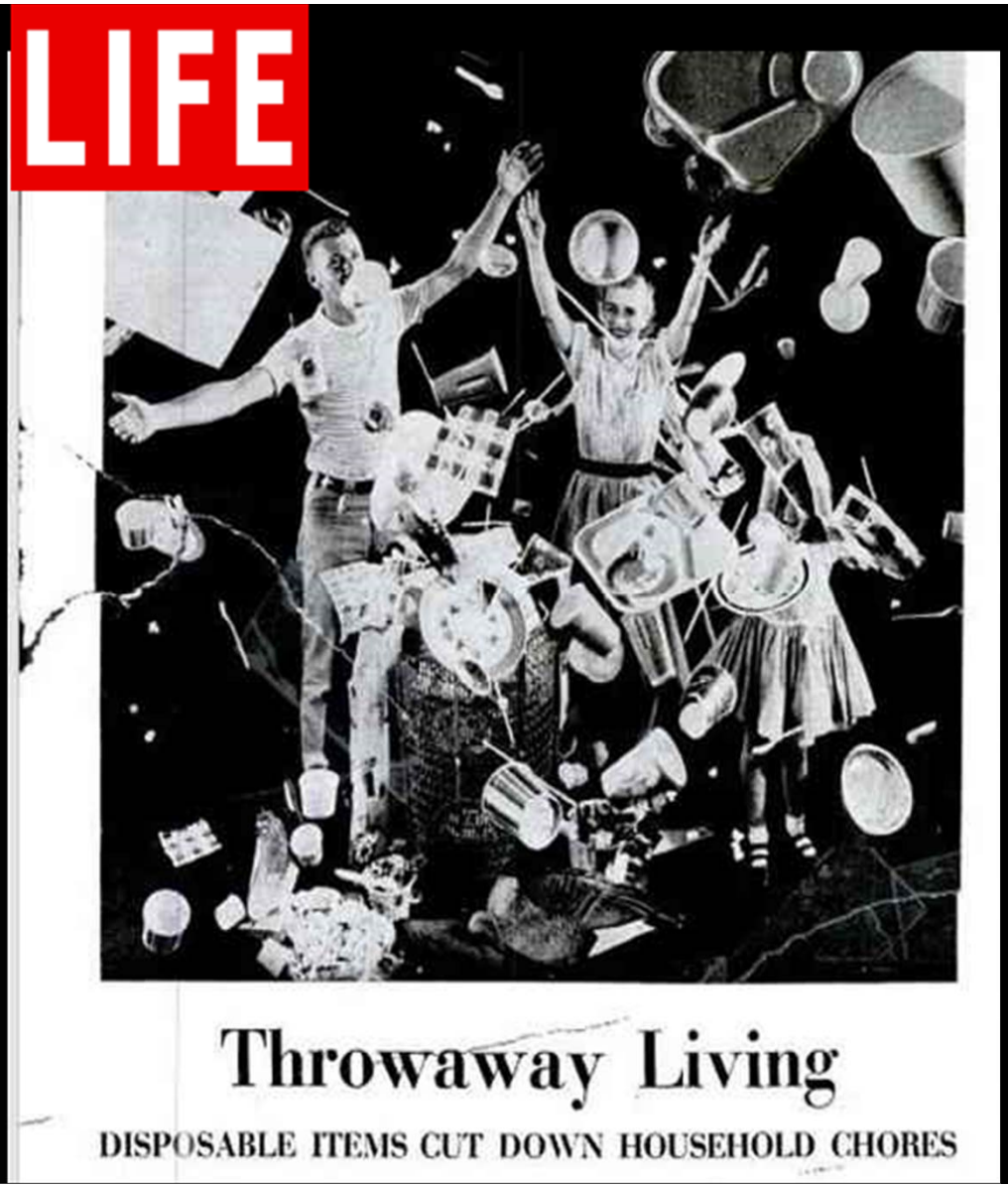
CALIFORNIA
Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

# State Water Board Research and Regulations on Microplastics in Drinking Water

National Environmental Monitoring Conference
August 9th, 2021

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

Photo: Getty


LIFE
Throwaway Living
DISPOSABLE ITEMS CUT DOWN HOUSEHOLD CHORES

1955

# **1960:** Plastic Particles Can be absorbed in Mice

*Experimental Cell Research* **22** *137–145 (1961)*



## A STUDY OF PARTICULATE INTESTINAL ABSORPTION AND HEPATOCELLULAR UPTAKE

### USE OF POLYSTYRENE LATEX PARTICLES

E. SANDERS and C. T. ASHWORTH

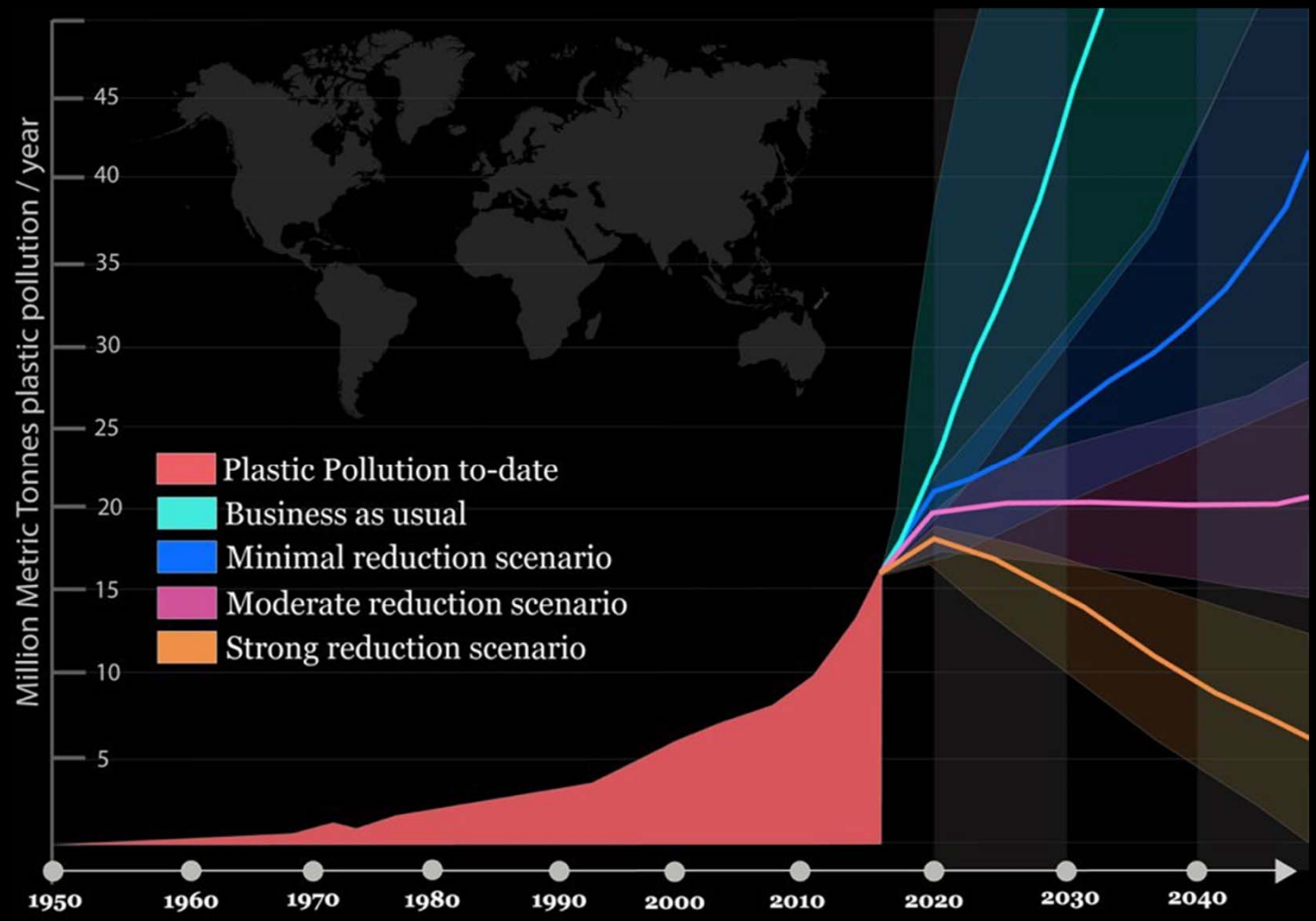
*Department of Pathology, University of Texas, and Southwestern Medical School, Dallas, Texas, U.S.A.*

Received February 1, 1960

**1969**
Plastic found in 90/91 Laysan Albatross in Hawaii

Kenyon & Krieder, *The Auk (*1969)

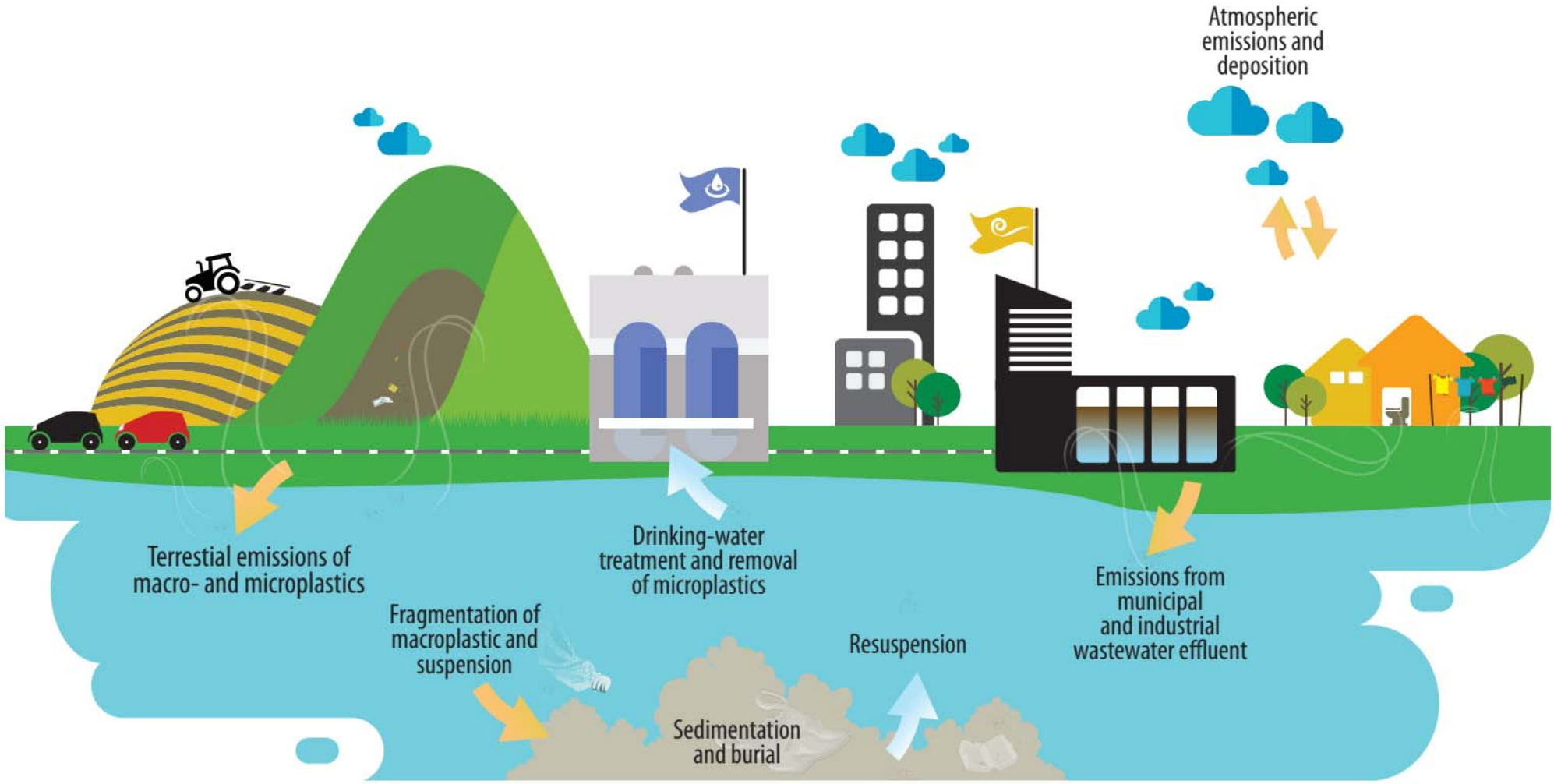
# Plastic Pollution Increased **Exponentially**




