

Perspective

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Micro-consumerist bollocks in the fight against plastic pollution: when good intentions - and regulatory initiatives - go awry

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Abstract

Plastic pollution has emerged in recent decades as one of the most pressing issues of environmental concern. However, most of the regulatory and legislative initiatives aimed at curtailing this problem have centered on measures that have very limited impact on the overall prevalence of these materials in all environmental compartments. The minimal influence of these initiatives has been due to their often limited and minor effects on the overall production, use and waste management of plastics. Additionally, the onset of the 2019 global pandemic has resulted in many of these measures being put on hold or cancelled altogether, resulting in increasing levels of plastics in the environment and significantly hampering the combat against plastic pollution. This perspective focuses on microplastics, given their pervasiveness and potential ecological, environmental, and health effects. The sectors and industries contributing the most to this pollution are reviewed and assessed from a societal and environmental perspective. Effective regulatory tools are suggested to help reduce plastic emission levels into the environment.

Keywords: Plastic, microplastic, pollution, regulatory initiatives, laws



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PERSPECTIVE

Global plastic production reached 367 million tons (Mt) in 2021, a figure that does not account for the production of recycled plastics^[1]. It has been estimated that, with the contribution of recycled plastics, the overall plastics production has surpassed 400 million tons in 2021^[2]. Around 80 Mt (20%) of the produced plastics is not well managed and can pollute terrestrial ecosystems. An additional 20 Mt of plastics is estimated to reach the oceans each year, totaling 100 Mt, which is expected to increase to 110 Mt by 2040^[3]. This is not surprising, given that plastics are highly versatile materials that can be found everywhere in the modern world and have, indeed, saved countless lives through medical tools and devices^[4]. However, in recent years, humanity has faced the consequences of this widespread use of plastics and subsequent environmental - and even health - repercussions are becoming increasingly prominent^[5]. Surprisingly, confronted with this and other environmental crises, such as global warming and climate change, that the threat exists, humanity has been, at best, wary in offering potential solutions for these challenges. Perhaps nowhere is this wary more visible than in the fight against plastic pollution^[6]. Plastics are found across all spheres of the environment, from shallow coastal areas to the deepest regions of the oceans and in remote and pristine locations on Earth. Plastic pollution is also a global issue since it is not restricted nor constricted by borders^[7]. Considering the current trends in plastic production, use, and waste generation and management, it is estimated that 12 billion metric tons of plastic waste will accumulate on the planet by 2050^[8].

Plastic pollution is also a complex and multi-tiered issue. For example, environmental awareness campaigns often rely on images highlighting the impacts of plastics on biota [Figure 1]. However, these pertain solely to a layer of plastic pollution, as there are other layers, perhaps even more pervasive, associated with plastic pollution, including microplastics and additives.

Microplastics are small plastic particles (< 5 mm) that exhibit inherent physical and chemical characteristics that render them more hazardous to the environment and organisms. Additives consist of a plethora of compounds that serve numerous purposes in the plastic manufacturing industry. Additives may be released throughout the entire life cycle of the plastic materials, posing risks to the environment and, ultimately, human health^[9]. In particular, due to their reduced size, microplastics may be ingested by organisms at the base of food chains and bioaccumulate throughout different food webs, as depicted in Figure 1D. Moreover, their large surface area-to-volume ratio and chemical profiles render these materials particularly well-suited for adsorbing environmental pollutants, including organic pollutants, found in the environment, which may subsequently leach, directly impacting organisms. Given their ubiquity in the environment, particularly in the marine ecosystem, these materials may act as vectors for invasive species or even pathogens^[10].

Nevertheless, the issue of plastic pollution has long been recognized, particularly by those responsible for generating these polluting products. For example, in 1953, American Can Co. and the Owens-Illinois Glass Co. founded Keep America Beautiful, which Coca-Cola and the Dixie Cup Co., among others, later joined. Keep America Beautiful began anti-litter campaigns in the 1960s. But the most well-known campaign featured the now (in) famous “Crying Indian”^[11], which became, as noted by Dunaway, the “quintessential symbol of environmental idealism”^[12]. As the corporations involved in this campaign did not reveal their participation, there was the inherent assumption that Keep America Beautiful was a truly disinterested group driven by that same environmental idealism. However, this did not represent an embrace and adoption of ecological values but rather the industry’s fear of them, owing to the massive demonstrations over environmental issues in the months and weeks leading up to the first Earth Day in 1970. Interestingly, all these protests held not consumers but the industry as those responsible for the proliferation of single-use plastics, namely, throwaway containers, that actively contributed to the depletion of natural resources and

