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Microplastics Analysis and Quantification of Benthic Sediments of the Salish Sea

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Introduction

Microplastics are a source of marine pollution and have shown to have a negative effect on aquatic organisms. Microplastics have been found in oceans, freshwater, and estuarine environments throughout the world (Wang et al. 2019) and microplastic contamination is a growing concern for the environment. Microplastics have been present in our marine ecosystems for almost 50 years and legislation has attempted to make change in this arena by restricting microplastics through implementing laws such as the Microbead Free Waters Act in the U.S. in 2015.

Category	Size (mm)
Megaplastics	> 100
Macrplastics	5 - 100
Microplastics	**0.33 -5**
Nanoplastics	<0.033

Microplastics are organic polymers between 0.33 and 5 mm in length. Two types of microplastics are primary and secondary sources (Arthur et al. 2009). Primary microplastics are those that have not broken down into smaller pieces in the environment but have been produced as microbeads or pellets. Secondary microplastics include pieces that have been degraded by photo- or chemical processes in the environment (Masura et al. 2015). Microplastics are highly persistent easily accumulating in bed sediments and produce sinks for chemical contamination. These contaminants may be ingested continuously by aquatic species living in those environments.

Figure 1: Primary microplastics

Figure 2: Secondary microplastics

The purpose of this study is to provide data for an understudied topic and determine and quantify the presence of microplastics in Puget Sound marine environments. Although this study does not provide an outlined solution to marine contamination via microplastic debris, it does provide knowledge about the ecosystems in the Puget Sound and introduces some new questions to researchers in the field to answer. This study will show the presence and abundance of microplastics at 22 monitoring stations. By performing a sequence of chemical and analytical methods this study quantified microplastic debris in marine sediment samples provided by the Washington Department of Ecology's Puget Sound Ecosystem Monitoring Program (PSEMP).

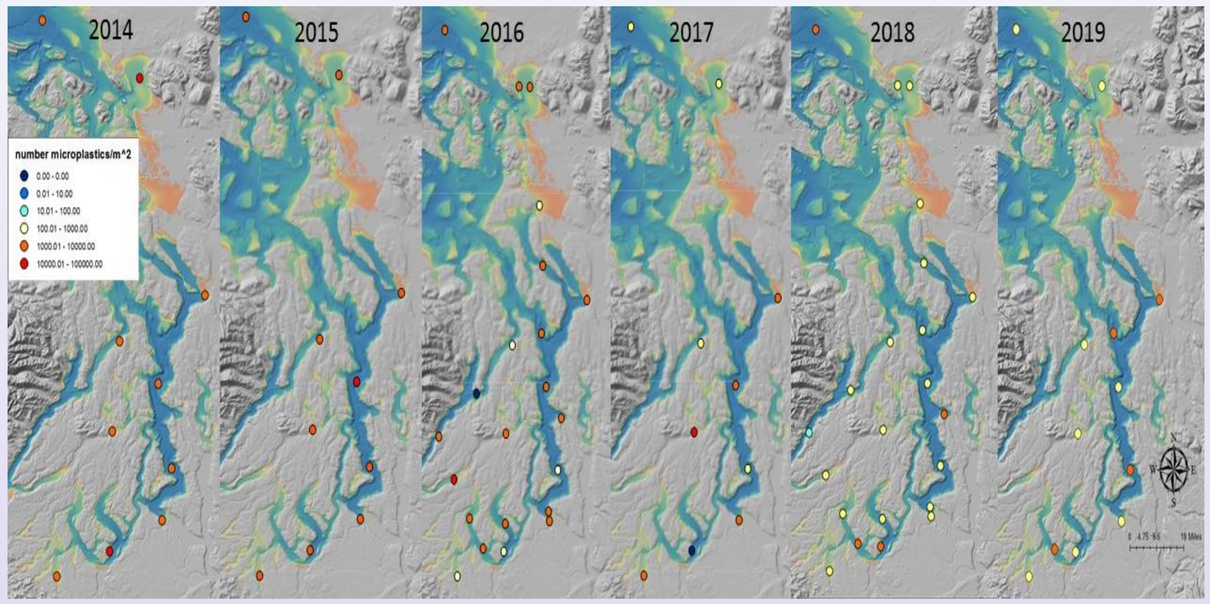

Figure 3: Heat map of microplastic abundance at 22 PSEMP stations in Puget Sound. Abundance is reported as number of microplastics/m²