Lebreton & Andrady, *Palgrave Comms.* (2020).


PHOTO BY GREG

# Plastic Breaks Down and Enters **Surface Waters**




*World Health Organization* (2019)

# California Senate Bill 1263 (2018): Statewide Microplastics Strategy

Deadlines

**2022**

- Initiate Statewide Microplastics Strategy

**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

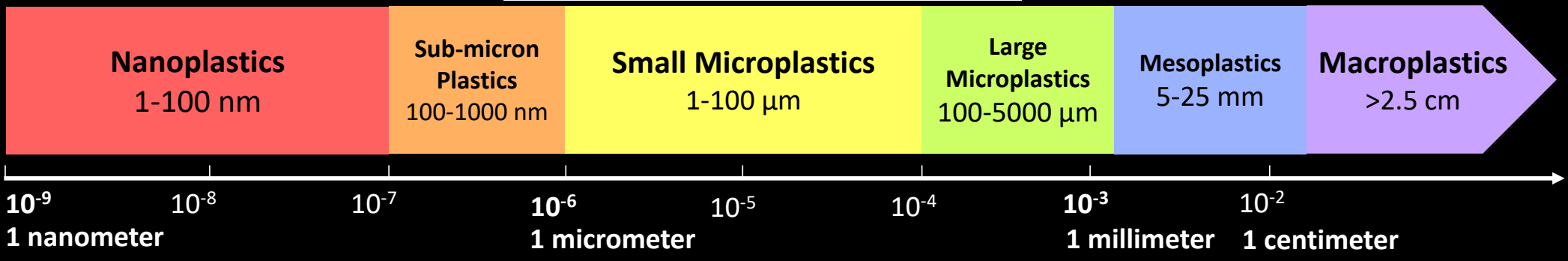

Photo: Mandy Barker

# 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




State Water Board (2020)

# Polymers included in Regulatory Definition

## All "Traditional" Plastics…


State Water Board (2020)

# Polymers included in Regulatory Definition

## …and "Non-Traditional" Plastics


Synthetic rubber

Synthetic fibers

Silicones


Bio-based and biodegradable polymers

Cellulose acetate

# 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
- Accredit laboratories
- Health-based guidance level
- Four years of testing

# Method Development and Standardization

Drinking Water

Ocean Water

Fish Tissue

Sediment

# Method Development and Standardization

## 40 Participating Organizations



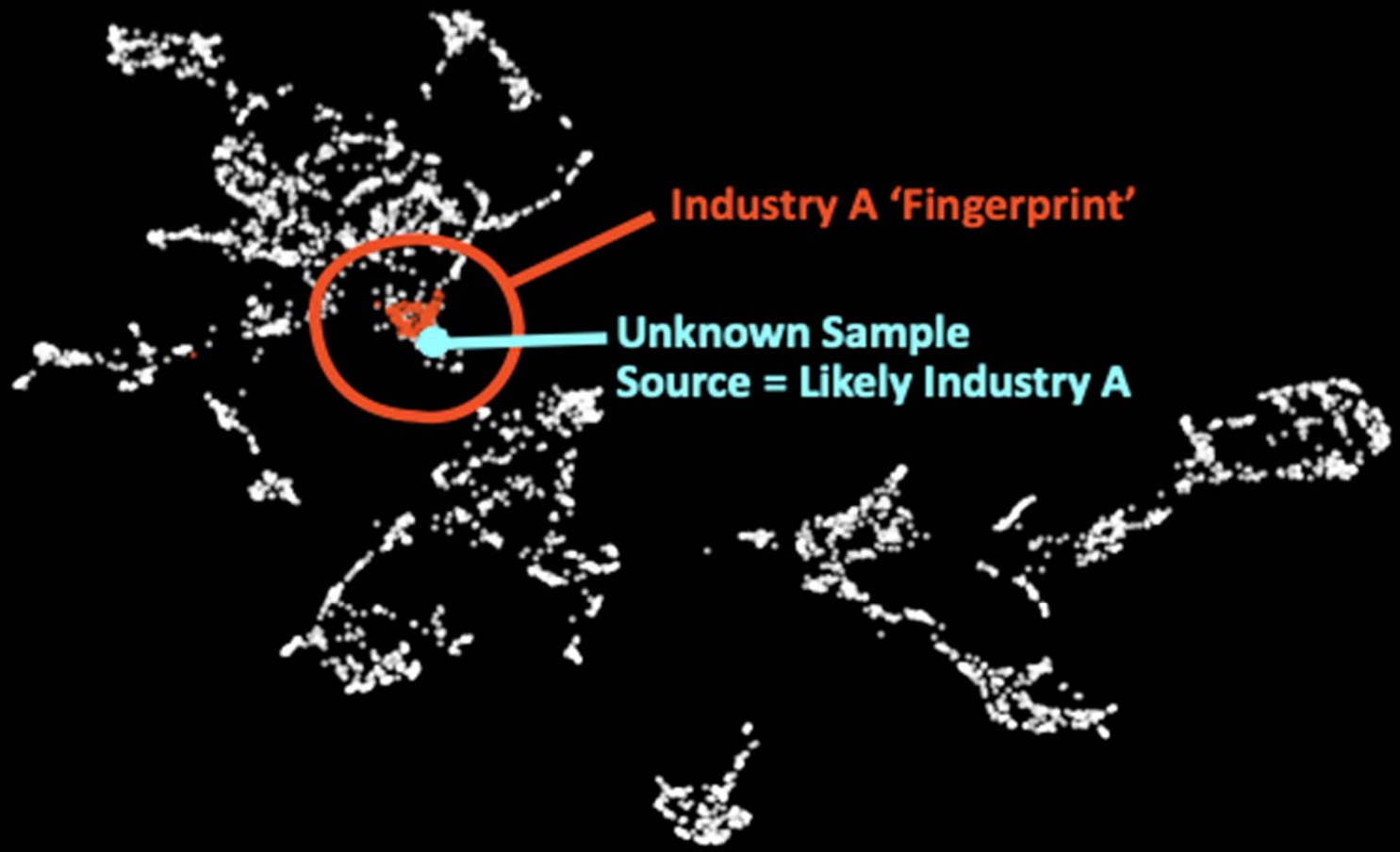






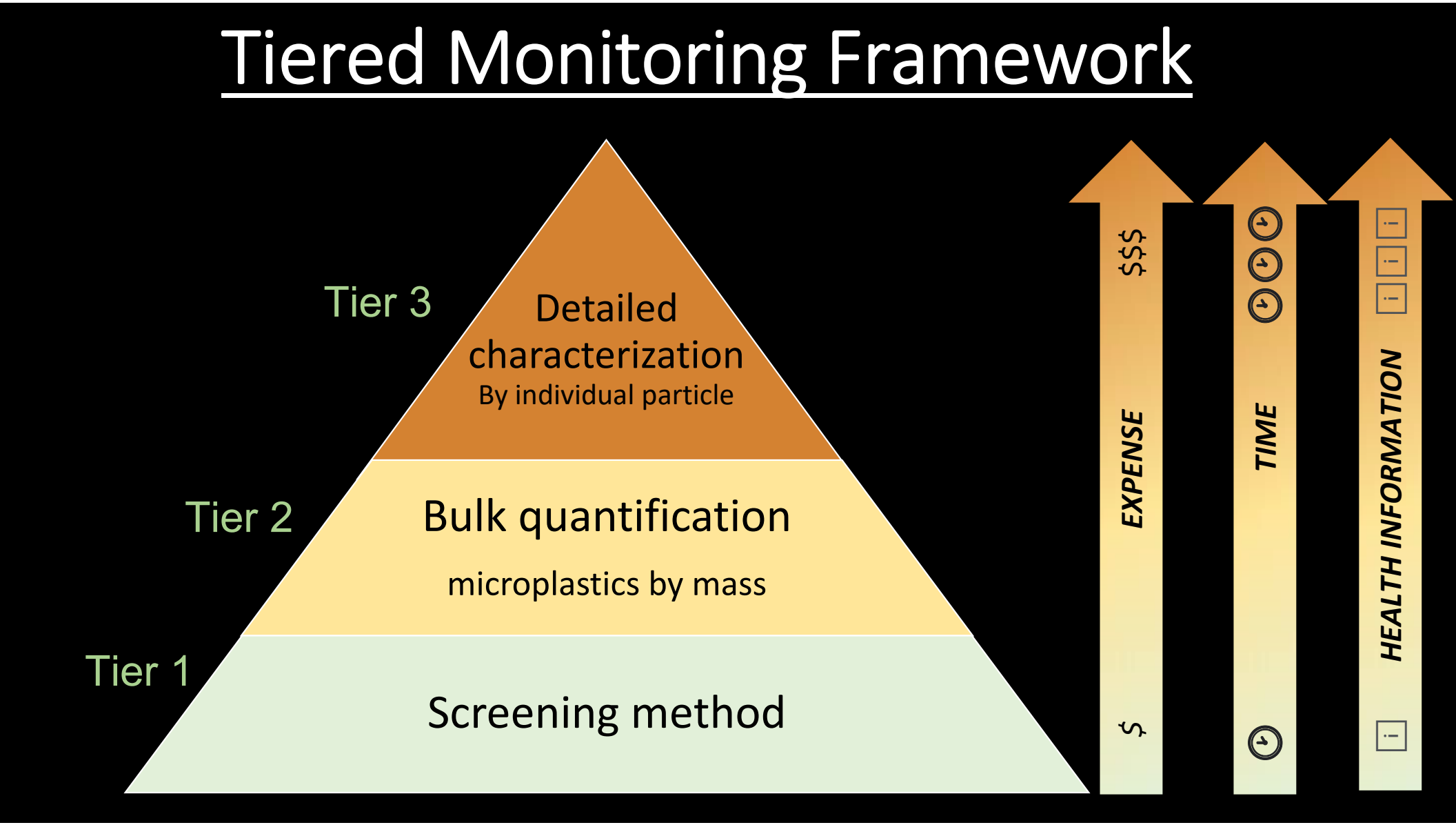

Stay Tuned!
Dr. Charles Wong's presentation follows

# Ongoing Project :Source ID by Fingerprinting




Sarabeth George (San Francisco Bay Regional Water Quality Control Board)

