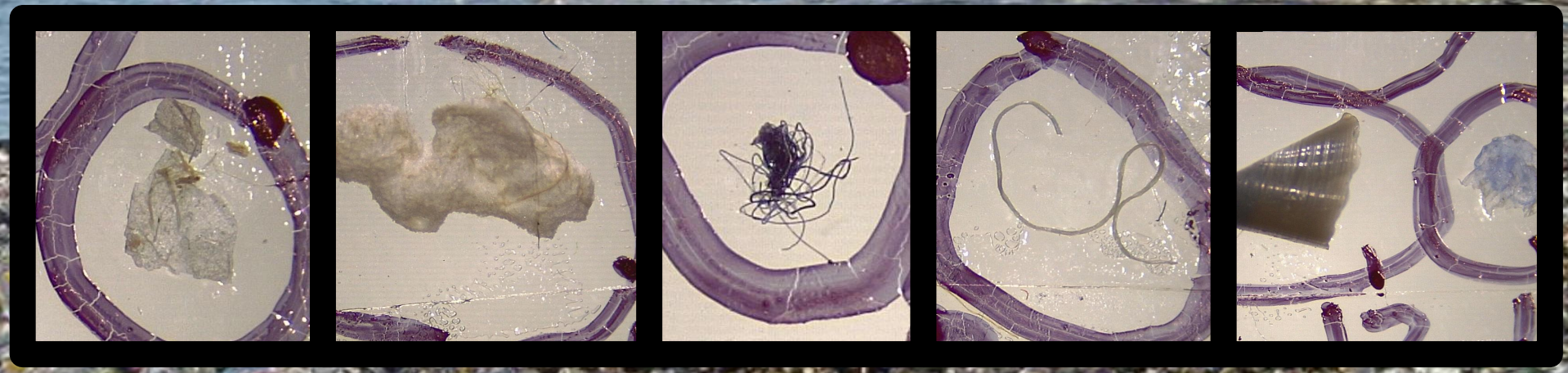
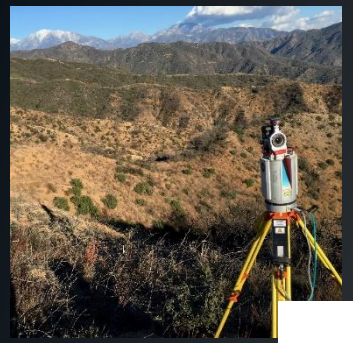
Microplastic Pollution in Southern California

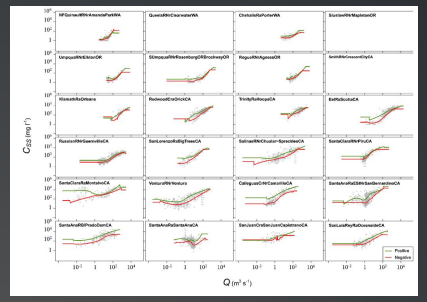


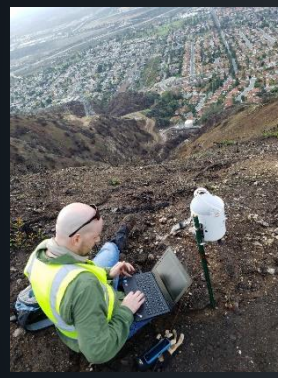
Andrew Gray
Department of Environmental Sciences
University of California, Riverside

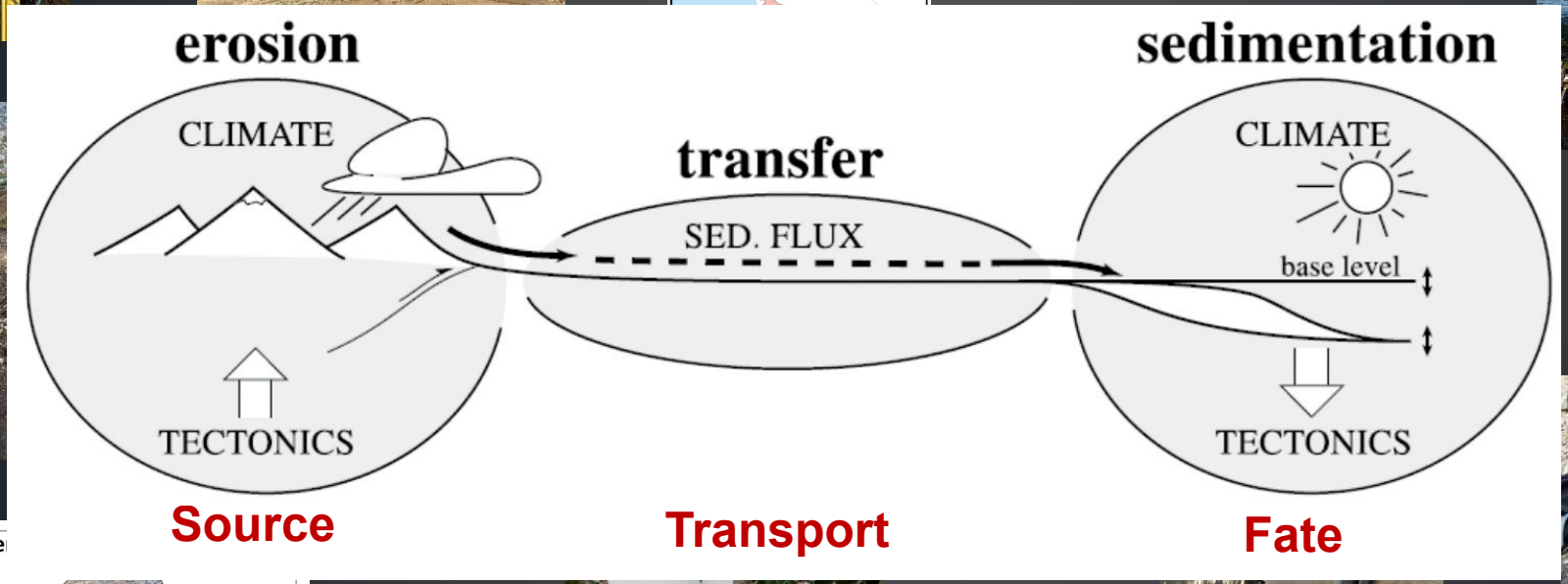
LA River
State of the Watershed Symposium
9/19/2023

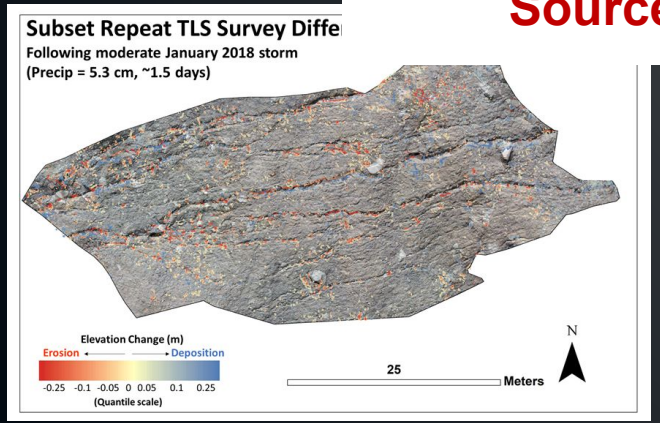
UCR Watershed Hydrology & Geomorphology Lab

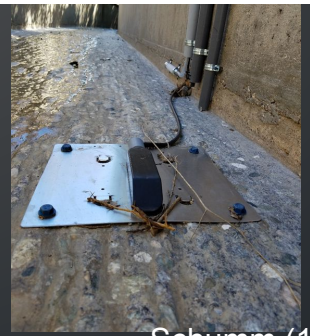












Schumm (1970) from Castelltort and Driessche (2003)

Plastic Pollution Team

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Haley Johnson
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Current Undergraduate Research Assistants

Thyra Tran
Julianna Gutierrez
John Perna
Bani Badwal
Jackie Gonzalez
Alyssa Fundal

…and many before…

Sponsors

NOAA MARINE DEBRIS PROGRAM
California Water Boards
SAFE CLEAN WATER PROGRAM
MOORE INSTITUTE for Plastic Pollution Research
USDA
DEPARTMENT OF ENERGY
NSF
FULBRIGHT
National Marine Sanctuary Foundation

