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PERSPECTIVE

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It's the product not the polymer: Rethinking plastic pollution

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Abstract

Mismanaged plastic waste poses a complex threat to the environments that it contaminates, generating considerable concern from academia, industry, politicians, and the general public. This concern has driven global action that presents a unique opportunity for widespread environmental engagement beyond the immediate problem of the persistence of plastic in the environment. But for such an opportunity to be realized, it is vital that the realities of plastic waste are not misrepresented or exaggerated. Hotspots of plastic pollution, which are often international in their source, present complex environmental problems in certain parts of the world. Here we argue, however, that the current discourse on plastic waste overshadows greater threats to the environment and society at a global scale. Antiplastic sentiments have been exploited by politicians and industry, where reducing consumers' plastic footprints are often confused by the seldom-challenged veil of environmental consumerism, or "greenwashing." Plastic is integral to much of modern day life, and regularly represents the greener facilitator of society's consumption. We conclude that it is the product, not the polymer that is driving the issue of plastic waste. Contemporary consumption and disposal practices are the root of much of the anthropogenic waste in the environment, plastic, or not. Effective environmental action to minimize plastic in the environment should be motivated by changes in consumption practices, policies, and product design, and should be informed by objective science and legislation.

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emerging contaminants, microplastics, pollution, river catchments, water quality

1 | INTRODUCTION

Plastic is a ubiquitous pollutant (Eriksen et al., 2014; Xanthos & Walker, 2017), and its persistence in the environment, and the potential harm that it may cause to organisms and ecosystems is an emotive modern day reality. The amount of mismanaged plastic waste in the environment was estimated to be as much as 60–99 million metric tonnes in 2015 (Lebreton & Andrady, 2019). Plastic in the environment can entangle organisms (Gregory, 2009) and ingestion of plastic particles has been observed in organisms as large as whales (Lusher et al., 2015) and small as zooplankton (Cole et al., 2013). Plastic can also act as a dispersal vector of harmful chemicals such as persistent organic pollutants (Frias, Sobral, & Ferreira, 2010), heavy metals (Vedolin, Teophilo, Turra, & Figueira, 2018), and pharmaceuticals (Xiong, Wu, Elser, Mei, & Hao, 2019) and, as they degrade, can introduce chemicals such as plasticizers (Rochman, 2015) and dyes (Massos & Turner, 2017) into their environment.

Because of this potential harm, key political, public, and industrial stakeholders have effected change to minimize their plastic footprints. Notable efforts to achieve this include the widespread phasing out by industry and legislative bans of plastic bags (Maes et al., 2018; Xanthos & Walker, 2017) and of microplastic particles (<5 mm in their largest dimension) used in certain cosmetic products (Fendall & Sewell, 2009; Xanthos & Walker, 2017). Off the back of priorities to minimize plastic pollution, there is great potential to elicit widespread environmental action beyond the problems of plastic in the environment. However, media coverage of plastic pollution, driven by public interest in this topic, is regularly alarmist with broader claims of significance unsubstantiated by current knowledge. Examples of this include online news headlines such as "*How your clothes are poisoning our oceans and food supply*" (The Guardian online, 2016); "*Average person swallows plastic equivalent to a credit card every week, report finds*" (The Telegraph online, 2019); and "*Where's Airborne Plastic? Everywhere, Scientists Find*" (The New York Times, 2020). The aversion to plastic associated with this could encourage the use of alternative materials with potentially greater harmful effects. The scientific community has an obligation to inform stakeholders objectively, as detailed with specific reference to microplastic pollution by Provencher et al. (2020). But, within a culture of antiplastic sentiments, industry, governments, and media platforms also have an obligation to ensure members of the public are not mislead.

The benefits of plastics are often overlooked in plastic pollution discourses. Plastic is cheap, lightweight, and durable (Hopewell, Dvorak, & Kosior, 2009), and plastic products have benefited society greatly. Durable packaging reduces food waste and, though the leaching of chemicals from plastic food packaging is known to occur (Carlos, de Jager, & Begley, 2018), plastic packaging is used to safely store and transport a variety of consumables including food, drink, and toiletries, as well as having multiple medical applications (Andrady & Neal, 2009). Plastic polymers are also constituent components of vital composite materials including tyre rubber and vehicle brake linings. Plastic has driven down day-to-day expenditure, and its durability has been exploited across numerous municipal sectors including energy, sewerage, and transport.