# Tiered Monitoring Framework



# California Senate Bill 1422 (2018)

Deadlines

July 1,2020

- Define ‘microplastics’

July 1,2021

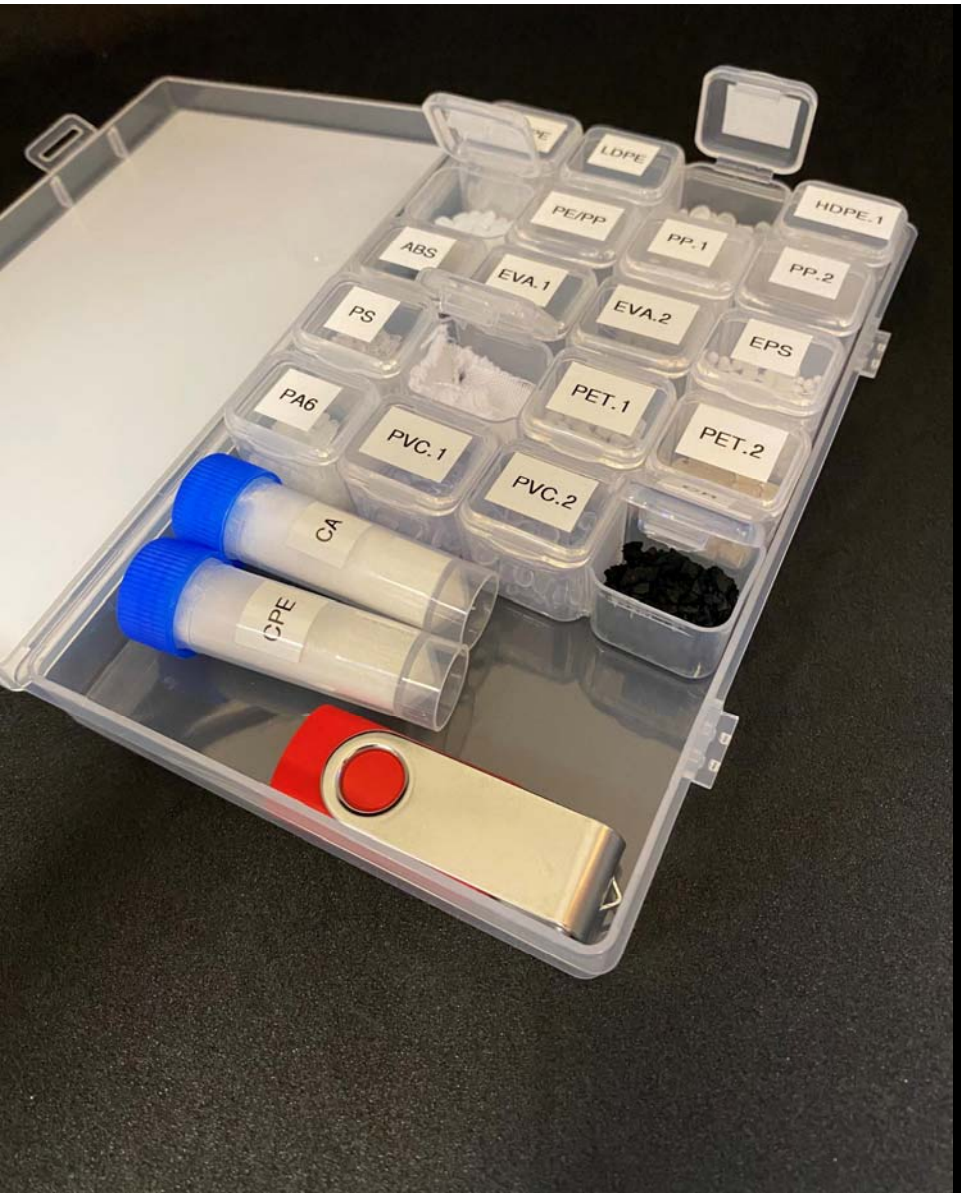
- Standard method
- Accredit laboratories
- Health-based guidance level
- Four years of testing

# Laboratory Accreditation

**Components for** accreditation:

1. Inspections ✓
2. Documentation ✓
3. Performance Evaluation Samples ✓
4. Quality criteria for labs ✓

   - Will be developed during monitoring Phase I




National Institute of Standards and Technology
U.S. Department of Commerce

# Polymer Kit 1.0

- Easily obtained, affordable kit
- 22 plastic materials typically found in the environment
- Pellets, fibers, beads, powder forms
- ATR FT-IR and DSC data
- $375 including shipping

# 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
- Accredit laboratories
- Health-based guidance level
- Four years of testing

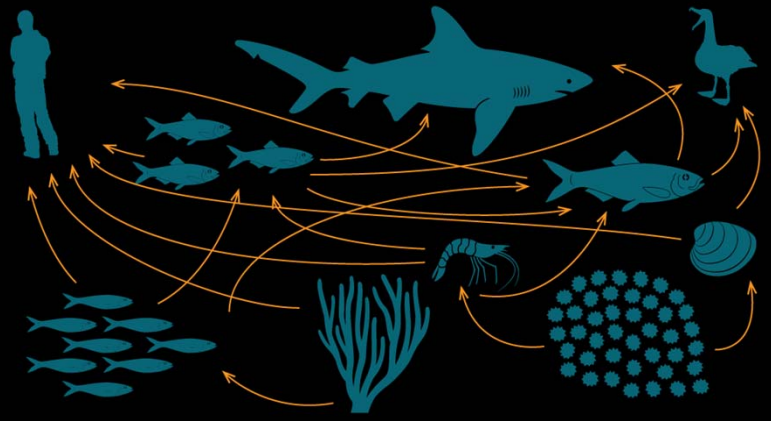
# Health Effects Workshop

Drinking Water Thresholds

October 2020

–

Summer 2021



Ecosystem Thresholds

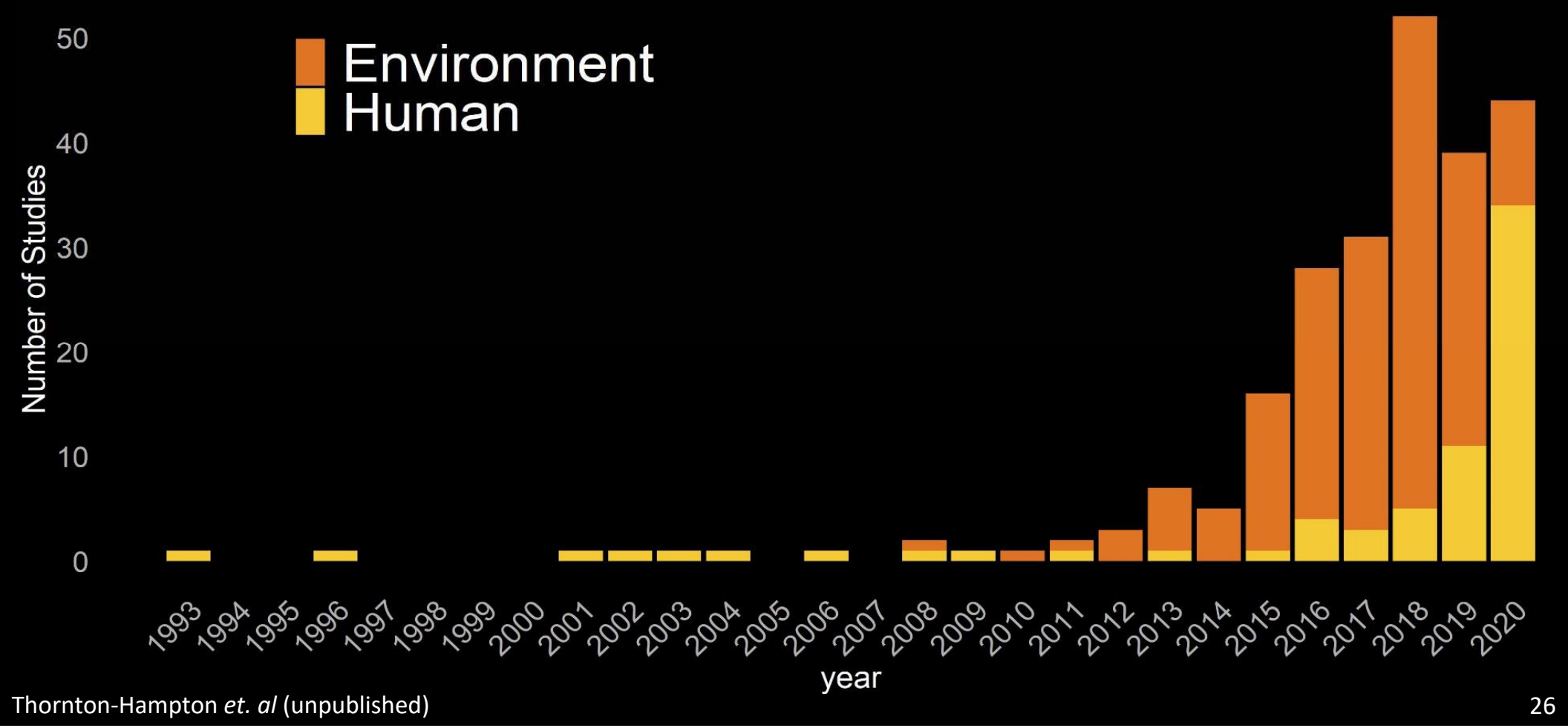
SCCWRP Established 1969

SFEI

UNIVERSITY OF TORONTO

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

# Rapidly Developing Science




Thornton-Hampton *et. al* (unpublished)

