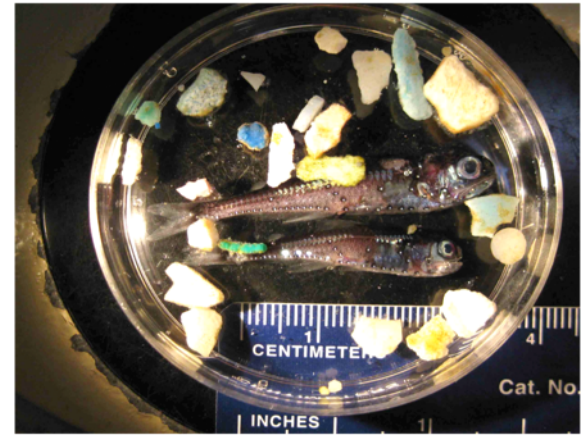
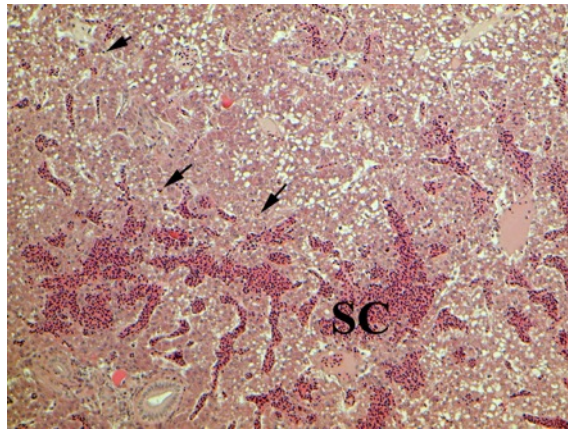
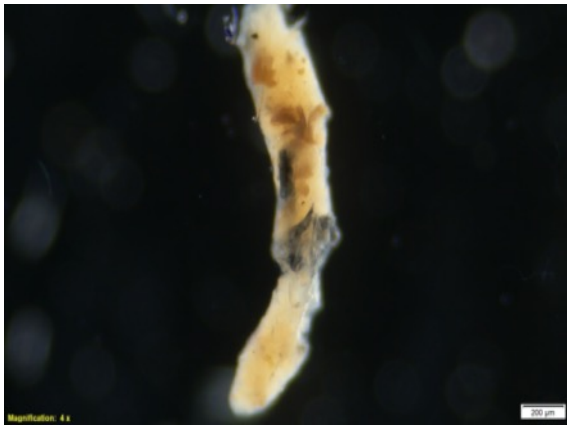
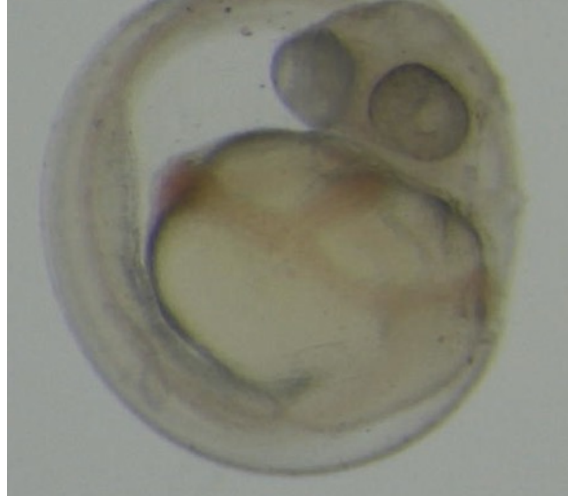
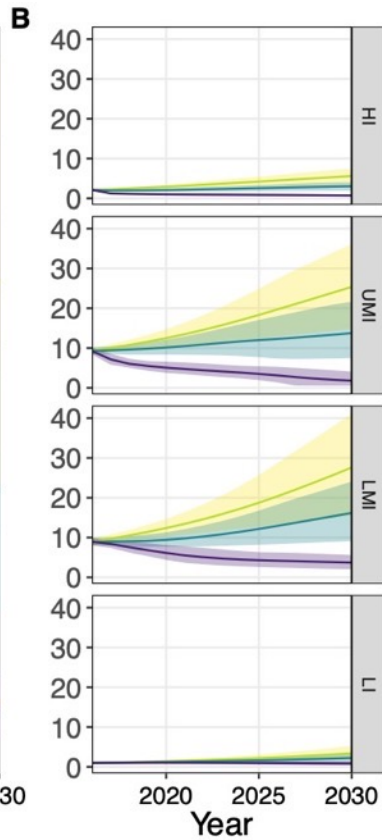
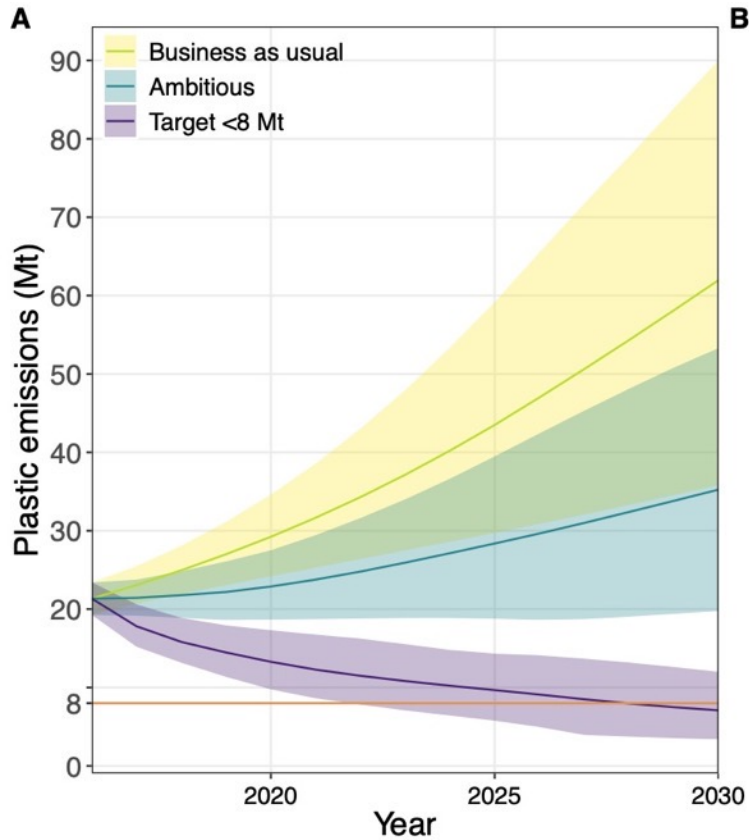


