

Microplastics Monitoring in Drinking Water

Trash Free Webinar: You Are What You Eat
(and Breathe): Exposure and Impacts of
Nano- and Microplastics on Human Health

Nov 30, 2023



Scott Coffin, Ph.D.
California State Water
Resources Control Board

 @DrSCoffin



Mandy Baker

PLASTIC FIBERS IN TAP WATER, 2017



orb. one world. one story.



PREVALENCE OF MICROSCOPIC PLASTIC FIBERS BY SAMPLE SOURCE LOCATION.



WORLDWIDE
83%



USA
94%



EUROPE
72%



INDONESIA,
JAKARTA
76%



INDIA,
NEW DELHI
82%



LEBANON,
BEIRUT
94%



UGANDA,
KAMPALA
81%



ECUADOR,
QUITO
75%



CALIFORNIA

Water Boards

STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

July 1, 2020

California Senate Bill 1422 (2018)

- Define 'microplastics'



July 1, 2021

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

Deadlines



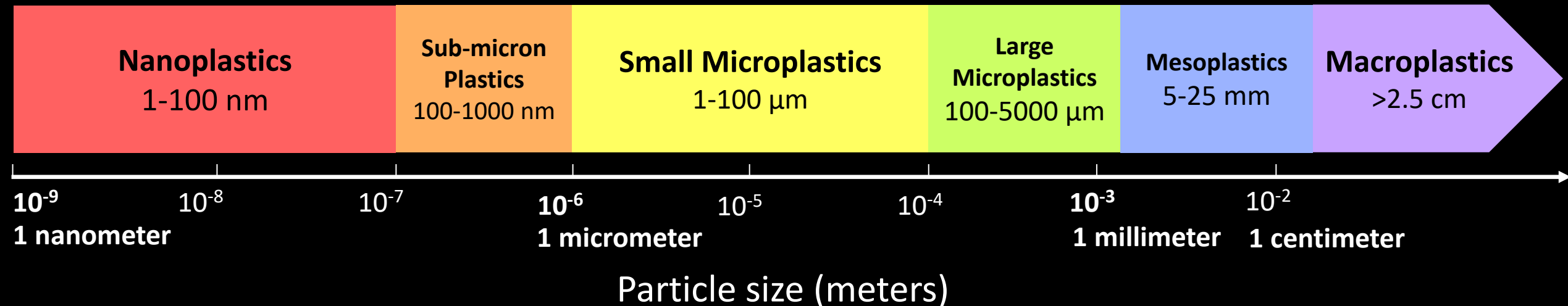
Photo: Mandy Barker

Official Definition: 'Microplastics in Drinking Water'

'solid polymeric materials to which chemical additives or other substances may have been added, which are particles which have at least three dimensions that are greater than 1 nanometer and less than 5,000 micrometers.

Polymers that are derived in nature that have not been chemically modified (other than by hydrolysis) are excluded.'

Size-Based Classification





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California's Inter-Lab Validation Study

Two Methods



FTIR
Spectroscopy



Raman
Spectroscopy

26 Laboratories



Four Matrices



Drinking Water



Ocean Water

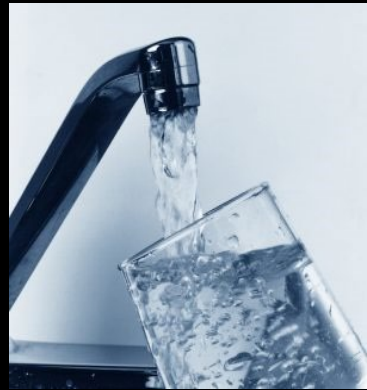


Fish Tissue



Sediment

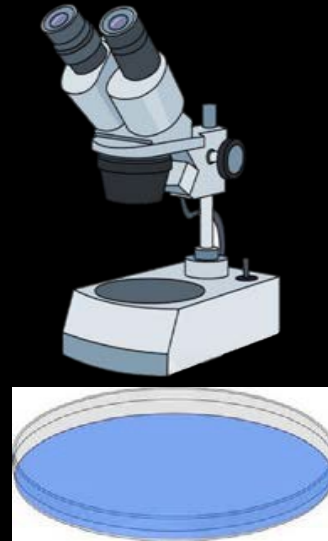
Laboratory Process for Microplastics Analysis



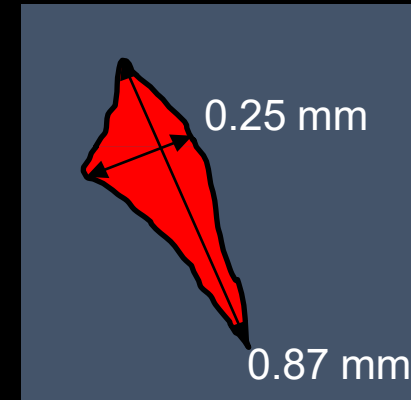
Sample
Collection



Particle
Extraction



Particle
Identification &
Categorization



Pictures &
Measurements



Chemical
Analysis

Blind samples

- **Four Polymers**

- Polystyrene, polyethylene, polyvinyl chloride, polyethylene terephthalate

- **Four size fractions**

- 1-1000 μm
- 1-20 μm , 20-212 μm , 212-500 μm , >500 μm

- **Four shapes**

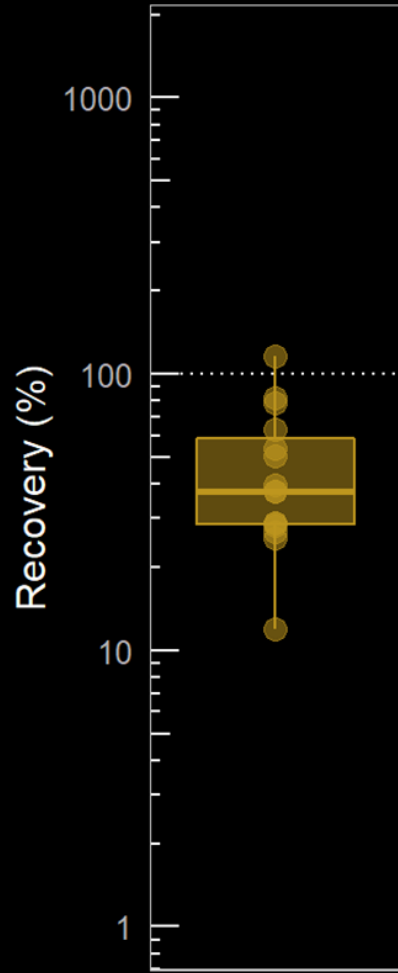
- Pellets, fragments, spheres, fibers

- **False positives**

- E.g., sand, shell fragments, cotton, cellulose, bunny fur



Method Performance at a glance



Total Particles

Method Strengths and Weaknesses

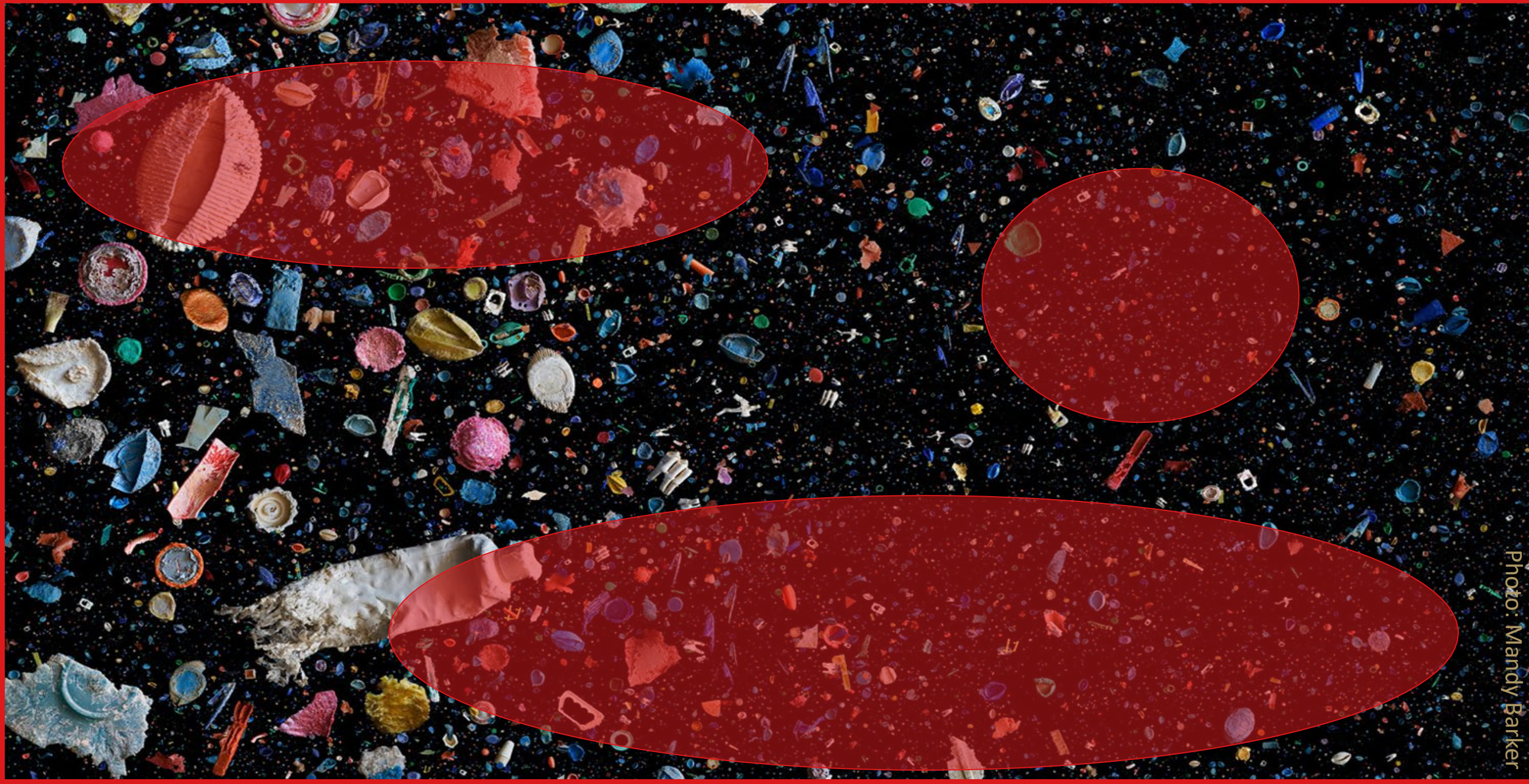
	Optical Microscopy	Infrared Spectroscopy	Raman Spectroscopy
Accuracy (Overall)	44 ± 27%	93%	83%
Measurement time/sample	26 ±54 hours	10 ±9 hours	15 ±16 hours
Instrument cost	\$26,500 (\$500 - \$110,000)	\$95,000 (\$550 - \$300,000)	\$165,000 (\$10,000 - \$337,000)
Consumables cost	\$1,100 (\$84-\$50000)	\$900 (\$10 -\$50000)	\$2,500 (\$10-\$120000)
Chemical identification	No	Yes	Yes
Lower size limit (approximate)	> 20 μm	> 10 μm	> 2 μm

