Policy and regulatory strategies for managing human risks of microplastics: a California perspective

NASEM Food Forum
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CALIFORNIA
Water Boards

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Disclaimer

The views expressed here are solely those of the author and do not necessarily represent the views or policies of the California State Water Resources Control Board or other State Agencies

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%

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

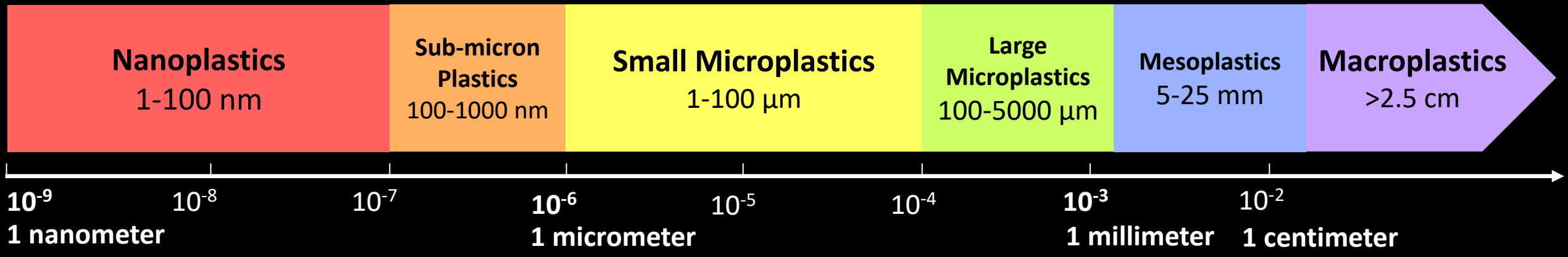
- Standard method
- Accredit laboratories
- Four years of testing
- Health-based guidance level

Definition of ‘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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Method Standardization

Two Methods

infrared Spectroscopy

Raman Spectroscopy

26 Participating Labs

AMI
RJ Lee Group
Delivering Scientific Resolution
The Metropolitan Water District of Southern California
Oregon State University
UMD
University of Minnesota Duluth
Barnett Technical Services
CDPH California Department Of PublicHealth
LeverPhotonics
California State University Channel Islands
eurofins
Ontario Ministry of the Environment and Climate Change
California State University Bakersfield
Eastman
The Pennsylvania State University
Moore Institute for Plastic Pollution Research
NIVA Norwegian Institute for Water Research
NatureWorks
SiMPore Inc. Precision Membrane Technologies
Ocean Protection Council
California Water Boards
University of California
SCCWRP Established 1969
ThermoFisher Scientific
United States Environmental Protection Agency
HORIBA
NOAA National Oceanic and Atmospheric Administration U.S. Department of Commerce
BASF We create chemistry
University of Toronto
Orange County Sanitation District Protecting the Environment

Standardized **methods available** at
waterboards.ca.gov/drinking_water/certlic/drinkingwater/microplastics

Inter-Laboratory Validation Study

Blind Samples

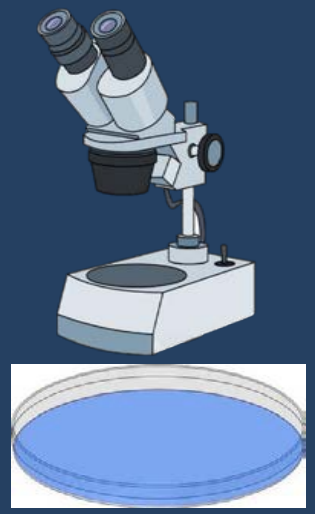
- 4 shapes
- 4 polymers
- 1 – 1,000 µm
- false positives

