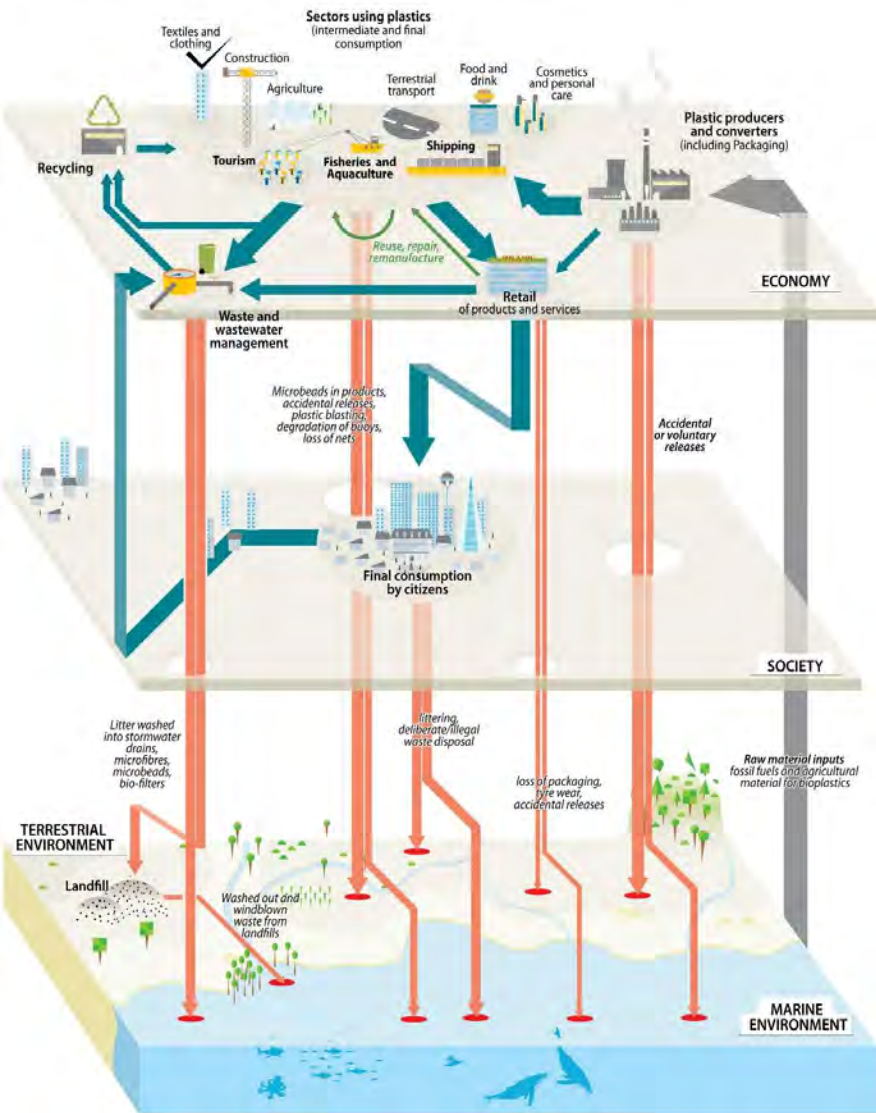


Approaches to the risk assessment of microplastics

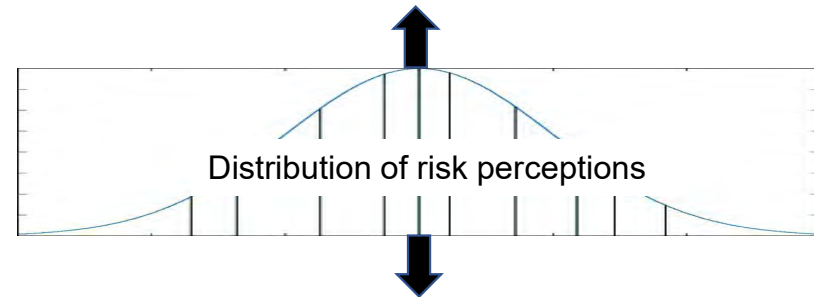
bart.koelmans@wur.nl

How plastic moves from the economy to the environment



Society

- anything leading to uncertain adverse effects on something that **humans value**
- subjective judgement
- values, world views, biases, emotions



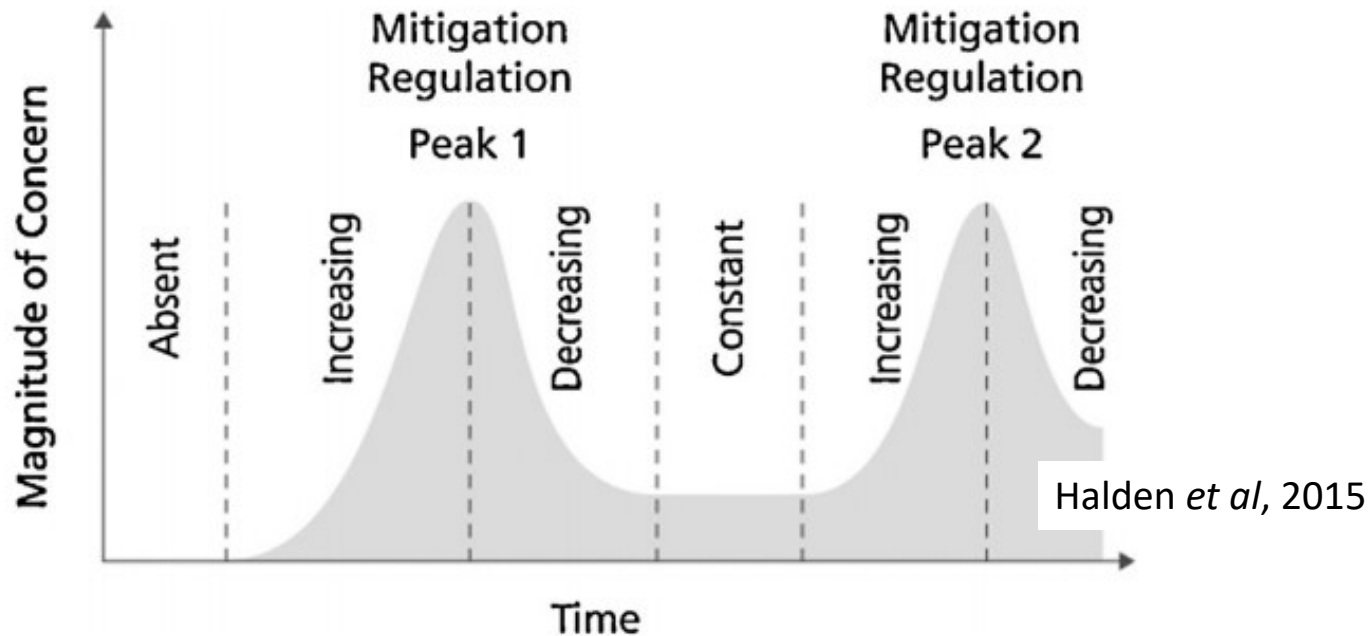
Environment

- Exposure x hazard; **PEC/PNEC** etc.
- objective judgement
- 'just look at the data'

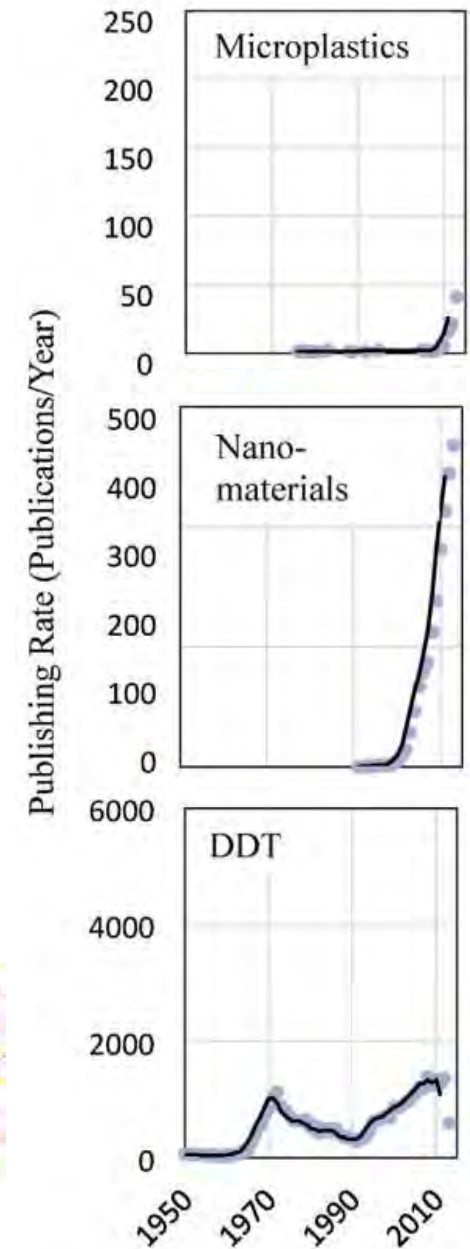
Credit: GRID-Arendal and Maphoto/Riccardo Pravettoni

