

# Using Stock and Flow Modeling to Address Knowledge Gaps in Marine Plastic Pollution Data

Daniel Martin<sup>1</sup>, Kelly Jones<sup>1</sup>, Dr. Hans-Peter Plag<sup>1,2</sup>

1. Department of Ocean and Earth Sciences, Old Dominion University  
2. Mitigation and Adaptation Research Institute, Old Dominion University

## Plastic Lifecycle

### Knowledge Gaps

The system of plastic from production to waste, and from waste to proper management or to mismanagement and the environment, contains many gaps in knowledge. These gaps may result from a lack of historical production or usage data, or a difficulty in measuring existing plastic quantities in certain environments such as the environments. Such gaps make plastic pollution mitigation and removal difficult as it is not known where efforts need to be targeted for maximum effectiveness. One of these knowledge gaps is the residence time of plastic in the ocean. Many times, the volume of plastic estimated by surveys of the ocean greatly mismatches the amount entering the ocean that is estimated by studies of the mismanagement of plastic waste. Synthesizing an accurate residence time for marine plastic pollution will allow for better estimation of the exact quantity of plastic in the ocean.

Million Tons of Plastic Produced Globally

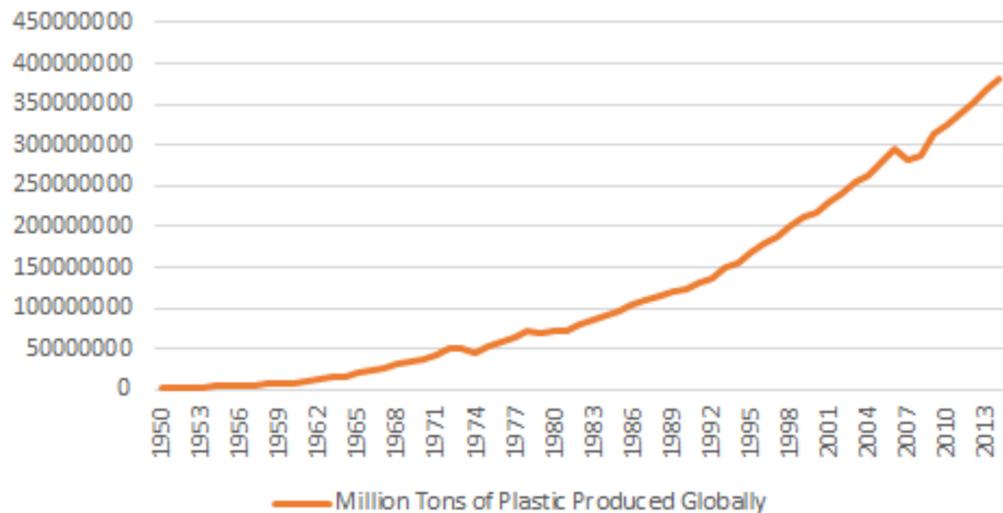


Figure: A graph showing the growth of plastic production over time, in millions of tons of plastic produced globally

### The Project

The goal of this project is to obtain an average residence time using a stock and flow model of plastic production and pollution, examining the different types of plastic produced and quantities therein and using this to determine both individual and overall residence times for plastic in the ocean. There is enough adjacent data to extrapolate equations for the amount of plastic entering the ocean as well as the rest of the stocks and flows along the route plastic takes to reach the ocean. Using this and using estimations of how much plastic is in the ocean alongside any available data on how much plastic is estimated to exit the ocean through various pathways such as intentional removal, shoreline deposition, benthic settling, biotic ingestion, and aerosolization through wave action, residence times for different types of plastic in the ocean can be determined. The ocean is often thought of as one of the final resting places for plastic in the environment, but by approximating how long plastic actually stays in the ocean we can better grasp what researchers are now discovering to be a “plastic cycle.” By studying the insidious effects of plastic as it goes from the use cycle into the terrestrial environment, from the terrestrial environment into the ocean, and from the ocean into the atmosphere and back into the terrestrial environment and ocean, we can discover where best to arrest the flows of plastic and mitigate the damage to the environment and ourselves.