Norwegian Institute for Water Research

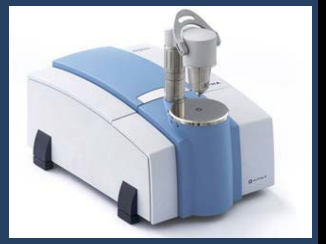
SCCWRP Established 1969

participating laboratories

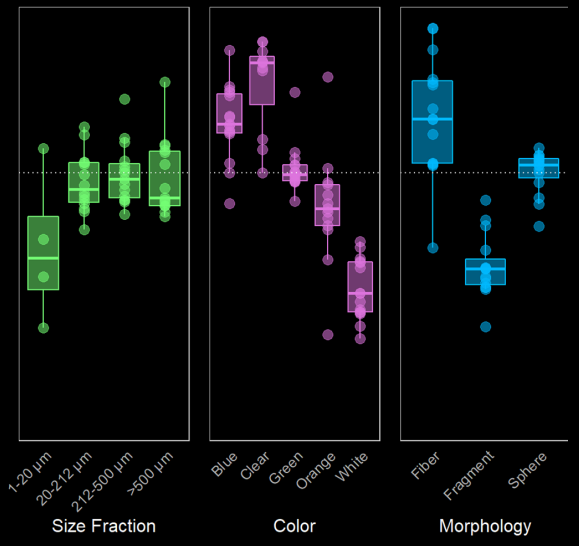
Particle Extraction



Particle Identification & Categorization

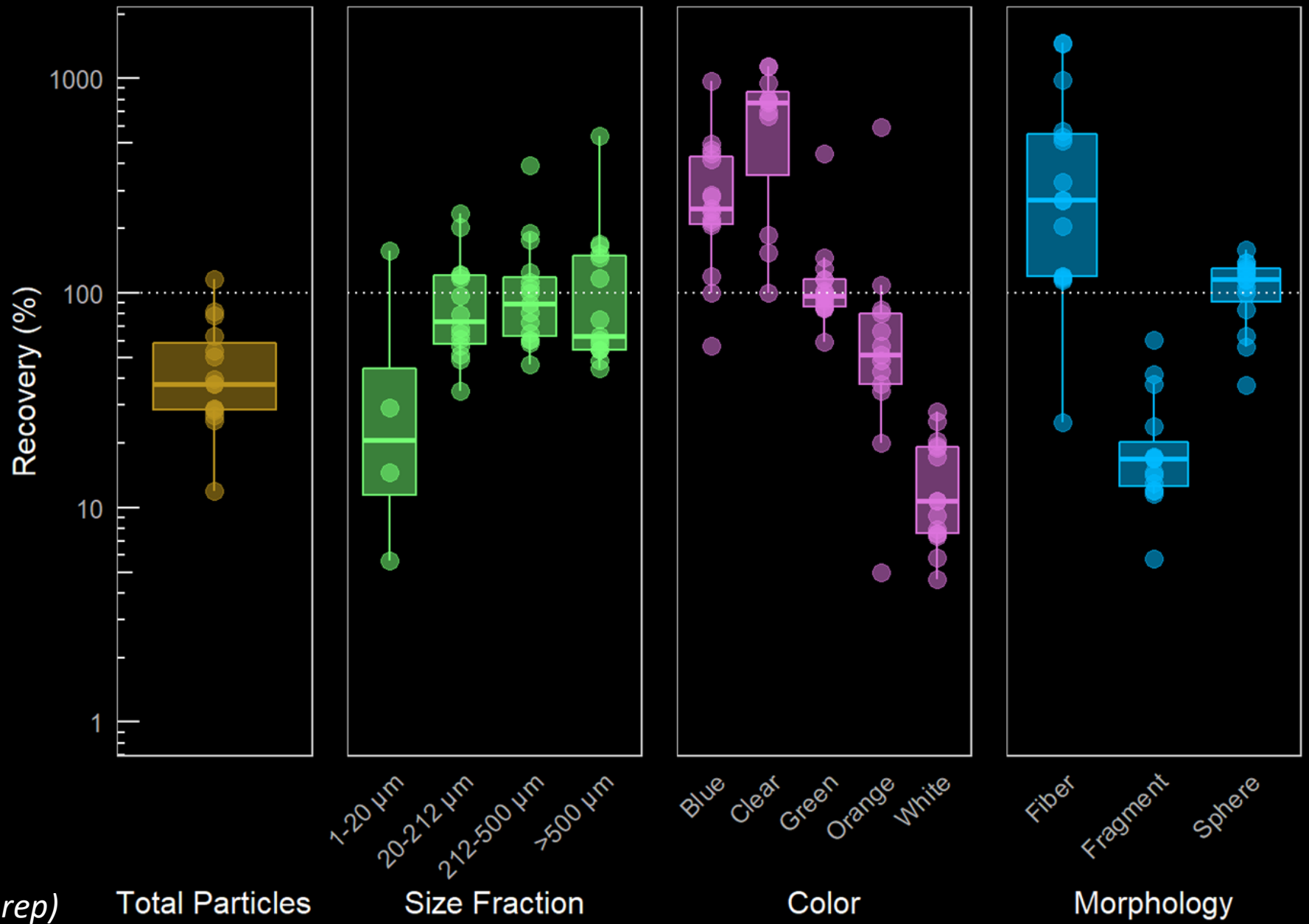


Chemical Analysis



Data Analysis

Spectroscopy Method Performance



De Frond et al (*in prep*)

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-$5000)	$900 ($10 -$5000)	$2,500 ($10-$12000)
Chemical identification	No	Yes	Yes
Lower size limit (approximate)	> 20 µm	> 10 µm	> 2 µm

De Frond et al (*in prep)*

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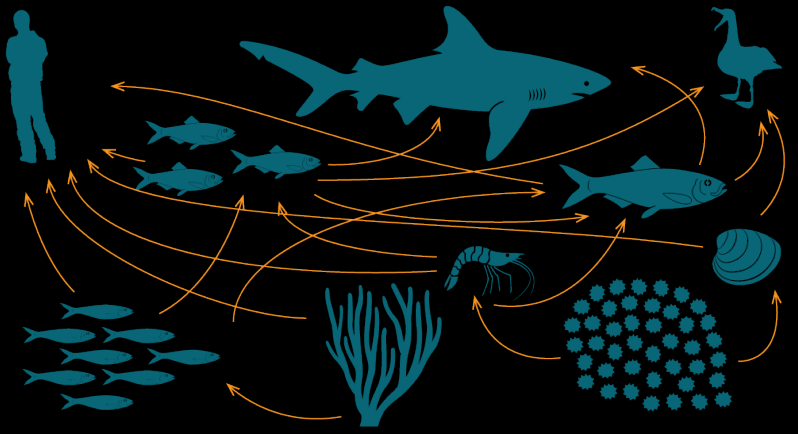
Microplastics Health Effects Workshop

2020-2021

Drinking Water



Ecosystem

SCCWRP Established 1969

SFEI

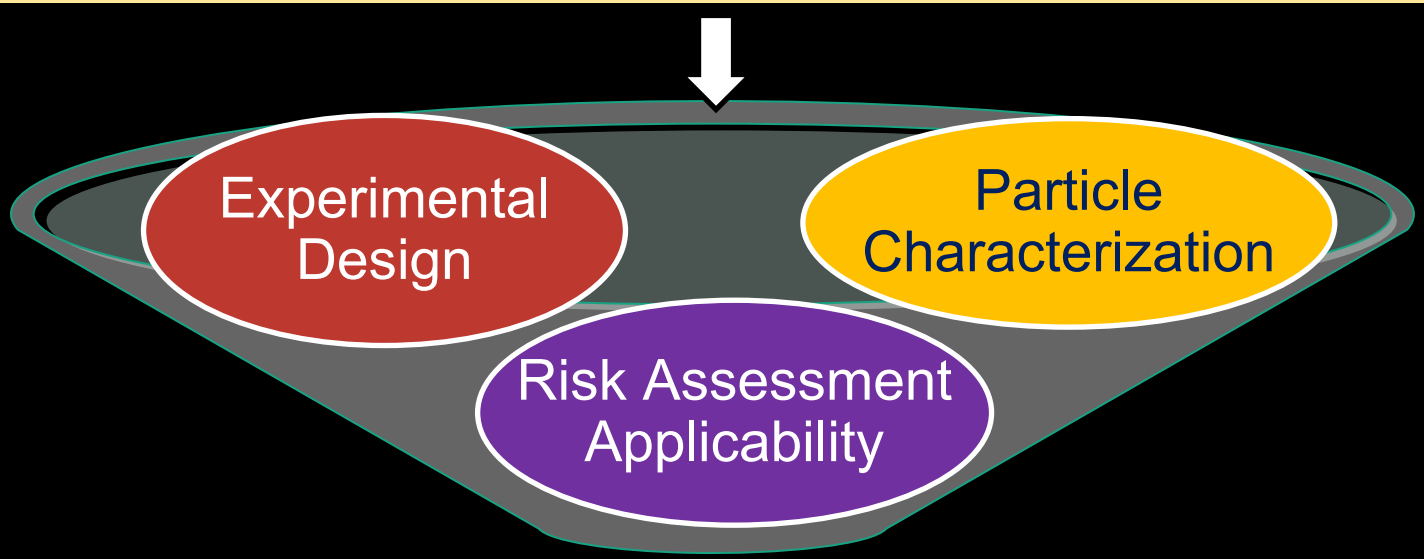
UNIVERSITY OF TORONTO

California Water Boards
State Water Resources Control Board
Regional Water Quality Control Boards

