Assessing and Mitigating Impacts of Microplastics in Aquatic Environments: Lessons Learned from California and Elsewhere

State of the Los Angeles River Watershed Symposium
September 19, 2023

Scott Coffin, Ph.D.

California State Water Resources Control Board

Mandy Baker

California Senate Bill 1263 (2018): Statewide Microplastics Strategy

2022

- Initiate Statewide Microplastics Strategy

Deadlines 2026

- Develop **risk assessment** framework
- Develop standardized **methods**
- Establish baseline **occurrence** data
- Investigate **sources** and **pathways**
- Recommend **source reduction** strategies

PLASTIC FIBERS IN TAP WATER, 2017

orb. one world. one story.

PREVALENCE OF MICROSCOPIC PLASTIC FIBERS BY SAMPLE SOURCE LOCATION.

WORLDWIDE	USA	EUROPE	INDONESIA, JAKARTA
83%	94%	72%	76%

INDIA, NEW DELHI	LEBANON, BEIRUT	UGANDA, KAMPALA	ECUADOR, QUITO
82%	94%	81%	75%

Orbmedia.org

California Senate Bill 1422 (2018)

CALIFORNIA Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

Deadlines

July 1,2020

- Define ‘microplastics’

July 1,2021

- Standard method
- Four years of testing
- Health-based guidance level
- Accredit laboratories

California Senate Bill 1422 (2018)

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California's Inter-Lab Validation Study

Two Methods

FTIR Spectroscopy

Raman Spectroscopy

26 laboratories

Four Matrices

Drinking Water

Ocean Water

Fish

Sedimen

Method Should Be Tailored to Specific Particle

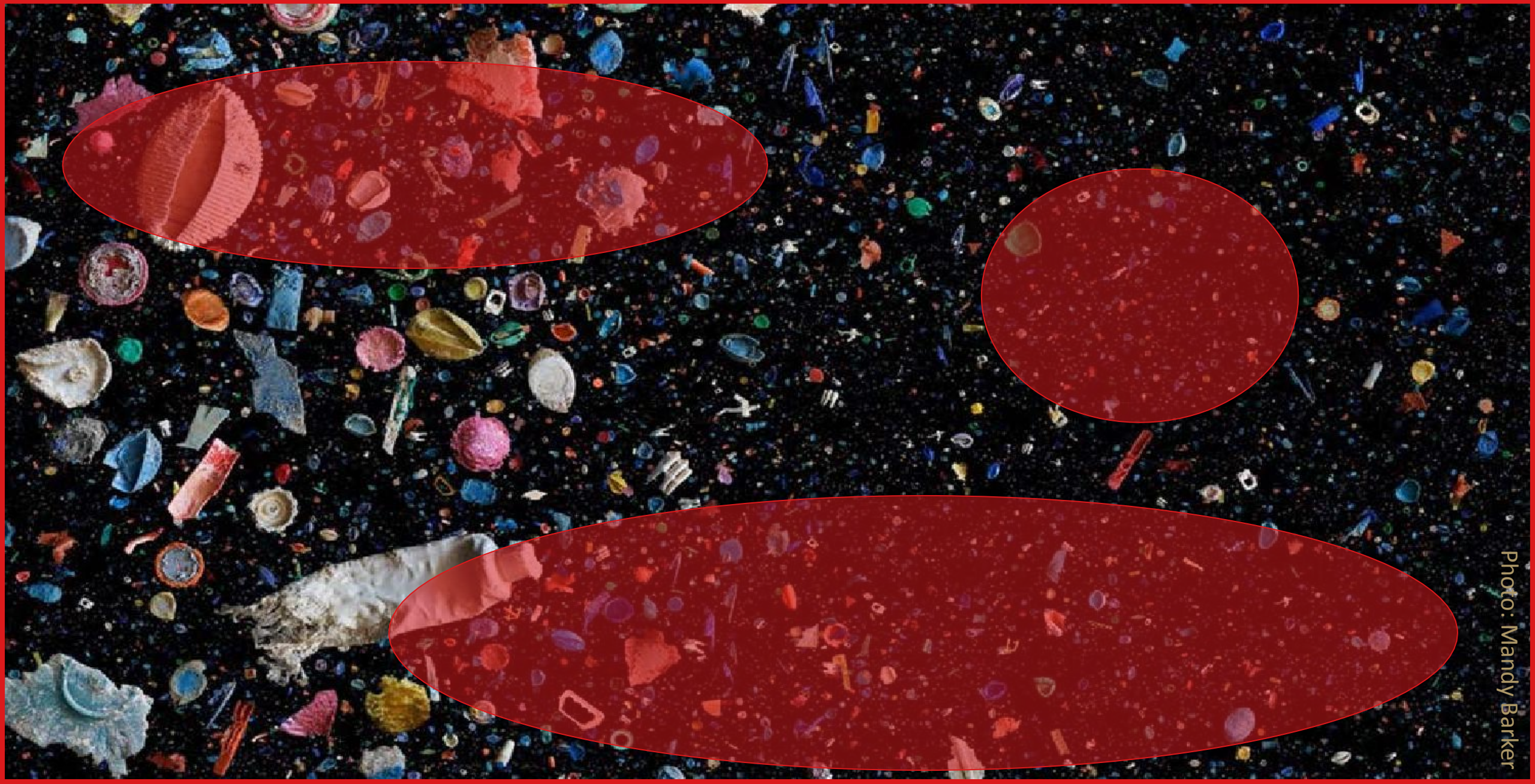


Photo: Mandy Barker

Standardized Method Available for Accreditation

Moore Institute for Plastic Pollution Research
(April, 2022)

Environmental Laboratory Accreditation Program
STATE WATER RESOURCES CONTROL BOARD

