



RMP Microplastics Workgroup Meeting

30 April 2026

Zoom Stuff

1. This meeting is being recorded and AI transcribed
2. Update your name and add your affiliation
3. Raise your hand if you have a comment or question
4. Unmute yourself and turn on video when you are speaking
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In person attendees

1. Mute your microphone and the volume on your laptop
2. Turn off your camera
3. Silence cell phone
4. Keep side conversations to a minimum, new SFEI mic system is very sensitive. Speak clearly and do not talk over each other
5. We assume consent from participants to photograph the event and attendees and use the photos for our website and newsletter unless you inform us otherwise

Guidelines for Inclusive Conversations

1. Try it on
2. Practice self focus
3. Understand the difference between intent and impact
4. Practice both / and
5. Refrain from blaming or shaming self and others
6. Move up / move back
7. Practice mindful listening
8. Right to pass
9. Avoid jargon
10. It's okay to disagree

The San Francisco Bay is the ancestral homeland of many indigenous people, including the Ohlone, Patwin, Coast Miwok, and Bay Miwok.



Microplastics Workgroup Expert Advisors



Chelsea Rochman
University of Toronto



Barbara Beckingham
College of Charleston





Introductions



Meeting Agenda

Information: Microplastics Update	9:45
Discussion: Microplastics Strategy and Multi-Year Plan	10:15
Short Break	10:45
Information: Dryer Study	11:00
Discussion: Microplastics in Sport Fish	11:30
LUNCH	12:00

Meeting Agenda

Discussion: Microplastics Stormwater Pilot Study Update	1:00
Proposed MPWG Special Study for 2027	2:15
Short Break	2:45
Discussion of Proposed Studies for 2027 - General Q&A	3:00
Closed Session - Decision: Recommendations for 2027 Special Studies Funding	3:20
Report out on recommendations	4:00
ADJOURN	4:15

Goals for Meeting - TODAY

- Provide updates on recent and ongoing MPWG activities
- Discuss MPWG multi-year plan and potential future studies
- Feedback on data interpretation
- Recommendations from the MPWG to the TRC regarding special studies funding

Regional Monitoring Program for Water Quality

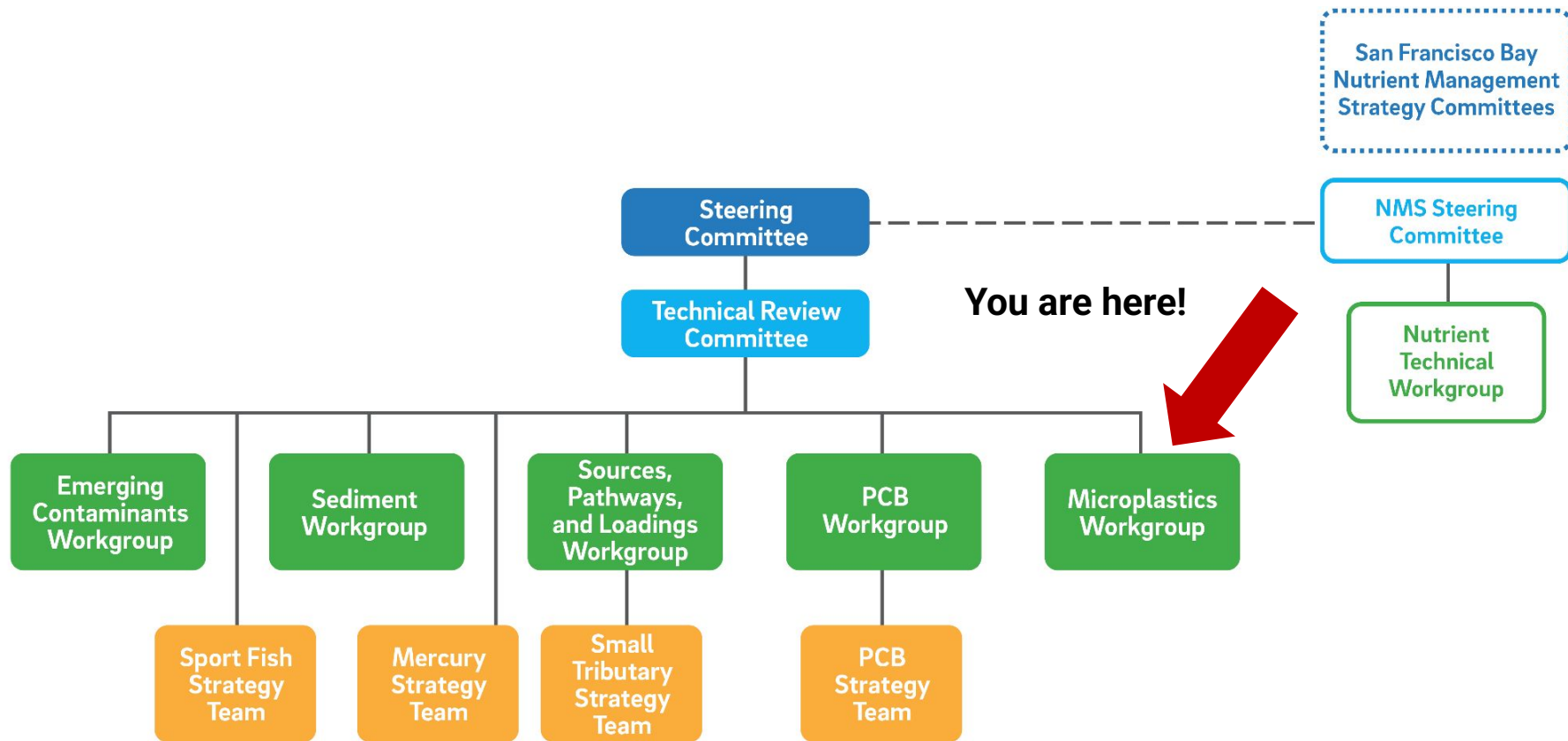
Collect data and communicate information about water quality in San Francisco Bay in support of management decisions

~ 68 entities in the Program

- Municipal wastewater
- Industrial wastewater
- Municipal stormwater
- Dredgers

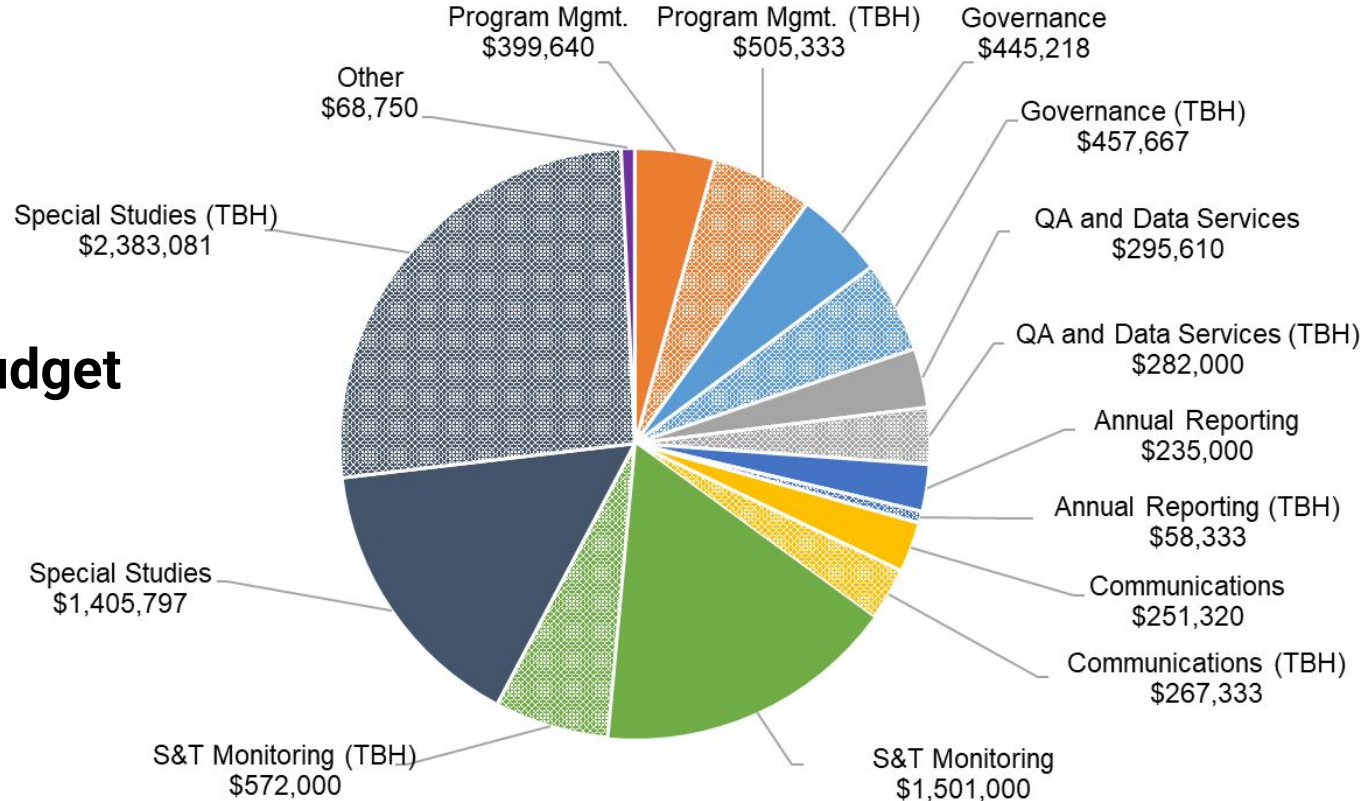


RMP Governance Structure



Regional Monitoring Program

**2026 Budget
\$9.2M**



Microplastics Workgroup Planning

2027 Planning Budget - \$154,650

RMP Committees recommended that workgroups plan multi-year proposals where possible



Item 2: Microplastics Update

Diana Lin, PhD

Our Team



Diana Lin
Managing Senior Scientist



Kayli Paterson
Associate Environ. Scientist



Ezra Miller
Senior Scientist



Rebecca Sutton
Managing Senior Scientist



Kelly D. Moran
Senior Scientist



Alicia Gilbreath
Managing Senior Scientist



Lester McKee
Senior Environ. Scientist



Maya Yu
Scientist In-Training

RMP Microplastics Strategy Development



2021 Synthesis of Sources and Pathways to Stormwater

Emphasize tires and fibers.
Hypothesized dryers is major source.



2019 San Francisco Bay Microplastics Study

Bay Water, Sediment,
Wastewater, and Urban
Stormwater Runoff

2024 RMP MPWG Strategy Update

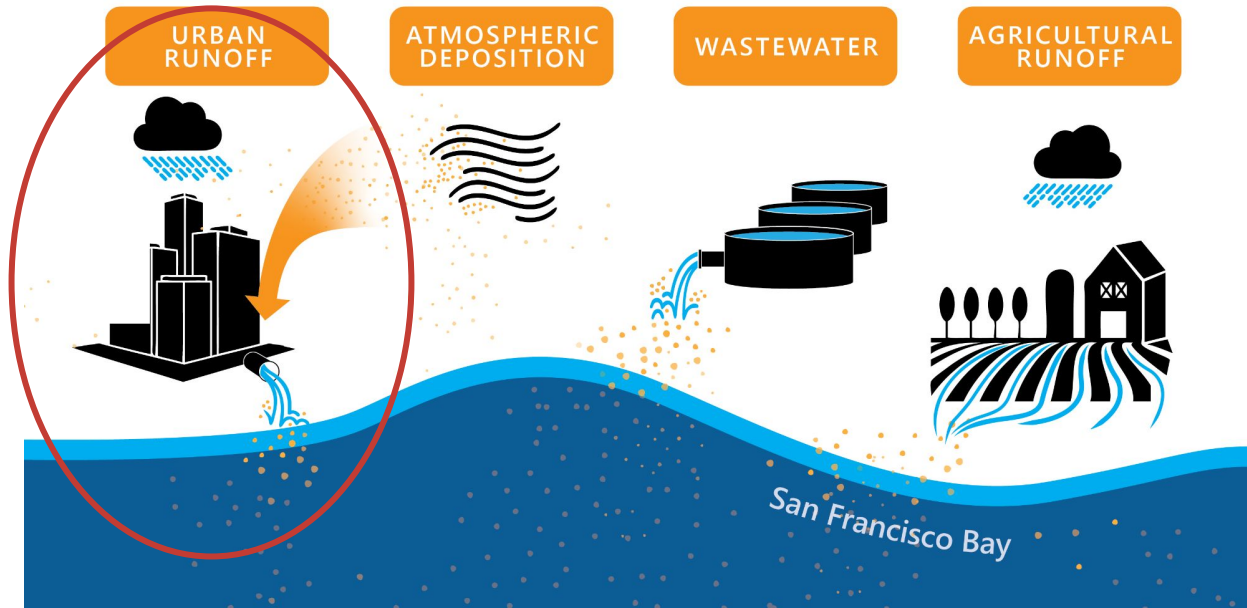
Priority Management
Questions

2025 Stormwater Pilot Study



RMP Microplastics Strategy Development

- Stormwater identified as major pathway for microplastics
- Tire wear particles, fibers, and other small microplastics ($<100\text{ }\mu\text{m}$) is a major data gap to inform risk





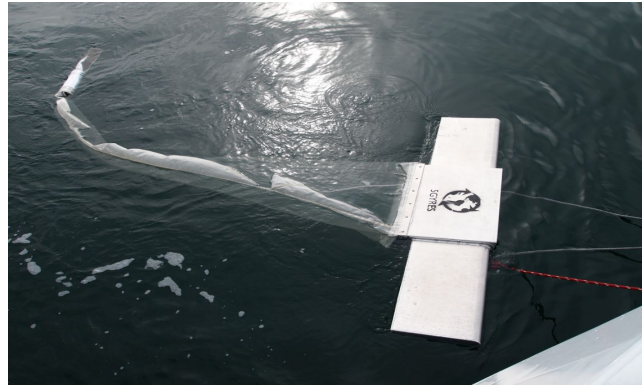
RMP Special Study Updates



Pilot Study to Evaluate Methods to Measure Small Microplastic Particles in Bay Water

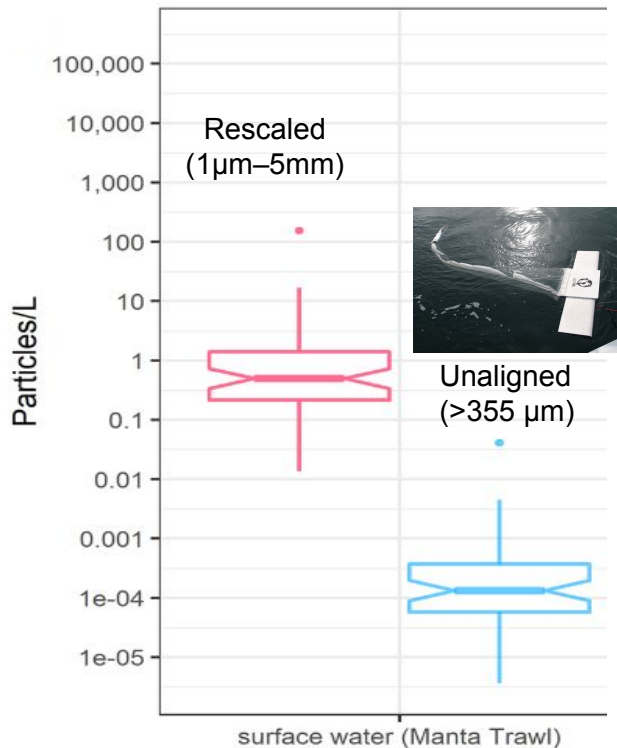
Bay Water Study: Motivation

- Smaller microplastics in previous Bay water monitoring is a priority data gap to understand microplastics levels
- Smaller particles are also important for risk characterization



Manta Trawl captures particles $>355 \mu\text{m}$

Background



Coffin et al., 2022

RESEARCH

Open Access

Risk characterization of microplastics in San Francisco Bay, California

Scott Coffin^{1*}, Stephen B. Weisberg², Chelsea Rochman³, Merel Kooi⁴ and Albert A. Koelmans⁴



- Coffin et al, 2022 estimated higher levels of microplastics in SF Bay with sized based re-scaling
- Introduces substantial uncertainty
- State Water Board water quality assessment indicates “beneficial uses may be potentially threatened”

Study Objectives

- Pilot sampling and analytical approaches for quantifying small microplastics (20–100 μm) in Bay water
- Inform future, more representative monitoring study that can update risk screening



Study Approach

- Leverage surface water sampling guidance developments for statewide monitoring and International Joint Commission efforts for Great Lakes
 - ISCO pump through 20 μm , 53 μm , and 125 μm sieve
- Sample Collection
 - Water at two open bay locations
 - Samples analyzed via Raman and LDIR