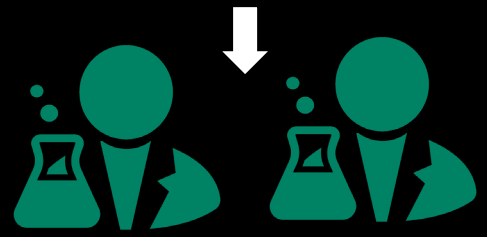
WAGENINGEN
UNIVERSITY & RESEARCH

Screening and Prioritization

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



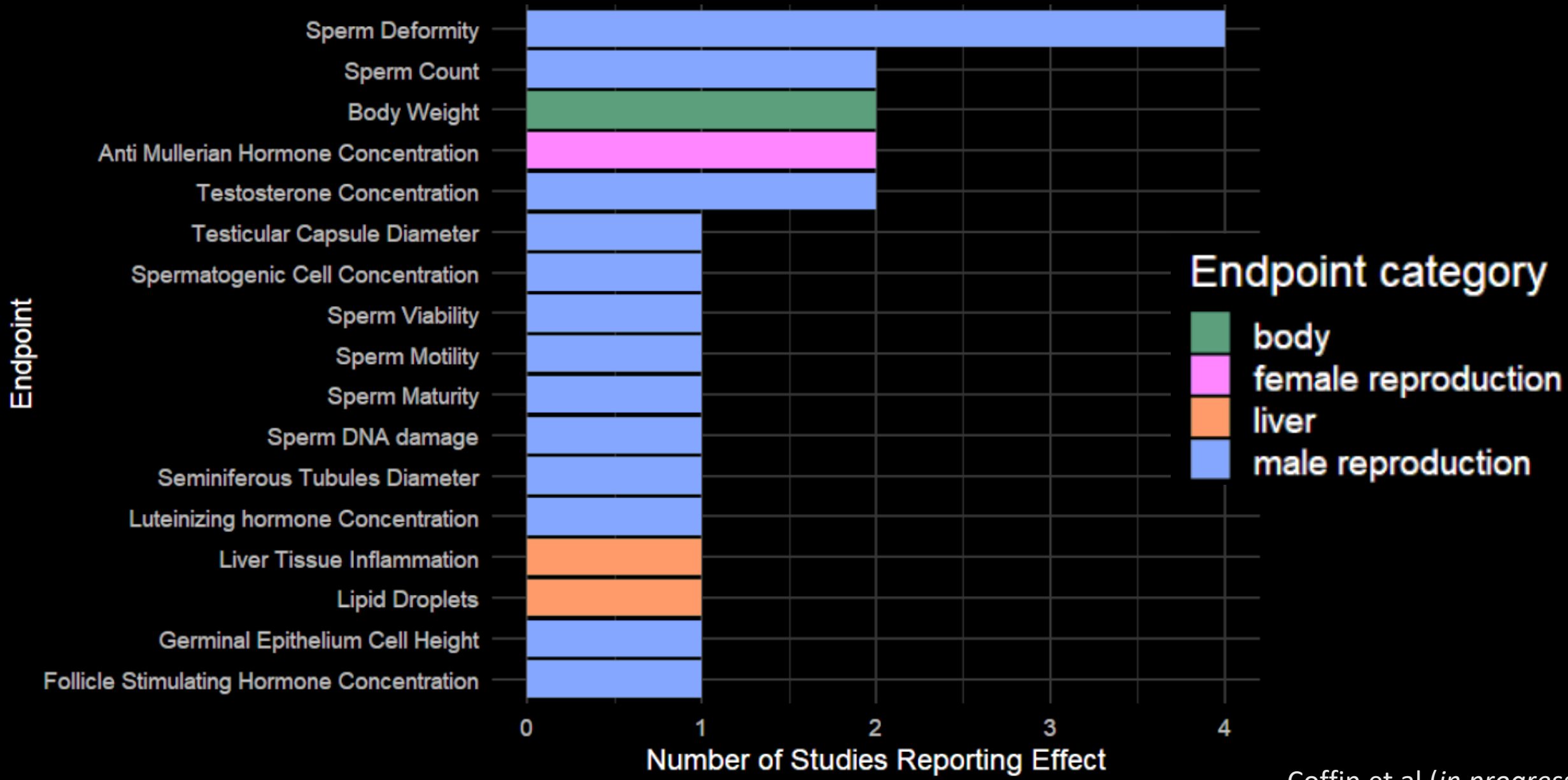
Fit for purpose studies
(n = 12)



Expert review

Coffin et al.,
Microplastics and Nanoplastics (*Submitted*)

Reliable Endpoints for Microplastics Effects in Mammals

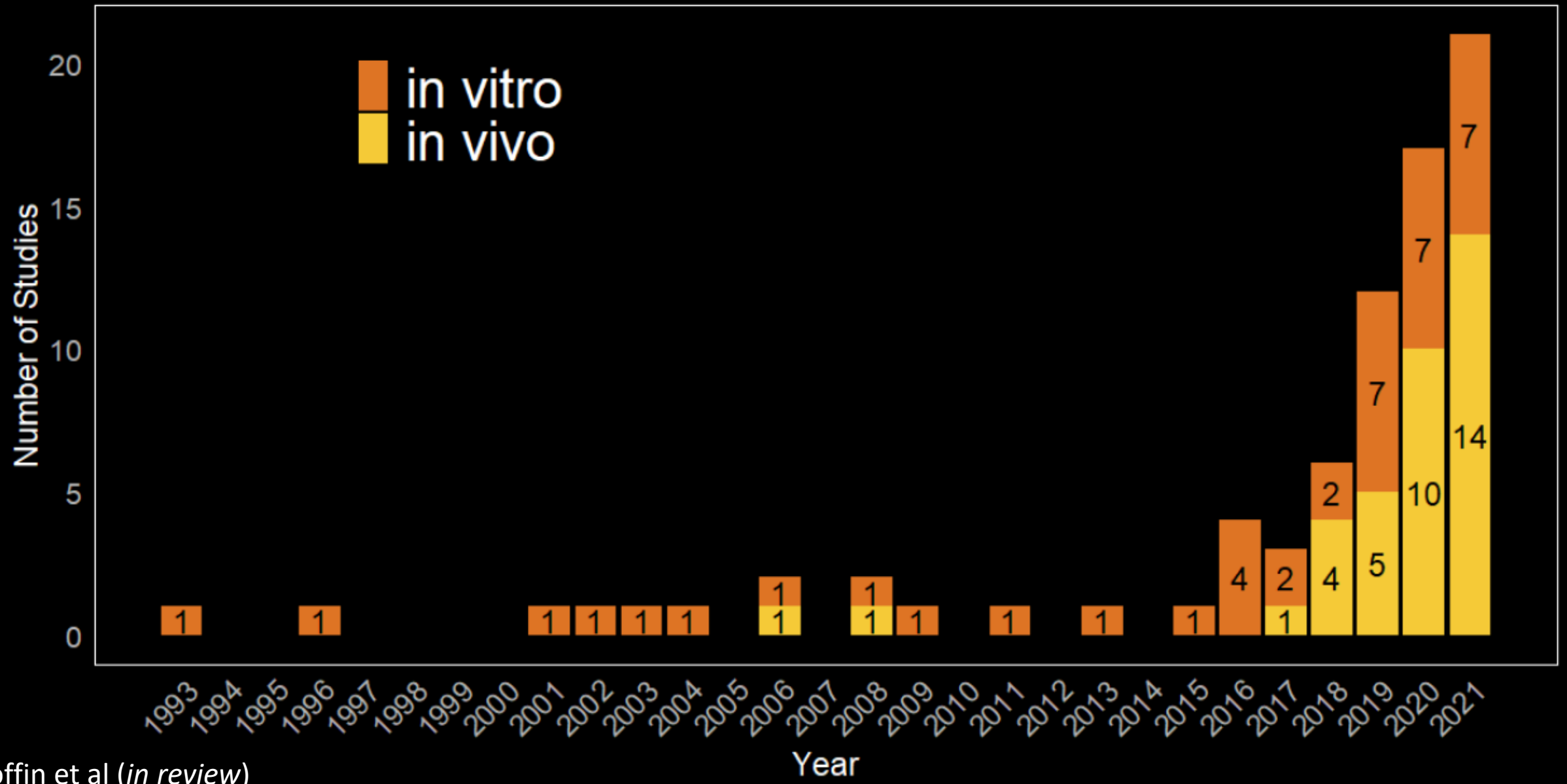


Coffin et al (*in progress)*

Not Currently Possible to Derive Regulatory Levels

1. Effects database inadequate
   - poor particle characterization
   - limited polymers, shapes, sizes tested
2. Effect Mechanisms Unknown
   - necessary for extrapolation to diverse particle types
3. Incomplete exposure data
   - limited food data
   - no harmonized drinking water data