Standardized Method Available for Accreditation



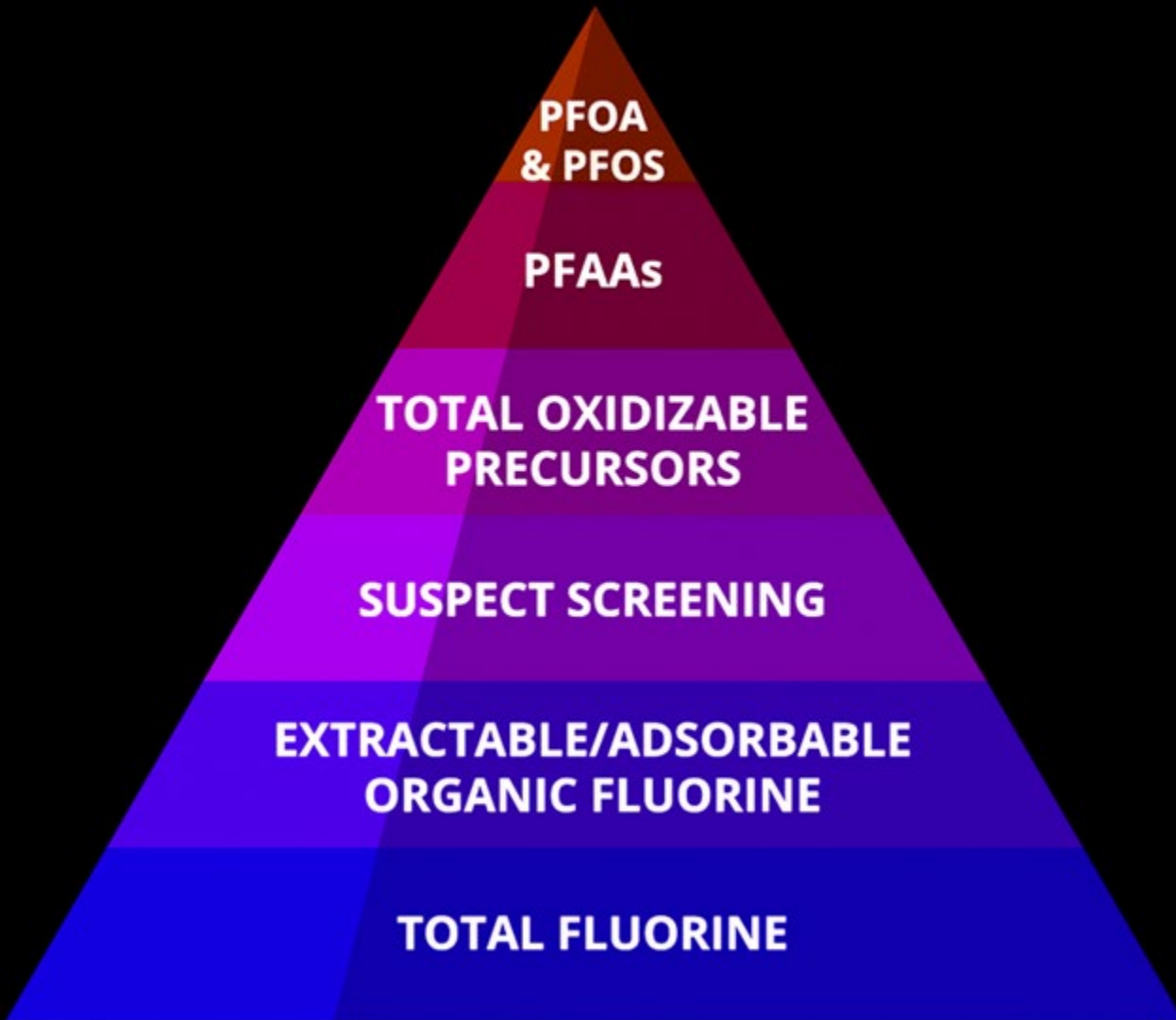
Moore Institute for Plastic Pollution Research
(April, 2022)

Method Should Be Tailored to Specific Particle Types

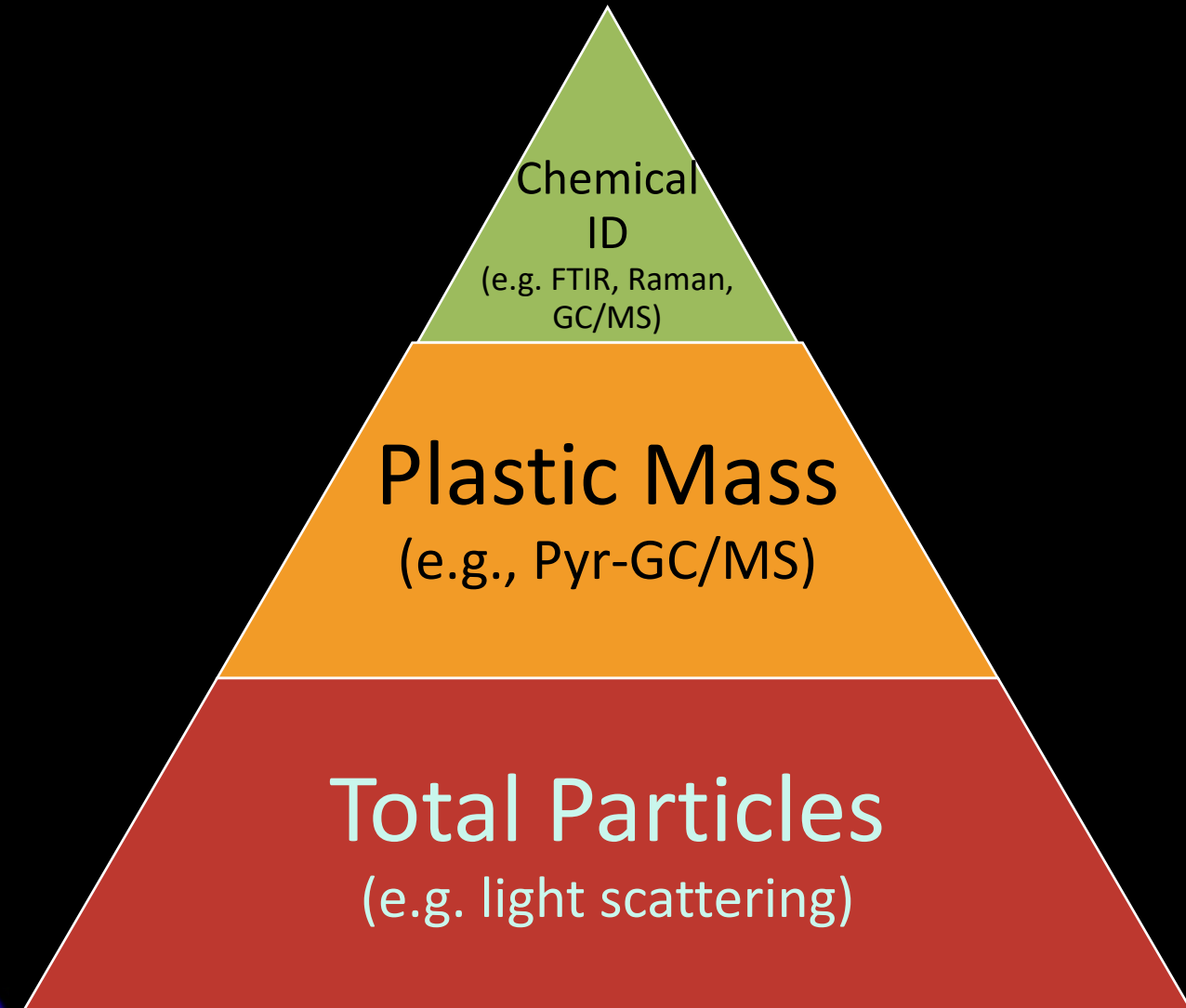


Tiered Monitoring Framework

PFAS



Microplastics





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- **Health-based guidance level**
- Four years of testing