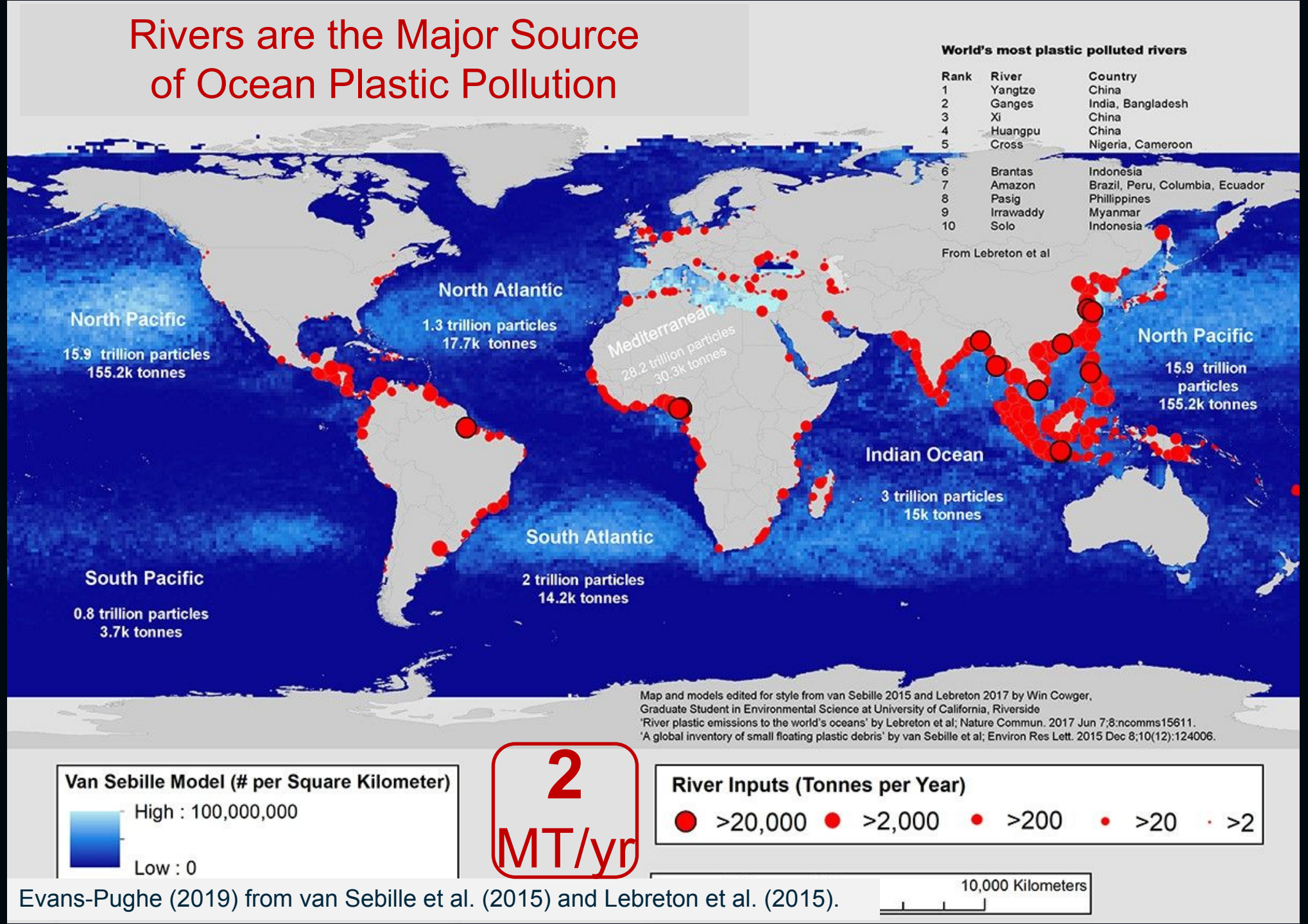

Umsunduzi River


Los Angeles River

Rivers

High concentrations of Plastics & Microplastics

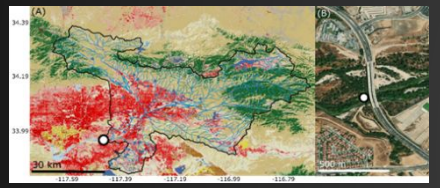
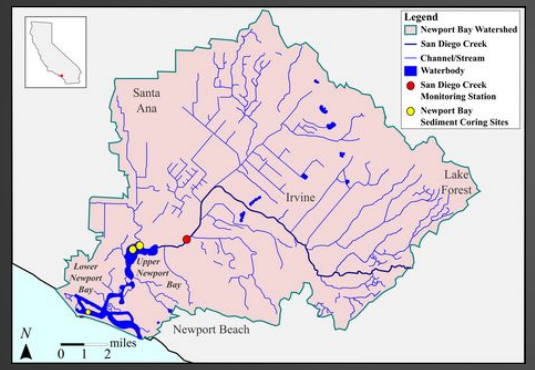
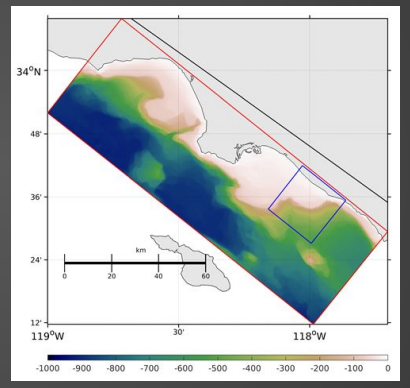
Rivers are the Major Source of Ocean Plastic Pollution



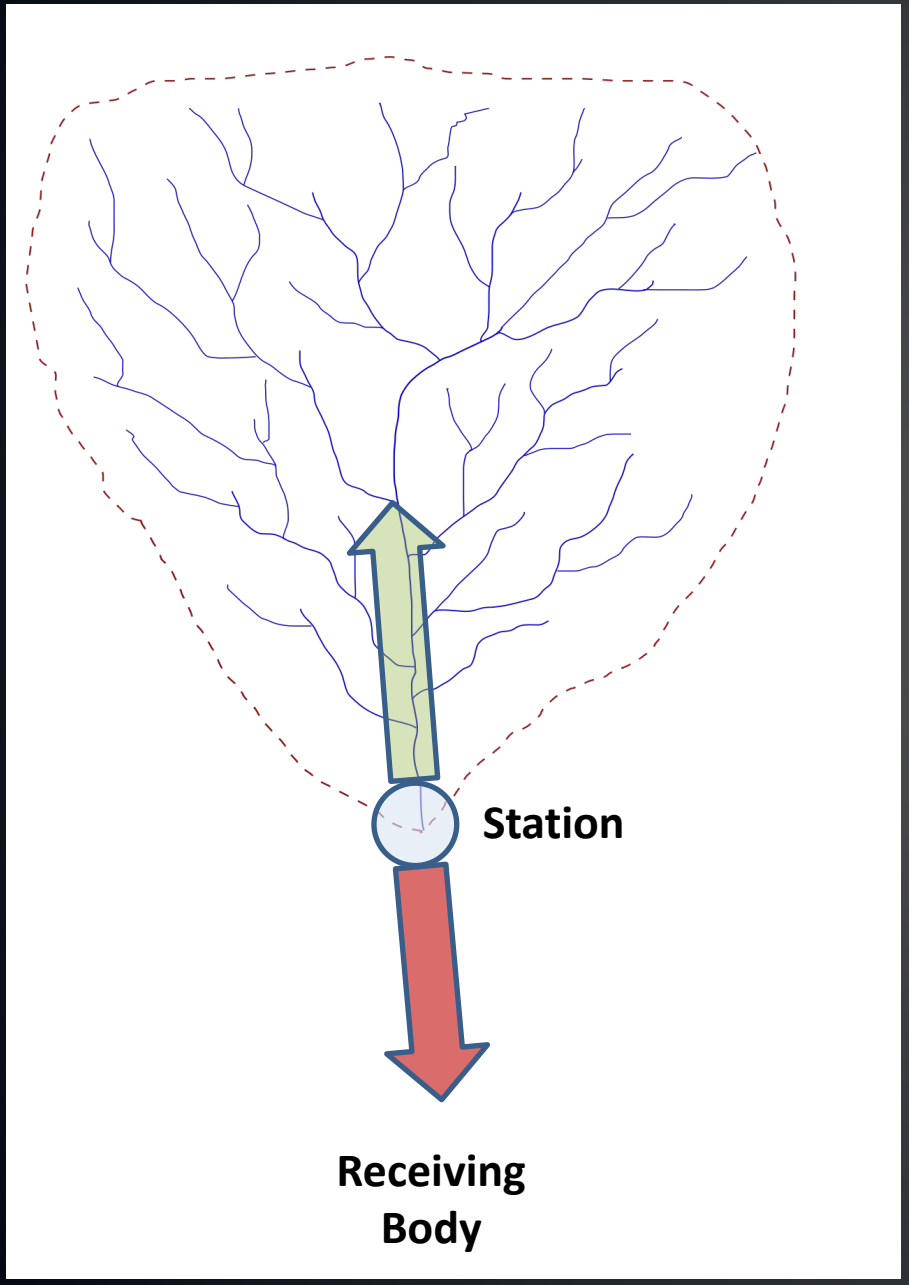
Very little field data!

Evans-Pughe (2019) from van Sebille et al. (2015) and Lebreton et al. (2015).