# The growing emissions of microplastics and their impacts

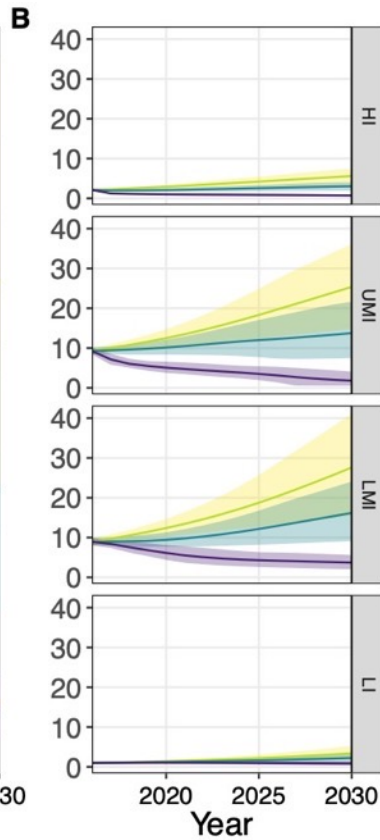
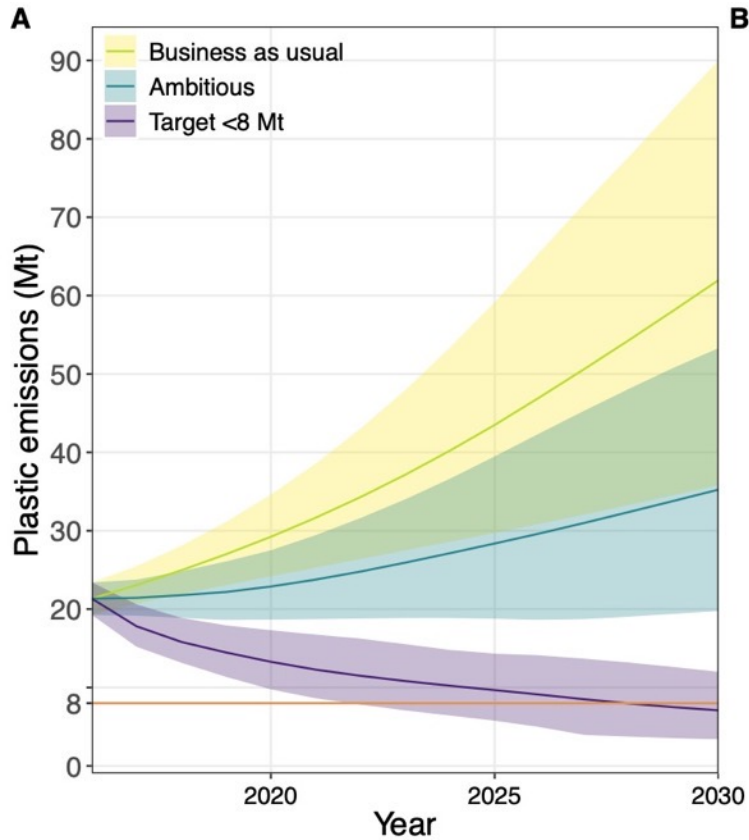


In 2015, the world decided 8MT of plastic emissions into the ocean was not okay.





