International Council of Chemical Associations

Microplastics Advanced Research and Innovation Initiative (MARII)
– A Global Perspective –

September 2024

International Council of Chemical Associations

CLOSING THE MICROPLASTIC INFORMATION GAP

-A MARII WEBINAR SERIES-

MICROPLASTICS ADVANCED RESEARCH AND INNOVATION INITIATIVE

Join us on this **webinar series** to discover how MARII is fostering global collaboration among researchers to facilitate the exchange of information and advance microplastics research and innovations

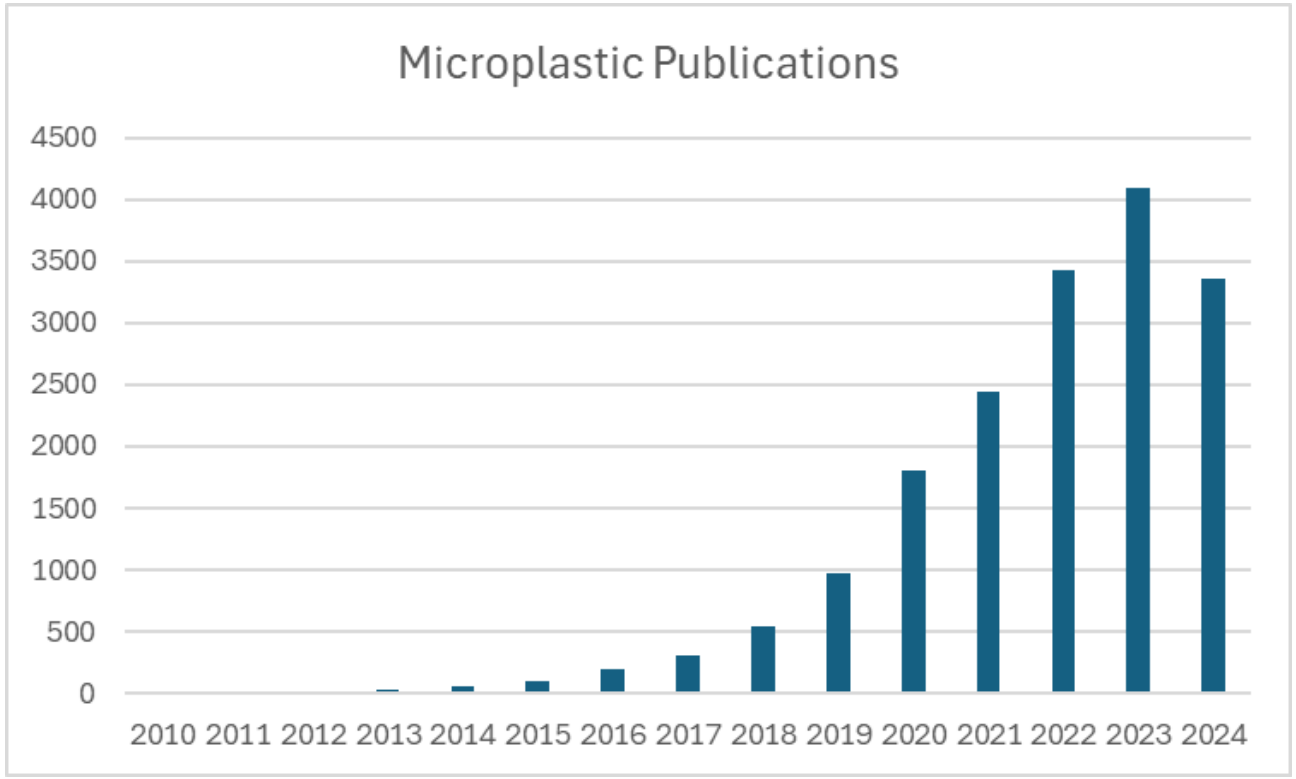
11 APRIL 2024	WATCH NOW	An introduction to MARII
28 MAY 2024		Modelling
12 SEPT 2024	2 pm CET	**Developing Standardized Microplastic Methods**
7 NOV 2024		Human health
23 JAN 2025		Ecotox
27 FEB 2025		Advancing risk-based solutions

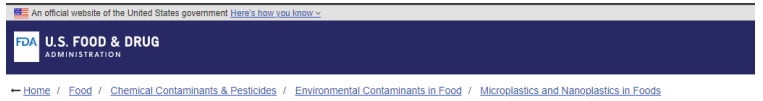
This webinar series is organised with the suppor of

ecetoc

Information Landscape

Increased Microplastics Information





Microplastics and Nanoplastics in Foods

Data acquired through PubMed on Sept 10, 2024:

https://pubmed.ncbi.nlm.nih.gov/?term=MICROPLASTIC

WHO, 2018. https://bit.ly/3ZkqoK7
SAPEA, 2019. https://bit.ly/47pahwR
WHO, 2022. https://bit.ly/3ZjPR6w
FDA, 2024. https://bit.ly/3ZhvBT1

Select Initiatives

Europe

- Restriction on intentionally released MPs

U.S. State Activity

- California, Hawaii, Minnesota – testing protocols for drinking water

Plastics Treaty

- Microplastics is part of the discussions and of the UNEP options paper for an Internationally Legally Binding Instrument on Plastics Pollution

Need for Risk Based Approaches

- **We need to have science developed when regulatory and public interest is sustained**

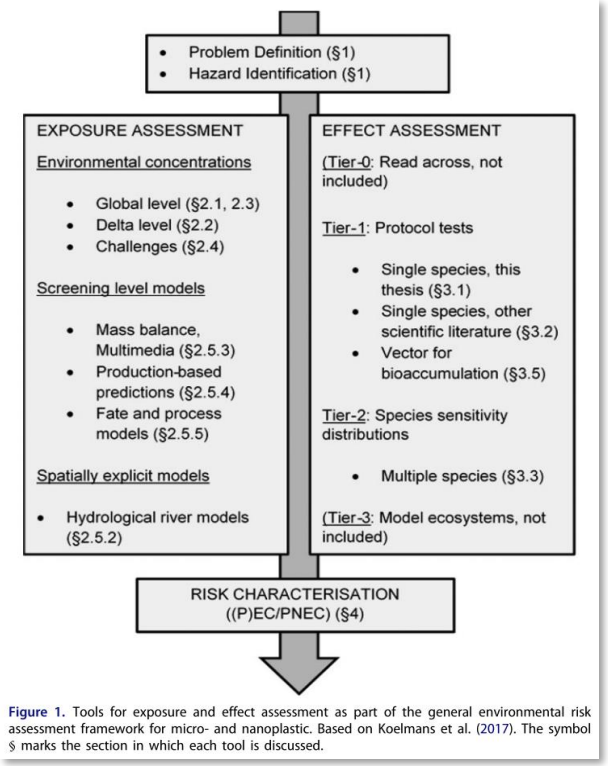
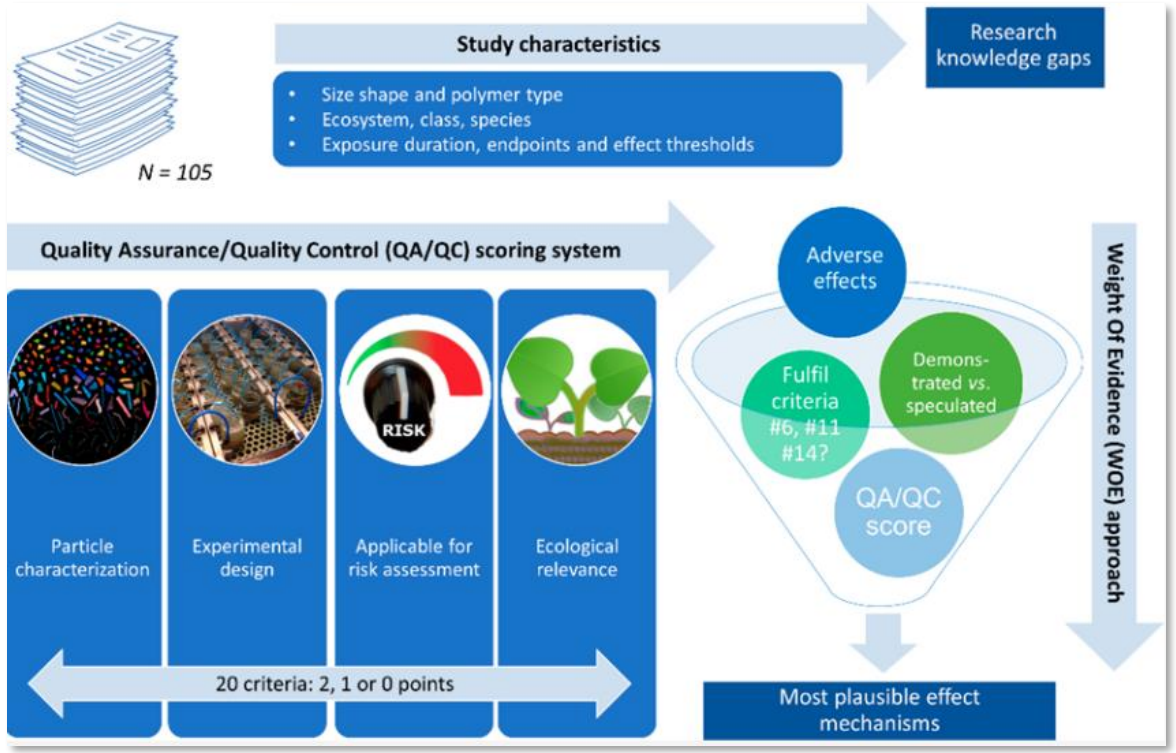


Figure 1. Tools for exposure and effect assessment as part of the general environmental risk assessment framework for micro- and nanoplastic. Based on Koelmans et al. (2017). The symbol § marks the section in which each tool is discussed.



https://dx.doi.org/10.1021/acs.est.0c03057

Closing the Research Gaps

Information Needs for Microplastics

Standardized methods and high-quality information is necessary to inform risk-based decisions

