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Evaluating the impact of mitigation strategies for marine litter and microplastics to inform policy: A white paper

By the **Plastic Pollution Emissions Working Group**

We are excited to introduce our project, get feedback, and discuss how we can collaborate to reach our shared goals of reducing plastic pollution.

The Plastic Pollution Emissions Working Group have developed a mechanistic framework and prototype model to evaluate the effectiveness of a range of reduction and mitigation strategies at different geographic scales to reduce the amount of litter entering our oceans.

This framework is designed to inform the Ad Hoc Open-Ended Expert Group on marine litter and microplastics, specifically in regards to research needed to support future response options on the effectiveness of different types of governance mechanisms.

To help meet global goals regarding plastic litter under Sustainable Development Goal 14, the UNE began an Ad Hoc Open-ended Expert Group on Marine Litter and Microplastics to discuss three options: 1) maintaining the status quo, 2) revise existing frameworks, or 3) establish a new globally binding mechanism to address plastic pollution. Depending on the agreed upon framework, it is likely that participating countries will be encouraged to create their own national strategies for pollution prevention and cleanup. At present, there are many different actions each country can take and some are likely more useful in certain economies or governance contexts, but it is unclear which actions in which context are most likely to achieve the goal of significantly reducing plastics in our oceans.

To inform this continuing discussion, we are conducting an evaluation of the relative effectiveness of at least 18 management interventions – from plausible reductions resulting from bans or social change, to broad scale investment in waste management in developing economies and the implementation of a circular plastic economy, and the cleanup of existing post-consumer plastic waste, including abandoned, lost or otherwise discarded fishing gear from the environment. Our analyses will support and inform participating economies with diverse resource availabilities and uniquely local relative sources of plastic debris, as they quantify their own plastics emissions and choose mitigation strategies. We hope to partner

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with interested parties to tailor the application to local contexts and coordinate with other groups carrying out research in this area.

Who we are

We are the **Plastic Pollution Emissions Working Group**. We are a group of independent scientists, and individuals from NGOs and organizations within a SESYNC (National Socio-Environmental Synthesis Center) working group, supported by the U.S. National Science Foundation (NSF).

Our Objectives

We aim to:

1) provide a country-level quantitative assessment of marine plastic pollution using empirical data and statistical modelling techniques to quantify the flow of plastic from production through disposal, and into the environment;

2) estimate the effectiveness of existing and proposed management strategies or interventions aimed at reducing plastic emissions to the environment;

3) provide a scientifically robust tool to measure progress on the initiatives proposed under the SDGs (notably Goal 14.1) and provide an indicator of plastic contamination levels in the ocean; and,

4) provide a qualitative assessment with an in-depth analysis of each mitigation scenario[1] to identify externalities, both positive and negative. For example, under a scenario in which bottle water usage is reduced to address plastic pollution, the required infrastructure to provide potable water may also contribute to improved health outcomes and gender equity in developing economies[2]. Where plastics are simply substituted by other materials, such as paper, we will explore the trade-offs of material substitution through life-cycle analyses considering, for example, the carbon footprint.

Our Strategy

Current estimates of plastic pollution fail to capture the mechanistic pathways linking resin production to inputs of plastic into the ocean, missing sources and sinks of plastic and how it enters the environment. Without a clearer understanding of these mechanistic pathways, and how existing and potential solutions reduce the amount of plastic pollution entering the environment, we risk wasting vast quantities of money, time, and social and political capital in attempting to preserve the integrity of the world's ecosystems.

The Plastic Pollution Emissions Working Group is addressing this knowledge gap using a novel analytical and evidence-based approach to map plastic from production through to use, disposal and waste management, and quantify the reduction in plastic waste entering the world's oceans directly resulting from existing and potential management actions. Our methods are embedded in the theoretical and conceptual foundations outlined in the

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[2] http://www.un.org/waterforlifedecade/gender.shtml

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Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) methodological assessment[3]. The IPBES Conceptual Framework was designed to proactively develop assessments that match policy needs, and support capacity building for the co-construction of integrative knowledge.

We use an impact forecasting approach (sometimes referred to as 'wedges') to evaluate mitigation strategies at both the country and global level. If the Ad Hoc Open-Ended working Group on marine litter and microplastics agrees on option three: an international agreement, this approach can be used to inform the development of measurable targets and effective strategies. Initially we will forecast three reduction effort scenarios versus a business as usual scenario (Fig. 1):