**Hazard**
*Potential to cause harm*


**Exposure**

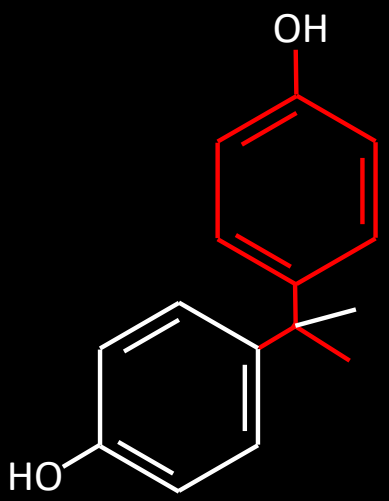
**Risk**
*Probability to cause harm*

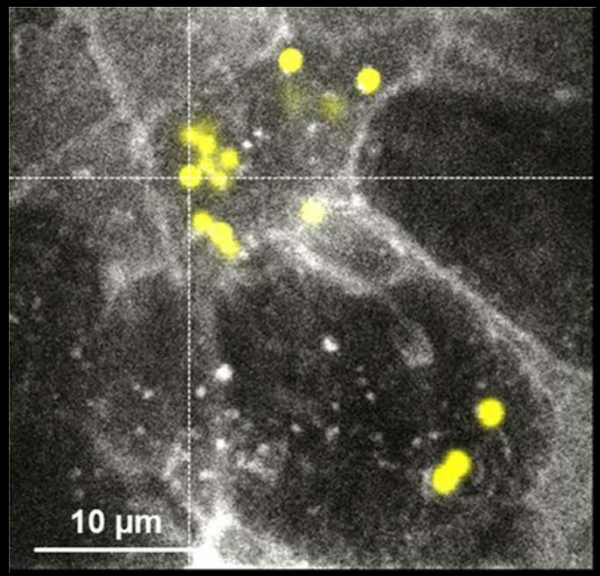
**Hazard**
*Potential to cause harm*


**Exposure**

**Risk**
*Probability to cause harm*

# Chemical and Particle Hazards



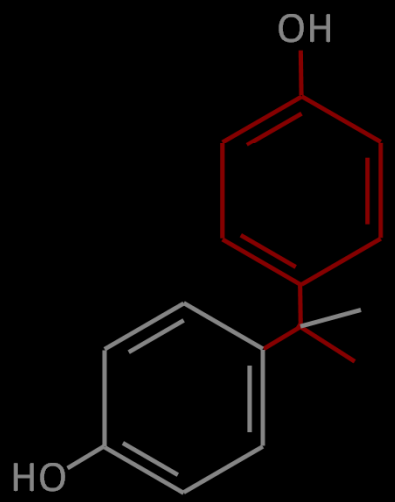

Stock et al. (2019). *Archives of Toxicology*

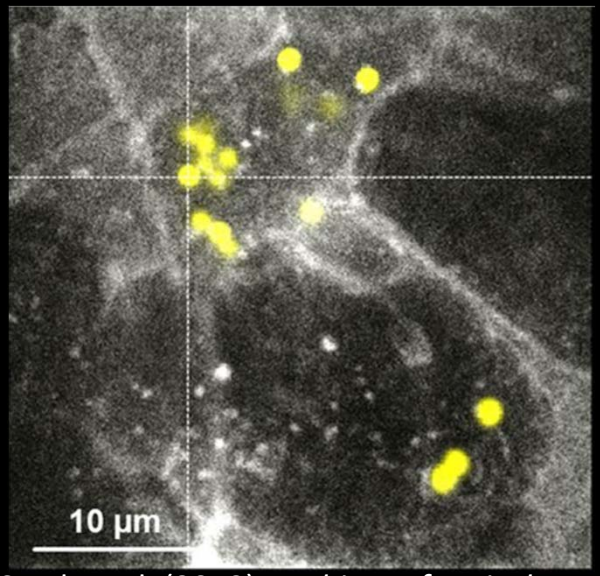
# Plastic Often Contains Hazardous Chemicals

- >3,300 known additives
- 98 hazardous
- 7 persistent, bioaccumulative, toxic
- 15 endocrine disrupting

Groh et al. (2019), *Science of the Total Environment.*

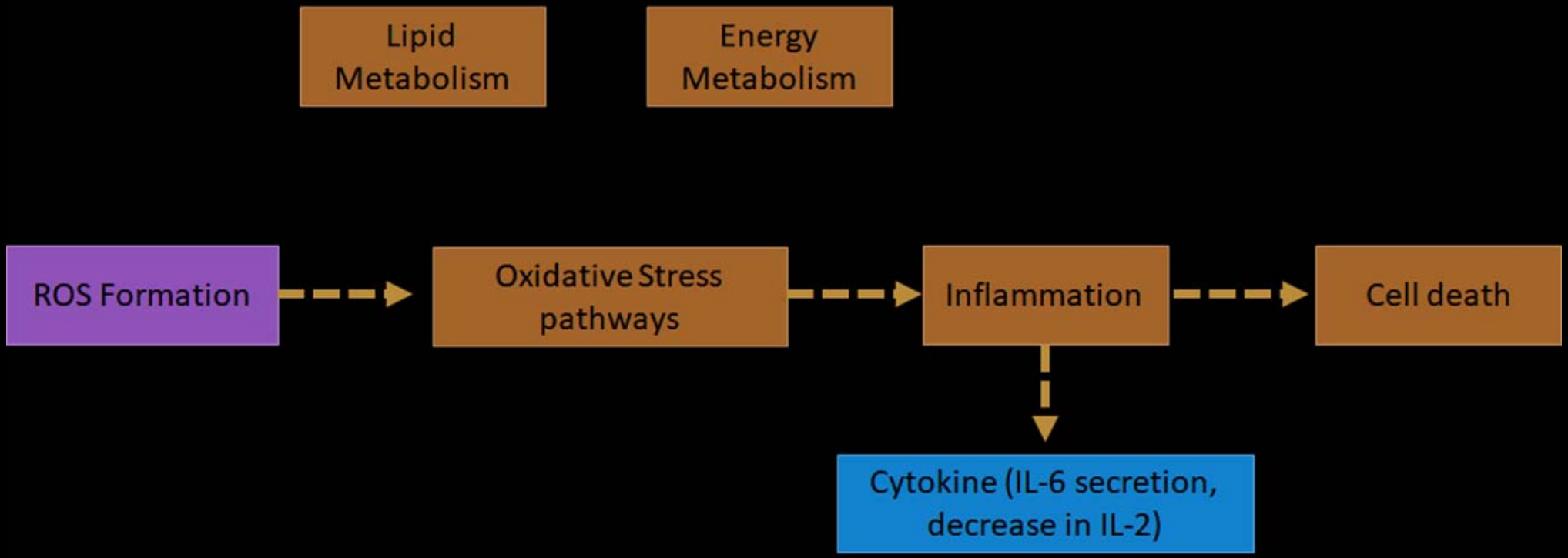
# Chemical and Particle Hazards




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

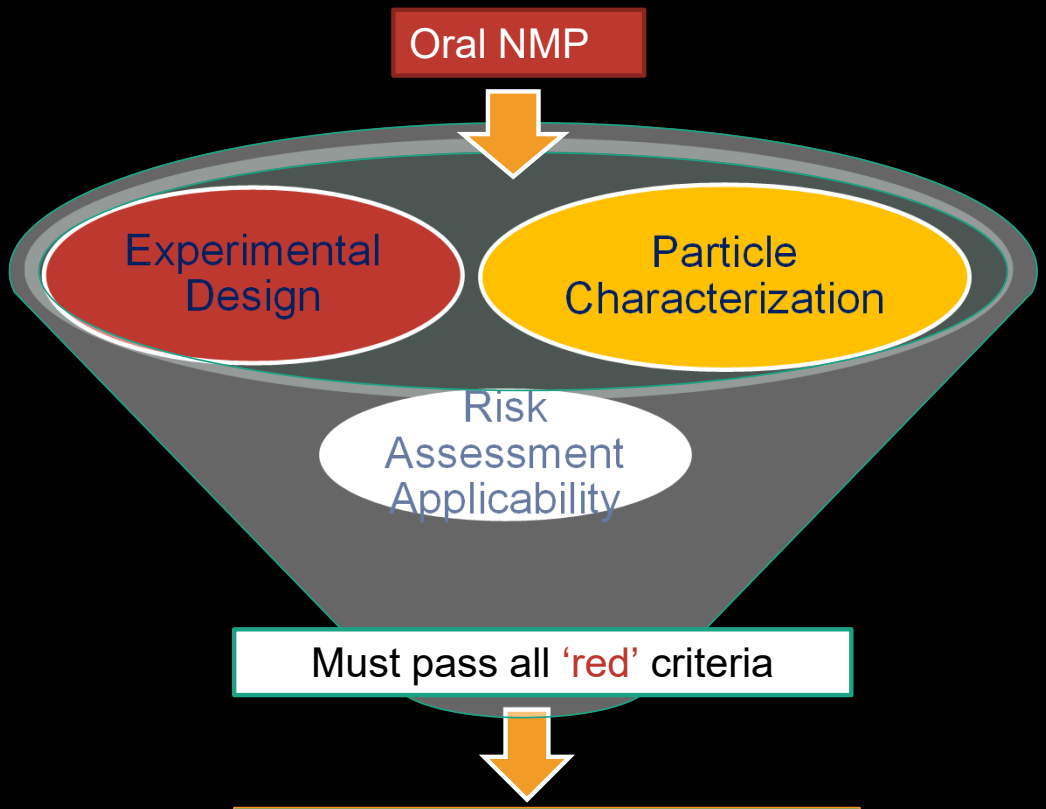
# Hypothesized Particle Effects in Humans




Kooi, Primpke, Mintenig, Lorenz, Gerdts, Koelmans (2021). *Water Research*. Submitted.