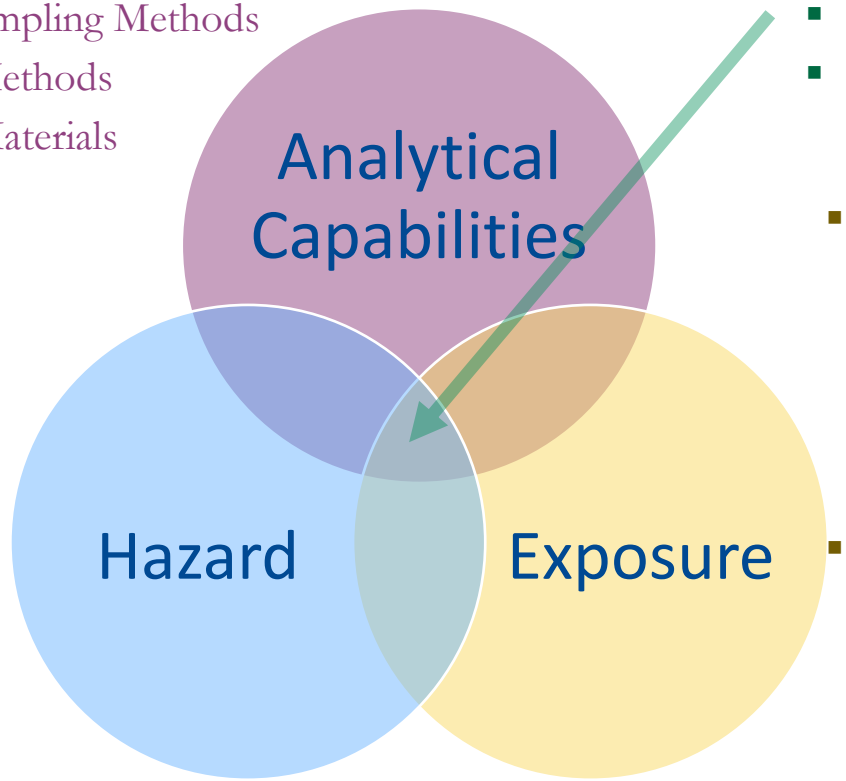
- QA/QC Needs - Sampling Protocols, Analytical Standards, Reference Materials
- Exposure - Routes of Exposure and Environmental Fate
- Hazard - Human v. Ecological Targets
- Risk Assessment - Framework to Inform Regulatory Actions

Translating Information Needs into a Quantitative Risk Assessment Framework

Risk Assessment

- Probabilistic Risk Modelling
- Environmental Risk Framework

- Standard Sampling Methods
- Analytical Methods
- Reference Materials



- Approaches to identify **human health** hazards
  - Via ingestion pathway
  - Via inhalation pathway

- Approaches to identify **environmental** hazards
  - Aquatic ecotoxicity
  - Model organisms

- Human Health
  - Uptake and internal distribution
  - Composition of indoor and outdoor air

- Environmental Exposure
  - Fate, transport, and sediment deposition
  - Adsorption and bioaccumulation

Microplastics Advanced Research and Innovation Initiative (MARII)

A global forum on exchange for microplastics research

MARII is a global forum for industry, academic, agency, and renowned research institutions to exchange on microplastics research.

Exchange forum for industry on microplastic research

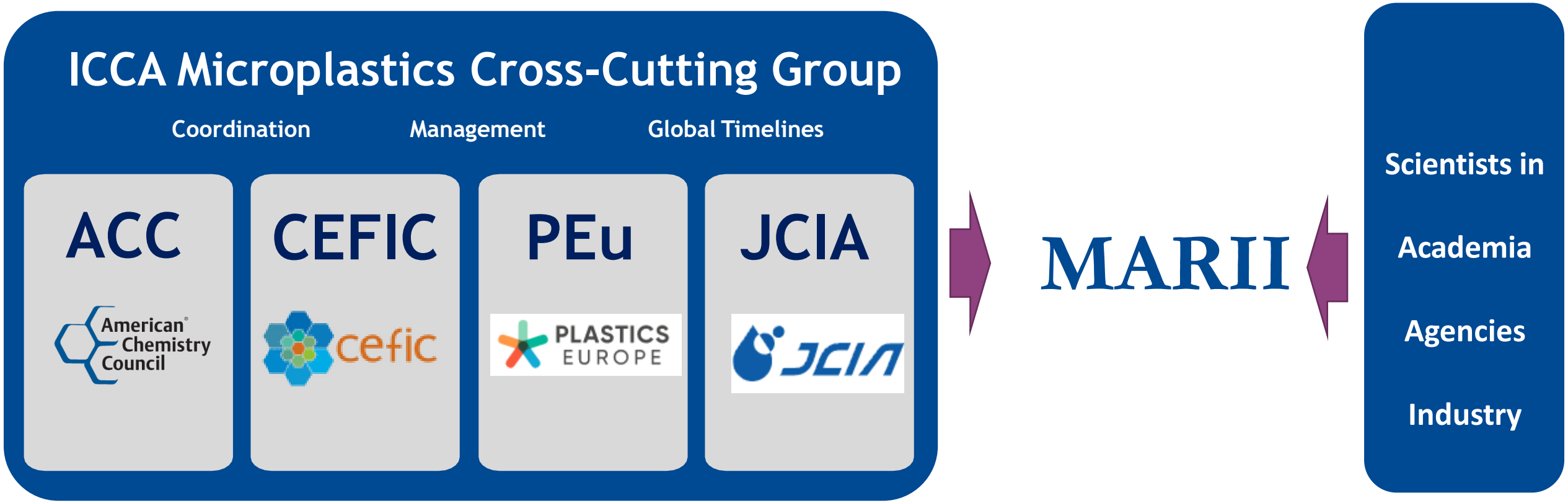
Provide the full picture on microplastics research across industries and regions.

Organize global meetings to facilitate information exchange

Engagement with world-renowned academics to complement industry research

Demonstrate active commitment by industry on the research topic.

Ongoing Industry Microplastics Research



MARII Engagement

2023

Society of Toxicology Annual Meeting

- March 2023 - Symposium on Microplastic Risk Assessment
- Microplastic Meet and Greet Reception

Workshop on Human Health

- May 2023 – Sessions on Human Health & Microplastic by Plastic Europe's Brigid

SETAC Europe 33rd Annual Meeting

- May 2023 - Three sessions
- Microplastic Meet and Greet Reception

Second MARII Symposium (Seattle, US)

- June 12-13 – Focus on progressing risk assessment
  - Presentations: https://www.ecetoc.org/marii-workshop-seattle/

SETAC North America Annual Meeting

- November 2023 – Session on Fate of Plastics
- MARII Booth

2024

MARII Webinar Series

- 2024 – Six joint webinars planned with ECETOC

Society of Toxicology Annual Meeting

- March 2024 – Continuing Education Course and Reception

SETAC Europe 34rd Annual Meeting

- May 2024 – Microplastics and additives with reception

Workshop on Human Health

- 2024 – Sessions on Human Health & Microplastic by Plastic Europe's BRIGID

Third MARII Symposium (Sao Paulo, BR)

- Latin America Regulatory Cooperation Forum

More to come in 2025…

Today's Presentations

Todd Gouin

TG Environmental Research

Dietary and inhalation exposure to nano- and microplastic particles and potential implications to human health

Kara Franke

ToxStrategies

An Update on the MNP Health & Environmental Literature Platform (MNP-HELP): A Curated Literature Repository

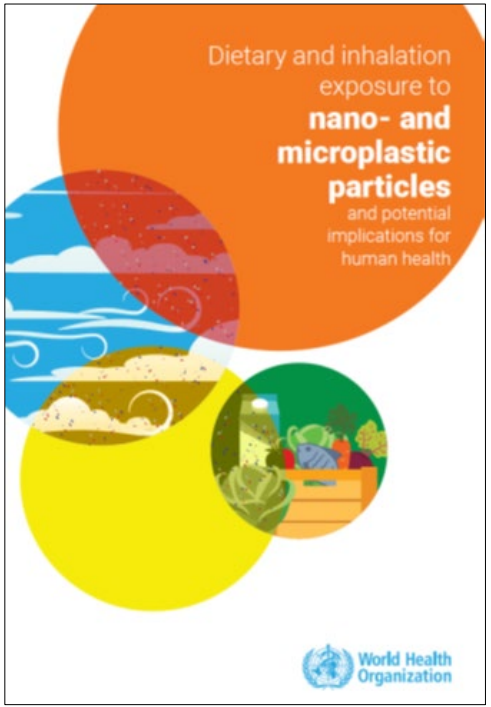
Thank you

TG ENVIRONMENTAL RESEARCH

Dietary and inhalation exposure to nano- and microplastic particles and potential implications to human health

Todd Gouin

ACKNOWLEDGEMENTS



The World Health Organization expresses its appreciation to all those who contributed to the preparation and development of this report, including the colleagues named below.

This report is the product of several expert meetings held between 2019 and 2022, and represents a follow-up to the WHO report on Microplastics in Drinking Water, published in 2019.

Lead authors

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- Flemming Cassee, National Institute for Public Health and the Environment, Netherlands
- Todd Gouin, Independent Consultant, United Kingdom
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- Shirley Price, University of Surrey, United Kingdom
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- Stephanie Wright, Imperial College London, United Kingdom

Experts who provided insights, wrote text, offered peer review, and/or participated in meetings:

- Guillaume Duflos, Agence Nationale de Sécurité Sanitaire de l'Alimentation, de l'Environnement et du Travail, France
- John Fawell, Cranfield University, United Kingdom
- Jennifer De France, WHO, Switzerland
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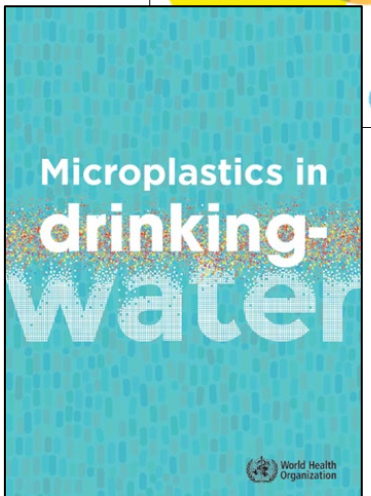
Nano- and Microplastic particles: WHO response

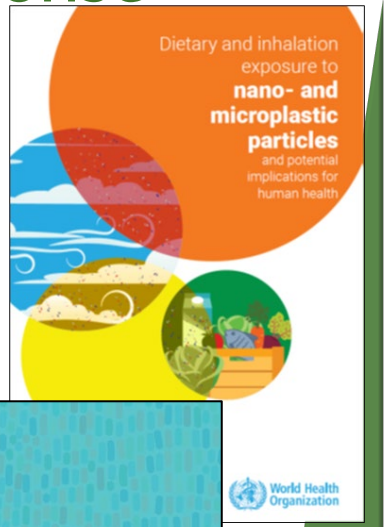
Context

- World Health Organization (WHO) regularly issues health-based guidelines on health and environment
- Emerging issues, such as plastics are identified as important issues in the health and environment department

