Quantification of microplastic in the Caloosahatchee River during three different hydrological periods

Felicia Nudo

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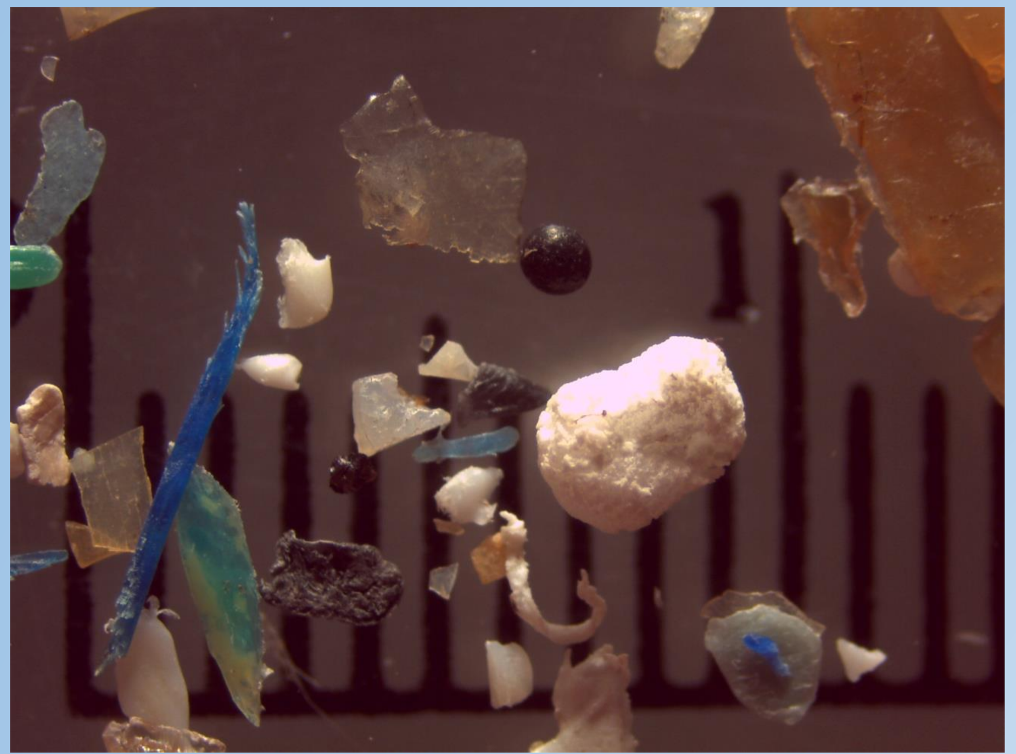

Microplastic

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Abstract

Plastic accumulation in waterways has been gaining attention as a prominent pollution issue. The plastics that enter these aquatic environments generally are larger in size and are then broken down into increasingly smaller fragments. The smallest pieces of plastics that persist in the environment are known as microplastic (5,000-0.1 μm) and even nanoplastic (<0.1 μm). Marine ecosystem contamination by microplastics is well documented and is of major concern, especially in marine systems such as the center of the oceanic gyres where they tend to accumulate. However, there is not sufficient data available on microplastics in freshwater systems, especially within estuarine urban rivers. This study aims to assess microplastic concentration in the Caloosahatchee River and how such a concentration varies in response to different hydrological events. Water samples will be collected along a set transect positioned perpendicular to the Caloosahatchee River during three different hydrologic events and will be analyzed using the NOAA Laboratory Methods for the Analysis of Microplastics.

Introduction

Linked to inefficient recycling programs, millions of tons of plastics enter oceans and landfills each year (Gourmelon, 2015). Plastics that enter aquatic environments have a large size distribution, ranging from micrometers to meters (Hidalgo-Ruz et al., 2012). These plastics generally are larger in size and are then continuously broken down into smaller fragments. The smallest pieces of plastics that persist in the environment are known as microplastic. There are a variety of sources of microplastics including: cosmetics, clothing, and industrial materials (McCormick et al., 2014).

