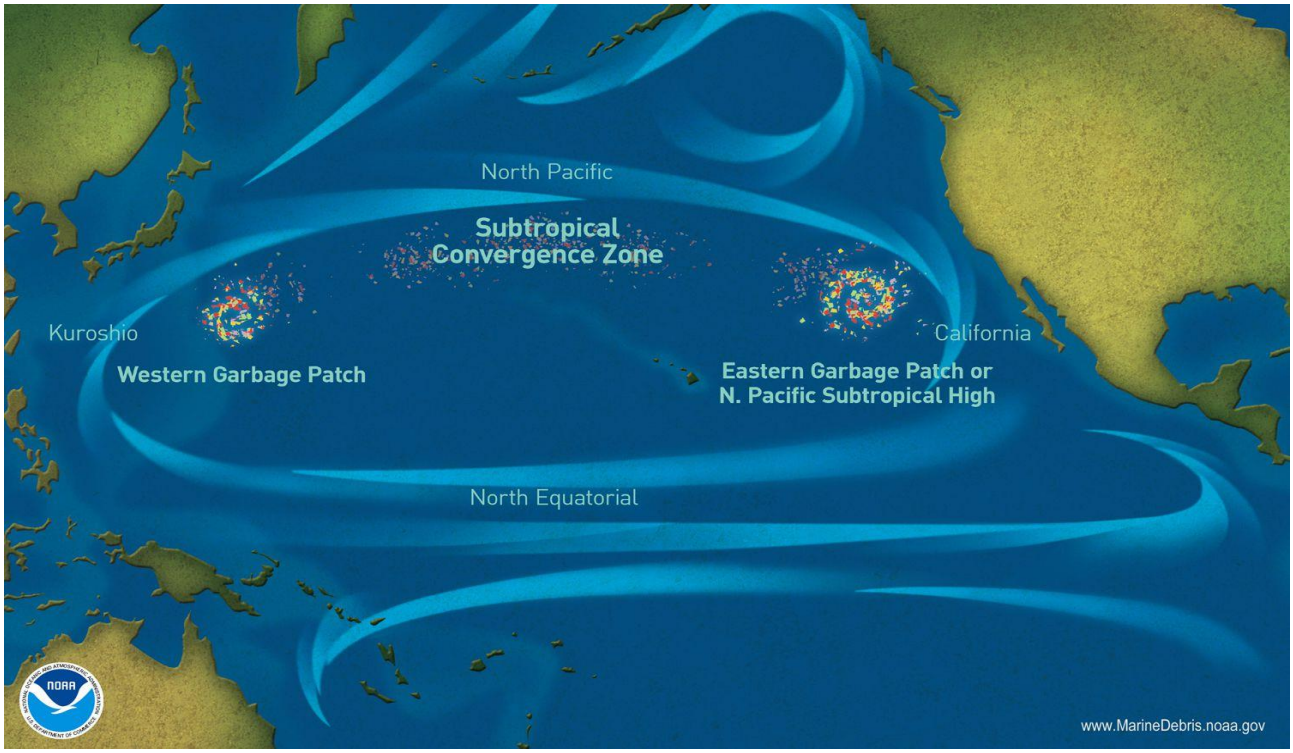
the ocean meaning the seafloor beneath the Great Pacific Garbage Patch may also be filled with plastic debris (Society, 2018).



Source: Society, N. (2018).

2.2. The effects of plastic pollution on the marine ecosystem

The effects of plastic pollution on the marine ecosystem are extensive ranging from the destruction of the aesthetics of coastlines to affecting the food web.

i. Aesthetics

Across the world, people are attracted to coastal areas for tourism and According to the World Health Organization, a clean beach is one of the most significant characteristics sought by tourist (Derraik, 2002). Plastic pollution results in the loss of tourist days, resultant harm to tourism infrastructure, harm to commercial activities reliant on tourism, the impairment to fishery activities, and harm to the local, national and international image of a tourist attraction. One such example was a case in New Jersey, USA in 1987 and Long Island, USA in 1988 where news reports of medical waste, such as syringes, vials and plastic tubes, along the coastline, resulted in an estimated loss of between 127 and 337 million user days at the beach and between 1 and 5 billion dollars in tourism-related expenditure (Moore, 2008).