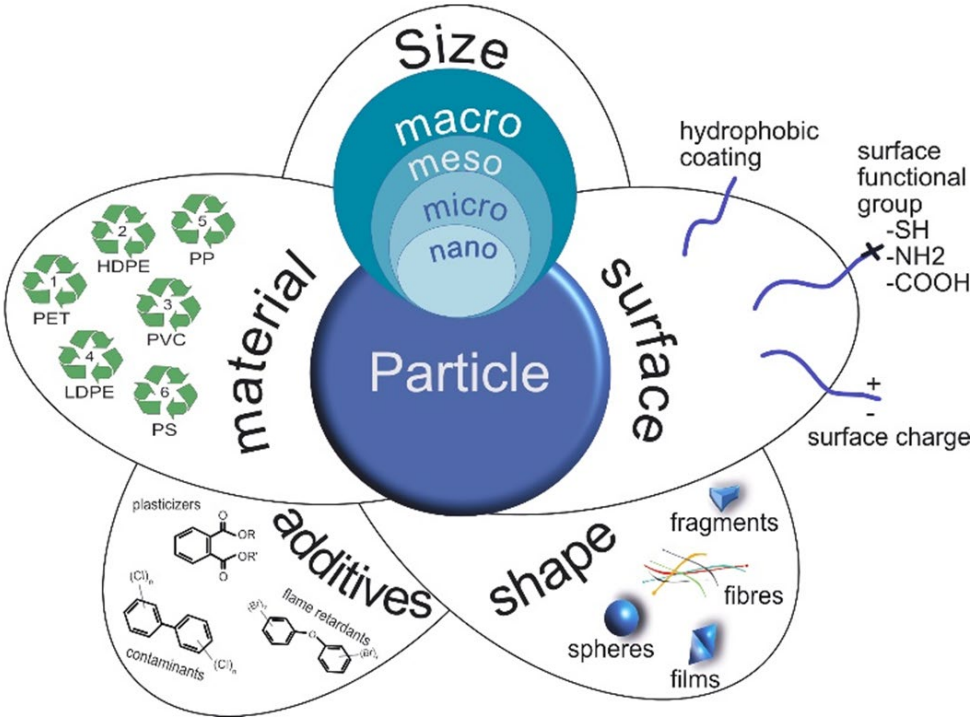
Technical work:

- Systematic review of data quality
  - Microplastics in Freshwaters and Drinking Water, Koelmans et al, 2019
  - Microplastics in air, Wright et al, 2021
  - Microplastic effect studies, Gouin et al, 2022
- WHO Report on microplastics and drinking-water (published 2019)
- Evaluation of human health implications that include additional relevant exposure routes (air, water, food and beverages) (published 2022)



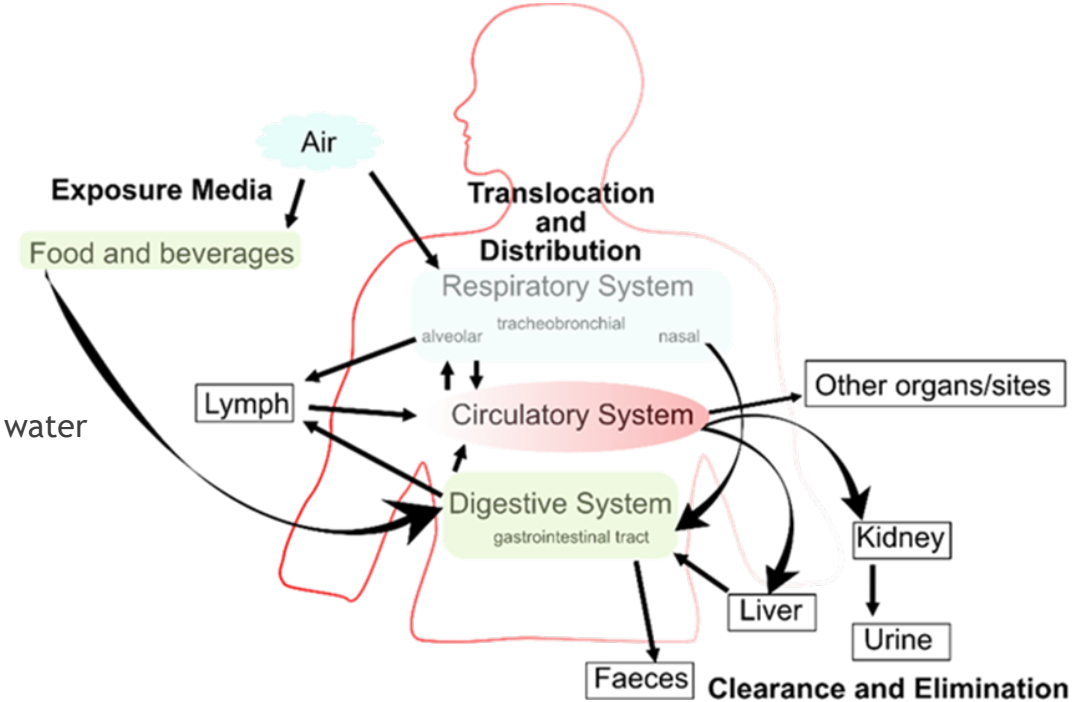


Complexity of nano- and microplastic particles



Nano- and Microplastic particles and human exposure

- What we know
  - Ubiquitous
    - Water
    - Air (indoor/outdoor)
    - Soil
  - Oral
    - **Particles >10µm**
    - Food, beverages and drinking water
- What we know we don't know
  - Inhalation and oral
    - **Particles <10µm**
  - Dermal
  - Elimination
    - Faeces

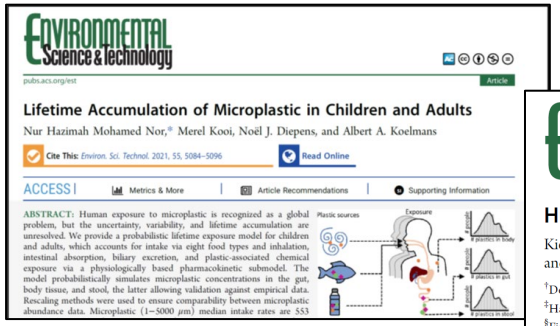


Microplastic in seafood – sources of contamination

- Marine waters – filter feeders
  - Filter feeders ingest and accumulate MPs from contaminated seawater and sediment, resulting in dietary exposure for consumers of seafood products (van Cauwenberge and Janssen, 2014; Renzi et al., 2018)
- Food processing and/or packaging
  - Observations that higher levels of contamination associated with processed seafood.
    - Processed mussels with higher levels of MPs as compared to live mussels from farmed sources, implying potential contamination during the de-shelling and cleaning processing of the mussels (Li et al., 2018).
    - Canned fish possibly contaminated during processing and packaging steps (Karami et al., 2018).
- Atmospheric deposition
  - Observations that contamination via deposition to possibly be >100x than contamination via the environment (Catarino et al., 2018)

Dietary exposure of microplastic particles

- Concerns regarding the representatives of food and beverage categories that have been studied to date.
  - Significant underrepresentation of human daily caloric intake
  - What are the levels in more representative foods and beverages?
  - Are there cultural, socioeconomic, age and gender differences?



Environmental Science & Technology

pubs.acs.org/est

Article

Lifetime Accumulation of Microplastic in Children and Adults

Nur Hazimah Mohamed Nor,* Merel Kooi, Noël J. Diepens, and Albert A. Koelmans

Cite This: *Environ. Sci. Technol.* 2021, 55, 5084−5096 | Read Online

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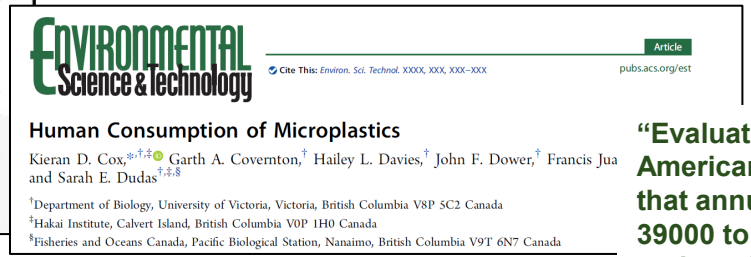
ABSTRACT: Human exposure to microplastic is recognized as a global problem, but the uncertainty, variability, and lifetime accumulation are unresolved. We provide a probabilistic lifetime exposure model for children and adults, which accounts for intake via eight food types and inhalation, intestinal absorption, biliary excretion, and plastic-associated chemical exposure via a physiologically based pharmacokinetic submodel. The model probabilistically simulates microplastic concentrations in the gut, body tissue, and stool, the latter allowing validation against empirical data. Rescaling methods were used to ensure comparability between microplastic abundance data. Microplastic (1−5000 μm) median intake rates are 553



Environmental Science & Technology

Article

Cite This: *Environ. Sci. Technol.* XXXX, XXX, XXX−XXX

pubs.acs.org/est

Human Consumption of Microplastics

Kieran D. Cox,[†,‡,§] Garth A. Covernton,[†] Hailey L. Davies,[†] John F. Dower,[†] Francis Jua and Sarah E. Dudas[†,‡,§]

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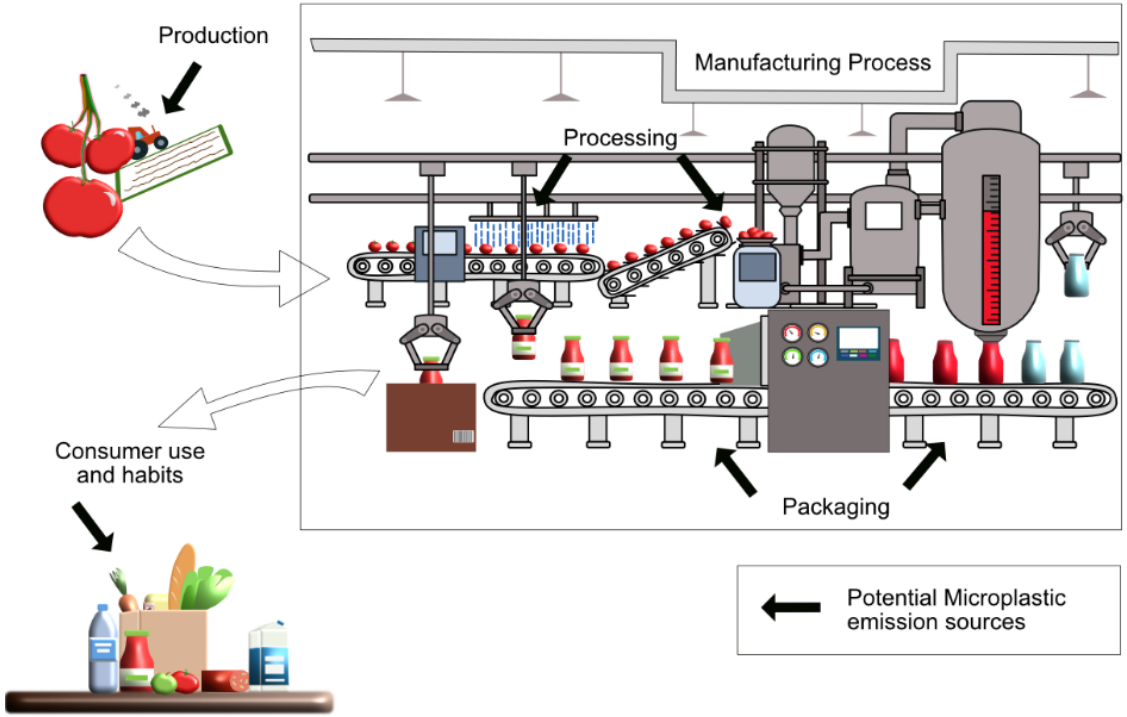
[§]Fisheries and Oceans Canada, Pacific Biological Station, Nanaimo, British Columbia V9T 6N7 Canada

"Evaluating approximately 15% of Americans' caloric intake, we estimate that annual consumption ranges from 39000 to 52000 particles depending on age and sex."

