Microplastics Effects in the Ambient Environment

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So. Cal. Coastal Water Res. Project

Microplastics Health Effect Workshop September 8, 2021
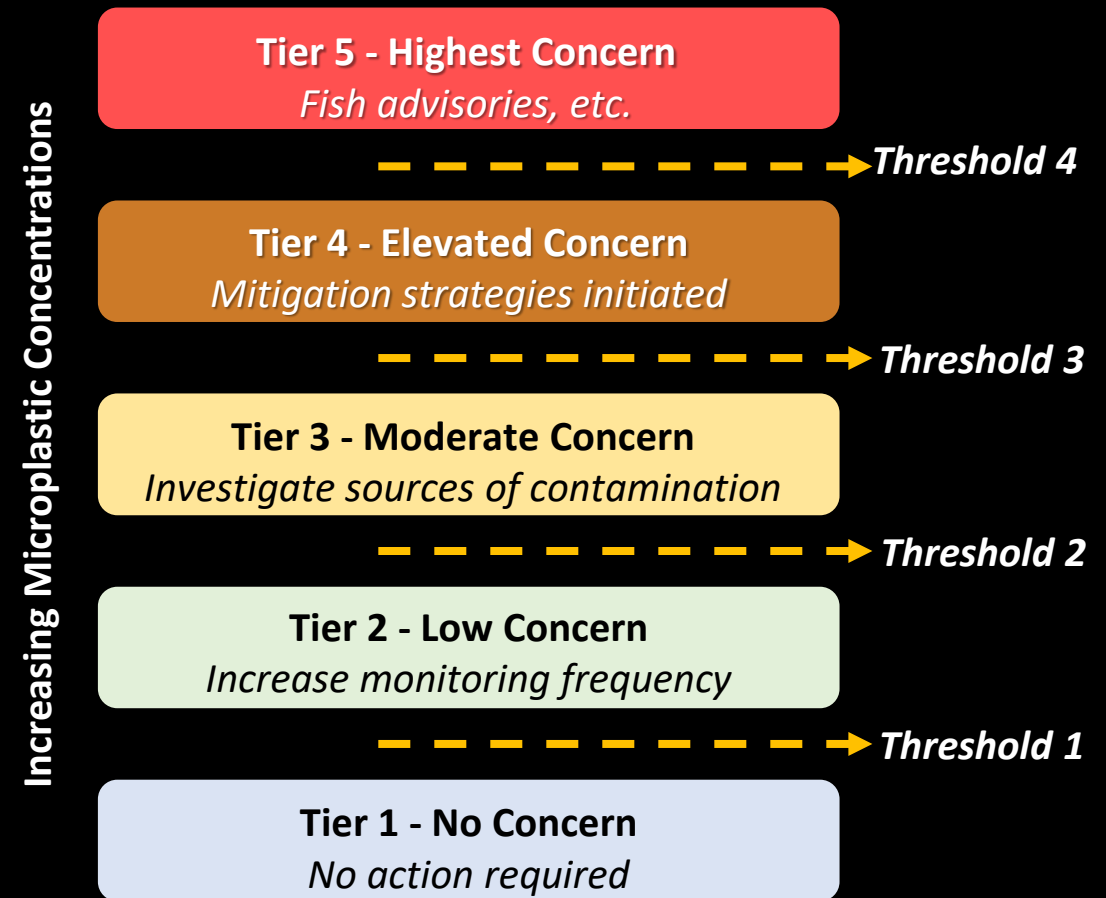
Rationale and Objectives

- Optimized analytical methods will soon be available to measure microplastics as part of monitoring programs

- Next challenge is understanding the implications of occurrence data
    - I.e., what are the levels of concern for aquatic health?

- This workshop aimed to develop health-based thresholds that will:
    - Support the upcoming legislations
    - Provide context for interpretation of occurrence data

Overall approach

1. Select the appropriate decision framework for microplastics assessment in ambient waters

2. Develop and apply a process to calculate health-based thresholds

3. Conduct expert evaluation of the confidence level in the proposed framework, analytical process and thresholds

Tiered management framework

- Experts agreed on the development of multiple thresholds

- Decision framework adapted from the model used by the State of California to monitor emerging contaminants

Increasing Microplastic Concentrations

Tier 5 - Highest Concern
Fish advisories, etc.

- - - - - - - - - → *Threshold 4*

Tier 4 - Elevated Concern
Mitigation strategies initiated

- - - - - - - - - → *Threshold 3*

Tier 3 - Moderate Concern
Investigate sources of contamination

- - - - - - - - - → *Threshold 2*

Tier 2 - Low Concern
Increase monitoring frequency

- - - - - - - - - → *Threshold 1*

Tier 1 - No Concern
*No action required*

Progression of management steps

1. Invest in monitoring to better characterize the problem
   - Provide funding or encourage inclusion of microplastics into monitoring programs

2. Evaluate the pathways for microplastics contamination
   - Include discharge monitoring

3. Initiate management planning
   - Identify a water body as impaired

4. Implement source control measure and regulate use
   - Classify a water body as inappropriate for recreational and/or commercial use

Deriving microplastics thresholds

- Species Sensitivity Distribution (SSD)