19 – 23  
Mt of  
plastic  
emissions  
per year  
in 2016

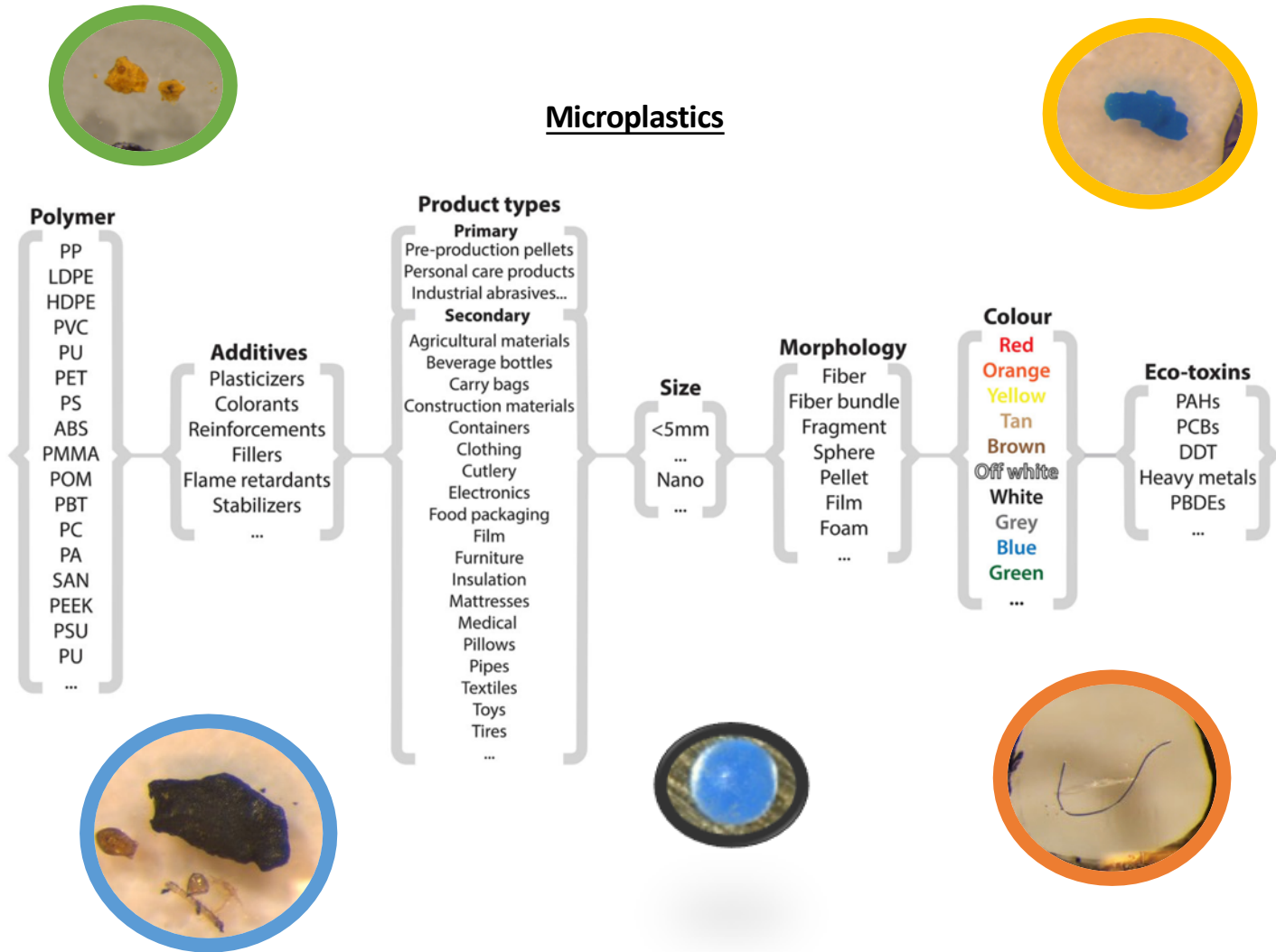


**Business  
As Usual:  
36 – 90  
Mt per  
year by  
2030**



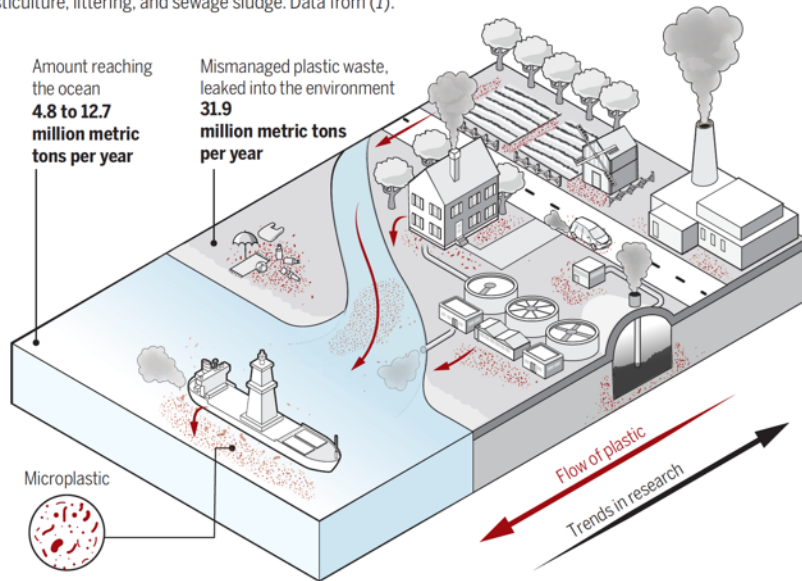
*Photo: Ilja Leo Lang for AECO*

# Microplastics



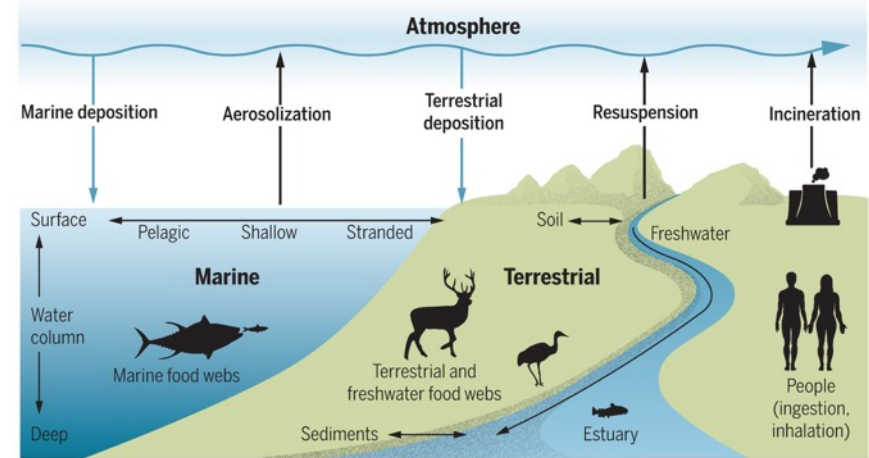
## Microplastics everywhere

High amounts of microplastics have been found not just in the sea and on beaches, but also in rivers and soils around the world, demonstrating how pervasive this modern pollution is. Sources include leakage from landfills, plasticulture, littering, and sewage sludge. Data from (1).



## Microplastic pollution is pervasive

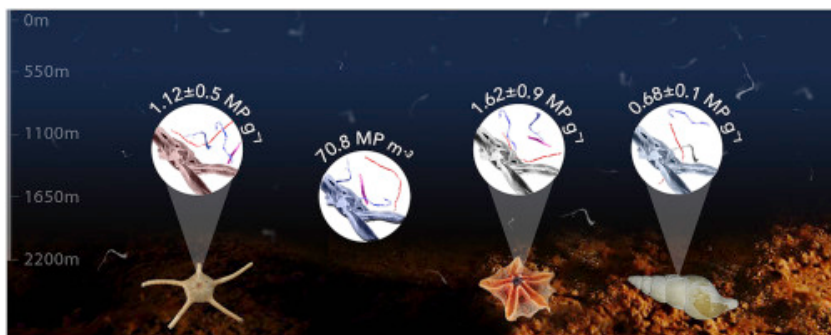
Emerging research pinpoints atmospheric deposition as a mode of microplastic transfer to the western United States. Mapping microplastic pools (water, land, organisms) and fluxes (arrows) will guide delineation of the global microplastic cycle.