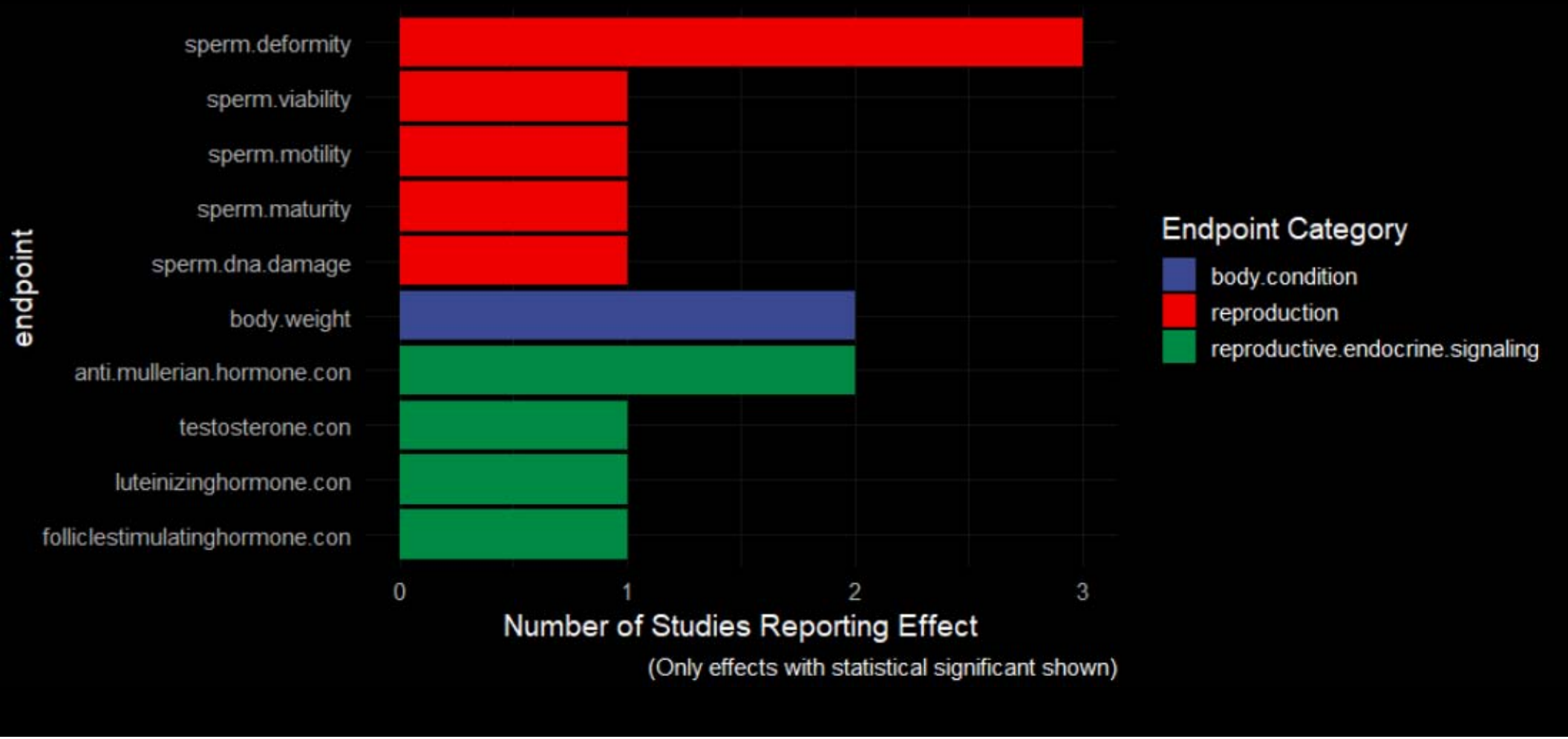
# Foundation for Risk Assessment

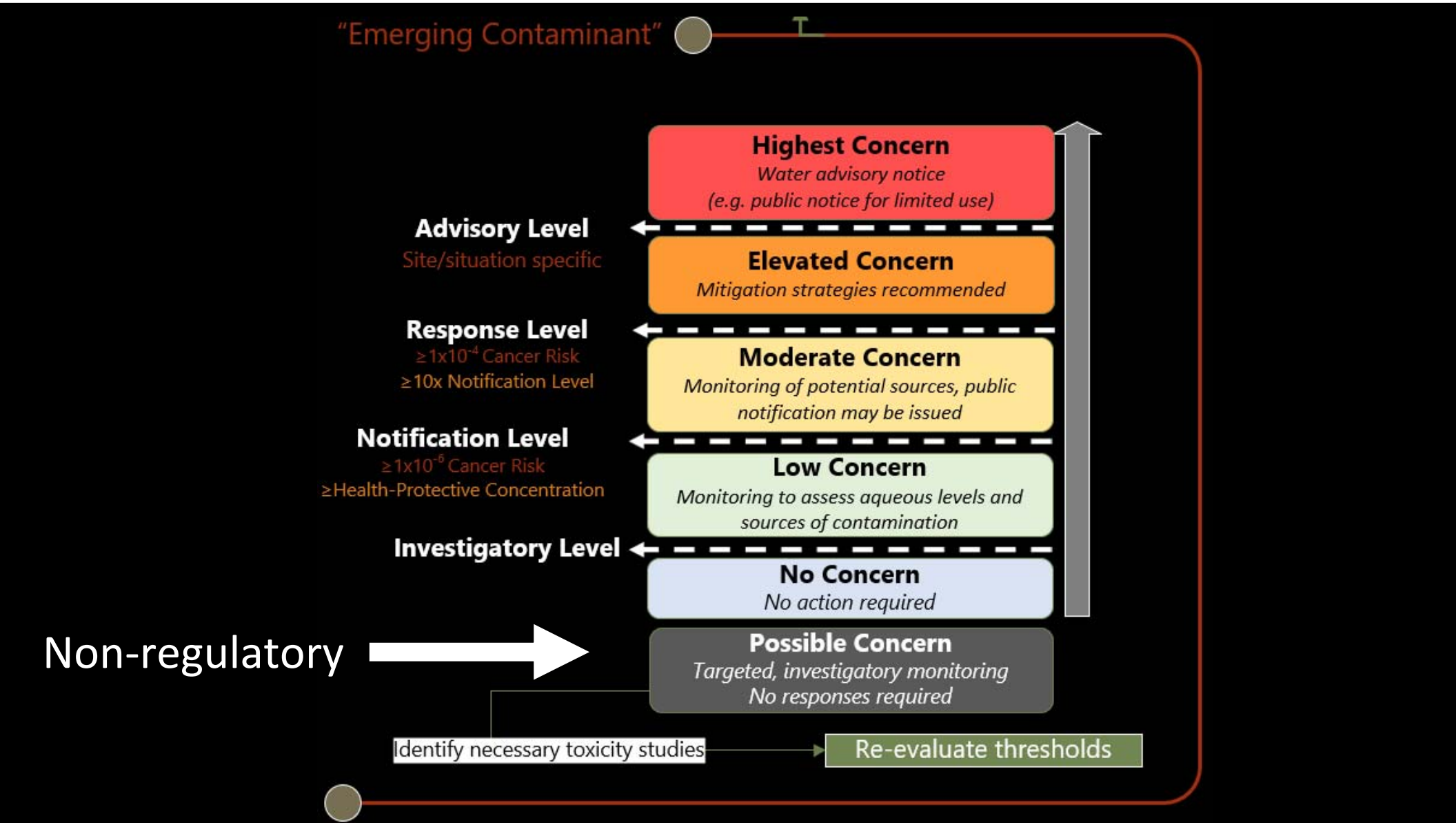
Relevant Microplastics Hazard Studies (*In vivo)* (**n = 25**)




Proceed to **Tier 2 (Expert Review)** prior to inclusion in the Risk Assessment

# Relevant and Reliable Endpoints




"Emerging Contaminant"
Highest Concern
Water advisory notice
(e.g. public notice for limited use)
Advisory Level
Site/situation specific
Elevated Concern
Mitigation strategies recommended
Response Level
≥1x10-4 Cancer Risk
≥10x Notification Level
Moderate Concern
Monitoring of potential sources, public notification may be issued
Notification Level
≥1x10-6 Cancer Risk
≥Health-Protective Concentration
Low Concern
Monitoring to assess aqueous levels and sources of contamination
Investigatory Level
No Concern
No action required
Non-regulatory
Possible Concern
Targeted, investigatory monitoring
No responses required
Identify necessary toxicity studies
Re-evaluate thresholds