Human and Ecological Health Effects Workshop

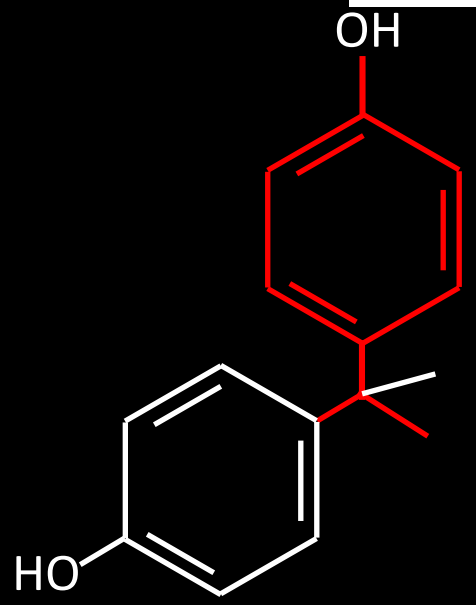
Dose Metrics

Particle Characteristics

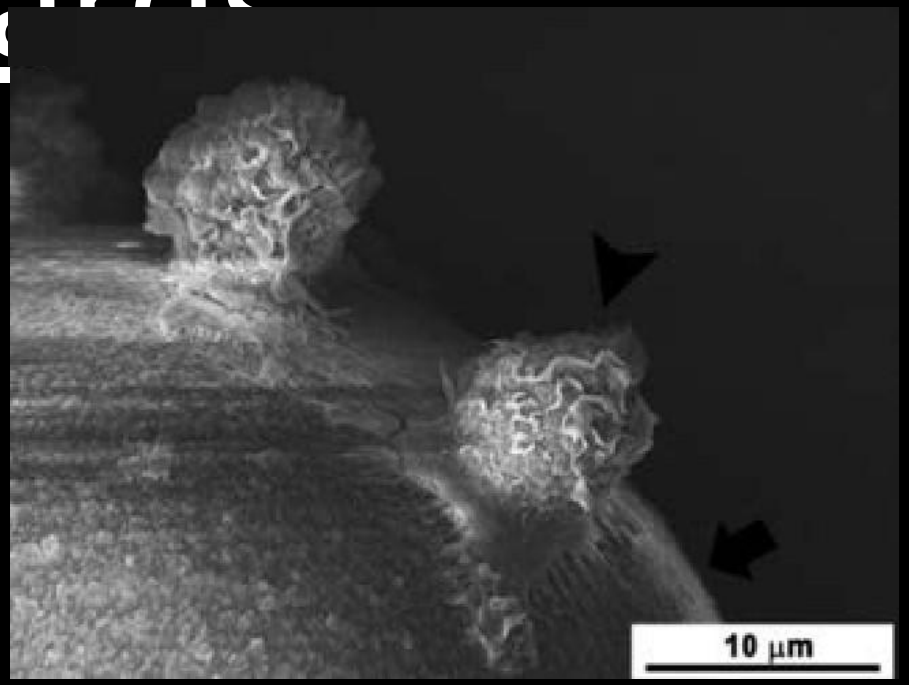
Adverse Effects

Threshold Framework

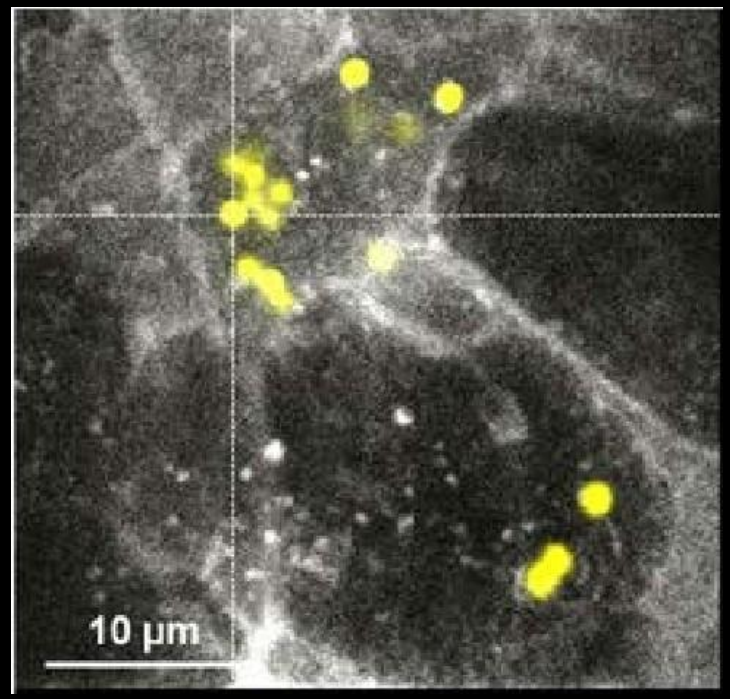
Microplastic Hazards



Bisphenol A



Jeon et al. (2021). *Environmental Pollution*



Stock et al. (2019). *Archives of Toxicology*

Chemica

Biologica

Particl

e

Problem: Mis-match in Particle Types

Environmental Microplastics

polydisperse

Lab Studies

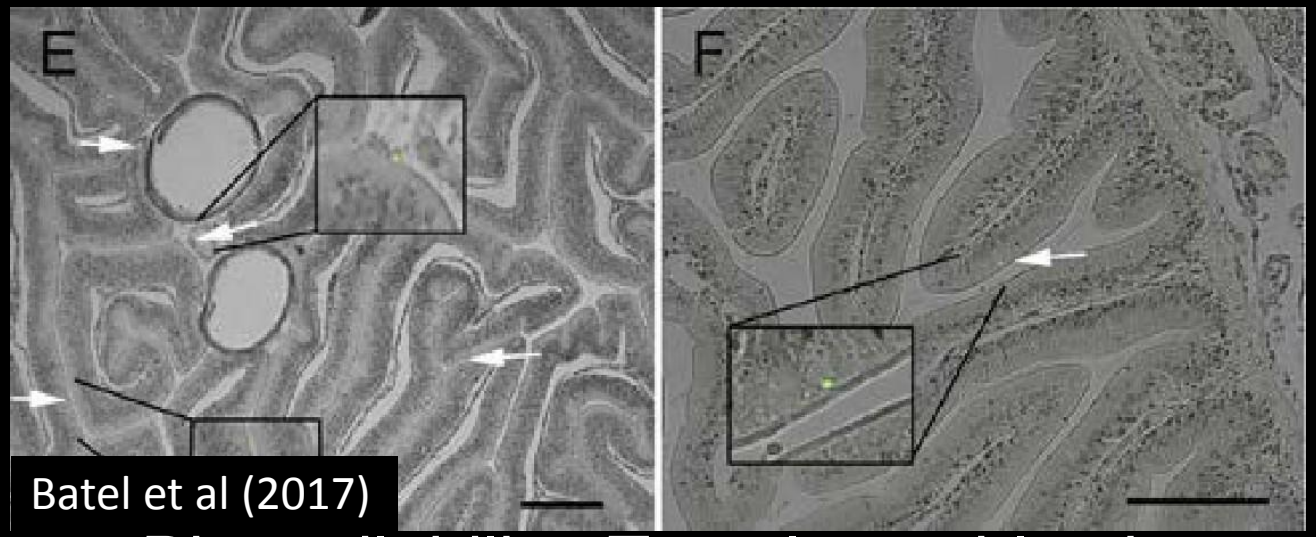
monodisperse

Toxicologically-Relevant Metrics

Food Dilution

- Bioavailability: Ingestible sizes
- Exposure metric: Volume

Tissue

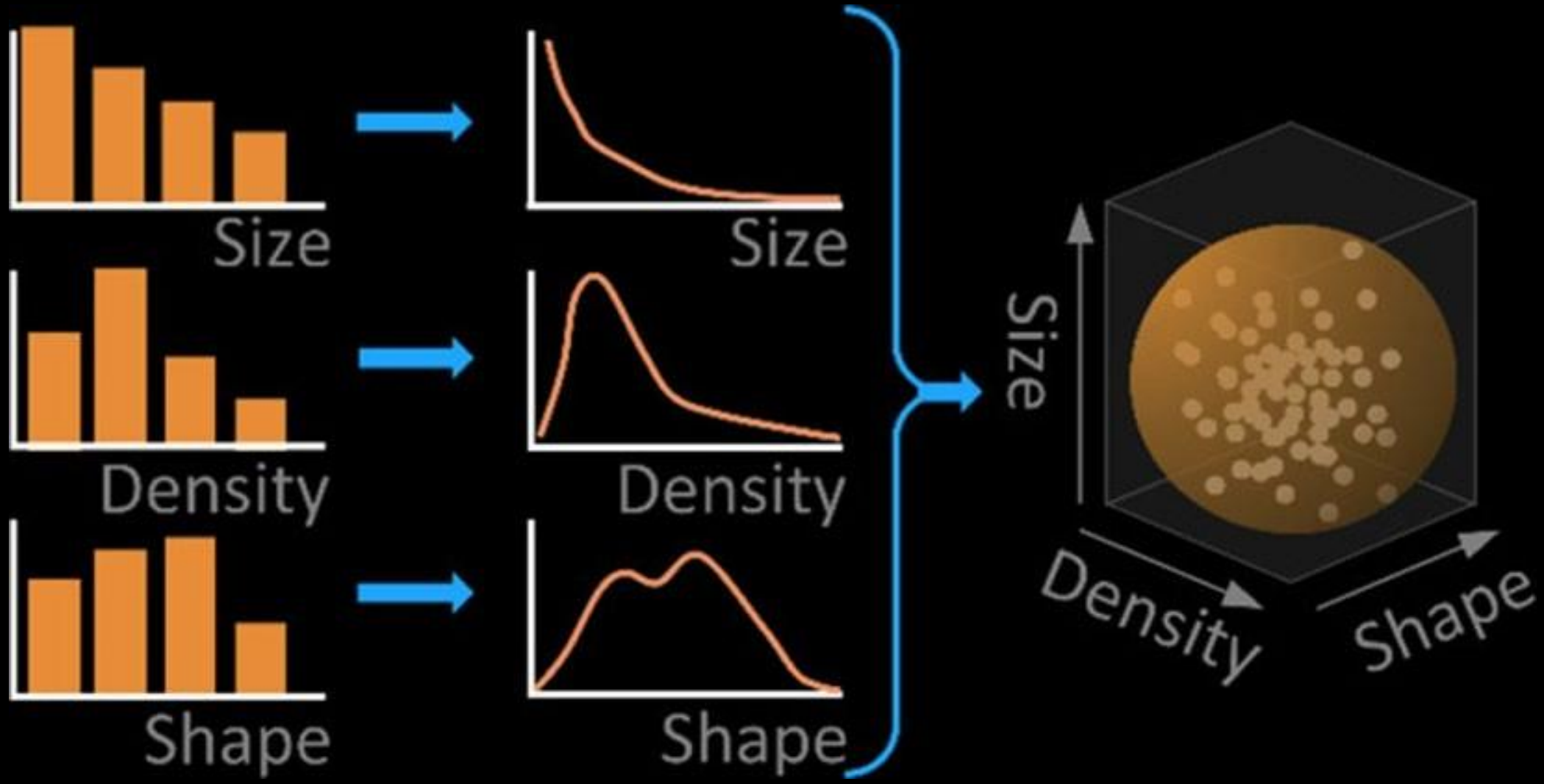


Batel et al (2017)

- Bioavailability: Translocatable sizes
- Exposure metric: Surface area

Koelmans *et al (*2017) *ES&T*; de Ruijter et al (2019) *ES&T*;
Mehinto et al (2022) *Microplastics & Nanoplastics*

Align with Probability



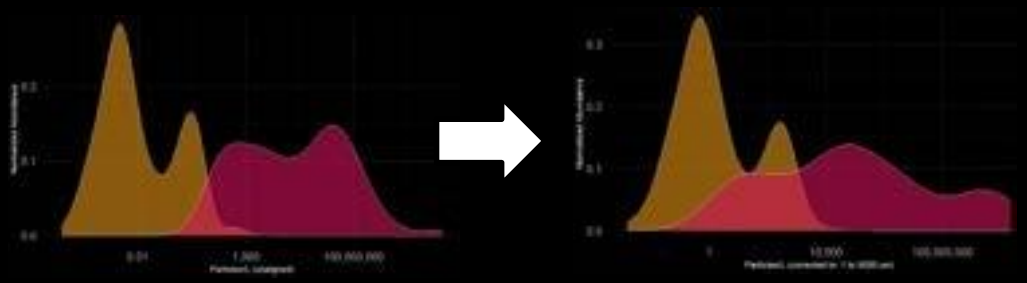
Kooi and Koelmans, *ES&T Letters*

Eco-toxicity Thresholds Derivation

in vivo aquatic microplastics toxicity studies
(n = 167 studies; 117 species)

De Ruijter et al. (2019)

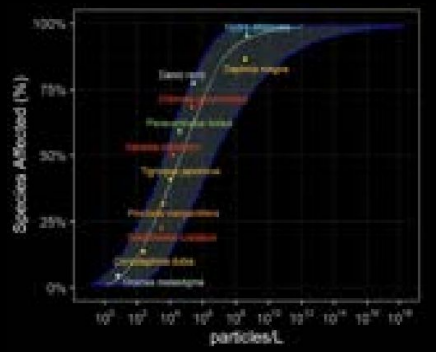
Fit for purpose studies
(n = 22 studies; 16 species)



Expert review

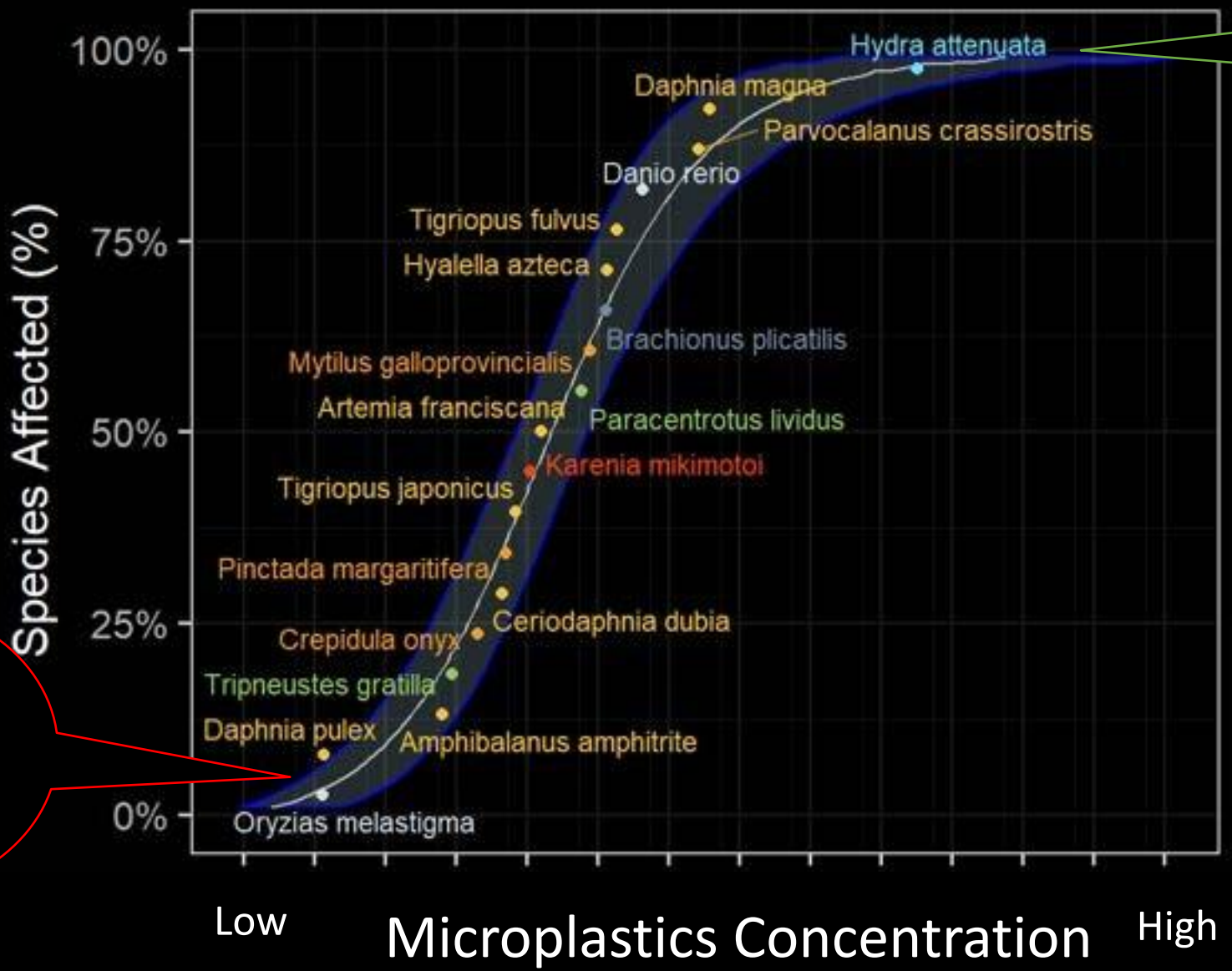
Data Alignment

Species sensitivity distribution



Mehinto et al (2022), *Microplastics & Nanoplastics.*

Species Sensitivity Distributions



Least Sensitive Species

Most Sensitive Species

Taxonomic Group

- Algae
- Cnidaria
- Crustacea
- Echinoderm
- Fish
- Mollusca
- Rotifera

Mehinto *et al.* (2022). *Microplastics & Nanoplastics.*

Microplastics Aquatic Toxicity Thresholds

Threshold	Food Dilution (particles/L)	Tissue Translocation (particles/L)
1- Investigative monitoring	0.3	60
2- Discharge monitoring	3.0	320
3- Management planning	5.0	890
4- Source control measures	34	4,100

*Based on species sensitivity distributions with 27 studies, 14 species and 6 taxa for all endpoints

** Concentrations aligned to 1 to 5,000 µm size range

Mehinto *et. al, Microplastics & Nanoplastics* (2022)

Logo created by J.C. Leapman.