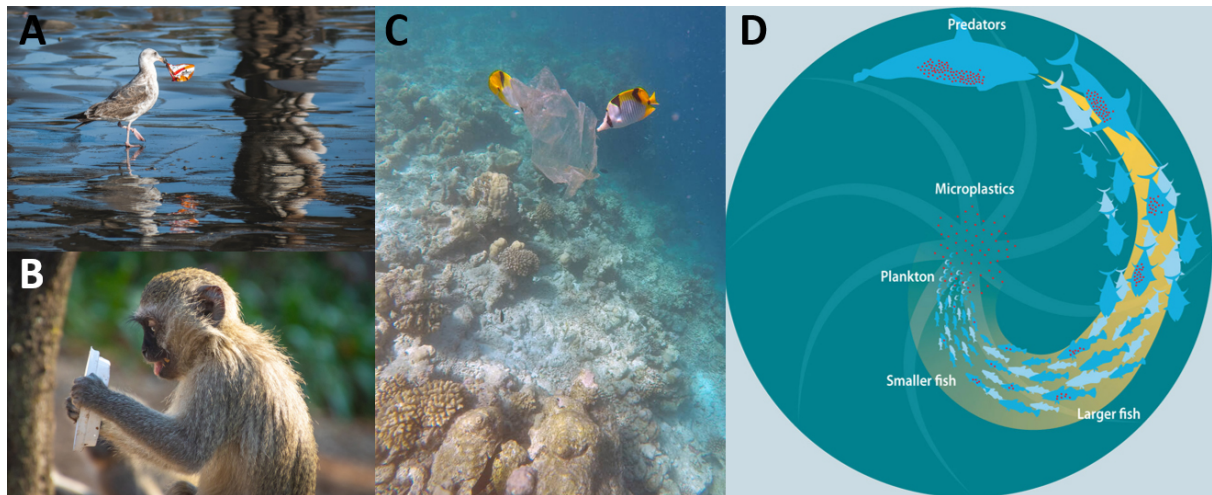


Figure 1. Some visible impacts of larger plastic debris in biota. However, smaller plastic particles, such as microplastics, could pose a more significant threat to the environment and even human health, as noted in D. Image credit: (A) Tim Mossholder; (B) Magda Ehlers; (C) swissippo; (D) Maphoto/Riccardo Pravettoni (<https://www.grida.no/resources/6917>).

created vast quantities of waste. The “Crying Indian” was a landmark in shifting that responsibility to consumers, which, to a large extent, remains to this day. It became the consumers’ responsibility to buy conscientiously, the consumers’ responsibility to adequately dispose of the generated plastic waste and, ultimately, the consumers’ responsibility to press their governments to provide (some) regulations guiding consumers to more sustainable sources. This shift in responsibility became entrenched in society. Schoolchildren, for example, are taught very early on that it is their responsibility to separate their waste and even call out their parents if they are not recycling at home. It worked. Those who did not recycle were frowned upon, and governments felt increasingly pressured to implement mitigating strategies to curb plastic pollution at their own expense. Nonetheless, in most cases, the devised strategies focused on smaller, symbolic gestures^[9]. It is why one may go to the supermarket now, buy plastic-wrapped ham, plastic-wrapped fruit and plastic-wrapped loaves of bread, but be forced to pay an extra fee for a plastic bag to bring all the plastic-wrapped products home. That is why plastic straws became forbidden and replaced with paper straws that continue to be encased in a plastic wrapper [Figure 2]. All in all, “micro-consumerist bollocks,” as coined by George Monbiot, are tiny issues that do not address the underlying structural problems^[13]. That is why governments are forced to invest in the creation of infrastructures, enforcement measures and deterrence mechanisms for addressing the issue of plastic pollution, while producers, responsible for generating all of this plastic waste, remain largely unaccountable and, perhaps more importantly, their margins of profit are not affected.

A 2021 report prepared by the Minderoo Foundation noted that just 20 companies are responsible for over 50% of all single-use plastic thrown away globally, with ExxonMobil topping the list, with an overall contribution of 5.9 Mt to global plastic waste, closely followed by U.S. chemicals company Dow and China’s Sinopec^[14]. Interestingly, when considering the top 100 polluting companies, the report highlighted that they accounted for 90% of global single-use plastic production. Nevertheless, regulatory efforts and initiatives have primarily focused on companies selling finished plastic products, such as taxes on grocery bags and food containers or bans on specific products, such as plastic straws. Comparatively, little attention has been paid to the vastly more limited number of companies at the base of this supply chain, which produce the building blocks for the finished materials almost exclusively from fossil fuels.



Figure 2. The product of recent symbolic measures enforced in numerous European countries: the plastic-wrapped paper straw.