Rochman, 2018; Rochman and Hoellein, 2020 *Science*

# Contamination is widespread

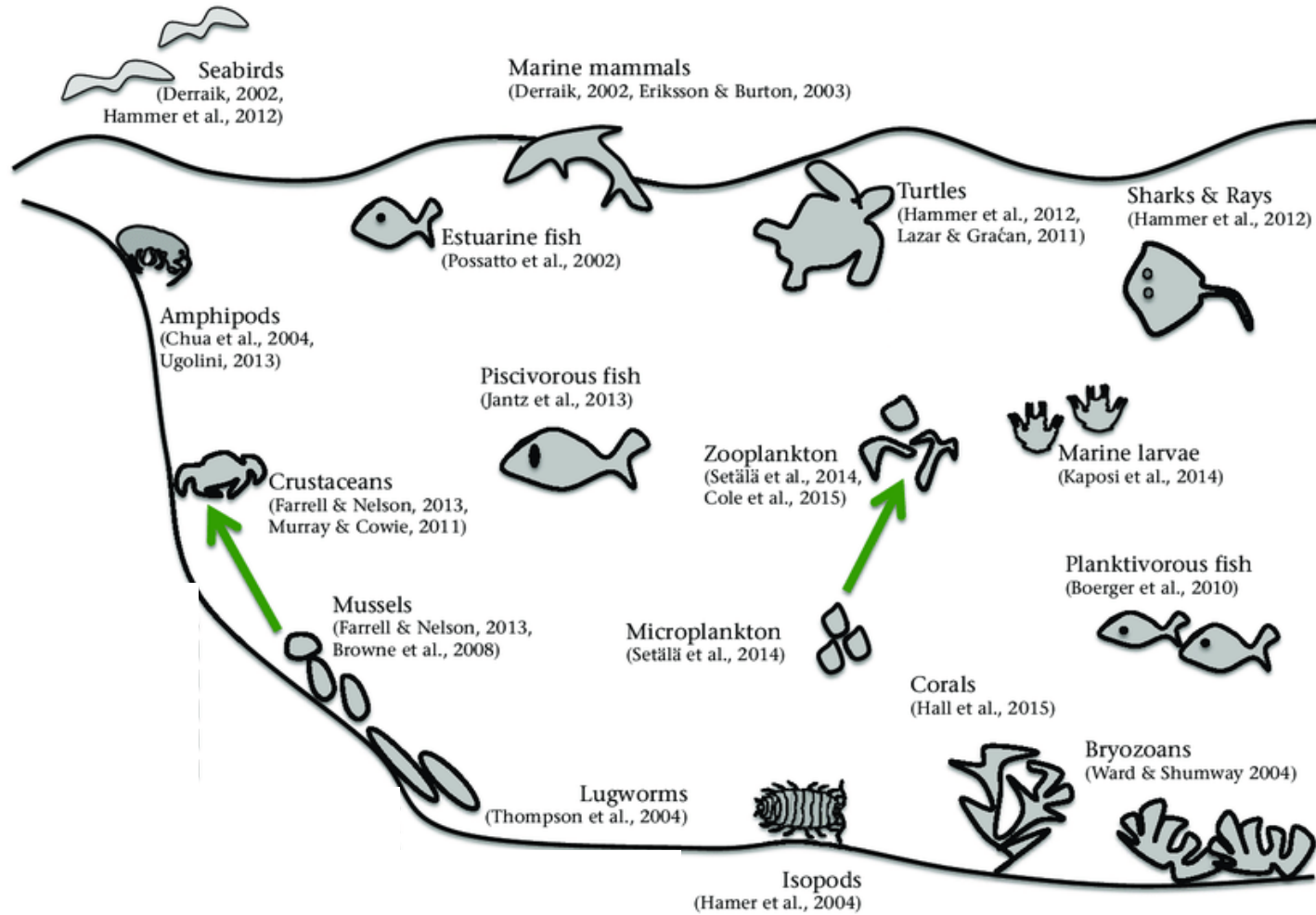
Courtene-Jones et al., 2017 *Environ Pollut*



Peeken et al., 2018 *Nature Communications*



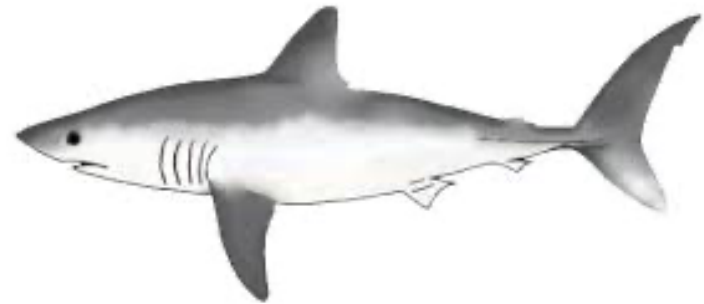
# Contamination is widespread



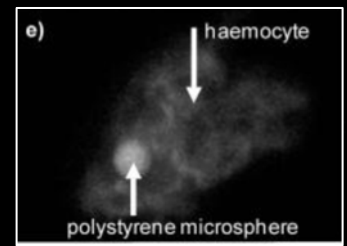
# Contamination is widespread



915 particles - Munno et al., *in review*



3850 particles - Maes et al., 2020



Browne et al., 2008





Averages range  
from ~100 – 6500  
particles per L

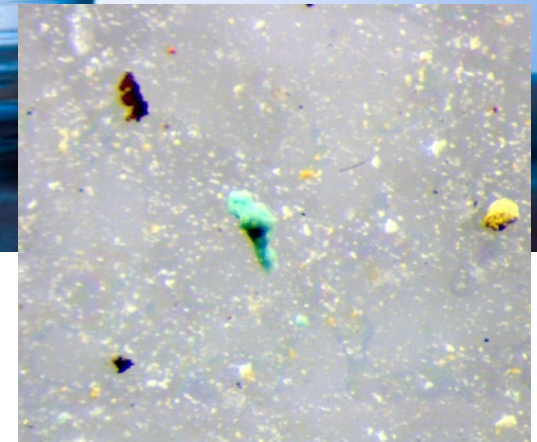
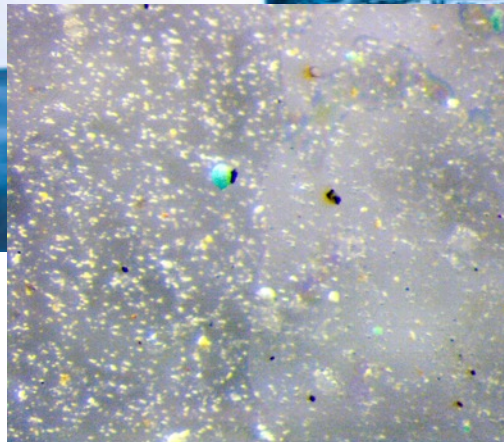


Averages range from ~0 – 600  
particles per L



Ossman et al., 2018 *Water Research*;  
Schymanski et al., 2018 *Water Research*;  
Mason et al., 2018 *Frontiers in Chemistry*