Andrady (2003) argues that the environmental debate, and the variety of parties within it, have politicized and polarized public environmental concern, complicating the implementation of positive environmental action. Seventeen years later, we argue that while it is important not to quash positive environmental action, this statement is embodied by the polemic discourse surrounding plastic use and waste. With this in mind, here we comment on the existing science of plastic prevalence through inadequate waste management and identify requirements to better inform the research, communication, and future management of plastics in the environment. Stafford and Jones (2019) argue that current discourses around plastic pollution distract from more pressing environmental threats such as climate change and biodiversity loss. We support this view, and comment on the role of current scientific practices in facilitating this.

2 | HOW MUCH PLASTIC IS IN THE ENVIRONMENT?

Unconstrained plastic debris is transported through and between environments. Plastic has been found in even the most remote locations including Arctic ice floes (Bergmann et al., 2019) and the deep sea (Chiba et al., 2018); however, it is not distributed equally around the planet. Microplastic surveys in particular seldom report very low concentrations, but they do occur (Stanton, Johnson, Nathanail, MacNaughtan, & Gomes, 2020). True indications of global distributions of plastic prevalence are hard to ascertain in a field where monitoring exercises are focused on highly developed and/or connected systems. As a result, current understanding of plastic ubiquity and its concentrations are limited.

Environmental modeling can estimate plastic concentrations and abundances in the environment. Geyer, Jambeck, and Law (2017) estimate that 79% of the 6,300 metric tons of plastic waste generated up to 2015 are either in landfill or in the natural environment. In the marine environment alone, floating plastic waste has been estimated at 5.25 trillion pieces totally 268,940 tons (Eriksen et al., 2014). However, quantifying the amount of plastic waste in the environment is challenging, and global estimates of plastic waste vary. For example, Lebreton et al. (2017) propose an annual global input of plastic waste from rivers to the marine environment of 1.15–2.41 million tons, while Schmidt, Krauth, and Wagner (2017) put this figure at 0.41–4 million tons. The spatial and temporal sparsity of data availability contribute to uncertainty in the current modeled estimates of global plastic emission (Schmidt et al., 2017).

Rivers are known to be sources of much of the plastic in the marine environment. Models of riverine plastic fluxes have identified particular hotspots of plastic discharge to the marine environment across east and south-east Asia (Lebreton et al., 2017; Schmidt et al., 2017). While this region may be the source of vast quantities of plastics, it is also true that countries in this region have, until recently, imported plastic waste from developed countries that do not have the desire, intention, or capacity to recycle their own waste. As such, the responsibility for these hotspots of discharge may be global, not local.

Estimating plastic prevalence is especially complicated for microplastic particles, the majority of which are sourced from the breakdown of plastic in the environment, which is not consistent between products, polymers, and environments. Current understanding of the environmental prevalence of microplastic particles, particularly in the freshwater environment, is also based on research that seldom considers the variability of the environment under investigation (Stanton et al., 2020). Moreover, microplastic concentrations are often presented in units that unduly inflate recorded values. Despite regularly collecting ≤30 L of water, the majority of suspended and floating riverine microplastic surveys published in 2019 reported microplastic concentrations per m^3, a unit two orders of magnitude greater than their sample volume, regularly presenting concentrations that equate to <1 particle L^{-1} (Di, Liu, Wang, & Wang, 2019; Li et al., 2019) (Table 1). Such extrapolation would be rightly considered unacceptable for other pollutants. Apart from representing poor science, when gross extrapolation is combined with variable methodologies, low sampling volumes and no understanding of temporal variability, the potential for the incorporation of large errors is high. Indeed, collecting 13 samples over the course of 12 months, Stanton et al. (2020) found extrapolations from a single site varied over eight orders of magnitude depending on which of their measurements were used. Extrapolations over this scale almost inevitably result in large, misleading numbers, which can lead to alarmist headlines and are difficult to interpret, especially by the public, political groups, and those seeking to manage the problem.

In light of this, we recommend the adoption of higher resolution and/or longer duration sampling campaigns that are systematic and are able to expose the variability in microplastic concentrations at sites of investigation. In addition, microplastic concentrations should be reported in units that are representative of the sample volume used to quantify microplastic concentrations.

3 | IS PLASTIC A PROBLEM FOR ENVIRONMENTAL HEALTH?