- Welcome
- Overview
- Search
- Exploration
- SSD
- Study Screening
- Calculators
- Predictions
- Resources
- Contact
- Human Health
- Follow Us on Twitter!

Welcome to the Toxicity of Microplastics Explorer, Aquatic Organisms Database!

What is the Microplastics Toxicity Database?

This database is a repository for microplastics toxicity data for the California Microplastics Health Effects Workshop.

This web application allows users to explore toxicity data using an intuitive interface while retaining the diversity and complexity inherent to microplastics. Data is extracted from existing, peer-reviewed manuscripts containing toxicity data pertaining to microplastics.

Use the side panel on the left of the page to navigate to each section. Each section provides different information or data visualization options. More specific instructions may be found within each section.

Why was the Microplastics Toxicity Database and Web Application created?

The database and application tools have been created for use by the participants of the Microplastics Health Effects Workshop.The purpose of this workshop is to identify the most sensitive and biologically critical endpoints associated with microplastics exposure, prioritize which microplastics characteristics (e.g., size, shape, polymer) that are of greatest biological concern, and identify critical thresholds for each at which those biological effects become pronounced. Workshop participants will also make reccomendations for future research investments. Workshop findings will be published in a special issue of Microplastics and Nanoplastics. These findings will be used directly by the state of California to fulfill legislative mandates regarding the management of microplastics in drinking water and the aquatic environment.

Contributors

Dr. Leah Thornton Hampton, Southern California Coastal Water Research Project
Dr. Heili Lowman, University of Nevada Reno
Dr. Scott Coffin, California State Water Resources Control Board
Emily Darin, Southern California Coastal Water Research Project

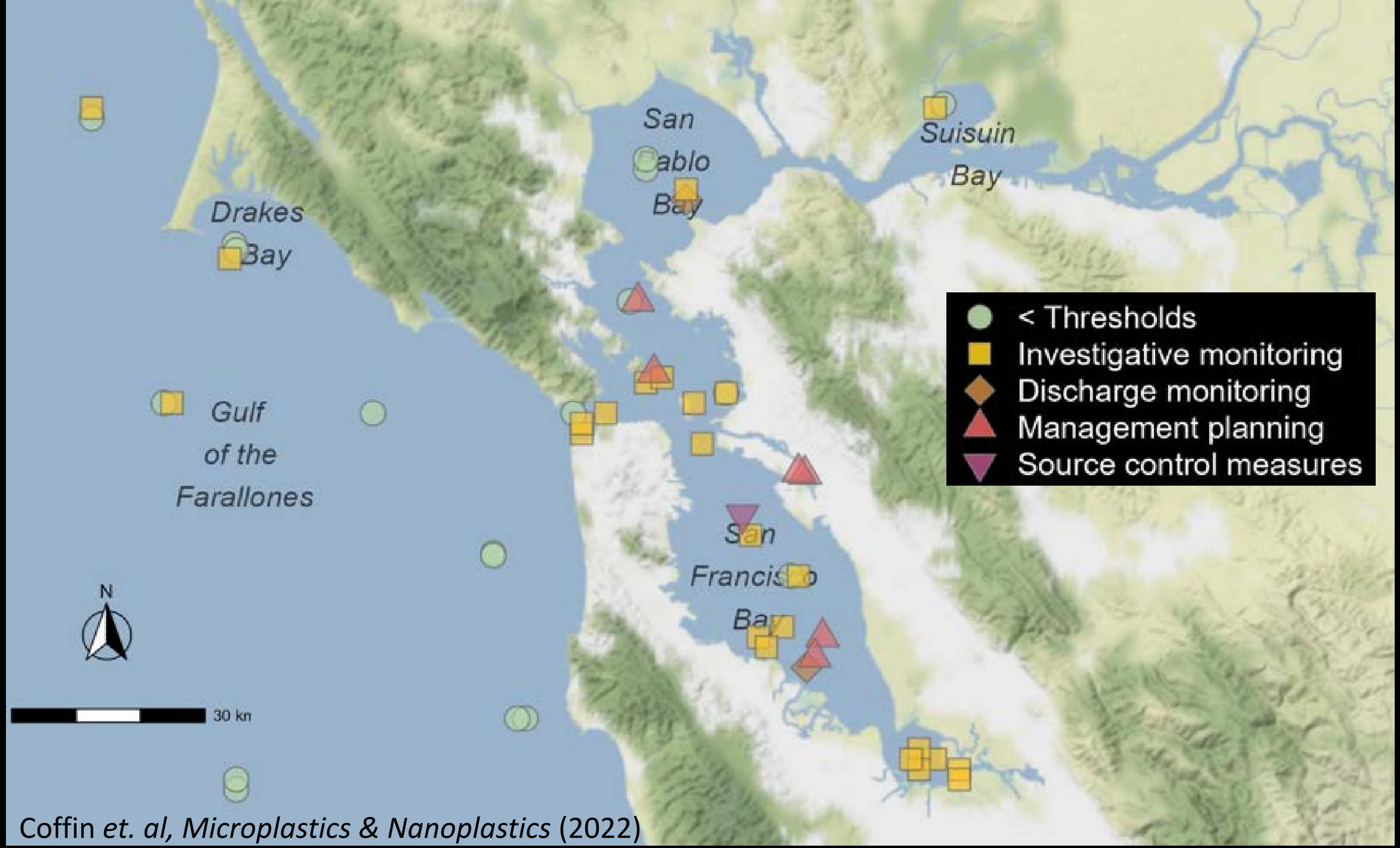
@ToMExApp

Thornton-Hampton et al. (2022), *Microplastics & Nanoplastics*

Characterizing Ecological Risks in San Francisco Bay, California

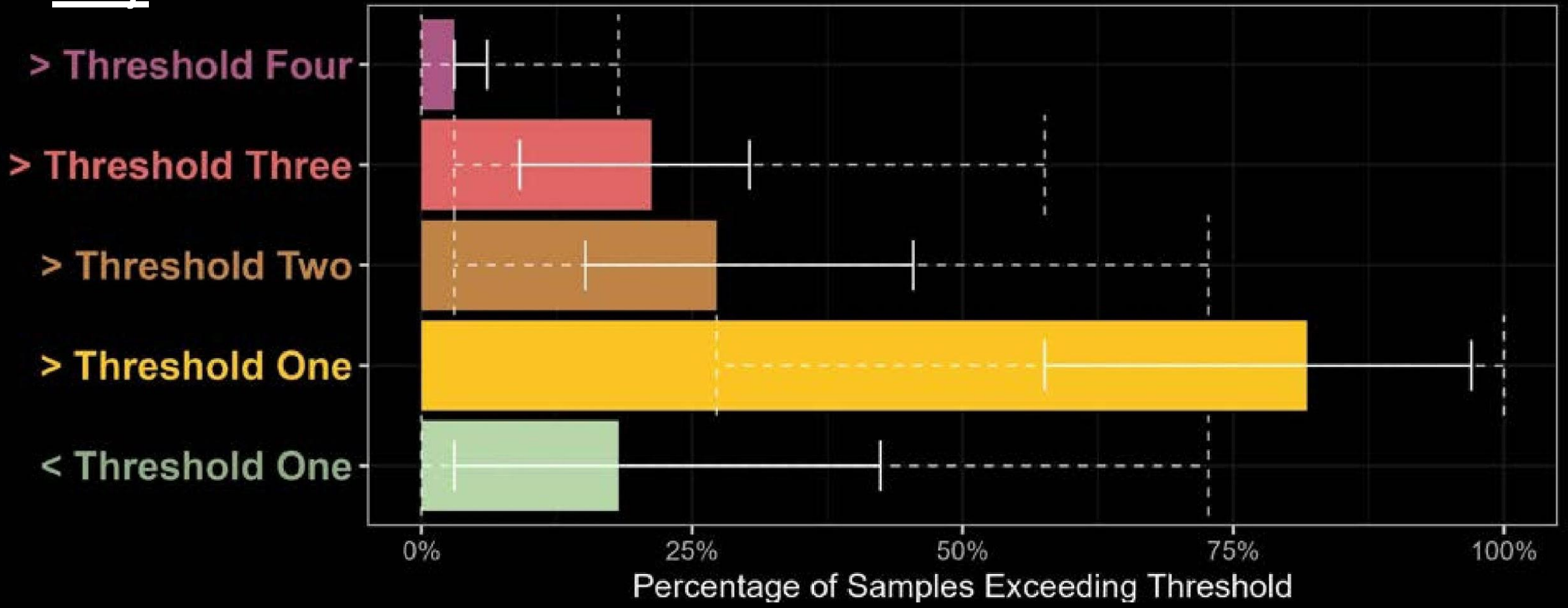
Photos: Erika Delemarre

Coffin et al. (2022). *Microplastics & Nanoplastics*



Coffin *et. al, Microplastics & Nanoplastics* (2022)