Leah Thornton Hampton



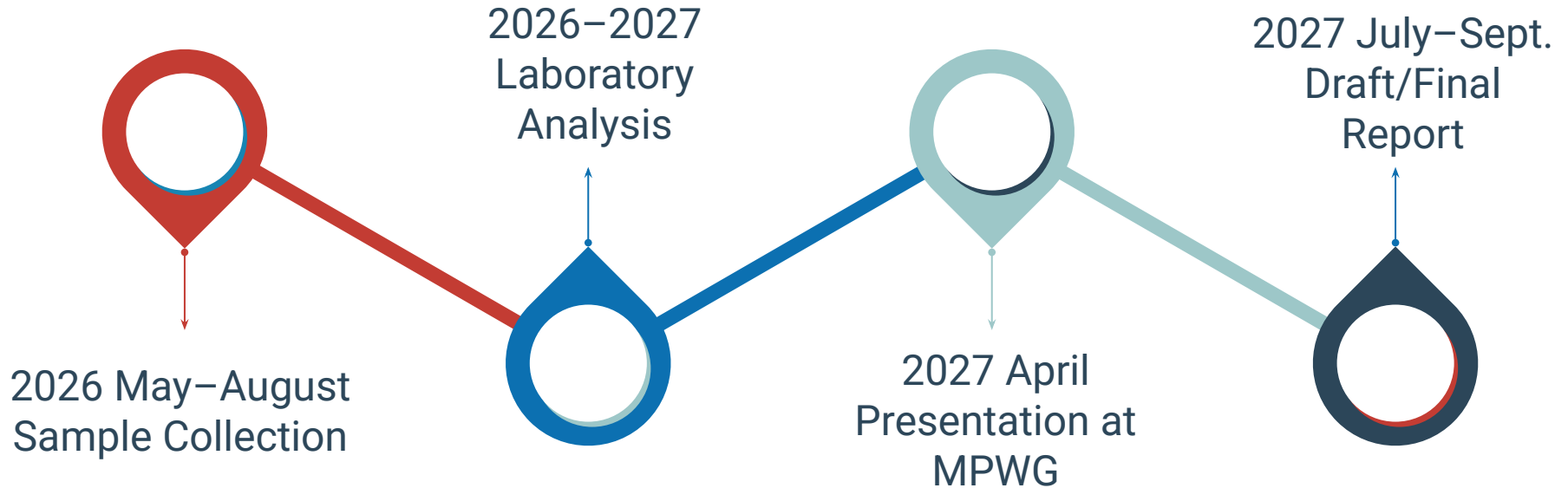
Raman analysis



LDIR analysis

Deliverables and Timeline

Bay Water Study





Tire Rubber Marker Analysis for Tire Wear Particle Quantification

Motivation

- Improve methods to quantify tire wear particles in Bay Area samples

Approach

- Purchasing 30 tires: representative of most popular tires on the road and diversity of tires
- Analyze for 4 tire rubber markers using pyrolysis GC-MS
- Results used as reference database for current and future RMP tire studies

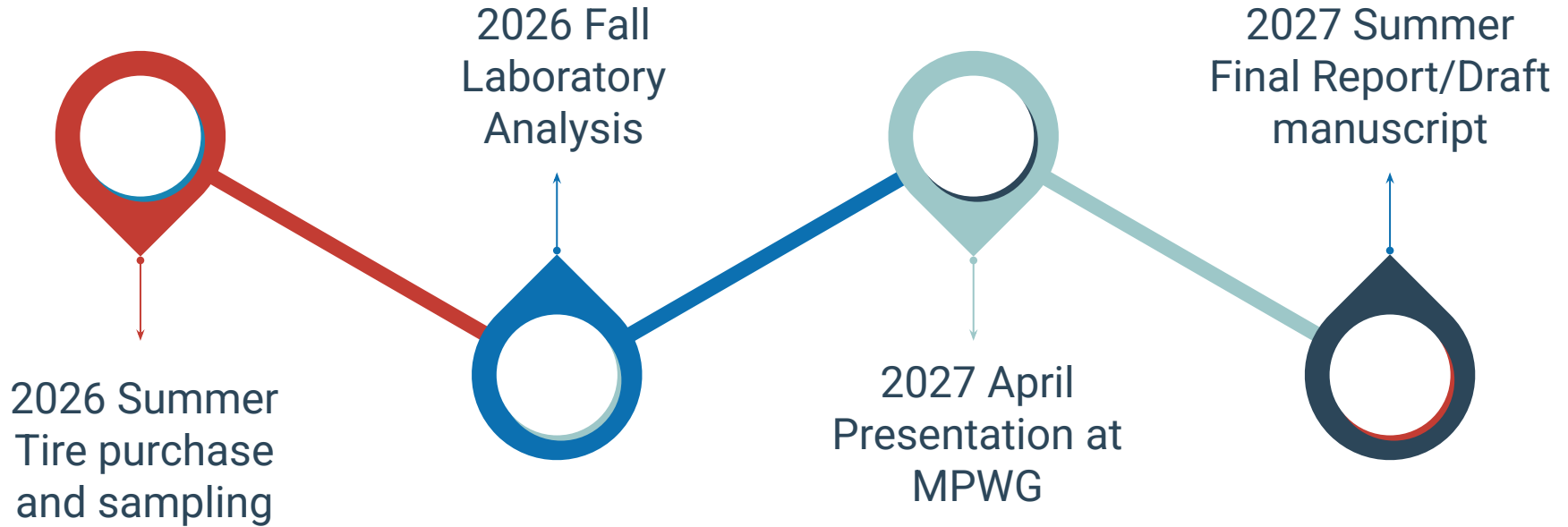


Elisabeth
Rødland



Deliverables and Timeline

Tire Rubber Marker Analysis Study



Seeking Collaborators

- Do you have insights in tire market and composition and would like to review our study design?
- Want tire tread material for scientific study?

Email: diana@sfei.org

Updates for Today

Item 4: Dryer Study

Item 5: Microplastics in Sport Fish

Item 6: MP Pilot Stage Study



Other Related Microplastics Updates

Recent Publications

ToMEx Update

The Toxicity of Microplastics Explorer (ToMEx) 2.0

Trends in Quality and Risk Assessment Applicability of Microplastic Ecotoxicity Studies

A Probabilistic Risk Framework for Microplastics Integrating Uncertainty Across Toxicological and Environmental Variability: Development and Application to Marine and Freshwater Ecosystems

Hampton et al. <i>Microplastics and Nanoplastics</i> (2022) 5:38 https://doi.org/10.1186/s40580-022-00145-6 RESEARCH The Toxicity of Microplastics (ToMEx) 2.0 Leah M. Thornton Hampton^{1*}, Dana Briggs-Wyler¹, Beth Damag Doyle¹, Eden K. Hataley¹, Sara J. Hutton¹, Mags Emma E. Sharpe¹, Siddiqui Samreen¹, Kazi Towse Ahmed¹, Davide Anicic¹, Jennifer L. Bane¹, Andrew Barric¹, Ra Virginia Bozovic¹, Agathe Bour¹, Julian Dietrich¹, Victor Patricia Cubanski¹, Pedro M. C. Da Silva¹, Luan de Souza Asta Hooge¹, Yuchi Iwasaki¹, Natasha Klossos¹, Christa Isaac B. Kudu¹, Anna Kuusk¹, Christian Laforon¹, Lucy Wei Li¹, Hsuan-Cheng Lu¹, Judd Mahan¹, Uddin Zacharia Pandelides¹, Tove Petersson¹, Danielle A. Phil Gabriele Rigotto¹, Sven Rischard¹, Monica H. Sandgaa Michael Schwartz¹, Katryna J. Seabrook¹, Teresa M. S. Allen N. Tetzlaff¹, Maake Vercauteren¹, Giffen M. Ward Alvine C. Mehrtens¹ Abstract In 2021 the Toxicity of Microplastics Explorer (ToMEx) 1.0 source, open access database and web application for microplastic research community for the exploration and characterization and risk assessment. The peer-reviewed ToMEx out-of-date. To ensure the continued utility of ToMEx 2.0 to update ToMEx by extracting data from additional studies both the aquatic and human health ToMEx databases regularly (e.g., number of species represented, types of test plans). However, most trends (e.g., greater toxicities observed with observed in the first iteration of ToMEx remained constant, health-based microplastic thresholds using species sensitivity data and their associated uncertainty intervals would change) remained minimum screening criteria and were deemed fit for data allowed for the integration of freshwater and marine data to a lack of applicable toxicity data for freshwater species. By freshwater thresholds were comparable or increased from * Correspondence: leah.m.thornton@hampton.com SpringerOpen Full list of author information is available at the end of the article © The Author(s) 2022. Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/.	<i>Journal of Hazardous Materials Advances</i> 2(2) (2022) Contents lists available at ScienceDirect Journal of Hazardous Materials Advances journal homepage: www.elsevier.com/locate/jhama Trends in quality and risk assessment applicability of microplastic ecotoxicity studies Stephanie B. Kennedy^{1,*}, Ana L. Antonio Vital¹, Anna Kukkola¹, Eze Scott Coffin¹, Towsef K. Ahmed¹, Lidwina Bertrand¹, Andrew Barric¹, Magdalena M. Mair^{1,*}, Daragh Doyle^{1,*} * Correspondence: s.b.kennedy@universityofbayreuth.de 1. <i>Institute of Environmental Health and Safety, University of Bayreuth, Universitätsstr. 30, 95404 Bayreuth, Germany</i> 2. <i>University of Bayreuth, Fachbereich Biologie, Universitätsstr. 30, 95404 Bayreuth, Germany</i> 3. <i>San Francisco State University, 421 California Street, San Francisco, CA 94133, USA</i> 4. <i>Graduate Center, CUNY, 3335 Queens Blvd., Flushing, NY 11355, USA</i> 5. <i>Department of Fisheries Biology and Genetics, Bangladesh Agricultural University, Moulvibazar Road, Moulvibazar, Bangladesh</i> 6. <i>Center for Environmental and Estuarine Science (CEES), University of Maryland System, P.O. Box 38, Poolesville, MD 20854, USA</i> 7. <i>Faculty of Science, University of Bayreuth, Universitätsstr. 30, 95404 Bayreuth, Germany</i> 8. <i>Department of Biological and Environmental Sciences, University of Cambridge, Madingley Road, CB3 0ET, UK</i> 9. <i>Department of Biology, University of Bayreuth, Universitätsstr. 30, 95404 Bayreuth, Germany</i> 10. <i>Department of Biological and Environmental Sciences, University of Cambridge, Madingley Road, CB3 0ET, UK</i> ARTICLE INFO Keywords: Microplastics Toxicity Ecotoxicology Ecotoxicity Ecotoxicity Ecotoxicity Abstract The Toxicity of Microplastics Explorer 2.0 (ToMEx 2.0) is a web-based platform that has been used for quality and risk assessment of microplastic ecotoxicity studies. This platform includes a quality assurance and quality control criteria for the evaluation of microplastic ecotoxicity studies. The platform also includes a quality assurance and quality control criteria for the evaluation of microplastic ecotoxicity studies. The platform also includes a quality assurance and quality control criteria for the evaluation of microplastic ecotoxicity studies. 1. Introduction Microplastics (MPs), typically defined as plastic particles smaller than 5 mm by researchers and some authoritative bodies (Environment Canada, 2022; European Commission, 2022; Hovgaard et al., 2022; Hovgaard et al., 2022). * Corresponding authors. E-mail address: s.b.kennedy@universityofbayreuth.de (S. B. Kennedy). E-mail address: m.mair@universityofbayreuth.de (M. Mair). https://doi.org/10.1016/j.jhama.2022.100042 Received 8 September 2022; Received in revised form 12 November 2022; Accepted 13 November 2022 Available online 14 November 2022 © 2022 The Author(s). Published by Elsevier B.V. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).	<i>Journal of Hazardous Materials Advances</i> 2(2) (2022) Contents lists available at ScienceDirect Journal of Hazardous Materials Advances journal homepage: www.elsevier.com/locate/jhama A probabilistic risk framework for microplastics integrating uncertainty across toxicological and environmental variability: Development and application to marine and freshwater ecosystems Scott Coffin^{1,*}, Lidwina Bertrand¹, Kazi Towsef Ahmed¹, Luan de Souza Leite¹, Wijn Conger¹, Mariela Sina¹, Andrew Barric¹, Anna Kukkola¹, Bethanne Carney Altmouth¹, Ezra Miller¹, Andrew Yeh¹, Stephanie Kennedy¹, Magdalena M. Mair^{1,*} * Correspondence: s.coffin@universityofbayreuth.de 1. <i>California Office of Environmental Health Hazard Assessment, 1001 P St., Sacramento, CA 95814, USA</i> 2. <i>Department of Environmental and Occupational Health Sciences, University of California, 1601 S. Shields Ave., Davis, CA 95616, USA</i> 3. <i>Department of Chemistry, University of Bayreuth, Universitätsstr. 30, 95404 Bayreuth, Germany</i> 4. <i>Department of Chemistry, University of Bayreuth, Universitätsstr. 30, 95404 Bayreuth, Germany</i> 5. <i>Department of Chemistry, University of Bayreuth, Universitätsstr. 30, 95404 Bayreuth, Germany</i> 6. <i>Department of Chemistry, University of Bayreuth, Universitätsstr. 30, 95404 Bayreuth, Germany</i> 7. <i>Department of Chemistry, University of Bayreuth, Universitätsstr. 30, 95404 Bayreuth, Germany</i> 8. <i>Department of Chemistry, University of Bayreuth, Universitätsstr. 30, 95404 Bayreuth, Germany</i> 9. <i>Department of Chemistry, University of Bayreuth, Universitätsstr. 30, 95404 Bayreuth, Germany</i> 10. <i>Department of Chemistry, University of Bayreuth, Universitätsstr. 30, 95404 Bayreuth, Germany</i> ARTICLE INFO Abstract Quantitative risk assessment for microplastics (MPs) is complicated by uncertainties between environmentally relevant particles and those used in toxicity studies. Previous approaches addressed this using compound-specific data, but this approach is not feasible for many MPs. This study develops a probabilistic risk framework for MPs that integrates uncertainty across toxicological and environmental variability. The framework is applied to marine and freshwater ecosystems. 1. Introduction Microplastics (MPs) are small plastic particles that are found in the environment. They are a major source of pollution and can have negative impacts on the environment. This study develops a probabilistic risk framework for MPs that integrates uncertainty across toxicological and environmental variability. The framework is applied to marine and freshwater ecosystems.
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Upcoming Publications

¹ Load and Concentration Based Performance Outcomes for Emerging Organic

² Contaminants in Bioretention Stormwater Treatment Systems

³ Jennifer A. Dougherty¹, Kayli Paterson¹, Melissa Gonzalez^{2,3}, Edward P. Kolodziej^{2,3,4}, Diana Lin¹, Alicia Gilbreath¹, Elisabeth Rodland¹, Win Cowger¹, Hazel Vaquero⁵, Andrea Amend⁶, Rebecca Sutton^{1,7}

⁶ ¹San Francisco Estuary Institute, Richmond, CA 94530, USA

⁷ ²Center for Urban Waters, Tacoma, WA 98421, USA

⁸ ³Interdisciplinary Arts and Sciences, University of Washington-Tacoma, Tacoma, WA 98421, USA

Accepted with revisions

¹⁴ *Corresponding author email: RebeccaS@sfei.org

¹⁵ ABSTRACT

¹⁶ The performance capabilities of bioretention systems for a range of stormwater constituents
¹⁷ remain lightly characterized, particularly for emerging organic contaminants. To address this gap,
¹⁸ we evaluated concentration- and load-based treatment outcomes at four urban bioretention
¹⁹ systems for tire wear particles (TWPs) and 21 chemical contaminants, including 6PPD-quinone
²⁰ (6PPDQ), 1,3-diphenylguanidine (DPG), hexa(methoxymethyl)melamine (HMMM),
²¹ benzothiazoles, benzotriazoles, pharmaceuticals and personal care products (PPCPs), and
²² pesticides. Inlet concentrations of vehicle-derived contaminants were generally at least twice the
²³ values reported for regional stormwater, consistent with these systems draining primarily
²⁴ roadway and parking lot runoff. Concentration-based removal varied widely across compounds,
²⁵ storms, and sites and was moderately associated with predicted organic carbon-water
²⁶ partitioning. Median concentration-based removal efficiencies exceeded 76% for 9 of 19
²⁷ contaminants, whereas the remaining compounds exhibited lower and more variable removal.
²⁸ Although bioretention reduced 6PPDQ concentrations by 95%, the median outlet concentration
²⁹ of 12 ng/L remained above the US EPA acute freshwater screening value. At one site with
³⁰ modeled flow data, load-based estimates provided complementary context for treatment
³¹ performance by integrating measured concentrations with modeled event volumes, revealing

Microplastics Removal in Rain Gardens

Load and Concentration Based Performance Outcomes for Emerging Organic Contaminants in Bioretention Stormwater Treatment Systems

Statewide Plastics Monitoring Strategy - Goals

- Articulate and coordinate vision for a future statewide plastics monitoring program
- Implement monitoring that will inform
 - Understanding of exposure and risks from macro- and microplastics
 - Management actions
- Recommend phased approach for near-term and long-term implementation



Kyla Kelly
Water Quality
Program Manager



Tony Hale



Diana Lin

SFEI

Deliverables and Timeline

Statewide Plastics Strategy



Other Related Statewide Microplastics Strategy Work

- Southern Coastal Water Research Project (SCCWRP) coordinating publishing sampling guidance for water and stormwater for statewide monitoring strategy



Chelsea Rochman leading
surface water studies
Draft manuscript



Andy Gray, UC Riverside
leading stormwater studies
Analysis in progress

- Bight Monitoring: 2023 sediment and shellfish monitoring
 - Anticipated reporting winter 2026



DTSC Safer Consumer Products Program

- 2025: Initiated rulemaking to add microplastics to its Candidate Chemicals List
 - Broad definition of microplastics to avoid regrettable substitutions
- Preliminary screening research on products that can release microplastics



Narrowed List of Products

- Artificial turf infill
- Children's toys containing primary microplastics
- Plastic film mulch
- Single-use cigarette filters
- Water-based interior wall paints
- Cleaning products
- Food contact articles





Item 3: Microplastics Strategy and Multi-Year Plan

Diana Lin, PhD

Priority Management Questions

1. What are levels of microplastics in the Bay? What are the risks of adverse impacts?
2. What are the sources, pathways, processes, and relative loadings leading to levels of microplastics in the Bay?
3. Are microplastics levels changing over time? What are potential drivers contributing to changes?
4. What are the anticipated effects of management actions?