Everaert et al. (2018) propose a safe concentration of microplastic particles in the marine environment of up to 6,650 buoyant particles m^{-3}, or 6.65 particles L^{-1}. Though their environmental risk assessment does not consider the

TABLE 1 A summary of peer-reviewed literature from 2019 that quantified suspended (nonsedimentary) microplastic concentrations in rivers

Authors	Sample type	Chosen unit	Lowest particles/unit	Lowest particle concentration
Mai et al. (2019)	Net trawl	m^3	>0.005	0.000005/L
Kataoka, Nihei, Kudou, and Hinata (2019)	Net trawl	m^3	>0.0295	0.0000295/L
Mani et al. (2019)	Net trawl	m^3	>0.03	0.00003/L
Cheung, Hung, and Fok (2019)	Net trawl	m^3	>0.059	0.000059/L
Lenaker et al. (2019)	Net trawl	m^3	>0.06	0.00006/L
Tan, Yu, Cai, Wang, and Peng (2019)	Net trawl	m^3	>0.28	0.00028/L
Dikareva and Simon (2019)	Net trawl	m^3	>17	0.0017/L
Simon-Sánchez, Grelaud, Garcia-Orellana, and Ziveri (2019)	Net trawl	m^3	>1.95	0.00195/L
Bordós et al. (2019)	1,500 L grab	m^3	>3.25	0.00325/L
Luo et al. (2019)	5 L grab	L	>0.08	0.08/L
Zhao et al. (2019)	100 L grab	m^3	157.2[a]	0.1572/L
Weideman, Perold, and Ryan (2019)	30 L or 60 L grab	L	0.21[a]	0.21/L
	Net trawl	m^2	<0.05[a]	0.05/m^2
Li et al. (2019)	25 L grab	m^3	>240	0.24/L
Eo, Hong, Song, Han, and Shim (2019)	100 L grab	m^3	>293	0.293/L
Di et al. (2019)	20 L grab	m^3	>467	0.467/L
Jiang et al. (2019)	30 L grab	m^3	>483	0.483/L
Wu et al. (2019)	20 L grab	m^3	>788	0.788/L
Wang et al. (2019)	20 L grab	m^3	>1760	1.76/L
Zhang et al. (2019)	5 L grab	L	>13.53	13.53/L
Xiong et al. (2019)	Net trawl	Km^2	>195,000	195/m^2
Ding et al. (2019)	30 L grab	L	>3.67	3.67/L
Wiggin and Holland (2019)	20 L grab	m^3	>4,161	4.161/L
Alam, Sembiring, Muntalif, and Suendo (2019)	1 L grab	L	5.85[a]	5.85/L
Yan et al. (2019)	20 L grab	m^3	>8,725	8.725/L

Note: Publications were identified using a Web of Science search (February 3, 2020) for "Microplastics" AND "River."
[a]Values represent mean particle/unit concentrations where publications do not present a range of values.

chemical threat of microplastic particles, Everaert et al. (2018) predict buoyant marine microplastic concentrations no greater than 48.8 particles m^{-3} (0.0488 particles L^{-1}) by the end of the century. While localized hotspots of microplastic pollution may exceed this safe concentration in the present day, the mere observation of microplastic particles may not necessarily be the cause for concern that has been previously claimed.

Impacts of microplastics on biota have been investigated with laboratory experiments typically performed using concentrations vastly in excess of those found in natural environments (Lenz, Enders, & Nielsen, 2016). Though variable within taxa, research on the effects of microplastic exposure on fish and aquatic invertebrates in particular has regularly found no, or minimal negative effects (Foley, Feiner, Malinich, & Höök, 2018). This is true even when studies have used experimental microplastic concentrations far in excess of those recorded in the environment (Ašmonaitė, Larsson, Undeland, Sturve, & Carney Almroth, 2018; Mateos-Cárdenas, Scott, Seitmaganbetova, van Pelt Frank, & AK, 2019; Weber, Scherer, Brennholt, Reifferscheid, & Wagner, 2018).

However, plastics may also act as vectors for other pollutants. The ingestion of plastics to which chemicals are sorbed is a known pathway by which organisms are exposed to chemical pollution (Gallo et al., 2018). But, the adsorption of toxins to environmental particulates is not exclusive to microplastic pollution. In the freshwater system, for example, this is a known property of suspended particulate matter (Rügner et al., 2019). Furthermore, while there is evidence that harmful chemicals, particularly hydrophobic organic pollutants, can adhere to the surface of plastic material, the ingestion of plastic material is unlikely to increase exposure to these chemicals (Koelmans et al. 2016).Objective assessments of plastic pollution must assess risk in the broader context of other particulate vectors of chemicals which have been studied for years.