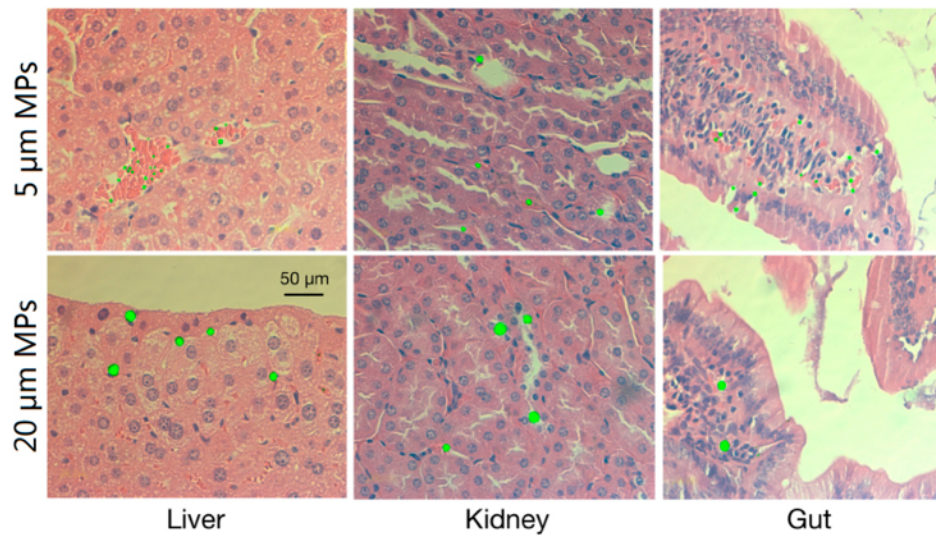
Kosuth et al., 2018 *PLOS One*;  
Pivokonsky et al., et al., 2018  
*STOTEN*



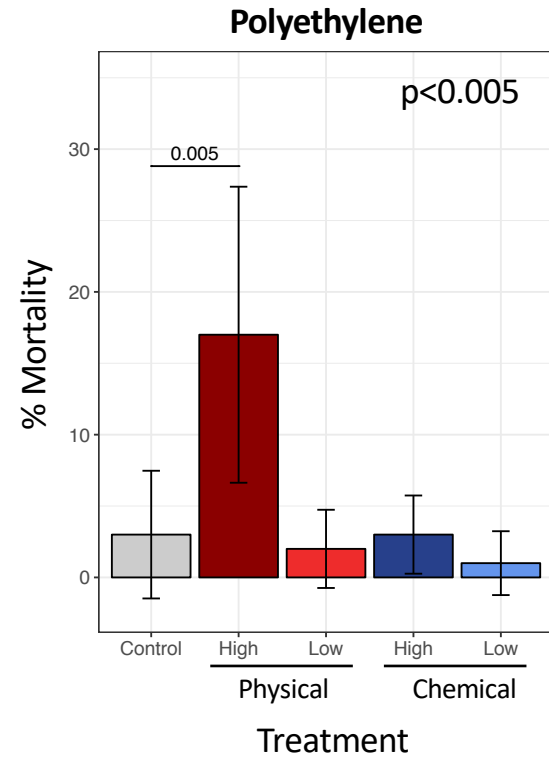
What are the effects of  
microplastics?



# Modes of Impact: Physical



Mice: Deng et al., 2017 *Scientific Reports*



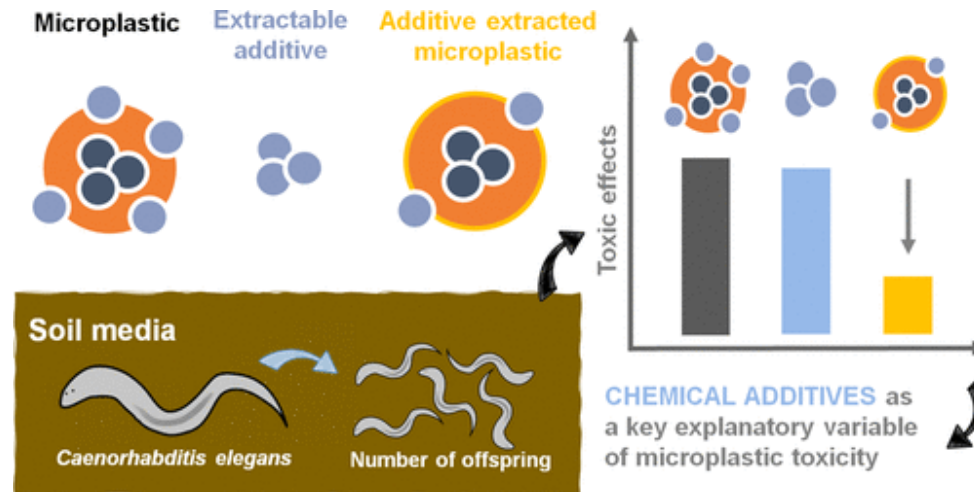
Fish: Bucci et al., *in review ES&T*

# Modes of Impact: Chemical (plastic-specific)



Figure 6. Fathead minnows exposed to the leachates from the CO<sub>2</sub> experiments at 600 ppm a) control; b) Tire 1 ; c) Tire 2. The black bar represents 1 mm.