UCR Microplastics Monitoring Studies

	Santa Ana River	Newport Bay	San Pedro Bay	LAC Stormflow	DOE WaterPACT
Partners	NSF	California Water Boards Santa Ana - R8; County of Orange California	NOAA Marine Debris Program; SCCWRP Established 1969	Safe Clean Water Program; Public Works Los Angeles County	NREL Transforming ENERGY
					
Study Type	Preliminary investigations/ Method Development	Fluvial flux and sedimentation monitoring	Integrated river/coastal ocean monitoring/modeling	Flow-Integrated paired w/ LACPW autosamplers at Mass Emission Stations.	Point based
Target	Macro/Microplastics	Microplastics	Microplastics	Microplastics	Macro/Micro
Study Systems	• Santa Ana River above Prado	• San Diego Creek • Santa Ana Delhi Channel • Marsh and subtidal sediment	• Los Angeles River • San Gabriel River • Coyote Creek • Santa Ana River below Prado • San Pedro Bay	• Los Angeles River • Ballona Creek • Dominguez Channel • Coyote Creek	• Los Angeles River

A Watershed Approach to Microplastics

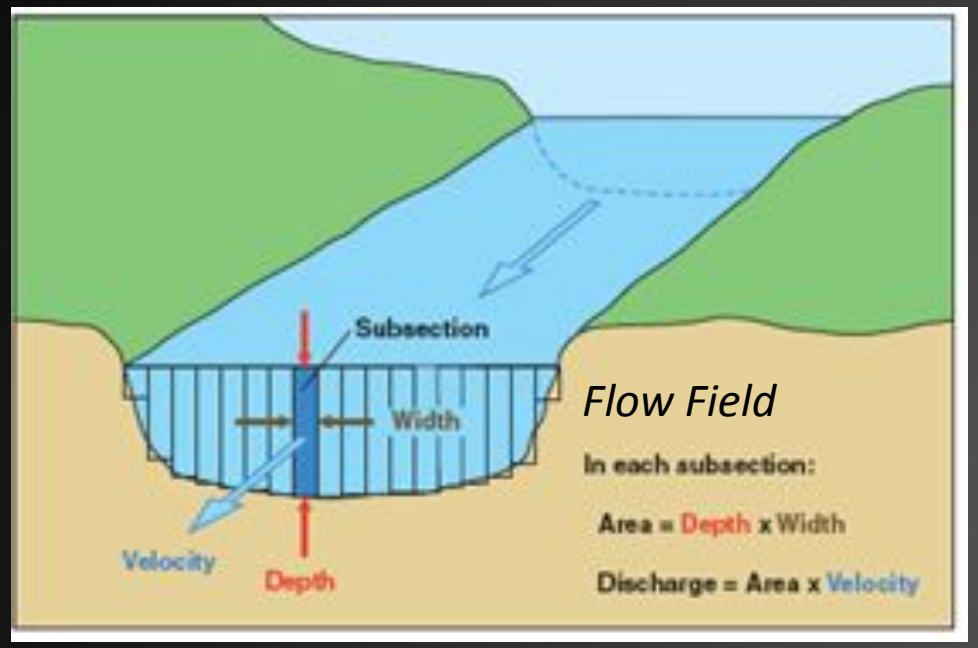


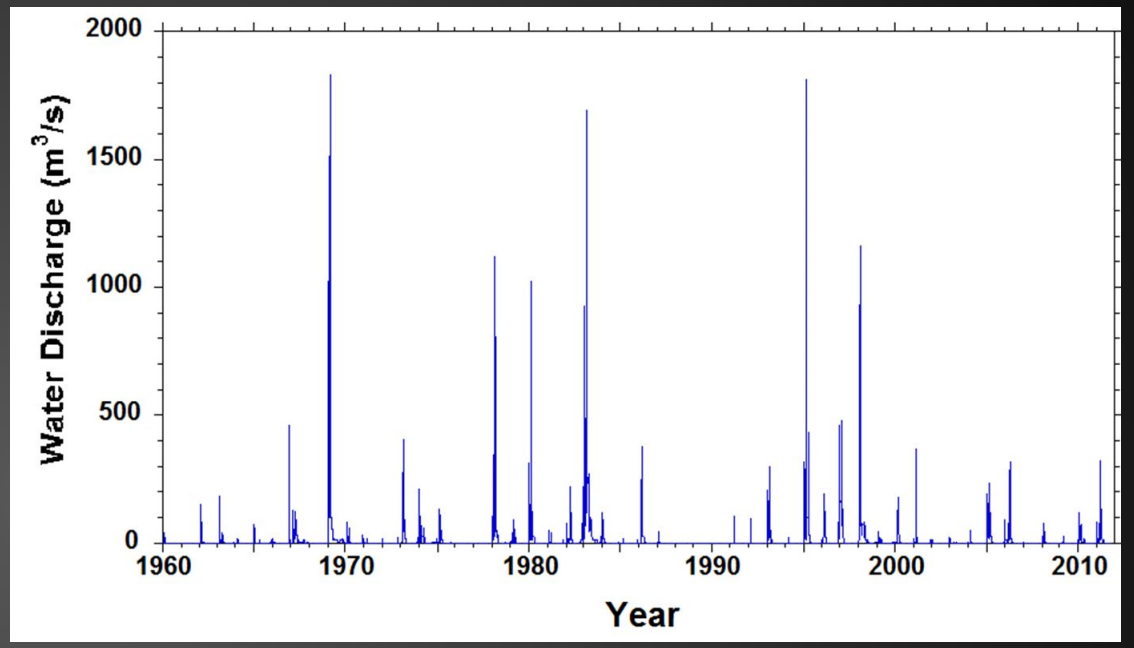
Watershed Processes

Ambient Conditions

Receiving Body

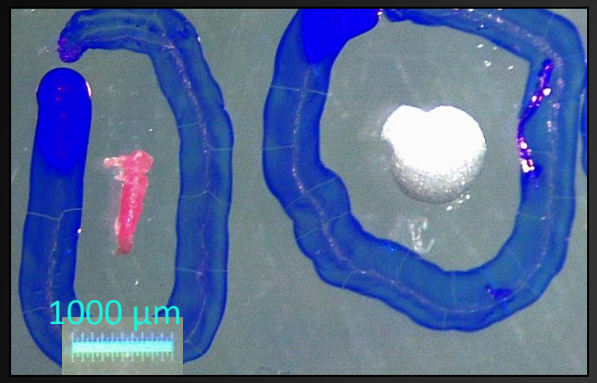
Streamflow

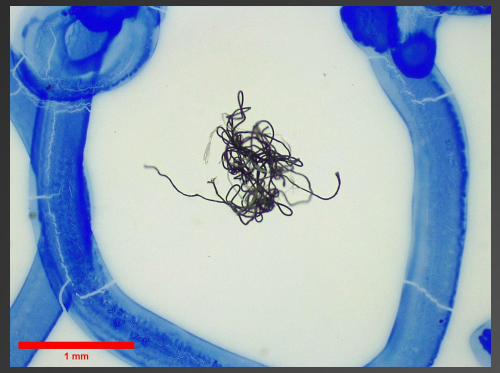




- Predominantly Unidirectional Water Flux
  - Often turbulent, unsteady
  - Integrated expression of watershed hydrology
  - Wide range of hydrologic modes => wide range of constituent states
- River station => cross section normal to flow

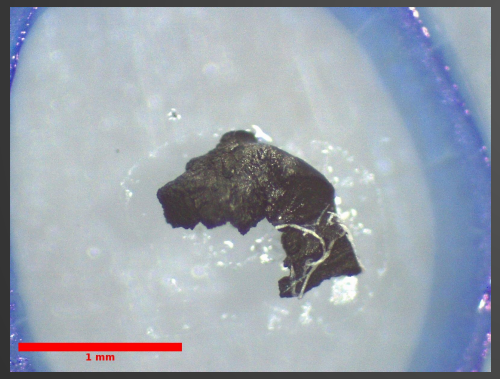
Diversity of Particles ⟶ Diversity of Fluvial Transport





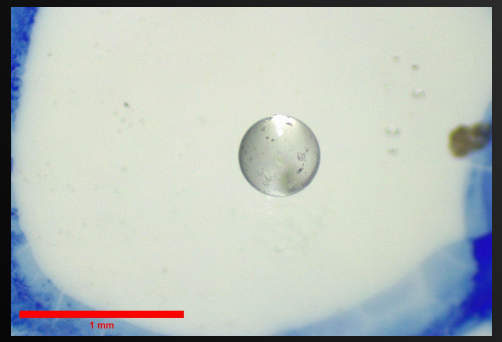
Left: fragment and foam

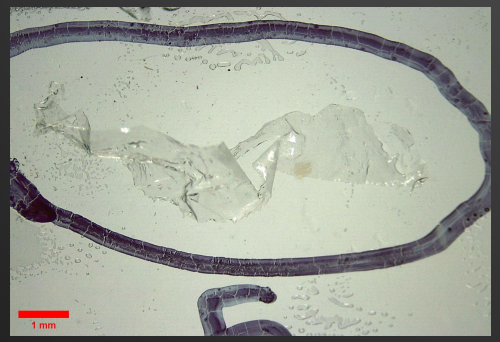
Right: Fibers



Left: fiber

Right: Tire Road Wear Particle (TRWP)