In addition to their chemical and physical impacts, recent research has also documented the colonization of plastic material by potentially harmful bacterial communities, including pathogens, (Frère et al., 2018; Kirstein et al., 2016; Viršek, Lovšin, Koren, Kržan, & Peterlin, 2017). Of particular concern is the reported enhanced plasmid transfer of bacterial communities that have colonized plastic waste, with potential implications for the transfer of antimicrobial resistance (AMR) (Arias-Andres, Klümper, Rojas-Jimenez, & Grossart, 2018). However, this is not an observation that is unique to plastic material. Similar findings have been noted for the bacterial colonization of airborne particulate matter <10 μm (PM_{10}) and <2.5 μm ($PM_{2.5}$) (Hussey et al., 2017).

Though diverse in their size and composition, plastics represent a small proportion of the diversity of substrates, anthropogenic, and natural, that environments and ecosystems coexist with and, in some cases, are threatened by. There is therefore a need to assess both the concentrations of different particulates that threaten environmental systems, and the relative toxicity of these particulates in order to appropriately summarize on the threat(s) that (micro) plastics pose to the environment.

4 | THE IMPACT OF PLASTIC ON HUMANS

It has been proposed that plastics and microplastics may also cause harm to humans. Chemical concerns regarding the leaching of plasticizers from everyday items such as food packaging and children's toys have proven to be well-founded, and include the endocrine disrupting plasticizer bisphenol A (BPA) (Huang et al., 2012). Legitimate public health concerns led to the international banning of BPA in many countries from the end of the 2000s and the start of the 2010s (Jalal, Surendranath, Pathak, Yu, & Chung, 2018; Usman & Ahmad, 2016). But while the chemical threat of plastic-associated compounds is relatively easy to constrain and legislate, understanding the threats of microplastic and nanoplastic particles to humans, and taking appropriate action on this knowledge, is more challenging.

In high concentrations, the exposure of textile factory workers to airborne microplastic fibers has been associated with pulmonary diseases (Pimentel, Avila, & Lourenco, 1975), but it is not yet known how environmental concentrations of airborne microplastics compare to those of textile factories. Microplastic particles with aerodynamic diameters <2.5 μm have the potential to reach the deep lung (Wright, Levermore, & Kelly, 2019), however, the proportion and ubiquity of airborne PM_{10} and $PM_{2.5}$ that is formed from plastic material is not yet known. Moreover, comparative studies of the relative harm of plastic and nonplastic particulate matter are currently lacking. Of all of the particles inhaled and ingested, nanoplastic particles (<1 μm) have the potential to cross epithelial linings of the lungs and the gastrointestinal tract (Wright & Kelly, 2017). Airborne microplastic research has consistently recorded microplastic particles too large to inhale (Cai et al., 2017; Dris et al., 2017; Dris, Gasperi, Saad, Mirande, & Tassin, 2016; Stanton, Johnson, Nathanail, MacNaughtan, & Gomes, 2019), though the presence of microplastic particles <63 μm (Klein & Fischer, 2019), ≤50 μm (Allen et al., 2019), and ≤25 μm (Bergmann et al., 2019) may include respirable particles.

Ingestion of microplastic particles presents a further, as yet unquantified, threat to humans. The presence of microplastic particles in human stools has been confirmed (Schwabl et al., 2019), and it has even been claimed that citizens of the USA could ingest up to 52,000 microplastic particles per year (Cox et al., 2019). Microplastic particles have been identified in food on sale for human consumption including bivalves (Li, Yang, Li, Jabeen, & Shi, 2015; Van Cauwenberghe & Janssen, 2014), fish (Karami, Golieskardi, Ho, Larat, & Salamatinia, 2017; Rochman et al., 2015), and table salts (Iñiguez, Conesa, & Fullana, 2017; Yang et al., 2015), as well as drinking water (Oßmann et al., 2018; Schymanski, Goldbeck, Humpf, & Fürst, 2018). More research that explores the physical and chemical impacts of plastic, and particularly micro- and nanoplastics, on human health is required. However, the presence of microplastic particles in drinking water, for example, is not currently thought to warrant routine monitoring as there is currently no evidence to warrant human health concerns (World Health Organization, 2019). Particular care should therefore be taken in discussing the potential human health impacts of plastic until such an evidence base is established.

5 | IS PLASTIC AN ISSUE RELATIVE TO OTHER POLLUTANTS?