MPWG Multi-year plan

Year	Special Studies
2027	Stormwater multi-year Study (2027-2029)
2028 - 2029	Water monitoring, current pilot follow-up Sediment monitoring, leverage S&T
2030	Wastewater monitoring Air monitoring Characterizing microplastic additives

Monitoring Strategy Discussion

1. Are we missing any important topics?
2. Any updates on upcoming management decisions and priority management questions?
3. What topics are of highest priority?





Item 4: Dryer Study

Kayli Paterson

Project Team



Diana Lin
SFEI



Kayli Paterson
SFEI



Monica Arienzo
 **DRI**



Lisa Erdle

5GYRES



**OCEAN
PROTECTION
COUNCIL**




Sea Grant

Publications

Environmental Research Communications

LETTER

Commercial clothes dryers: a source of microfiber emissions to air

Lisa M Erdle^{1,2}, Victoria Fulfer³, Lucinda Anderson^{1,2}, Win Cowger^{1,2} and Marcus Eriksen¹

¹ The S Cyres Institute, Los Angeles, CA, United States of America
² Brown University, Providence, RI 02912, United States of America
³ Moore Institute for Plastic Pollution Research, Long Beach, CA, United States of America
⁴ University of California, Riverside
* Author to whom any correspondence should be addressed

E-mail: lisa@sgyres.org

Keywords: microfibers, textile pollution

Supplementary material for this article

Abstract

Background. Microfiber from dryers are poorly commercial dryers and spheric sampling using microfiber emissions from significantly higher down million microfibers per microfibers annually. G microfiber pollution. M

1. Introduction

Plastics, and microplastics, microfibers environment, including of terrestrial environments (2020). Atmospheric trans comprehensive account magnitude and sources for microfibers (Chen et al. 2019). Although microfiber per et al 2020, Geyer et al 2020. Recent studies show that e may equal to or exceed m as significant sources of m of volumes of textiles, rema microfibers.

Airborne microfiber e enter the respiratory system (Jenken et al 2022), placenta bulb via the nasal passage (Inhalation. Microfibers m (Calzadilla and Rasmann 20

Environmental Toxicology and Chemistry, 2025, 1-8
<https://doi.org/10.1080/10667632.2025.2522222>
Advance access publication: September 3, 2025
Original Article

Environmental Chemistry

A participatory science approach to quantify microfiber emissions from clothes dryers

Monica M. Arienzo^{1,4}, Meghan Collins¹, Emily Justice Frey^{1,4}, Marilee Movius¹, Laura Patten¹, Angelique DePauw¹, and Rachel Kozloski¹

¹ Desert Research Institute, Reno, Nevada, United States

² Tongue to Sew Lake Tahoe, South Lake Tahoe, United States

³ Corresponding author: Monica M. Arienzo. Email: Monica.Arienzo@desert.edu

⁴ Present address: Tahoe Regional Planning Agency, Kingsbury, Nevada, United States

Abstract

Studies have shown that washing and drying clothes contribute microfiber contamination to the environment. However, there is a lack of data from clothes dryers under normal household use. To begin to address this data gap, we recruited participatory volunteer scientists to install a mesh on their dryer vents for 3 weeks. During that time, the volunteers used a mobile phone application to record information about what was dried. The material accumulated on the mesh was analyzed for material composition. The results showed that the items dried were primarily composed of cotton, followed by polyester. The textile-derived microfibers on the mesh were primarily cellulose, followed by polyethylene terephthalate/polyester and other plastics. When we compared the microfibers on the mesh with the textiles dried, we found that the relative percentage of cellulose microfibers on the mesh was higher than the percentage of cellulose textiles dried. This suggests cellulose textiles potentially released more microfibers than synthetic textiles. On average, 138 mg of material was emitted per dryer load. When scaled to the number of electric clothes dryers in the United States and the average number of dryer loads per household per year, we estimated dryers release approximately 364.6 metric tons of microfibers per year in the United States. The results indicate that clothes dryers are potentially a significant source of cellulose and synthetic microfibers being released into the air, and steps should be taken to reduce these emissions. The methods outlined here can be applied to other studies to assess microfiber emissions from dryers under normal household use.

Keywords: tumble dryer, microfiber, textiles, participatory science

Introduction

Textiles are fiber products that are spun and woven or knitted into fabric for a variety of uses, such as carpeting, clothing, construction, and marine uses. Synthetic textiles are composed of solid polymeric materials (California State Water Resources Control Board, 2020) such as polyester (PEST), polyethylene terephthalate (PET), polyamides, polyethylene, polypropylene, polyacrylonitrile, and polyurethane (Athey & Erdle, 2022; Truett-Carew et al., 2025; Interagency Marine Debris Coordinating Committee, 2024). In 2023, PEST comprised 57% of global fiber production (Textile Exchange, 2025). Textiles can also be composed of natural materials, such as cellulosic textiles from cotton and hemp or proteinaceous textiles from silk, cashmere, and wool (Athey & Erdle, 2025), with cotton comprising approximately 20% of the global fiber production in 2023, and approximately 60%-70% of cotton fibers produced are used for apparel (Textile Exchange, 2025). For apparel, PEST is the most common fiber used (Khan, 2022; Smolke, 2023), followed by cotton. Both synthetic and natural textiles can be treated with dyes, flame retardants, per- and polyfluoroalkyl substances (PFAS) for repellency, and formaldehyde and carboxylic acids for wrinkle-free fabrics (Durbes et al., 2012; Maitel et al., 2023; Penales et al., 2020;

Sabir, 2018; United Nations Environment Programme, 2023). During production, use, and washing and drying processes, textiles can shed microfibers, which are either natural or synthetic (fibrous material with a three structure (Interagency Marine Debris Coordinating Committee, 2024). The chemical composition of microfibers generally reflects the chemistry of the textile material and is added treatment chemicals. A strict size definition was not implemented in this study. However, some studies limited the size of microfibers to a width <50µm and a length of between 1-5 mm (Athey & Erdle, 2022; Liu et al., 2019).

Microfibers have been observed in environments around the globe (Interagency Marine Debris Coordinating Committee, 2024; Ross et al., 2023), with one study estimating that global microfiber emissions were 6.5 × 2.9 Tgyr⁻¹ (Vangelopoulos et al., 2022). Considering their ubiquity and potential to contain other chemicals (e.g., PFAS and flame retardants), microfibers have potential increasing scientific focus, especially for their potential negative effects on organisms (Giddeke et al., 2023). However, questions remain regarding the sources of microfibers, their contributions to the environment, and their impacts on biota, humans, and the environment (Interagency Marine Debris Coordinating Committee, 2024).

The washing and drying processes for textiles are potentially important sources of microfiber emissions to the environment.

Commercial clothes dryers: a source of microfiber emissions to air

Environmental Research and Communications (2025)

Lisa M. Erdle, Victoria Fulfer, Lucinda Anderson, Win Cowger and Marcus Eriksen

A participatory science approach to quantify microfiber emissions from clothes dryers

Environmental Chemistry (2025)

Monica M. Arienzo, Meghan Collins, Emily Justice Frey, Marilee Movius, Laura Patten, Angelique DePauw, and Rachel Kozloski

Received: April 29, 2025, Accepted: August 24, 2025.

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Dryers as a Source of Microplastics

- Emission directly outside - possibly to atmosphere
- Atmospheric fibers can travel long distances
 - Sources from outside the Bay Area
 - Source to other areas
- Growing human health concern from microplastic fiber exposure



Photo by Lorien Fono

Study Goals

- Are clothing dryers a significant source of microplastic pollution?
- Are commercially available secondary dryers filters effective? - 5Gyers Institute

STORMWATER:

Vehicle tires, textiles, single-use plastic litter, cigarette filters, construction and roadway debris, spills, many others



WASTEWATER:

Textiles (via washing machines), personal care and cleaning products with microbeads, single-use items such as wet wipes



ATMOSPHERIC DEPOSITION:

Textiles (via clothes dryers), brake pads, auto shredders, abrasive blasting



RIVERS:

Delta wastewater and stormwater discharges, agricultural sources including land applied biosolids



AQUATIC AND SHORE ACTIVITIES:

Fishing lines, nets, marine and shipping spills, litter and debris



SFEI 2019 study estimated that trillions of fibers are discharged into the Bay annually

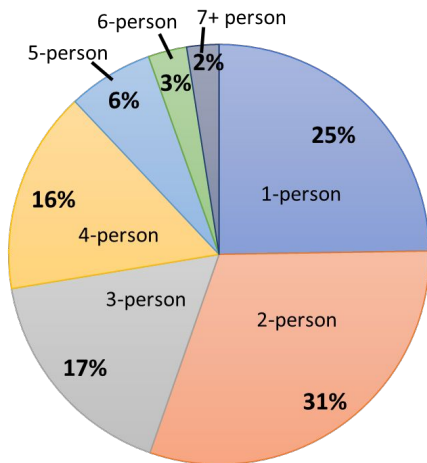
San Francisco Bay

Study Demographics

Total Bay Area Population

6.9 million people
(2020 U.S. Census)

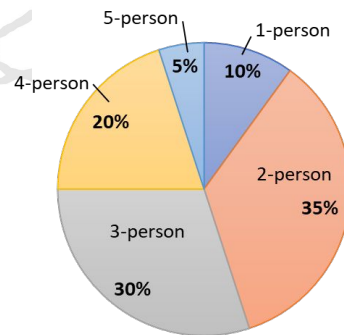
Bay Area Household Sizes



Average Bay Area Household Size: 2.70

Community Scientist Household Size

19 Community Scientist
1 Community Laundromat



Average
Household Size:
2.75

Community Scientist Demographics

Households with Children: 7

Households with Pets: 8

Single family homes: 16

Apartments: 3

Row-house: 1

Most Bay Area counties represented

Sample Collection

Individual Households

- 19 volunteer households
- September 2024 - May 2025
- 3 laundry load collections per household

Community Laundromat

- April 2025 - single 12 hr collection
- California State University East Bay dormitory on campus



Photo by Kayli Paterson

Methods

Sample Collection



100 μ m Nylon Mesh



Sample Mass



Micro-Scale

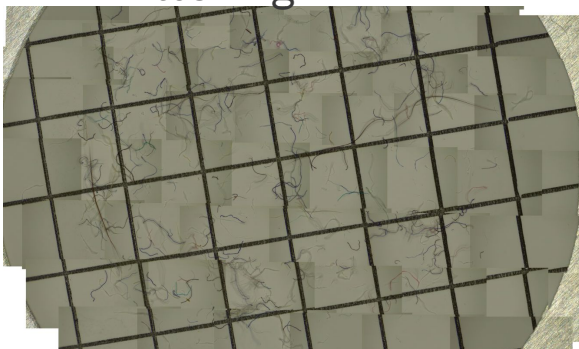


Dilution/agitation/subsampling



1-2L DI dilution,
1% Micro90, 2x
50mL aliquots

Filtering



47mm, 0.45 μ m pore size



FTIR Analysis



Match Value >0.7

Dryer Use Surveys

- **2019 Canadian Natural Resources Survey of Household Energy Use¹**
 - 67% of the 2.5 million respondents had an in-home dryer unit
- **2020 U.S. Energy Information Administration (EIA) Residential Energy Consumption Survey²**
 - 83% of the 123 million residential households surveyed had in-home dryers
- **SFEI outreasearch survey**
 - 84% of 436 respondents had in-home dryers, of those 6% had ventless dryers
- **Community Scientist Participants**
 - 19 households

¹ Natural Resources Canada (2019). Table 10.6a - Clothes dryer by household size.

<https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=SH§or=AAA&juris=CA&year=2019&rn=76&page=1>

² U.S. Energy Information Administration (2020). Residential Energy Consumption Survey (RECS).

<https://www.eia.gov/consumption/residential/data/2020/>

Project Outreach and Engagement

SFEI published articles, Public Surveys, SFEI Newsletter, Social Media, Radio and newspaper interviews

SFEI San Francisco Estuary Institute

WHAT WE DO PROJECTS & RESOURCES ABOUT DONATE

Are clothing dryers a major source of microplastics pollution in the San Francisco Bay? Study participants needed!

February 5, 2025

SFEI is studying dryer emissions to find out if clothing dryers are a significant source of microplastic pollution in the San Francisco Bay. The study will measure the dryer emissions from single-family homes, laundromats, apartment buildings, and other shared laundry facilities. The study will also evaluate the efficacy of commercially available secondary dryer filters (screens installed on a dryer's exhaust duct) in capturing microplastic fibers before they enter the environment. The dryer study will contribute to the Statewide Microplastics Strategy led by the California Ocean Protection Council (OPC) to investigate the sources and pathways of microplastics and develop action plans for combatting microplastic pollution.

In California's most comprehensive microplastics pollution study, SFEI found that almost half of the microplastics in urban stormwater runoff are fibers. Microplastic fibers are tiny thread-like pieces of plastic less than 5mm long (smaller than a grain of rice) that are shed from clothing, towels, and other everyday household products made from synthetic fabrics. During the drying process, fibers aren't captured by the lint trap are vented outdoors, settle on nearby surfaces, and wash into stormwater collection systems or are carried directly to waterways by the wind. While air drying is common in most parts of the world, clothing dryers with outdoor ventilation are the standard in the United States. In the Western United States,



2nd most visited SFEI webpage

November 2025 Sea Grant Webinar

SETAC North America 46th Annual Meeting

Oh, what does a laundry dryer vent?

SAN FRANCISCO ESTUARY INSTITUTE
KAYL PATTERSON - CHAIR LIA
ANALYST FOR THE PROJECT

RESEARCH INSTITUTE
PROJECT RELEASE

SFEI
SAN FRANCISCO ESTUARY INSTITUTE
DRI
DRI
DRI

What did we do?

Microplastic fibers are a major global pollutant, being found in the farthest corners of our planet, such as the depths of the ocean and our most isolated arctic peaks. We set out to realize whether our everyday household laundry dryers are a possible major source of these microplastic fibers. If so, how much is coming from a major city, such as San Francisco, California? What kinds of materials are escaping from our laundry dryer vents?

This study called upon a fantastic group of 19 community scientists in the San Francisco Bay Area to collect the vented material from their home laundry dryers carrying vented laundry loads. The community scientists collected the vented materials from 19 laundry loads. Each load represented a different type of laundry, such as daily clothing, children's clothing, bedding, etc. Each participant reported information about the laundry load, its weight, material (e.g., cotton, polyester), and how frequently they do this type of laundry load, etc. Samples were weighed to find emission per load, and analyzed using FTIR analysis for material composition.

To help extrapolate our results to a broader population we also conducted an online public survey, where 498 respondents told us how they do their laundry from this survey, we were able to make a much more informed extrapolation from the laundry done by our 19 community scientists to the entire San Francisco Bay Area.

Artist's representation of what collecting the vented laundry looks like. The artist's representation of what collecting the vented laundry looks like. The artist's representation of what collecting the vented laundry looks like.

What did we find?