Environmental Psychology: An Introduction, Second Edition. Editor(s): Linda Steg Judith I. M. de Groot

RA frameworks: 'snapshots' in time



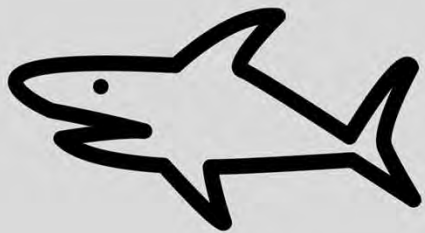
than the year 2016. Microplastics triggered initial concern only very recently, starting in 2008; if current trends continue, which at this point is uncertain, scientific attention is projected to peak in 2022 (± 4 years).



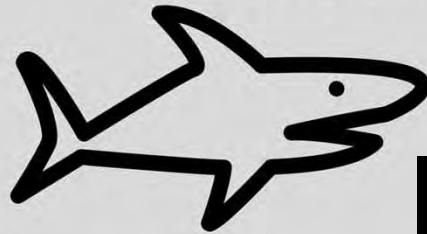
Risk Assessment: Essential Concepts

Hazard

Something that can potentially cause harm



Risk



= hazard + exposure

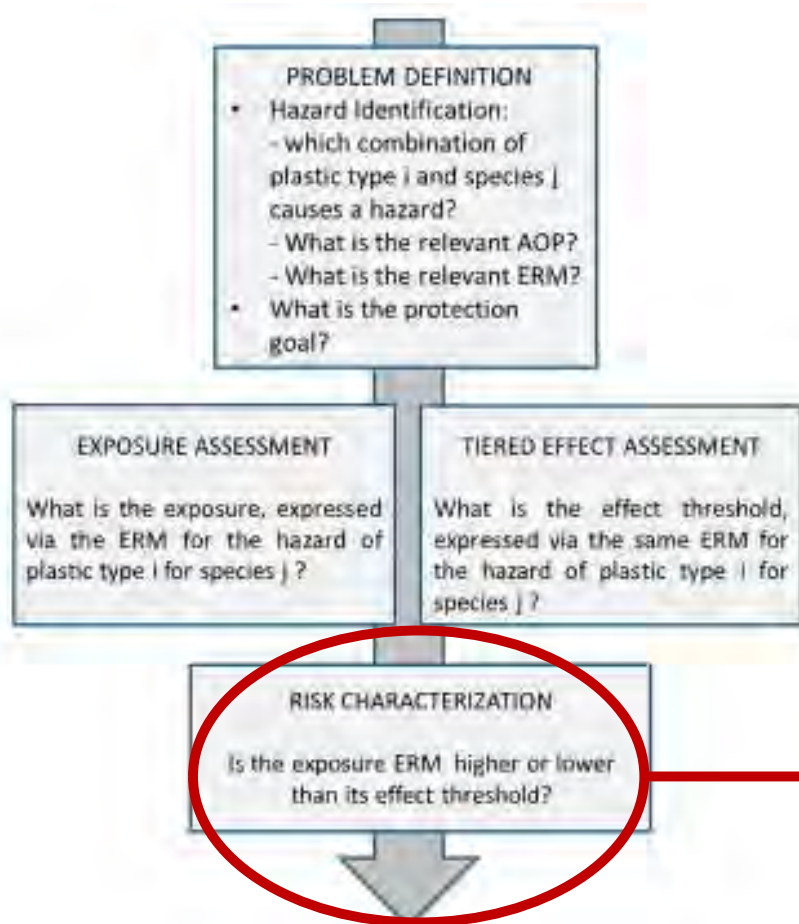
1493-1591



The dose makes the poison.

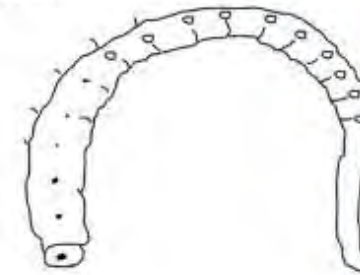
(Paracelsus)

RA frameworks



Only ± 10 out of >2000 studies

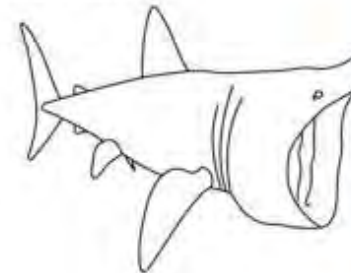
Lugworm



Plastic type	ERM nr	Suggested ERM	Potentially Relevant (Y/N)
Nanoplastic	1	#	Y
Highly contaminated microplastic	2	C	Y
'Clean' microplastic	3	#	Y
Rugby ball sized plastic item	4	#	N
Fishing net	5	#	N

Assess combined stressor effects

Basking shark



Plastic type	ERM nr	Suggested ERM	Potentially Relevant (Y/N)
Nanoplastic	1	#	Y
Highly contaminated microplastic	2	C	Y
'Clean' microplastic	3	#	N
Rugby ball sized plastic item	4	#	Y
Fishing net	5	#	Y