Kolomijeca et al., 2020 *ES&T*



Kim et al., 2020 *ES&T*

# Modes of Impact: Chemical (ambient)

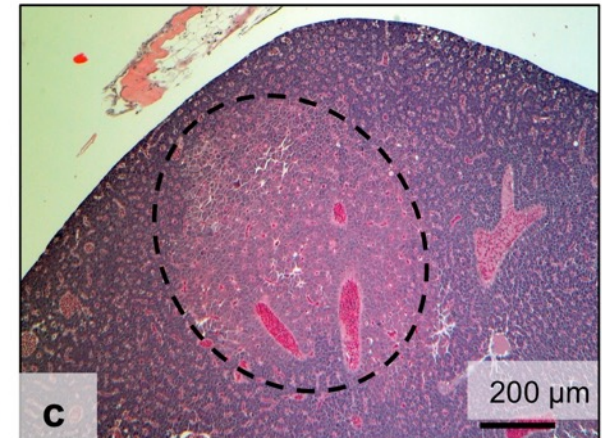
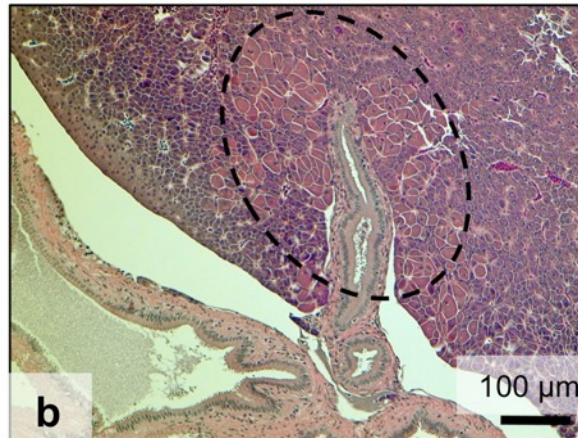
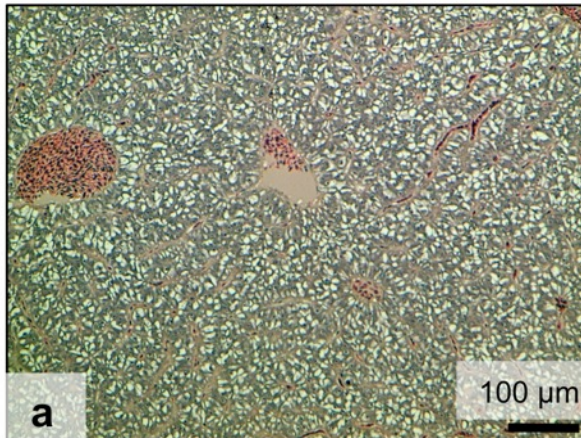
Number of deformities  
(n=5, 20 fish per replicate tank)

PE	Scoliosis	Edema	Hatch	Tail	Other	Total
Control	0	0	0	0	0	0
Chem-Low	0	0	0	0	0	0
Chem-High	0	1	0	0	0	1
Phys-Low	0	0	0	0	0	0
Phys-High	0	3	0	0	0	3
PP						
Control	0	2	0	0	0	2
Chem-Low	0	0	0	0	0	0
Chem-High	0	1	0	0	0	1
Phys-Low	1	1	1	0	0	3
Phys-High	0	0	0	0	0	0

## LO

Control	0	1	0	0	0	1
Chem-Low	1	4	1	1	0	7
Chem-High	0	5	0	0	1	6
Phys-Low	1	2	1	2	0	6
Phys-High	1	11	2	1	0	15

Bucci et al., *in review: ES&T*



Rochman et al., 2013, *Scientific Reports*



Specific, sensitive, and reproducible  
Yet difficult to relate to ecological change

**HIGH  
TOXICOLOGICAL  
RELEVANCE**

Determine health and fitness of individuals  
Allow extrapolation to population/community effects

**SHORT-TERM  
RESPONSE**

**HIGH**

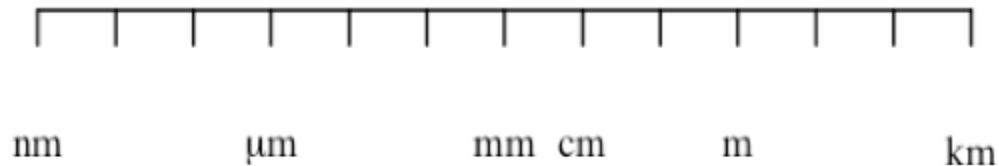
**LONG-TERM  
RESPONSE**

Directly indicative of ecosystem health  
Yet difficult to determine, less specific AND manifest  
when environmental damages have already occurred