Probabilistic Risk Characterization of San Francisco Bay

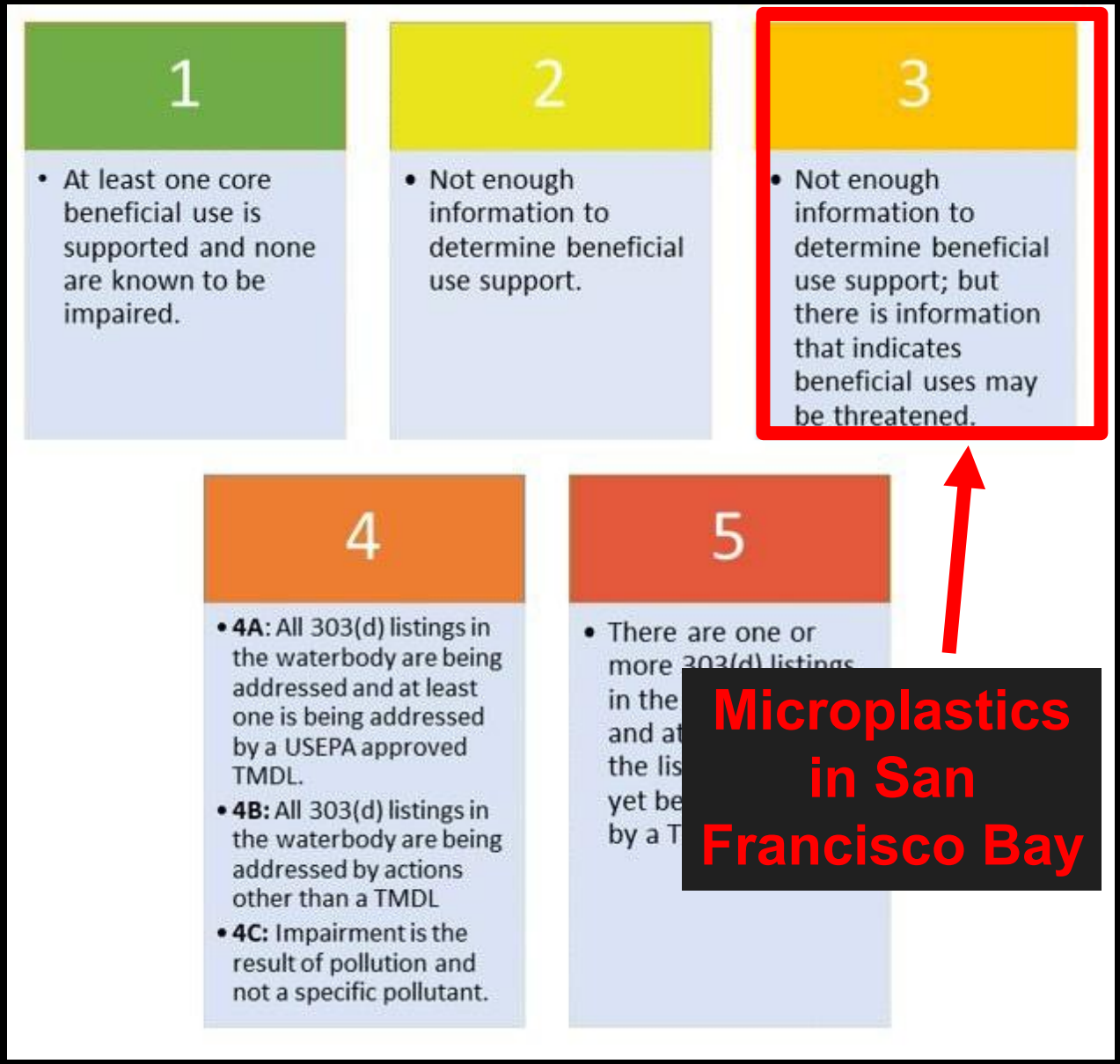


Coffin *et. al, Microplastics & Nanoplastics* (2022)

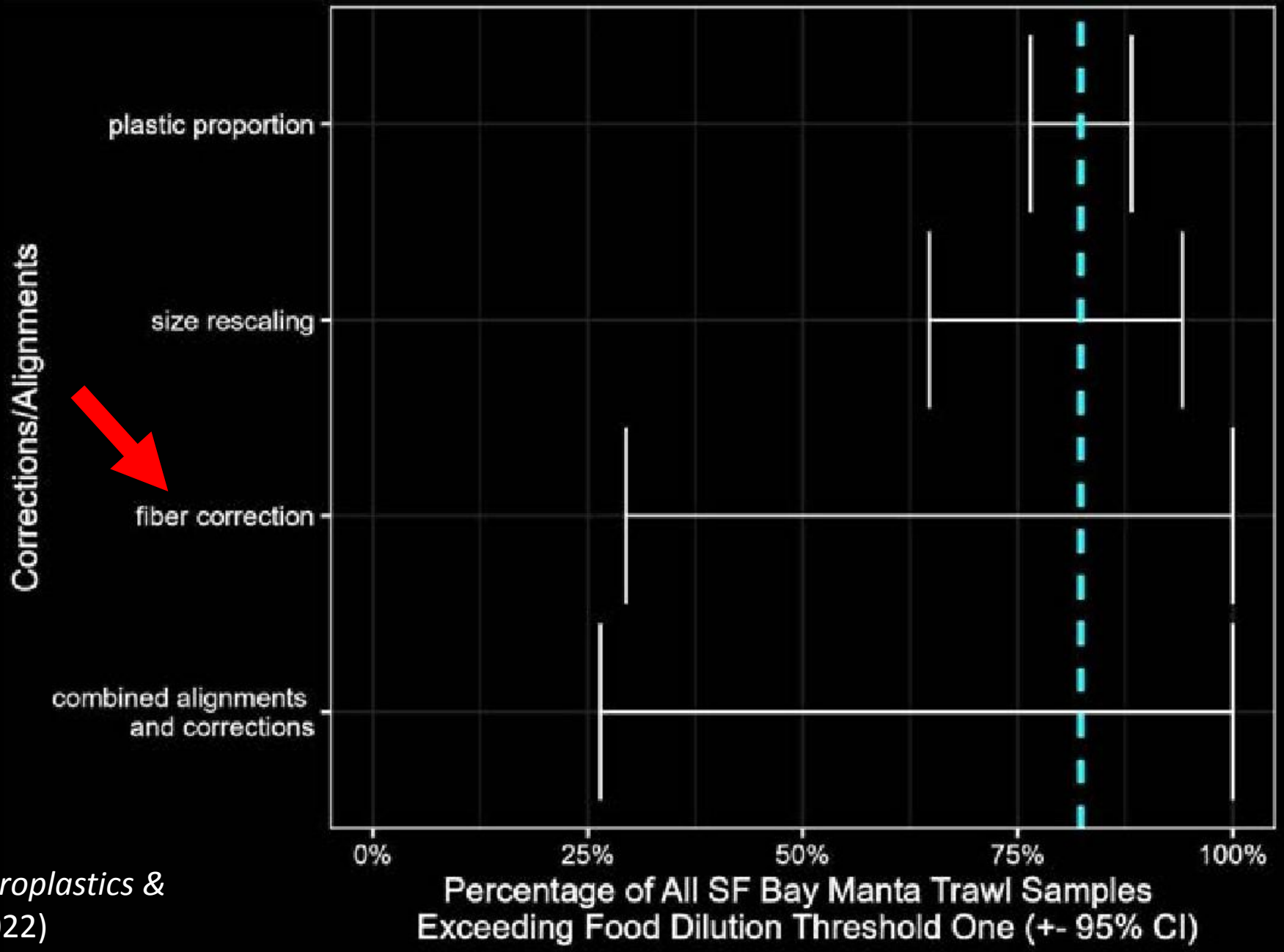
Potential Regulatory Implications

The 303(d) List:

- Impaired waterbodies that do not meet water quality standards
- Informs remediation, e.g. - total maximum daily loads (TMDLs)
  - TMDLs often inform monitoring