The FTIR analysis results showed the vented materials collected were highly diverse and contained a broad range of materials and plastics. The average sample of the vented material was 23.6g and ranged from 1.2g to 3.2g. Laundry fibers were the most abundant, fiber length between 1-77mm, the width of a thick human hair. Most of the vented material was cotton, which is not considered an important respiratory pollutant.

FTIR Analysis results showed the vented materials collected were highly diverse and contained a broad range of materials and plastics. The average sample of the vented material was 23.6g and ranged from 1.2g to 3.2g. Laundry fibers were the most abundant, fiber length between 1-77mm, the width of a thick human hair. Most of the vented material was cotton, which is not considered an important respiratory pollutant.

The 19 participants reported laundry load frequency and the percentage of plastic in their load. The average community reported 62.24 loads of laundry per year. This means that they vent around 4kg of total fibers materials and 4g of microplastic fibers annually. It was an average to find that small children make a big mess and need more laundry done! And so do these people living in a household!

Primary Load Type	Last Type Frequency (loads/year)	Average Percentage Plastic (0% - 100%)	Number of Samples (N)
Bedding	2.0 ± 1.4	11.0% (4.4 - 37.3%)	5
Children's Clothing	8.5 ± 8.0	32.0% (14.8 - 59.3%)	2
Daily clothing	5.0 ± 2.9	32.0% (0% - 29.3%)	14
Delicates	2.0 (N/A)	N/A	1
Per Washed Laundry	1.0 (N/A)	7.3% (N/A)	1
Total	2.5 ± 1.0	7.2 (3.3 - 19.5%)	7

The 19 participants reported laundry load frequency and the percentage of plastic in their load. The average community reported 62.24 loads of laundry per year. This means that they vent around 4kg of total fibers materials and 4g of microplastic fibers annually. It was an average to find that small children make a big mess and need more laundry done! And so do these people living in a household!

What's the big deal?

With the help of our wonderful 19 community scientists and the Sea Grant researchers, we were able to roughly estimate our small number of vented emissions to the **SETAC 46th Annual Meeting** that will be held in San Francisco, California, vented around 25,000 kg, or 6.6 million pounds of microplastic fibers per year! That's around 10 million additional pounds of plastic, not all of these fibers are plastic, and not all of them make it to our marine systems. Just around 10% they usually, that's around 400 kg of plastic fibers washing into the Bay annually through stormwater runoff.

That's a **mountain load of microplastic**!

References: Patterson, K. (2023). A Study of Microplastic Fibers in Household Laundry Vents. San Francisco Estuary Institute. Patterson, K. (2023). A Study of Microplastic Fibers in Household Laundry Vents. San Francisco Estuary Institute. Patterson, K. (2023). A Study of Microplastic Fibers in Household Laundry Vents. San Francisco Estuary Institute.

Why does this poster look different? This poster presents its findings in a fun and engaging way. (What, you're not a scientist? You don't have to be! Scientists are very diverse and can be difficult to visualize. We can speak their language, but we can't speak their language in a way and everything more. This can help in making science and research accessible. The most effective science communication can happen when we speak their language, but we can't speak their language in a way and everything more.)

For More Information
Kayl Patterson (Kayl@sfci.org) or
Diana Lin (Diana@sfci.org)



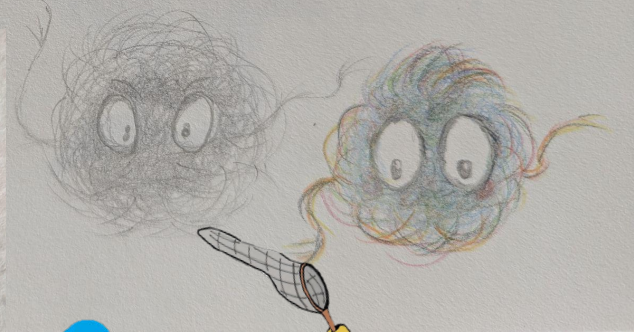
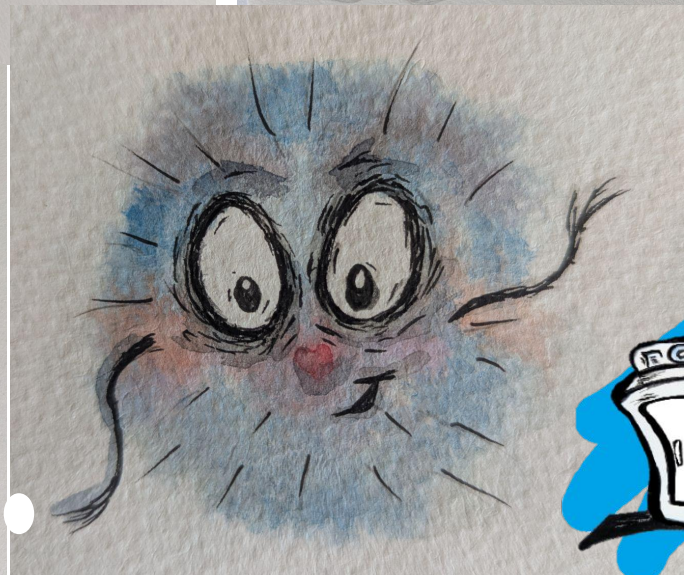
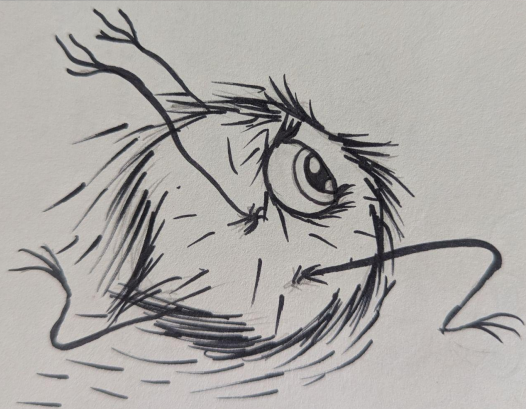
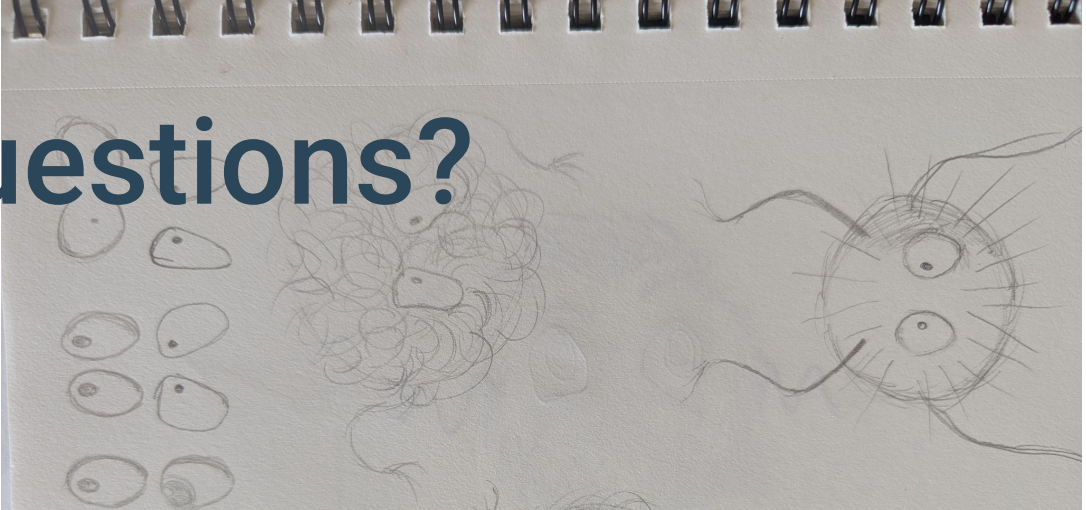
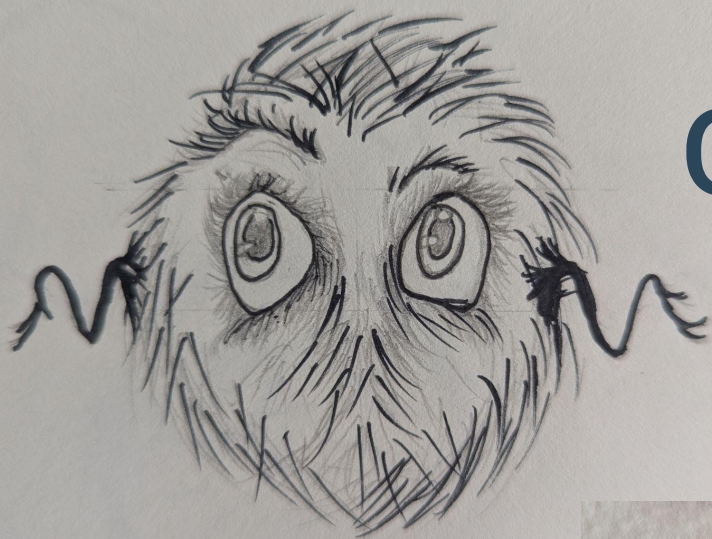
Deliverables

- Draft Manuscript: July 2026
- Final Manuscript: September 2026

Discussion

- Do you have any concerns about how we are extrapolating the data to a larger population?
- Are there any shortfalls in the study we should look to address?

Questions?



Madeleine Milne & Chelsea Rochman
University of Toronto, Department of Ecology and Evolutionary Biology

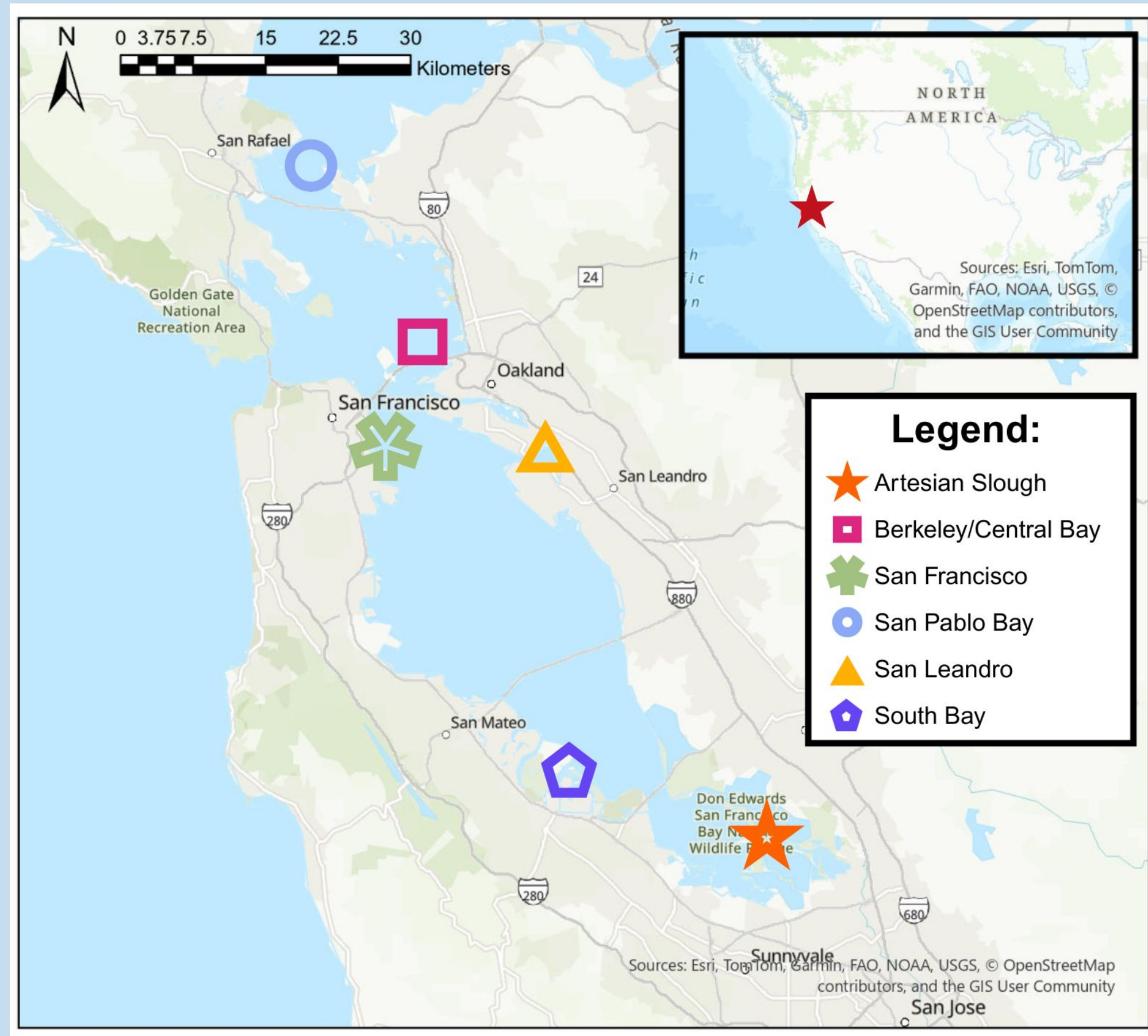
Microplastics Workgroup Meeting

Microplastics are prevalent in striped bass and shiner surfperch tissues across San Francisco Bay, California



Study Design

- 25 striped bass
- 3 tissues analyzed individually: gut, muscle, and liver.
- 36 shiner surfperch
- 3 tissues pooled: gut, muscle, and liver.
- Fish were collected from six sites in the Bay.



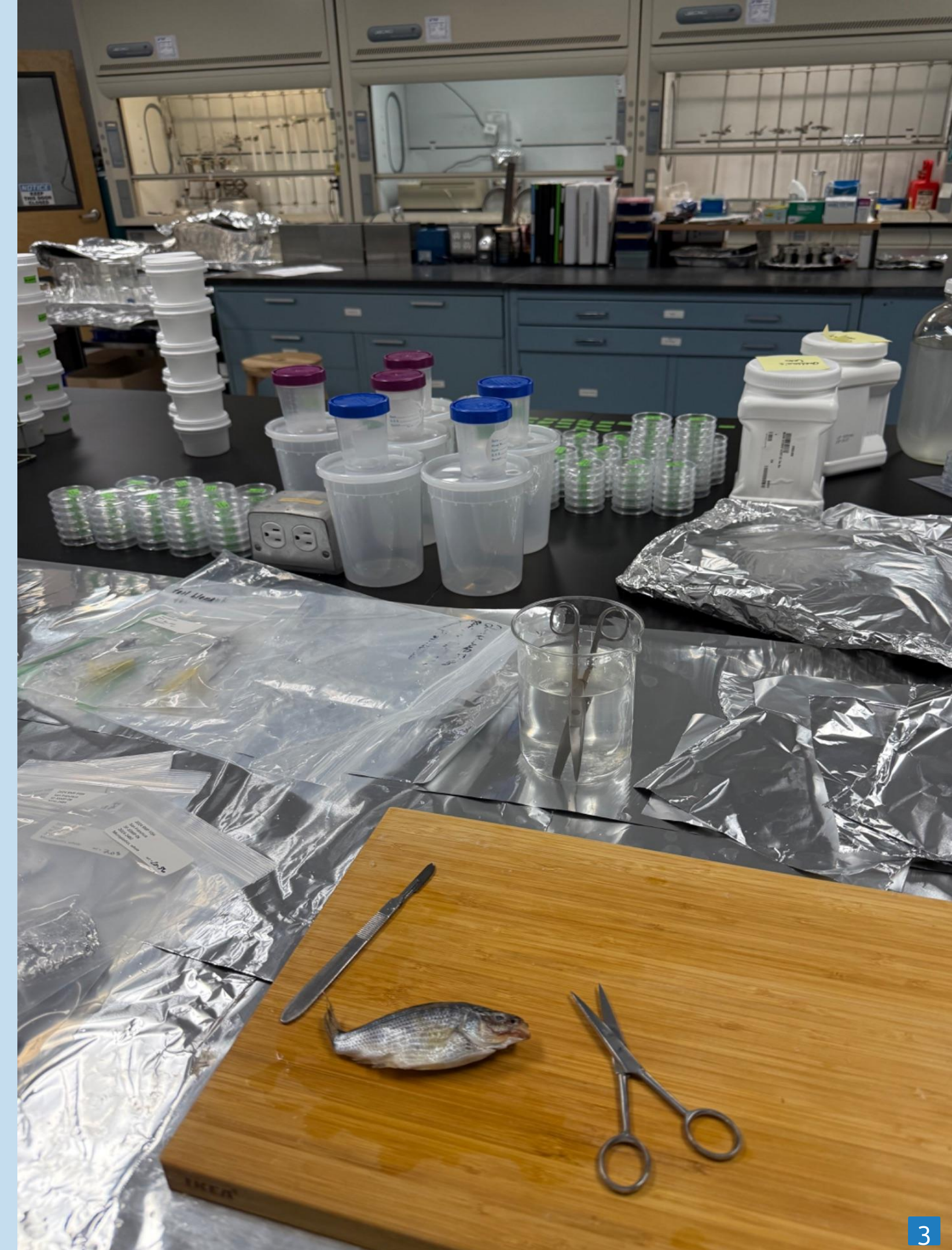
Methods

- Potassium hydroxide
 - Breaks down fish tissues leaving behind microplastics.
- Detergent soak
 - Removes any residual fatty materials.
- Microscopy
 - Identify suspected MPs.
- Raman spectroscopy
 - Chemically confirm the polymer/material.