Developing a targeted exposure assessment



Holistic approach that considers total food basket and which evaluates potential sources throughout the whole life cycle.

Evaluating effects data


Gouin et al. Microplastics and Nanoplastics (2022) 2:2
https://doi.org/10.1186/s43591-021-00023-x
Microplastics and Nanoplastics
RESEARCH ARTICLE Open Access

Screening and prioritization of nano- and microplastic particle toxicity studies for evaluating human health risks – development and application of a toxicity study assessment tool

Todd Gouin[1*], Robert Ellis-Hutchings[2], Leah M. Thornton Hampton[3], Christine L. Lemieux[4] and Stephanie L. Wright[5]

Particle Characterization

1. Particle size
2. Particle shape
3. Particle polymer composition
4. Source of particles
5. Particle surface chemistry
6. Chemical purity
7. Microbial contamination

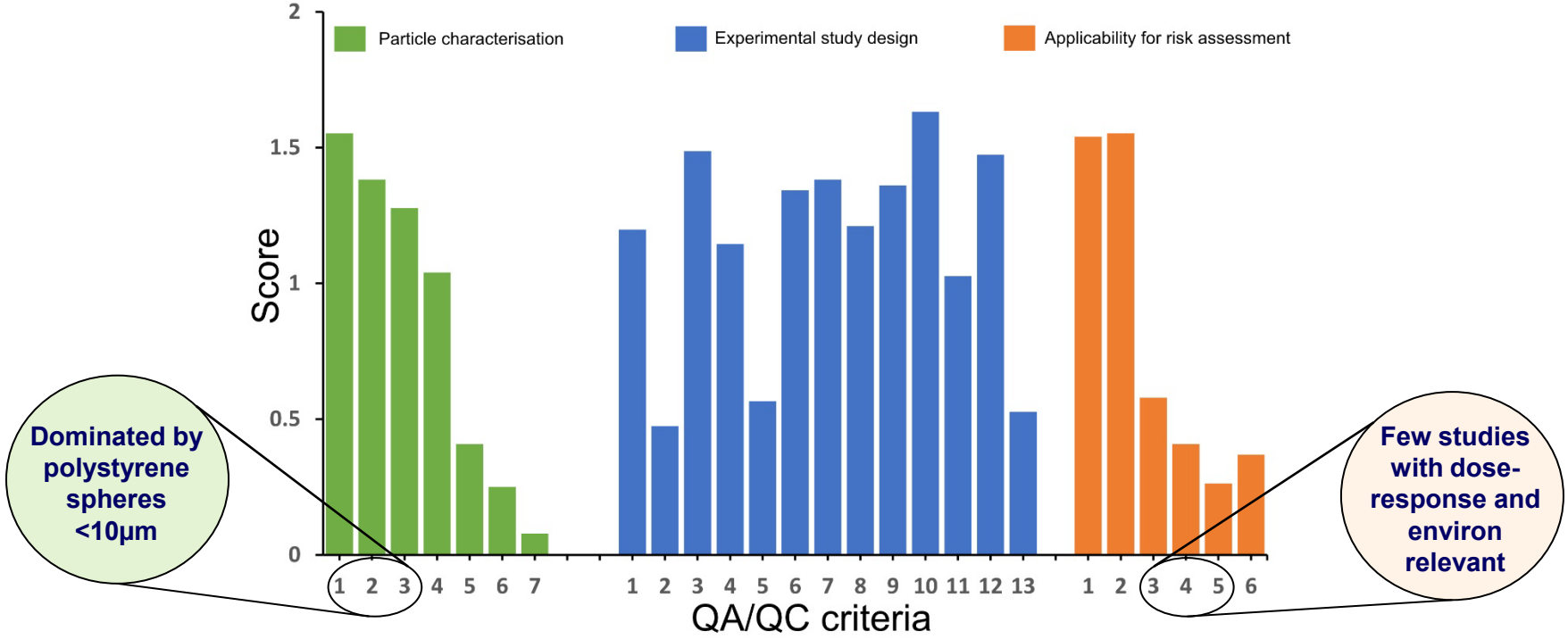
Experimental study design

in vivo	in vitro
1. Concentration units	1. Concentration units
2. Particle stability	2. Particle stability
3. Test medium / delivery vehicle	3. Test medium / delivery vehicle
4. Administered dose / concentration	4. Administered dose / concentration
5. Homogeneity of exposure	5. Homogeneity of exposure
6. Administration route	6. in vitro test system description
7. Test species	7. Additional in vitro test elements
8. Feeding / housing conditions	8. Sample size
9. Sample size	9. Frequency and duration of exposure
10. Frequency and duration of exposure	10. Controls
11. Controls	
12. Replicates	
13. Confirmation of internal dose	

Applicability for risk assessment

1. Statistical analysis
2. Endpoints
3. Dose-response relationship
4. Concentration range
5. Effect threshold
6. Test particle relevance

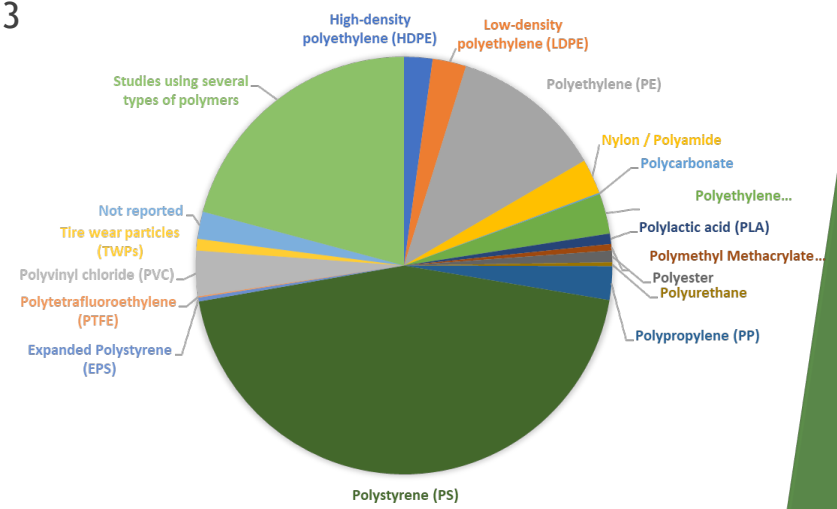
Data quality scores



QA/QC evaluation scores for 76 studies in mammals in vivo exposed by ingestion or inhalation

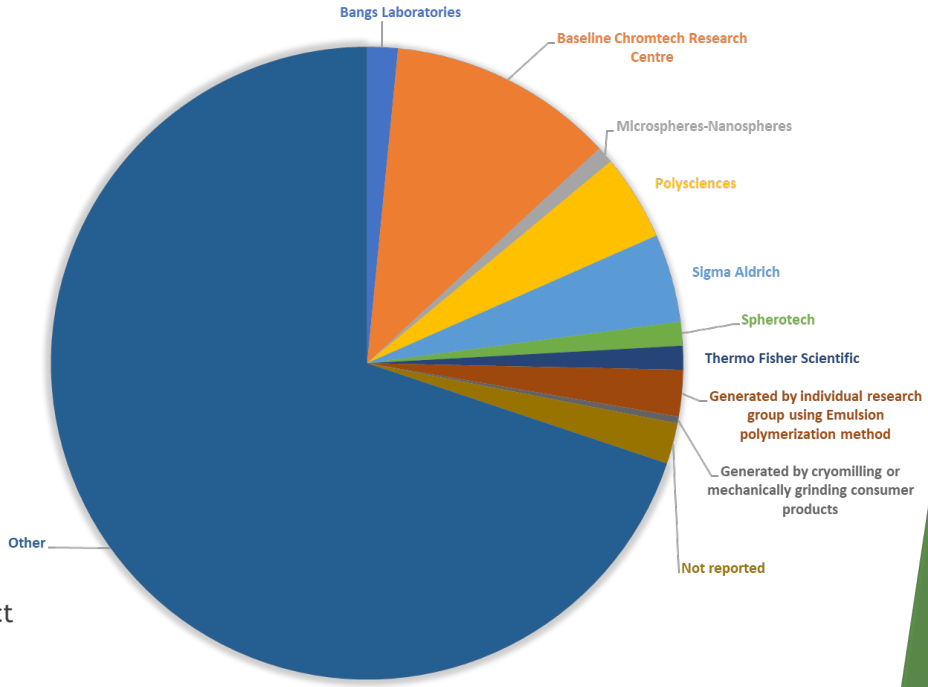
Summary of types of NMPs being used

- Literature review performed up to August 2023
  - 2607 studies identified
    - 44.5% used polystyrene (1160)
    - 897/1160 (77%) use PS to support effects testing



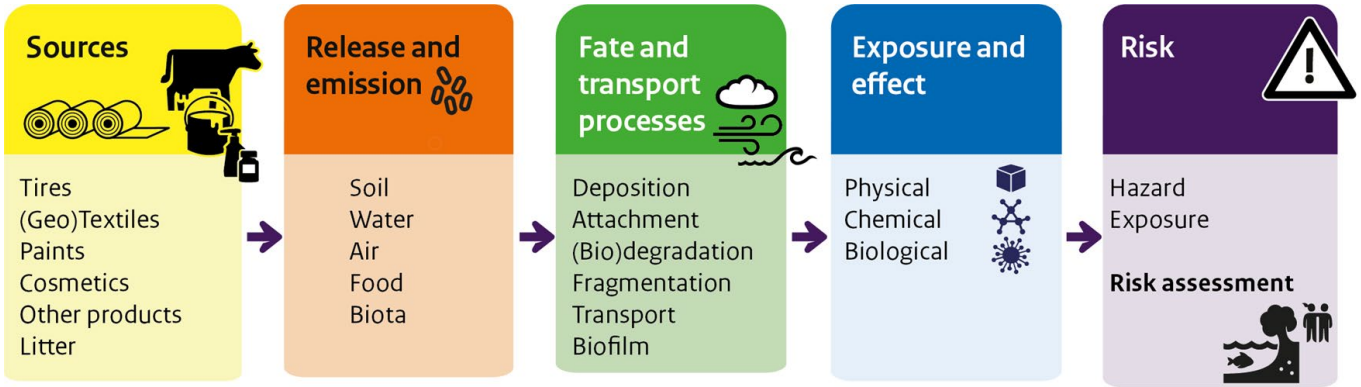
Suppliers of NMPs reported in the literature

- Notable observations
  - Seven major suppliers identified (≈30% of total)
    - Bangs Laboratories
    - Baseline Chromtech Research Centre
    - Microspheres-Nanospheres
    - Polysciences
    - Sigma-Aldrich
    - Spherotech
    - Thermo Fisher Scientific
  - Approximately 3% of studies generated their own particles
  - Majority of studies report a variety of suppliers
    - 90 different companies largely based in China
  - Lack of transparency characterizing the particles used in studies and unclear in majority of instances how particles were generated
  - No harmonization with respect to the use of NMPs with respect to toxicity testing
  - Unable to extrapolate to environmentally relevant exposures of NMPs for humans



How to prioritize future research?