# Streamline Meta-Analysis with Open Data Repo


@ToMExApp

## Hazard

*Potential to cause harm*


## Exposure

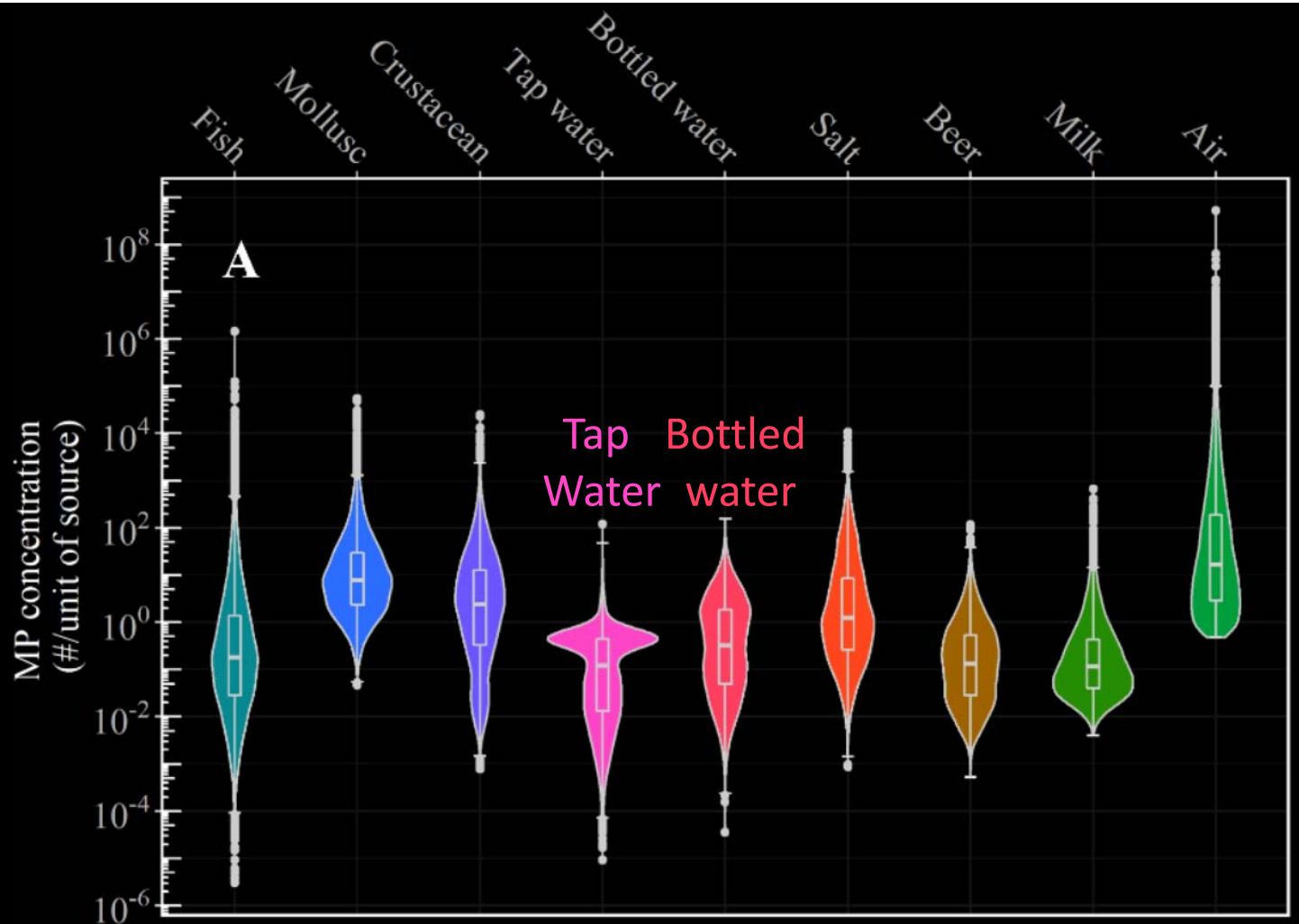
## Risk

*Probability to cause harm*

# Assessing Human **Exposure**

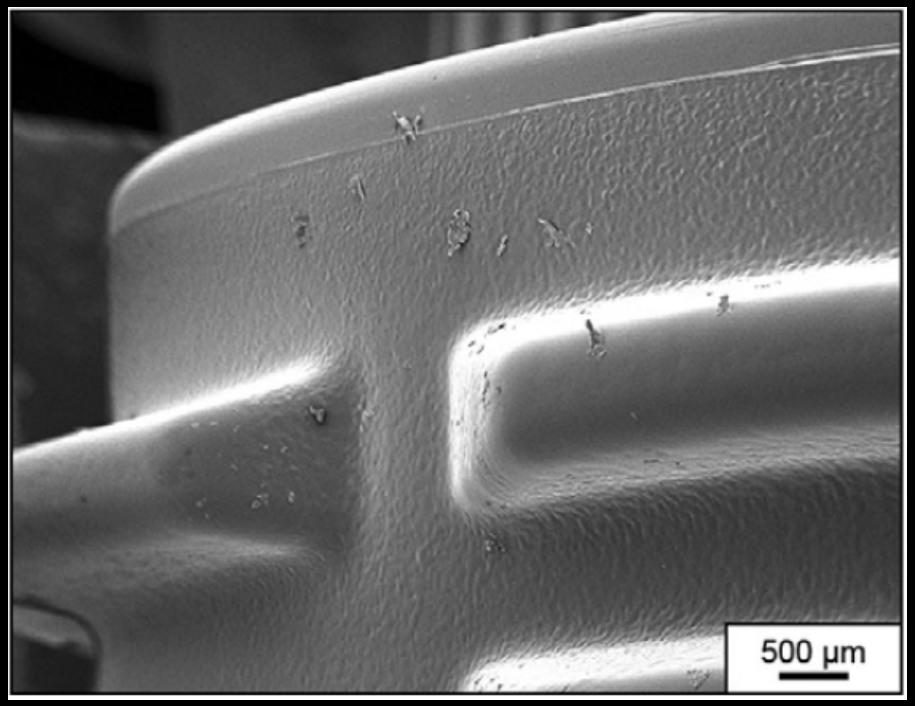

Mohamed Nor *et al.* (2021). *ES&T*

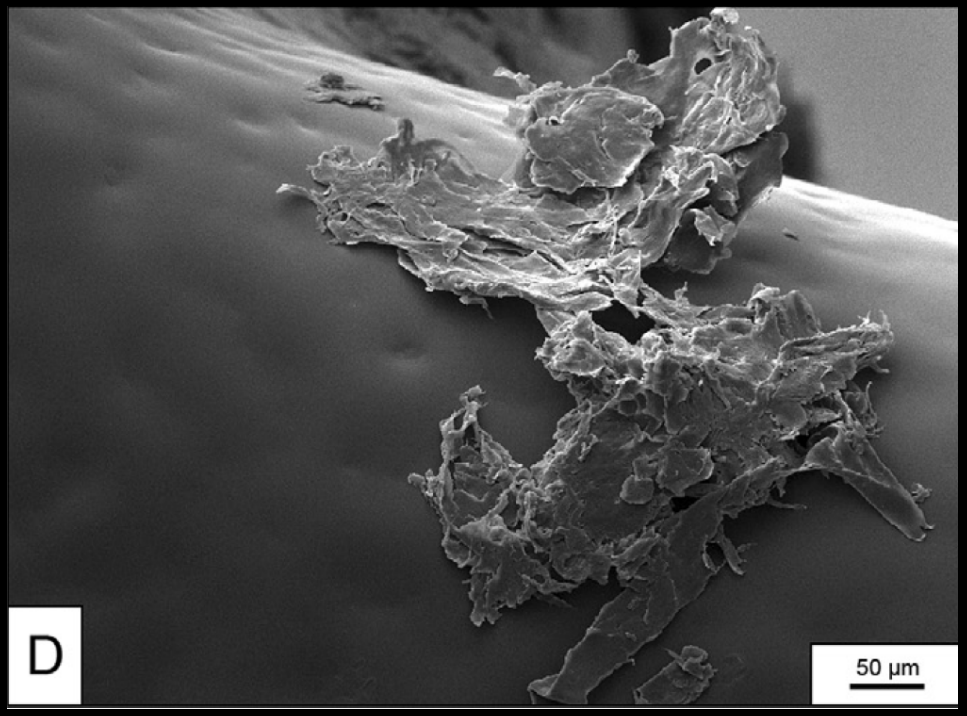
# More Microplastics in **Bottled Water** than **Tap Water**




Mohamed Nor *et al.* (2021). *ES&T*

# Plastic Packaging Releases Microplastics

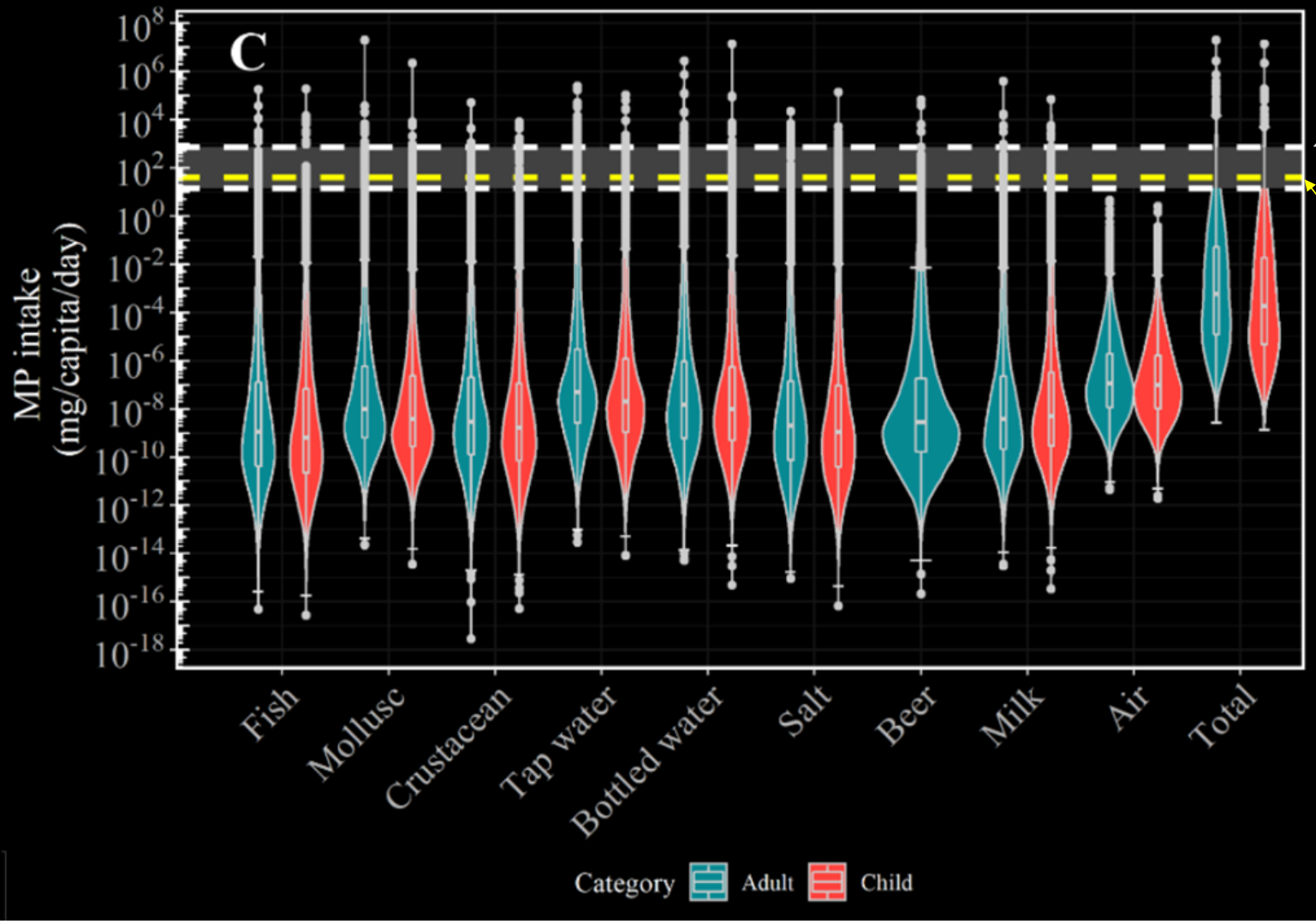



Opening a plastic water bottle releases **14-2,400** microplastic particles

Sobhani, *et al. Sci Rep* (2020)
Winkler, *et al. Water Research* (2020)