As stated above, plastics are only one type of anthropogenic material that contaminates the environment. Examples include natural textile fibers such as cotton and wool (Stanton et al., 2019), spheroidal carbonaceous particles, and black carbon (Ruppel et al., 2015) and brake-wear particles (Gietl, Lawrence, Thorpe, & Harrison, 2010) all of which are present in different environmental matrices, where they may have adverse environmental effects. These materials are often much more abundant than microplastics and some, such as glass, aluminum, and paper, are associated with "plastic alternatives" that are marketed as solutions to plastic pollution, but in reality side step the inconvenience of changing the consumption practices at the root of the problem. The eco-toxicological impacts of some of these materials are less well known than plastic and microplastic pollution, yet they could have significant impacts.

The biodegradation of cotton and wool for example, which is perceived as a benefit over their plastic analogues, could lead to the more rapid release of chemicals such as the dyes used in their manufacture (Ladewig, Bao, & Chow, 2015). Moreover, natural fibers are widely assumed to biodegrade in the environment. However, archeological studies have noted the preservation of natural fibers in certain, particularly anoxic, environments over centuries (Chen & Jakes, 2001), and even millennia (Müller et al., 2006).

In a soup of chemical pollutants and plastic and nonplastic anthropogenic particles, the absence of objective assessments of anthropogenic pressures on environmental systems presents a challenge to environmental monitoring, assessment, and regulation. It has been estimated that the Yangtze River discharges a maximum of 480,000 tonnes of plastic (including microplastic) per year (Lebreton et al., 2017). With an annual total discharge of approximately 500 trillion liters of water, this represents 0.001 g/L in a river that also discharges highly toxic concentrations of mercury, lead, arsenic, copper and zinc (Yin et al., 2016), as well as raw sewage, pharmaceuticals and pesticides.

Heavy metals, elevated nutrients and fine sediment are sometimes termed "legacy" pollutants. However, these pollutants are known to be globally widespread, highly toxic, very long lasting in environments, and can cause significant ecological and human harm (Hutchinson, Lyons, Thain, & Law, 2013). "Legacy" does not refer to their persistence or their threat. Moreover, the age of much of the plastic material that is in the environment is not known, and could therefore be categorized as a legacy pollutant in its own right. By their definition, legacy pollutants persist to this day, and the problems they present relative to, and in combination with, "contemporary pollutants" must be considered and understood if we are to achieve an objective assessment of environmental health.

Influenced by media and political exploitation of an emotive environmental issue, public concern for the environment is dominated by plastic pollution (Henderson & Green, 2020). However, as a scientific community, it is important that the amount of time and funds devoted to addressing this popular concern are not disproportionate to less tangible anthropogenic pressures on our environment such as that of heavy metals, pharmaceuticals, and pesticides. Environmental research that does not fairly represent the problem under investigation risks undermining public and political trust in environmental science. Plastic pollution presents a generational opportunity to alter society's behavior, and use the currently unprecedented engagement with environmental issues and concern to reduce the "throw-away" culture and overhaul waste mismanagement, and raise awareness of other, potentially greater environmental issues. We believe, however, that continued prioritization of plastic over other, known issues, will lead to this opportunity being missed.

6 | HOW MUCH CAN WE CUT BACK?

Plastic materials help reduce food waste, improve sanitation, and can drive down product costs and carbon footprints where plastic packaging is used in preference to heavier alternatives such as glass. Reduced plastic packaging of food may increase the use of chemical preservatives in supermarket foods and/or increase food waste. Footprint comparisons and life cycle assessments (LCAs) can begin to unpack this debate. Examples include the need to reuse a multiuse low-density polyethylene bag at least 10 times to see an environmental benefit over high-density polyethylene single-use plastic bags (Civancik-Uslu, Puig, Hauschild, & Fullana-i-Palmer, 2019). Similarly, glass and metal containers have higher global warming potentials than some plastic containers because of greenhouse gas emissions associated with particular stages of their life cycle, such as transport (Pasqualino, Meneses, & Castells, 2011). There are plastic products that are unnecessary, and for which suitable alternatives are available, such as glitter in cosmetics and microplastic beads in personal care products. However, the high profile reporting of small actions to minimize plastic pollution including legislation banning cosmetic microplastics and taxing plastic bags, and financial incentives for using reusable containers, risks instilling in societies a complacency toward other environmental problems that are not as tangible as plastic pollution (Stafford & Jones, 2019). Before substantial social and economic changes are encouraged or demanded, the environmental issues associated with plastic alternatives, including biodegradable plastics, need to be defined and communicated to stakeholders. Solutions are likely to come from a greater focus on designing materials and products that can be recycled and that have their end-of-life built in, and that markets and facilities exist to recycle all plastic waste (Hahladakis, Velis, Weber, Iacovidou, & Purnell, 2018).