- There are negative effects (laboratory)
- There is exposure
- Risks are unknown and which properties influence the responses?

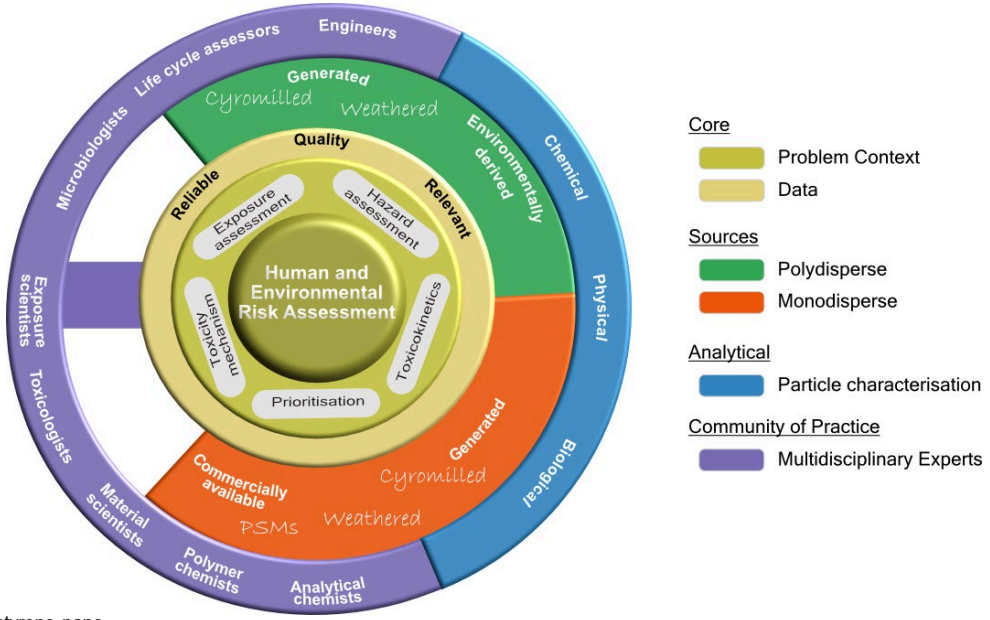


Research needs

- Standard and harmonized methods:
  - Sampling and analysis of NMP in air, water, food and beverages require robust, quality-assured methods and suitable **Model particles representative of environmentally relevant NMP**.
- Particle characterization:
  - Quality-assured environmental monitoring studies should be conducted to characterize the distributions of size, shape and composition of NMP in the environment for studies of the effects of exposure on human health and to prepare reference standards for environmentally relevant testing of toxicity.
- Sources:
  - The contributions of different factors would guide strategies for mitigating exposure.
- Uptake and fate for both inhalation and oral ingestion exposure:
  - More information is required on the absorption, distribution and elimination of NMP.
- Toxicology
  - Quality-assured experiments suitable for risk assessment should be conducted, with adequate characterization of exposure to the types of NMP to which humans are most commonly exposed.

Research needs

- Standard and harmonized methods supported by a suite of environmentally relevant NMPs
  - Common recommendation
    - No consensus on definitions
    - Clarity on problem formulation
- Moving forward
  - Need for inclusivity
    - Opportunities to leverage learnings
      - Multi-disciplinary expertise
      - Multi-stakeholder engagement



Gouin, T., Ellis-Hutchings, R. Pemberton, M., Wilhelmus, B. Addressing the relevance of polystyrene nano- and microplastic particles used to support exposure, toxicity and risk assessment: Implications and recommendations. Particle & Fibre Toxicology *in press*.

Acknowledgements

An Update on MNP Health & Environmental Literature Platform (MNP-HELP):

A Curated Literature Repository for Risk Assessment Research

Kara Franke

September 12, 2024

Agenda

- Overview: What is MNP-HELP?
- Planning: Scoping & protocol
- Implementation: Search & review
- Results: Summary of current holdings
- Next: Future directions

Overview of project

Develop

Develop a searchable, user-friendly database of MNP literature and associated meta-data that is relevant to human health and ecological risk assessment

Reduce

Reduce need for researchers to independently track and review published literature

Streamline

Streamline literature reviews and data gathering for existing and new R&D efforts.

Foundation for Chemistry RESEARCH & INITIATIVES

webuild DATABASES

ToxStrategies

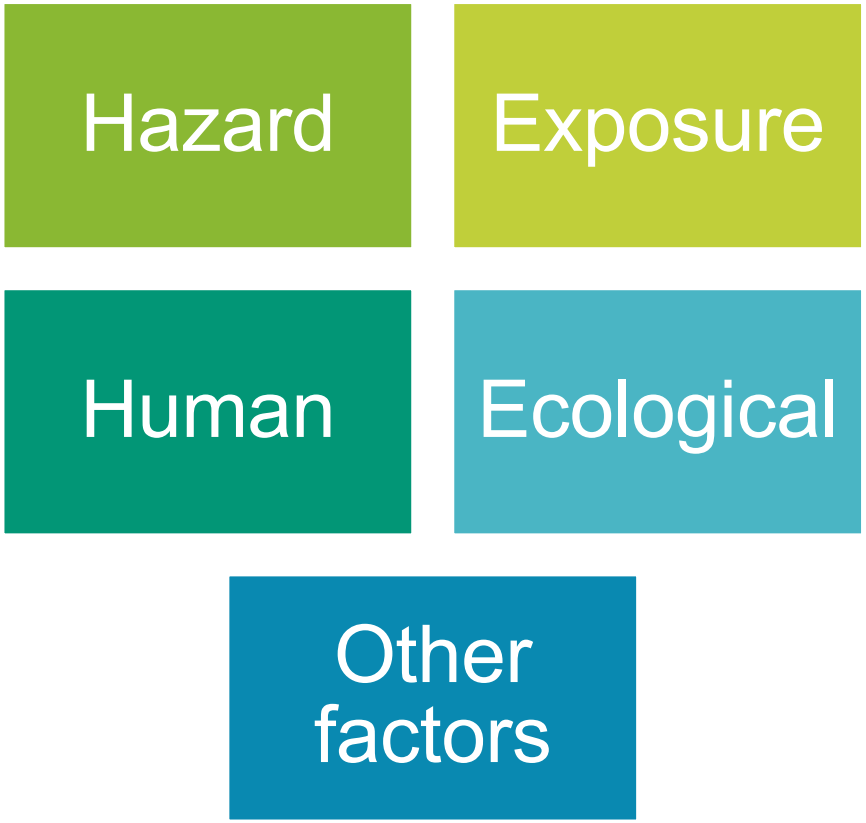
Planning

Problem formulation

- >10,000 of papers on MNP by 2023
  - Can we develop a machine learning approach to sift and categorize?
  - Use systematic review methods and tools to expedite and standardize
- Information Gap: who can find and access these papers?
  - Standard literature reviews take significant amounts of time and require experience and tools to be done efficiently
  - Develop a user-friendly database anyone can search via category or key words
    - Access to full articles remains an issue due to copyright issues

Research objective

- Collect published data assessing MNP that could inform a risk assessment
  - Hazard and exposure data
  - Human and ecological risk
  - “Other factors” includes:
    - Fate & transport
    - Chemical characterization
    - Methodology
    - Risk assessment frameworks

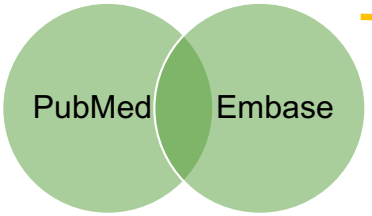


Protocol

- Although this was not a systematic review, a protocol helped to align project team and stakeholders
- Provides a record of early project decisions = transparency
- Description of methodology
  - Search strategy and syntax
  - Reference identification
  - Inclusion/exclusion criteria
  - Categorization
- Reviewed by the project team and stakeholders; filed internally