Of these sources, microplastics can then be further categorized into primary and secondary sources. Primary sources of microplastics are manufactured and are the result of human materials and product use, while secondary sources are the plastic fragments derived from the breakdown of larger plastic debris. Often mistaken for food, secondary microplastics can be ingested by aquatic organisms and accumulate in their body tissues. Microplastics have been found in the stomachs of many marine organisms from plankton species to whales. Chemical additives can leach out of microplastics into the ocean; conversely, contaminants from the water may adhere to microplastics. (NOAA, 2015). Recent studies on microplastics in lakes and rivers have reported microplastic concentrations to be as high, or higher, than in oceanic gyres. In addition, litter-related plastics such as fragments, foams, and films were found at higher concentrations in samples from urban watersheds and during runoff-event conditions. (Baldwin et al., 2016).

The Caloosahatchee River is an urban river that drains into the surrounding watershed. As such, this river serves as a pathway for microplastics to enter the Gulf of Mexico. This study entails monitoring and collecting water samples near the estuary in the Caloosahatchee River. Samples will be analyzed for quantity and characteristics of microplastics present during 3 contrasting hydrological events.

Research Objectives

- Estimate microplastic loading into the Caloosahatchee estuary and thus the Gulf of Mexico over a full hydrological year
- Contrast the microplastic loading against the three hydrological seasons
- Contrast the characteristics of the microplastics overall and against the hydrological season

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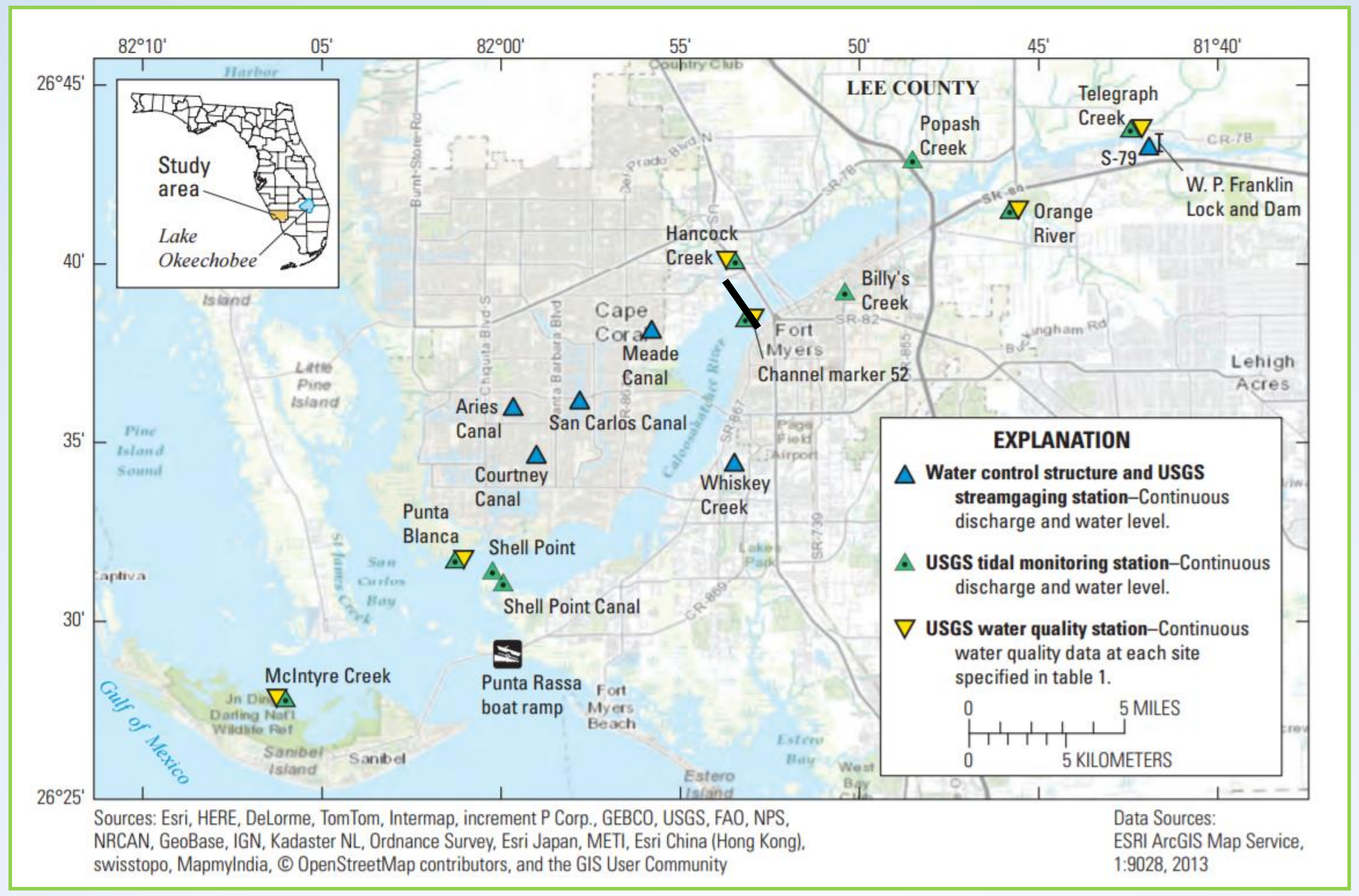