- Maintain status quo (business as usual, including current mitigation efforts)
- *Minimal reduction effort*, that is, broad-scale implementation of proposed single-use plastics (SUP) bans (e.g., shopping bags, straws, packaging).
- *Moderate reduction effort*, that is, the above actions are implemented along with riverine trash-capture devices are installed in the world's most polluting rivers[4], and investments are made to improve waste management infrastructure, particularly in developing countries.
- *Strong reduction effort*, that is, where the above actions are implemented along with an industry limit on plastic resin production (i.e., cap & trade system).
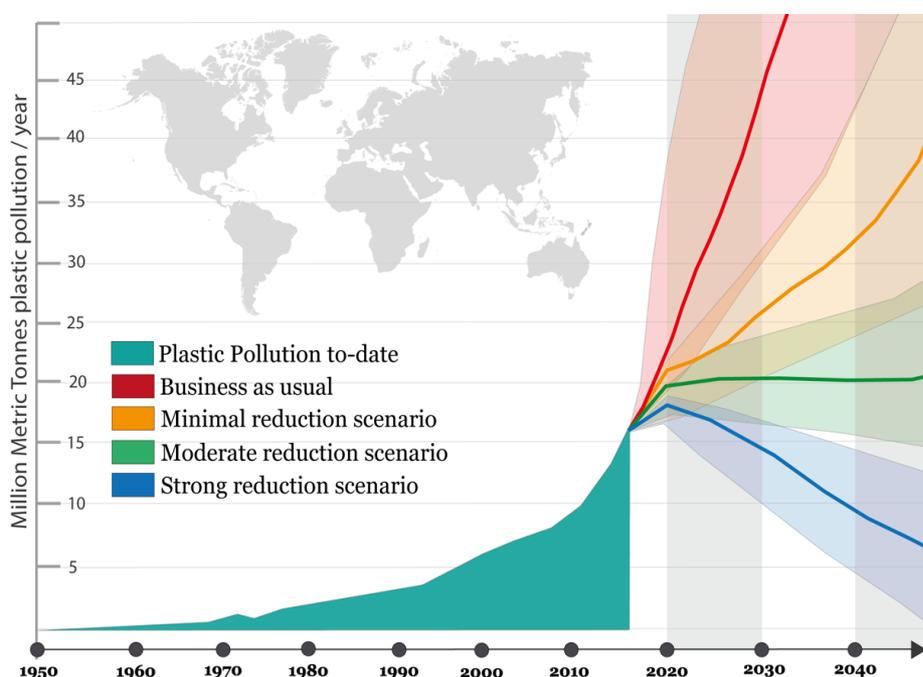

Figure 1: Illustrative example of a comparison between plastic emissions reduction scenarios for minimal, moderate and strong scenarios versus business as usual (BAU).

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[3] Ferrier, S. *et al.* Summary for policymakers of the assessment report of the methodological assessment of scenarios and models of biodiversity and ecosystem services. (2016).

[4] Lebreton, Laurent CM, Joost Van der Zwet, Jan-Willem Damsteeg, Boyan Slat, Anthony Andrady, and Julia Reisser. "River plastic emissions to the world's oceans." Nature communications 8 (2017): 15611.

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Our model is designed to quantify the impact of an intervention at local, regional and international scales compared to business as usual (BAU). Further, multiple interventions at different stages along the life-cycle of plastics can be evaluated. For example, we can assess the impact of a ban - before the plastic enters the market, compared to a clean-up – after plastics have entered the environment. Intervention strategies we will examine include, but are not limited to, clean-ups, bans, taxes on plastics, trash capture devices (e.g., river booms, storm drain capture devices), incentivized return or recycling programs, collecting abandoned, lost or otherwise discarded fishing gear, and a cap and trade system on production of virgin plastic resins. Because the model is a discrete time series model, we can quantify recently implemented interventions (e.g., bans on SUPs) coupled with delayed or potential future interventions, such as the establishment or improvement of waste management infrastructure or reduced costs and market drivers influencing a circular economy for plastics. We aim to have the initial results of the scenario model peer-reviewed and published by March 2019.

Significance

Plastics production is expected to increase to 600 million metric tons per year in the next two decades[5]. To date, end-of-life management of plastic products has not kept pace with the rapid increase in production, resulting in the contamination of the environment. Solving this growing problem of plastic pollution requires a multifaceted approach because mitigation strategies effective in one region/economy may be more or less effective in another. Proposed and implemented strategies need to be evaluated in regionally specific contexts to identify those that will achieve meaningful reduction targets globally.

The Plastic Pollution Emissions Working Group is building a powerful prototype tool to help quantify the flow of plastics into the environment as well as the effectiveness of a range of mitigation strategies at multiple temporal and geographic scales. This tool will:

1) have the capacity to be tailored to specific users across specific sectors and geographies;
2) provide opportunities for quantitative and qualitative assessment of mitigation strategies, and
3) provide a way to measure if progress is being made to reduce plastic emissions into the environment.

The tool will eventually allow stakeholders from international and regional bodies, national governments, local decision-makers, and consumer goods companies and the plastics industry to evaluate which proposed interventions or reduction strategies will make the most significant gains for their specific context. It will also enable the verification of success for initiatives that fall under Goal 14.1 of the SDGs and any actions taken by the UNE Ad Hoc

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[5] Geyer, R., Jambeck, J. R., & Law, K. L. (2017). Production, use, and fate of all plastics ever made. Science advances, 3(7), e1700782.

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Open-Ended Expert Group on marine litter and microplastics, providing a quantitative measure of plastic pollution reduction.

The Plastic Pollution Emissions Working Group are seeking input on the model to cultivate stakeholder engagement and ensure that it will meet stakeholders needs.

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[6] The findings and conclusions in this white paper are those of the author(s) and do not necessarily represent the views of the U.S. Fish and Wildlife Service.