Assess combined stressor effects

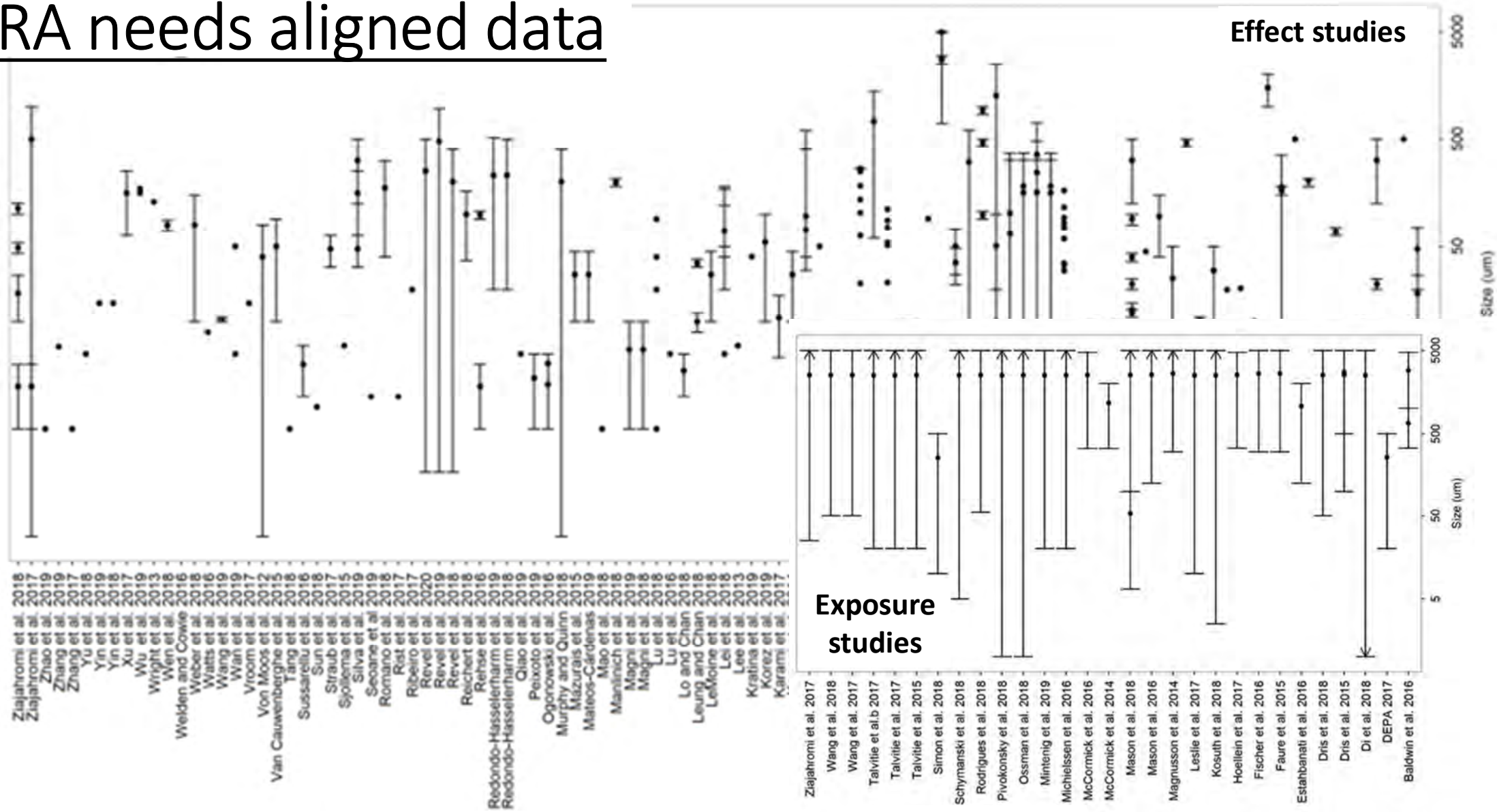
Humans



Plastic type	ERM nr	Suggested ERM	Potentially Relevant (Y/N)
Nanoplastic	1	#	Y
Highly contaminated microplastic	2	C	Y
'Clean' microplastic	3	#	Y
Rugby ball sized plastic item	4	#	N
Fishing net	5	#	N

