Spatial and Temporal Effects on Abundance and Variation of Microplastics in Mangrove and Beach Sediments on Southeast Florida Barrier Islands

Kayla O'Brien
Email: obrienk2022@fau.edu

Presented By: Kayla O'Brien

Advisor: Dr. Tiffany Roberts Briggs

Charles E. Schmidt College of Science, Florida Atlantic University, Boca Raton, Fl, USA

Introduction

Bulk production of plastics began in the 1940's. Plastic production has since flourished, and plastic products have been integrated into all areas of our lives. Plastic was first developed as a substitute for ivory and other natural materials. This new synthetic material was marketed as being cheap, easily shaped, indestructible, and environmentally friendly. The manufacturing of plastic meant we no longer had to deplete nature's limited supply of ivory and other natural materials. Annually over 380 million tons of plastic are produced, half is manufactured for single use products, and 10 million tons ends up in our oceans (POI 2022). Today a variety of plastic waste pollutes our environment globally. Microplastics were first described in the 1970's, but it wasn't till the early 2000's when microplastics began to raise concerns for the environment and human health.

Microplastics are described as being less than 5mm in length. Microplastics are separated into two groups primary and secondary. Primary microplastics are manufactured for commercial use. Secondary microplastics form from the breakdown of larger plastics. Microplastics can enter the marine environment through stormwater, wastewater, municipal waste, recreational activities, industrial plants, and by improper disposal of plastics. Microplastics have been found in several aquatic systems, numerous sediments, and inside a variety of organisms. The highest concentrations have been found in mid-ocean gyres and along coastlines (Cole et al. 2011).

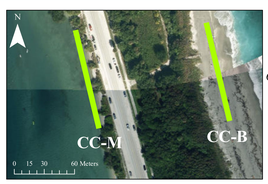
This project aims to quantify the abundance and variation of microplastics in mangrove and beach sediments on Southeast Florida barrier islands, which are vulnerable and important coastal ecosystems. There have been no extensive studies or monitoring efforts evaluating microplastics in Southeast Florida barrier islands sediments, nor comparing geomorphic properties of an area on microplastic accumulation. Gaining a better understanding on the current microplastic conditions along Southeast Florida barrier islands is imperative for conserving and managing the health of these coastal systems.

Research Questions

- Are microplastics present in Southeast Florida barrier islands mangrove and beach sediments?
- Is there a spatial or temporal effect on the abundance and variation of microplastics in mangrove and beach sediments?
- Are microplastics more abundant in mangrove or beach sediments?
- Is there a difference in variation of microplastics in mangrove and beach sediments?

Study Sites

Fig 1. Map showing the three study sites and transects located in Palm Beach County, Florida.



Coral Cove Park
(2) 100 meter transects
CC-M Mangrove transect
CC-B- Beach transect
6 samples per 100 meter transect

Phipps Ocean Park
(1) 100 meter transects
PP-B- Beach transect
6 samples per 100 meter transect

Boynton Inlet Park
(2) 100 meter transects
BI-M Mangrove transect
BI-B- Beach transect
6 samples per 100 meter transect

Methodology

Methods Overview

Methods for sampling and extraction follows Besley et al., suggested standard operating procedure for beach sand and extraction for microplastics, with slight modifications (Besley et al. 2017). Microplastic identification follows standardized criteria: small size (the largest dimension being less than 5 mm), uniform thickness and homogeneity throughout the entire microplastic, relatively uniform colors shown by the particle (particles that are white or transparent should be examined under a microscope at high magnification), and absence of cellular or organic structures (Laju et al. 2022). The Marine and Environment Research Institute Guide to Microplastics Identification is referred to for identification (MERI 2020).

Field Collection

- Two sampling events in summer and winter. The summer sampling event was completed in August. The winter sampling event is expected to occur in November or December (Fig. 1).
- Initiating at the mean high tide line 6 samples are collected every 20 meters from each 100 meter transect.
- A 15x15cm quadrat is used to set the sample area at each collection site (Fig. 2).
- The first 5cm of sediment is collected using a metal spoon and a metal ruler to control depth. Plastic free attire is worn to minimize contamination of microplastics from commonly worn materials.
- Samples are then placed in aluminum trays and wrapped in aluminum foil for transport to the lab.
- At each sample collection point beach profile data is collected through spot measurements using Real-Time Kinematic Global Positioning Systems (RTK-GPS).

Fig 2. Sample collection tools 15x15cm quad, ruler, spoon, and aluminum tray.