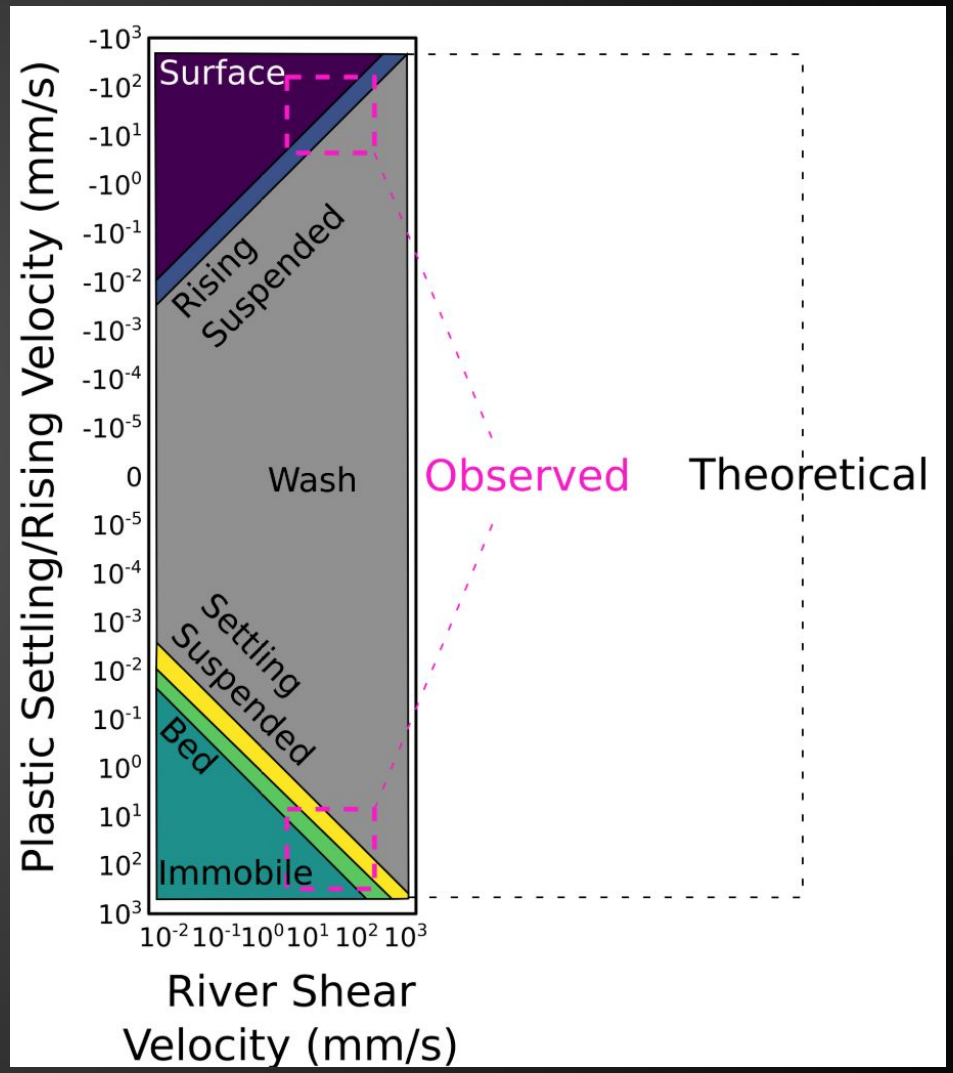




Left: sphere

Right: film

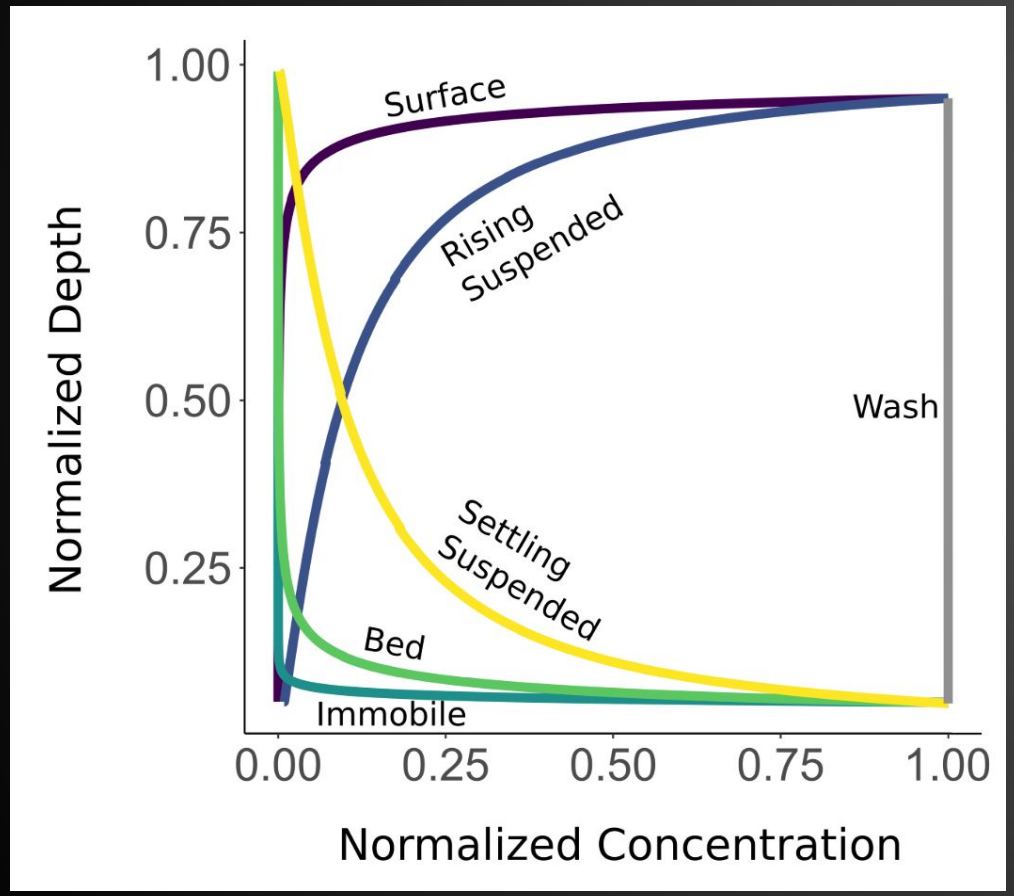
UCR Gray Lab



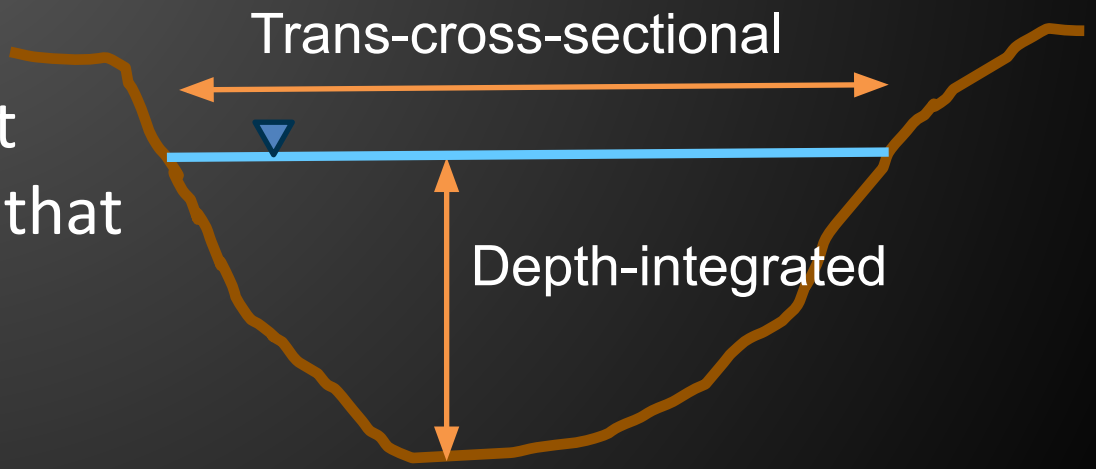
Cowger et al. (2021) *Environ. Sci. Technol.*

Streamflow Sampling

In order to represent all transport modes of microplastics we use:



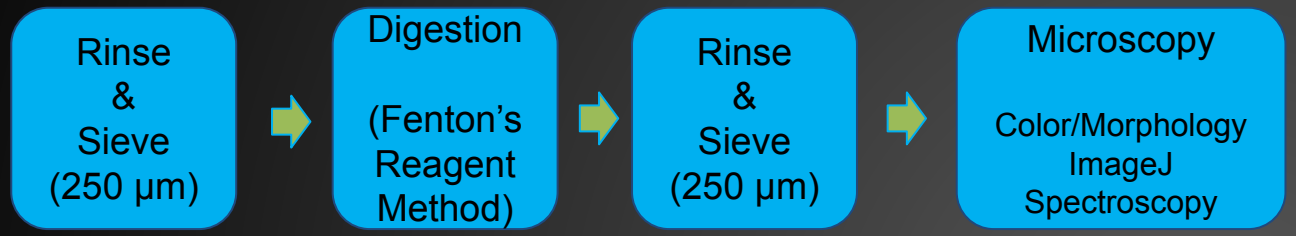
to collect samples that are …



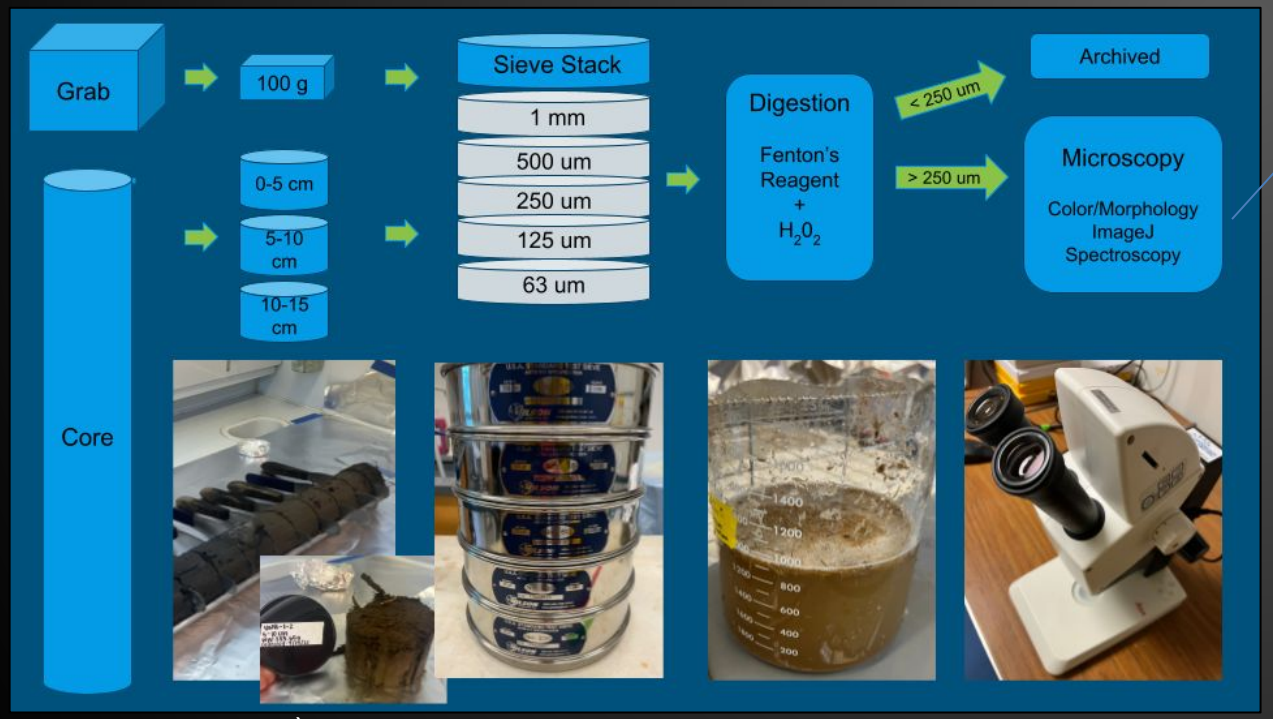
Cowger et al. (2021) *Environ. Sci. Technol.*

Microplastic Extraction: Methods

Streamflow:



Sediments:

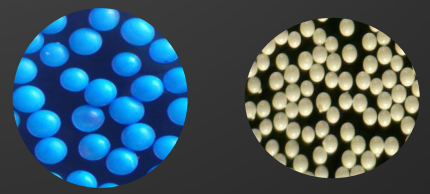


OPEN SPECY[1]

QA/QC Protocols

- Cotton lab coats/coveralls
- Non-plastic equipment
- Triple DI Rinse
- HEPA filters in lab
- Processing Blanks
- Equipment Blank
- Filter Blanks (Core Cutting)

Spiked Sediments (0.98 - 1.03 g/cc)



500-600µm	250-300µm

~ 90% Recovery

Cospheric ©

1. Cowger et al. (2021b)

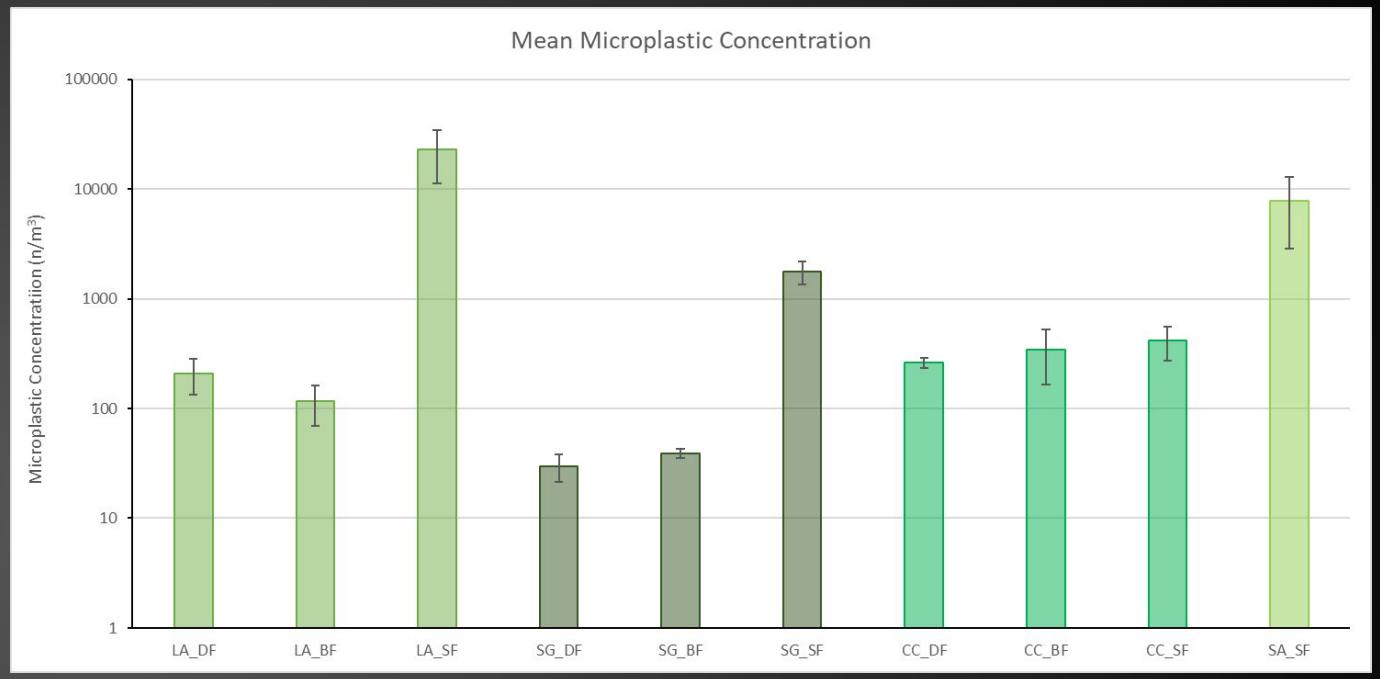
Streamflow Microplastics Concentrations (> 300 µm)

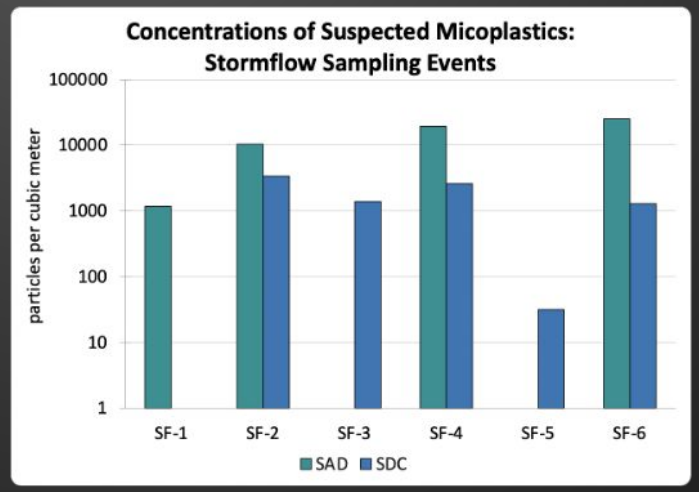
Mean of Stormflows [particles/m³]:

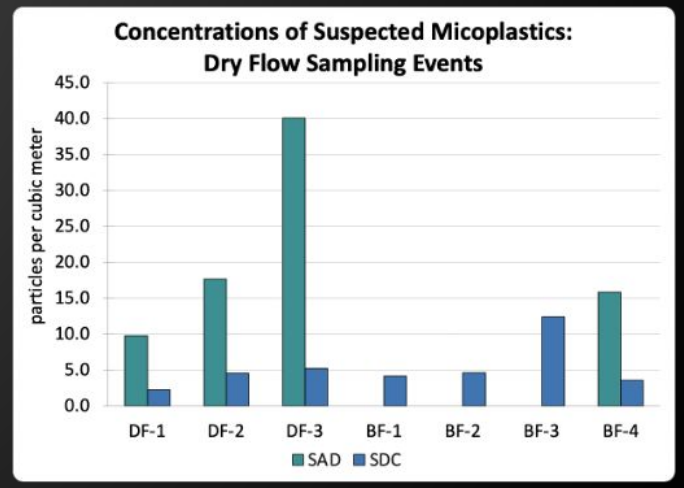
LLAR: 23,000
LSGR: 1,800
CC: --
SAR: 7,900
SDC: 1,800
SAD: 14,000

Mean of Low Flows [particles/m³]:

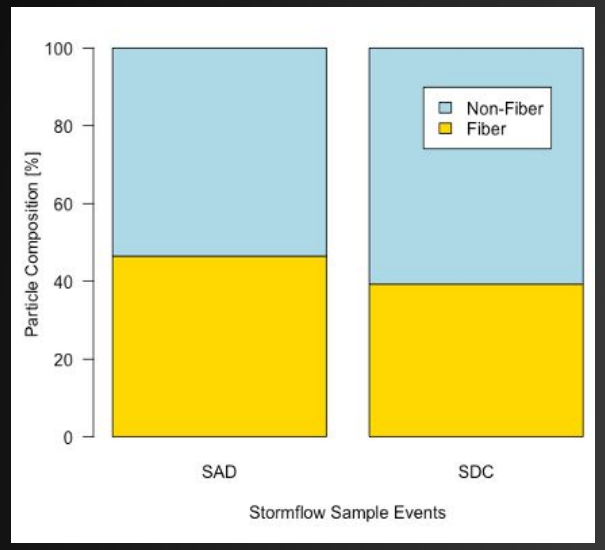
LLAR: 150
LSGR: 35
CC: 300
SAR: --
SDC: 5
SAD: 21

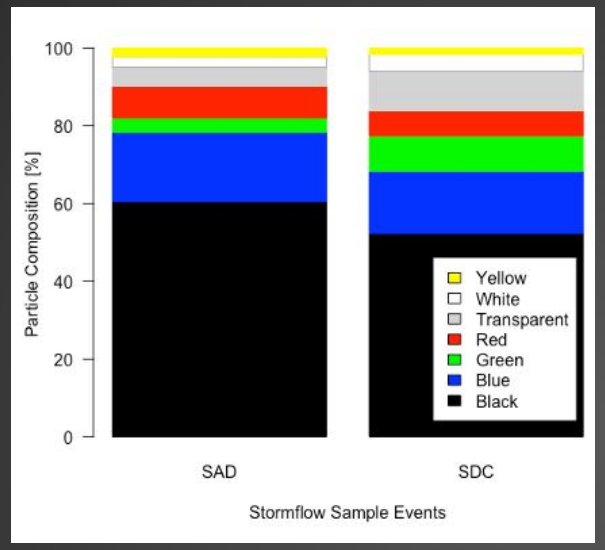


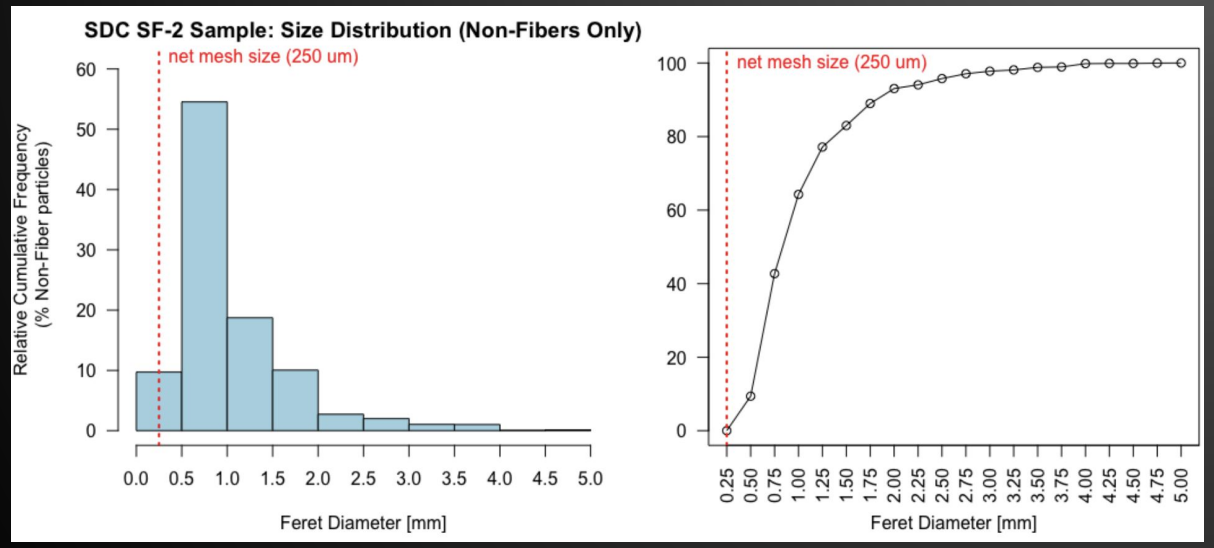


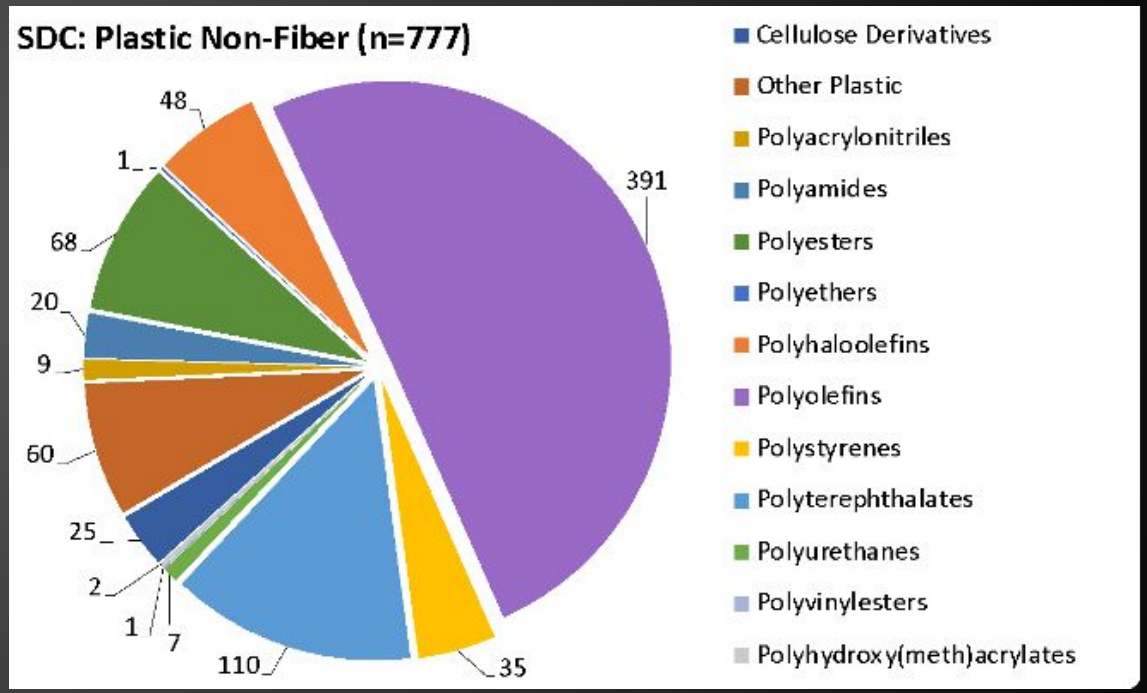


Microplastic Polymer Types in Streamflow





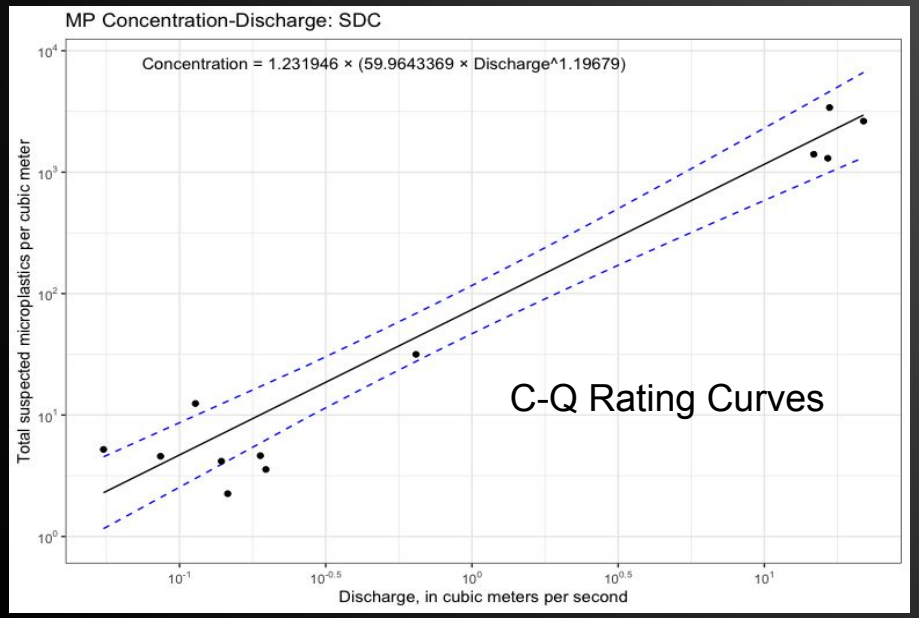


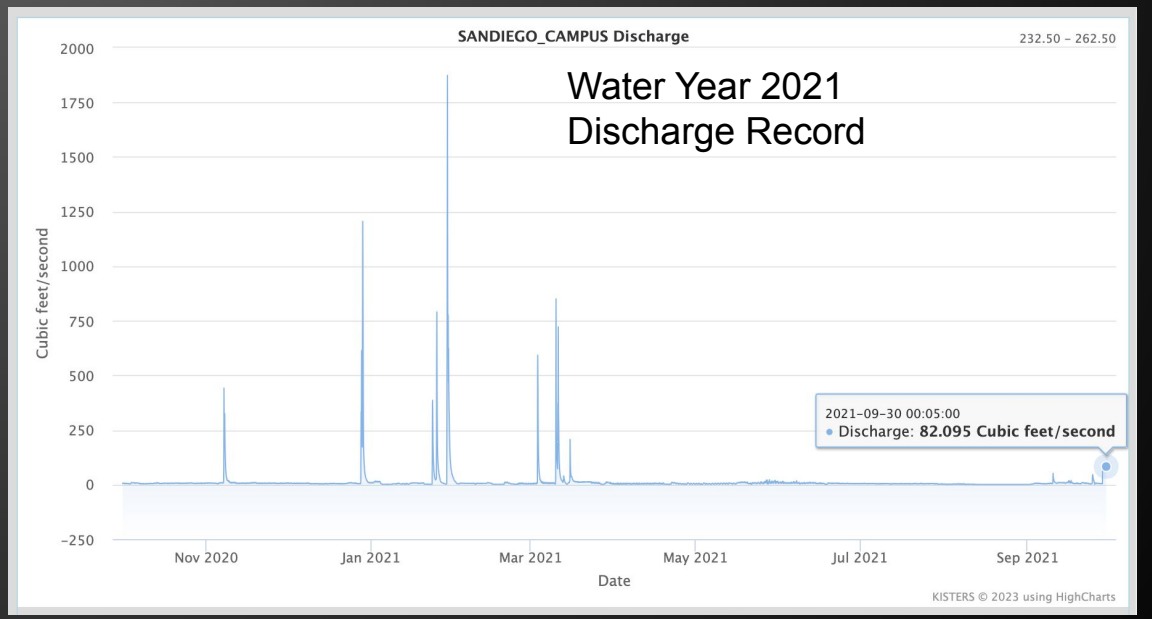


Riverine Microplastic Flux to the Coast (> 300 μm)