Methods

Sampling

1. Sediment samples were collected by a 0.1-m² van Veen grab sampler deployed to the bottom of the sediment surface. The grab was triggered to close and was raised back up.
2. Approximately 200 mL of sediment was taken from the grab and was stored in glass individual glass jars and ultimately transported to the University of Washington Tacoma where they were kept in cold storage at 4°C.

Processing

1. 200 g of sediment was disaggregated using 5.5 g/L potassium metaphosphate solution.
2. Sediment mixture was rinsed through a 0.33 mm sieve and dried.
3. Dried sediment was separated by density using 1.6 g/mL lithium metatungstate and then sieved (fig. 4 and 5), and dried again.

Figure 4: Lithium metatungstate

Figure 5: Sieving lithium metatungstate separated sediment

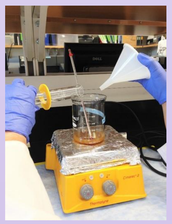

Figure 6: Wet peroxide oxidation

Figure 7: Density separator

4. Sediment was run through at least three wet peroxide oxidations to reduce organic materials in sample using 30% hydrogen peroxide and a 0.05 M iron sulfate solution (fig. 6).
5. 6 g of NaCl was added to sample per 20mL of hydrogen peroxide and placed in a density separator (fig. 7) to float out plastic debris and then sieved for final microscope analysis.

Analysis

1. A dissecting microscope was used to examine samples in sieve and forceps were used to remove any visible microplastics.
2. Each piece of microplastics was counted as either fragments (fig. 8), fibers (fig.9), nurdles, or films

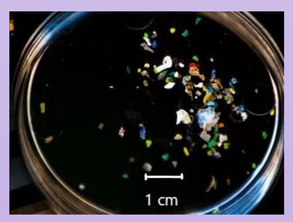

Figure 8: Microplastic fragments in petri dish

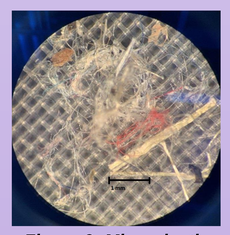

Figure 9: Microplastic fibers in 0.33 mm sieve

Results

The results of this study revealed an average of 3,700 microplastics/m² of surface sediment. The highest abundance found was at a station in 2016 in Sinclair Inlet which showed 27,000 mp/m², and the year with the highest overall abundance was 2014 with an average of 7,400 mp/m².

Figure 3 shows the abundance at all stations from 2014-2019. The data suggest that there could be a decline in microplastics in the Puget Sound, however that conclusion does not show statistical significance, so continued monitoring and collection of data is necessary to determine what is really occurring over time.

Conclusions

Although this study showed there are microplastics in Puget Sound, there is still little known about the effects of microplastics on marine organisms. Larger mega-, and macro-plastics have been shown to cause digestive issues in marine birds as well as entangle and restrict larger epipelagic organisms (Acampora et al. 2016), but the next steps would focus on finding out how microplastics that we can sometimes barely see with our eye are impacting smaller benthic organisms.

There is also little research quantifying the types of locations that are being sampled and if that influences the amount of microplastics found in sediments in specific areas. There is some evidence that shows the level of anthropogenic activity can be linked to the abundance of microplastics in marine environments (Curren and Leong 2019) so further studies of these Puget Sound stations could be conducted in such a way to account for the type of location and frequency of human activity.

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