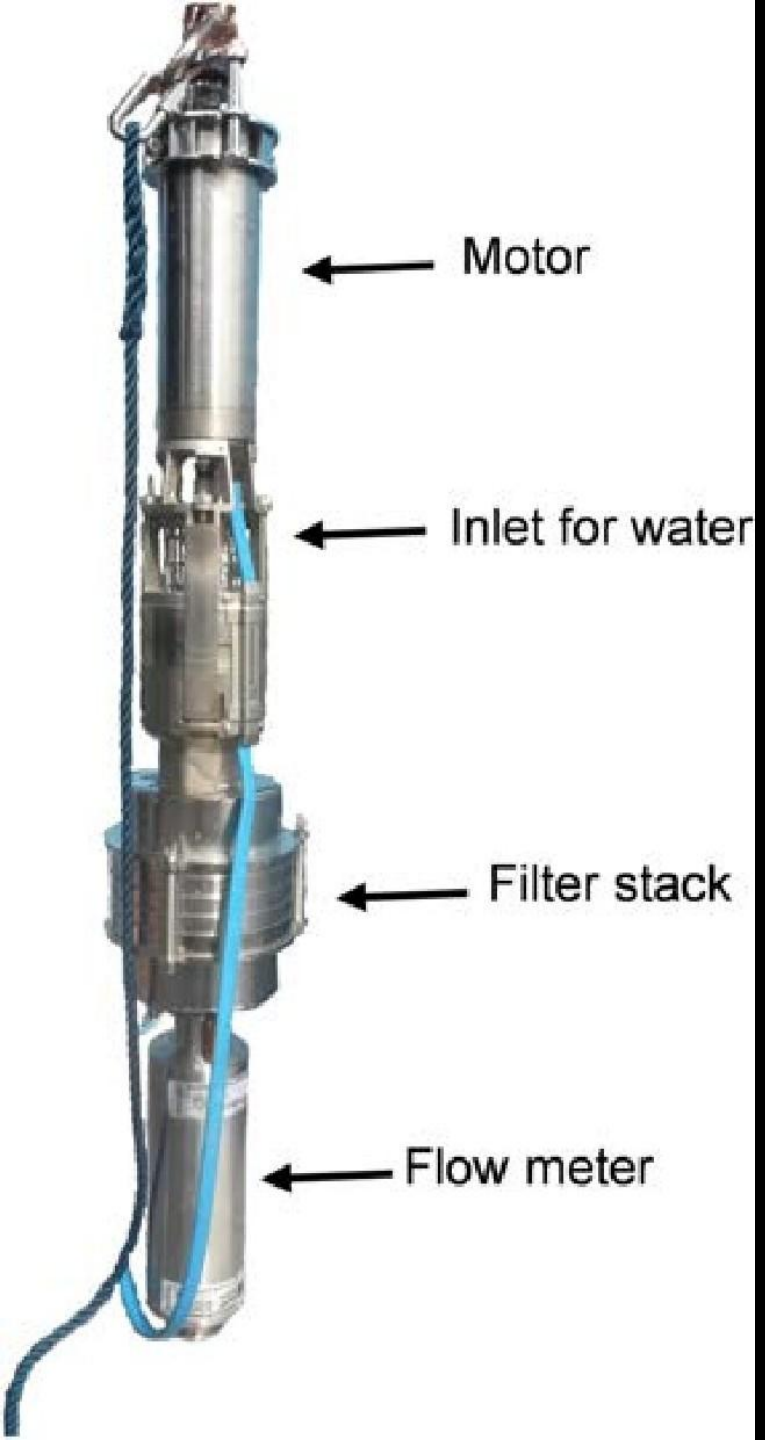


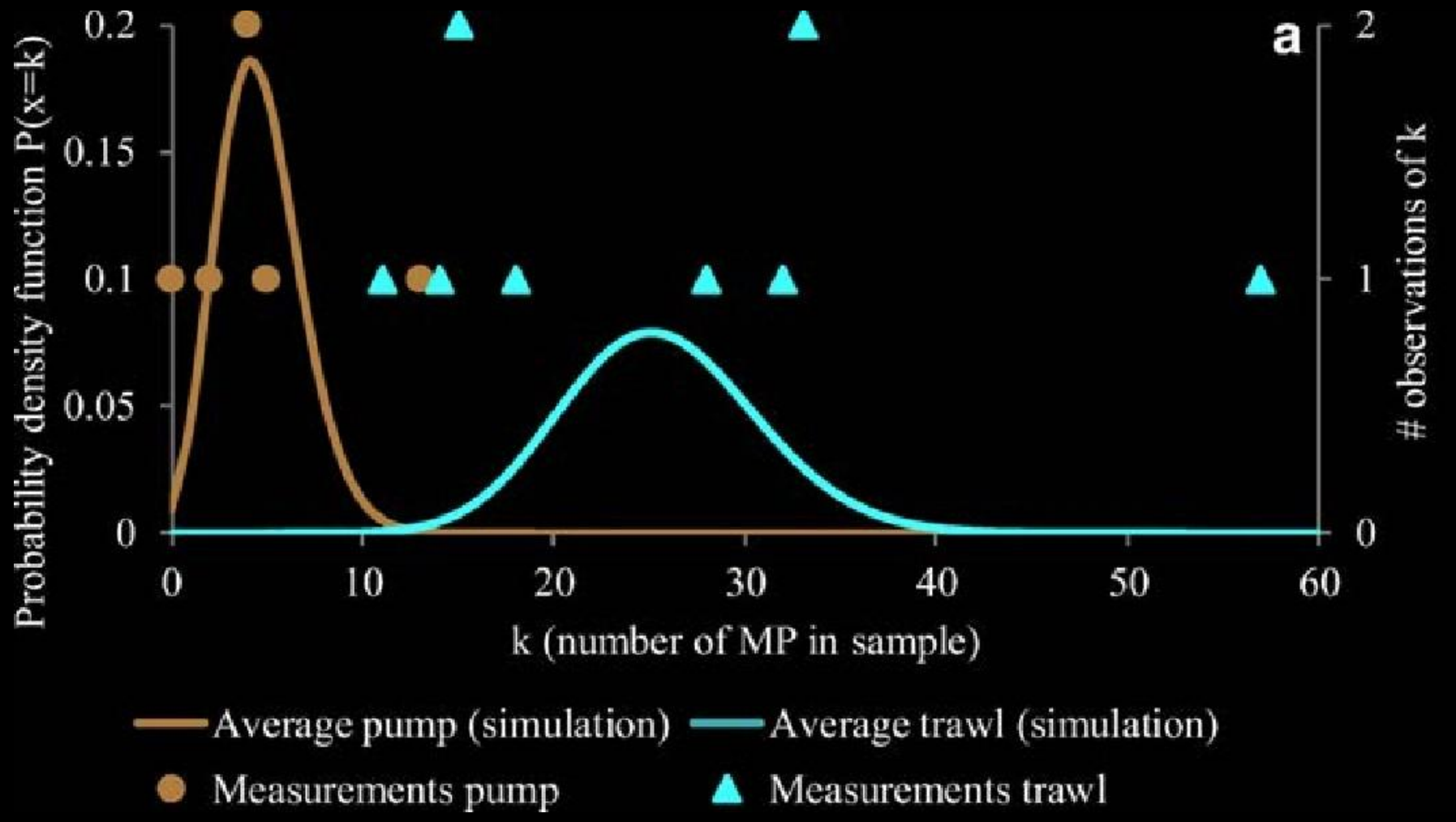
Missing Fiber Data Introduced Highest Uncertainties



Coffin *et. al, Microplastics & Nanoplastics* (2022)

Monitoring Recommendation: *In-situ* pumps





Karlsson *et al.* (2020). *Environmental Science and Pollution Research*

Ocean Risks Expected to Increase Exponentially

A black-to-yellow color scale is used to indicate plastic concentration:
- black = low concentrations
- yellow = high concentrations
(all concentrations are in microplastics per m²)

A year can be selected using the slider below.
Pushing the green play button will allow you to progress automatically through the years from 1960 to 2100.
You can also click on the map to see the number of microplastics per m².

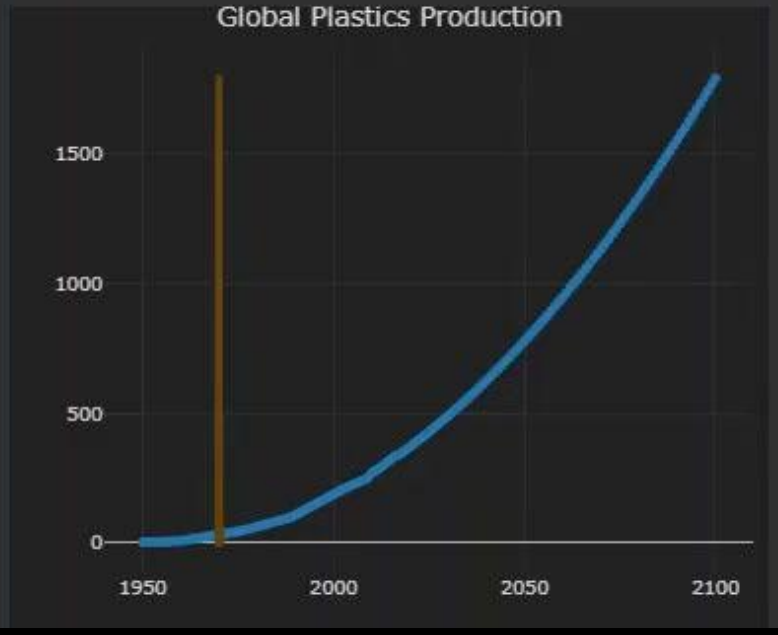
Year selection

1,973

1,961 1,975 1,989 2,003 2,017 2,031 2,045 2,059 2,073 2,087 2,100

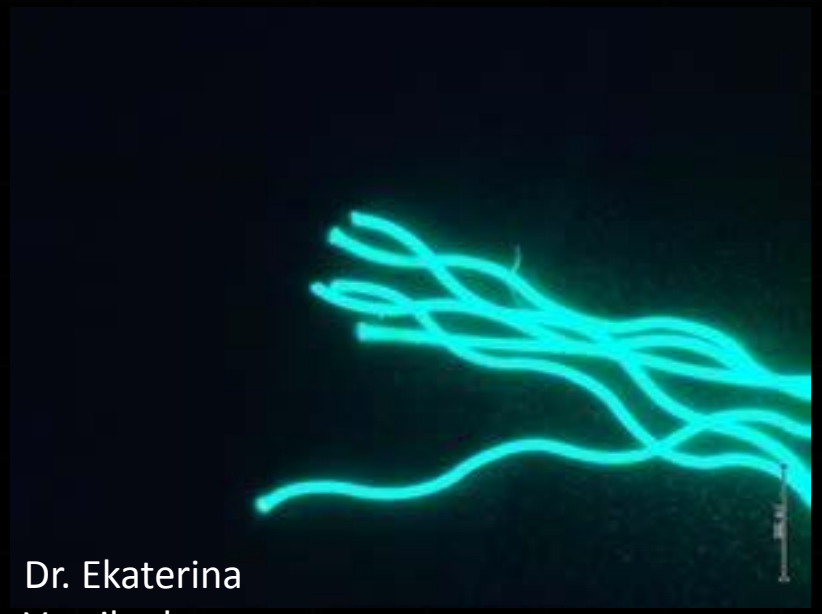
Year = 1970

Global Plastic Production = 32.5 MT



Everaert et al. (2020). *Environmental Pollution*

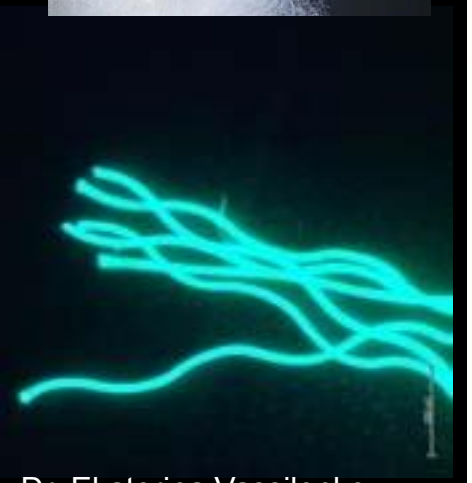
Microfiber emissions to land rival those to water and are rising