Deadlines

Human and Ecological Health Effects Workshop



**Health Effects
Workshop**



Dose Metrics



Particle Characteristics

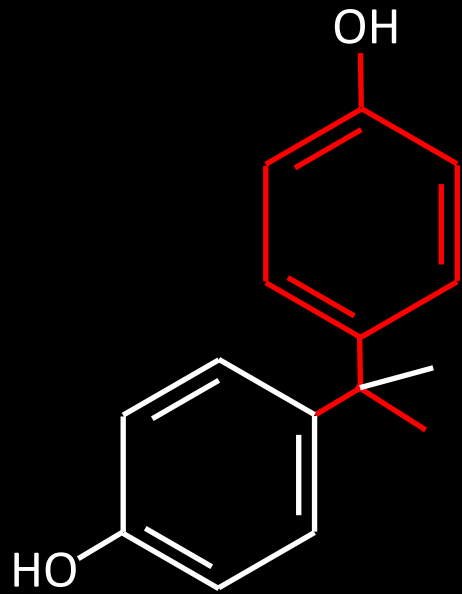


Adverse Effects



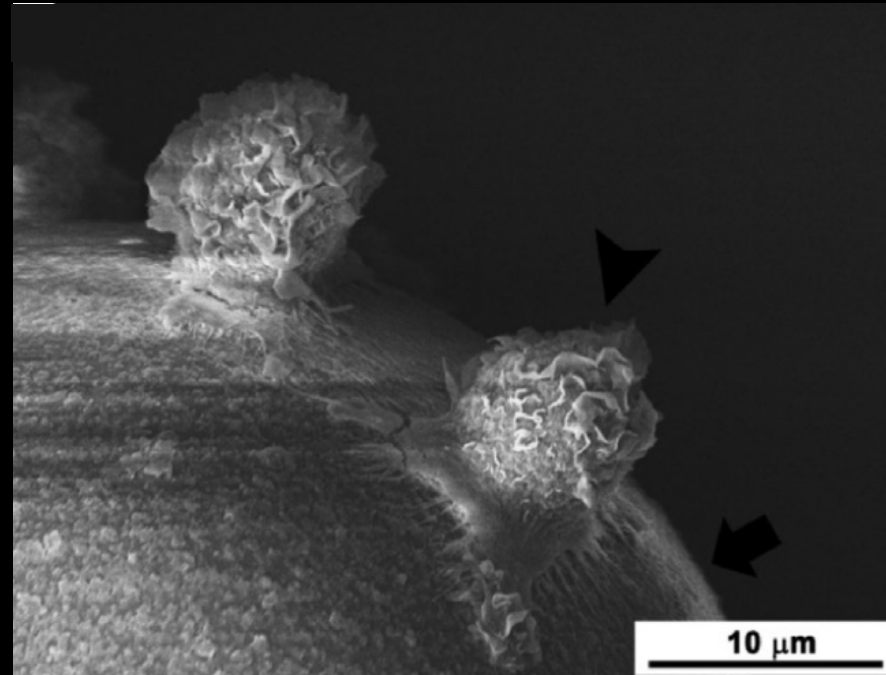
Threshold Framework

Microplastic Hazards



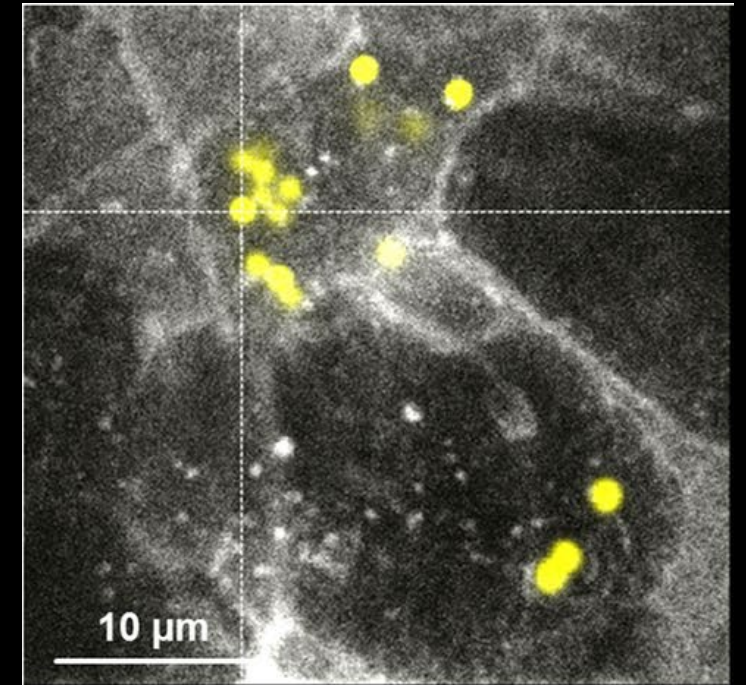
Bisphenol A

Chemical



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

Biological



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

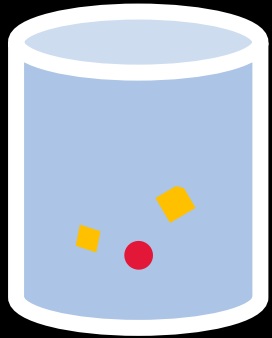
Particle

Mammalian Toxicity Study Screening

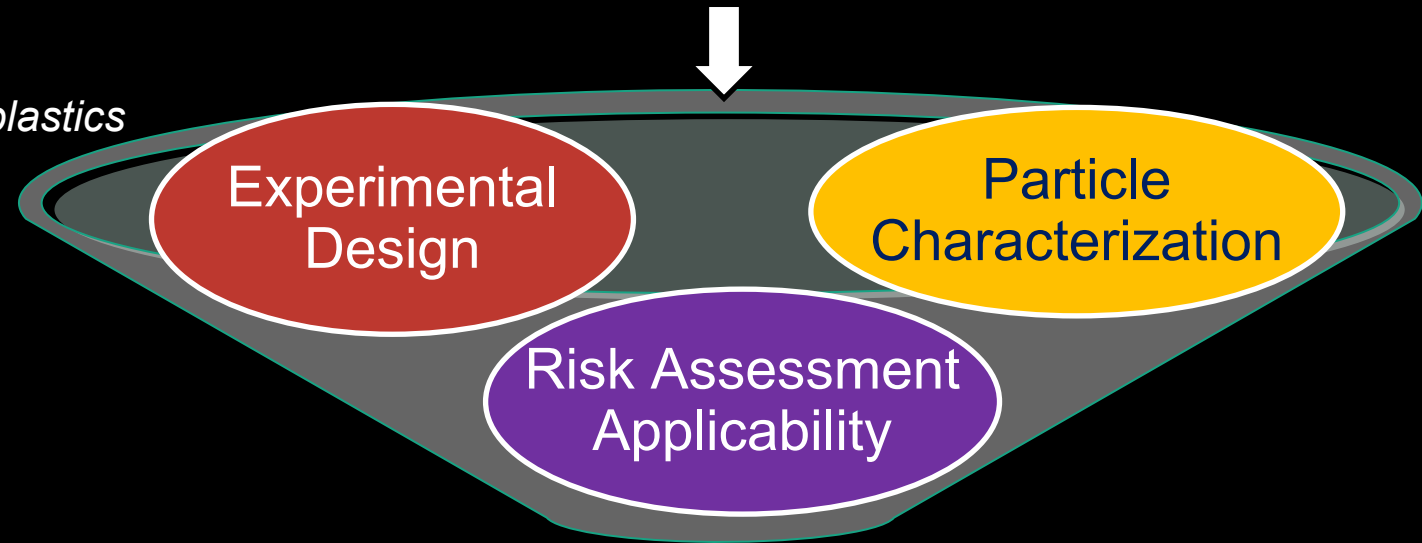


Ingestion-based *in vivo* mammalian microplastics toxicity studies
(n = 29)

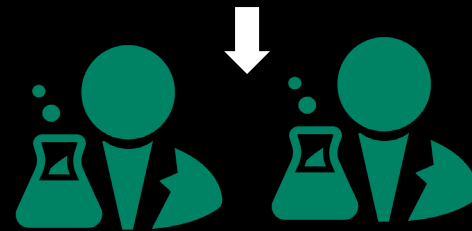
Gouin et al (2022), *Microplastics & Nanoplastics*



Drinking Water



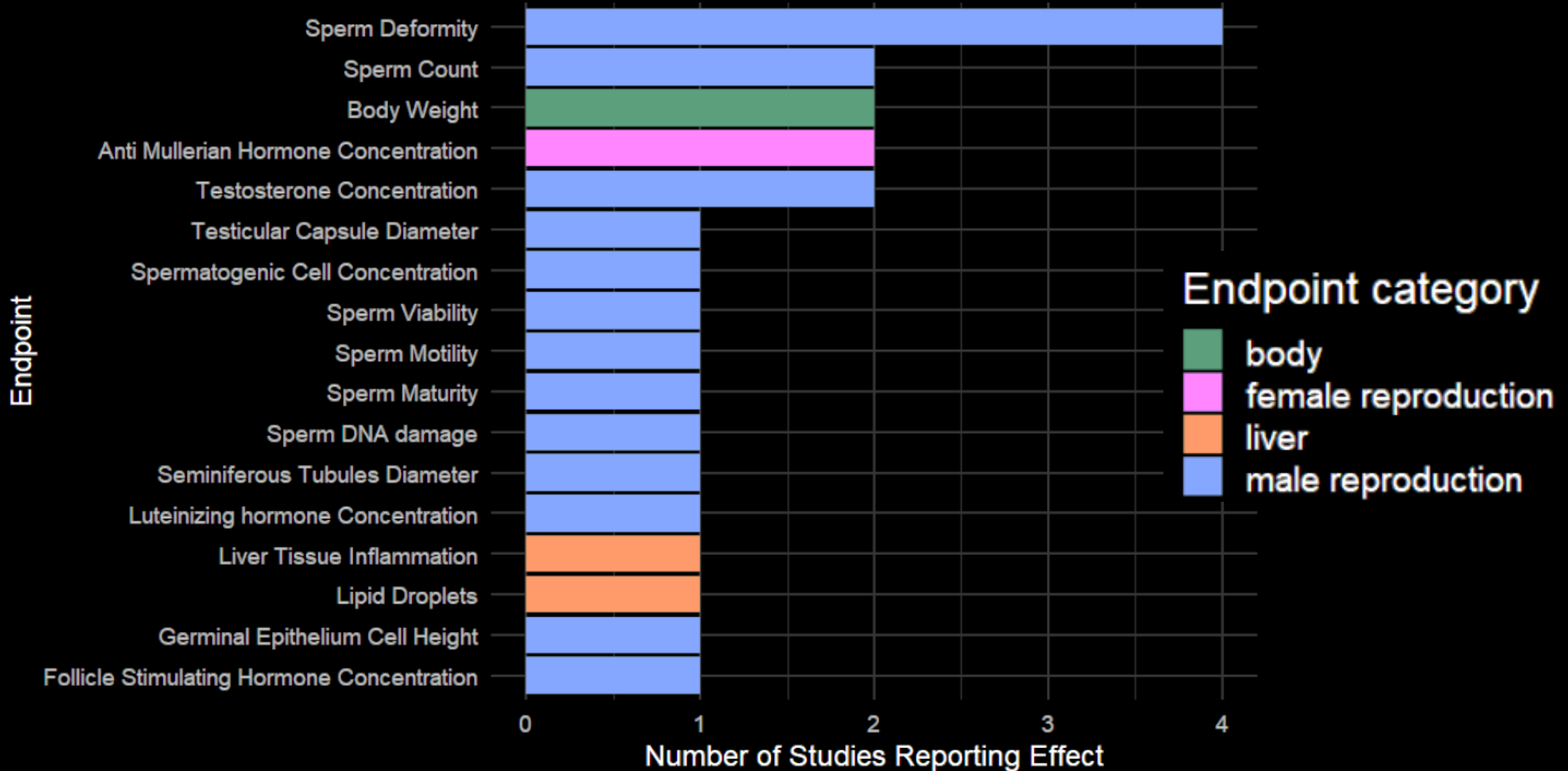
Fit for purpose studies
(n = 12)



