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# Editorial: Plastic Ingestion: Understanding Causes and Impacts

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**Editorial on the Research Topic**

**Plastic Ingestion: Understanding Causes and Impacts**

Imagine you have a persistent stomachache. No matter what you eat, your stomach is upset. What would you do? A logical start would be to consult with an expert to identify the cause of your gastrointestinal distress. However, when it comes to the pervasive issue of wildlife consuming plastic debris, identifying the cause of this maladaptive behavior is often overlooked by researchers. The effects of plastic ingestion – particularly sublethal effects, which are difficult to isolate and quantify – are understudied as well. In this Research Topic, we solicited work that addressed the root cause of plastic ingestion by marine wildlife and its effects on the organisms themselves and the ecosystems they inhabit.

We now find plastic debris everywhere, particularly in the marine environment. From the ocean surface to abyssal trenches, on remote beaches and seas near and far from human population centers. Plastic is everywhere it shouldn't be. The universality of plastic pollution enabled it as a key stratigraphic marker for our current geological epoch, the Anthropocene (Zalasiewicz et al., 2016). It is therefore unsurprising that plastic debris has infiltrated most food webs, terrestrial and marine. Currently it is estimated that 1500 species have ingested plastic (Santos et al., 2021), and this number will likely increase in the coming decades (Borrelle et al., 2020; Savoca et al., 2021). Identifying the causes and monitoring the effects of ingested plastic debris will be paramount to ameliorate this mounting threat.

## WHY DO ORGANISMS INGEST PLASTIC?

In recent years, the answer to this question has evolved beyond the overly simplistic view of plastic ingestion as a visual trap. In addition to the appearance of plastic, olfactory cues play a role for certain organisms (Savoca et al., 2017; Procter et al., 2019) as does the organism's physiological and nutritional state, behavioral type (i.e. 'personality') and exposure levels to plastic pollution (Santos et al., 2021; Chen et al., 2022). Between species, (Cardozo-Ferreira et al.) found that feeding behavior is related to plastic ingestion, whereas within one species Phillip et al. found that individual's nutritional state was positively correlated with plastic burden. To understand how plastic flows

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through the food web, knowing its entry point is important. Trophic transfer of plastic is the main route of plastic ingestion for some predators (Nelms et al., 2018; Zantis et al., 2022), but for others the opposite is true. By analyzing hundreds of individuals of both predator and prey and thousands of ingested plastic items, Robuck et al. conclude that great shearwaters (*Ardenna gravis*) ingest the majority of their plastic directly, and not from their prey. In a separate study on fish, Wooton et al. related geography and waste management to plastic ingestion by fish in the South Pacific.

## WHAT ARE THE IMPACTS OF INGESTED PLASTIC?

The effects of ingested plastic are vital to monitor, but notoriously hard to measure. Several articles in this special issue confronted this challenge in organisms as diverse as single-celled microbes and harbor porpoises (*Phocoena phocoena*). Fulfer and Menden-Deuer reported that dinoflagellates fed microplastics in the laboratory experienced a growth rate reduction by one-third on average. Reduced growth rates leading to lower fecundity in zooplankton that ingest microplastic is a common finding across studies (Cole et al., 2013; Zhang et al., 2021). As Fulfer and Menden-Deuer highlighted, this could have consequences that ripple through food webs by affecting unseen microbial dynamics. Microplastic ingestion among zooplankton could also negatively impact their ecosystem services by reducing sinking rates of their fecal pellets, thereby reducing the efficiency of the biological carbon pump (Cole et al., 2016; Wieczorek et al., 2019). Negative results further expand our knowledge on the extent to which plastics impact different species and ecosystems, an example of this is the research done by Phillip et al. on harbor porpoises.

## A FRAMEWORK FOR MONITORING AND MITIGATION ASSESSMENT

As baseline data on plastic ingestion continues to increase, it will be essential to move beyond isolated descriptions and integrate plastics into risk assessments and management plans. An effective way to do that is by identifying bioindicator species and tracking the incidence and effects of ingested plastics on these species across regions and over time. One of the most well-known examples is the Northern fulmar's (*Fulmaris glacialis*) use as a bioindicator in the North Sea (van Franeker et al., 2011). In the South Atlantic, Carman et al. highlight a suite of bioindicator species that can be monitored over time to serve as living conservation tools. In this sense, Robuck et al. suggested that great shearwaters should be considered as a potential sentinel species of plastic debris throughout their range, which spans the entirety of the temperate and tropical Atlantic Ocean. Duncan et al. used a long-term dataset to evaluate potential temporal trends in plastic ingestion among sea turtles providing a clear example on how long-term datasets can enable transitions from trend monitoring to effect monitoring. These techniques harness the power of standardized data collection and analyses to understand the extent of plastic pollution and to evaluate whether mitigation strategies are likely to be effective in keeping plastic out of marine food webs.

We have crossed the planetary boundary for pollutants, and plastic pollution plays a central role in this story (Persson et al., 2022). The number of marine species reported ingesting plastics is growing at a fast pace (Santos et al., 2021). As we are navigating outside the safe operational space of the planetary boundary for novel entities, we hope that this Research Topic will help us to move toward a better understanding of the causes and consequences of plastic ingestion.

## AUTHORS CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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