WY 2021 (*preliminary*)

- Lower Los Angeles River: 3.1×10^{11} - 5.1×10^{11} MPs
- Coyote Creek: 2.4×10^{9} - 4.6×10^{9} MPs
- San Diego Creek: 7.3×10^{9} - 9.7×10^{9} MPs
- Santa Ana Delhi Channel: 1.6×10^{10} - 3.1×10^{10} MPs





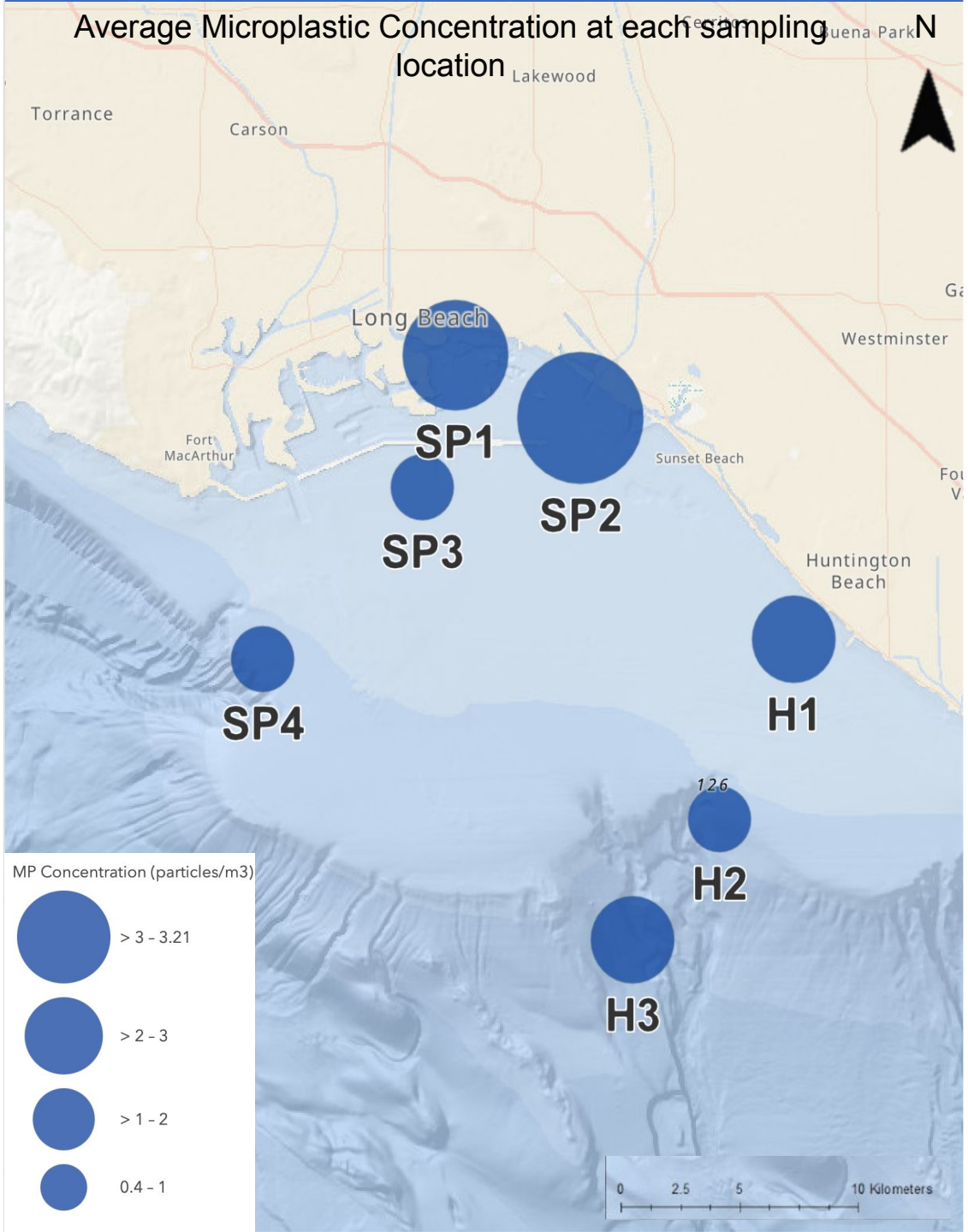
Microplastics in San Pedro Bay

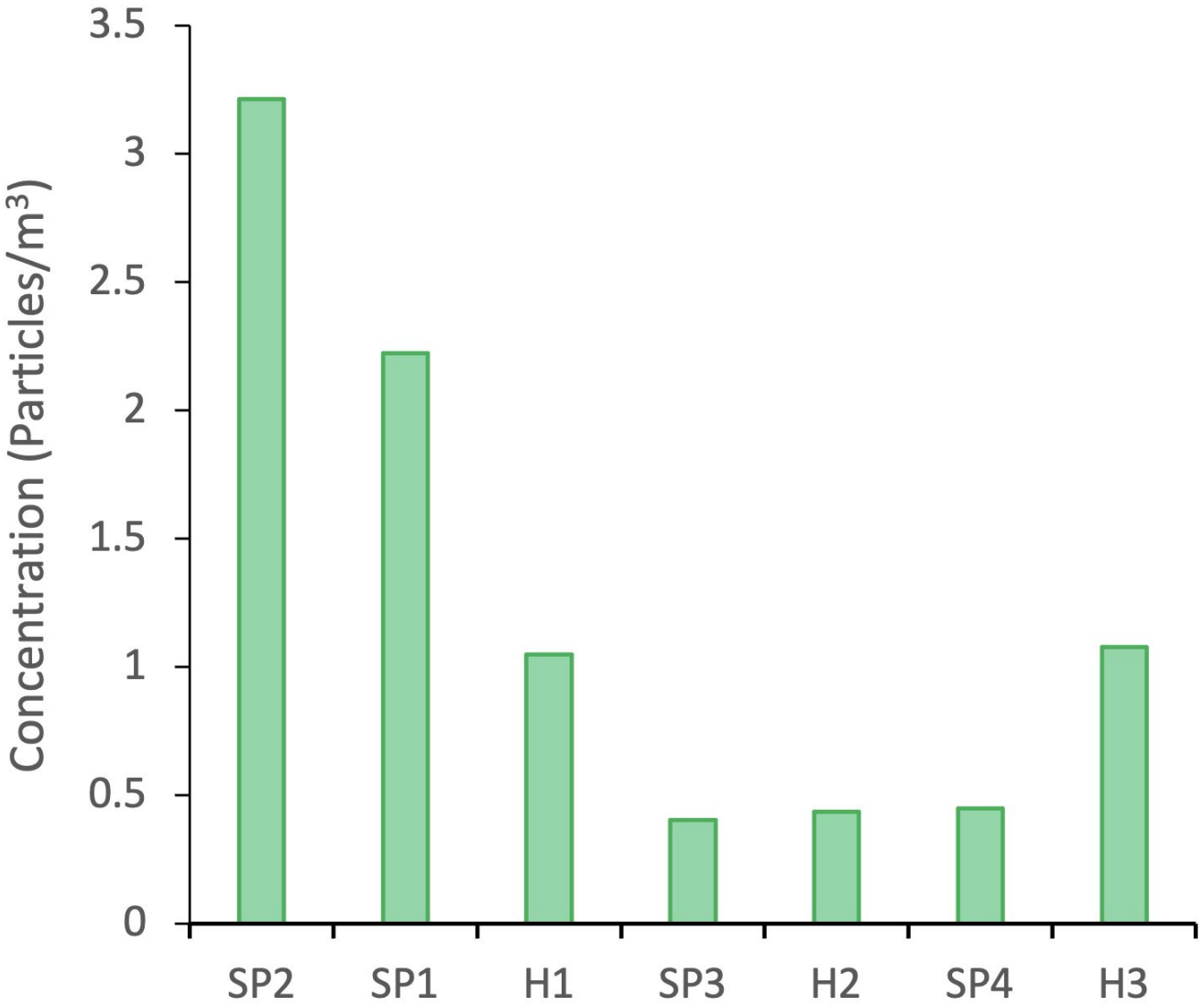
Net Samples (> 330 µm)