QA/QC

- Blank-correction
 - Account for contamination associated with laboratory processing.
- Spectroscopy correction
 - Excludes proportion of particles that were natural/unknown.
- Spike and recovery
 - Measure of particle loss from the processing steps.

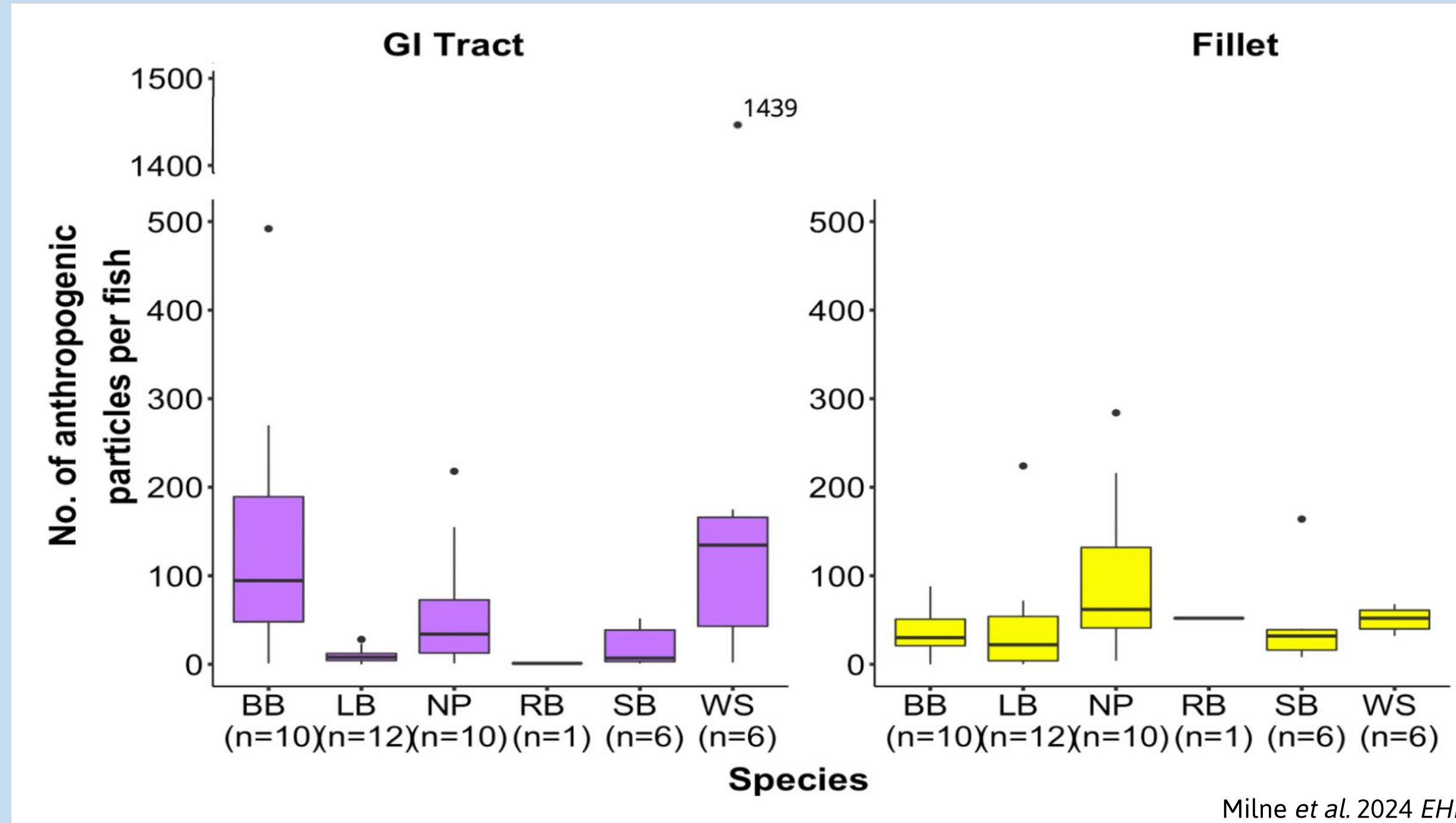


Environmental Exposure

- Limited alignment with previous measures of MPs in the water, sediments, and fish in the Bay.
- Highest surface water concentrations of microplastics were reported in Central Bay by Zhu *et al.* (2021), and this is where we observed both our most and least contaminated shiner surfperch.
- For shiner surfperch, our lowest contamination sites are where the contamination in topsmelt and northern anchovy in Zhu *et al.* (2021) were highest.

Parallel Work

- Similar monitoring of fish in the Great Lakes.



Largemouth Bass



Smallmouth Bass



Northern Pike



Brown Bullhead



White Sucker



Rock Bass

MPs as a Chemical of Mutual Concern

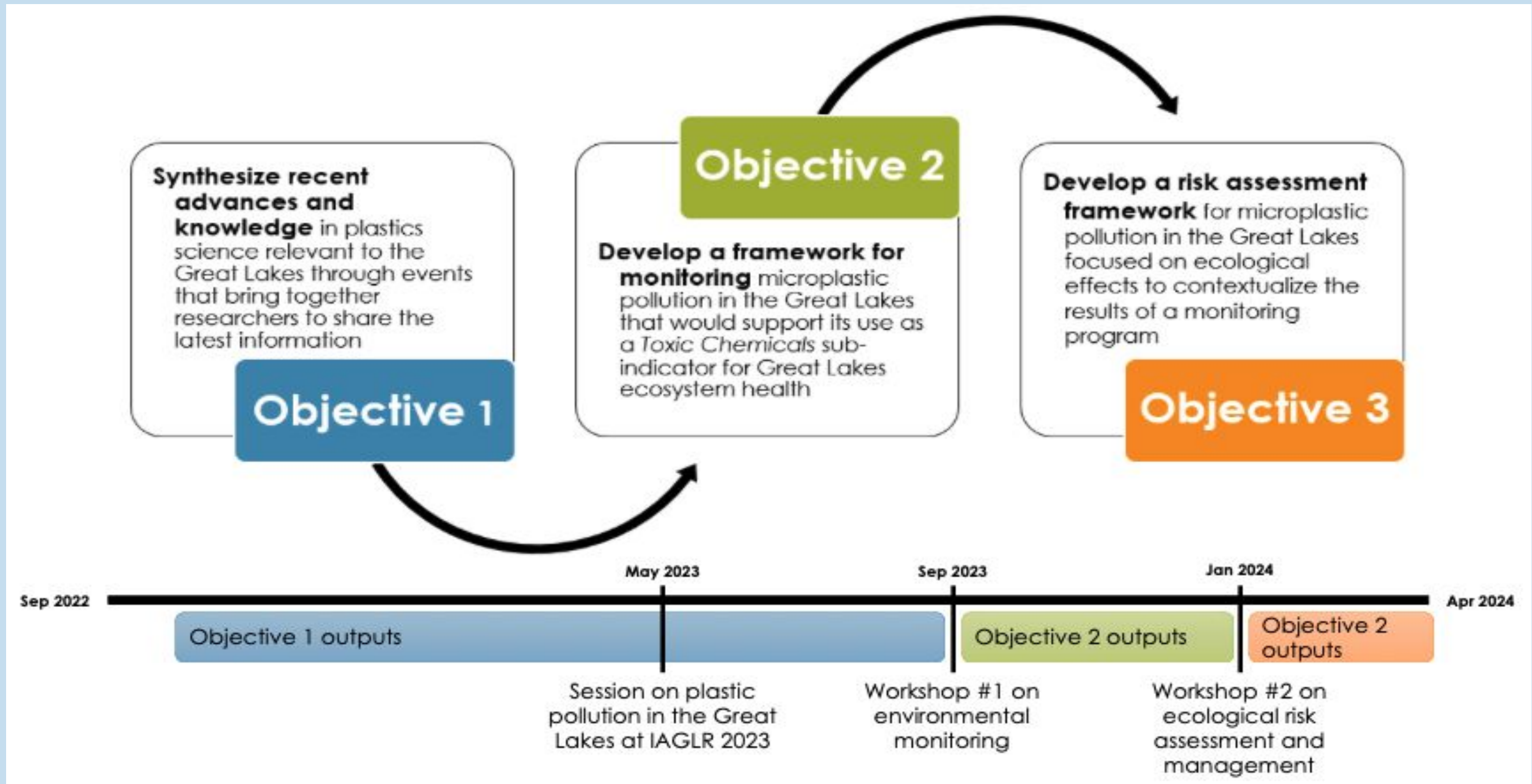
- ECCCC report and an IJC work group with same goals as California, and to inform how microplastics fit under the Great Lakes Water Quality Agreement.

The Great Lakes Microplastics Monitoring and Risk Assessment Project and Work Group



Based On California Work

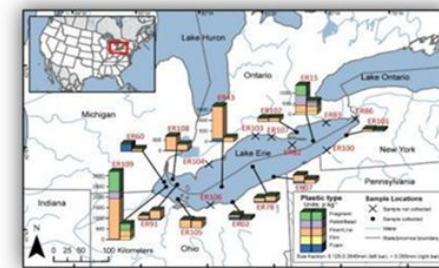
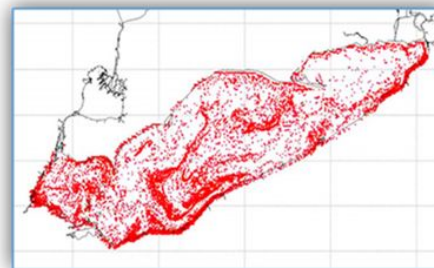
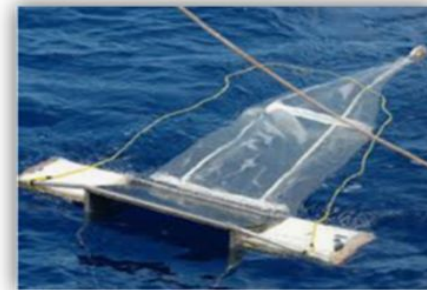
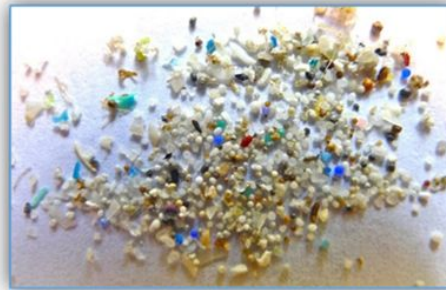
- Products developed based on the methods and findings from California.



Our Products

Final Report of the IJC Great Lakes Science Advisory Board Work Group on Microplastics

Monitoring, Ecological Risk Assessment, and Management of Microplastics in the Laurentian Great Lakes



A report submitted to the International Joint Commission by the Great Lakes Science Advisory Board

November 2024

Report and tools available at:



bit.ly/SAB-Plastics

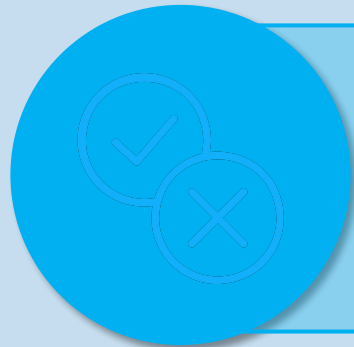
IJC Recommendations



Develop a regionally coordinated monitoring program



Support continued research to refine monitoring and analytical capabilities, and ecological risk assessments



Under the GLWQA, adopt microplastics as a Toxic Chemicals sub-indicator and as a Chemical of Mutual Concern



Prevent the emissions of plastic and reduce plastic pollution in the Great Lakes

Thank-you!

- Diana Lin
- Jay Davis
- Ezra Miller
- Martin Trinh

And for the support from:

- The Southern California Coastal Water Research Project.
- The Moss Landing Marine Laboratories.
- Brenda Li from the Rochman Lab.



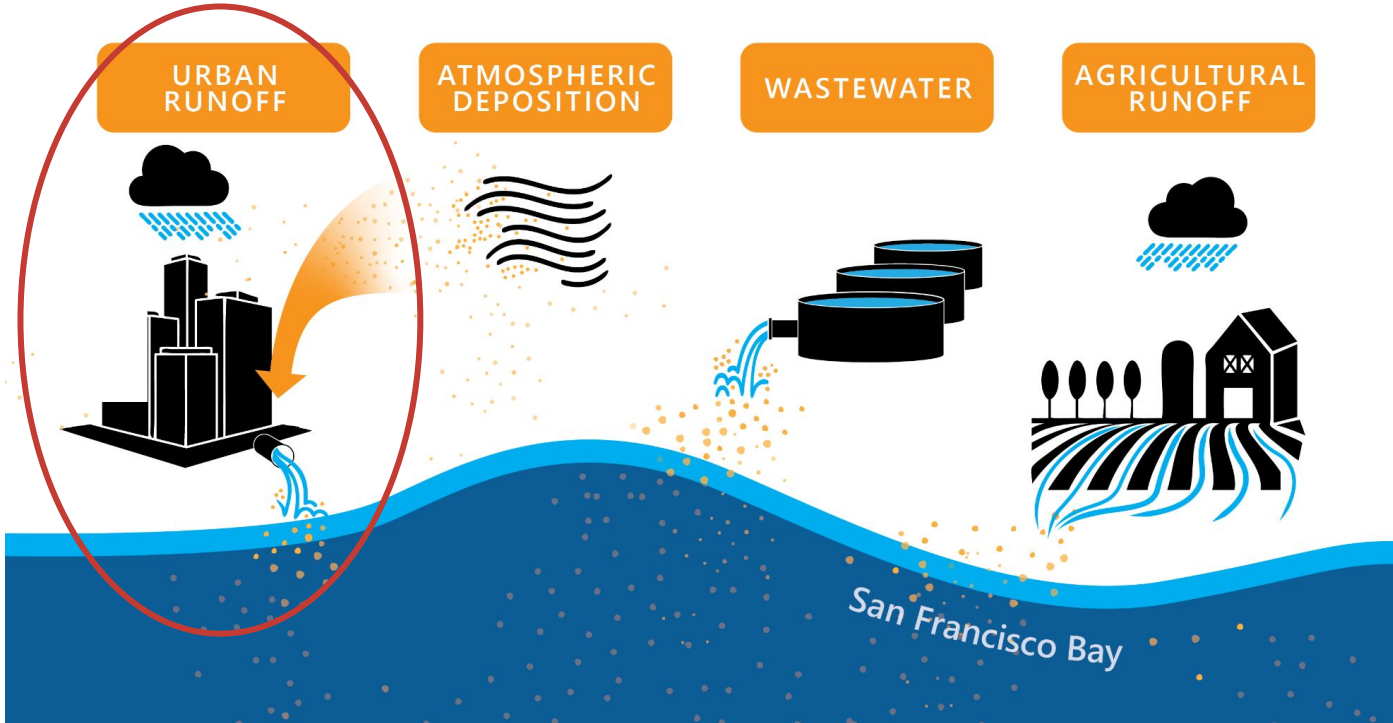


Item 6: Microplastics Stormwater Pilot Study Update

Diana Lin and Kayli Paterson

Motivation

- Stormwater monitoring is a priority for RMP and statewide microplastics monitoring strategies



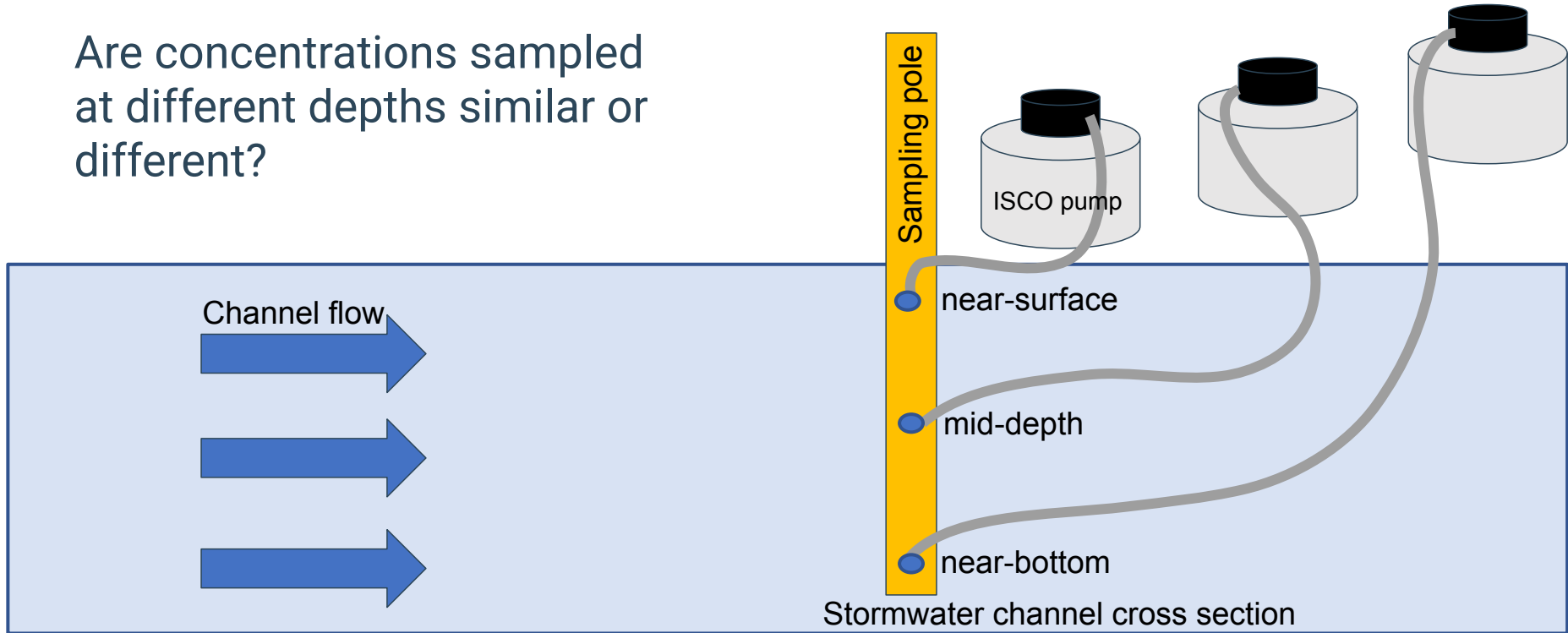
Motivation

- Leverage RMP stormwater monitoring efforts
- Study Questions:
 - Can we sample at a single depth during storm flows (versus depth integrated sampling)?
 - Are stormwater channels well-mixed during storm flows?