Dr. Ekaterina Vassilenko

Gavigan *et al.* (2020). *Plos One*

Washing Machines Potentially Significant Transport for Microfibers



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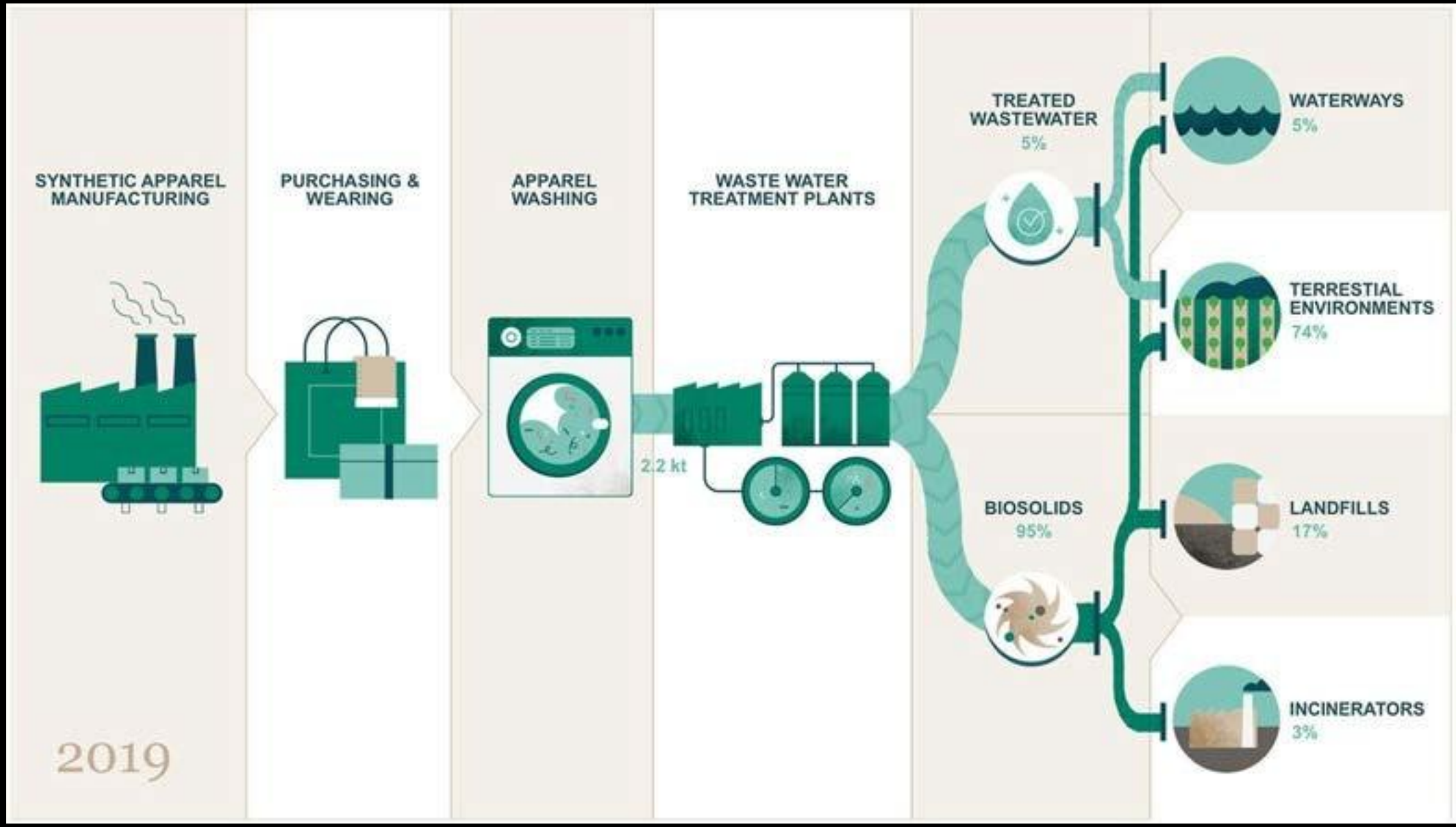
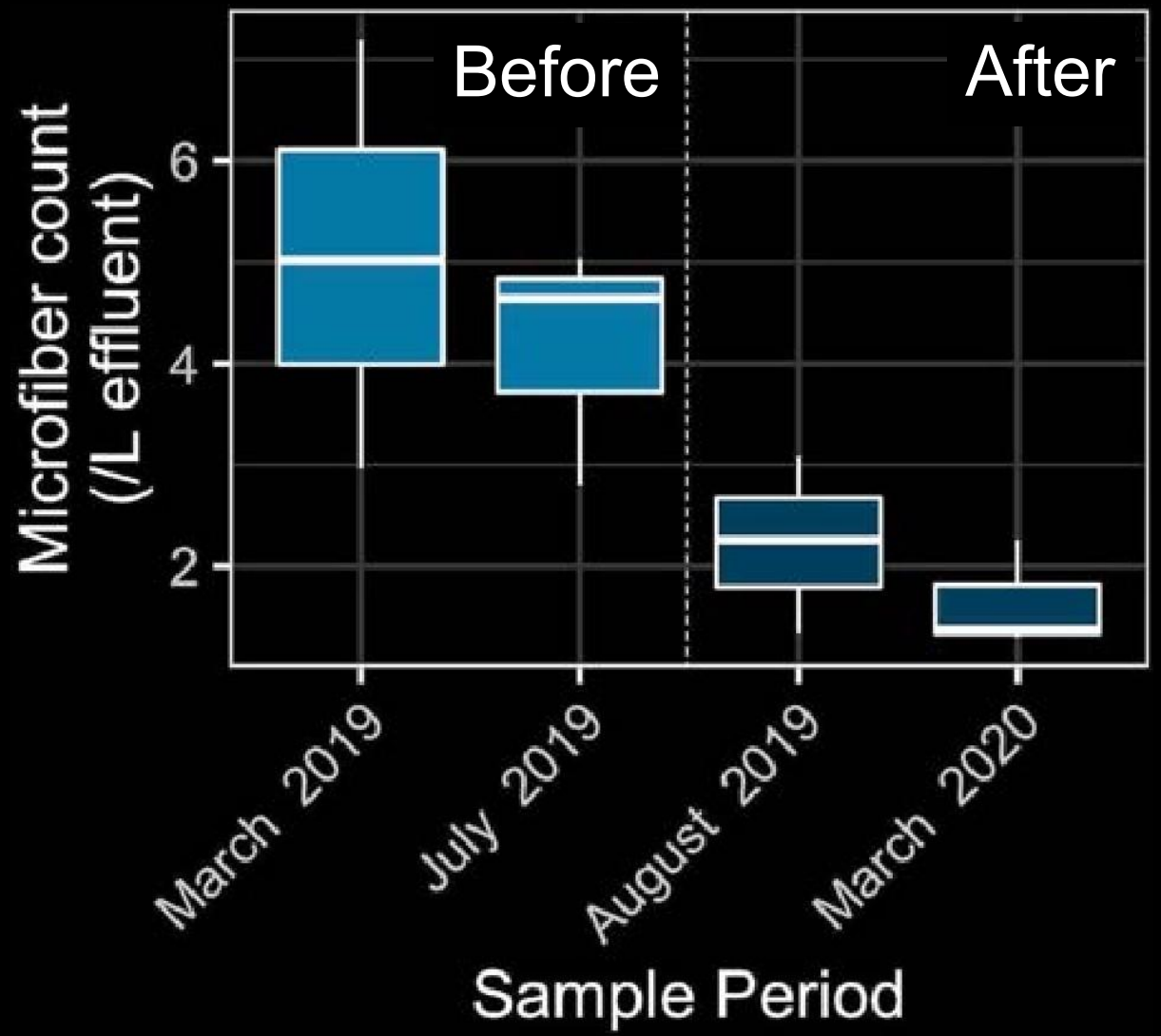


Geyer et al (2022). *Environmental Pollution*

Washing Machine Filters Reduce Wastewater Discharge Concentrations of



Erdle et al (2021). *Frontiers in Marine Science*

California Senate Bill 1263 (2018): Statewide Microplastics Strategy

2022 Deadlines 2026

- Initiate Statewide Microplastics Strategy

- Develop **risk assessment** framework
- Develop standardized **methods**
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- Investigate **sources** and **pathways**
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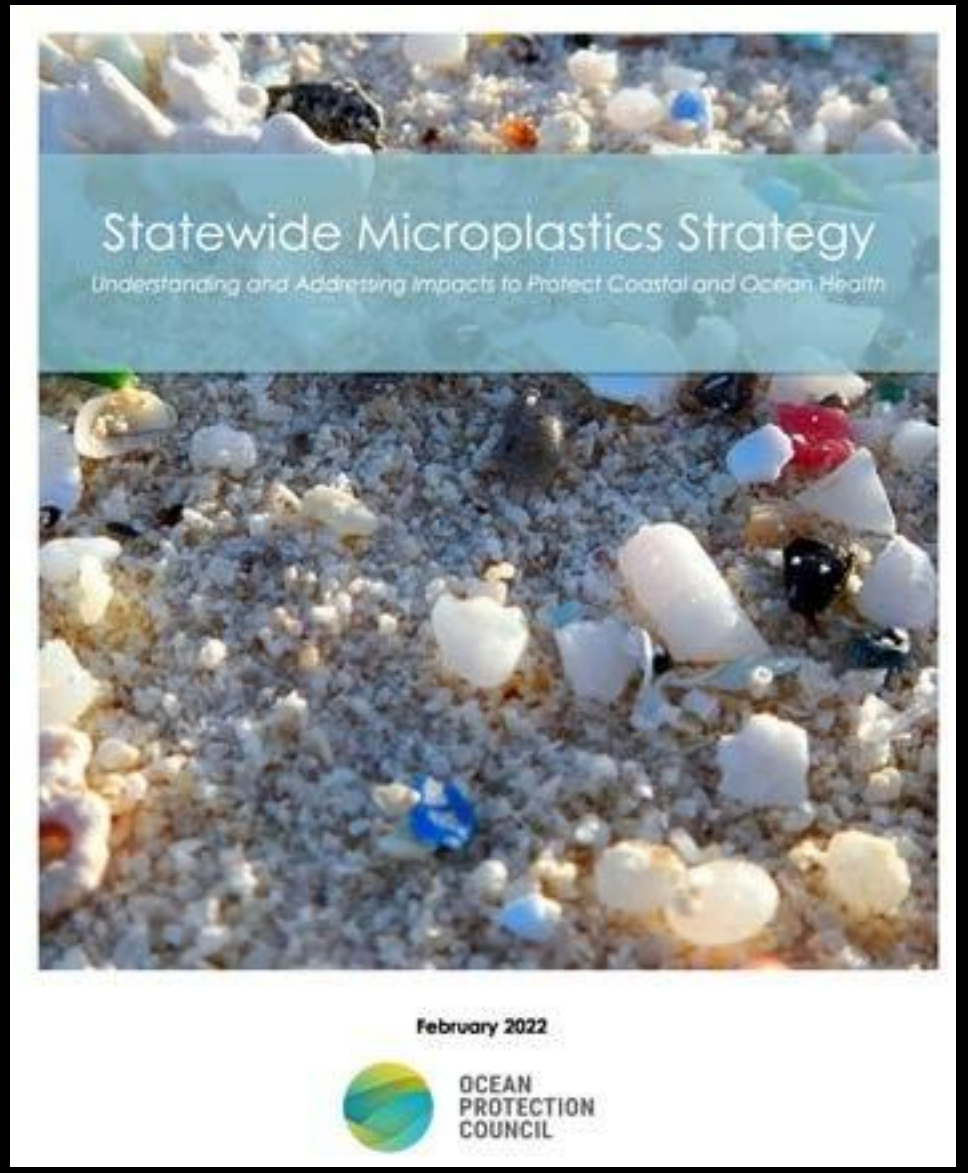
Statewide Microplastics Strategy: 2-Track Approach

Track 1: Solutions

- **Pollution Prevention**
  Eliminate plastic waste at the source
- **Pathway Interventions**
  Intervene with the mobilization of microplastics into CA waters
- **Outreach & Education**

Track 2: Science to Inform Future Action

- **Monitoring**
  Understand and identify statewide trends
- **Risk Thresholds & Assessment**
  Understand thresholds for aquatic life & humans are impacted
- **Sources & Pathways Prioritization**
  Identify & prioritize solutions based on dominant pathways
- **Evaluating New Solutions**