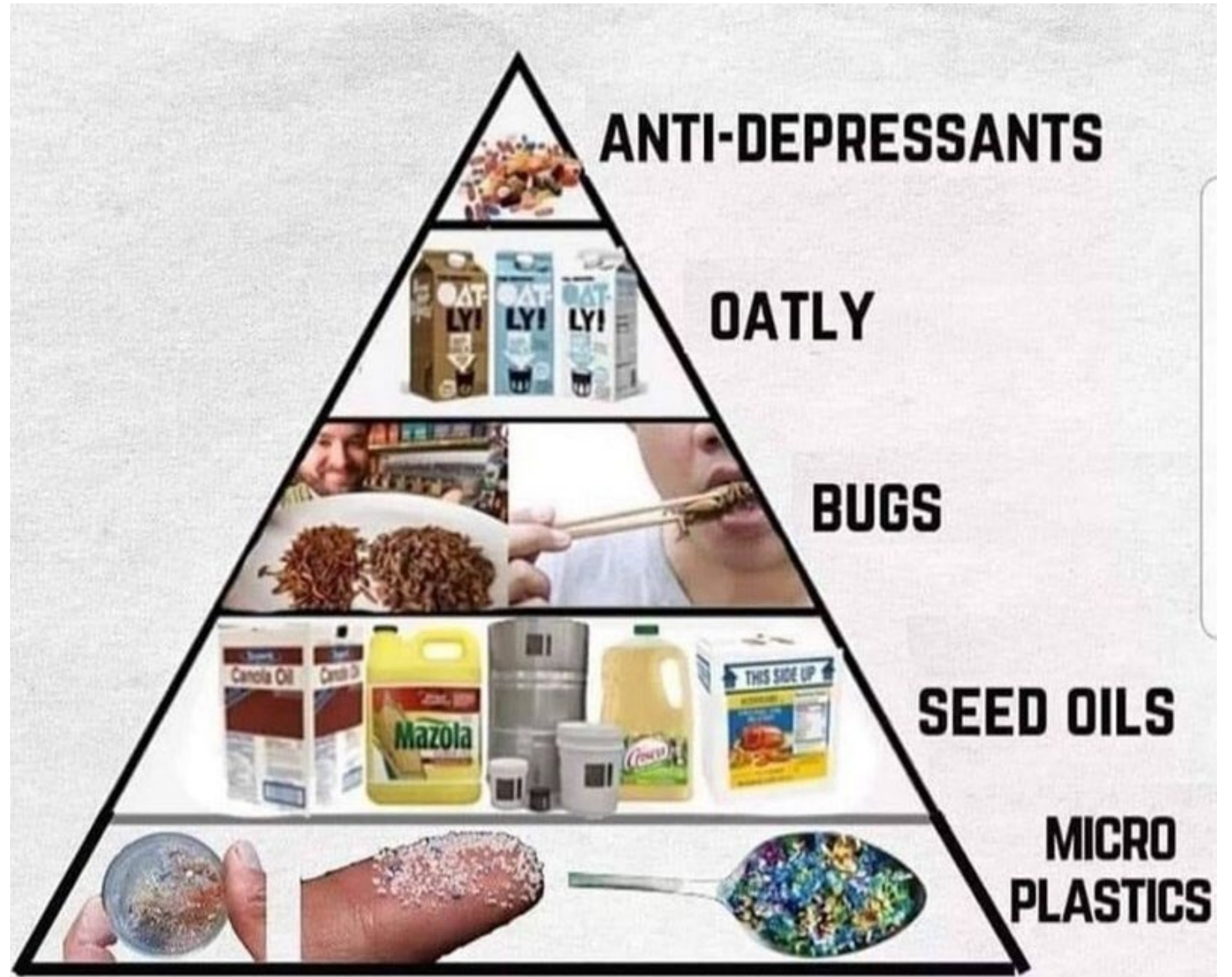
Expert review

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

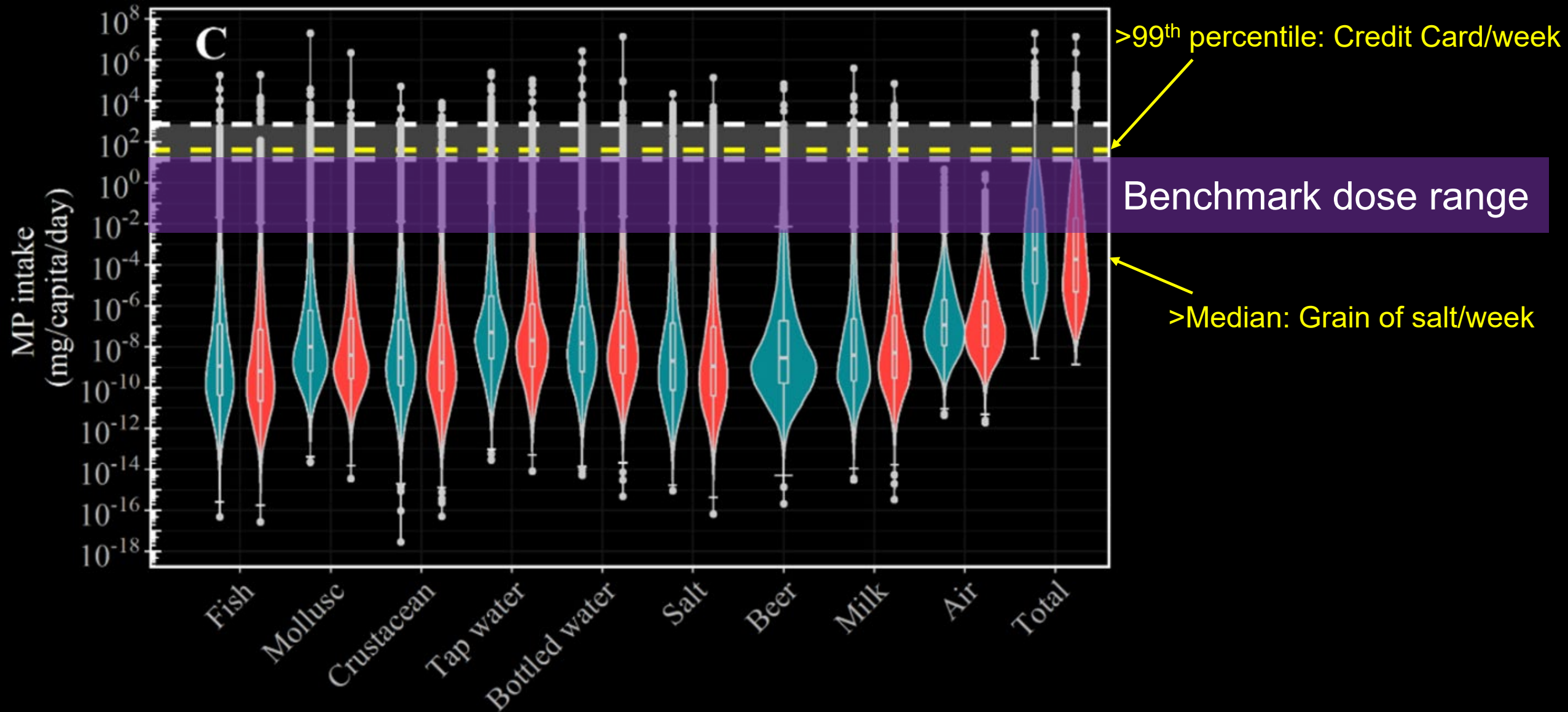
Reliable Endpoints for Microplastics Effects in Mammals



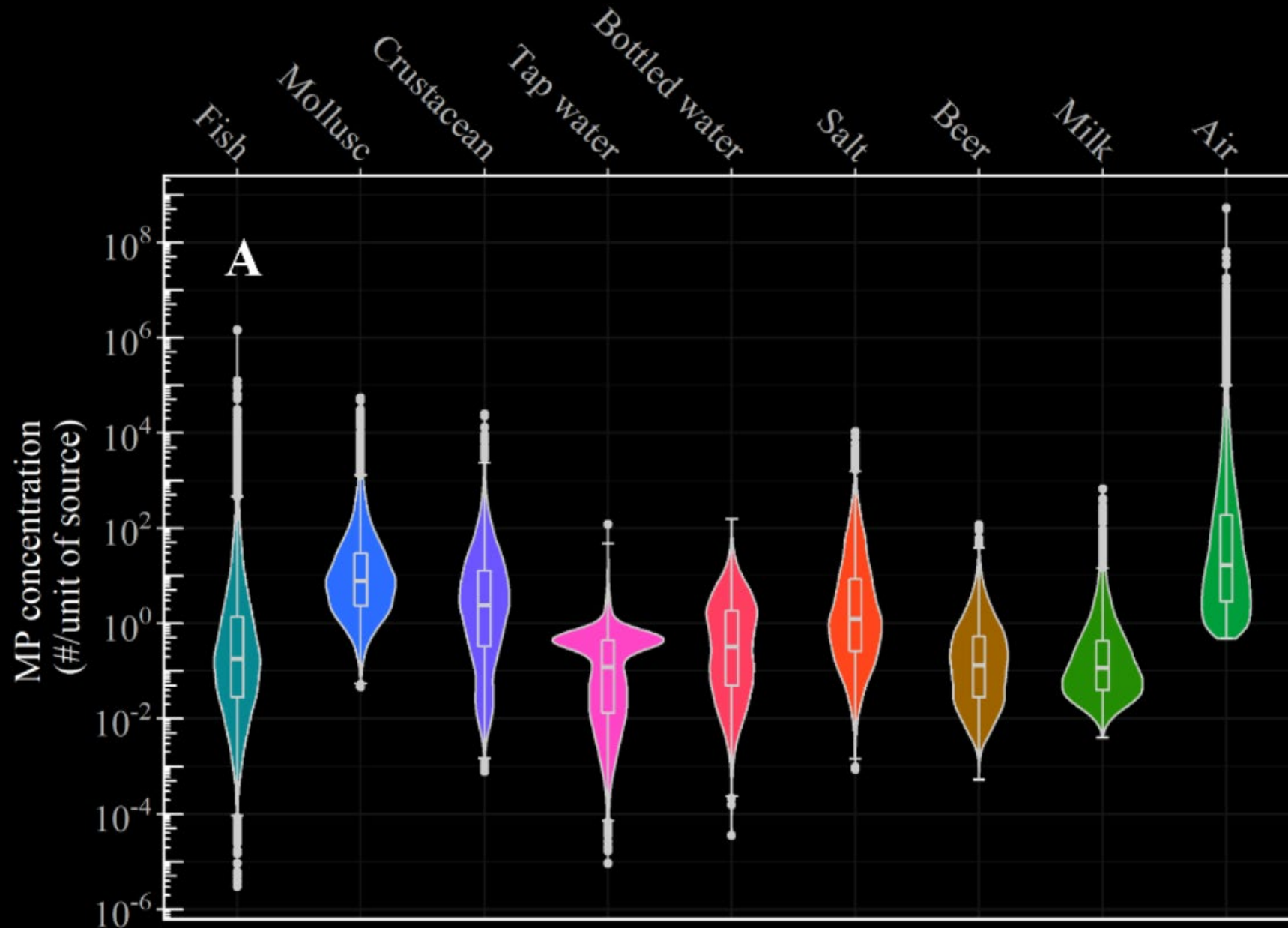
“2023 Food Pyramid”



Wide Uncertainties and Variability for Exposure

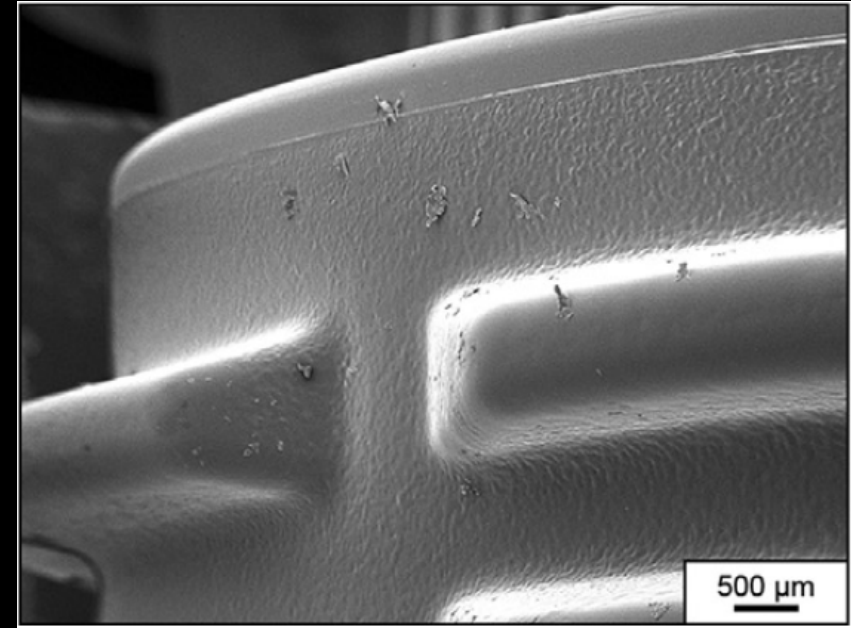


Bottled Water Typically more Contaminated than Tap

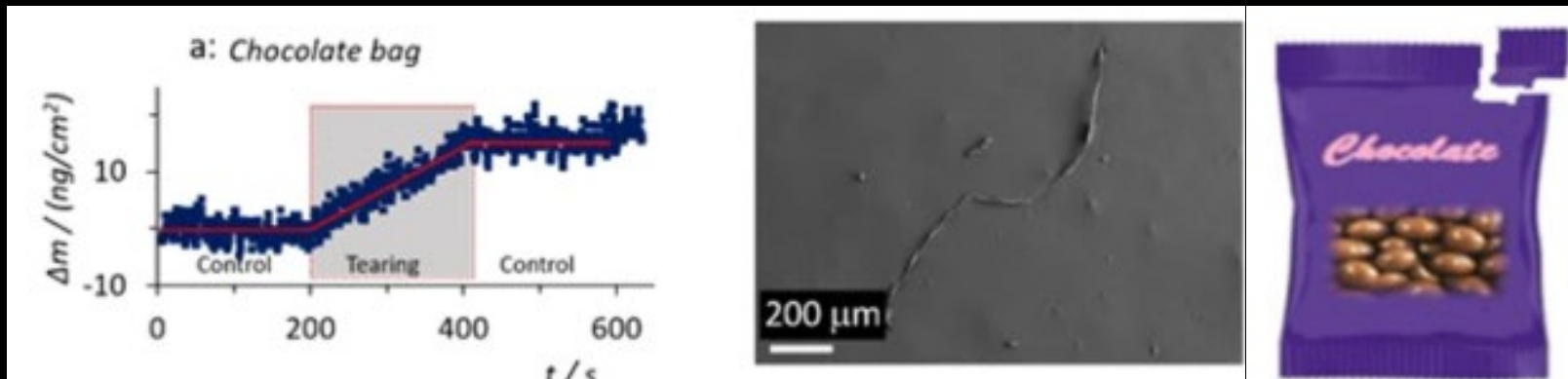


Plastic Packaging Releases Microplastics

Opening a plastic water bottle releases **14-2,400** microplastic particles



Winkler, et al. *Water Research* (2020).



