MONITORING MICROPLASTICS IN SAN FRANCISCO BAY

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ESTIMATED COST: $8,800
OVERSIGHT GROUP: Emerging Contaminants Work Group (ECWG)

PROPOSED DELIVERABLES AND TIMELINE

Deliverable	Due Date
Task 1. Project Management (write and manage sub-contracts, track budgets)	Summer – Dec 2014
Task 2. Collection of ambient sediment samples	Summer 2014
Task 3. Collection of ambient water samples	Fall 2014
Task 2. Collection of wastewater effluent	Fall 2014
Task 3. Laboratory analysis	Fall/Winter 2014
Task 4. Data management	Spring 2014
Task 5. Presentation to ECWG	Apr 2015

Background

General Background:
Microplastic is a term used to describe fragments of plastic that are less than 5mm (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 are not captured by wastewater treatment plants because they are buoyant and do not flocculate; therefore, they are released in wastewater (Hogue, 2013). It is important to note that both California and New York have proposed bans on microplastics found in cosmetics (Badore 2014). Additionally, Johnson & Johnson, L'Oréal, Colgate-Palmolive, and Procter & Gamble have pledged to phase out the use of microbeads in their skin cleansers (Hogue 2013). Therefore, the concentrations entering wastewater may decrease in the future.

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 toxins (Wright et al., 2012). The potential for ingesting toxins 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 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). Studies regarding microplastic pollution have been focused in the North Sea. However, there has recently been a handful 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 Sherri Mason (SUNY Fredonia), are currently considering adding effluent sampling to the monitoring effort.

Previous San Francisco Bay Monitoring

In 2011, microplastics were sampled in San Francisco Bay surface waters at six sites. The RMP partnered with Ian Wren at San Francisco Baykeeper and Joel Baker and Julie Masura at the University of Washington, Tacoma to complete the study. The study determined the mass of microplastic at sites in Central Bay that were suspected to be most influence by trash. The six sites were Oyster Bay, San Leandro Bay, Oakland Estuary, Berkeley Marina, Richmond Inner Harbor, and the San Francisco Waterfront. The concentration of microplastics ranged from 0.064 to 7.215 ug/L, similar to the concentration range observed in Puget Sound (LaRocque et al., 2011). However, the study only measured the mass of the microplastics, rather than the abundance and composition. Additionally, effluent has not yet been monitored in San Francisco Bay. Monitoring effluent would help identify whether personal care products were a significant source of microplastic pollution in the Bay.

Applicable RMP Objectives and Management Questions

This study will address the following RMP Objectives and Management Questions:

MQ.1 Are chemical concentrations in the Estuary at levels of potential concern and are associated impacts likely?
- A: Which chemicals have the potential to impact humans and aquatic life and should be monitored?

MQ.2 What are the concentrations and masses of contaminants in the Estuary and its segments?
- A: Do pollutant spatial patterns and long-term trends indicate particular regions of concern?

MQ.3 What are the sources, pathways, loadings, and processes leading to contaminant-related impacts in the Estuary?
- A: Which sources, pathways, and processes contribute most to impacts?

Approach

San Francisco Bay is a densely populated area with a high potential for microplastic pollution. Given the risk of microplastic ingestion by aquatic life, monitoring the abundance and composition of microplastics in WWTP effluent and the ambient Bay would be worthwhile.

Two size fractions of microplastics will be sampled, > 0.355-mm and 0.125-0.355-mm (the size fraction that is characteristic of personal care product microbeads), in WWTP effluent and Bay sediment and water. Ambient Bay sediment sampling will occur during the 2014 RMP S&T sediment cruise (August 2014). Ten sediment samples will be collected throughout the Bay using a modified van Veen grab. The 10 stations will be a subset of the 27 stations sampled during the S&T sediment cruise and will emphasize Central and South Bay, where microplastic contamination is expected to be greater. Ambient Bay water sampling will occur soon after sediment sampling in Fall 2014. The samples will be collected from the same sites using planktonic nets. The samples will be collected separately from the sediment samples because it is logistically difficult to complete both types of field sample collections during one cruise.

WWTP effluent samples will be voluntarily provided by six Bay Area dischargers in Fall 2014. SFEI field staff will visit the sites and set-up a pump with a 0.355-mm sieve and pump water from the plant's effluent trough through the sieve for 24 hours. Dischargers are not specifically identified here, and they will have the option to keep their identities confidential in subsequent reporting of the data.

The effluent, water, and sediment samples will be sent to Dr. Sherri Mason at SUNY Fredonia for sample processing, visual sorting, and abundance measurements.

Reporting

Results of these proposed study elements will be reported to the Emerging Contaminants Workgroup during its Spring 2015 meeting. Comparisons will be made to monitoring efforts in other locations.

Proposed Budget

Task	Estimated Cost
Field collection of WWTP effluent and ambient Bay water for microplastics, vessel rental, and shipping	$5,400
Analysis of 2014 WWTP effluent (n=6), ambient Bay sediment (n=10), and ambient Bay water (n=10) for microplastics	$2,600
Project management and power point presentation to ECWG	$800
Total	**$8,800**

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