Special Study Proposal: Monitoring Microplastics in the Margin

Summary: Building upon the RMP Special Study for 2015 to characterize microplastics in Bay Area effluent and ambient Bay sediment and water, this study seeks to augment the planned 2015 Bay Margins Sediment Study by including microplastics monitoring in the study design. Microplastics are well known to accumulate in sediments from densely urban areas. This study will provide a characterization of microplastics in surface sediments in the shallow Central Bay margin areas, thereby addressing an important data gap.

Estimated Cost: $14,325

Oversight Group: ECWG

Proposed by: Rebecca Sutton (SFEI)

PROPOSED DELIVERABLES AND TIMELINE

Deliverable	***Due Date***
Task 1. Project Management (write and manage sub-contract, track budgets)	May-December 2015
Task 2. Select sites and conduct field sampling (part of margins study)	Summer 2015
Task 3. Laboratory analysis; QA/QC	Fall/winter 2015-2016
Task 4. Draft/final factsheet	March 2016

Background

General Background:
Microplastic is a term used to describe fragments of plastic that are less than 5 mm (Wright et al., 2012). Microplastics can be pellets that are used as precursors for industrial products, microbeads used in consumer products (e.g., exfoliants), or fragments/fibers of plastics that are the breakdown products of larger plastic materials. Microplastics can enter the aquatic environment through wind, stormwater runoff, or illegal dumping of plastic materials (Eriksen et al., 2013). Additionally, both microbeads from cosmetic products and plastic fibers (e.g., polyester and acrylic) from clothing can be washed down the drain and enter wastewater treatment plants (European Commission 2012). Microplastics may not be captured by wastewater treatment plants because they are buoyant and do not flocculate; therefore, they can be released in wastewater (Hogue, 2013).

Microplastics are found in surface waters, the water column, and sediment because of the varying density of plastic particles. They can also be found in the gut and circulatory system of aquatic organisms that ingest the particles. Studies have found that microplastics are also able to adsorb to organisms, blocking their feeding appendages

(Wright et al., 2012). Ingestion of microplastics can block the digestive tract, reduce growth rates, block enzyme production, lower steroid hormone levels, affect reproduction, and cause the adsorption of toxicants (Wright et al., 2012). The potential for ingesting toxicants occurs because microplastics readily accumulate hydrophobic organic compounds, due to their high surface area to volume ratio (Teuten et al., 2007). In fact, the sorption of persistent organic pollutants (POPs) to microplastics exceeds sorption to sediments by two orders of magnitude (Mato et al., 2001); in one study, the concentration of POPs on microplastics was six orders of magnitude higher than the concentration in the surrounding water column (Teuten et al., 2007). Therefore, the ingestion of microplastics by organisms can increase the exposure of aquatic life to toxic pollutants.

Microplastic Monitoring Studies

Plastic pollution has increased over the past several decades and is often the dominant type of pollution in aquatic environments (Eriksen et al., 2013). Both industrial and densely populated coastal areas have been identified as microplastic hotspots (Wright et al., 2012). Most studies on plastic pollution in the United States have focused on macro-plastics (Ryan et al., 2010). However, there are a growing number of microplastic monitoring efforts in the United States, including a study in Santa Monica Bay, the Los Angeles River, and an on-going study in the Great Lakes.

The Santa Monica Bay study was completed in 2001 and was a partnership between the Algalita Marine Research Foundation and the Southern California Coastal Water Research Project. The study was noteworthy because it was the first microplastic monitoring effort that not only measured the abundance in the surface layer, but also at mid-depth and at the sediment-water interface (Lattin et al., 2004). The study monitored microplastics at varying depths because only 46% of microplastics are positively buoyant. The study observed microplastics at all depths and found that the abundance increased considerably after a storm event. Another microplastic study is just beginning in the Los Angeles area; Dr. Marcus Eriksen is monitoring microplastics in the Los Angeles River. The study will help determine if microplastics are entering Los Angeles' coastal waters through the urban watershed.

Microplastic pollution is also currently being measured in the surface waters of the Laurentian Great Lakes. The study found that microplastic pollution was greatest in Lake Erie, most likely because it is the most populated region (Eriksen et al., 2013). Unlike the Santa Monica Bay study, the microplastics were analyzed using scanning electron microscopy. Therefore, both abundance and the chemical composition of the particles were analyzed. The study is on-going and the researchers, including the project lead Dr. Sherri Mason (SUNY Fredonia), are currently considering adding effluent sampling to the monitoring effort.