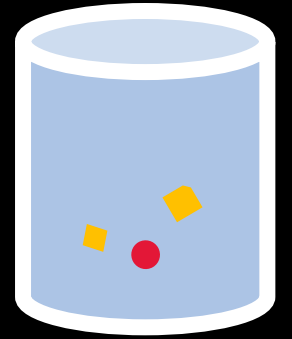
Opening a plastic snack bag releases **14,000-75,000** microplastic particles

Sobhani, et al. *Sci Rep* (2020).

Not Currently Possible to Derive Regulatory Levels

1. **Effects database inadequate**

- poor particle characterization
- limited polymers, shapes, sizes tested



Drinking Water

2. **Uncertain Effect Mechanisms**

- necessary for extrapolation to diverse particle types

3. **Incomplete exposure data**

- limited food data
- no harmonized drinking water data



Logo created by J.C. Leapman.

Welcome

Overview

Search

Exploration

Study Screening

Resources

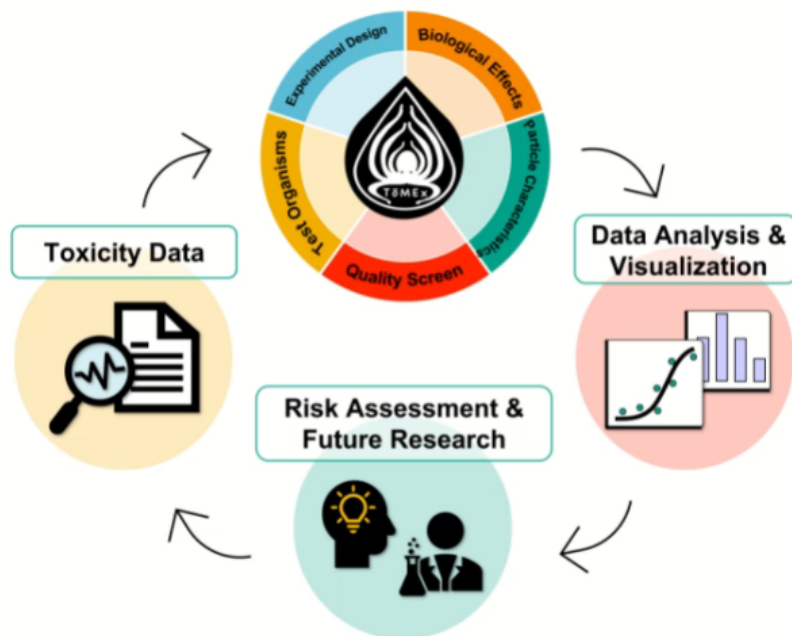
Contact

Aquatic Organisms

Follow Us on Twitter

https://sccwrp.shinyapps.io/human_mp_tox_shiny/-/_w_1298c1d9/#shiny-tab-Welcome

Welcome to the Toxicity of Microplastics Explorer, Human Health Database!



What is the Microplastics Toxicity Database?

This database is a repository for microplastics toxicity data that may inform possible effects on Human Health.

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.

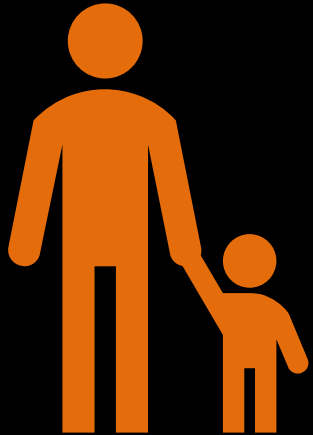
Use the side panel on the left of the page to navigate to each section. Each section provides different information or data visualization options. More specific instructions may be found within each section.

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 microplastics characteristics (e.g., size, shape, polymer) that are of greatest biological concern, and identify critical thresholds for each at which those characteristics will have adverse effects on human health. Workshop findings will be published in a peer-reviewed journal.

ToMEx 2.0 Coming Soon!

Human Health Studies



	ToMEx 1.0	ToMEx 2.0
Total Number of Publications	55	77
Particle Only	54	76
Chemical Co-Exposure	7	7
Chemical Transfer	-	-
Leachate	-	1
Data Points	3,904	6,977
In vivo data	2,512	4,059
In vitro data	1,392	2,918
Species Represented	6	8



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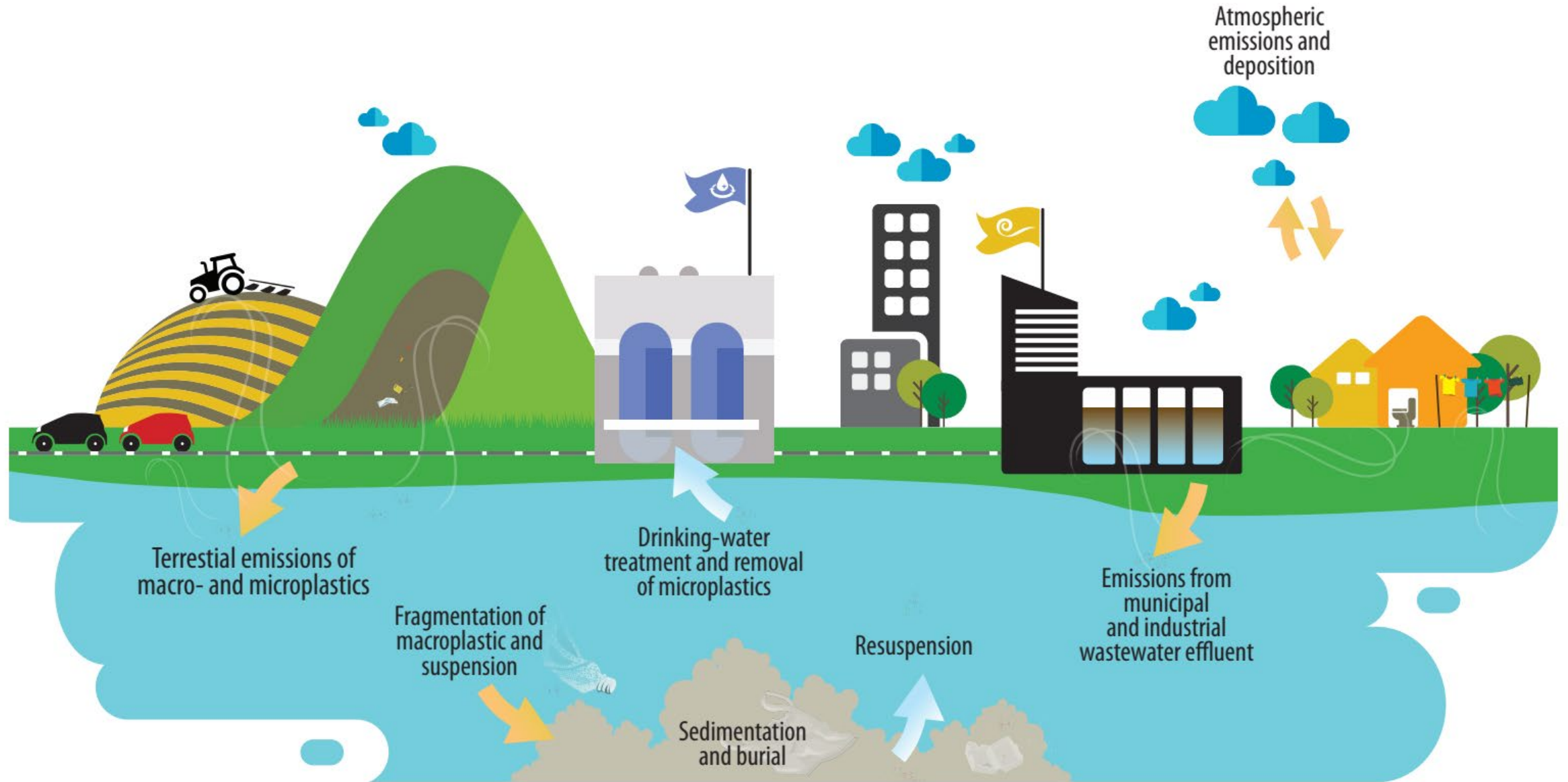


July 1, 2021

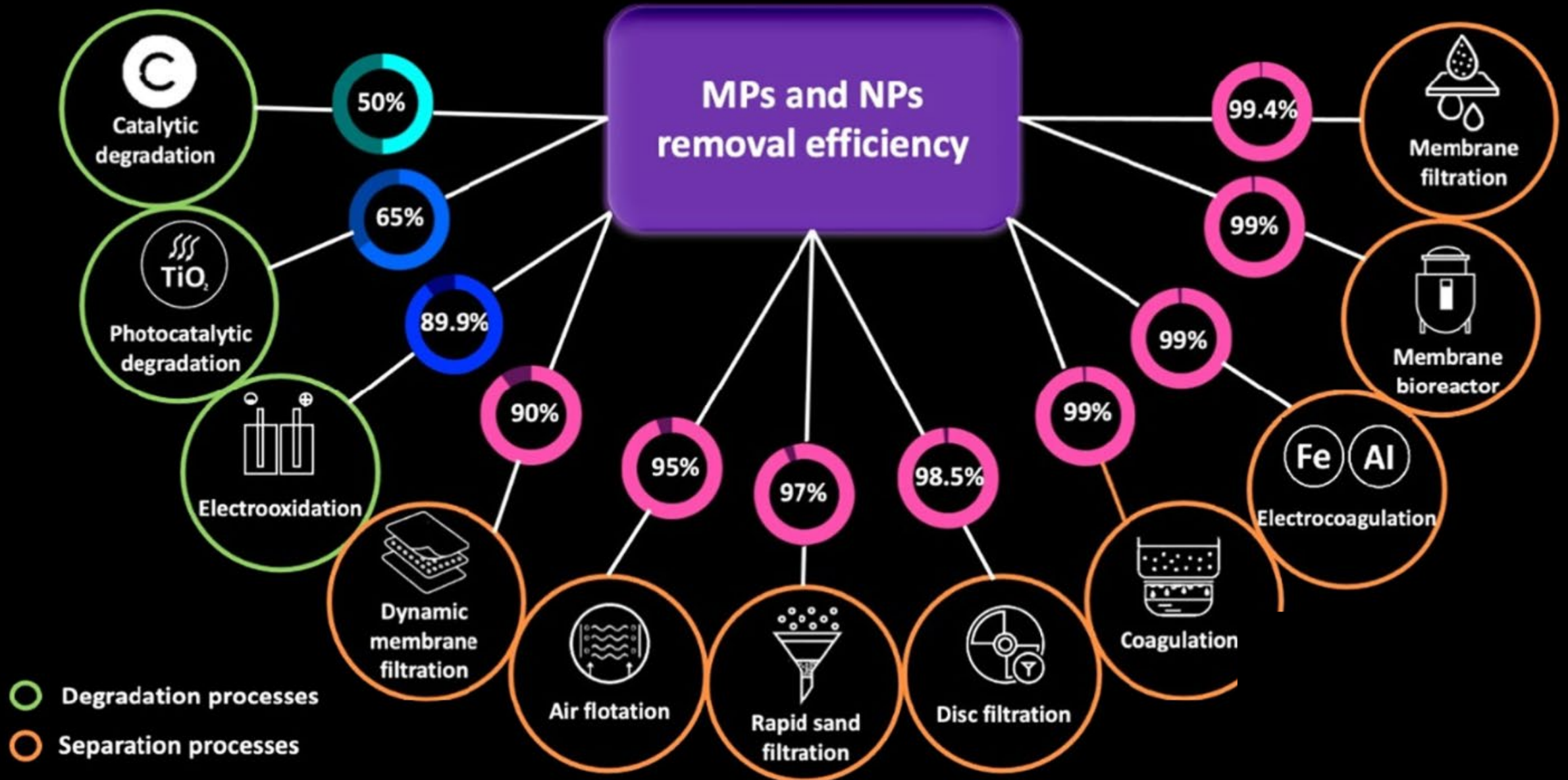
- Standard method
- Accredited laboratories
- Health-based guidance level
- Four years of testing