Surface

Midwater

Epibenthic



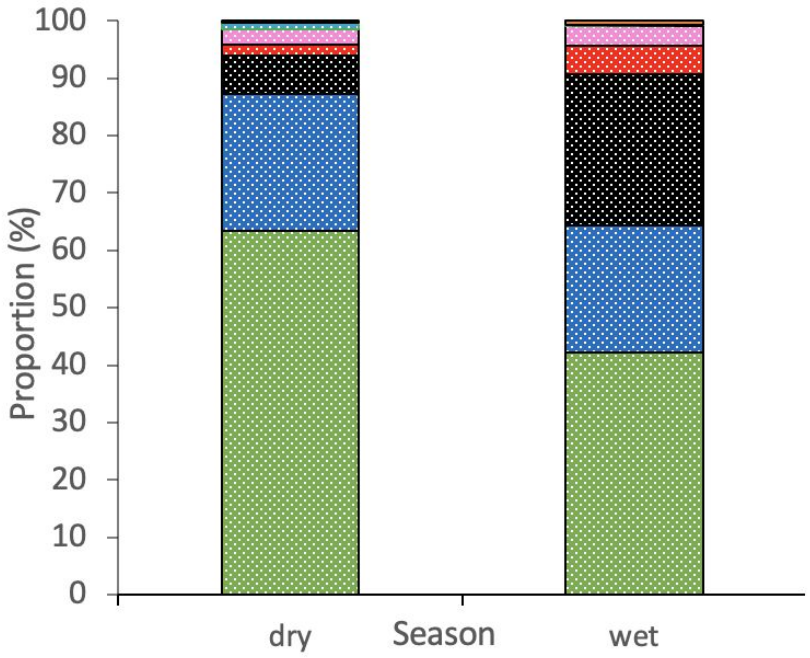


Microplastic concentration at each sample site

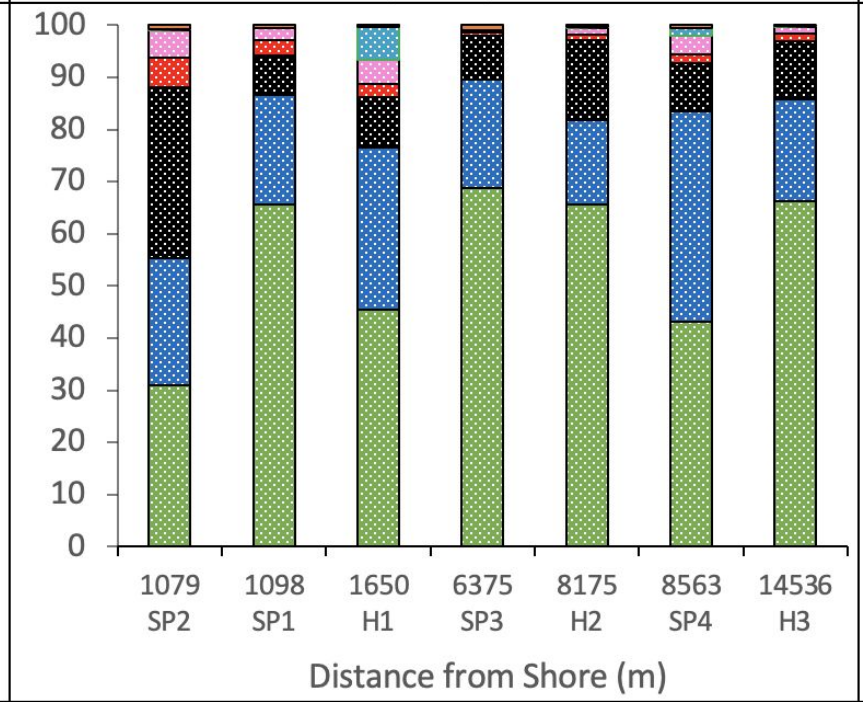
(water column location and season integrated)

Morphology

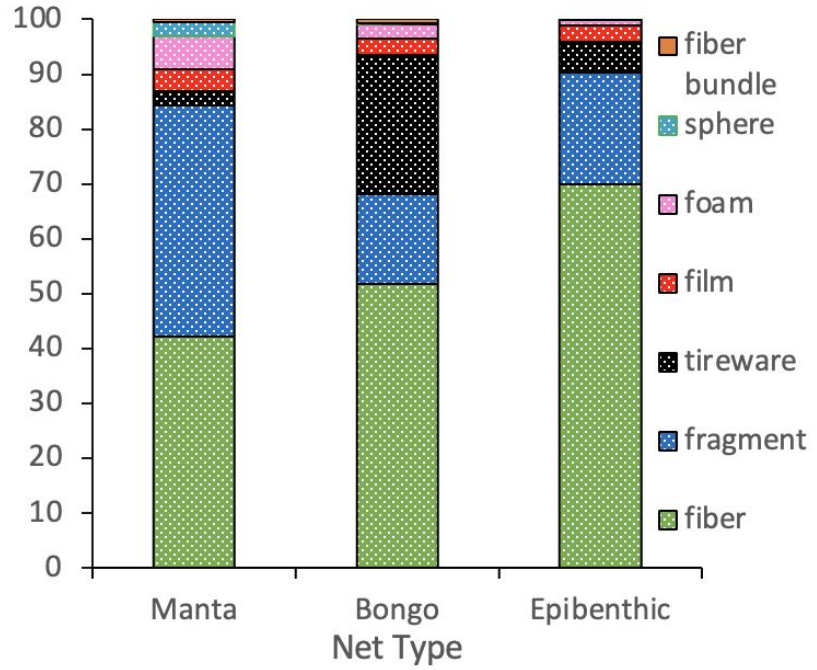
Seasonally



Spatially

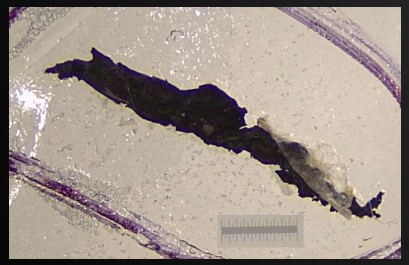
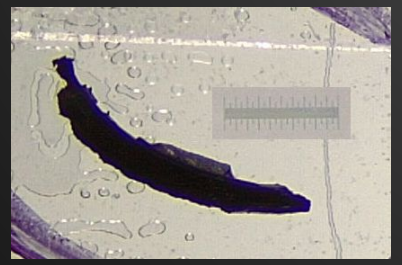
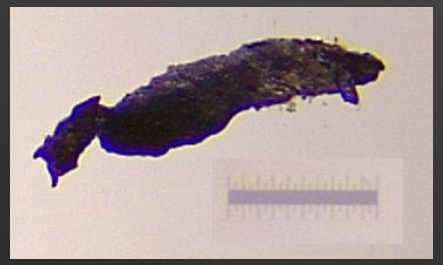
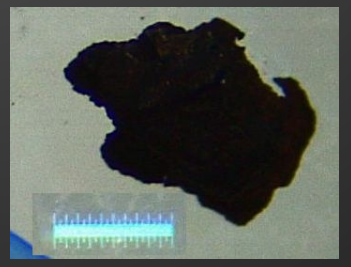
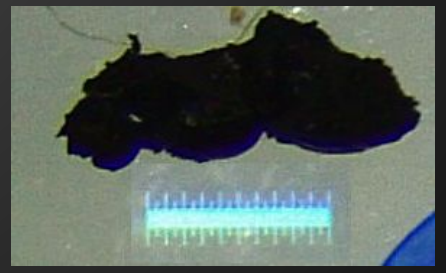


Water column depth



Tire and Road Wear Particles

- Streamflow (up to 25%)
- Subtidal Sediments (up to 45%)
- Coastal Marine Water Column (up to 35%)
- Identified during microscopy by:
- Confirmation by Pyrolysis-GC-MS (~ 95% positive ID rate)

scale bars are 1mm

Next Steps

- More samples!
  - LA SCWP: 3 years of intensive monitoring in the Los Angeles River, Coyote Creek, Ballona Creek, and the Dominguez Channel.
  - NPB Phase II – stormflow, water column, sediment
- Standardize MP monitoring in stormflow (SCCWRP/OPC)
- Small size classes
- Specific polymer classes (TRWP…)
- Transport modeling (atm, watersheds, rivers, coastal oceans)

Sources

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Thank You