Assess combined stressor effects

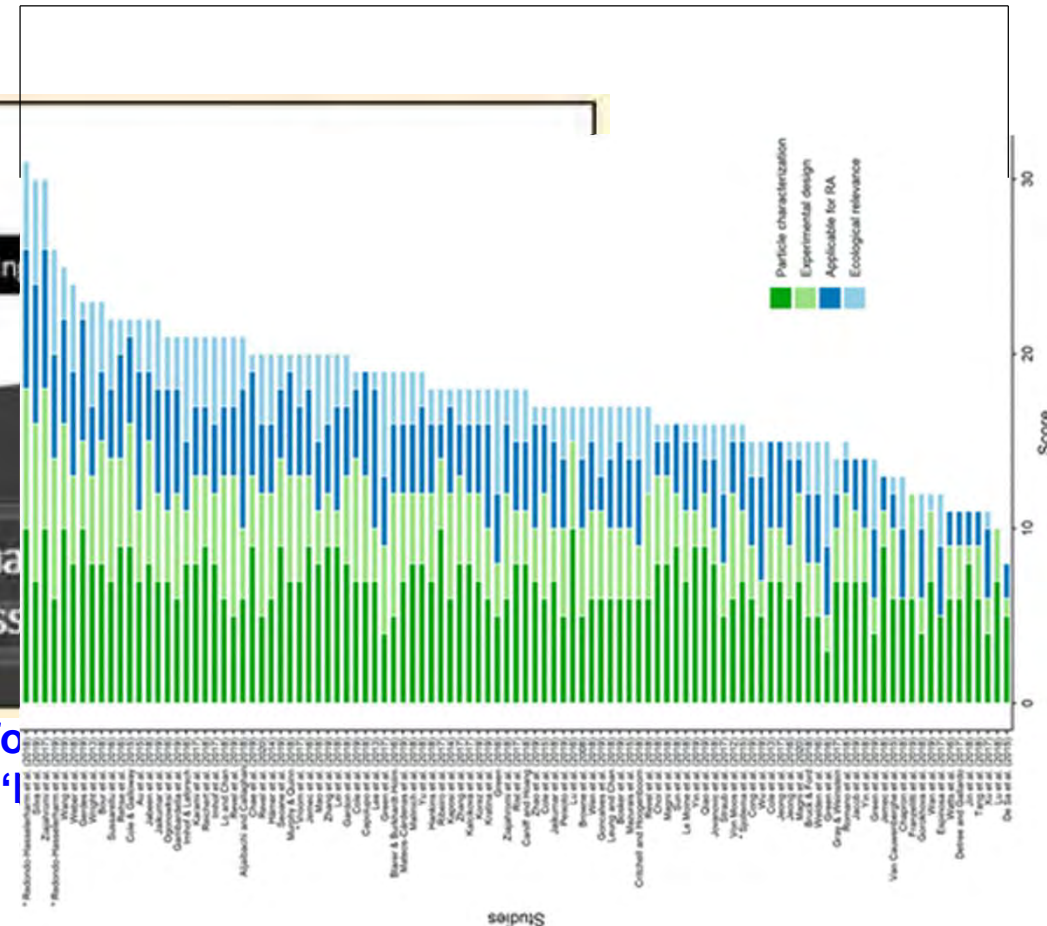
RA needs aligned data



RA needs reliable data

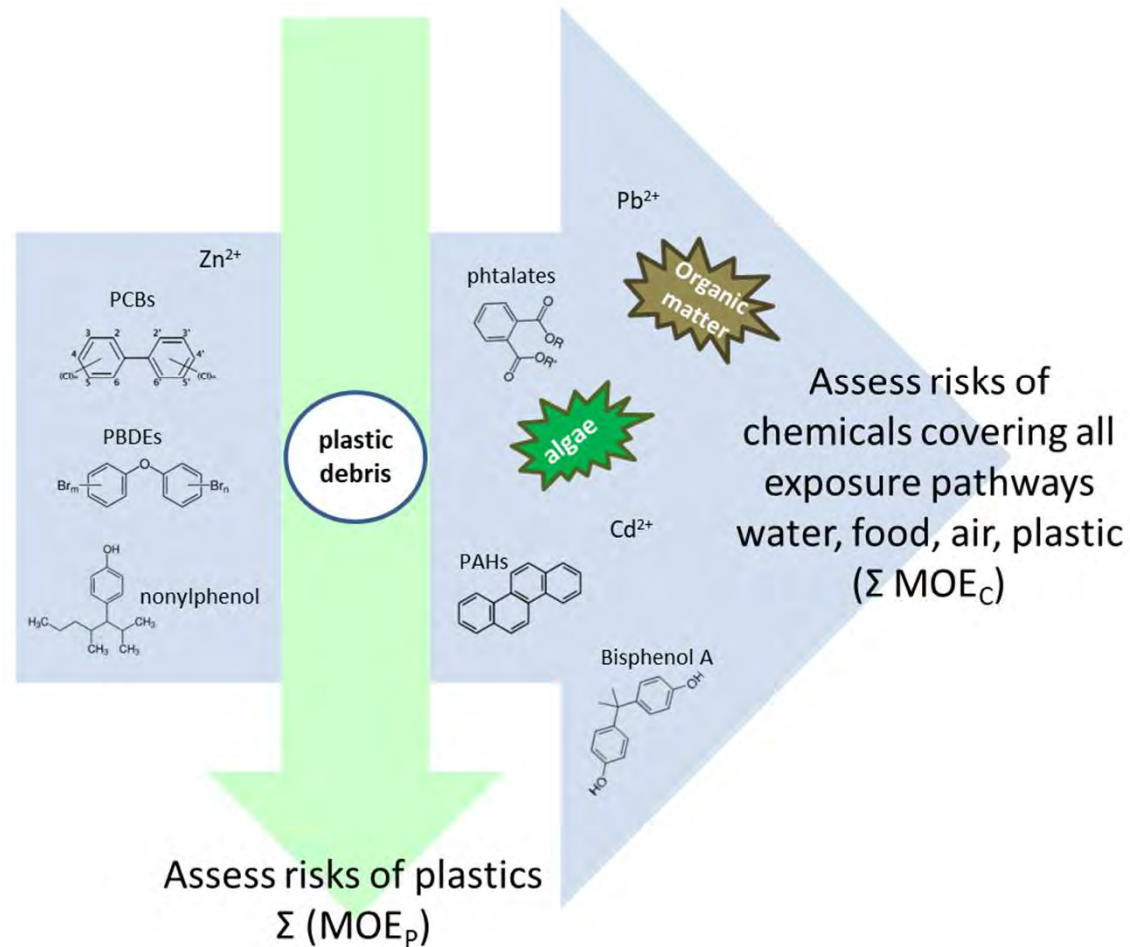


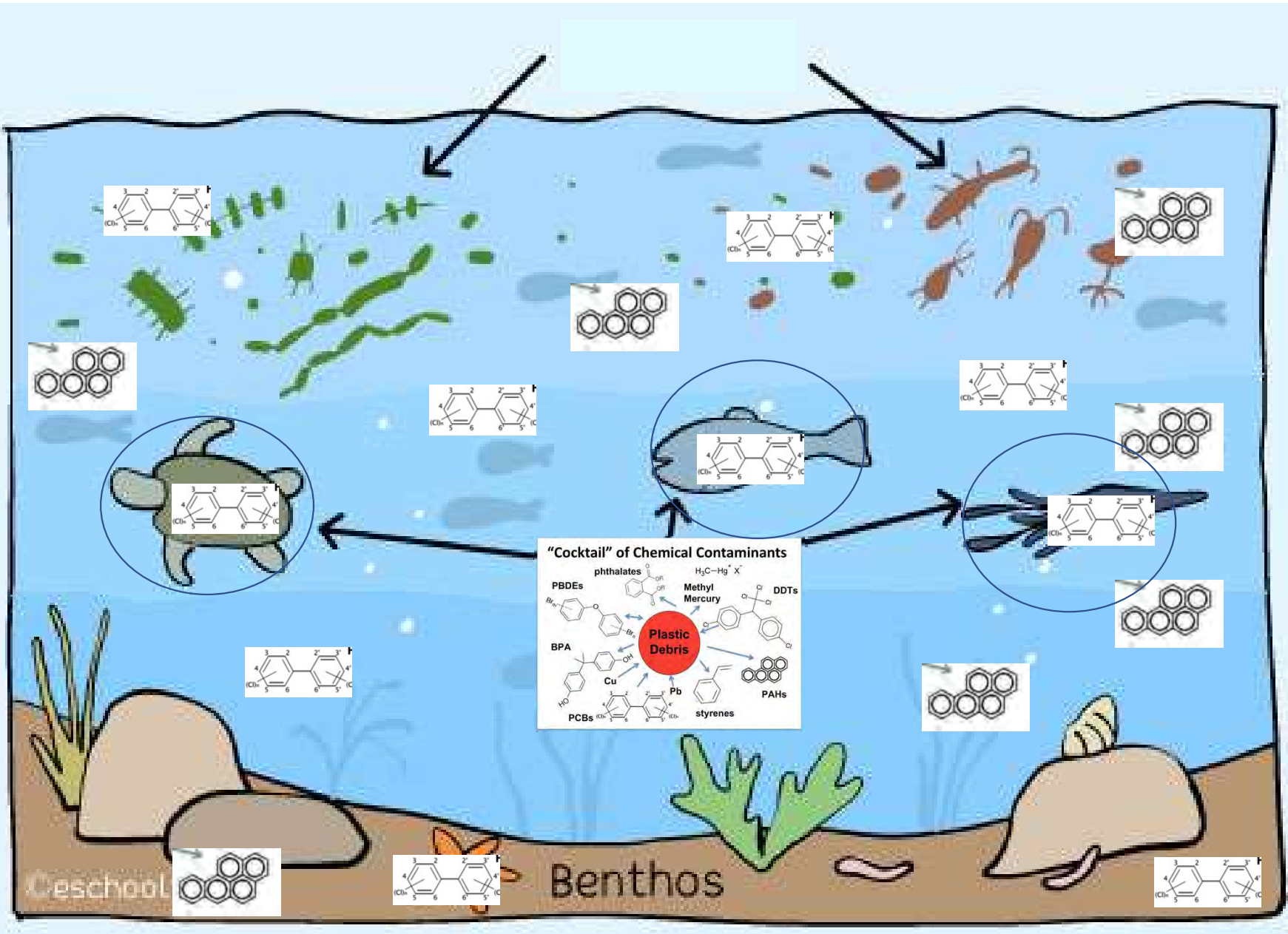
Scoring systems for
of MP studies ('



Available for:
MP biota samples, water samples, air samples
(*in prep.*), MP effect studies, MP chemical
vector studies (*in press*).

Risk of plastic-associated chemicals versus particles