The problem of plastic pollution on beaches goes beyond macro plastics, studies have found microplastics on beaches and in their sediments across the globe, some of which isolated from human activity. A study conducted near an urban waterway mouth, found the silt to be 1% plastic by volume down to a depth of 20 cm (Moore, 2008).

ii. Entanglement

Several marine animals (sea turtles, mammals, seabirds, fish and crustaceans) are either attracted to or inadvertently entangled in netting, rope and monofilament lines that have their sources in junks and losses from commercial fishing activities Fig 2(Gregory, 2009). In the 1980s it was estimated that 100,000 marine mammal deaths per year in the Atlantic were related to entanglement in plastic nets and fishing line (Moore, 2008). Abandoned and Misplaced nets, also known as ‘‘ghost nets’’, continue to fish and desecrate marine life. A study by Canada’s Food and Agriculture Organization approximates that 10% of all static fishing gear is lost which results in a loss of 15% of the target fish population. Abandoned net entanglement might threaten the economic feasibility of commercial fishing (Moore, 2008).

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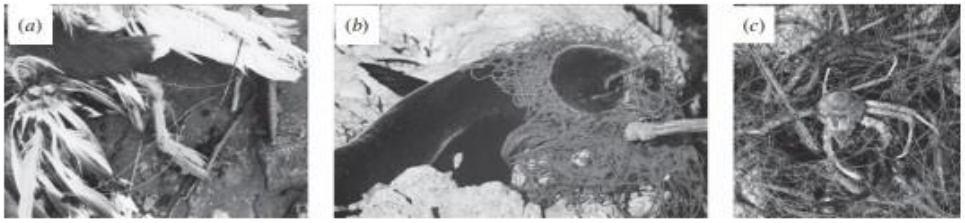

Figure 2. Examples of entanglement from New Zealand that draw immediate public sympathy and anger: (*a*) Karoro (southern black-backed gull, *Larus dominicanus*) caught and hooked in nylon filament fishing line; (*b*) a New Zealand fur seal trapped in discarded netting and (*c*) Ghost fishing—derelict fishing gear dredged from >100 m on the Otago shelf.

Figure 3. Examples of ingestion: (*a*) Laysan Albatross (*Phoebastria immutabilis*, at Kure Atoll, Courtesy of AMRF); (*b*) plastic from the stomach of a young Minke whale (*Balaenoptera acutorostrata)* that had been washed ashore dead in France (Courtesy of G. Mauger & F. Kerleau, Groupe d'Études de Cétacés du Cotentin GECC) and (*c*) stranded sea turtle disgorging an inflated plastic bag. One infers that it has been mistaken for an edible jellyfish (medusoid).

Source: Gregory, M. (2009).

iii. Ingestion

Extensive research on ingestion of plastic debris in marine wildlife is capacious and often monotonous, and the generally reported ecological problems recognised are global in nature(Gregory, 2009). These problems include: injuries (inside and outside), festering skin lacerations and ulcerating abscesses; obstruction of gastrointestinal tract followed by satiation, starvation and overall debilitation leading to death; drop in quality of life and procreative capacity; drowning and inadequate avoidance of predators; loss of feeding capabilities; and the likelihood that plastic resin pellets might adsorb and quintessence possibly harmful toxic composites from seawater(Gregory, 2009).

A hundred species of seabirds are estimated to ingest plastic objects and/or become entangled with them. Plastic balls share a resemblance to fish eggs, and plastic shopping bags could be misconstrued as a jellyfish to a starving sea turtle (Sheavly and Register, 2007). Countless marine animals obscure plastic debris as food and are unable to regurgitate these items once ingested; often times becoming lodged in their gullets and gastrointestinal tracts. Items that do not pass out of the gut gives an incorrect sense of satiation, causing countless animals to stop eating and starve to death. The U.S. Marine Mammal Commission has documented ingestion incidents in six of seven species of sea turtles, 111 out of the world's 312 species of seabirds, and 26 species of marine mammals (Sheavly and Register, 2007).

iv. Habitat Destruction & Alien Species Introduction

Plastic debris causes damage to the shoreline, alive coral reef, and other vital habitats. Macro plastics moved by currents and tides can scrape, scrub, tear, suffocate, and extinguish delicate marine habitats. Bundled fragments can also suffocate seagrass or corals, and may also cause augmented siltation and turbidity, obstructing crucial sunlight (Sheavly and Register, 2007). Floating fragments can host complete communities of coating and attached creatures, transporting them great distances to a new habitat where they can damage and vie with native organisms for resources (Derraik, 2002).