Rapidly Increasing Toxicity Evidence in Mammals

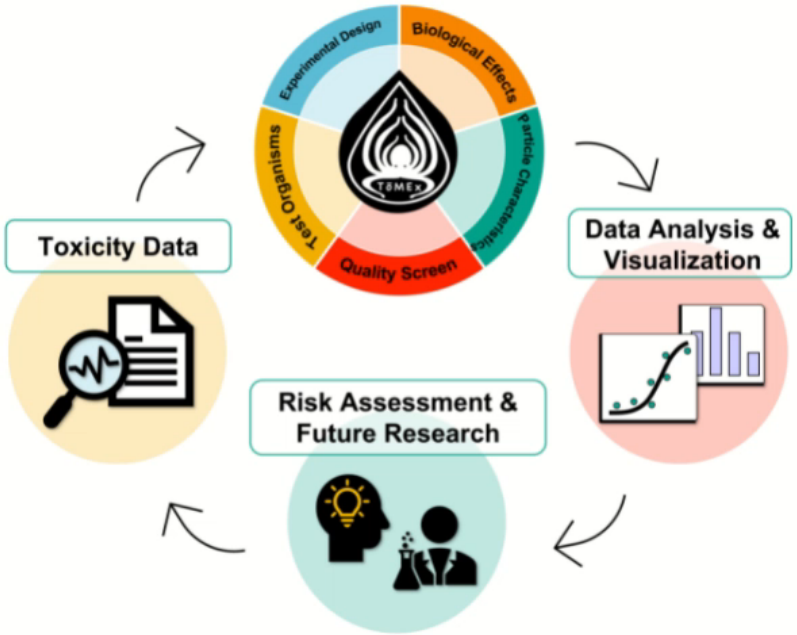


Coffin et al (*in review*)

Logo created by J.C. Leapman.

- Welcome
- Overview
- Search
- Exploration
- Study Screening
- Resources
- Contact
- Aquatic Organisms

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 posure, prioritize which microplastics characteristics (e.g., size, shape, polymer) that are of greatest biological concern, and identify critical thresholds for each at which those

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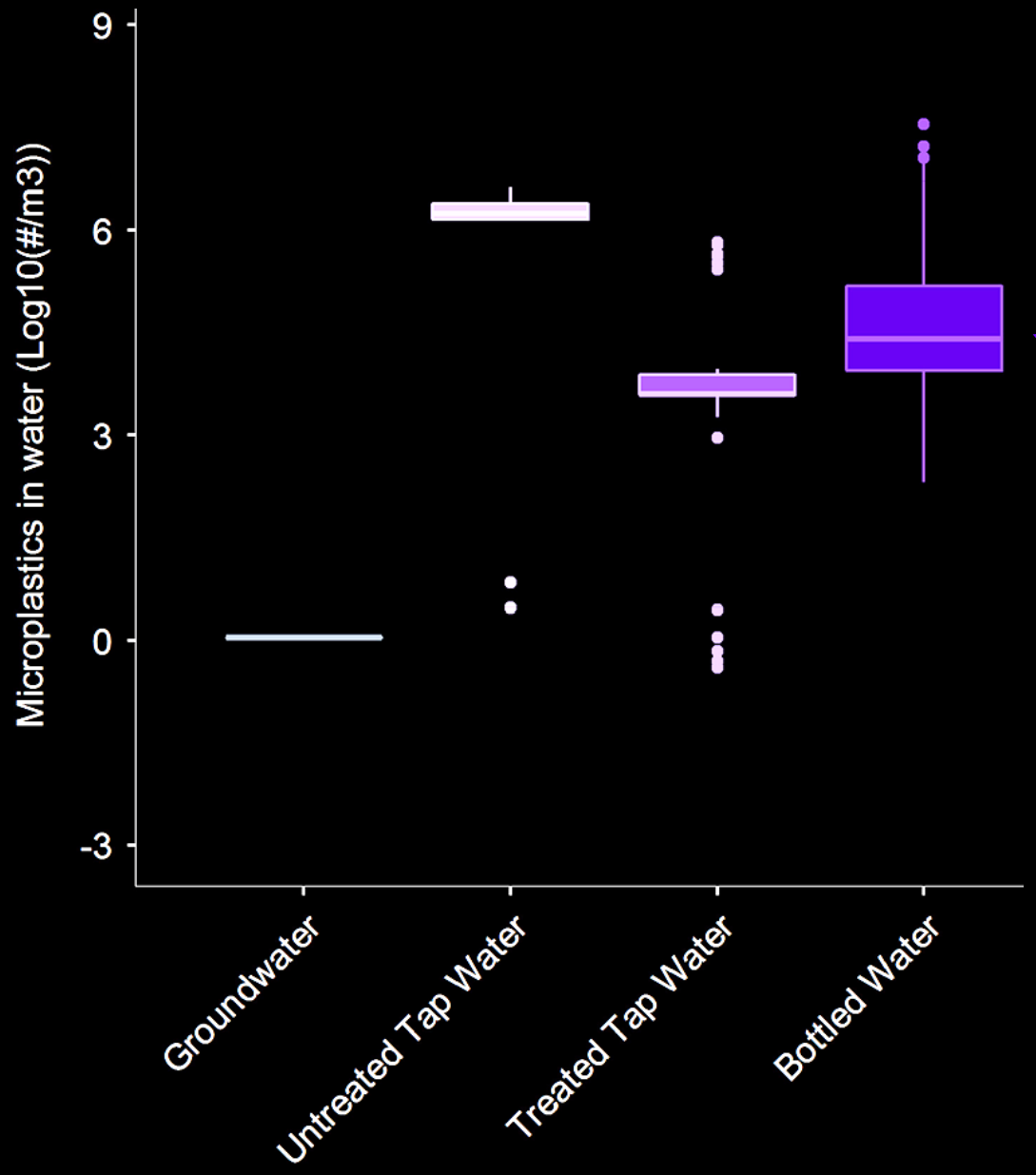
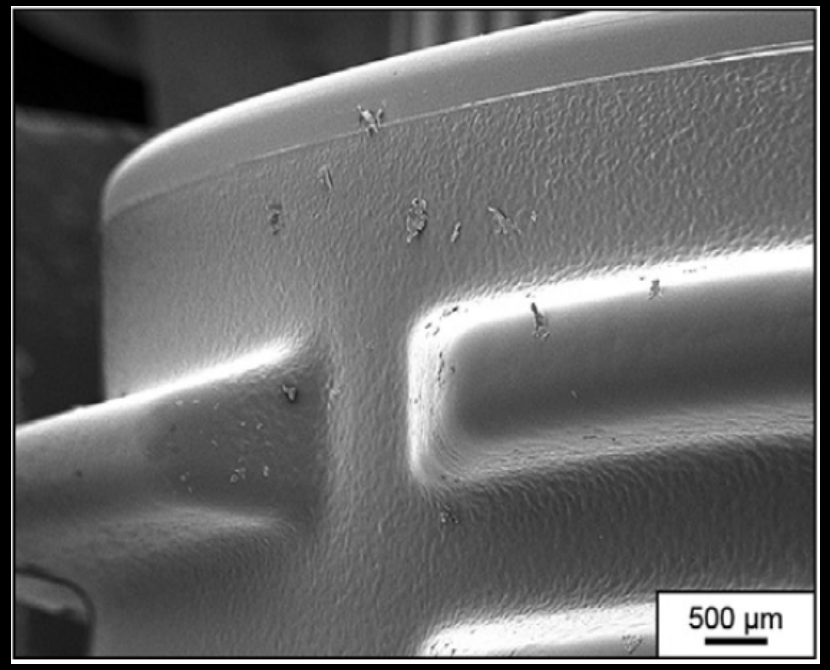
Contamination Depends on Source & Treatment