Implementation

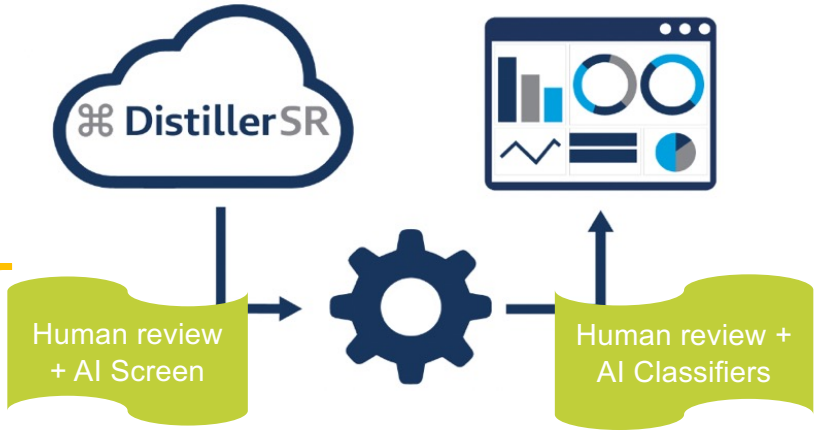
Search & screening approach



~10,000 references

- Validate success of search syntax with known key references

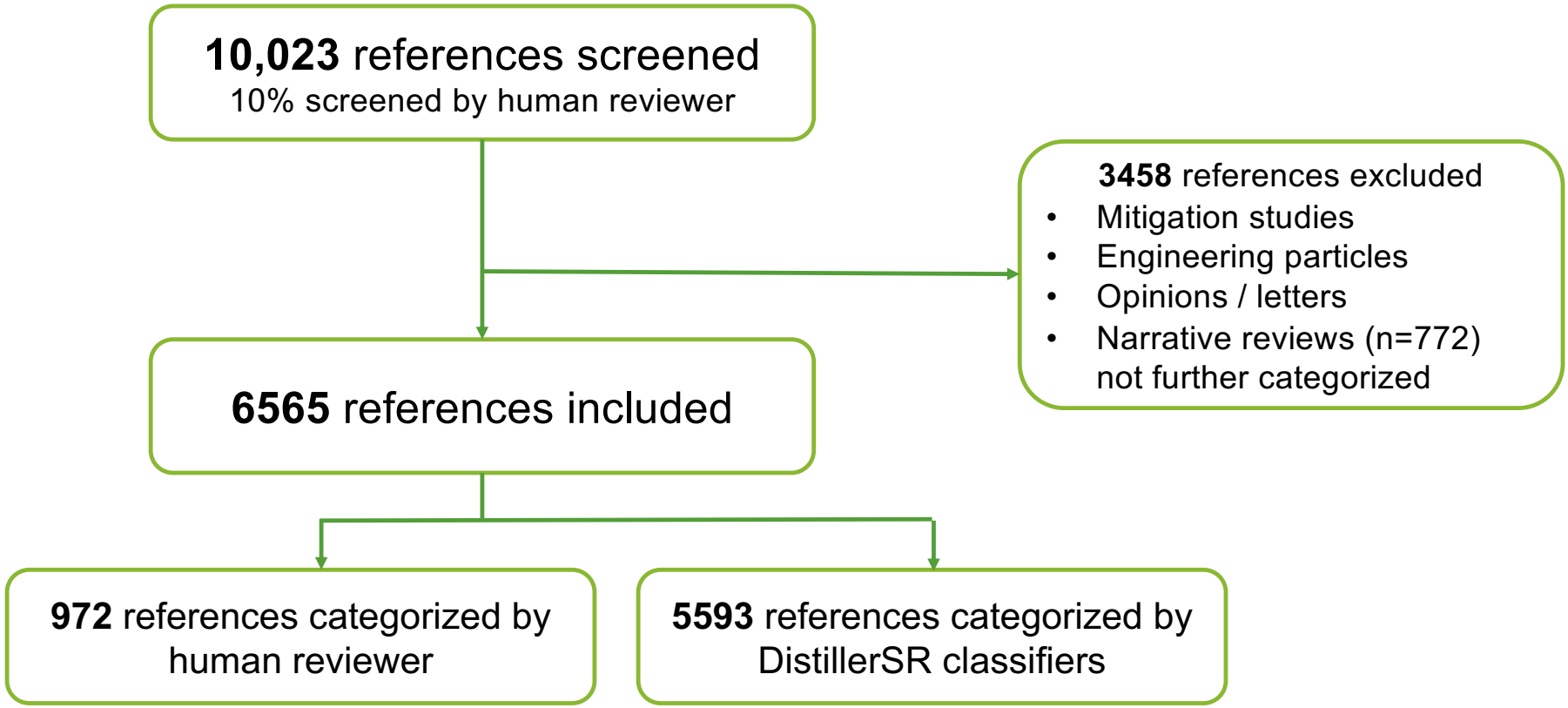
- Overall sense of landscape
- Topic modeling
- Identification of papers for DistillerSR AI training
- Validate with known key references



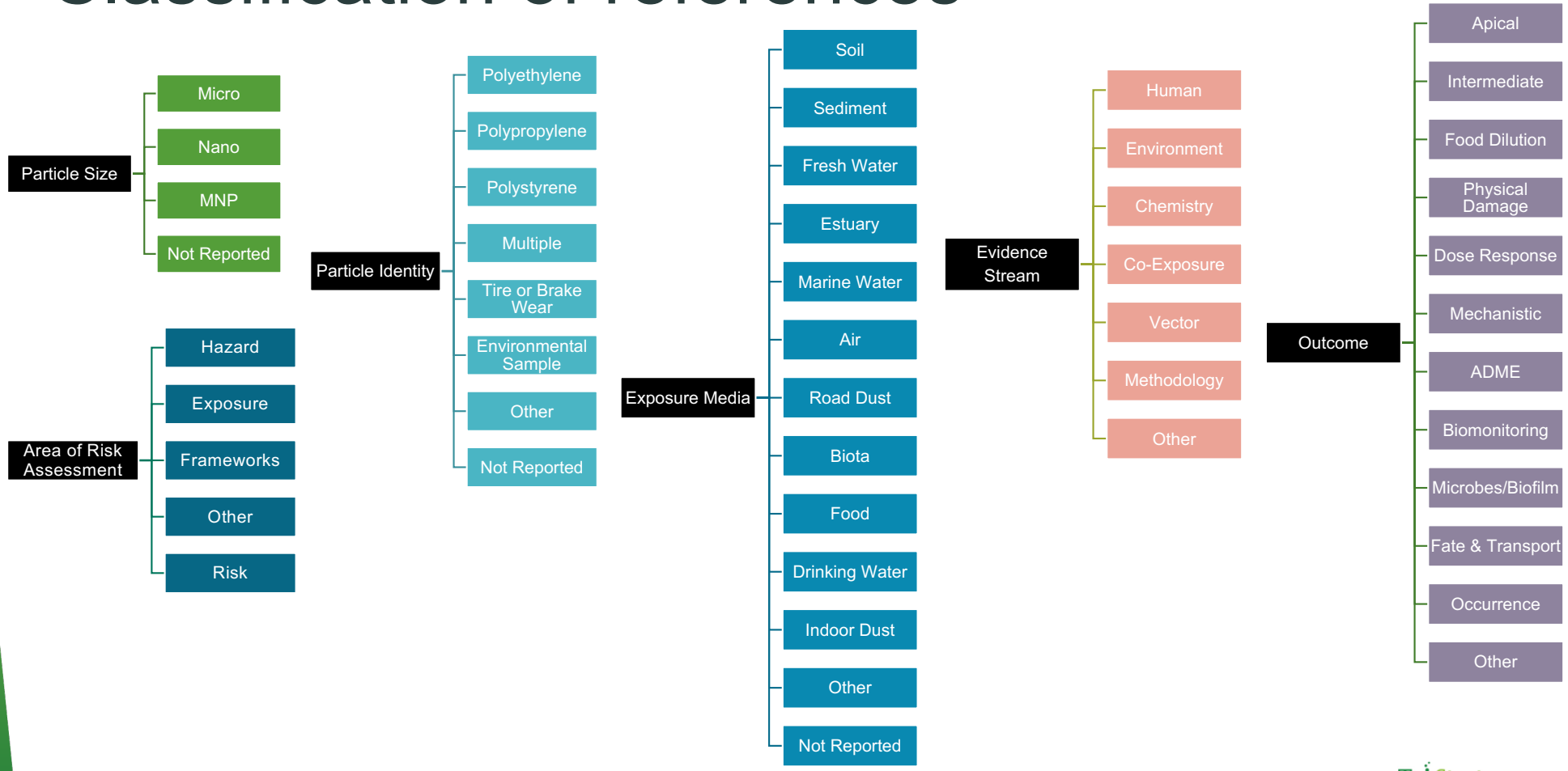
- Initial include/exclude using AI re-rank and human review plus AI screen
- Develop Classifiers for categorization as project progresses
- Train with known key references

ToxStrategies

Resulting dataset



Classification of references



ToxStrategies

AI model development

Humans review a subset of references for inclusion and categorization

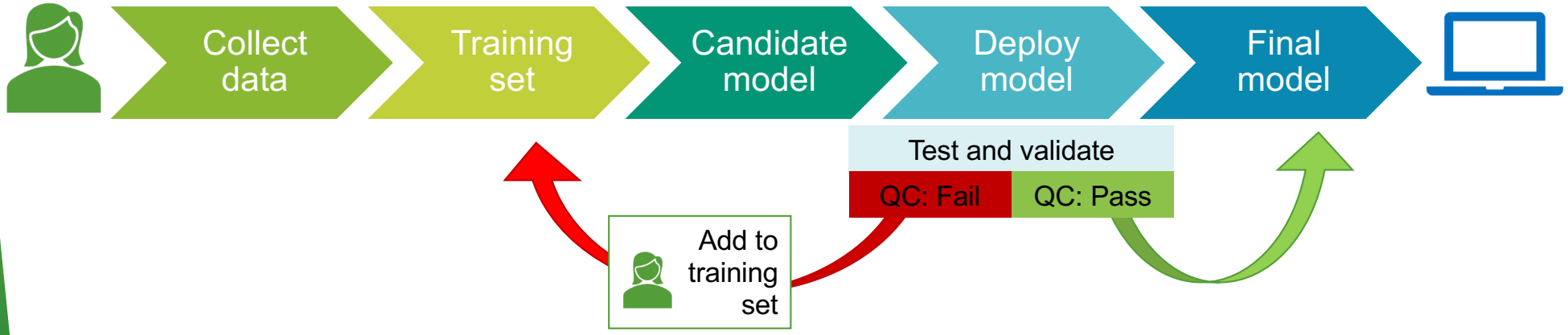
These records become the “training set” for Distiller machine learning

Candidate models are run and results undergo human QC

Parts of the model that are underperforming are targeted for additional training

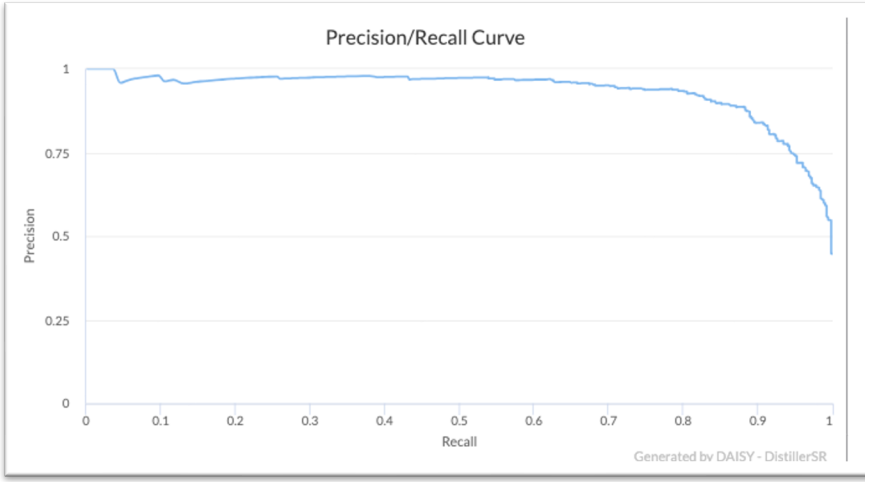
Once a candidate model passes QC, it becomes the final model

The model can now be used on additional references without further training, unless research needs change