Lab Analysis

- Dry samples.
- Split and sieve (5mm) dried samples (Fig. 3).
- Fully saturated NaCl solution is prepared, filtered, and combined with the sample to float the microplastics.
- The sample and NaCl solution mix is stirred for 2 minutes and left to settle for 10 minutes. Extraction is repeated for a total of 3 times (Fig. 4).
- The supernate is poured through the vacuum filtration set up (sterile gridded cellulose nitrate filters 0.45 µm pore 47mm diameter) (Fig 5).
- The filter is then placed into a sterile petri dish labeled, sealed, and allowed time to dry (Fig 6).
- Once dry the filters are analyzed under a microscope for identification.
- Part of the remaining split sediment sample is analyzed for moment method statistics (i.e., mean, standard deviation/sorting) at half-phi intervals above 63 µm.

Fig 3. Sample post split and sieve.

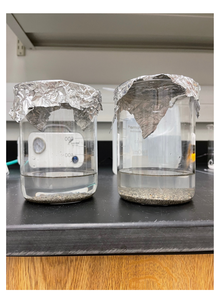


Fig 4. Flotation of microplastics.

Fig 5. Vacuum filtration.

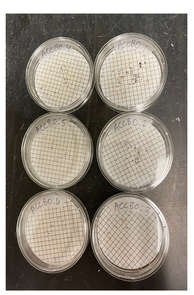


Fig 6. 0.45 µm filters.

Preliminary Results

Preliminary Results Overview

These preliminary results represent data obtained from the summer sampling event. The lab analysis for the summer samples has not been fully completed. One out of the six collected samples from each sites transects were selected and fully processed.

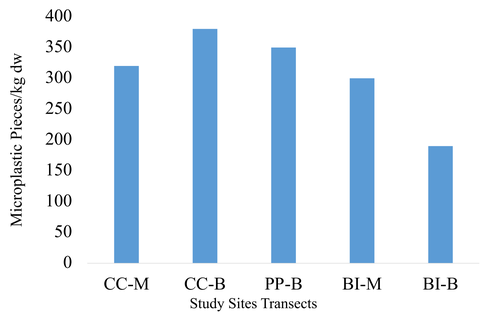


Fig 7. Microplastic pieces/ kg dw from each study site transect.

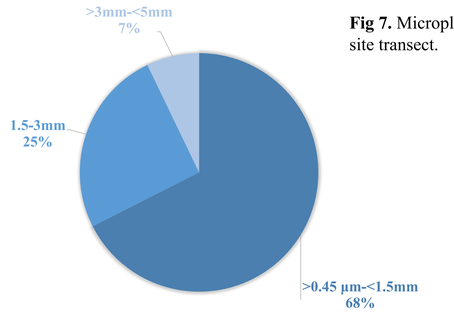


Fig 8. Percentages of microplastics per size category across all study sites.

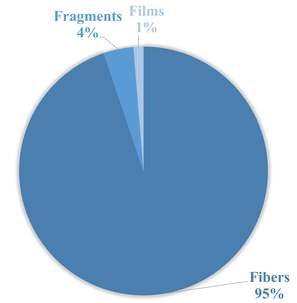


Fig 9. Percentages of microplastic types across all study sites.

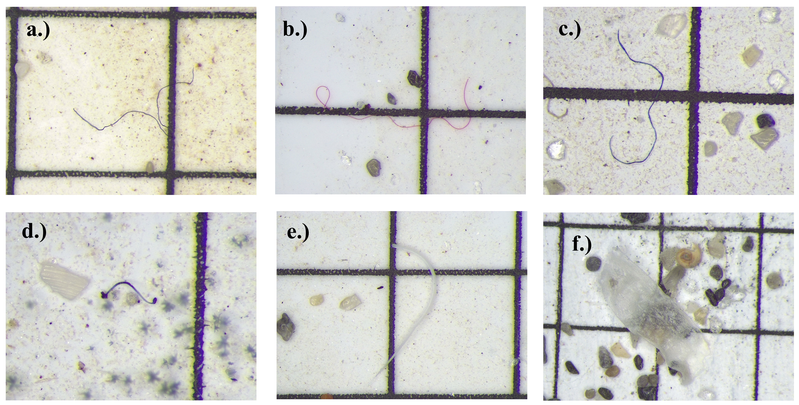


Fig . Floated microplastics on gridded filters (grids 3x3mm). Fibers (a, b, c, and d) and Fragments (e and f).

Acknowledgments

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