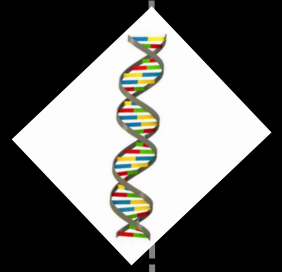
Opening a plastic water bottle releases **14-2,400** microplastic particles

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

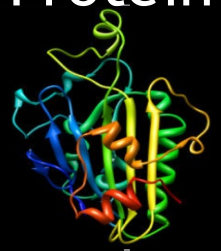
Koelmans *et al* (2019). *Water Research*

Microplastics Removal is Size-Dependent

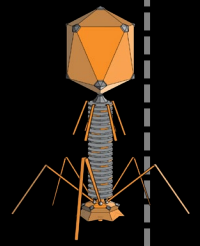
DNA



Protein

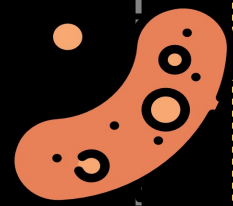


Virus



Red blood cell

Bacteria



Dust mite

Reverse Osmosis

Ultrafiltration

Flocculation/Sedimentation

Nanofiltration

Microfiltration

Raman & IR Limit of Quantification

1 nm | 10 nm | 100 nm | 1 µm | 10 µm | 100 µm

Proposed Iterative Monitoring Approach

Phase I

- Source waters only
- Mostly surface water
- >20 µm microplastics

Phase II

- Source waters
- Treated drinking water
- >1 µm microplastics

2022

2024

2026

Tentative approach. Dates subject to change.

Multiple Sources and Pathways to Humans

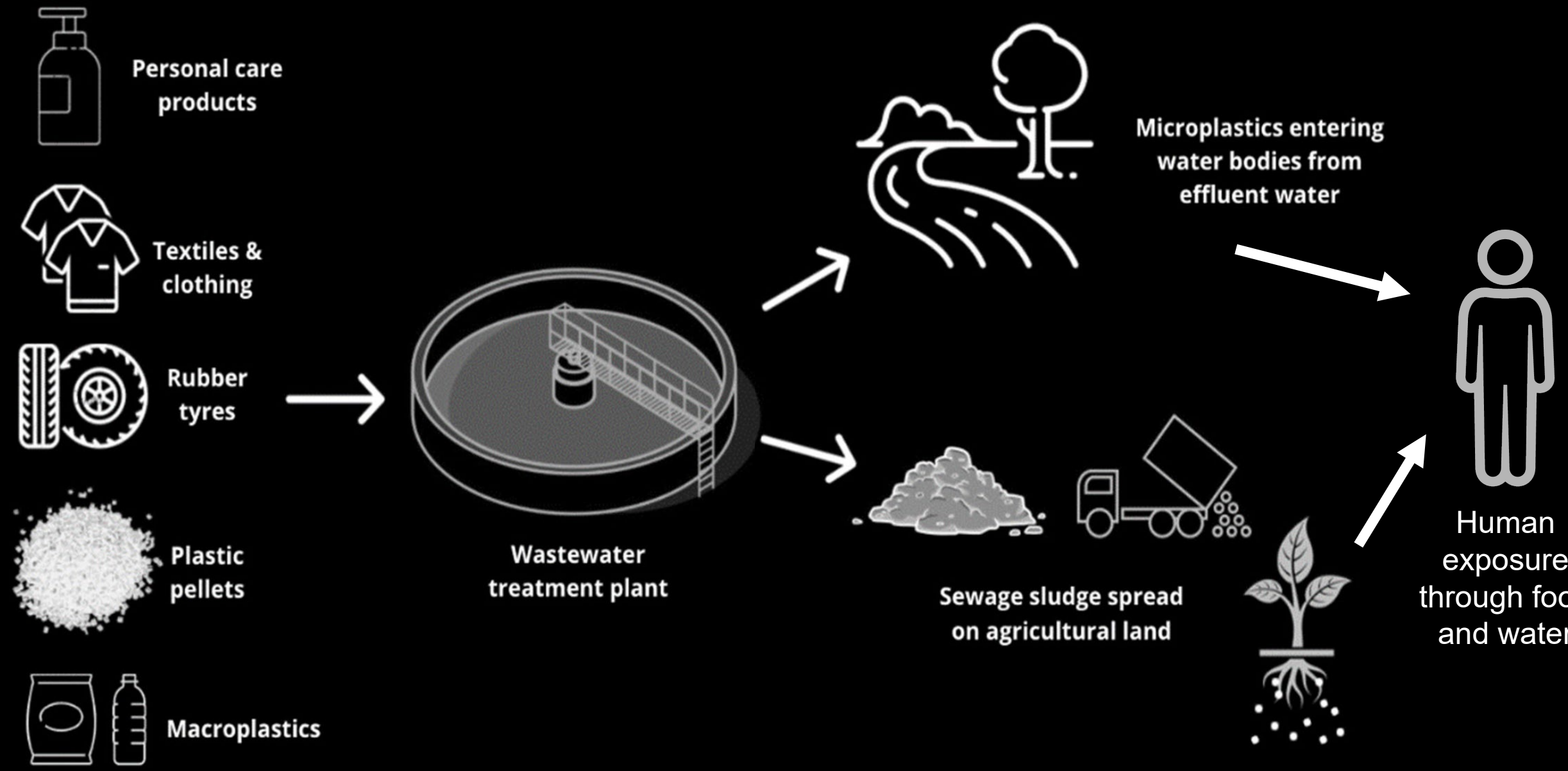
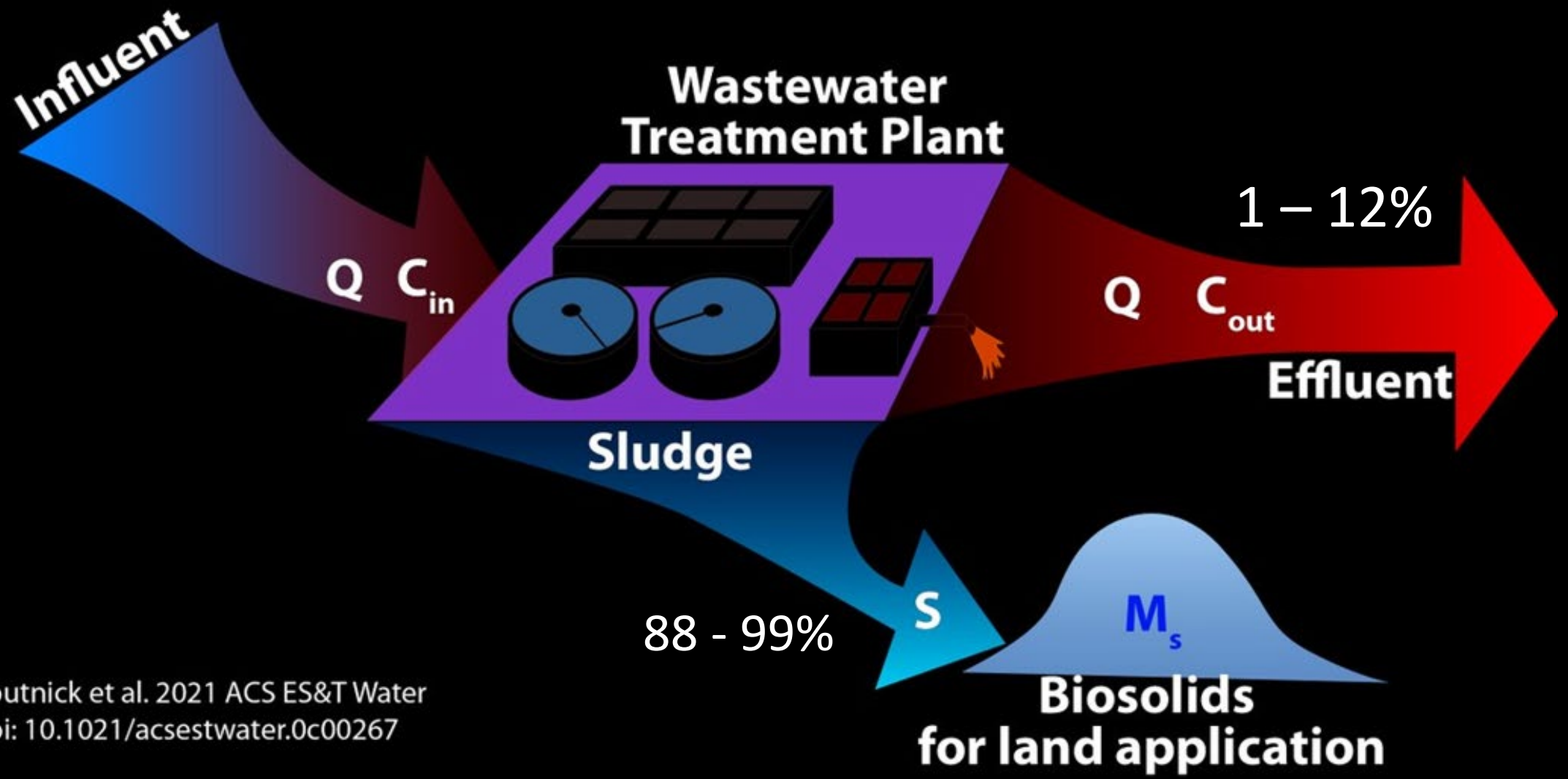