Figure 1: Caloosahatchee River Estuary monitoring stations and transect location (Patino, 2014).

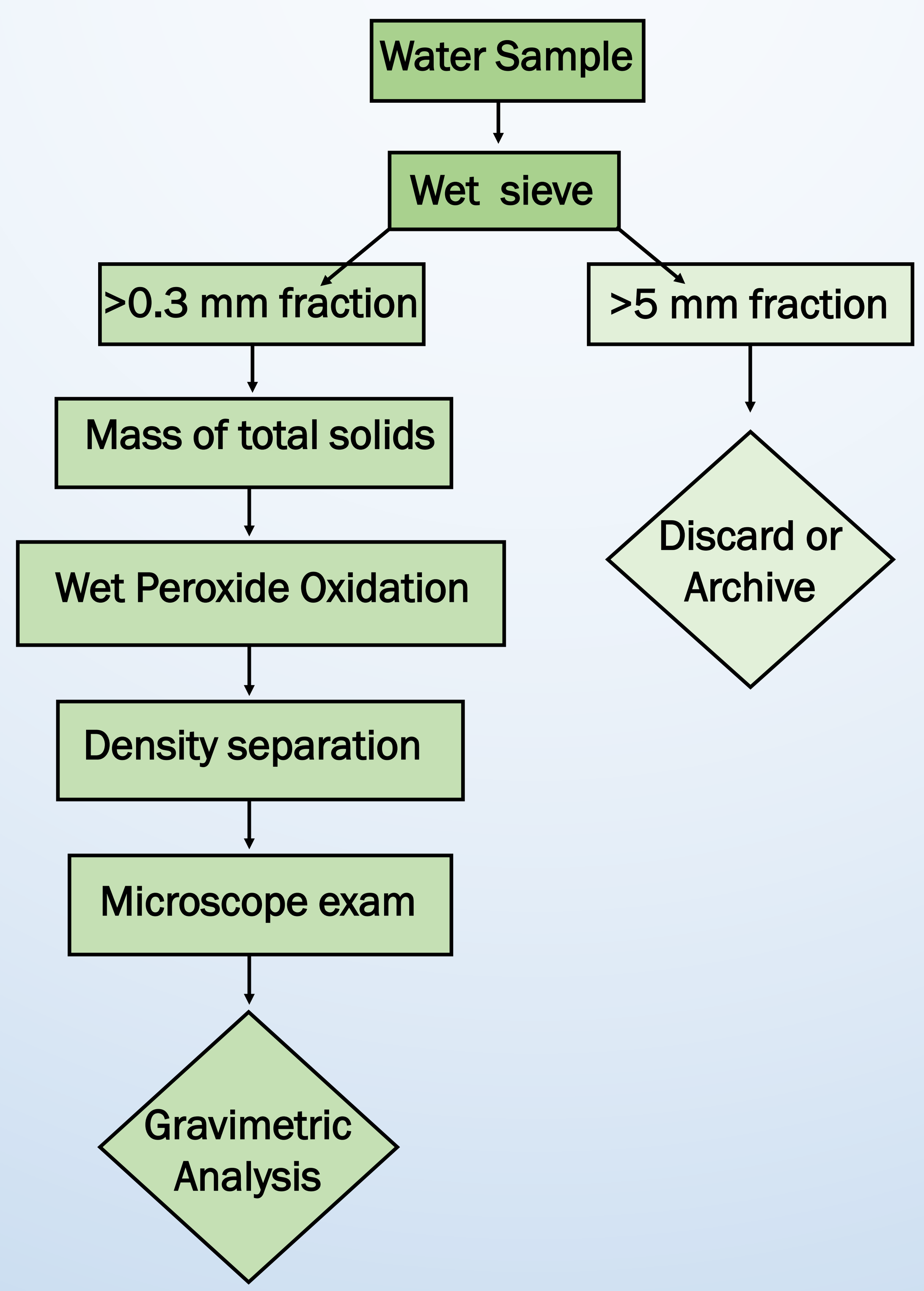

Figure 2: NOAA Laboratory Methods for the Analysis of Microplastics (NOAA, 2015).

Methods

The transect will be located near channel marker 52 (Figure 1). The bathymetric profile of the perpendicular cross section of the river (thereafter referenced as the transect) will be determined using Sonar technology and mapping via interpolation using Surfer 12™. Water velocity at low tide will be determined using a handheld Sontek Flowtracker. Based upon the surface area of the transect (m^2), and the water velocity ($m.s^{-1}$) measured at different points (depth and distance from shore) along the transect, the discharge rate ($m^3.s^{-1}$) will be computed. This computed discharge rate will be compared to the one provided by nearby USGS channel marker 52 monitoring station. Water samples will be collected along the transect during three different hydrologic periods:

- end of the dry season when discharges to the river are at their lowest
- after the flush of announcing the rainy season when discharges are high and potentially loaded with microplastics
- end of the rainy season when discharges are high but potentially diluted water (i.e. with potentially low microplastic densities)

Samples will be collected at low tide to avoid influx of salt water from the estuary and will be analyzed for the presence of microplastics. Plastics that will be examined include hard plastics, soft plastics (e.g. foams), films, line, fibers, and sheets. This methodology follows the procedures in NOAA Laboratory Methods for the Analysis of Microplastics (Figure 2).

Data Collection and Statistical Analysis

Data will be collected using Gravimetric analysis after materials in the samples have been completely dried. Once the total mass of microplastics collected across all samples has been determined, the data will be analyzed via ANOVA using season as a comparison factor. After the microplastic concentration of each sample has been determined, loads for each hydrologic period can be calculated and analyzed for differences. Attempts will be made to trace the source of microplastics based on their characteristics.

Broader Implications

One of the anticipated results would be that the highest levels of microplastic concentration should occur after the first flush of the rainy season, and thus contrast with the dry and the end of the rainy season loading. The data from this research has the potential to be an indication of the pollutant load of microplastics in the Caloosahatchee River and how hydrologic events affect the movement of and mass loading of plastic pollution. Since microplastic pollution is a result of the overconsumption and improper disposal, this study can support policy changes in banning plastics or implementing taxes to assist with watershed management.

References

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