# Do We Consume a "Credit Card Per Week?"

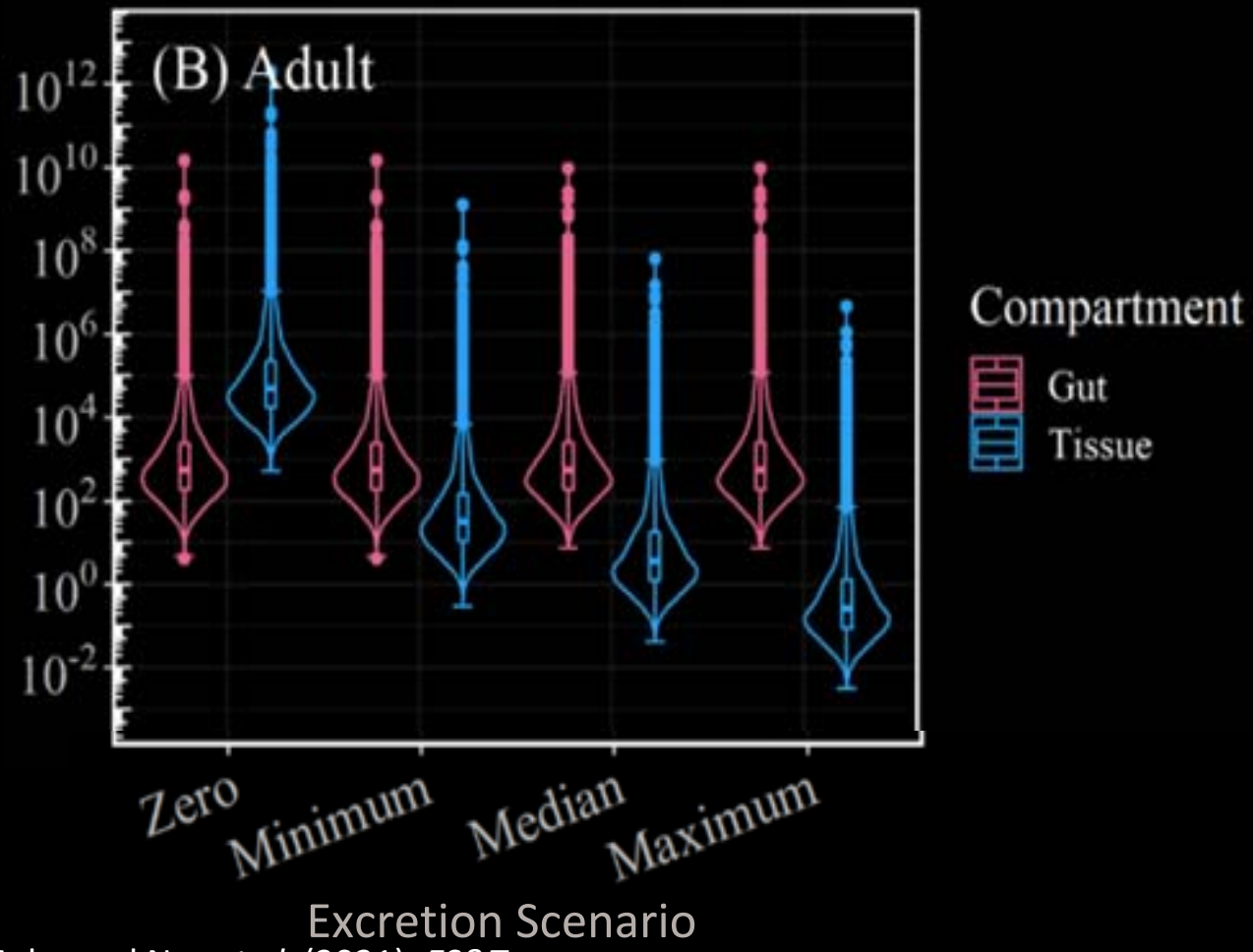



"Credit card" estimate from WWF 700 mg/person/day

95th Percentile Estimate: 17 mg/capita/day

Mohamed Nor *et al.* (2021). *ES&T*

# Microplastics **Accumulate** in Humans




525 – 9,330,000 microplastics/person (0.8 – 9,850 ng/person)

Mohamed Nor *et al.* (2021). *ES&T*

# Microplastics Found in Human Placenta

@MicheleDoesArt

4/6 placentas contained microplastics

Ragusa et a. (2021). *Environment International*

## Hazard

*Potential to cause harm*


## Exposure

## Risk

*Probability to cause harm*

# Nylon Flock Worker Lung Disease

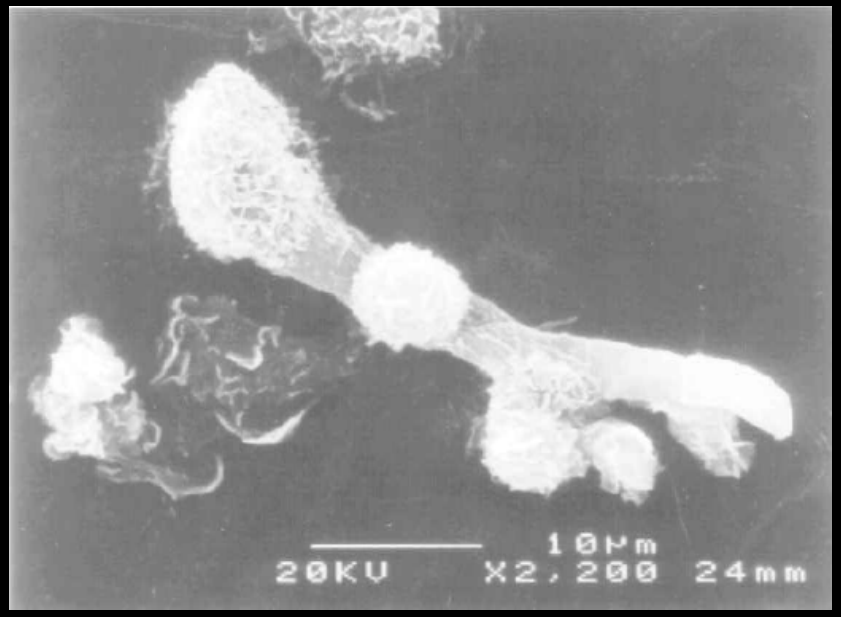
Inlet section of a nylon flocking machine

Oven used to dry glue

Marmo et al. (2019). *Journal of Loss Prevention in the Process Industries.*

# High Doses of Inhaled Microfibers Cause **Lung Cancer**

- Flock workers in Rhode Island plant had 3-fold increase in **lung cancer.**[1]
- **Fibers** (2-14 µm) found in lungs.[2]
- Chronic exposure -> infla**mmation**[2]
- Pulmonary toxicity confirmed *in vivo*.[3]




SEM image of alveolar macrophage interacting with nylon flock particle

[1]Kern et al. (2011), *Intern. Journ. Occ. & Env. Health.*
[2]Porter, et al.(1999), *J Toxicol Environ Health A.*
[3] Kern et al. (1998), *Ann Intern Medicine*

# California Senate Bill 1422 (2018)

Deadlines

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

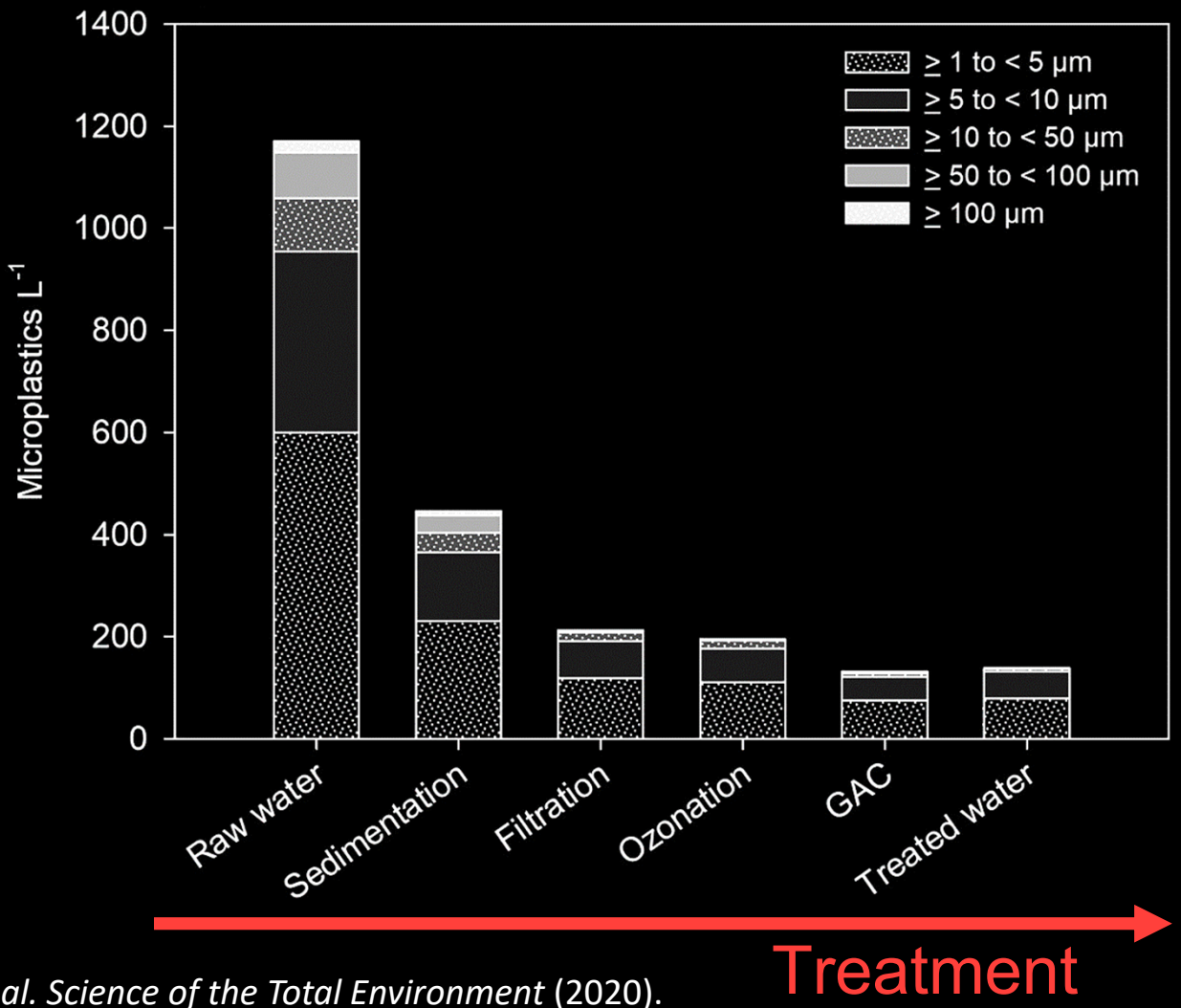
July 1,2020

- Define 'microplastics'