Figure adapted from Milojev et al (2021). *Energies*

Wastewater Treatment Sends 88-99% of Microplastics to Sludge

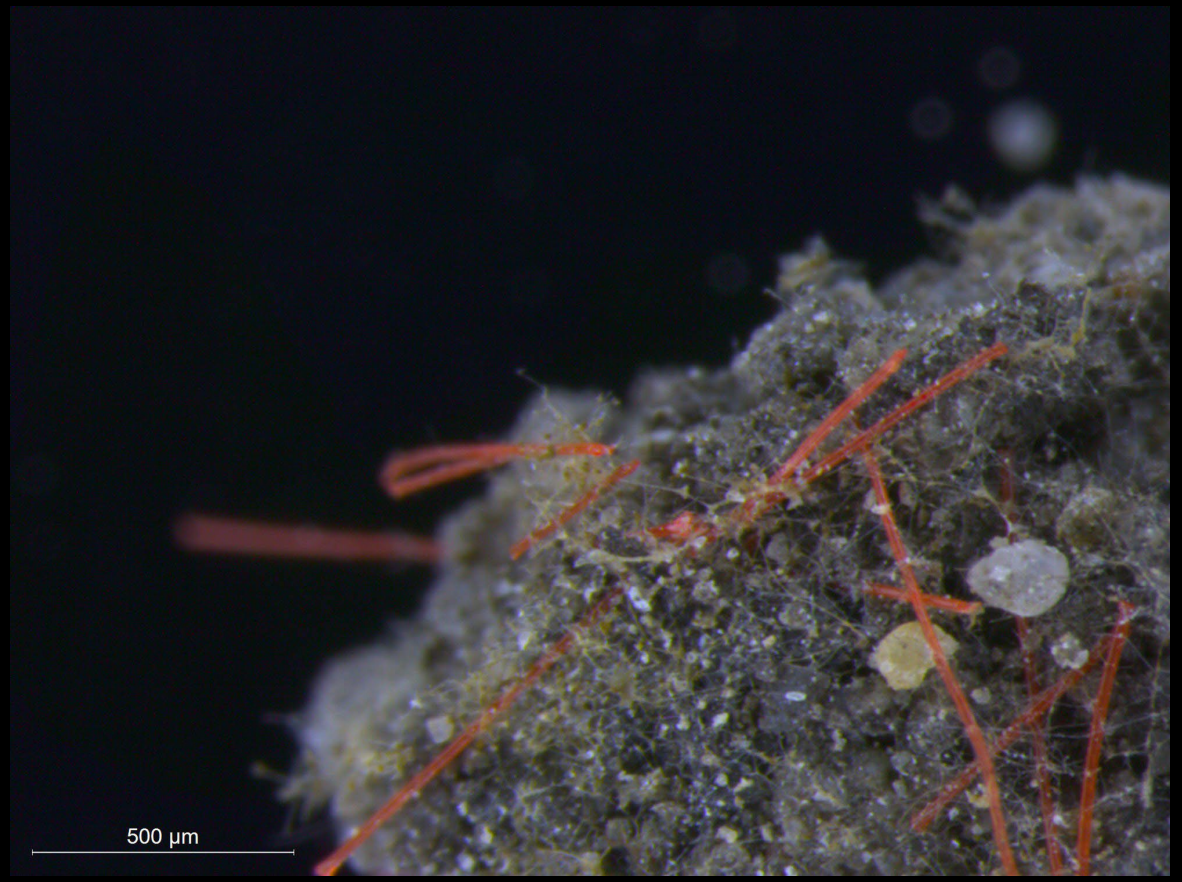


Treatment removal rates from Freeman et al. (2020). *Journal of Environmental Management*