Deadlines

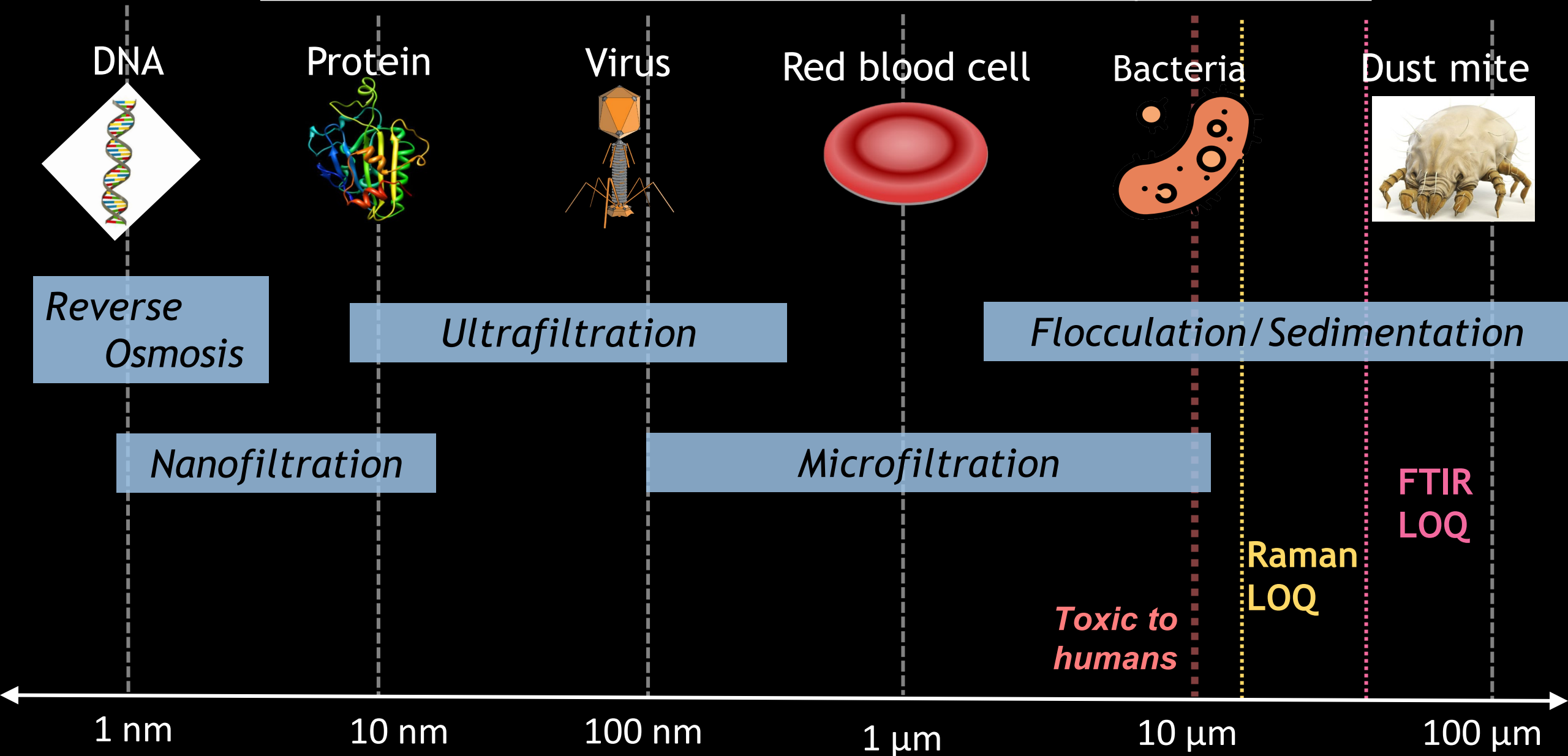
Plastics enter Surface Waters through many routes



50% to 99.4% Removal Rates



Treatment: Removal is Size-Dependent



Statewide Monitoring Plan Adopted 2022



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REGIONAL WATER QUALITY CONTROL BOARDS

POLICY HANDBOOK ESTABLISHING A STANDARD METHOD OF
TESTING AND REPORTING OF MICROPLASTICS IN DRINKING
WATER

August 9, 2022

Prepared by:
THE DIVISION OF DRINKING WATER
STATE WATER RESOURCES CONTROL BOARD
STATE OF CALIFORNIA

Iterative Monitoring Approach in Drinking Water

Pilot Phase

- Sampling method comparison
- Range-finding
- Sample training

Spring 2024 ↔ Spring 2026

Phase Two

- Additional systems
- Treated waters
- Tiered monitoring

Interim

Interim

Summer 2022 ↔ Winter 2023

Phase One

- Few water systems
- Source waters only
- Surrogate development

Fall 2026 ↔ Fall 2028

In-line Filtration Sampling Method Harmonization

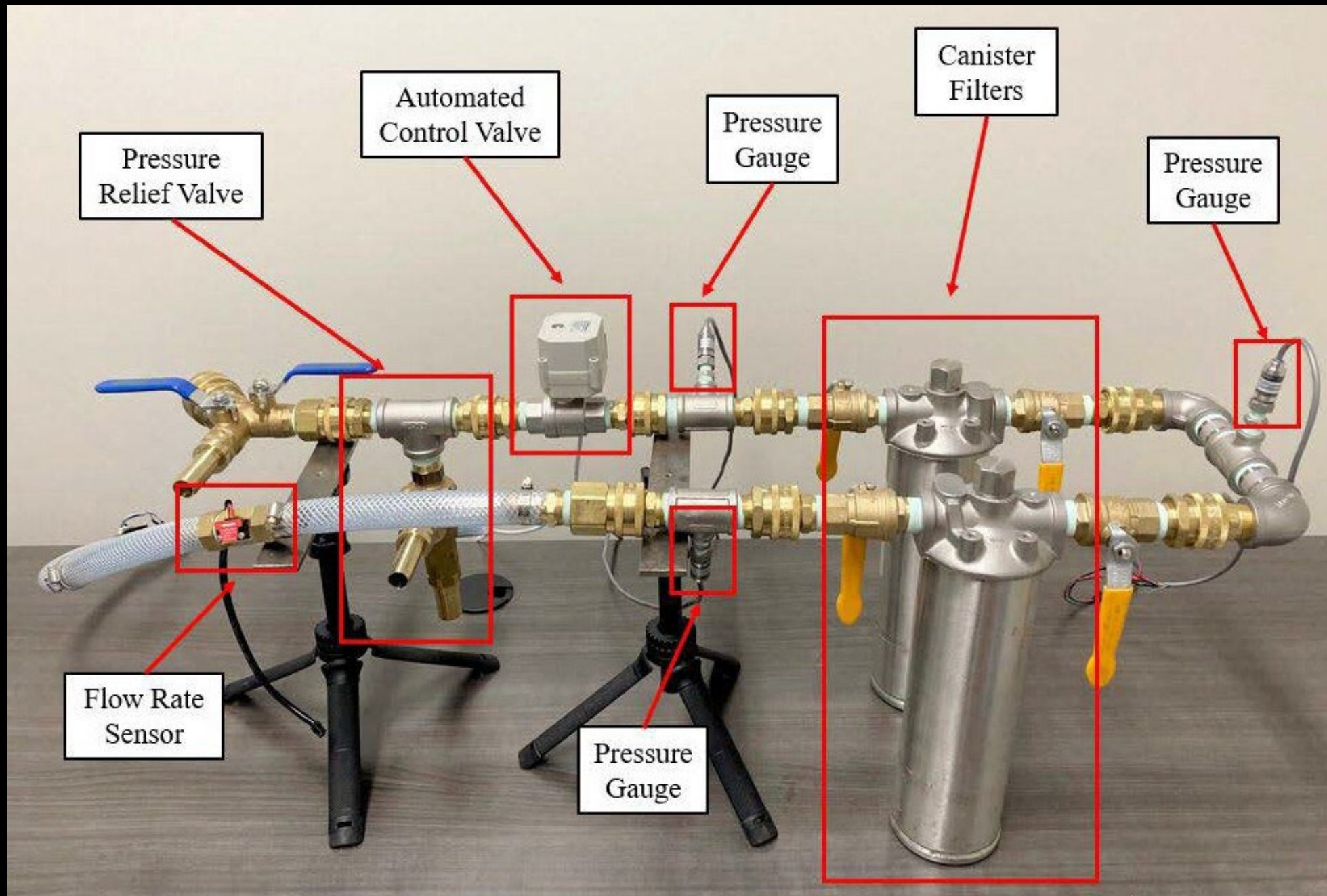
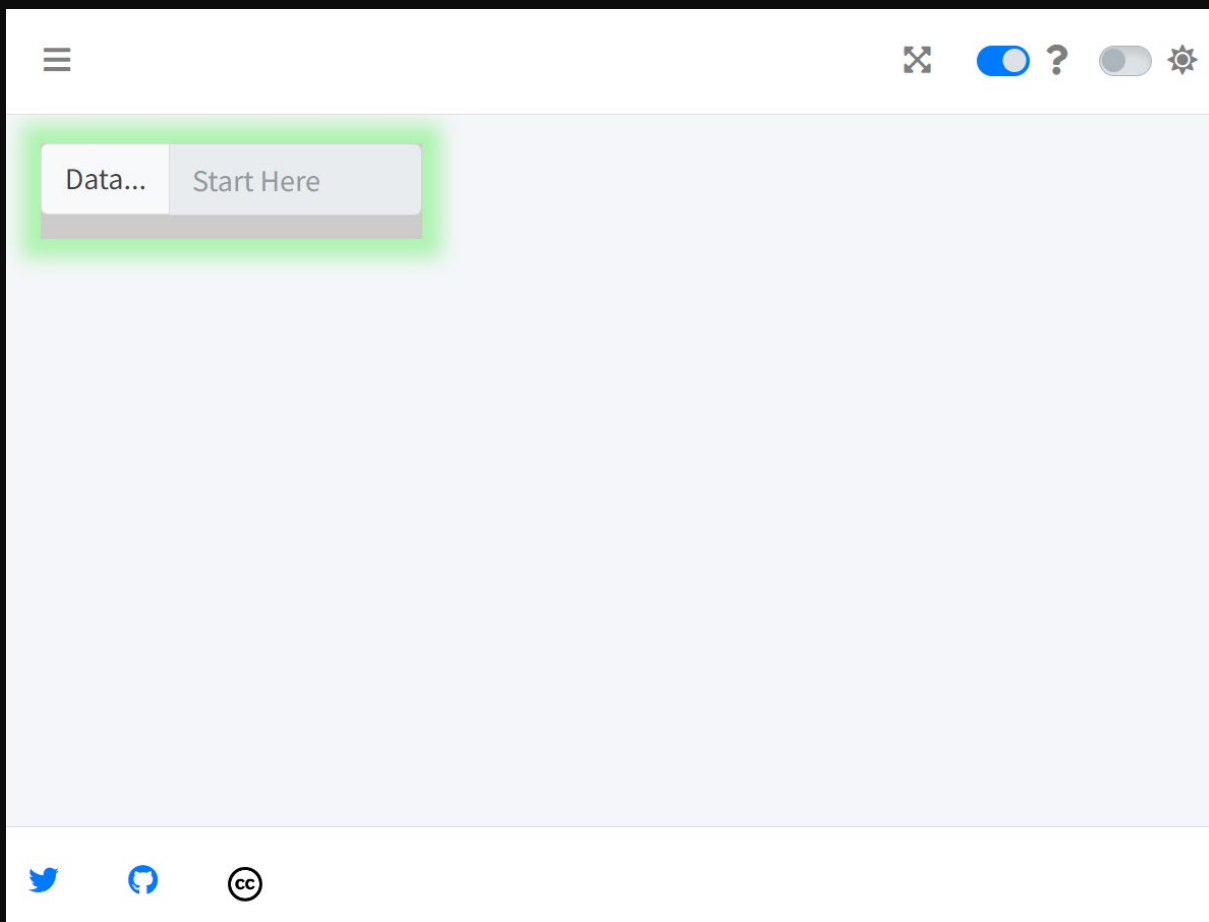