## Modeling

### Plastic Stocks and Flows

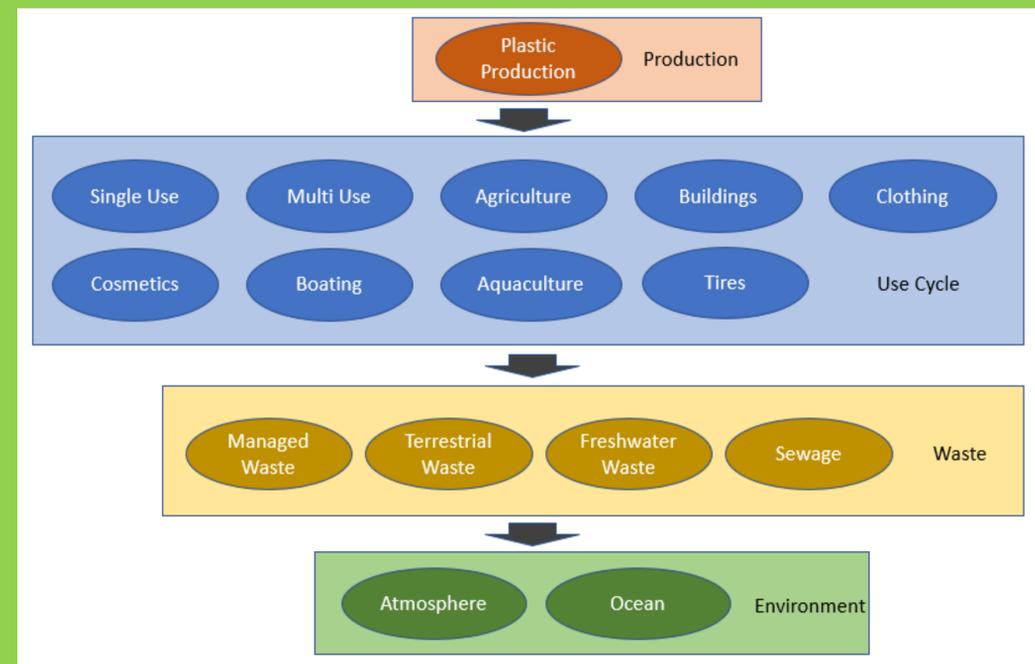


Figure: A simple stock- and flow-based model showing the various important stocks in the model and their categorization.

### Conceptual Model of Plastic Flows

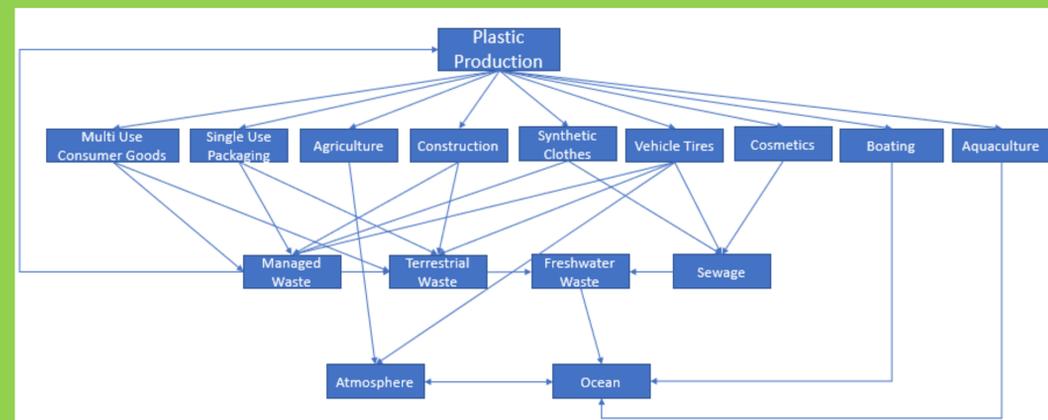


Figure: A conceptual model showing the potential complexity of the flows between plastic stocks in the model.

### Modeling Approach

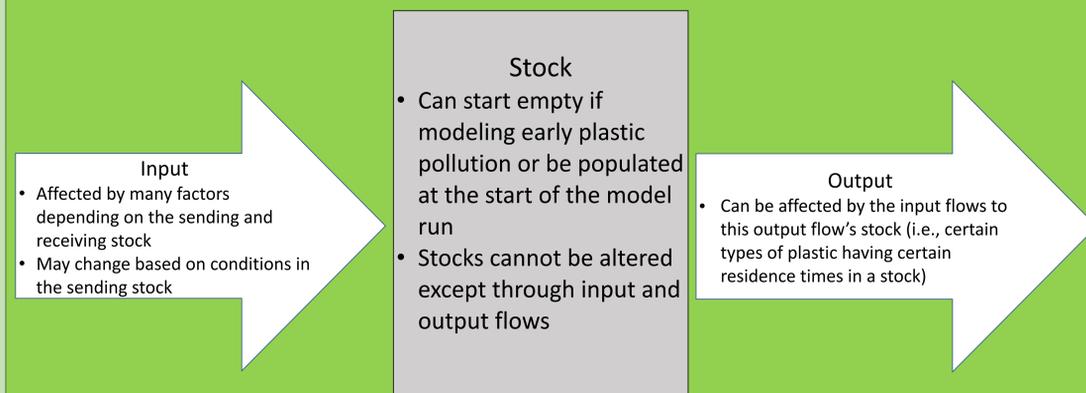


Figure: A basic illustration of the methods that will be employed to model plastic transport and destination