Plastic is a cocktail of contaminants

versus

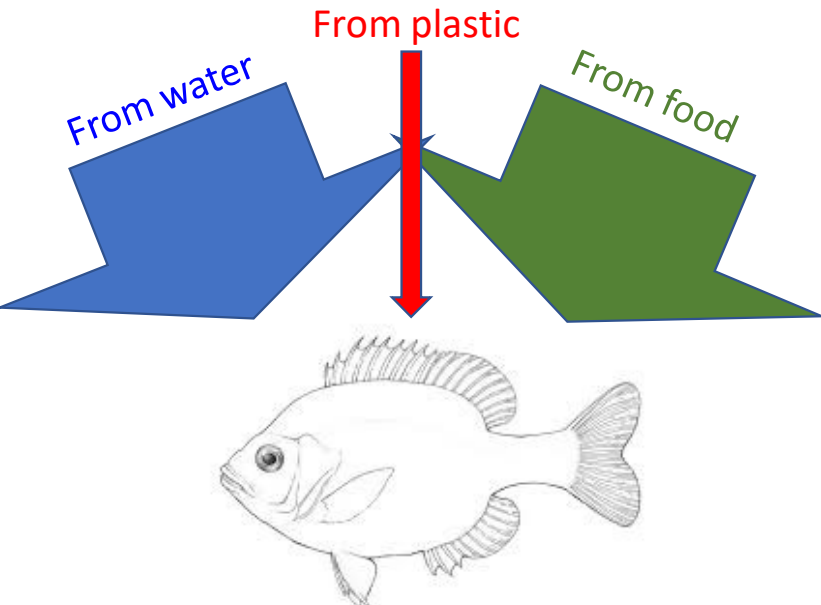
The environment is a cocktail of contaminants

Need for case-specific quantification

Prerequisites for chemical risk:

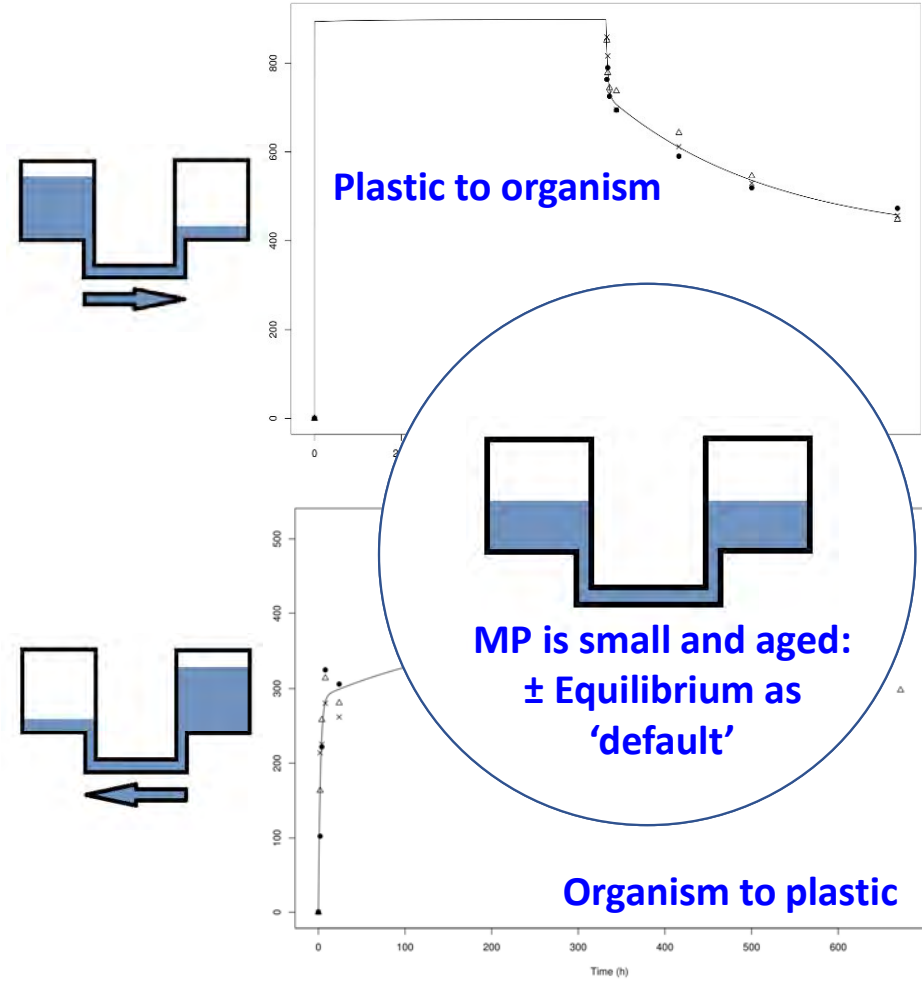
- 1. Interaction with **plastic (i.e. ingestion)** increases exposure (e.g. the 'vector effect')
- 2. That increase should lead to **exceedance of the threshold effect concentration**