  - Method widely used to set safety limits

  - Summarizes sensitivity of different species to the same stressor

  - Statistical approach to estimate concentration hazardous to a define proportion of the population
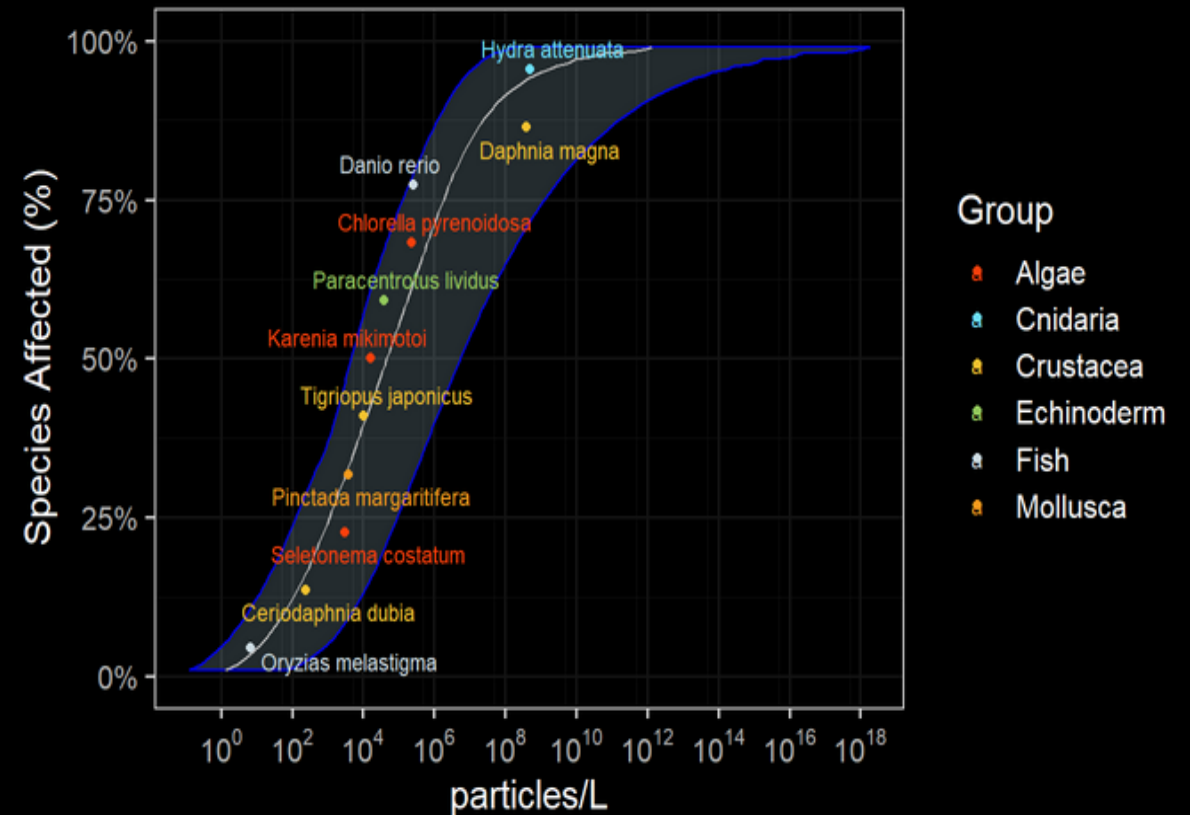
Screening toxicity data

- All 167 studies in our database were screened based on the following criteria

  - Minimum reporting requirements (particle characterization, exposure parameters)

  - Minimum of 3 doses + control

  - Established or suspected relationship with higher level of biological organization

- Over 80% of the studies did not meet our QA criteria

22 ~~167~~ manuscripts

297 ~~6,051~~ data points

16 ~~117~~ Species

SSD parameters for each threshold

Threshold	Hazard concentration (HC)	Data collapsing	HC metric	Biological endpoints
1- Investigative monitoring	HC5	1st Quartile	Lower 95%	Molecular to Population
2- Discharge monitoring	HC5	1st Quartile	Mean	Molecular to Population
3- Management planning	HC5	Median	Mean	Organism and Population
4- Source control measures	HC10	Median	Mean	Organism and Population

Comparing across datasets was challenging

- Size matters and species are affected differently by different size ranges

- Data available did not reflect the complexity of microplastics shapes in the environment

- We used a modeling approach to put the data on the same scale and facilitate comparisons
  - Based on Koelmans' lab models (Koelmans et al. 2020; Kooi et al. 2021)

Proposed thresholds- food dilution

- Thresholds based on species specific size distribution (1-5,000 μm)

Threshold	Volume (μm³/L)	Count (particle/L)
1- Investigative monitoring	38	0.5
2- Discharge monitoring	630	8
3- Management planning	1 093	14
4- Source control measures	7 294	94

Proposed thresholds- tissue translocation

- Thresholds based on size distribution between 1- and 83 µm

Threshold	Surface area (µm²/L)	Count (particle/L)
1- Investigative monitoring	16 712	236
2- Discharge monitoring	92 803	1 312
3- Management planning	218 962	3 097
4- Source control measures	1 018 046	14 397

DRAFT

Evaluating confidence level

- Experts had high confidence in the framework and approach to derive the thresholds

- Evaluating the confidence level for the actual numbers is still ongoing
  - Rating will be based on amount and quality of data available
  - .. And consistency of findings among studies

Recommendations to reduce uncertainties

- Better understanding of adverse outcome pathways

- Environmentally relevant exposure scenarios (size, shape and polymer type)

- Dose-response data to better understand effect concentrations (e.g. EC50, LC50)

QUESTIONS?

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