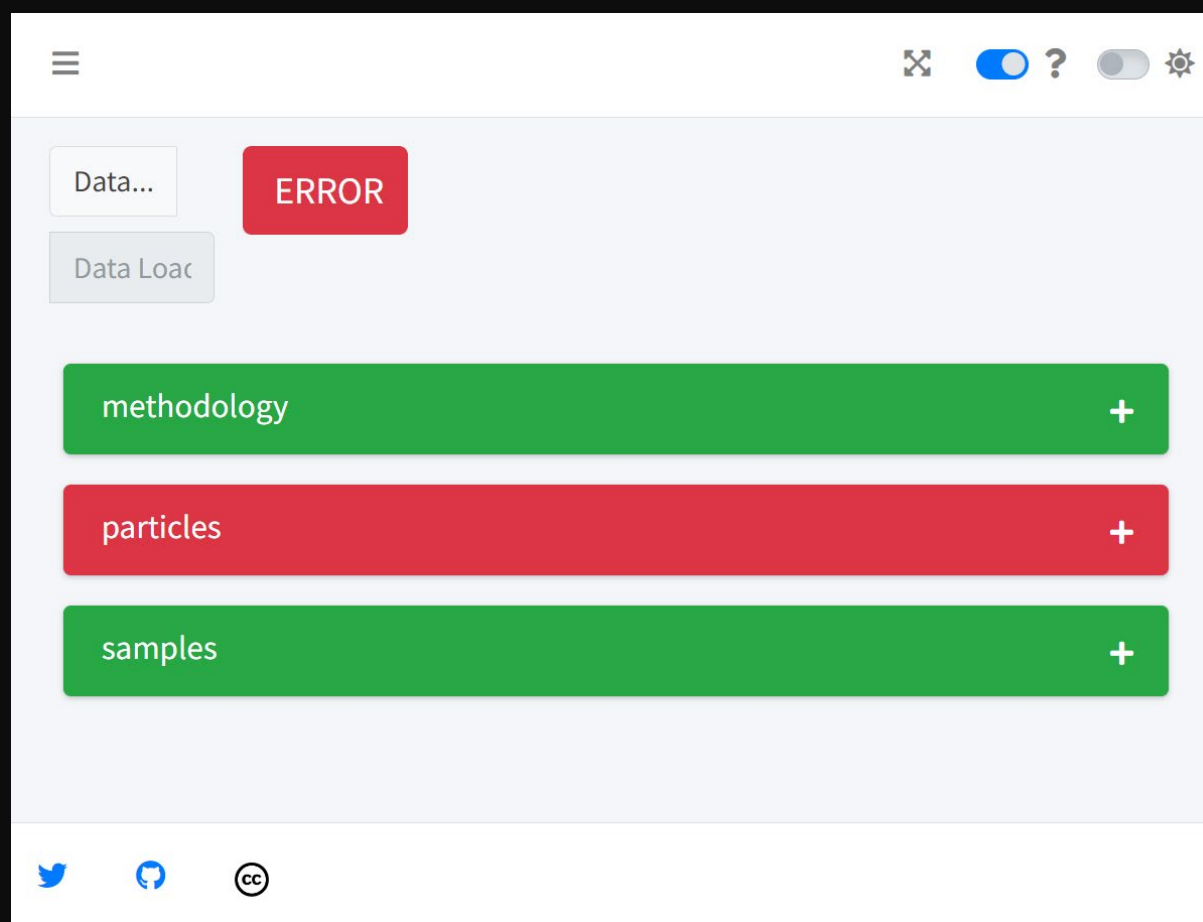
Image courtesy of
Dr. Robert Andrews

Microplastic Data Portal (One4ALL)

1. Upload data



2. If errors, correct them



Microplastic Data Portal (One4ALL)

3. If no errors, input key

Input Key

To share the uploaded data to the database you need to provide a key shared with you by win@mooreplasticresearch.org .

Is this an update to a previous submission? +

Cancel OK

4. Data sent to data.ca.gov

CALIFORNIA OPEN DATA PORTAL

Organizations / California State Water ... / Microplastics Data Portal

Microplastics Data Portal Manage

Dataset Topics Activity Stream Showcases

0 Followers Follow

Organization

California State Water Resources Control Board

Microplastics Data Portal PRIVATE

This is a dataset on microplastics in drinking water from peer-reviewed studies and accredited labs in California.

Data and Resources

- data_054488895a89483441d3a397dc4566** Explore
validated raw data upload to microplastic data portal
- data_054488895a89483441d3a397dc4566** Explore
validated raw data upload to microplastic data portal
- data_054488895a89483441d3a397dc4566** Explore
validated raw data upload to microplastic data portal
- data_054488895a89483441d3a397dc4566** Explore
validated raw data upload to microplastic data portal

Microplastics Monitoring Subcommittee

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

Quarterly Meetings

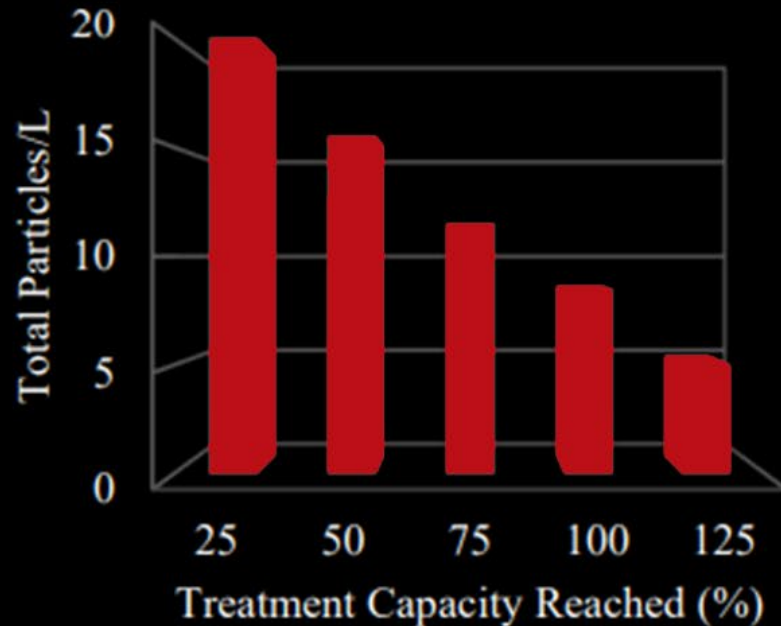
- **Sampling and analysis playbook**
- **Communication toolbox**
- **Laboratory accreditation & data analysis**



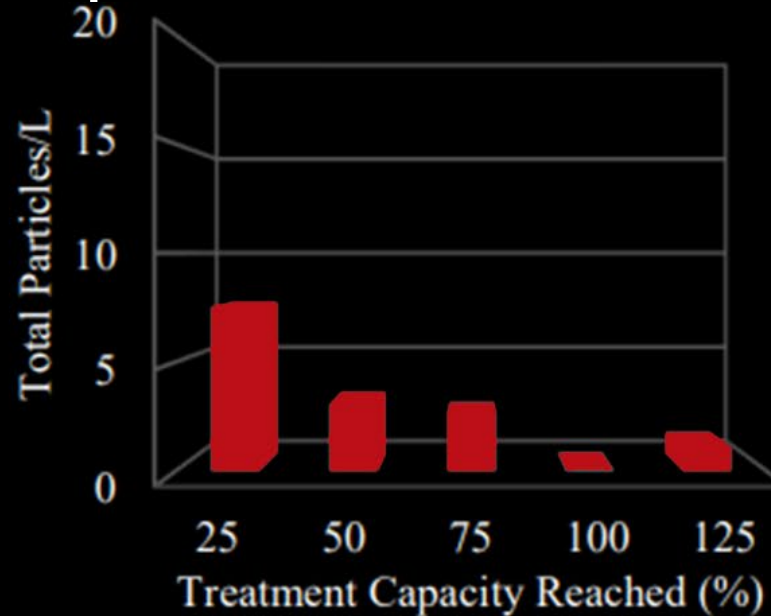
Next Meeting: January 17; 11 am to 1pm (PST)

Limited Data: Microfiltration Most Effective Point-of-Use

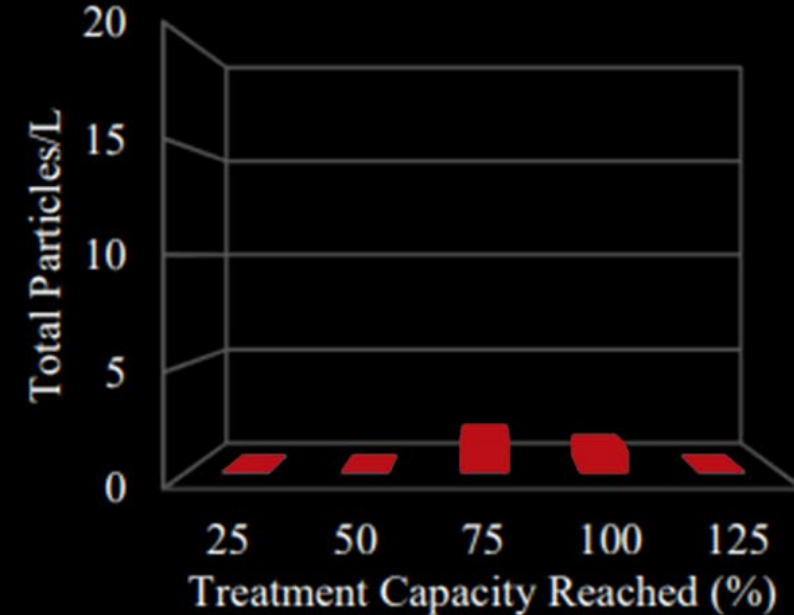
**Granular Activated Carbon +
Ion Exchange**