→ **Tools are available**



In the lab:

artificial gradient without parallel uptake



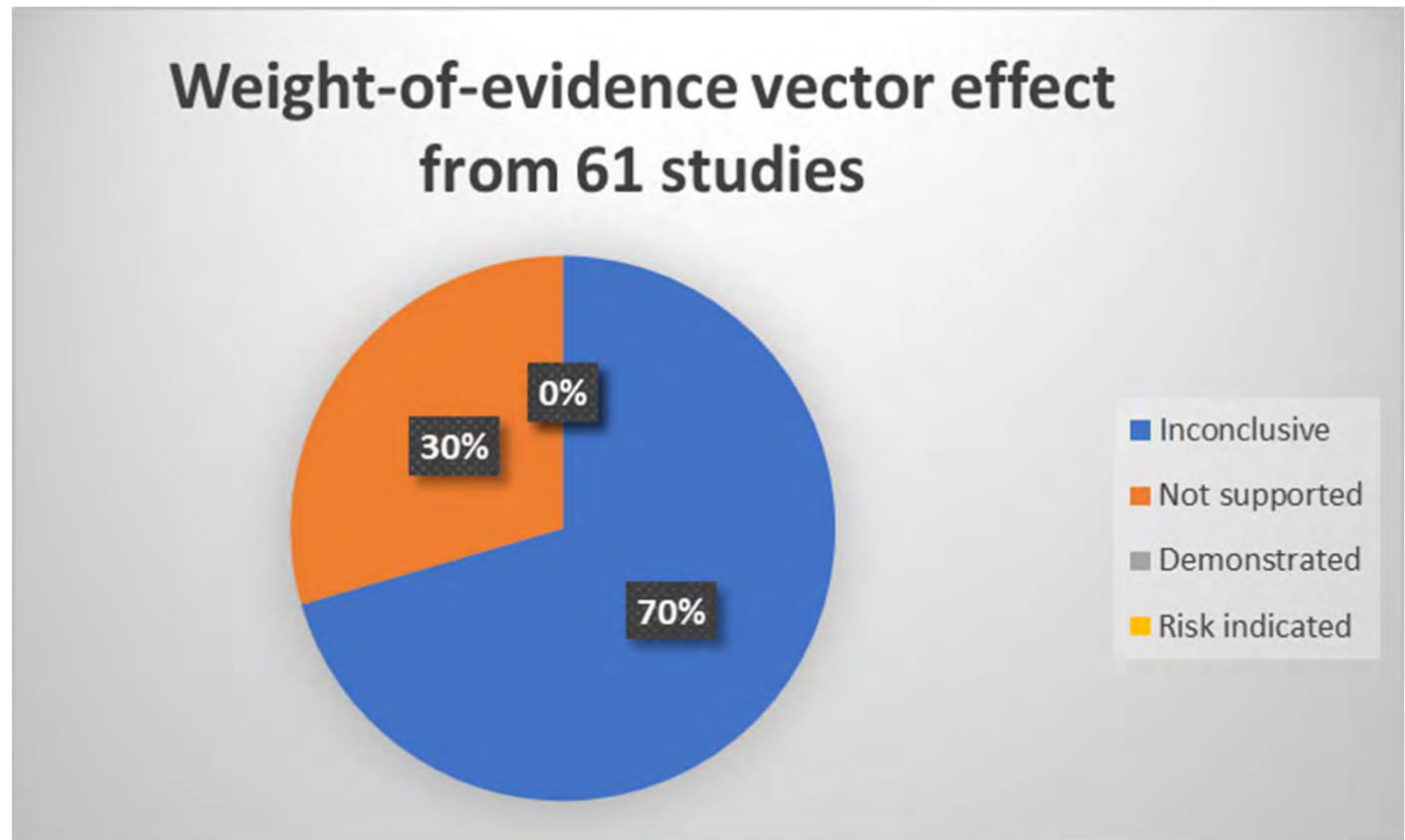
Gouin et al, ES&T, 2011; Koelmans et al. ES&T, 2013,, 2016; Bakir et al. ES&T, 2016; Wang et al, ES&T, 2019, 2020

Mohamed Nor & Koelmans, ES&T, 2019

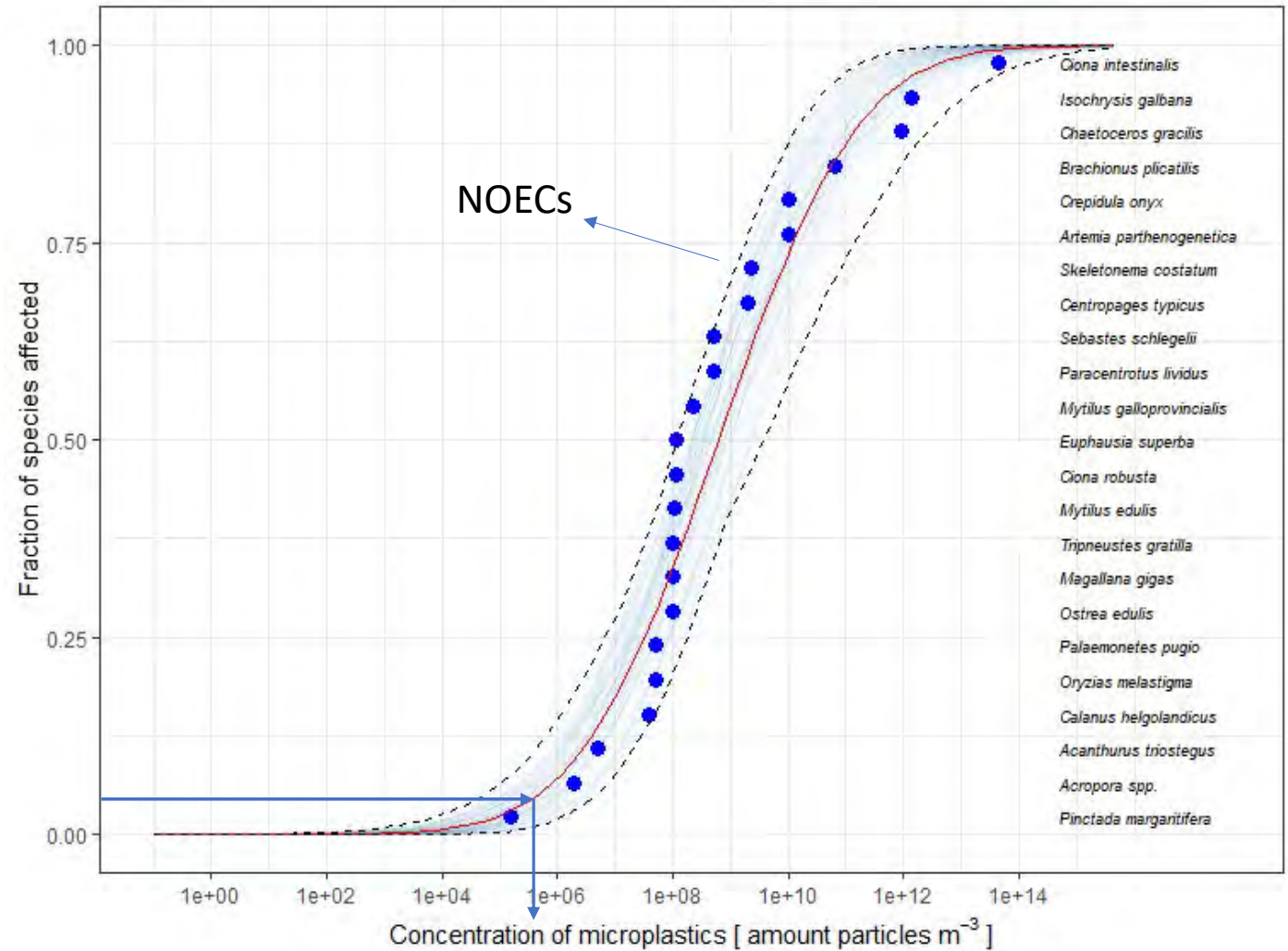
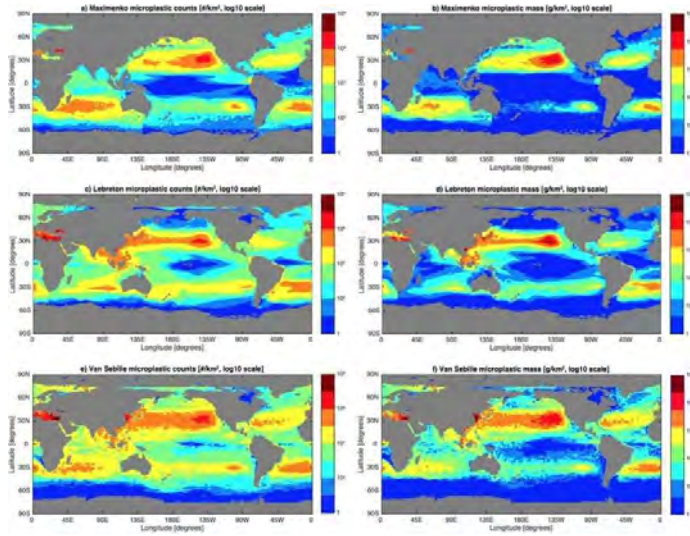
RA plastic-associated chemicals