The industry is the source of the single-use plastic crisis. The continued and ever-increasing production of new fossil-based “virgin” polymers perpetuates and will continuously aggravate the current take-make-waste dynamic of the plastics economy, concomitantly undermining a transition to a “circular” plastic economy and simultaneously impacting waste collection rates, end-of-life management and, ultimately, plastic pollution. Despite these threats and consequences, the plastic industry has, by and large, continued to be permitted to operate with minimal regulation and transparency. This is particularly evident when considering the issue of plastic additives, chemicals whose inclusion in the composition of polymers is frequently not disclosed, and any environmental and/or health potential outcomes cannot be adequately assessed, with regulatory efforts frequently lagging behind^[15]. This is, effectively, a key part of the problem: it is impossible to manage what cannot be measured, so focusing on real actions aimed at making these plastic producers accountable is essential.

As such, most of the generated plastic waste should be reduced or eliminated at the source. From a regulatory perspective, this may be partially achieved by making producers responsible for the waste phase of their products. This is at the core of the Extended Producer Responsibility (EPR) schemes, which makes plastic producers the owners of the plastic products they sell, and should accept these following their use^[16]. In other words, these are defined as environmental policy principles in which a producer’s responsibility is *extended* to the post-consumer stage of the product’s life cycle, and this may include their return, recycling, and final disposal^[16]. These principles are considered to be one of the most prominent waste management policy instruments designed to support the implementation of the European waste directives, markedly contributing to the collection and recycling of plastic waste, and may significantly contribute to achieving the waste management targets foreseen in the EU Circular Economy Package^[17]. Though less explored in the United States, at least four states have enacted EPR schemes for packaging^[18], and the Break Free From Plastic Pollution Act of 2021, which also includes some EPR requirements, is set to be implemented at the beginning of January 2033^[19]. In essence, EPR strategies leverage corporate resources to reduce the waste generated by consumers, namely, through single-use plastics. This allows local jurisdictions a higher degree of control over waste streams. In Canada, for example, in some municipalities, plastic producers are fully responsible for funding and managing drop-off and curbside collection recycling programs for packaging^[20]. Presently, existing EPR schemes are considered costly and time-consuming, and companies

have often fought against their implementation. Additionally, monitoring and enforcement are nearly non-existent, and some case studies point to no visible effects of implementing EPR schemes^[21]. The increase in online shopping, especially during the COVID-19 pandemic^[22], evidenced a legal vacuum and a lack of regulatory execution. This shortcoming resulted - and continues to result - in “free-riding” producers and retailers, which often have no physical legal entity in the country of destination and are not registered or subjected to national or local EPR schemes. Moving forward will require tougher and stricter regulations that should be applied in an integrative manner, including, but not limited to^[9]:

- Identifying the underlying drivers of plastic waste;
- Reducing single-use plastics and establishing reduction targets. This should be accompanied by severe (not merely symbolic) discouraging penalties for single-use plastics;
- Combating (eliminating) single- or mono-dose products;
- Creating the right for EU customers to return plastic packaging to retailers;
- Ring-fencing revenues from fines and levies to activities associated with zero plastic waste, including financing the recycling industry or supporting specific environmental projects;
- Combating the economic preference for the use of virgin polymers, which may be done through the application of progressive taxes on these materials;
- Devising policies addressed to support the implementation of reusable packaging and to regulate packaging practices across different sectors, but with a particular focus on the food supply chain and the cosmetic industry;
- Creating well-defined definitions, rules and labelling practices for biodegradable and biobased plastics, associated with structured efforts for the education and public awareness of these materials and related key aspects;
- Evaluating and exploring the viability of these materials, taking into consideration the inherent characteristics and limitations of each, in particular, their biodegradability and necessary conditions (environment or managed facilities) for biodegradation;
- Funding and investing in modern infrastructures for the collection, separation, and processing of plastic waste, including in rural areas, which are frequently left out of such operations; this is of particular importance in developing countries, and financial support for this from rich countries should be considered as a long-term investment in the environment;
- Establishing local, national and supra-national enforcement and monitoring bodies with clear and defined roles and responsibilities to ensure compliance.

Though it is essential to understand and have a deeper understanding of the sources, fate, and effects of plastic waste, it ultimately does not matter who is to blame, but rather what will we all, collectively, do about the increasingly alarming issue of plastic - including microplastic - pollution. Clearly, the onus of

responsibility in dealing with the generated waste should not be put on consumers, and the current regulatory initiatives are woefully insufficient to have any real impact. These are only “band-aids” for a large, gaping wound that will take considerable, lengthy, and costly efforts to heal.

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Authors' contributions

The author contributed solely to the article.

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The author declared that there are no conflicts of interest.