Sludge Application to Land

Biosolids applied to an agricultural field in California

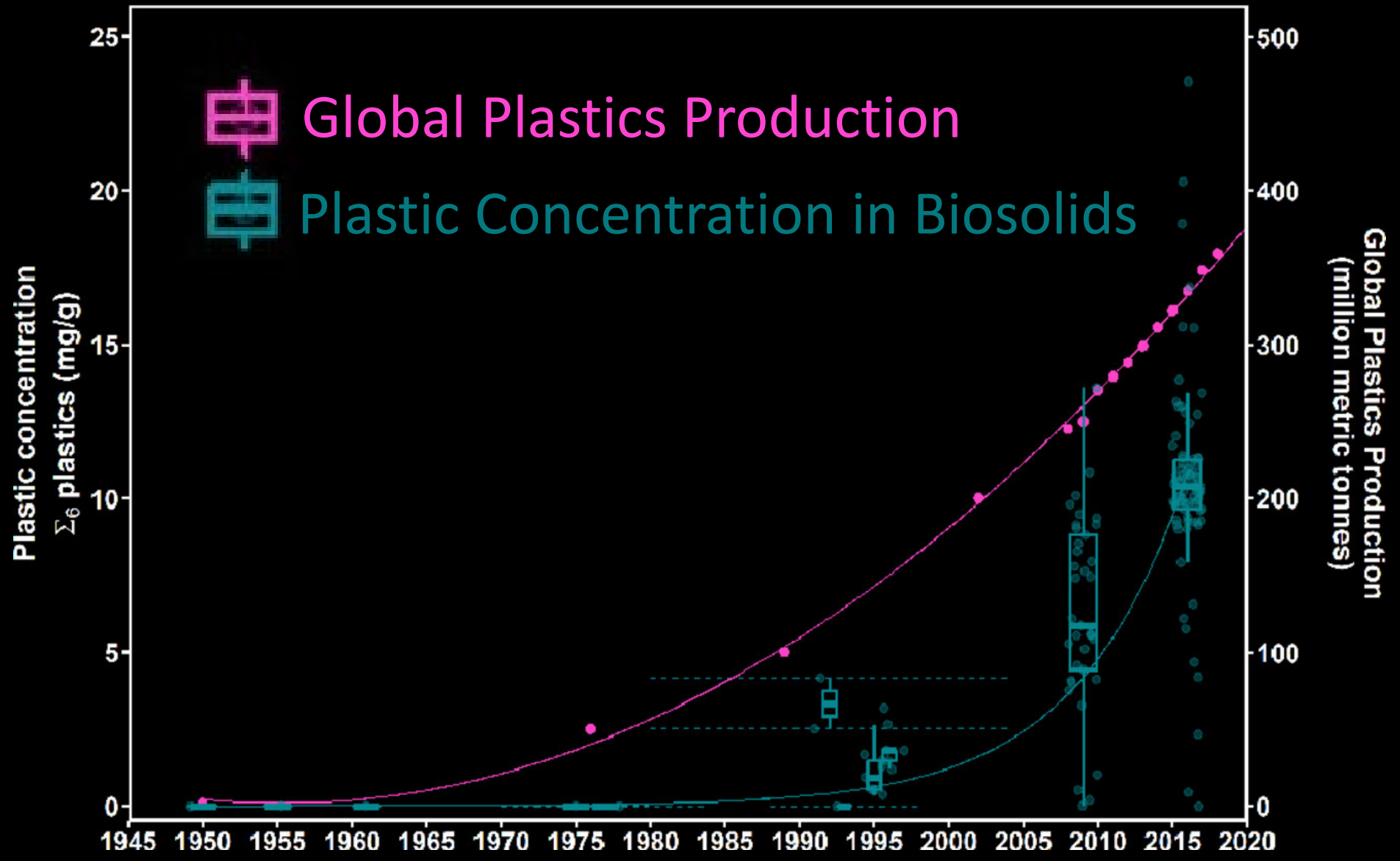
LACitySan.org



Microplastics aggregated in soil

Dr. Anika Lehmann (Freie Universität Berlin).