AI confidence & validation

- Human-in-the-loop training
  - Use the first 1000 papers manually reviewed by scientists to train AI program to recognize and tag the remaining 9000 papers
- Iterative process
  - Evaluate model performance and perform targeted re-training as needed
- Statistics
  - Scores: accuracy, recall, F1
  - Precision/Recall Curve



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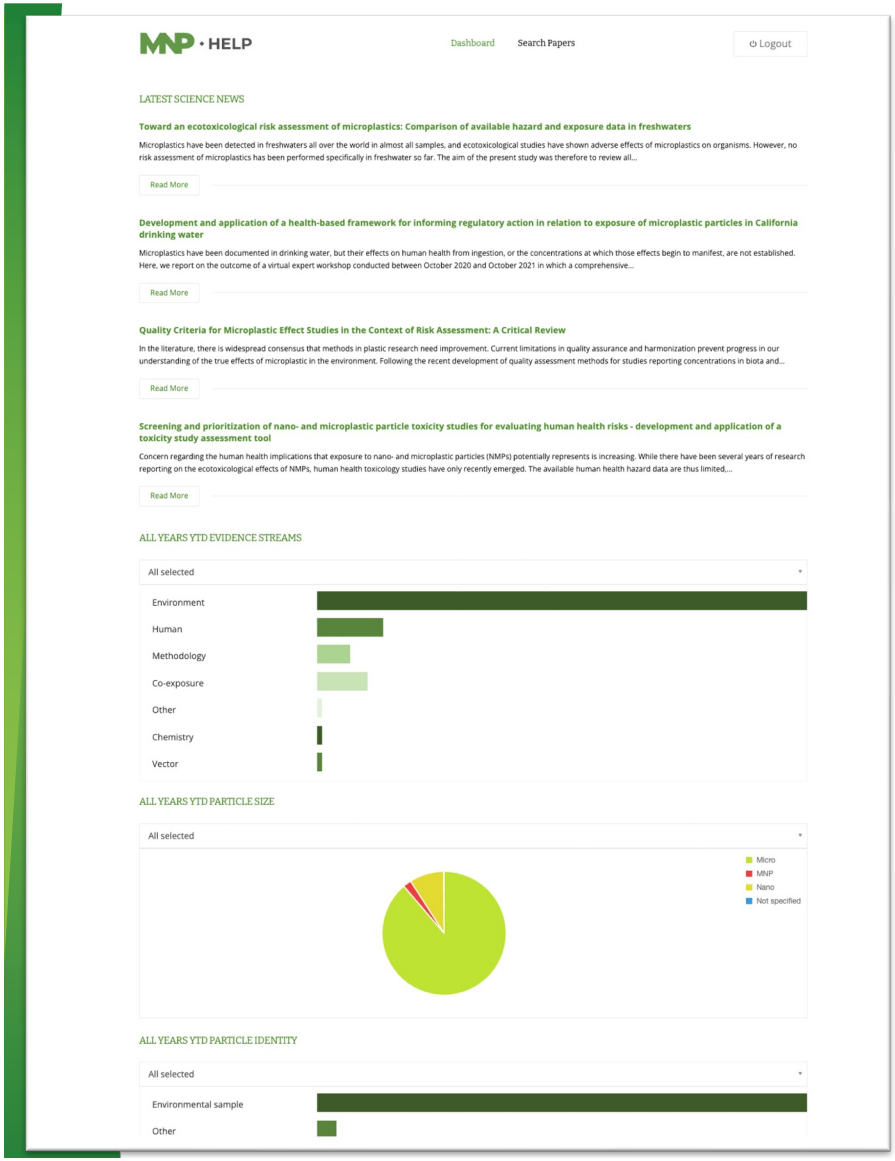

Database design

- Built by We Build Databases
  - Dashboard
  - Search page
  - Citation view
    - Citation information
    - Categories assigned during review
    - Open Access PDFs attached

webuild DATABASES

https://webuilddatabases.com/

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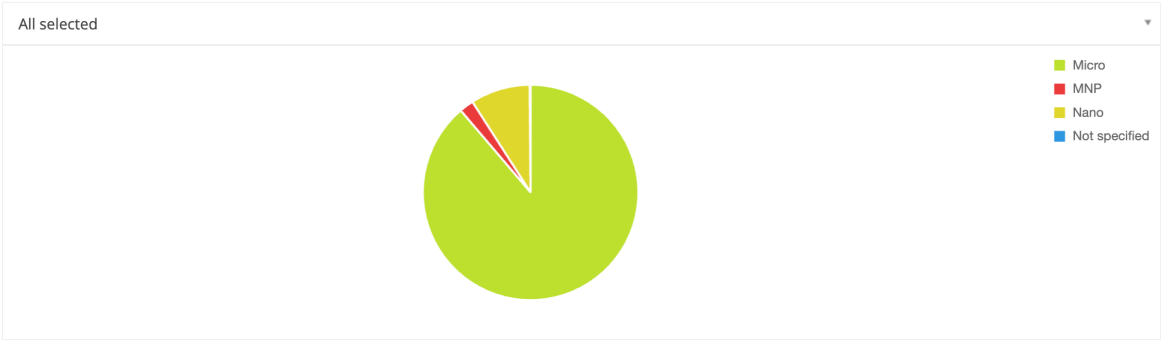
Results

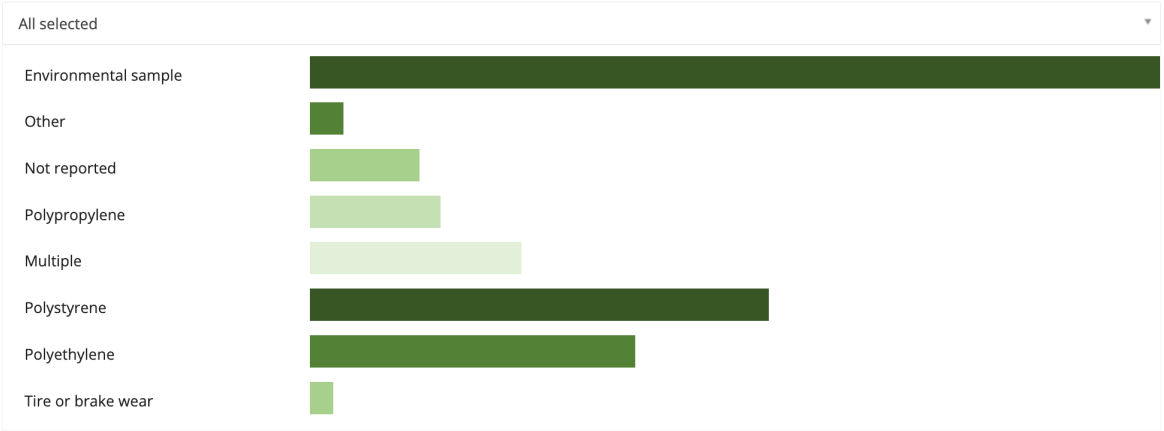
Database holdings

- 6564 unique references indexed
- ~600 attached Open Access full text articles
- Micro >> Nano
- Environmental samples, followed by polystyrene and polyethylene, were most commonly assessed

ALL YEARS YTD PARTICLE SIZE



ALL YEARS YTD PARTICLE IDENTITY



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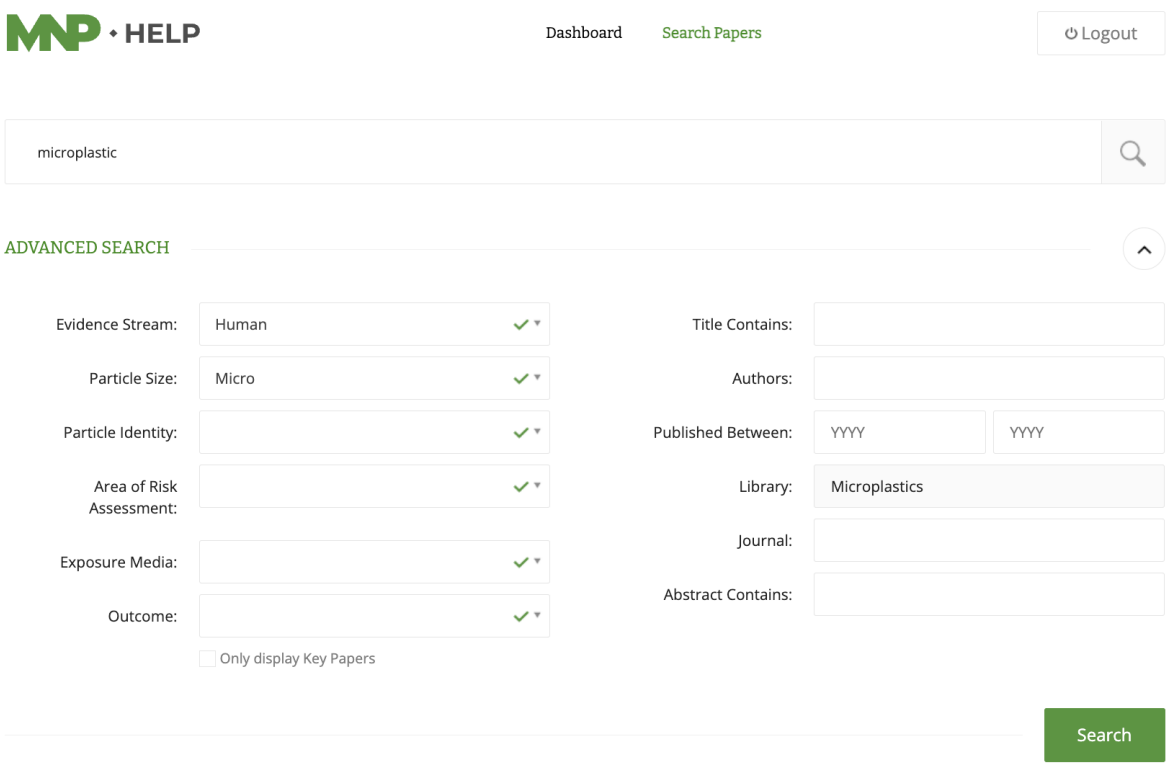
Search options

- Search full text
- Search title or abstract
- Filter by category using dropdown menu options
- Key papers = placeholder for high impact articles