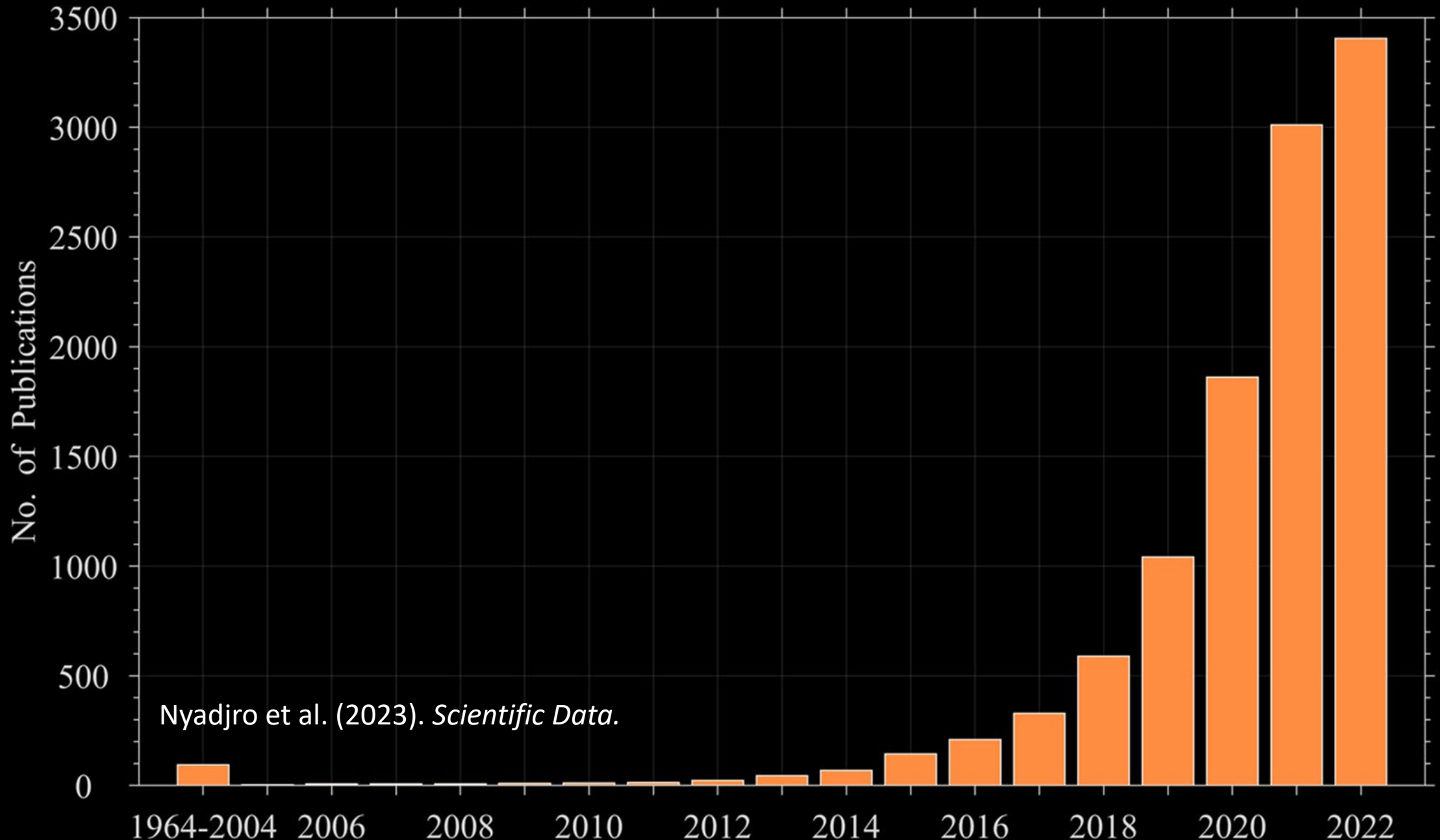
**Granular Activated Carbon +
Ion Exchange +
>1 μ m non-woven Membrane**



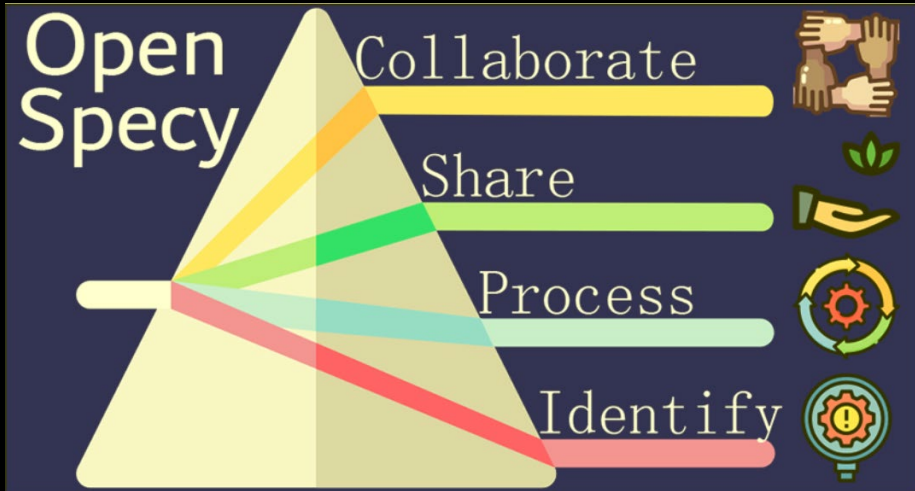
**Microfiltration +
Granular Activated Carbon +
Ion Exchange**



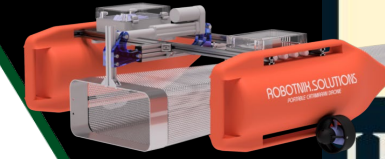
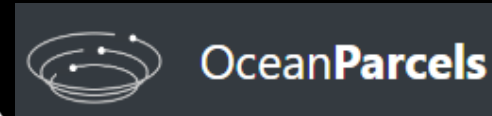
~10 New Microplastics Publications per Day!



The Microplastics Community is Built on Sharing Freely



#OpenLitterMap



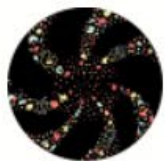
Removing barriers on plastic research



PLASTIVERSE

[X@ThePlastiverse](#)

Plastiverse.org



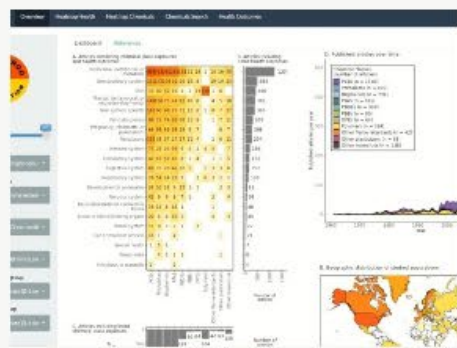
TOOLS

A vast number of software, databases, methods, and other resources have been developed to enable plastic pollution research. This page is a curated and living index of tools that we believe to be relevant and useful to the field. If you are aware of something missing or incorrectly described, please [let us know!](#)

Type

- Database (61)
- Tool (33)
- Device (21)
- Map (14)
- Citizen Science (10)
- Report (9)
- Protocol (8)
- Network (6)
- Webinar (6)
- Artificial Intelligence (4)

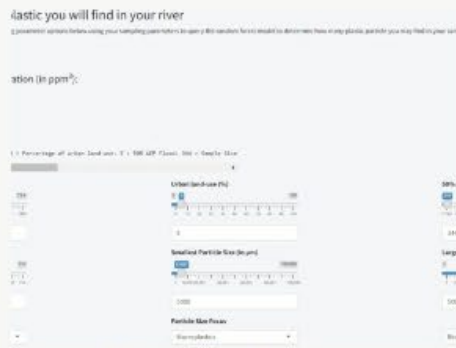
+ Show 18 more



Minderoo Plastic Health Map

Open access filterable database mapping >3,500 studies on plastic chemical exposure and human health impacts.

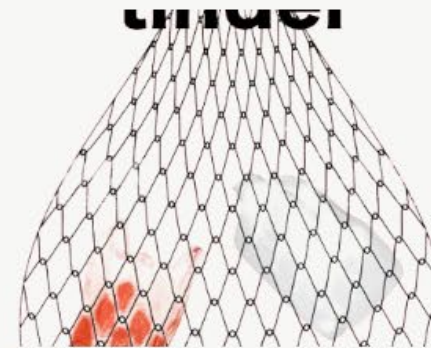
Open Data: Yes
Access: Open Access



Plastic Prediction

A machine-learning model that predicts (rough estimates) of micro- and macro-plastic abundance in rivers prior to sampling.

Open Data: Yes
Access: Open Source



Trash Tinder

A gamified web survey collecting information to inform educational and outreach tools for marine debris.

Open Data: Yes
Access: Open Source

Discover More at
Plastiverse.org

MICROPLASTICS

MICROPLASTICS EVERYWHERE

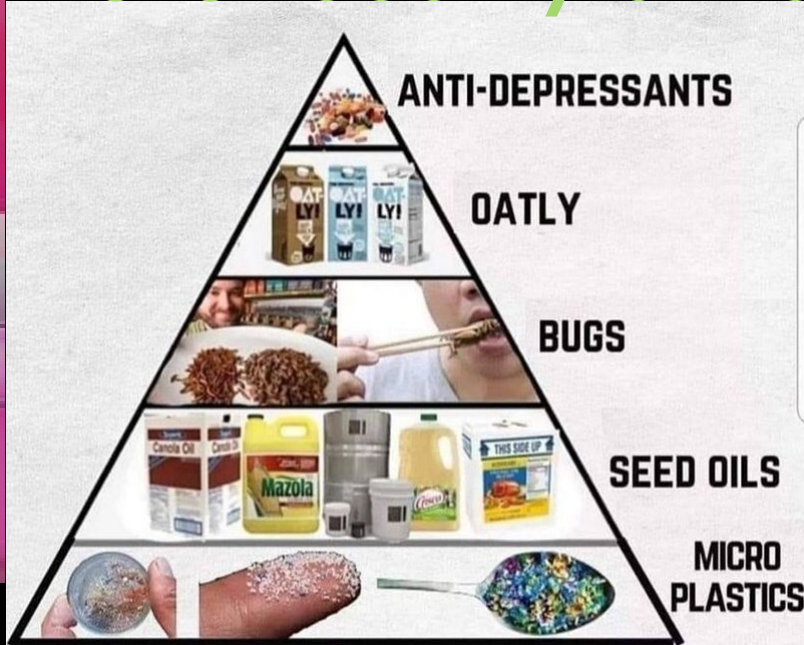
BODY BY



MICROPLASTICS

**Thank
you!**

2023 Food Pyramid



**We all have a little
Barbie in us
(the microplastics)**



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REGIONAL WATER QUALITY CONTROL BOARDS

Scott.coffin@waterboards.ca.gov

✕ @DrSCoffin