Risk assessment:

1. Calculate total bio-accumulation including all pathways
2. Assess the relative contribution from plastic
3. Check if plastic-inclusive bioaccumulation causes body burdens to exceed toxicity thresholds

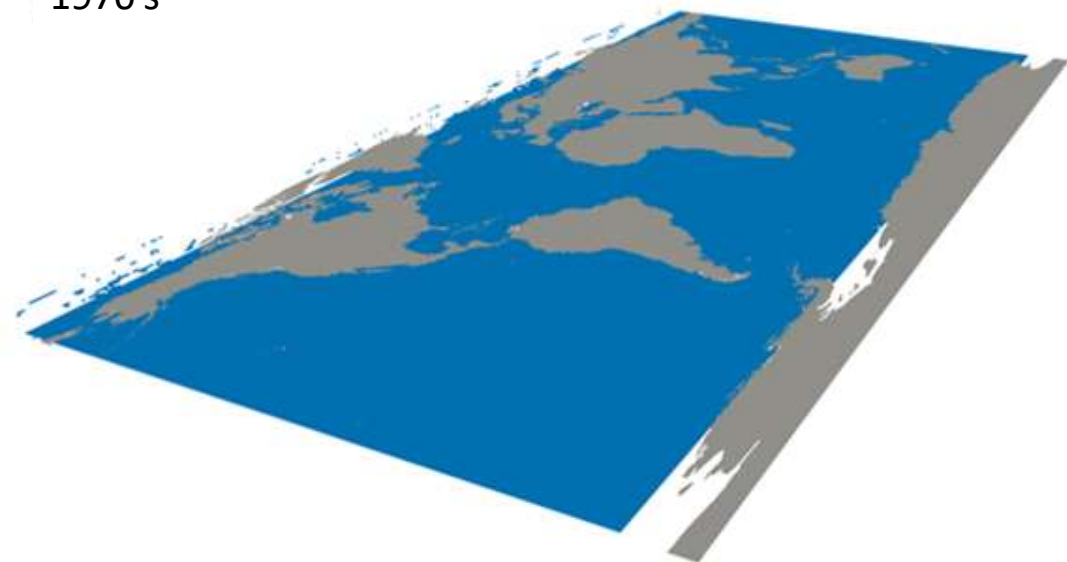


Prospective RA microplastic particles SSD approach

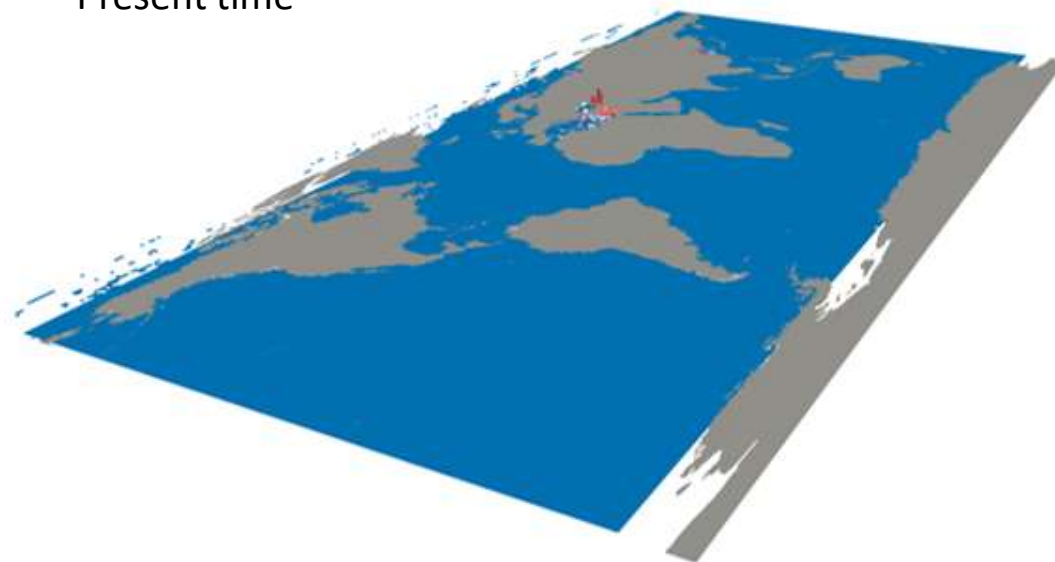


PEC/PNEC

1970's



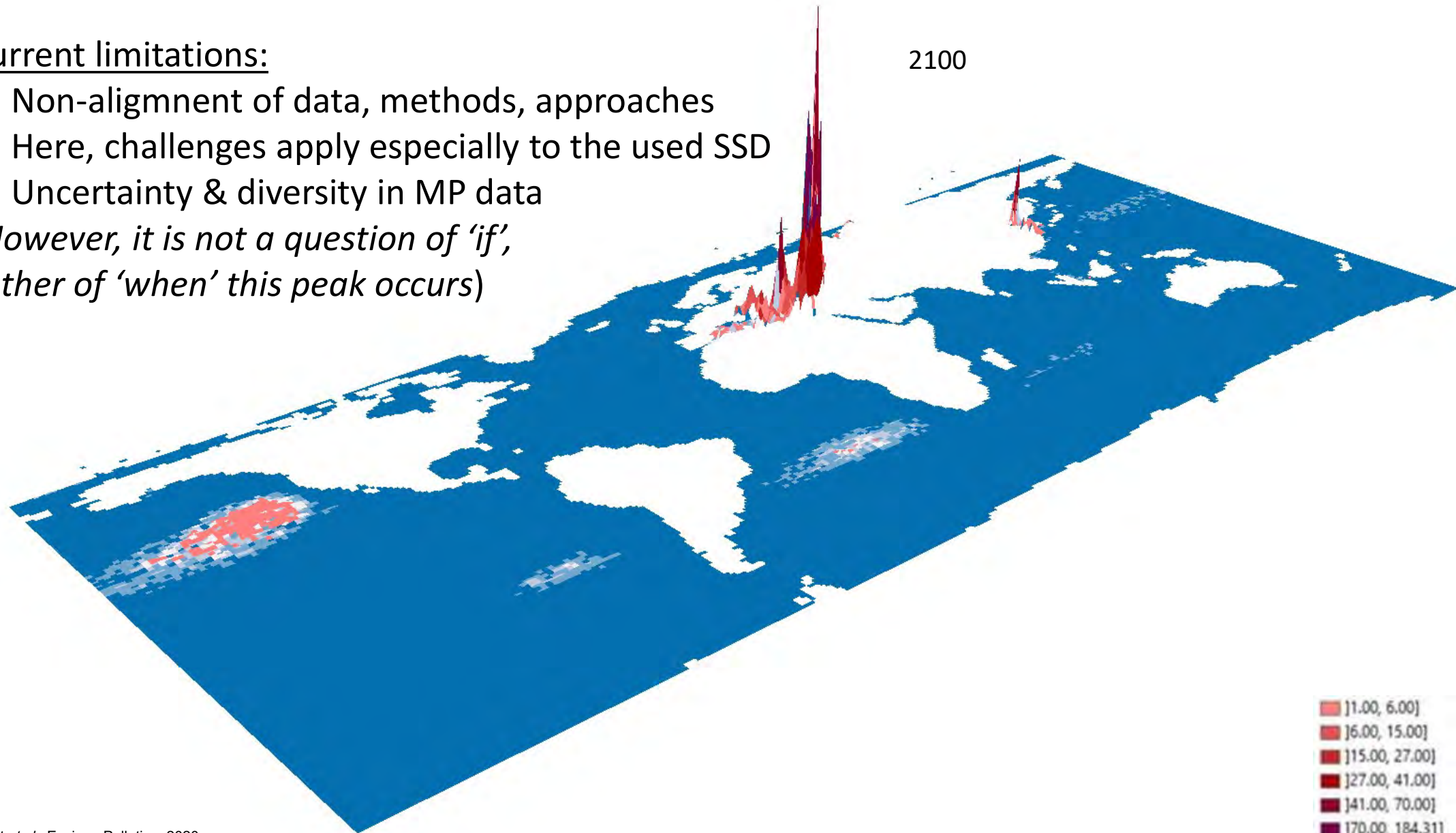
Present time



Current limitations:

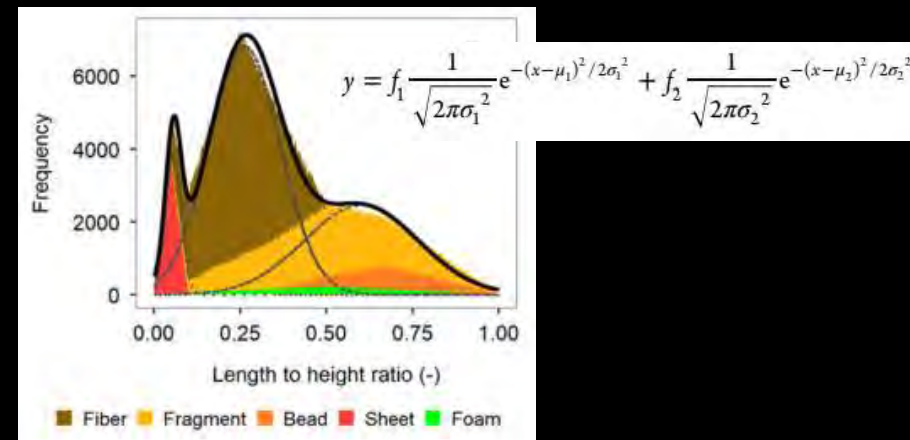
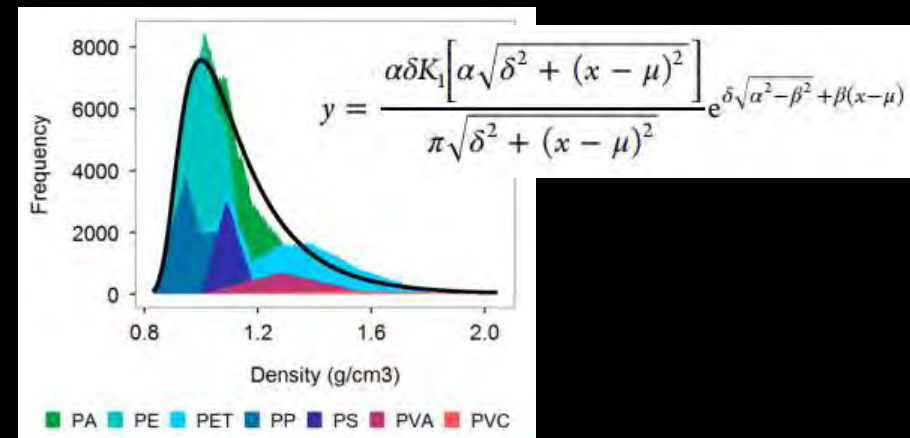
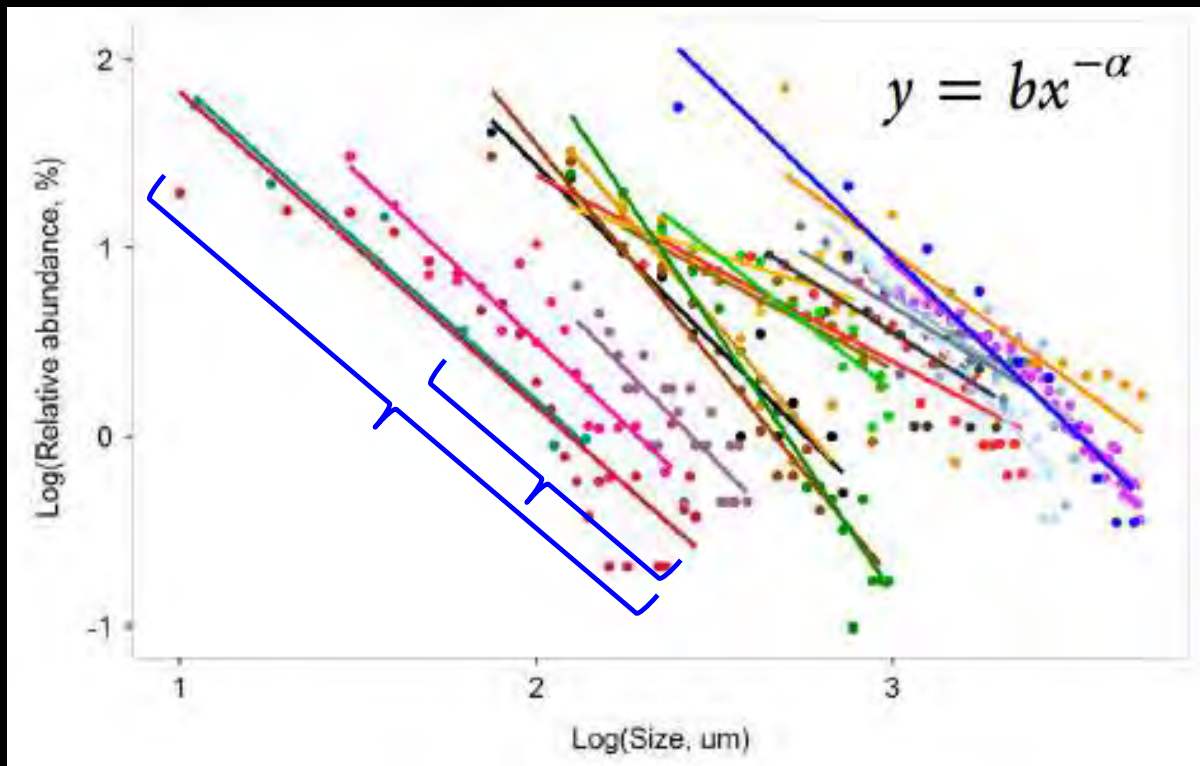
- Non-alignment of data, methods, approaches
- Here, challenges apply especially to the used SSD
- Uncertainty & diversity in MP data