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SEARCH RESULTS

1-50 of 53 records

Print

AUTHOR	TITLE	YEAR	JOURNAL, VOLUME, PAGE
Okamura, T., Hamaguchi, M., Hasegawa, Y., Hashimoto, Y., Majima, S., Senmaru, T., Ushigome, E., Nakanishi, N., Asano, M., Yamazaki, M., Sasano, R., Nakanishi, Y., Seno, H., Takano, H., Fukui, M.	Oral Exposure to Polystyrene Microplastics of Mice on a Normal or High-Fat Diet and Intestinal and Metabolic Outcomes		
Gupta, D. K., Vishwakarma, A., Singh, A.	Release of microplastics from disposable face mask in tropical climate		
Shi, Q., Chen, F., Feng, Y., Zheng, Y., Zhi, X., Wu, W.	Exogenous Hydrogen Sulfide Mitigates Oxidative Stress and Mitochondrial Damages Induced by Polystyrene Microplastics in Osteoblastic Cells of Mice		
Rotchell, J. M., Jenner, L. C., Chapman, E., Bennett, R. T., Bolanle, I. O., Loubani, M., Sadofsky, L., Palmer, T. M.	Detection of microplastics in human saphenous vein tissue using μFTIR: A pilot study		
Woo, J. H., Seo, H. J., Lee, J. Y., Lee, I., Jeon, K., Kim, B., Lee, K.	Polypropylene nanoplastic exposure leads to lung inflammation through p38-mediated NF-κB pathway du to mitochondrial damage		
Sincihu, Y., Lusno, M. F. D., Mulyasari, T. M., Elias, S. M., Sudiana, I. K., Kusumastuti, K., Sulistyorini, L., Keman, S.	Wistar Rats Hippocampal Neurons Response to Blood Low-Density Polyethylene Microplastics: A Pathway Analysis of SOD, CAT, MDA, 8-OHdG Expression in Hippocampal Neurons and Blood Serum Aβ42 Levels		
Zhang, X., He, Y., Xie, Z., Peng, S., Xie, C., Wang, H., Liu, L., Kang, J., Yuan, H., Liu, Y.	Effect of microplastics on nasal and gut microbiota of high-exposure population: Protocol for an observationa cross-sectional study		
Coffin, S., Bouwmeester, H., Brander, S., Damdimopoulou, P., Gouin, T., Hermabessiere, L., Khan, E., Koelmans, A. A., Lemieux, C. L., Teerds, K., Wagner, M., Weisberg, S. B., Wright, S.	Development and application of a health-based framework for informing regulatory action in relation exposure of microplastic particles in California drinkin water		

COFFIN, S., BOUWMEESTER, H., BRANDER, S., DAMDIMOPOULOU, P., GOUIN, T., HERMABESSIERE, L., KHAN, E., KOELMANS, A. A., LEMIEUX, C. L., TEERDS, K., WAGNER, M., WEISBERG, S. B., WRIGHT, S.

OVERVIEW

DOWNLOAD PDF

Title:

Development and application of a health-based framework for informing regulatory action in relation to exposure of microplastic particles in California drinking water

Journal: Microplast nanoplast **Vol.:** 2 **No.:** 1 **Pg.:** 12

Yr. Published: 2022

Author(s):

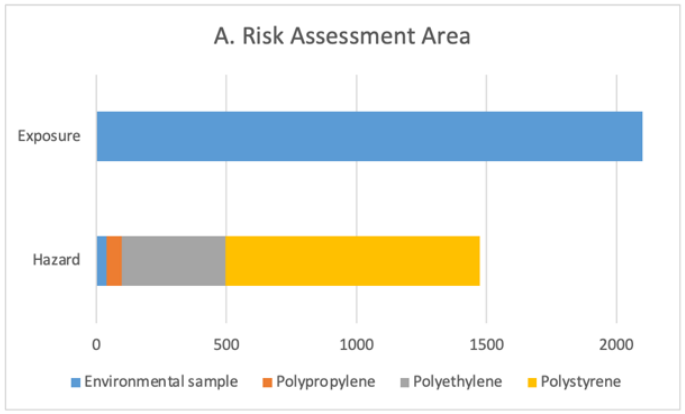
Coffin, S., Bouwmeester, H., Brander, S., Damdimopoulou, P., Gouin, T., Hermabessiere, L., Khan, E., Koelmans, A. A., Lemieux, C. L., Teerds, K., Wagner, M., Weisberg, S. B., Wright, S.

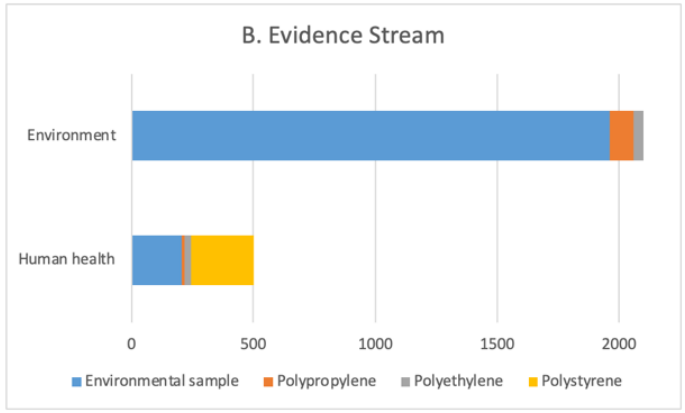
Library: Microplastics

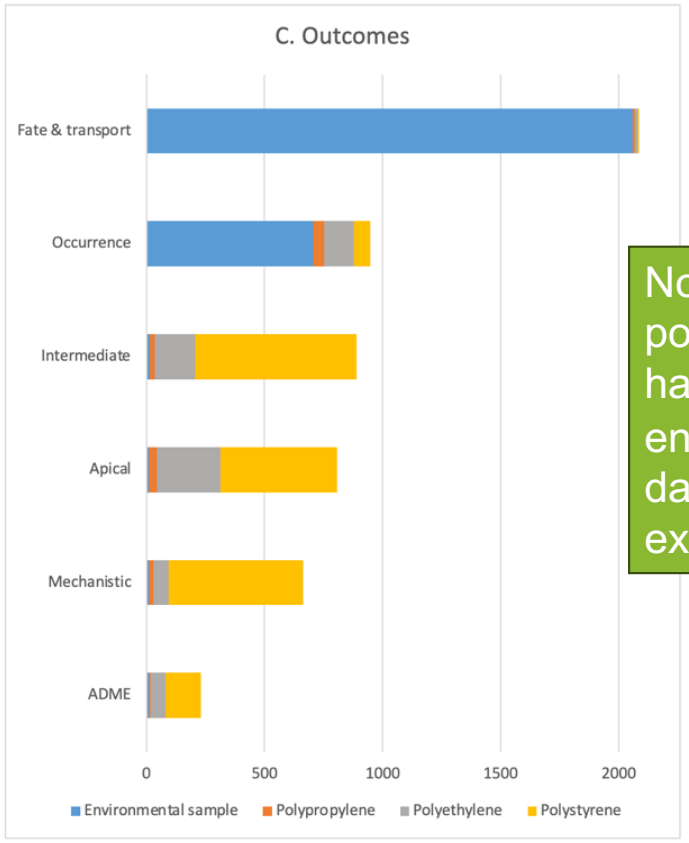
ABSTRACT

Microplastics have been documented in drinking water, but their effects on human health from ingestion, or the concentrations at which those effects begin to manifest, are not established. Here, we report on the outcome of a virtual expert workshop conducted between October 2020 and October 2021 in which a comprehensive review of mammalian hazard studies was conducted. A key objective of this assessment was to evaluate the feasibility and confidence in deriving a human

Summary of data for top substance categories







Note high rate of polystyrene papers for hazard studies; environmental sample data primarily consists of exposure data

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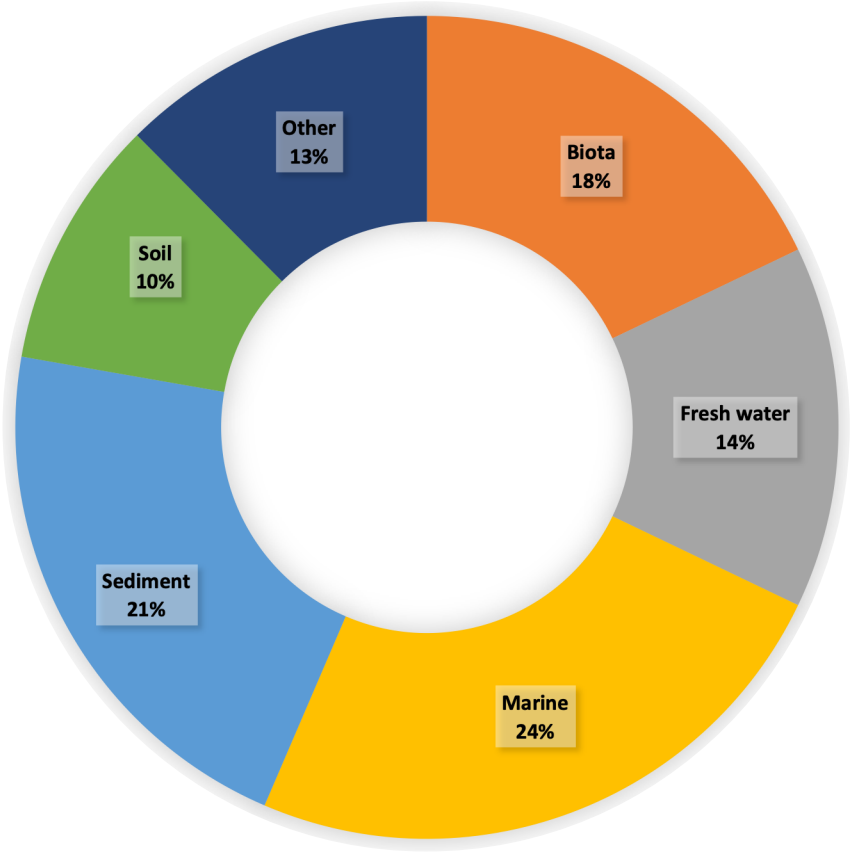
Summary of environmental sample media



When studies analyzed environmental samples, most were taken from marine environments (n=871) or sediment (n=762), followed by biota (n=640) and fresh water (n=509)

Lessons learned

AI classifiers are a powerful tool

- Recently validated by EFSA
- Requires significant effort in design, training, and validation
- Performs best with strictly defined bins
- Not for more complex questions like study quality

TiAb review alone does not allow for adequate prioritization for full-text review

- Future projects where full text is evaluated can still inform the database
- Identification of key studies requires full text

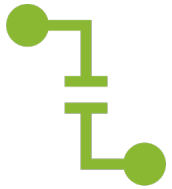
Next

Optimization of AI

Automated screening for regular and timely updates

Reuse of trained models to screen and categorize

Option to re-train models as science evolves



Alternative and emerging tools

OpenAI vs human-in-the-loop

ChatGPT and other existing models:

- Currently require some level of customization
- ToxStrategies team working on bespoke programs combining existing models with API calls specific to project needs
- Use caution with copyright and

Future directions

- AI optimization and modernization
- Implement update schedule
- Launch public-facing web interface:

MNP • HELP

Acknowledgments

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- ToxStrategies Project Team: Julie Panko, Jennifer Bare, Alison Gauthier, Sara Rogers