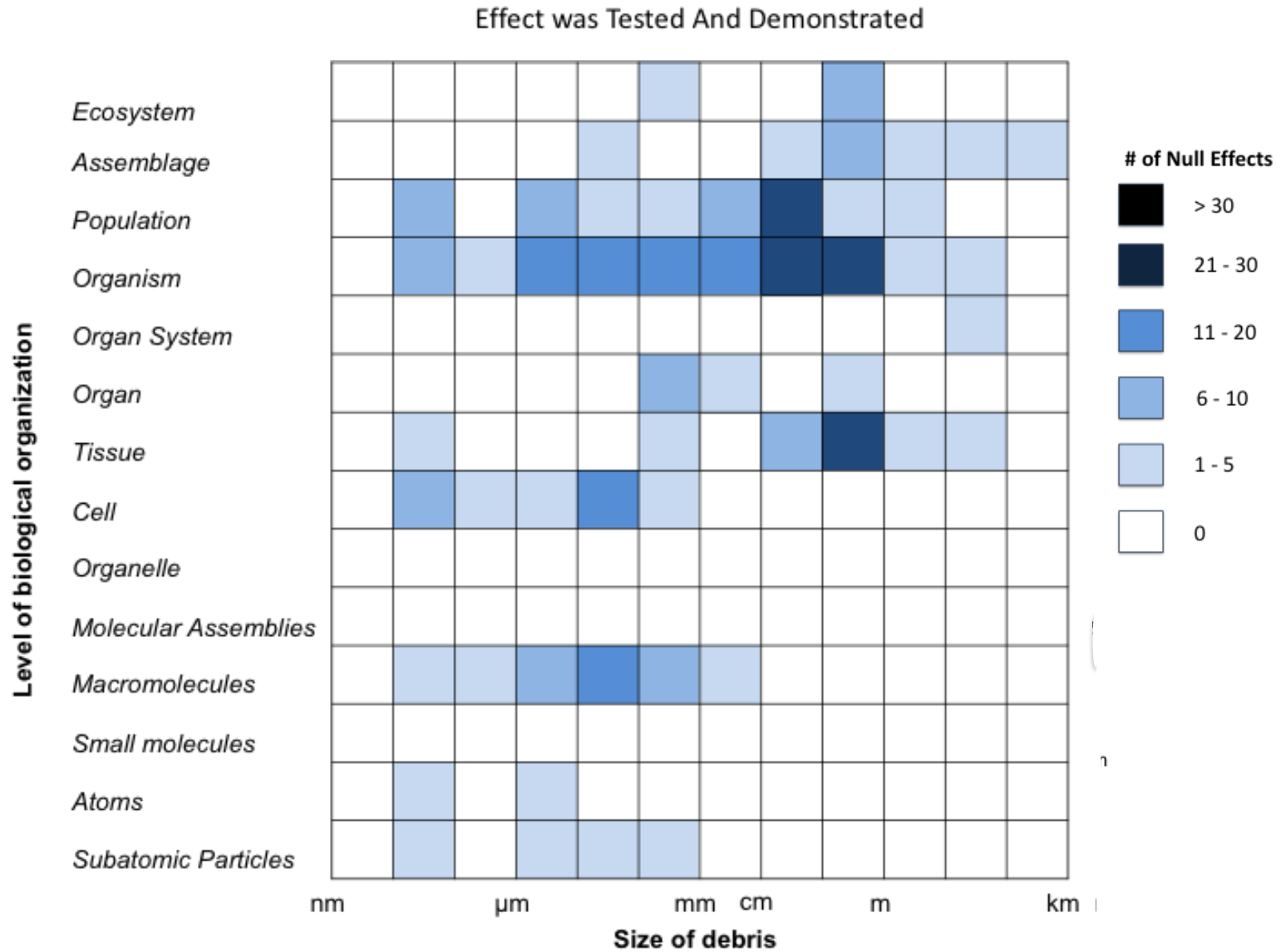
Levels of biological organization

Assemblage	14
Species	13
Population	12
Organism	11
Organ System	10
Organ	9
Tissue	8
Cell	7
Organelle	6
Molecular Assemblies	5
Macromolecules	4
Small Molecules	3
Atoms	2
Subatomic Particles	1

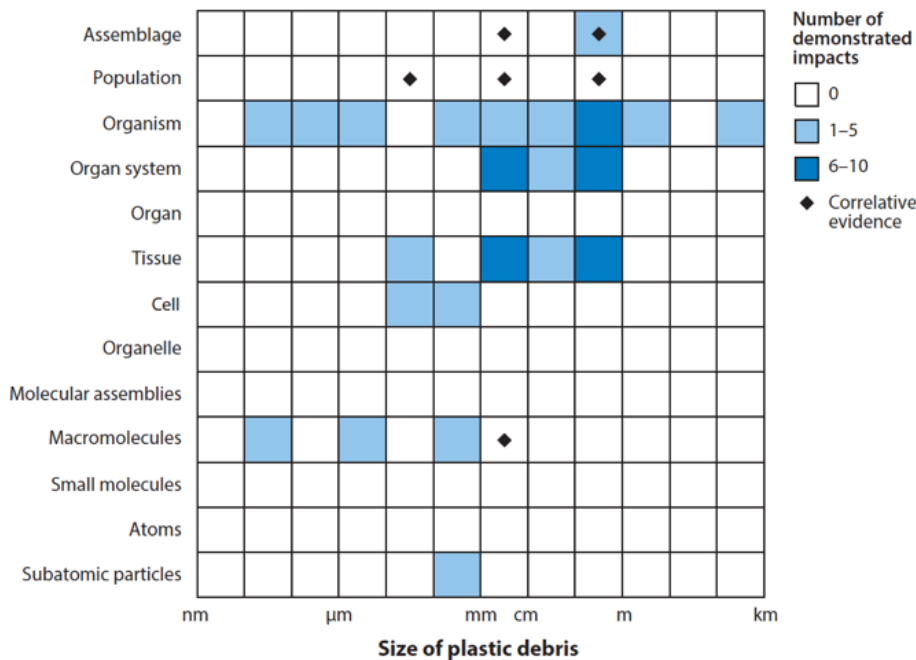
Impacts described were grouped by size of debris and level of biological organization.



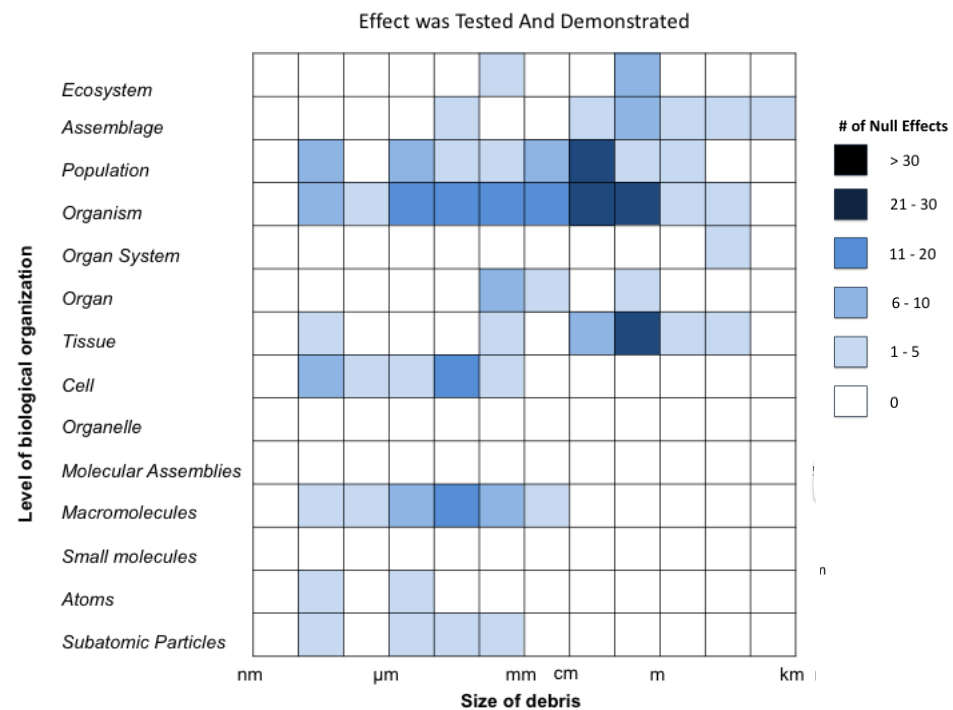
# The Evidence Demonstrating Impacts to aquatic biota is Growing