Study Design

Are concentrations sampled at different depths similar or different?



Sampling Sites

Sunnyvale East Channel

- Watershed area: 14.8 km²
- Residential (50%), transport-related (27%), commercial (13%)

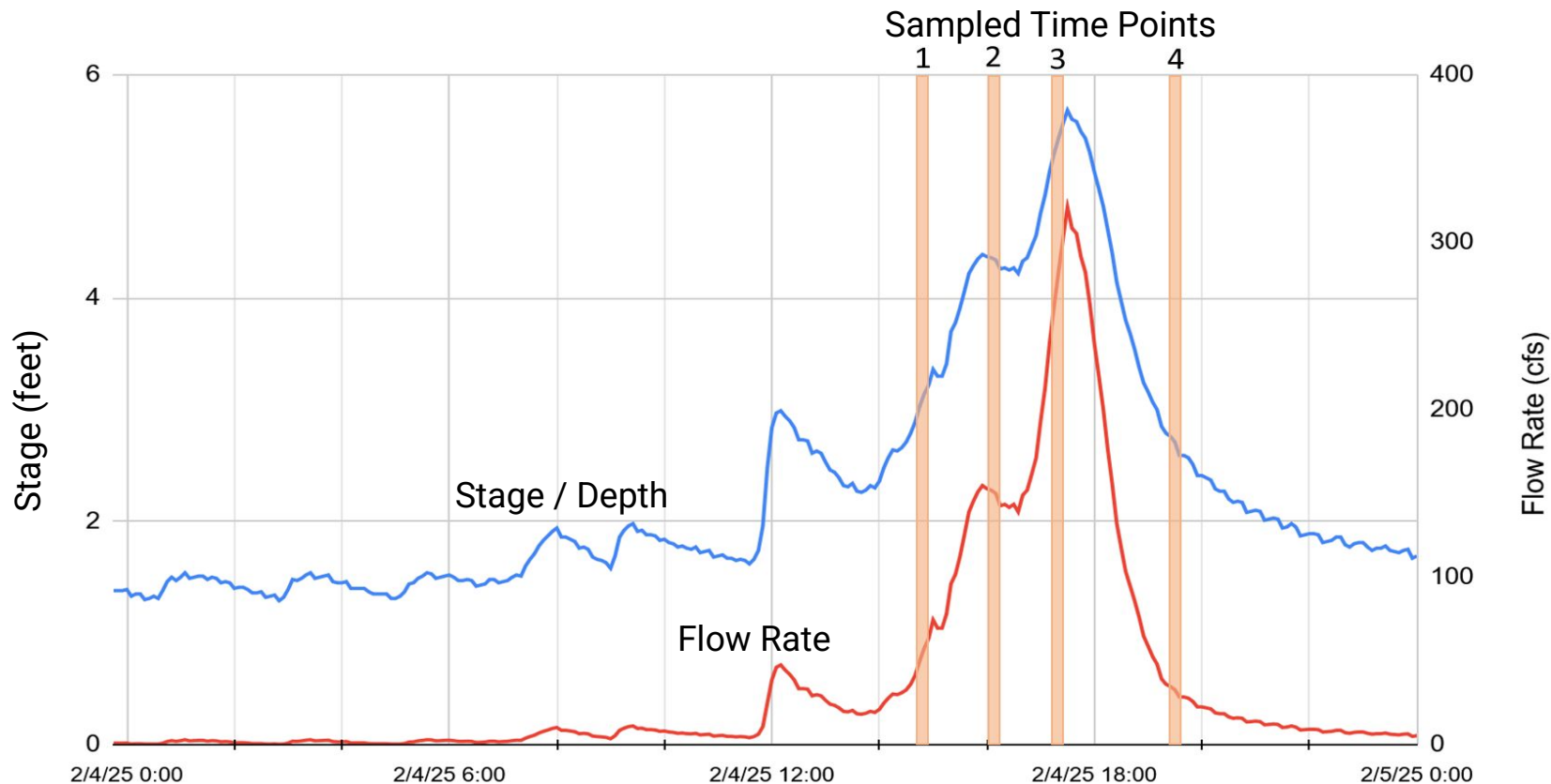


Zone 4 Line A, Hayward

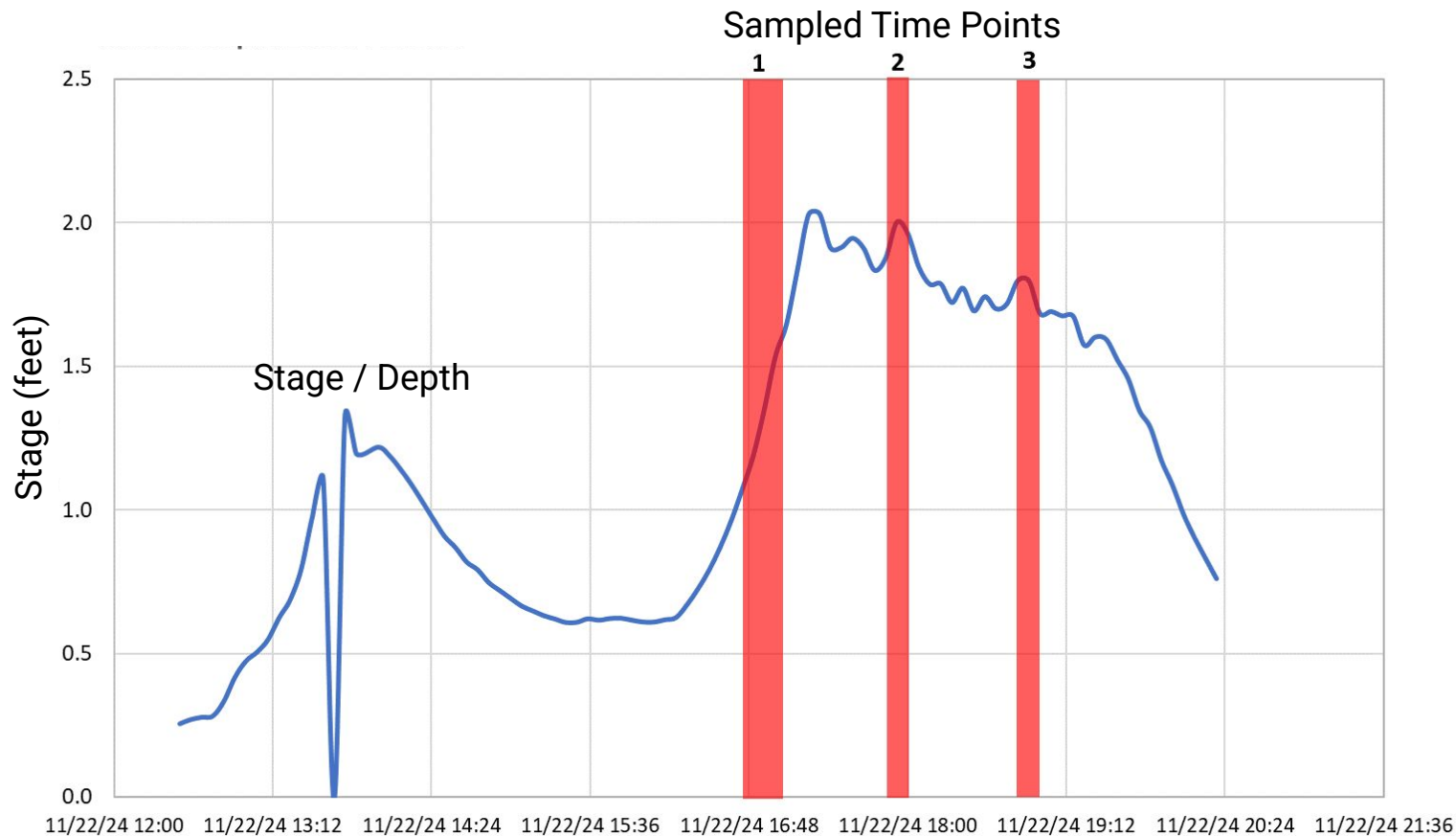
- Watershed area: 4.2 km²
- Residential (38%), industrial (23%), transport-related (18%), commercial (18%)



Hydrograph at Sunnyvale East Channel



Hydrograph at Hayward



Sampling Design



Martin
Trinh

SFEI

Turbidity &
suspended
solids conc.
(SSC)



Win
Cowger



Microplastics via
FTIR



Barbara
Beckingham



Tire wear particle (TWP) counts via LDIR



Stephanie
Whitmire



Elisabeth
Rødland



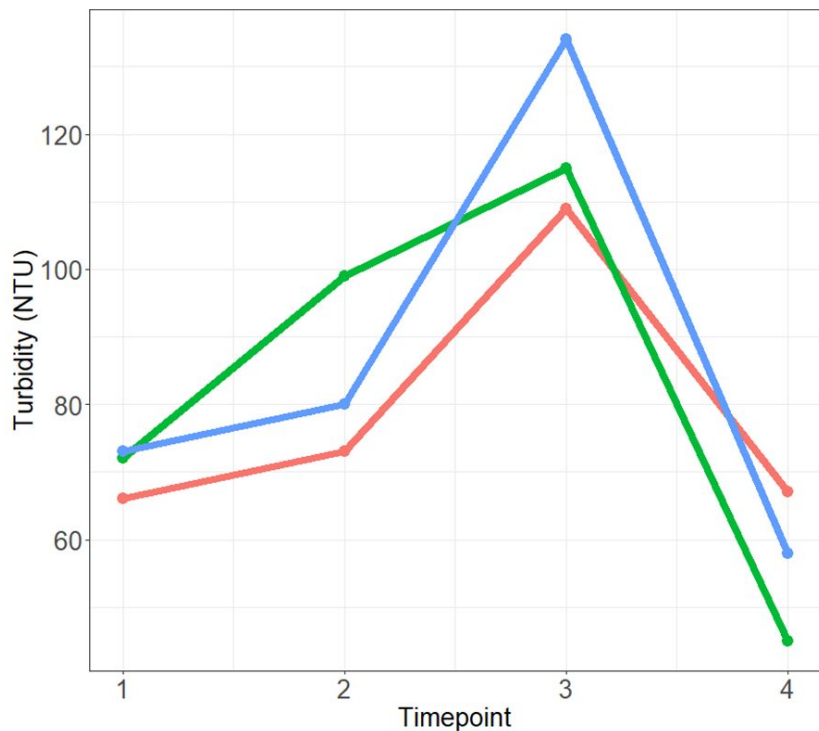
TWP Mass via
pyr-GC/MS



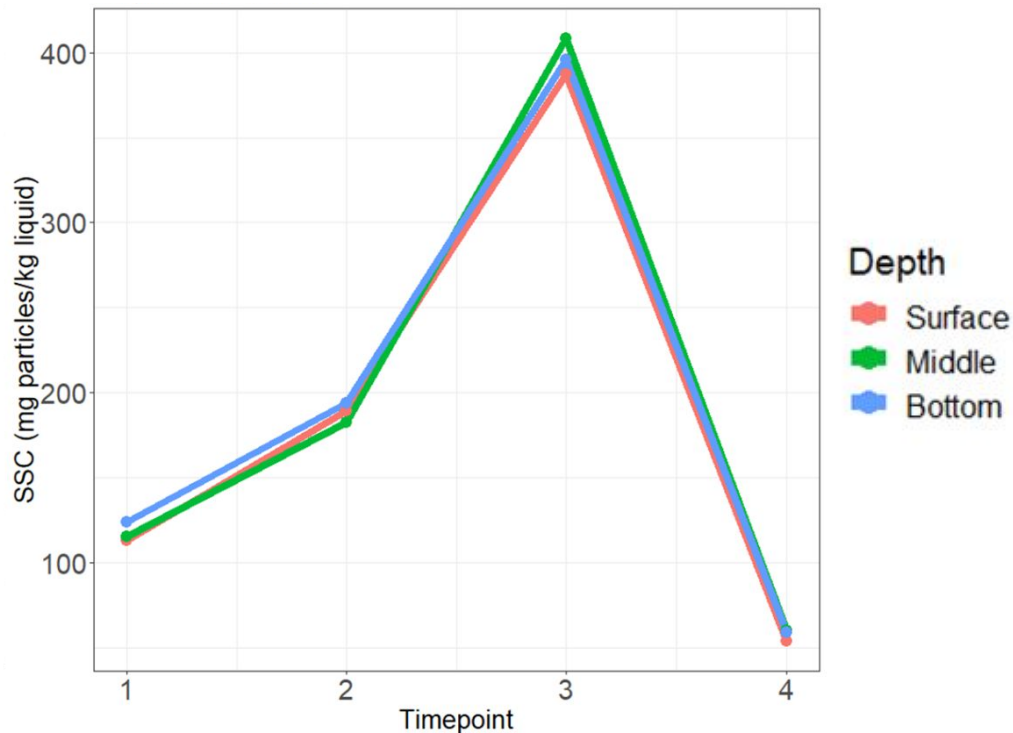
Suspended Solids Concentration (SSC) and Turbidity