*(However, it is not a question of 'if',
rather of 'when' this peak occurs)*



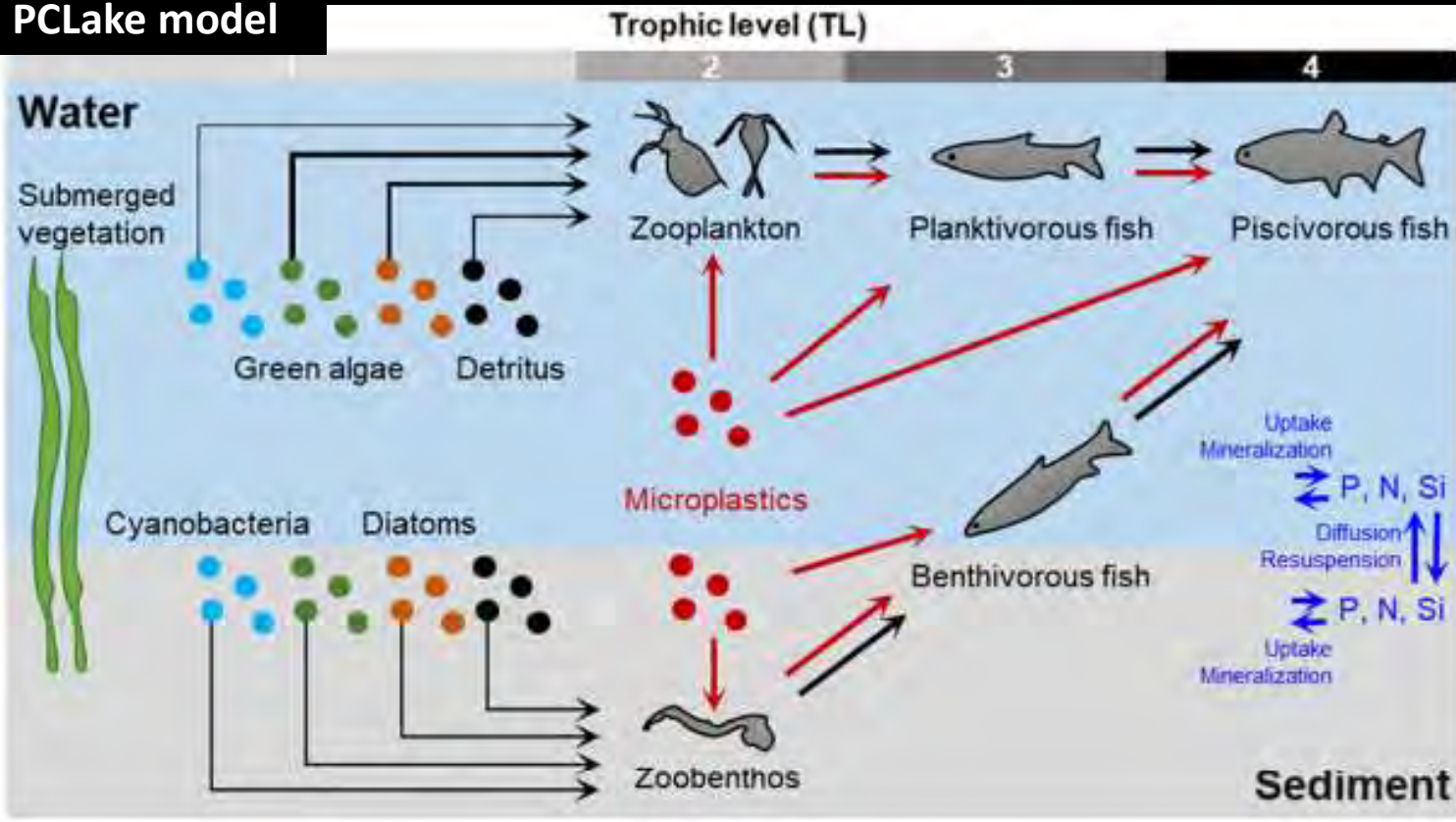


Opportunities for alignment using probability density functions (t.b.c. next week)

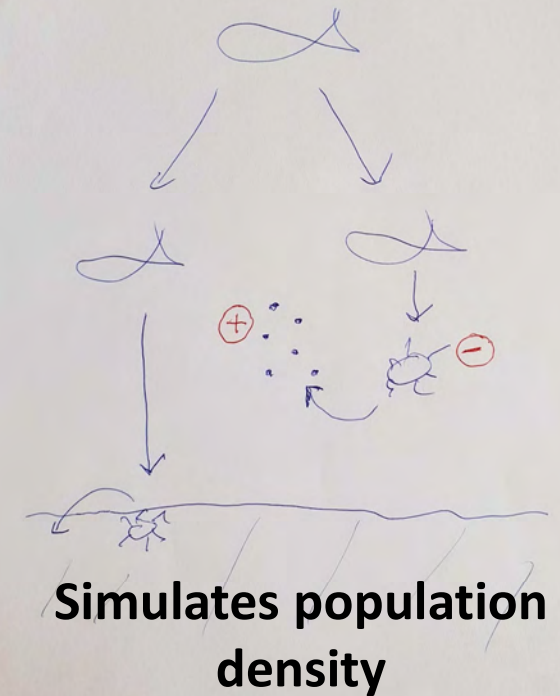


Prospective RA using full scale food web models

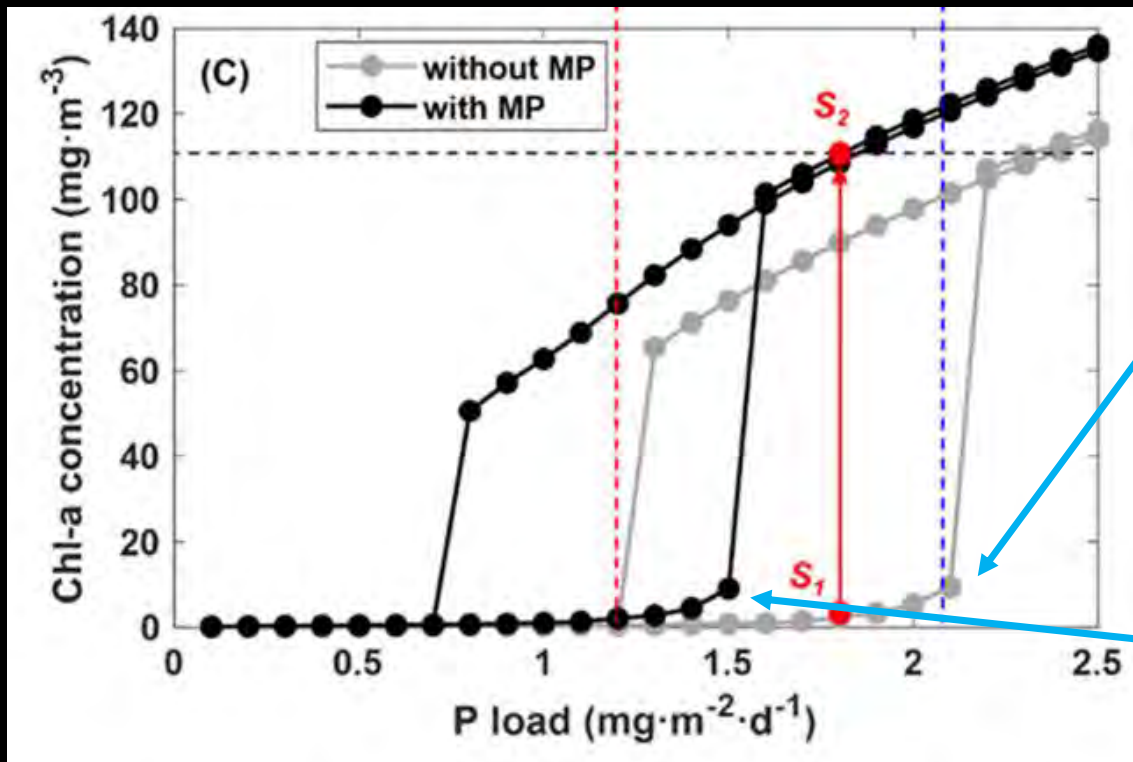
PCLake model



Theoretical ecology: 'trophic cascade'



Prospective RA using full scale food web models



Lake food web resilience

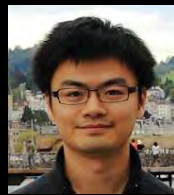
Zero, or present day MP level:
Lake tips into a turbid state at
2.1 mg P/m²/d

One century business as usual
MP emissions:
Lake tips into a turbid state at
1.6 mg P/m²/d

Prospect

- Harmonisation in a decade or so. Will improve data quality, accuracy, reliability. Slow process.
- Technical innovations → Same. Innovations will trigger new demands for harmonisation.
- Yet, risk assessments can and should be done any time
- May just take a higher share of 'pragmatic engineering approaches' for that what cannot be assessed accurately
- Compare concepts like Koc, BLM, TU, TEQ, LBB, QSAR ...

Thank You!



Paula Redondo, Merel Kooi, Frits Gillissen, Hazimah Mohamed Nor, Christiaan Kwadijk, Miquel Lurling, Noël Diepens, John Beijer, Edwin Peeters, Ellen Besseling, Enya Hermsen, Jeroen de Klein, Vera de Ruijter, Svenja Mintenig, Xiangzhen Kong, Changgui Pan

Summary

- 'Risk' is an ambiguous notion → need to define it
- Traditional RA framework, but different tools
- Plastic-associated chemicals: assess like chemicals in other contaminated environmental media. Tools available.
- Particles: issues with (a) **reliable** exposure & effect data, (b) harmonisation, (c) **understanding** effect mechanisms, (d) (conceptual) tools to **unify** everything.