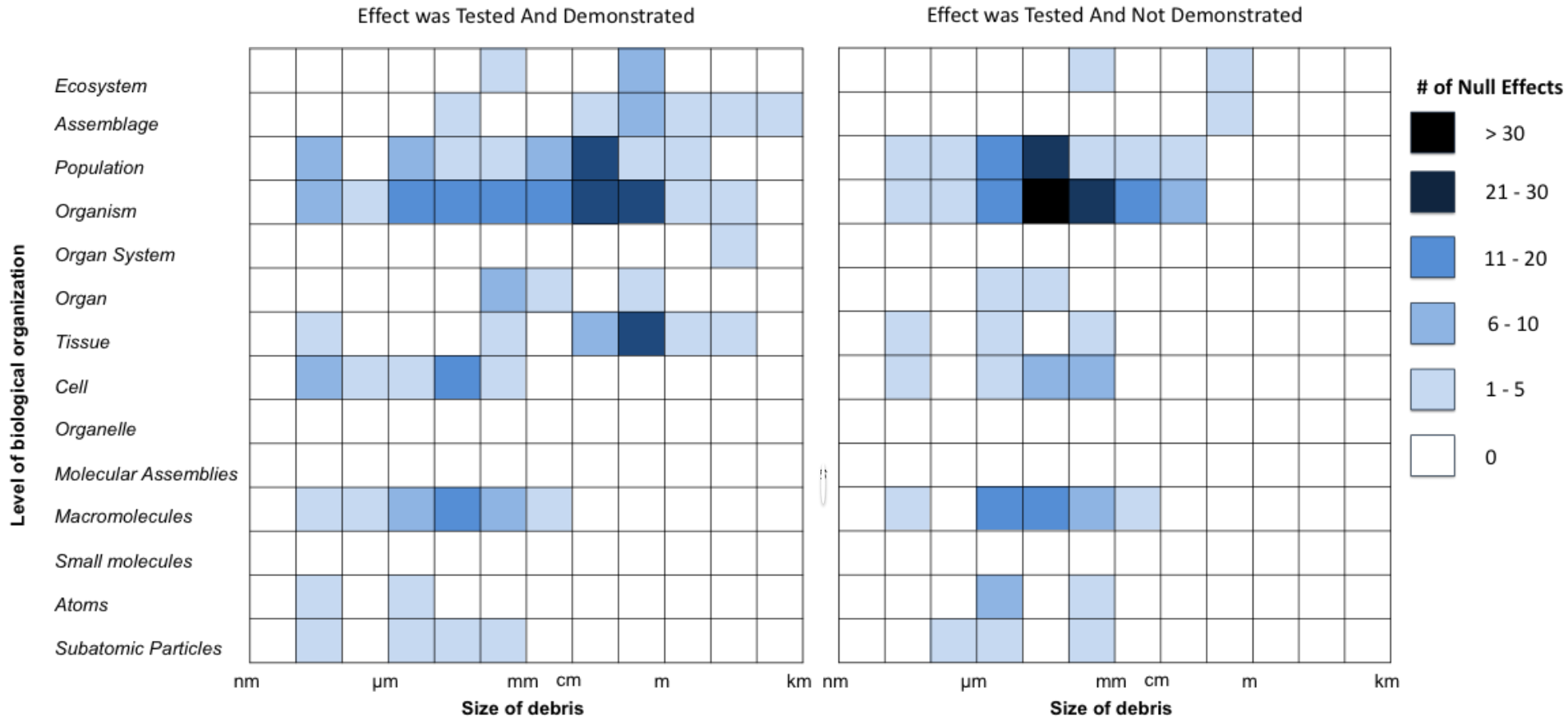
## Through 2013



## Through 2017

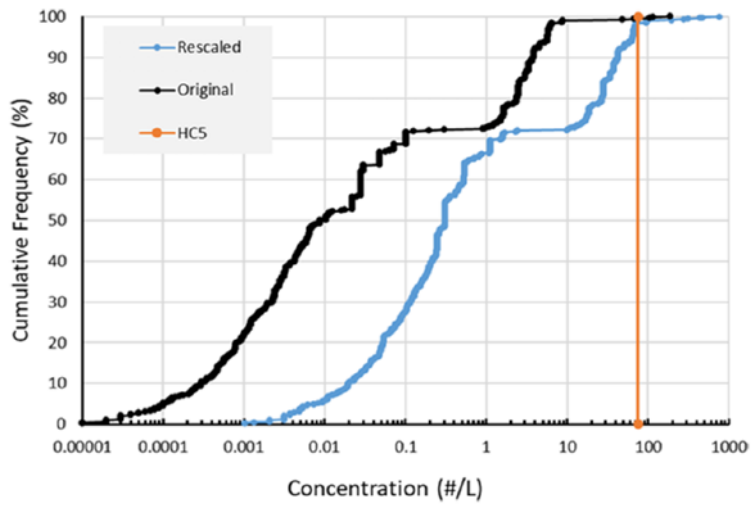


# Effect Detected vs Not Detected

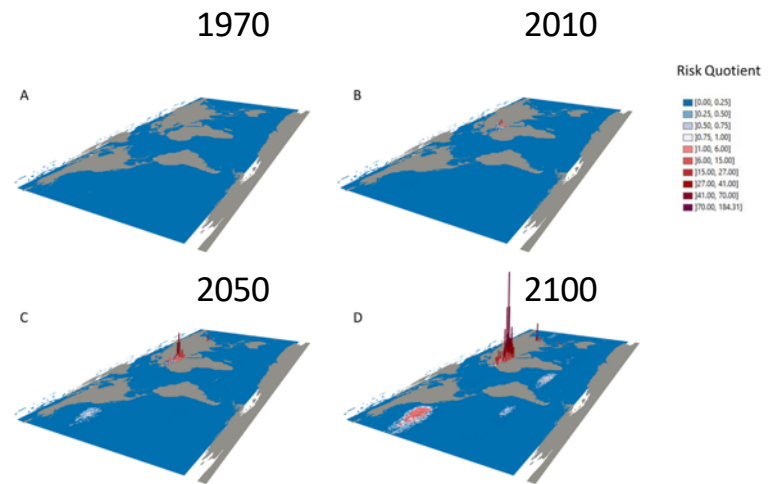


# What makes an effect detected vs not detected?

- dose
- shape of microplastic
- type of microplastic
- taxa
- size of microplastic
- experimental design



Koelmans et al., 2020



Evereart et al., 2020

## In Summary:

- For large plastic debris, there is no doubt that plastic harms wildlife.
- For microplastics, there is evidence that it can cause harm, but when and how is complicated and further work is needed to understand this.
  - We need more studies testing hypotheses about microplastic that recognize their complexity
- There is evidence that microplastics are already leading to measurable risk in freshwater and marine ecosystems.
- Thus, at the same time as we work to reduce microplastic emissions, we must also reduce microplastic emissions.



Thank you!