3. CONCLUSION

Much of the earth is covered by seas, far less is known about its ecosystem than that of the terrestrial Biodiversity. This study shows plastic pollution is a serious threat to the marine environment already suffering from overfishing, climate change and other forms of anthropogenic disturbance. Plastic production and manufacturing continue to grow at an alarming rate which continues to put the worlds waters and marine wildlife at risk affecting not only the habitats but also the food web. Mixture of precautionary and reparative actions adopted by both individuals and companies can mitigate the problem to allow the ecosystem to return to normal. The shelf life of plastics in the marine ecosystems forces us to

take severe measures to address the problem at both international and national levels because the halting production and disposal of plastics would not clear the current debris harming marine life now and for decades to come. Therefore the following are proferred viable and efficient means to curb the problem.

1. Plastic pollution is an extremely diverse and complex issue, the solutions to which would also need to be diverse. Like other forms of pollution, plastic debris needs to be prevented and controlled through the effective partnership of education, legislation, and innovation. Education of the Public and Industry- Individuals need to take responsibility for their own plastic waste from school children to commercial fishermen and workers in the manufacturing and transport of plastic, knowledge is key to this people need to be educated on the harm disposing of plastic causes and how to reuse reduce and recycle their plastic waste (Sheavly and Register, 2007).
2. Collation of Data—International Coastal Cleanup and National Marine Debris Monitoring Program research into plastic pollution in the marine environment is extensive but it is far from complete, more work needs to be done to fully understand the toll of plastic pollution on the waters and marine life and planet; a study in 2016 related plastic waste increased sea temperatures in the Pacific (Moore, 2008). Cleanup and national marine debris monitoring program occurs around the globe to track and reduce plastic debris, efforts such as these should be expanded upon (Sheavly and Register, 2007).
3. Engagement of Relevant Stakeholders- Stakeholders such as local citizens; governments, agencies and authorities; organizations; institutions; businesses; and industries (fisheries, tourism, waste management, and dive) need to be involved in the effort to effectively reduce and regulate marine debris and its environmental effects. Plastic industry collaboration- The plastic industry should be involved in cleanup projects, take steps to adopt degradable and durable plastics and actively help in the efforts to stop plastic pollution (Sheavly and Register, 2007). Implementaion of Legislation- laws to deter individuals from the consumption and dumping of plastics are essential to control plastic waste, in 2012 Scotland adopted a law to charge individuals for the use of plastic bags this saw the consumption of plastic bags reduce drastically and people began using these bags more than once. Technological advancements - innovative technologies that can increase the biodegradability and photodegradability of plastics are essential moving forward to mitigate the problem (Sheavly and Register, 2007).

REFERENCES

[1] Beachapedia.org. (2018). *Plastic Pollution Facts and Figures - Beachapedia*. [online] Available at: http://www.beachapedia.org/Plastic_Pollution_Facts_and_Figures [Accessed 9 Jun. 2018].

[2] Derraik, J. (2002). The pollution of the marine environment by plastic debris: a review. *Marine Pollution Bulletin*, 44(9), pp.842-852.

[3] EcoWatch. (2018). *22 Facts About Plastic Pollution (And 10 Things We Can Do About It)*. [online] Available at: https://www.ecowatch.com/22-facts-about-plastic-pollution-and-10-things-we-can-do-about-it-1881885971.html [Accessed 9 Jun. 2018].

[4] Eriksen, M., Lebreton, L., Carson, H., Thiel, M., Moore, C., Borerro, J., Galgani, F., Ryan, P. and Reisser, J. (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), p.e111913.

[5] Gregory, M. (2009). Environmental implications of plastic debris in marine settings--entanglement, ingestion, smothering, hangers-on, hitch-hiking and alien invasions. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364(1526), pp.2013-2025.

[6] Moore, C. (2008). Synthetic polymers in the marine environment: A rapidly increasing, long-term threat. *Environmental Research*, 108(2), pp.131-139.

[7] Seltenrich, N. (2016). Erratum: "New Link in the Food Chain? Marine Plastic Pollution and Seafood Safety". *Environmental Health Perspectives*, 124(7).

[8] Sheavly, S. and Register, K. (2007). Marine Debris & Plastics: Environmental Concerns, Sources, Impacts and Solutions. *Journal of Polymers and the Environment*, 15(4), pp.301-305.

[9] Society, N. (2018). *Great Pacific Garbage Patch*. [online] National Geographic Society. Available at: https://www.nationalgeographic.org/encyclopedia/great-pacific-garbage-patch/ [Accessed 9 Jun. 2018].