Plastic Content in **Biosolids** Correlates to **Global Production**

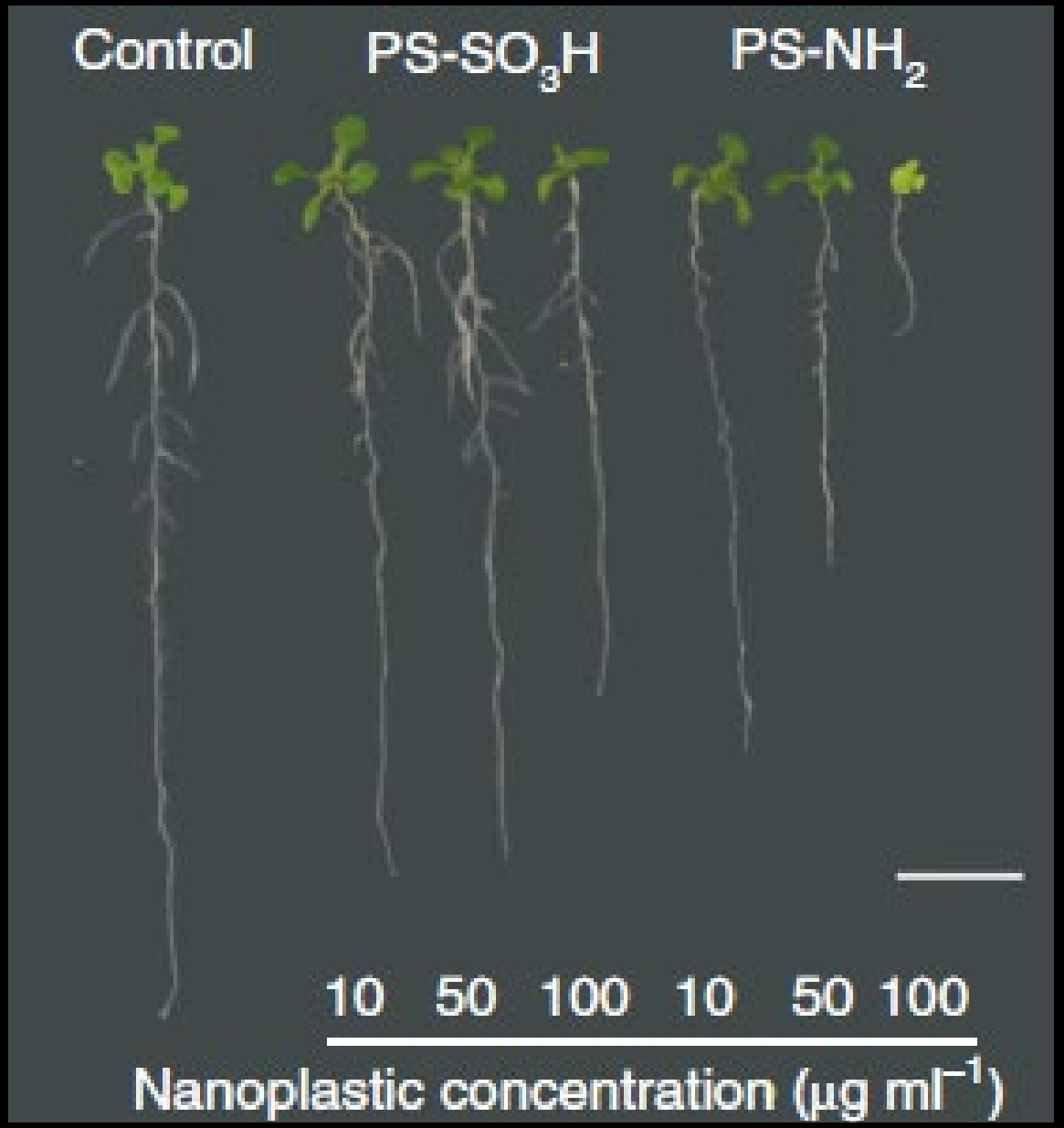


Okoffo et al (2021), *Water Research*

Several States banned Forever Chemicals (PFAS) in Compostable Food Packaging

Saferchemicals.org

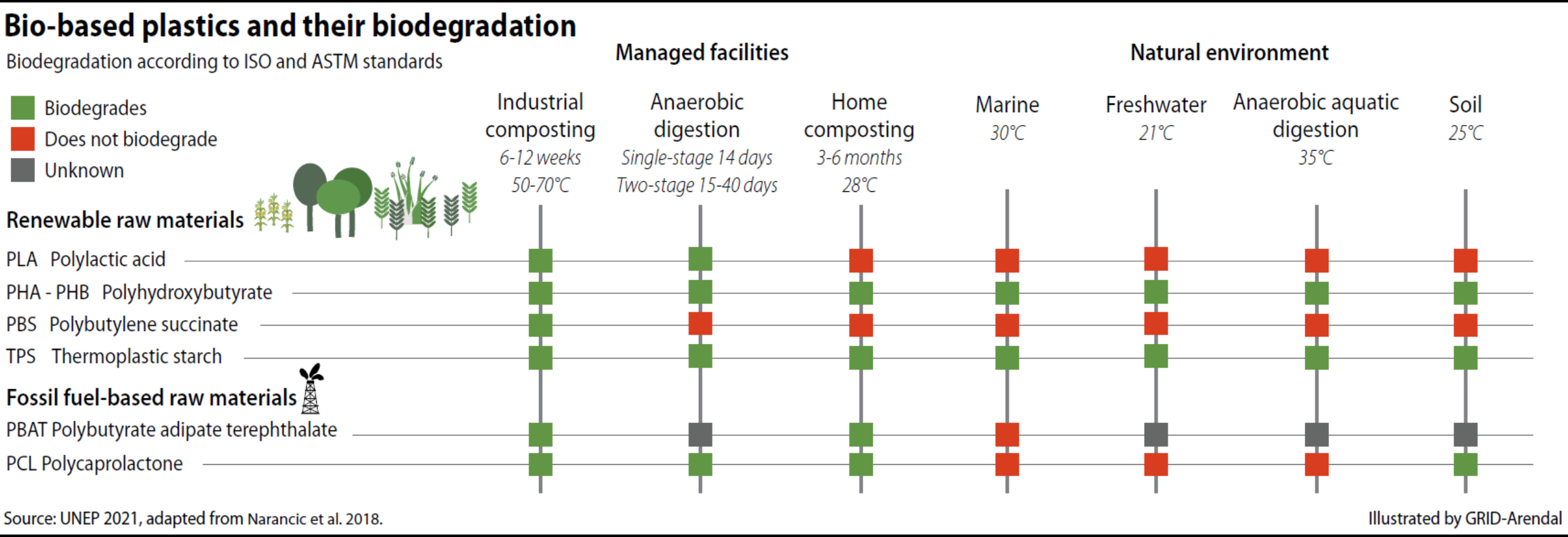
Microplastics **Reduce Plant Growth**



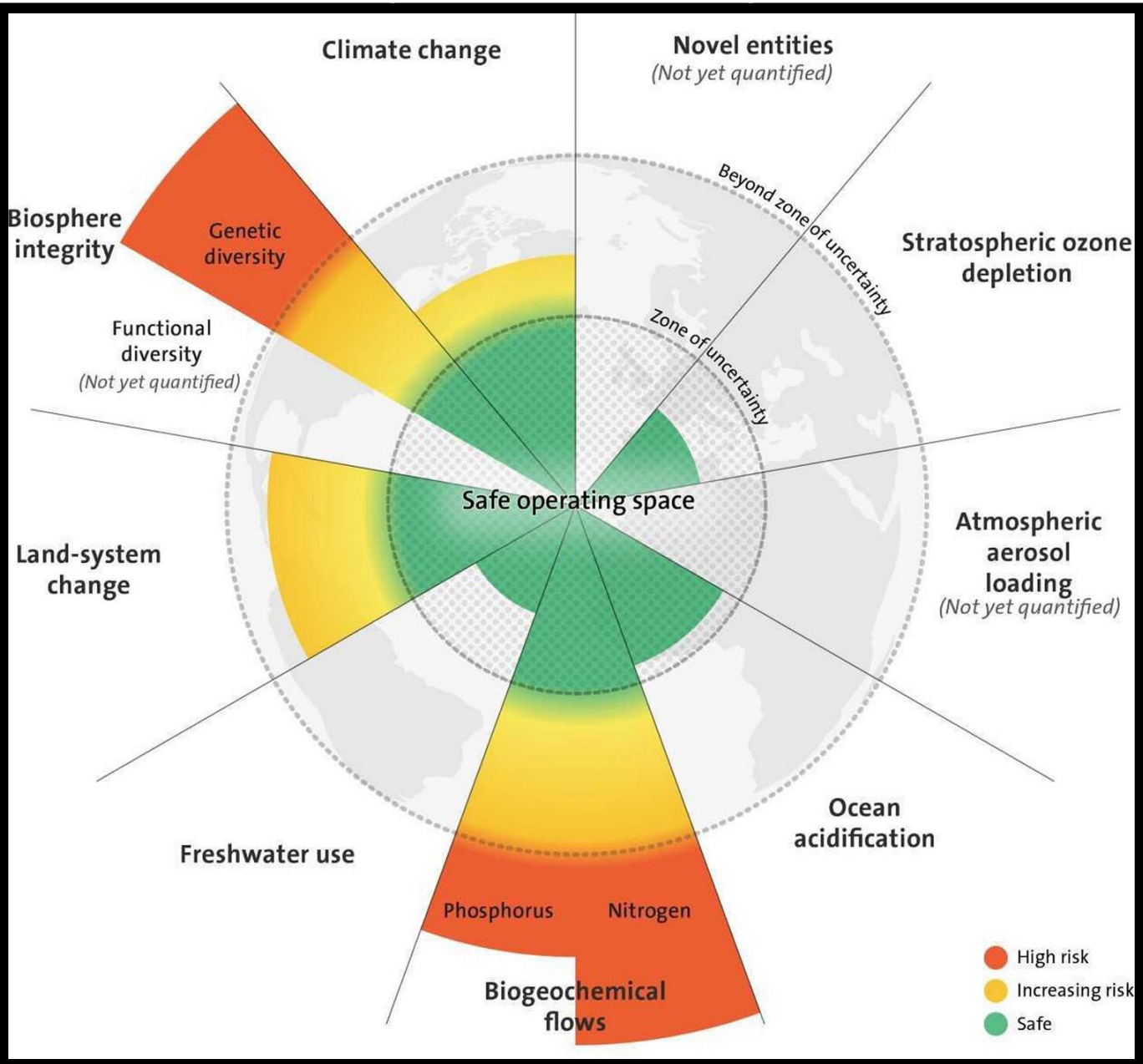
Sun et al. (2020). *Nature Nanotechnology.*

What's the deal with bioplastics?

Some bioplastics degrade - others do Not



Planetary Boundary for Biosphere already at Risk



Folke et al (2021). *Ambio*

Avoiding Regrettable Substitutions

Email updates: dtsc.ca.gov/dtsc-e-lists/

Upcoming Policy and Regulatory Actions in California

- **Drinking water and environmental monitoring**
  - 2022-2026

- **Safer Consumer Products Priority Product Evaluation**
  - 2021 - onwards