The RMP has undertaken a small special study evaluating microplastics in effluent, as well as ambient Bay water and sediment. Funding for this 2015 study was released early to allow sample collection beginning in 2014. Microplastics at two different sizes were collected from the treated effluent of 8 Bay Area wastewater treatment facilities. Ten

ambient Bay sediment samples were collected as part of the 2014 RMP Status and Trends sediment summer sampling cruise: Central Bay (4 samples), Lower South Bay (2), and South Bay (4). Although four samples have been collected in the Central Bay, they were not collected in close proximity to the margins, where we hypothesize the highest concentrations of microplastics are likely to exist. RMP staff, working in collaboration with non-profits San Francisco Bay Keeper and 5 Gyres, were able to collect 9 ambient Bay surface water trawl samples near the sediment sites. All Bay Area effluent, sediment, and water samples have been submitted to Dr. Sherri Mason at SUNY Fredonia for sample processing, visual sorting, and abundance analyses. Results are expected in the summer of 2015.

This study would address an important data gap by providing an estimate of microplastics in the margins of the Central Bay, an area that is ecologically quite productive and at the same time known as area that is highly contaminated, particularly by plastic trash. Sediment in densely populated areas can be heavily contaminated with microplastics (Wright et al., 2012); a statistically significant relationship between population and microplastic abundance has been identified (Brown et al., 2011).

Given the widespread detection of microplastics in the environment and the potential conduit these particles serve introducing POPs into the food chain, several state legislatures have begun proposing bans on the use of microplastics in certain industries. A bill to ban microplastics in cosmetics was introduced in the California assembly in 2014; however, it failed by one vote. A number of similar bills prohibiting microplastics in personal care products have been introduced in the other states such as the Great Lakes states (Council of State Governments, 2014). Illinois and New York states passed bans in 2014 (Council of State Governments, 2014). In addition, Johnson & Johnson, L'Oréal, Colgate-Palmolive, and Procter & Gamble have pledged to phase out the use of microbeads in their skin cleansers (Hogue 2013).

Study Objectives and Applicable RMP Management Questions

This study will provide an initial characterization of microplastics in the surface sediment in the shallow Central Bay margin areas. These data will help us better understand the distribution of microplastics in the Bay and the potential for uptake into the food web. The study will complement a 2015 special study on microplastics that measured concentrations in ambient water, ambient sediments, and wastewater effluent. The study will address two RMP Management Questions:

1) Are chemical concentrations in the Estuary at levels of potential concern and are associated impacts likely?
2) What are the concentrations and masses of contaminants in the Estuary and its segments?
    2.1 Are there particular regions of concern?

In addition, the study will address the emerging contaminants priority question: What emerging contaminants have the potential to adversely impact beneficial uses of the Bay?

Approach

Two size fractions of microplastics will be sampled, 5-mm-0.355-mm (the size fraction that is characteristic of personal care product microbeads) and 0.125-0.355-mm (the size fraction that is characteristic of microfibers), in Bay sediment. Sediment sampling will occur as part of the margins sampling study in the summer of 2015. Ten sediment samples will be collected using a modified van Veen grab or hand scooped from exposed intertidal sediment. The 10 stations will be a subset of the 40 stations sampled during the margins sediment monitoring. Station selection will be informed by available data on plastic trash abundance.

After collection, the sediment samples will be sent to Dr. Sherri Mason at SUNY Fredonia for sample processing, visual sorting, and abundance measurements. This laboratory was selected to ensure consistency because it is doing the analyses for the 2015 RMP sediment samples.

Budget

The proposed budget for the study is $14,325. This includes staff time to manage the project, coordinate collection and shipping of samples, and write a fact sheet that will include all RMP microplastics data (2015 and 2016 special studies).

Sample collection costs will be minimal, as samples will be collected as part of the existing margin sediment special study. Analytical costs are also low, at $100/sample.

Table 1. Budget summary.

Expense	Estimated Hours	Estimated Cost ($)
Labor		
Project Staff	50	7,050
Senior Management Review	4	800
Project Management	0*	
Contract Management	0*	
Data Technical Services	0	
GIS Services	4	325
Creative Services	18	1,500
IT Services	0	0
Communications	0	0
Operations	0	0
Subtotal		

Subcontracts	
Name of contractor	
SUNY	1,000
Graphic Design contractor	2,450
Direct Costs	
Equipment	500
Travel	100
Printing	100
Shipping	500
Other	
	14,325

*Not needed because core RMP funding provides this service.

Reporting

A draft fact sheet summarizing the approach, analyses and results of the study will be submitted to the ECWG and TRC. Upon receipt and incorporation of comments, a final factsheet will be issued.

References

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