July 1,2021

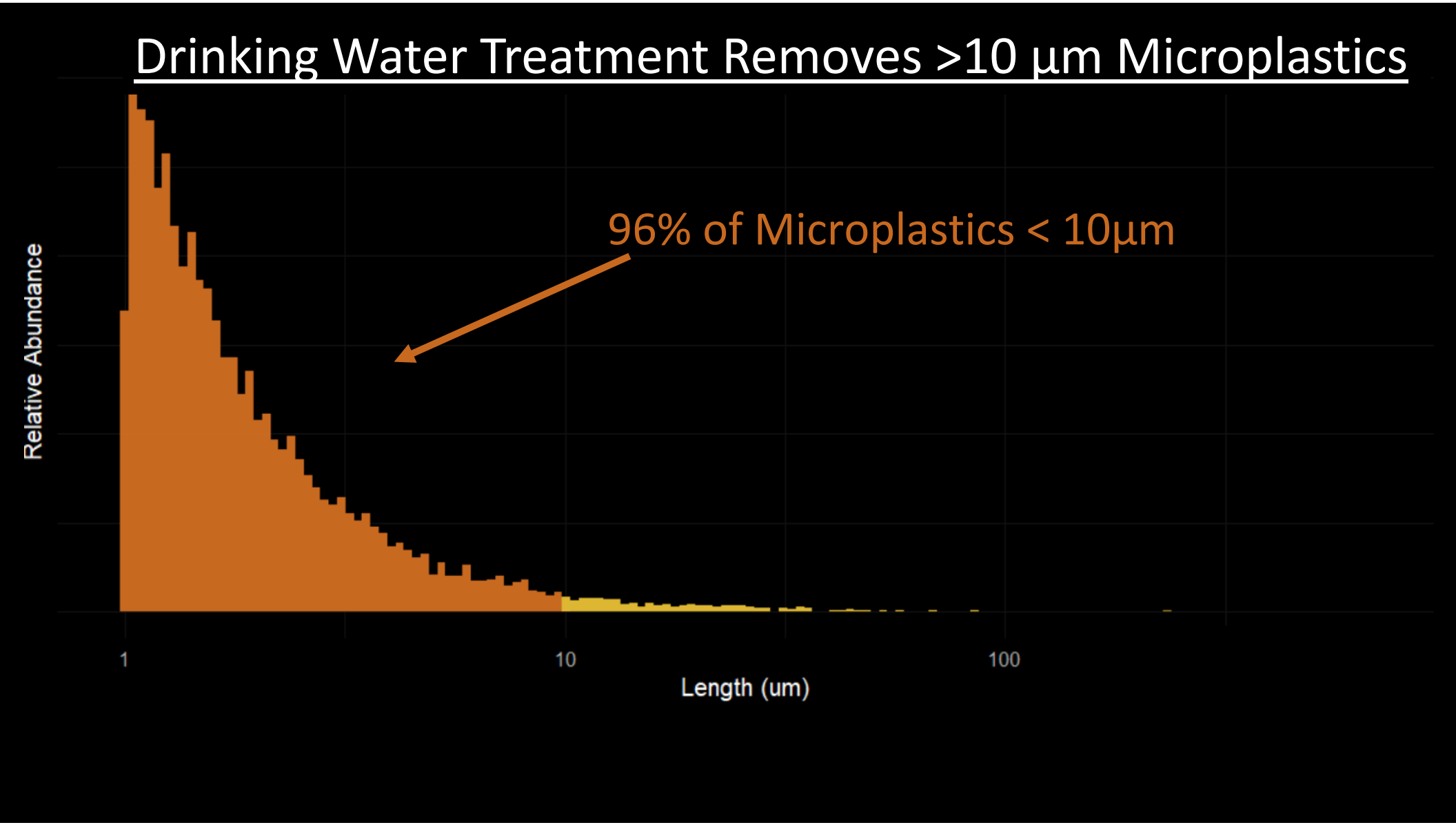
- Standard method
- Accredit laboratories
- Health-based guidance level
- Four years of testing

# Drinking Water Treatment Removes >10 µm Microplastics

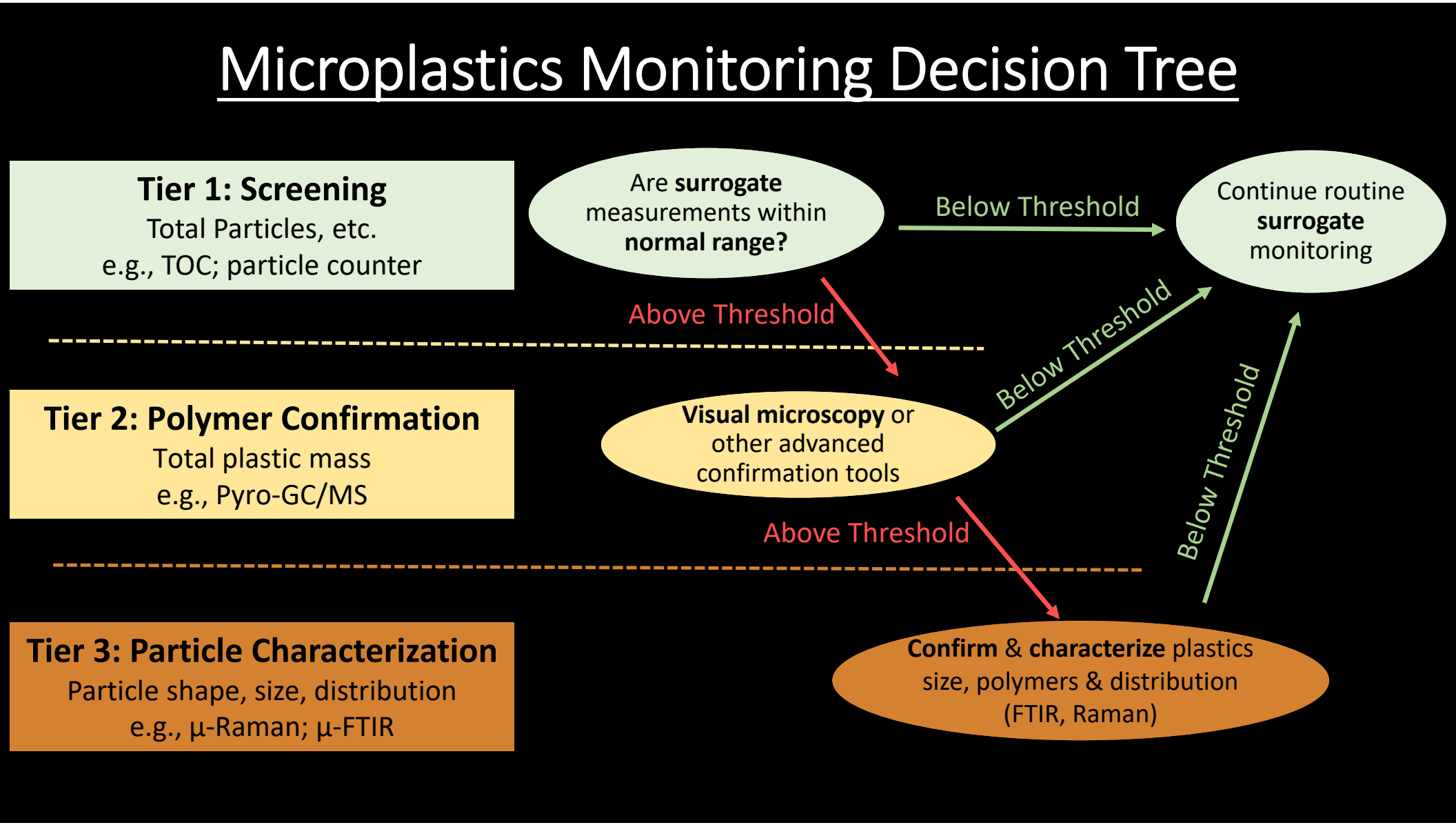



Pivokonsky *et al. Science of the Total Environment* (2020).

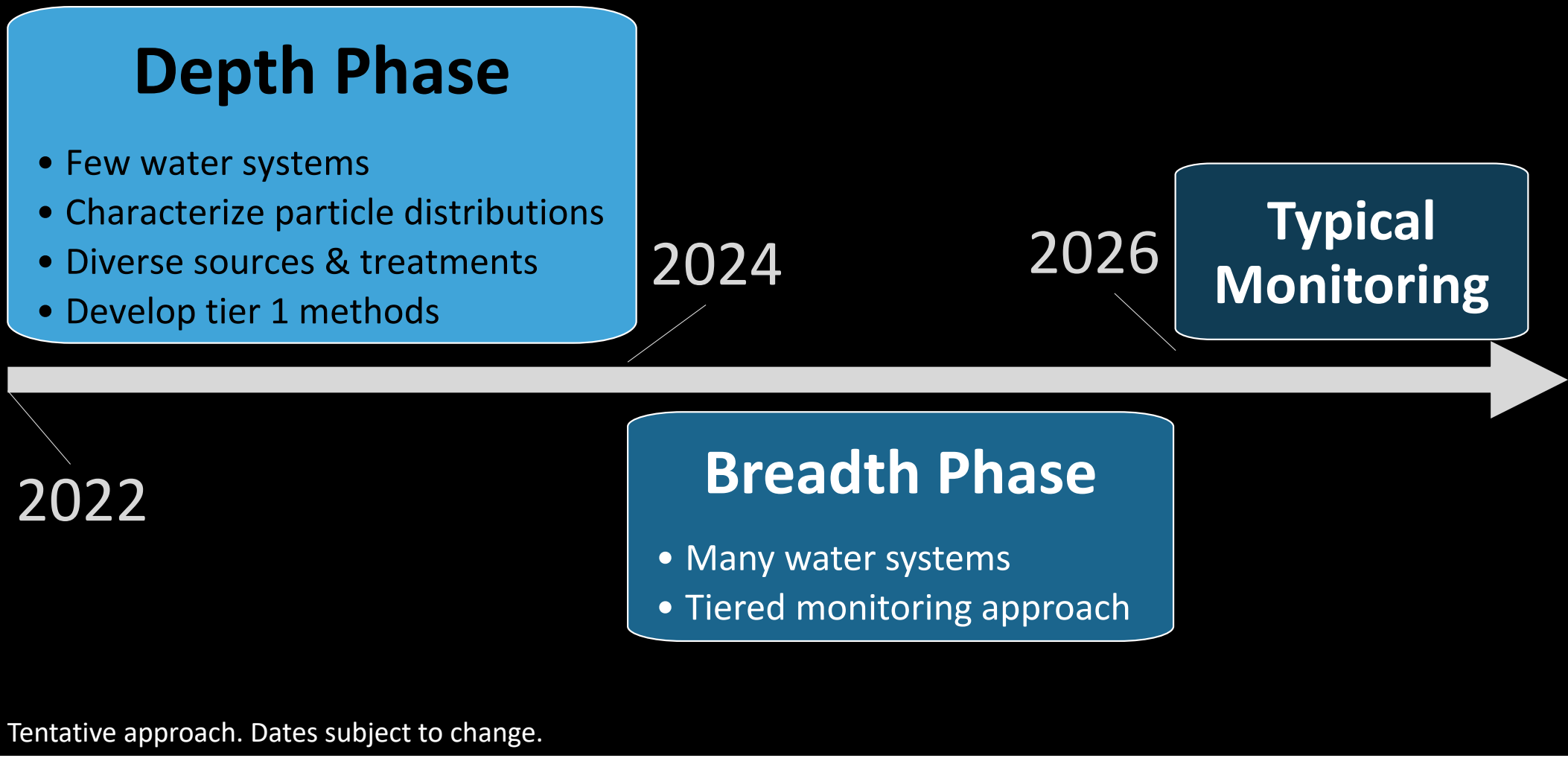
# Drinking Water Treatment Removes >10 µm Microplastics



# Microplastics Monitoring Decision Tree



# Two-Phased Monitoring Approach in Drinking Water




Tentative approach. Dates subject to change.

# Path Forward

- Health Workshop informs experiment needs
- Monitoring informs source control
- Water quality objective basis for regulations

# In Summary…

- Standardized methods coming soon
- More toxicity studies needed
- Monitoring in California 2021

Photo: Getty

@DrSCoffin