An Ounce of Prevention is Worth a Pound of Cure

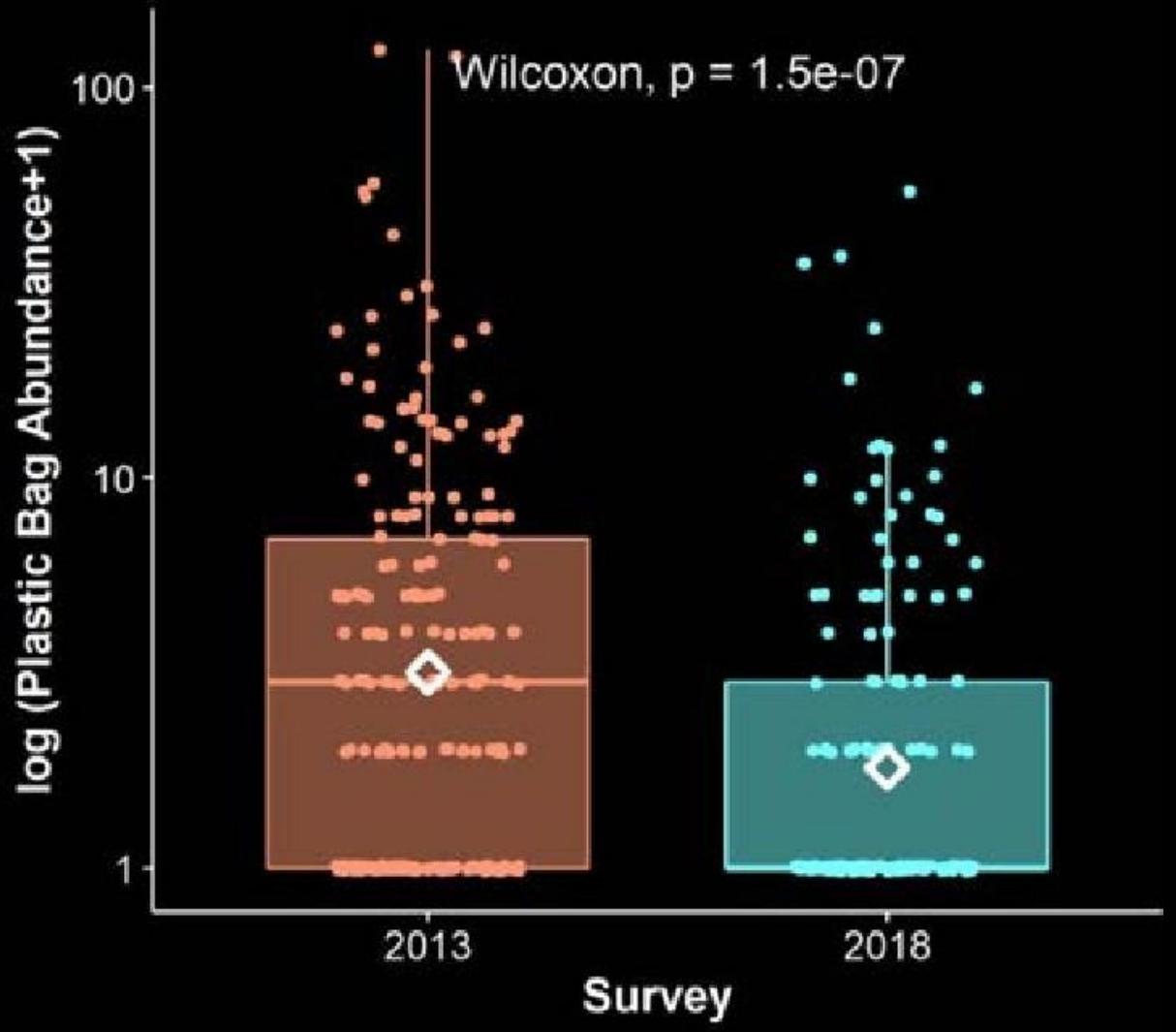
‘Upstream’
Cost-Effective

‘Downstream’
Expensive

Photo: James Wakibia

California's Bag Ban Works

Reduction of **plastic bags** observed in the Southern California Bight 2013 -



SCCWRP, Bight '18 Trash and Marine Debris Report

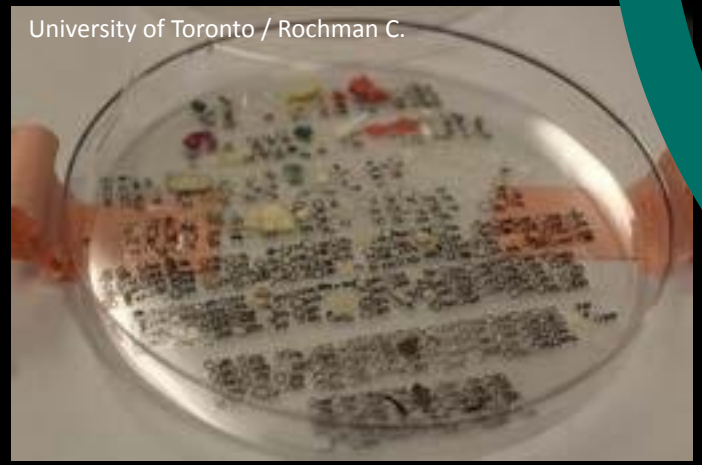
Science to Inform Future Action: Research Priorities

1. Monitoring

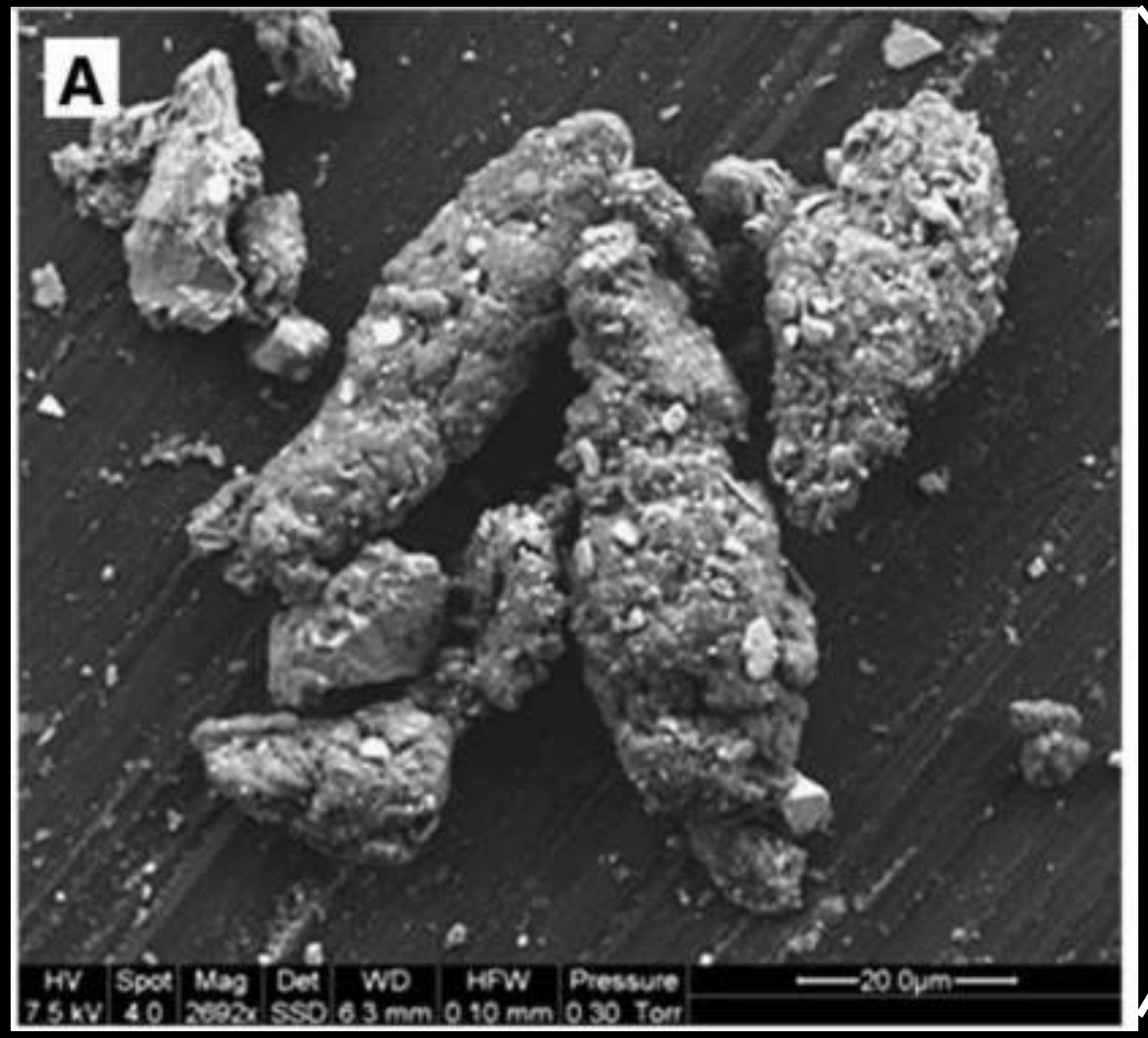
2. Risk Thresholds & Assessment

3. Sources & Pathways Prioritization

4. New Solutions



Rubber Fragments dominate SF Bay Stormwater



Pohrt (2019). “Tire wear particle hot spots – Review of influencing factors”

