

Concentrations of Marine Microplastics in Puget Sound and Chesapeake Bay

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Study Objective

To use new sampling and analytical methods to measure concentrations and distributions of microplastics in Puget Sound and Chesapeake Bay

BACKGROUND

- Plastics are composed of synthetic polymers
- Plastic debris is found in coastal and marine waters worldwide
- Microplastic size distribution 0.3 and 5 mm
- The sources and fate of microplastic debris in the ocean are unclear
- Microplastics may:
 - Remain buoyant or neutrally buoyant
 - Become fouled and sink into sediments
 - Become bioavailable to benthic fauna
- Reports of microplastics in the oceans have increased around the globe (Colton et al., 1974, Ng et al., 2006, Thompson et al., 2009)
- The main issues with this:
 - Possible ingestion by various organisms (Gregory 2009, Browne et al., 2008),
 - Transfer of pollutants from plastics to organisms (Mato et al., 2001)
 - Slow biodegradation of plastics



Figure 1: Puget Sound Sampling Locations



Figure 2: Chesapeake Bay Sampling Locations

Possible Sources

Primary microplastics: Intentionally produced for direct use, or as pre-cursors to other products.
Secondary microplastics: Formed from the breakdown of larger plastic material

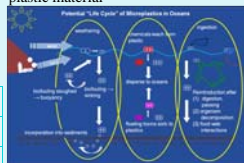


Figure 3: Potential Life Cycle of Microplastics in Ocean and Estuarine environments

Megaplastics: >100 mm
Macroplastics: 20-100 mm
Mesoplastics: 5-20 mm
Microplastics: 0.3 to 5 mm

Table 2: Plastics size distribution

Table 1: Attributes of most common plastics.
PE=Polyethylene PP=Polypropylene
PS=Polystyrene PVC=Polyvinyl chloride

Polymer	PE	PP	PS	PVC
Density	0.93	0.90	1.05	1.4
Melt Point, °C	135	170	240	273
Reactivity	low	low	low	low
Production (Million tons/yr)	80	45	19	40

SAMPLING METHODS

- Solid materials are collected from the upper 0.5 m of the water column
- Custom-fabricated manta net equipped with a 0.33 mm plankton net
- Towed at 0.7-4.5 m/s for 5-15 minutes for each sample
- Volume calculated from flow-rate
- Collected material rinsed into cod end
- Field sieved between .3 and 5 mm
- Transported on ice to laboratory



Figure 6: Cod End of Manta Net

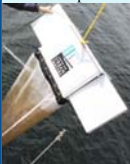


Figure 4: Custom-fabricated manta net with .33 mm plankton net used in Puget Sound



Figure 5: Field Sample in sieve



Figure 7: Manta Net used in Chesapeake Bay

LAB METHODS

Wet Peroxide Oxidation (WPO)

- After field sieve samples are dried and weighed
- Wet Peroxide Oxidation, with Fe (II) catalyst, used to breakdown organic matter
- Fe(II)/H₂O₂ oxidizes labile organic matter to enrich isolated microplastics prior to gravimetric analysis
- Plastics are resistant to WPO
- Samples visually inspected with microplastics removed
- Removed microplastics are gravimetrically analyzed



Figure 8: Sample being run through WPO



Figure 9: Density separation of Sample

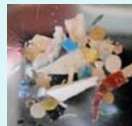


Figure 10: What is left of sample after WPO. Microplastic.



Figure 11: Flow Chart of Microplastic Method

RESULTS

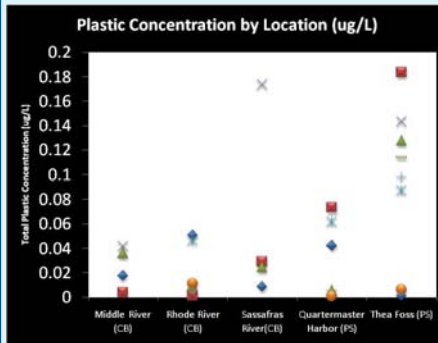


Figure 12: Concentrations by location in either the Puget Sound (PS) or Chesapeake Bay (CB). Not shown is an outlier of 7.5 ug/L detected in the Thea Foss

- The concentrations of the most sampled sites are represented here
- These are concentrations that would be seen in the water column
- This graph shows variability within each site
- It also shows similar concentrations between Chesapeake Bay and Puget Sound even though Chesapeake Bay has been inhabited for a much longer time
- Highest Concentration detected so far was 7.5ug/L in the Thea Foss

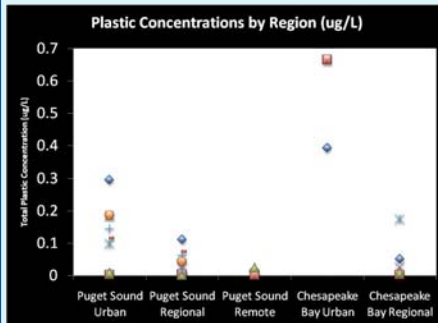


Figure 13: Concentrations by region broken down into: Urban, Regional, and Remote for Puget Sound and Chesapeake Bay. Not shown is the outlier of 7.5ug/L detected in Puget Sound Urban

- Graphs show concentrations by type of location
- The regions are broken down into Urban, Regional, and Remote
- Breakdown to see if the type of development, or lack of, located near the sampling has an effect on the plastic concentrations or total mass
- Highest Concentration detected so far was 7.5ug/L in the a Puget Sound Urban Region

DISCUSSION

- When comparing across different location types in Puget Sound, results suggest high within location type variability and little obvious differences in microplastic concentration as land use varies
- Industrial and urban areas do have the highest maximum concentration, which may indicate patches of floating material enriched in microplastics
- When microplastics concentrations are expressed per gram of collected solids, mean values decrease across the industrial and remote gradient
- Based on observations, this is due both to increased loads of plastics in urban areas and to high plankton production in some of the remote sites sampled



Figure 14: Photograph of Commencement Bay, Tacoma WA.



Figure 15: Sampling trip on the Thea Foss Waterway, Tacoma, WA.

CONCLUSION AND FUTURE WORK

Conclusion

- Data shows plastics in all environmental samples thus far
- When comparing Puget Sound to Chesapeake Bay results are similar
- Highest concentration yet detected in the Thea Foss
- Possible Impacts
 - False saturation
 - Clog gut

Future Work

- Determine fate of microplastics
- Identify type of microplastics in marine environments using:
 - Melt point
 - Infrared Analysis
- Build a more comprehensive data set on microplastic concentrations
- Correlate microplastics
 - tides, weather, bay-type

WORK CITED

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