Measurements support well-mixed profile

Sunnyvale: Turbidity

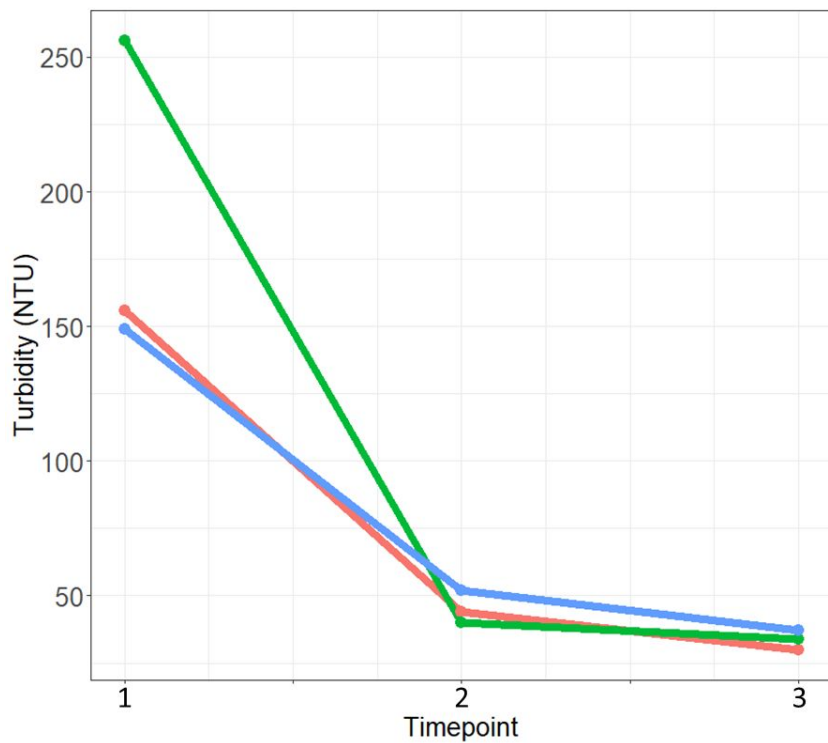


SSC

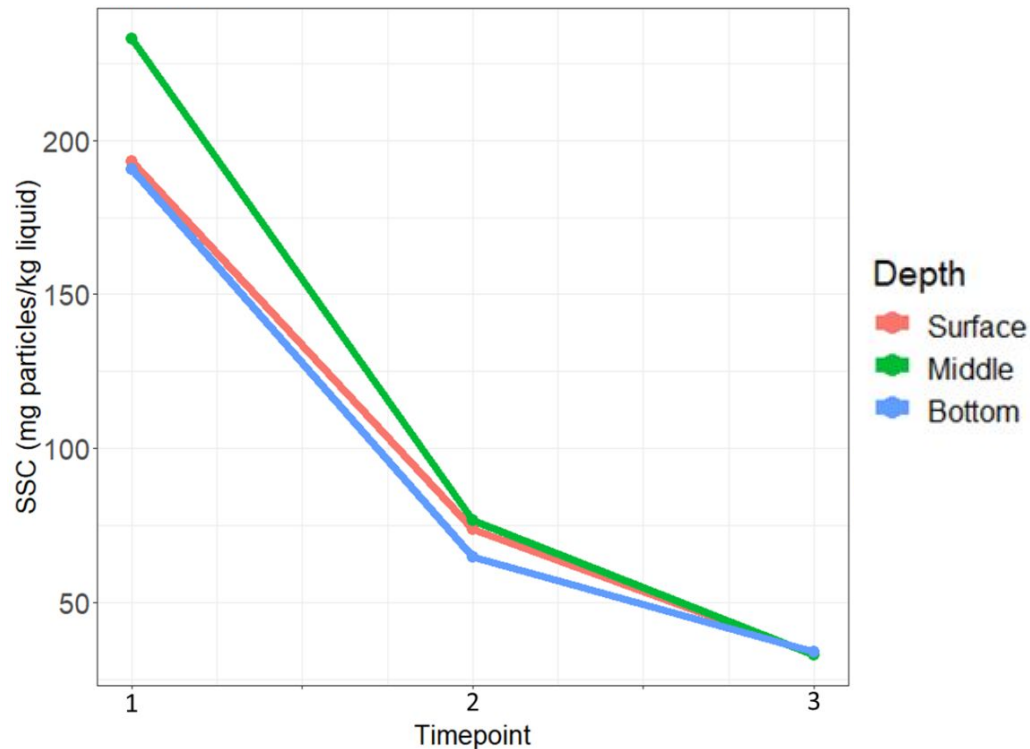


Measurements support well-mixed profile

Hayward: Turbidity



SSC





Microplastics (MP)

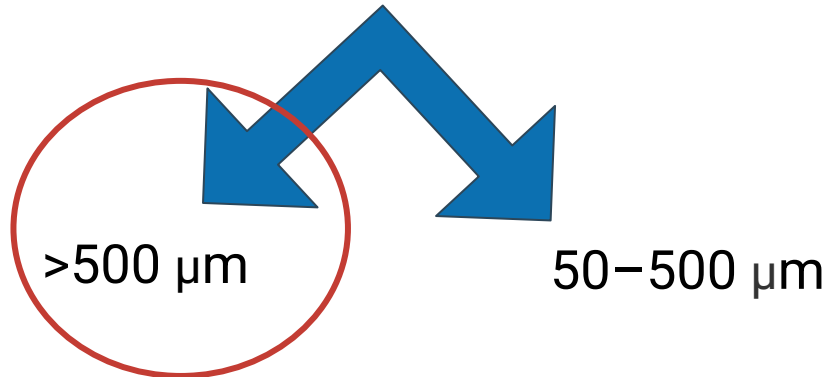


Win
Cowger



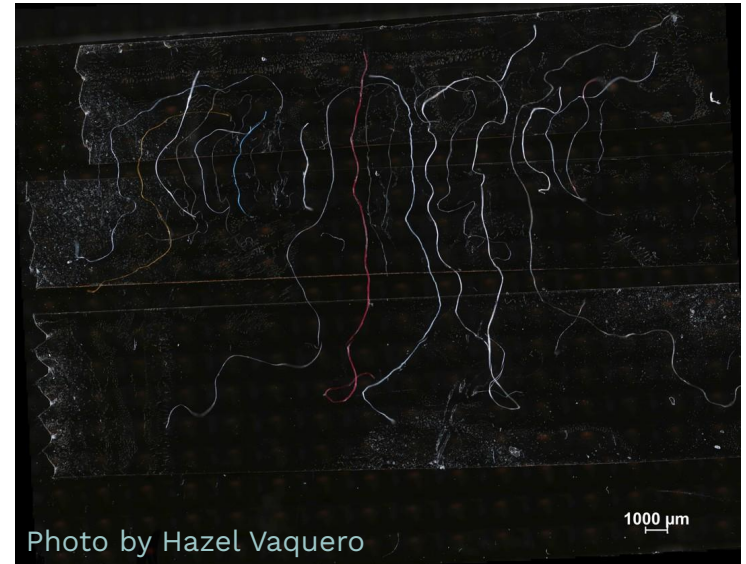
Microplastic Analysis

- Field: 10-L sieved sample
 - Particles on the 125 μm and 53 μm collected
 - Combined for analysis
- Lab:
 - Samples sieved at 500 μm and 20 μm before processing and separated into two processing streams

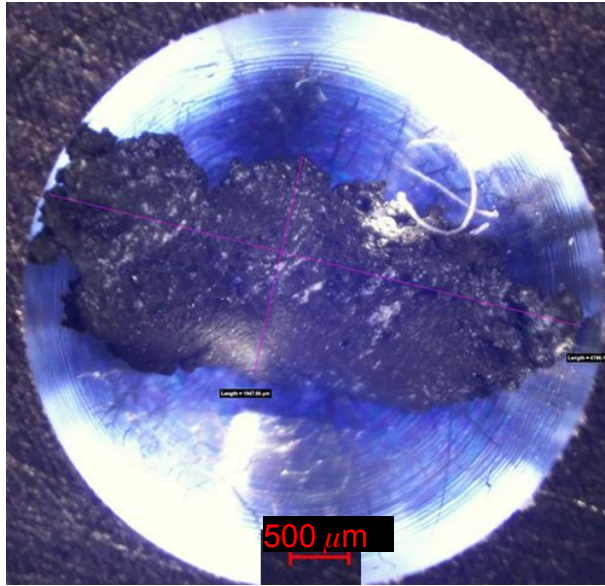


Microplastic Analysis ($>500\ \mu\text{m}$)

- Manual microscopy particle counts and images for all particles
- FTIR identification for all particles (match quality >0.6)
- Tire rubber identified
- Fibers quantified
- Reported concentrations = 0–2 MP/L
 - 0–21 microplastics per sample



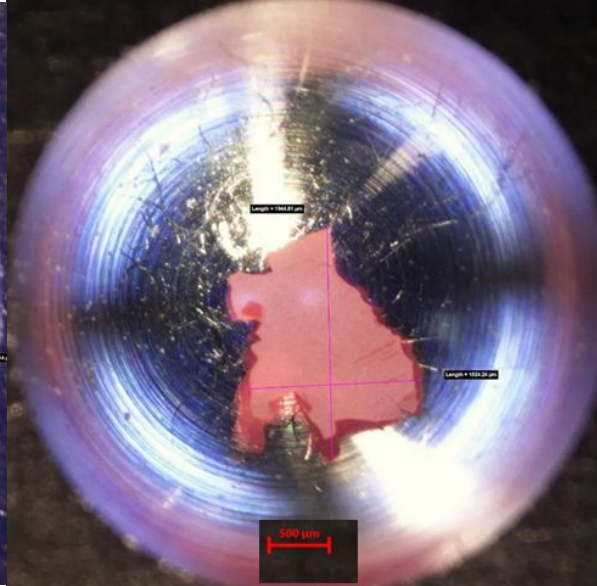
Microscopy provides clues to potential sources



Black rubbery fragment



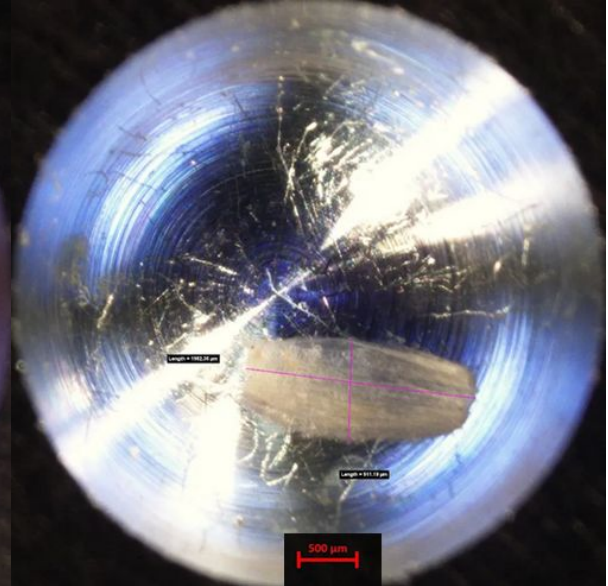
Tire wear particle??



Large red foam-like fragment



Paint or insulation??

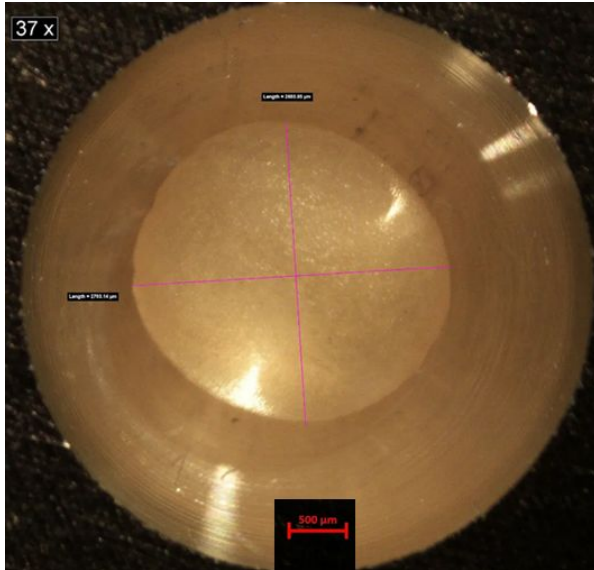


White fiber bundle



Cigarette butt filter??

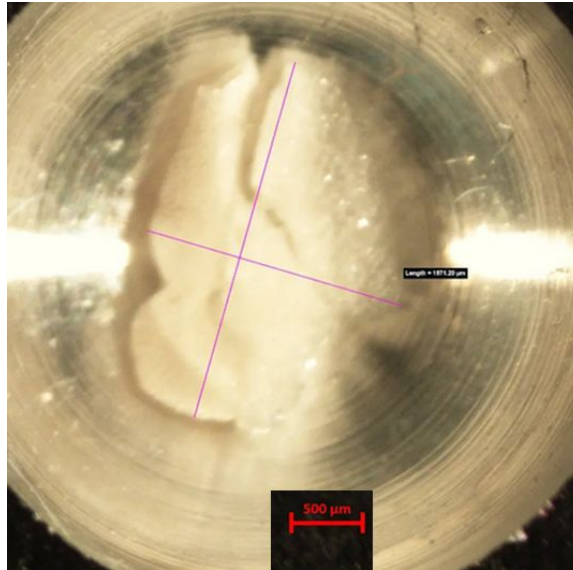
Microscopy provides clues to potential sources



Large sphere-like fragment



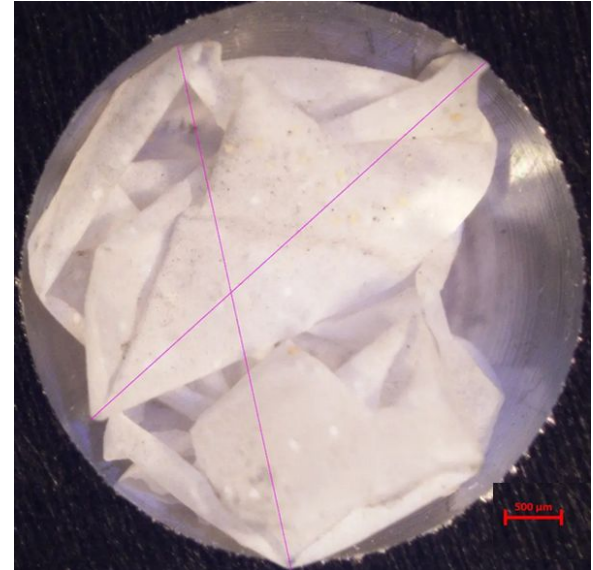
???



White and clear airy fragment



Packing peanut??



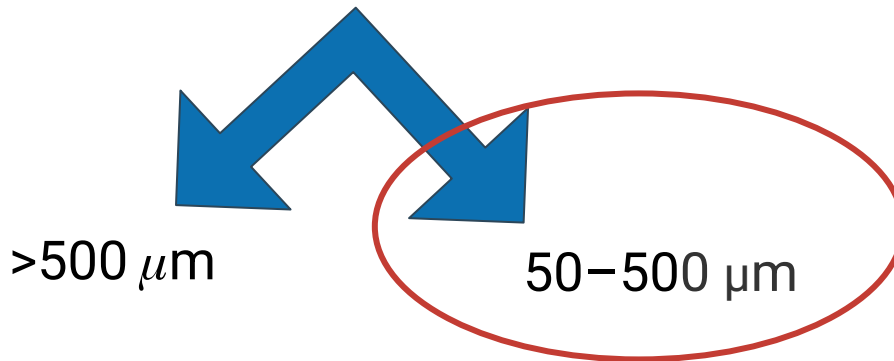
Large white flexible fragment



Plastic bag??

Microplastic Analysis

- Field: 10-L sieved sample
 - Particles on the 125 μm and 53 μm collected.
 - Combined for analysis
- Lab:
 - Samples sieved at 500 μm and 20 μm before processing and separated into two processing streams



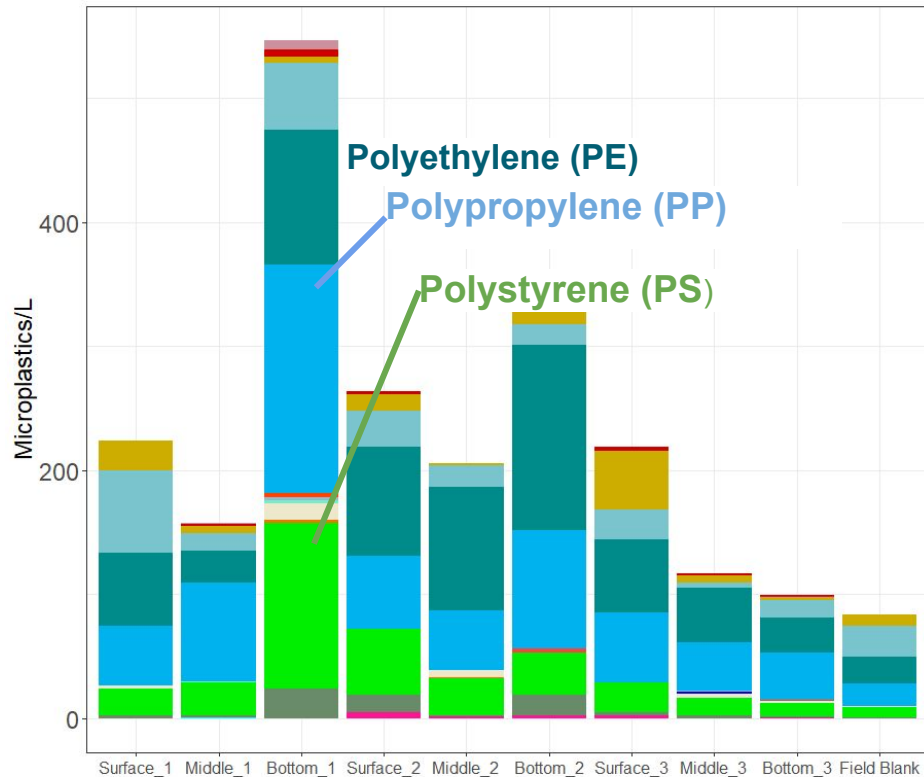
Microplastic Analysis (<500 μm)

- 3 aliquots of ~0.6–15mL
- Analyzed via automated software with FTIR analysis (match quality >0.6)
- Tire rubber not quantified due to low spectra match
- Fibers not counted due to challenges with software particle identification
- Reported concentration 90–500 microplastics/L
 - 10X previous results