Ethical approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

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REFERENCES

1. EPC. Plastics - the Facts 2021. Available from: <https://plasticseurope.org/knowledge-hub/plastics-the-facts-2021/> [Last accessed on 3 Feb 2023].
2. Mafuta C, Baker E, Rucevska I, et al. Drowning in plastics: marine litter and plastic waste vital graphics. Available from: <https://www.grida.no/publications/749> [Last accessed on 3 Feb 2023].
3. Lau WWY, Shiran Y, Bailey RM, et al. Evaluating scenarios toward zero plastic pollution. *Science* 2020;369:1455-61. DOI
4. Millet H, Vangheluwe P, Block C, et al. The nature of plastics and their societal usage; 2018.
5. Allouzi MMA, Tang DYY, Chew KW, et al. Micro (nano) plastic pollution: The ecological influence on soil-plant system and human health. *Sci Total Environ* 2021;788:147815. DOI
6. Kirk E A, Popattanachai N. Marine plastics: fragmentation, effectiveness and legitimacy in international lawmaking. *Rev Eur Comp Int Env* 2018;27:222-33. DOI
7. Ford HV, Jones NH, Davies AJ, et al. The fundamental links between climate change and marine plastic pollution. *Sci Total Environ* 2022;806:150392. DOI
8. Law K L, Narayan R. Reducing environmental plastic pollution by designing polymer materials for managed end-of-life. *Nat Rev Mater* 2022;7:104-16. DOI
9. Da Costa JP, Rocha-Santos T, Duarte AC. The environmental impacts of plastics and micro-plastics use, waste and pollution: EU and

- n a t i o n a l m e a s u r e s . A v a i l a b l e f r o m : [https://www.europarl.europa.eu/RegData/etudes/STUD/2020/658279/IPOL_STU\(2020\)658279_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/STUD/2020/658279/IPOL_STU(2020)658279_EN.pdf) [Last accessed on 3 Feb 2023].
10. Costa JP, Santos PSM, Duarte AC, Rocha-Santos T. (Nano) plastics in the environment - sources, fates and effects. *Sci Total Environ* 2016;566-567:15-26. DOI
 11. KAB. Keep America beautiful: the crying Indian (1970). Available from: <https://www.youtube.com/watch?v=h0sxwGITLWw> [Last accessed on 3 Feb 2023].
 12. Dunaway F. The 'Crying Indian' ad that fooled the environmental movement. Available from: <https://www.chicagotribune.com/opinion/commentary/ct-perspec-indian-crying-environment-ads-pollution-1123-20171113-story.html> [Last accessed on 3 Feb 2023].
 13. Monbiot G. Capitalism is killing the planet - it's time to stop buying into our own destruction. Available from: <https://mahb.stanford.edu/library-item/capitalism-is-killing-the-planet-its-time-to-stop-buying-into-our-own-destruction/> [Last accessed on 3 Feb 2023].
 14. Charles D, Kimman L, N Saran. The plastic waste makers index. Available from: <https://cdn.minderoo.org/content/uploads/2021/05/27094234/20211105-Plastic-Waste-Makers-Index.pdf> [Last accessed on 3 Feb 2023].
 15. Pellis A, Malinconico M, Guarneri A, Gardossi L. Renewable polymers and plastics: Performance beyond the green. *N Biotechnol* 2021;60:146-58. DOI
 16. Leal Filho W, Saari U, Fedoruk M, et al. An overview of the problems posed by plastic products and the role of extended producer responsibility in Europe. *J Clean Prod* 2019;214:550-8. DOI
 17. European Commission. A European strategy for plastics in a circular economy. Available from: <https://ec.europa.eu/environment/circular-economy/pdf/plastics-strategy-brochure.pdf> [Last accessed on 3 Feb 2023].
 18. Felton D. Four states enact extended producer responsibility laws for packaging. Available from: <https://www.packworld.com/news/sustainability/article/22419036/four-states-enact-packaging-epr-laws> [Last accessed on 3 Feb 2023].
 19. Congress.gov. S.984 - break free from plastic pollution act of 2021. Available from: <https://www.congress.gov/bill/117th-congress/senate-bill/984?overview=closed> [Last accessed on 3 Feb 2023].
 20. Diggle A, Walker TR. Implementation of harmonized extended producer responsibility strategies to incentivize recovery of single-use plastic packaging waste in Canada. *Waste Manag* 2020;110:20-3. DOI
 21. Harris L, Liboiron M, Charron L, Mather C. Using citizen science to evaluate extended producer responsibility policy to reduce marine plastic debris shows no reduction in pollution levels. *Marine Policy* 2021;123:104319. DOI
 22. Alfonso V, Boar C, Frost J, Gambacorta L, Liu J. E-commerce in the pandemic and beyond. Available from: <https://www.bis.org/publ/bisbull36.pdf> [Last accessed on 3 Feb 2023].