The root of the plastic pollution problem lies not in the plastic itself, but in people's relationship with it, which has been engineered and manipulated by industry to such a degree that it is regularly unavoidable. The convenience and affordability of short-lived plastic products including packaging and fast fashion has facilitated a disposable "on-the-go" lifestyle that is dominated by plastic, but should not be defined by it. There is an understandable desire to minimize the global plastic debris in the environment, but positive action to minimize plastic pollution needs to be well informed and should not exacerbate other forms of environmental degradation associated with alternative materials.

Plastic materials are so integrated into our lives that indiscriminate reductions in plastic use would be both extremely challenging and irresponsible. LCAs have the potential to inform environmental assessments and target efforts to reduce the use of plastic materials, and even specific polymers, in different industries. Similarly, improving the circularity of products by incorporating their disposal into product design has great potential in reducing the amount of plastic that finds its way to the environment.

However, though LCAs and increased circularity can direct plastic reductions and minimize the impact of plastic where reduction is less feasible, LCAs can lack the necessary robustness to account for the diversity of factors considered by decision makers, which span the social, environmental and economic value of products (Iacovidou et al. 2017), and improved circularity relies on appropriate waste management infrastructure which is lacking in regions of the world with sophisticated waste management procedures, and absent in those where much of the world's plastic pollution is concentrated and lost to aquatic environments.

While research documenting the presence of plastic in the environment and its impacts on ecosystems is extensive, an objective understanding of the problem cannot be achieved by changing scientific practices alone. To address the problem of plastic pollution requires large-scale political and economic change (Stafford & Jones, 2019), but this change must be informed by sound and objective science and social science. There is currently a disconnect between scientific research and the complementary research that is necessary to understand the social dimensions of the plastic pollution problem. Recognizing the importance of this knowledge gap, and closing it, is vital if we are to reduce the amount of anthropogenic material, plastic or otherwise, that persists in the environment.

7 | CONCLUSION

While there is a clear impact of plastic pollution in certain scenarios, we propose that the mere presence of plastic debris in the environment should not be considered a significant environmental threat. Knowledge gaps in the study of plastic pollution persist, and it is important that the direction of research follows a more critical approach that places new knowledge in the context of other particulates that have similar physical and chemical functions in the environment. Moreover, it is unhelpful to decision makers to promote the significance of plastic pollution above other anthropogenic pressures without sufficient evidence. It is imperative that the realities of plastic pollution are not misrepresented, particularly in the public dissemination this issue.

To truly assess the significance of plastic waste, environmental research and policy must:

1. Refrain from reporting the presence of plastic in environments and organisms at discrete points in time that cannot provide any indication of plastic loads; cannot be interpreted or extrapolated through time; and are unable to report representative environmental plastic concentrations.

2. Perform eco-toxicological risk assessments for humans and other organisms using environmentally representative concentrations.

3. Place the findings of plastic pollution in the context of other anthropogenic pressures on the environment, and alongside natural and other anthropogenic material present in the sampled environment.

4. Move to minimize the environmental impact of overconsumption, however inconvenient, through product design, truly circular waste-management, and considered rather than reactionary policy.

5. Capitalize on public interest and concern for the problems associated with plastic waste to raise the profile of greater, if less tangible, environmental concerns such as climate change and biodiversity loss.

In order to truly inform environmental management, and to focus investment and interest where it will make the most valuable contribution to protecting environments we urgently need to determine whether, and what, the ecological and toxicological effects of plastic in the environment are. In order to achieve this, studies of plastic debris could better engage with the vast existing literature on environmental risk assessment, pollutant quantification, and identification methods used for similar pollutants and in other disciplines (e.g., the textile industry, forensic science). Plastic waste has garnered substantial public and political interest and investment and it is not the intention of this article to undermine the threat that plastic pollution can pose in certain locations. The problems that plastic pollution can cause have steered considerable environmental action and protection, bringing the environment to the forefront of many sectors of society. However, there has also been a huge public worry and a "dash from plastic" that is partly driven by scientific findings that are inconclusive at best. It is therefore vital that academic research and policy do not undermine this unique opportunity to exploit further positive environmental progress.

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CONFLICT OF INTEREST

The authors have declared no conflicts of interest for this article.

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