Measurements support similarity at different depths

Hayward



- Concentrations with an order of magnitude (90–500 MP/L)
- Microplastics composed primarily of 3 polymers:
 - Polypropylene = 30%
 - Polyethylene = 28%
 - Polystyrenes = 22%

Microplastic Analysis

- Results deemed qualitative
 - Significant under-count of fibers and tire particles
 - Low recovery of small particles
 - Significant potential field blank contamination
- AND gathered important information
 - Source identification
 - High levels of microplastics in this pathway



Tire Wear Particle (TWP) Counts



**Barbara
Beckingham**



**Stephanie
Whitmire**



Tire Wear Particle (TWP) Count Analysis

- Field: 1-L bulk sample
- Lab:
 - Particles sieved $20\ \mu\text{m}$
 - Particles identified and counted with LDIR software
 - Match quality >0.7



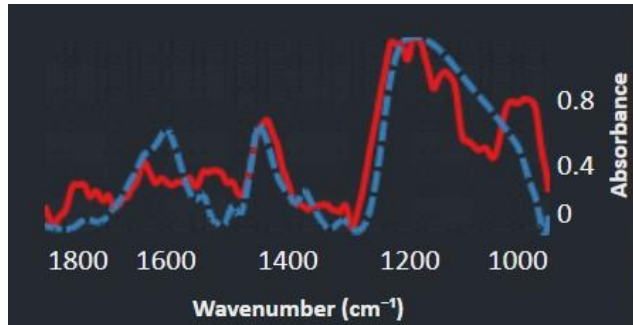
Photo by Kelly Moran

Variations in Rubber Match Quality

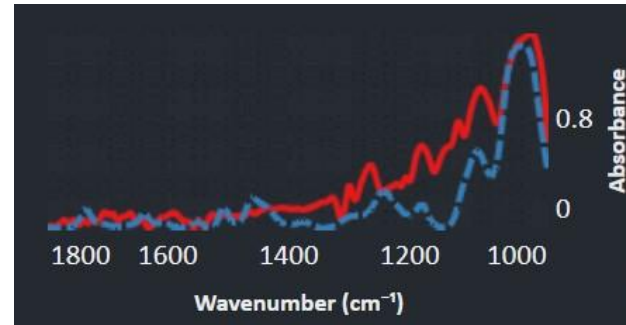
- >0.7 Match Criteria: Average concentration = 500,000 TWP/L
- If >0.8 Match Criteria: Results drop by order of magnitude (50,000 TWP/L)
- Reference tire material give a different spectra matches and match quality scores

Reference tire material from tire industry (**particle spectra** v. **library rubber spectra**)

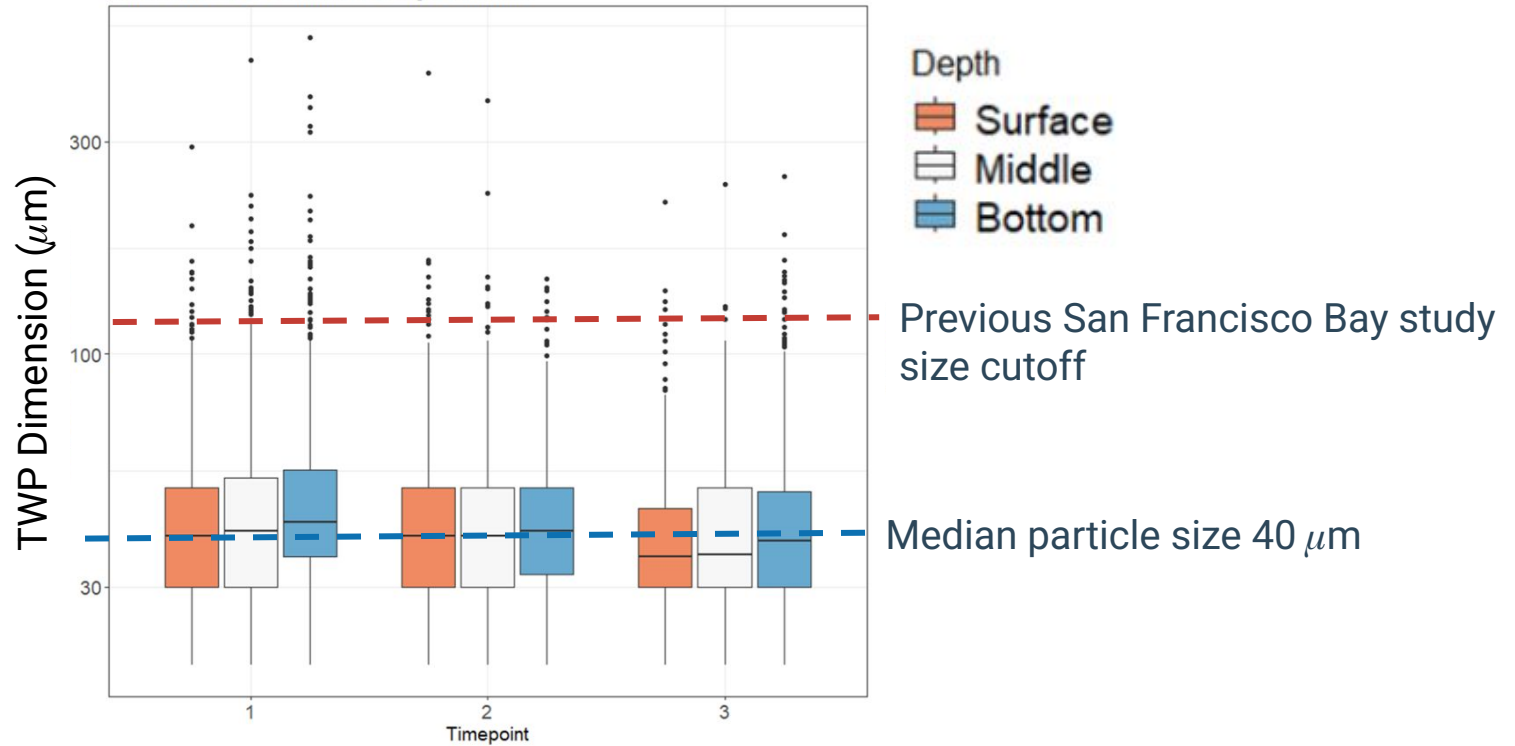
Spectra match quality = 0.774



Spectra match quality = 0.693



Particle Size Distribution





Tire Wear Particle (TWP) Mass



Elisabeth
Rødland



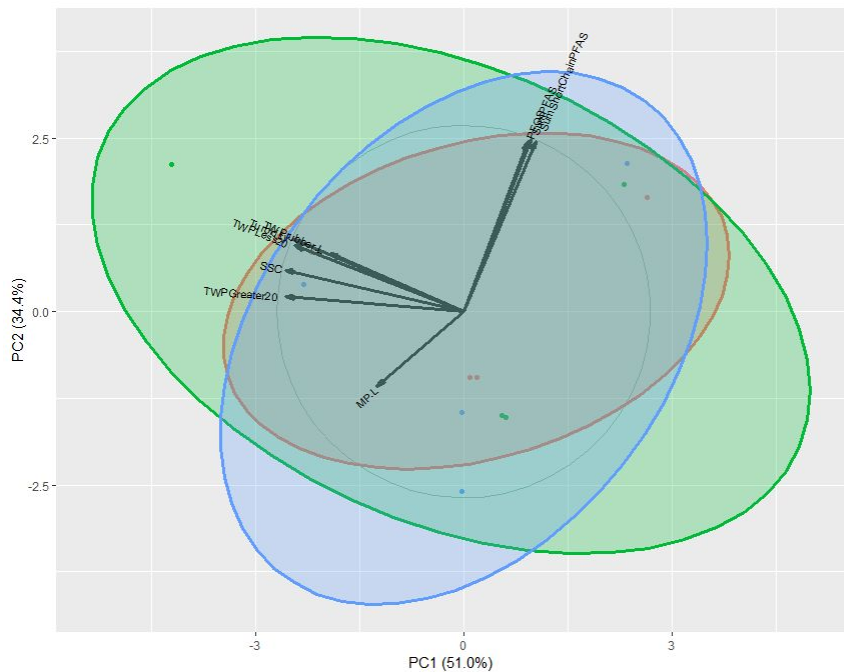
Tire Particle Mass Analysis

- Field: 1-L bulk samples
- SFEI sample preparation:
 - 50-100 mL laboratory duplicates
 - SFEI sieved sample to split $<20\ \mu\text{m}$ and $>20\ \mu\text{m}$ size fractions
- NIVA analyzed all field samples via pyrolysis-GCMS
 - Tire rubber chemical markers quantified
 - Tire particle mass estimated using NIVA tire database

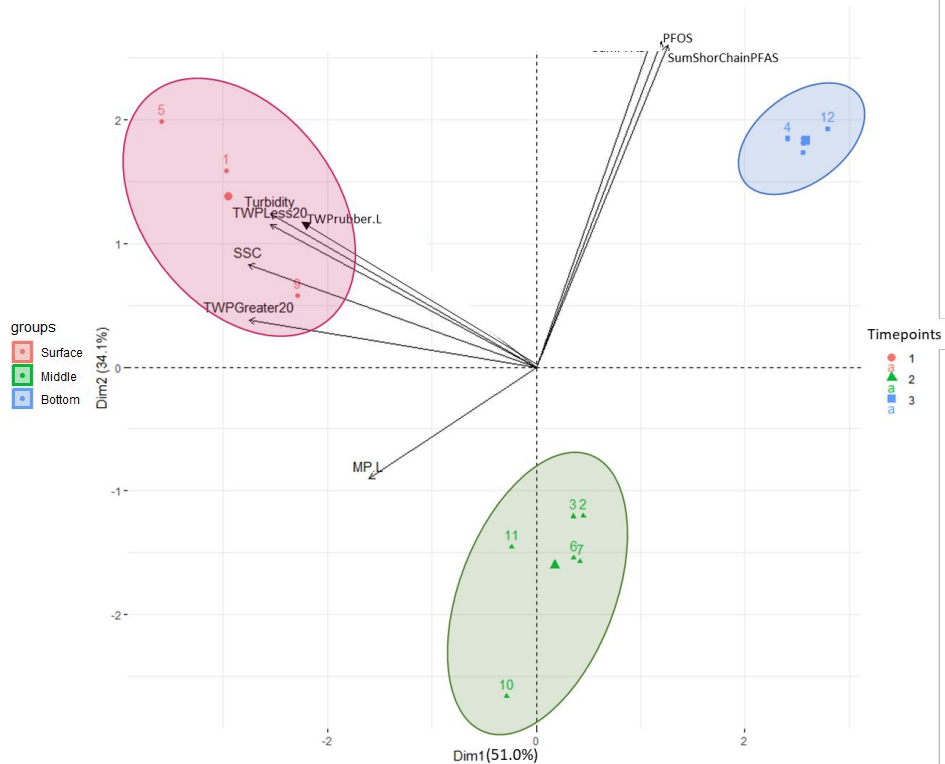
Principal Component Analysis - Hayward



PCA: Depth



PCA: Time Point





Key Takeaways

Motivation

- Leverage RMP stormwater monitoring efforts
- Study Questions:
 - Can we sample at single depth during storm flows (versus depth integrated sampling)?
 - Is stormwater channel well-mixed during storm flows?

Yes



Lessons Learned

- First known quantification of TWP in stormwater runoff using LDIR
 - TWP levels are greater than our previous results
 - LDIR provides good rubber matches for small particles compared to other methods
 - TWP outnumber other types of microplastics
 - Recommend further screening of additional watersheds

Lessons Learned

- TWP mass concentrations in the mg/L
 - Estimates will be improved by ongoing Tire Rubber Study
- SFEI first to measure and estimate TWP mass in stormwater runoff in U.S.

Lessons Learned

- Other types of microplastic concentrations significantly greater than previously reported levels
- PP, PE, and PS represent the vast majority of microplastics identified

Deliverables

- Draft Report: July 2026
- Final Report: August 2026



Discussion

- Is this sufficient information to support single-depth sampling for TWP and microplastics in stormwater?
- What level of accuracy is needed to inform management questions?
- Are there other interpretation considerations?





Item 7: MPWG Special Study

Diana Lin, PhD and Kayli Paterson



Evaluation of Tire Wear Particles in Urban Stormwater Runoff, and Method Evaluation for Other Types of Microplastics

(multi-year proposal)

Motivation

- Inform RMP microplastics stormwater monitoring approach
 - What are the sources, pathways, processes, and relative loadings leading to levels of microplastics in the Bay?
- Inform Statewide Microplastics Monitoring Strategy

Approach

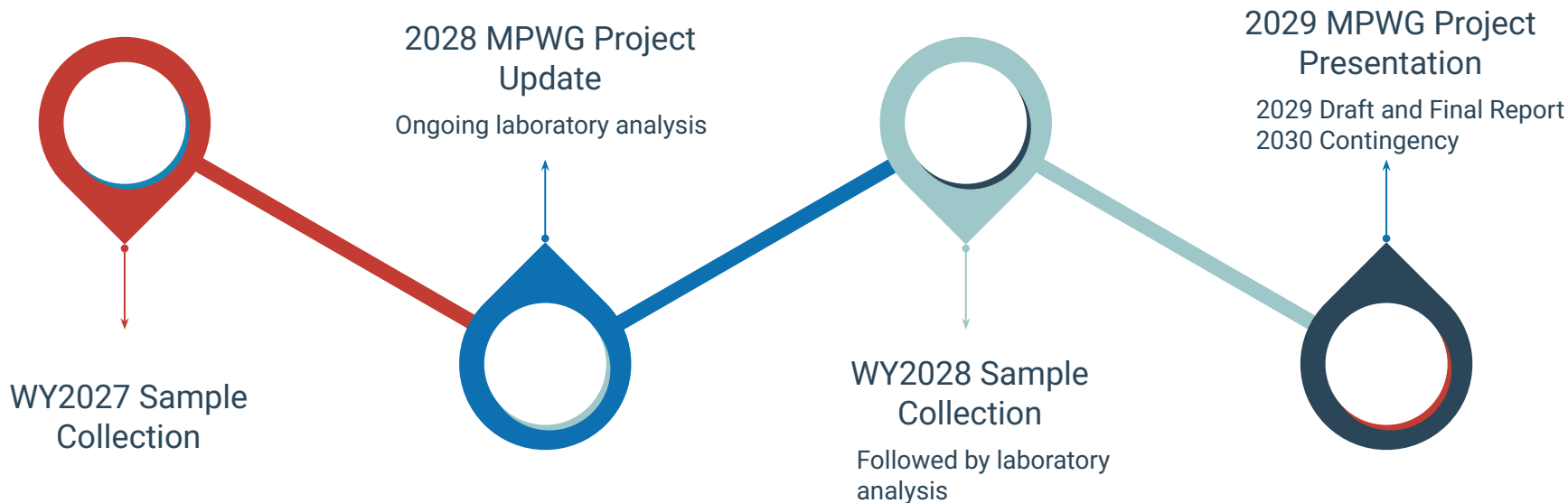
- 5 Sites x 2 Storm Events samples over 2 wet seasons
 - Leverage other stormwater sampling activities (ECWG and SPLWG)
 - Single depth sampling
 - Repeat at Hayward and Sunnyvale
 - Field blank and field duplicates collected at all sampling events
- TWP LDIR (particle counts)
- TWP pyrolysis GC-MS (mass)
 - Update analysis with ongoing Tire Rubber Marker study results

Approach

- Pilot LDIR for other microplastics, including fibers, at subset of storms
 - 3 storms
 - Include field blanks and field duplicates at each event
 - 10-L sieved samples
 - Matrix spike evaluations and extra lab blanks to evaluate uncertainty

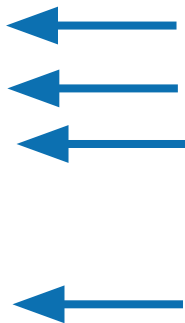
Timeline and Deliverables

Evaluation of Tire Wear Particles in Urban Stormwater Runoff, and Method Evaluation for Other Types of Microplastics



Budget & Deliverables

Expense	Est. Hours	Cost
<i>Project Management (Year 1, 2,3)</i>	110	\$26,400
<i>Study Design and Prep (Y1)</i>	110	\$22,000
<i>Stormwater sample collection (Y1, 2)</i>	220	\$39,600
<i>Sample Processing (Y1, 2)</i>	75	\$12,000
<i>Data management (Y2, 3)</i>	40	\$8,400
<i>Analysis and Reporting (Y3)</i>	240	\$48,000
<i>Final Report (Y3)</i>	70	\$14,000
<i>TWP and Microplastic Particle Analysis College of Charleston</i>		\$33,500
<i>TWP Mass Analysis Norwegian Institute of Water Research</i>		\$11,100
<i>Equipment and Supplies, Travel, Shipping</i>	--	\$6,500
GRAND TOTAL		\$221,500



over 3 years



Questions and Discussion