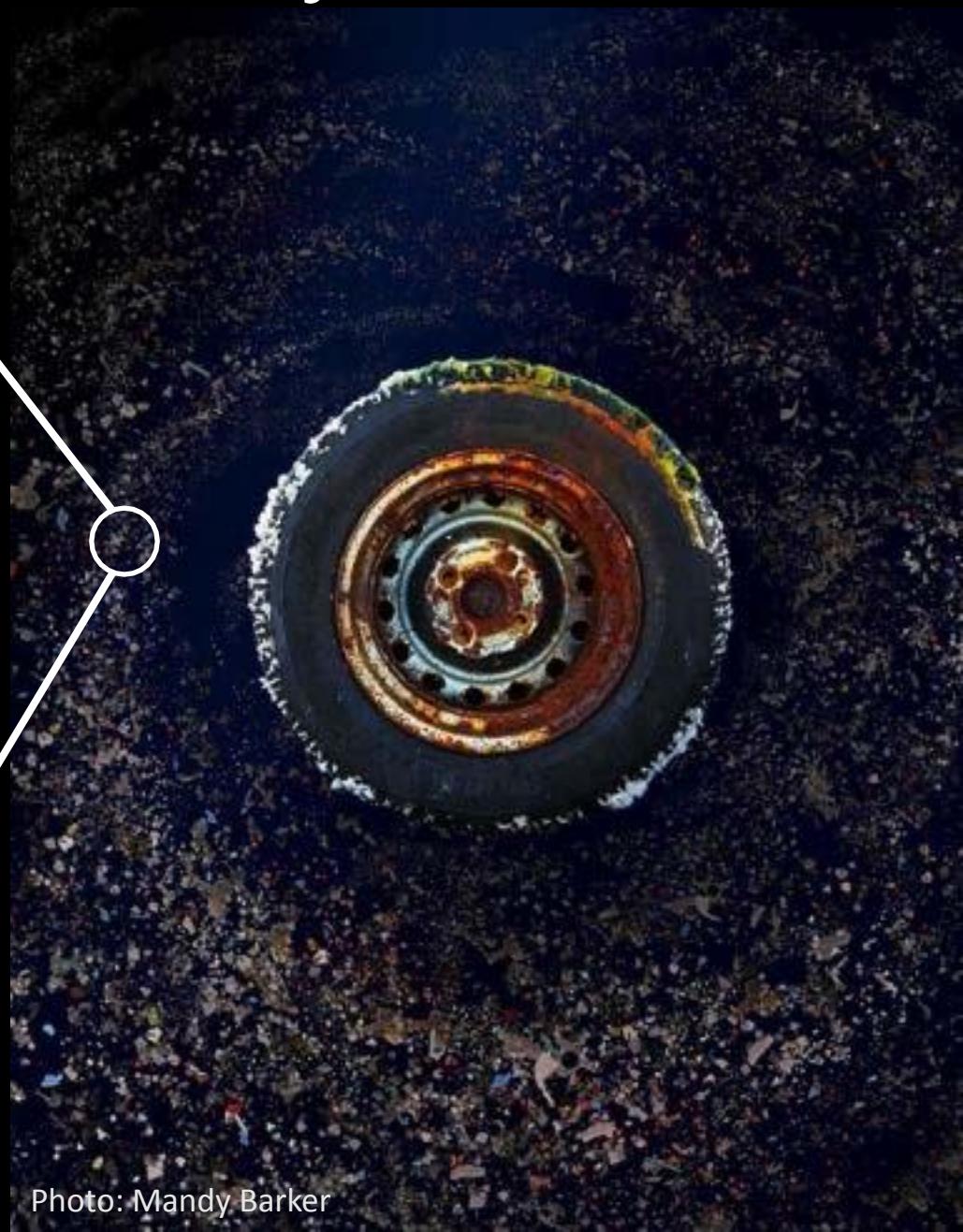
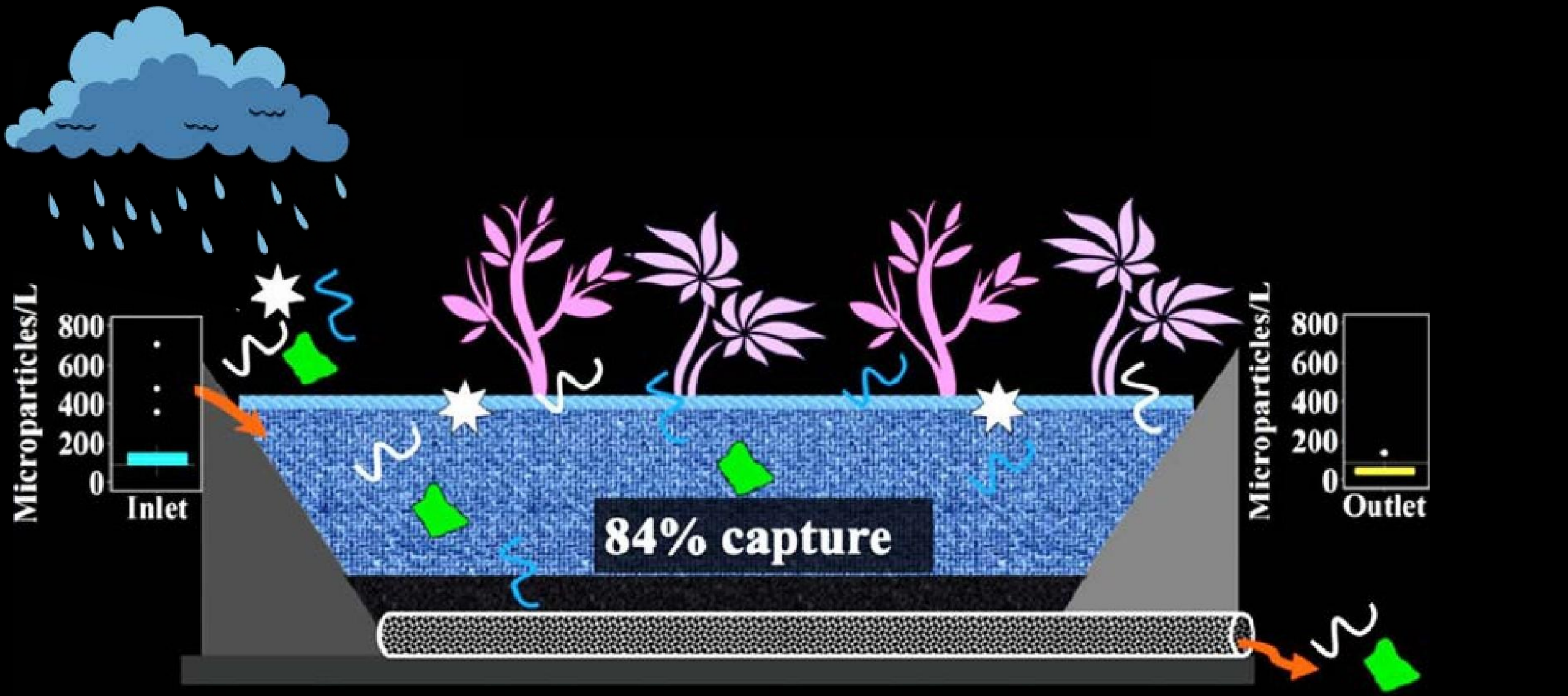


Photo: Mandy Barker

Bioretention Cells Remove Microplastics from Urban Stormwater



Smyth *et al.* (2021). Water Research.

Mouth of Los Angeles River in Long Beach, California

Photo: Bill McDonald, Algalita Foundation

Recent Plastic Pollution Control Measures in LA

- **Los Angeles County Single Use Plastics Ordinance** (May 1, 2023)
  - Bans single-use foodware in full-service restaurants
  - Bans syrofoam (unless encased in durable materials)

- **Plastic Pollution Prevention and Packaging Producer Responsibility Act (2022)**
  - Statewide requirements for 100% of packaging sold by recyclable or compostable by 2032

- **Total Maximum Daily Load (zero) for Trash in LA River Watershed (2007)**
  - Requires full capture systems that trap particles > 5mm

Microplastics Monitoring Subcommittee

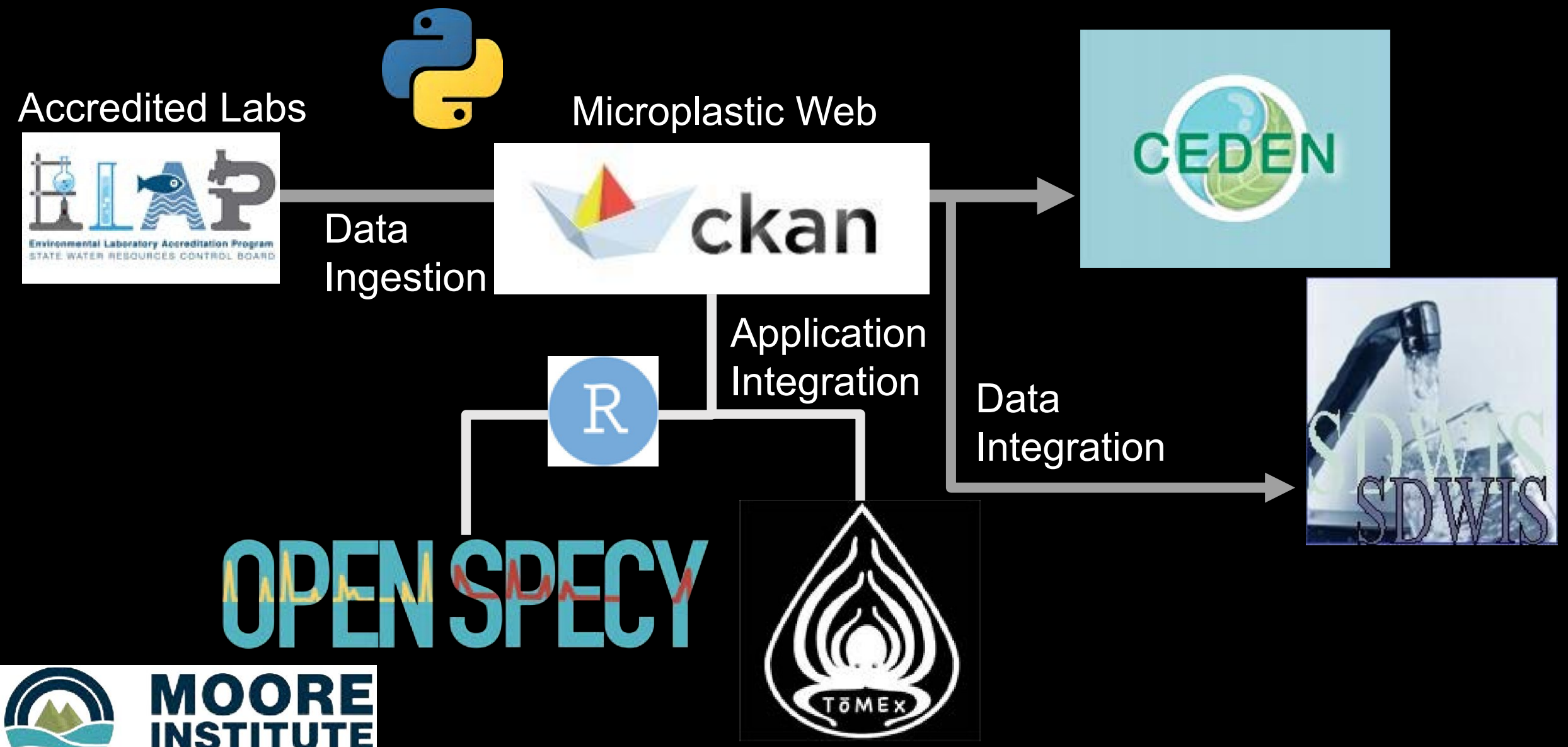
Local and global community exchange of information and data for microplastics monitoring methods and tools

Quarterly Meetings

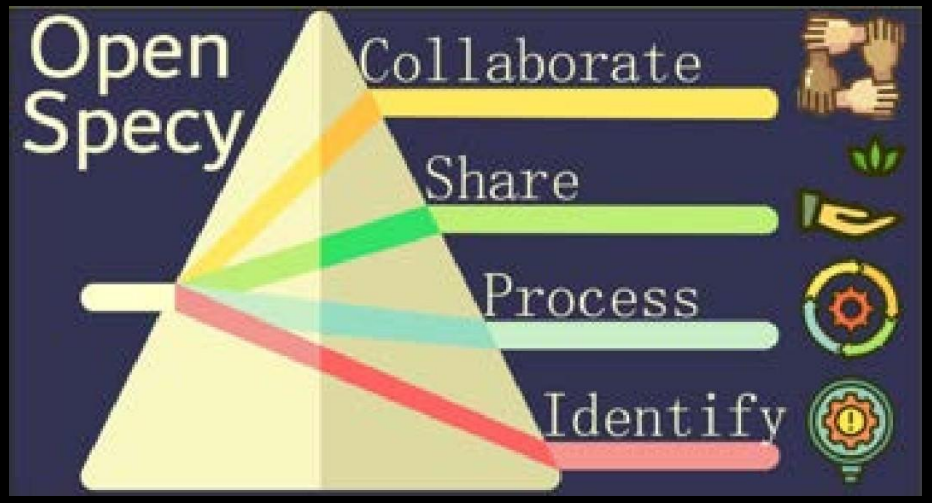
- **Sampling and analysis playbook**
- **Communication toolbox**
- **Laboratory accreditation & data analysis**

Next Meeting: August 7; 11 am to 1pm

Harmonized Data Reporting Vital: *OneForAll*



The Microplastics Community is Built on **Sharing Freely**



#OpenLitterMap

OpenDrift

TACO

Plastic DB

OceanParcels

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#TRASH DATA DIVE 19

TōMEx

BEAT THE MICRO BEAD

EAS-E SUITE

PAN-AFRICAN MICRO(NANO) PLASTIC RESEARCH NETWORK

TIDES
Trash Information and Data for Education and Solutions

micro investigators

IKHAPP

OpenOceans Global

Removing barriers on plastic research

@ThePlastiverse

Plastiverse.org

CALIFORNIA
Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

@DrSCoffin

Slides available free:
researchgate.net/profile/Scott-Coffin-2

Photo:
Mandy