Plastics in the environment: The state of the science

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Hosted by the Office of Water, Marine Pollution Control Branch

EPA

- What's the problem?
- What are the impacts?
  Macro- and micro-
  Human and ecological health
- What are the uncertainties?
- What do we need to know?

What’s the problem?

http://www.relatably.com/q/img/just-one-word-plastics-quote/plastics.png

A brief timeline…

Year	Material
1868	Cellulose Nitrate
1907	Phenol-Formaldehyde (Bakelite)
1927	Cellulose Acetate (Rayon)
1929	Urea Formaldehyde
1931	Polystyrene
1933	Polyvinyl Chloride
1935	Ethyl Cellulose
1936	Acrylic, Polyvinyl Acetate
1938	Nylon
1941	Polyethylene Terephthalate (PET)
1942	Polyester
1943	Silicone
1947	Epoxy
1954	Polypropylene

http://www.modip.ac.uk/resources/curators_guide/plastics_timeline

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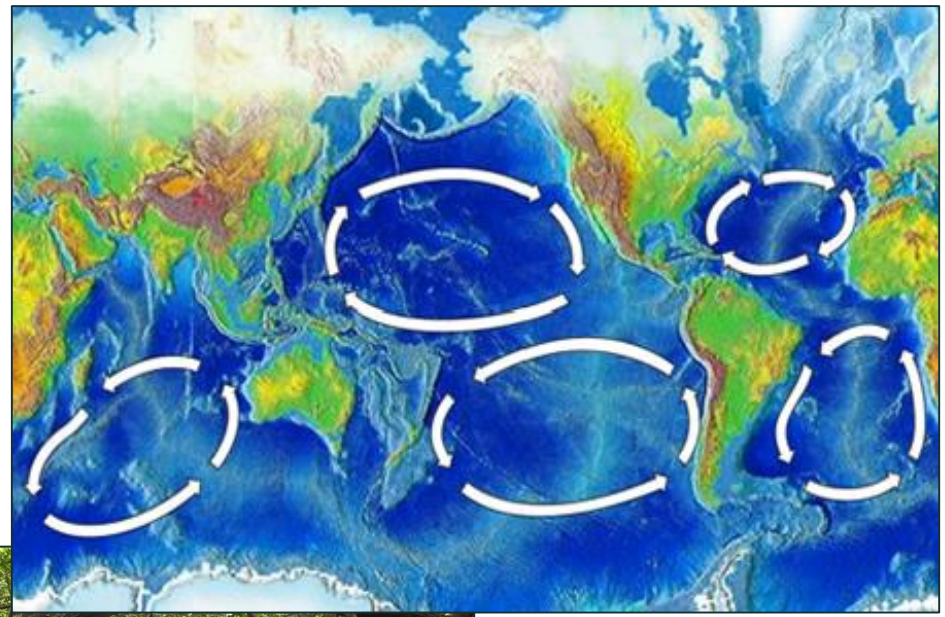
Plastics are widely available, useful, durable and cheap

http://www.modip.ac.uk/resources/curators_guide/plastics_timeline

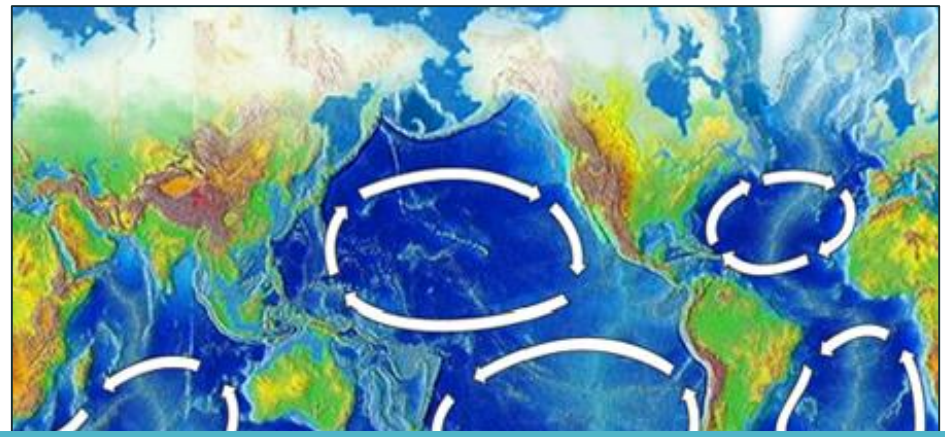
Plastics in the environment

NOAA

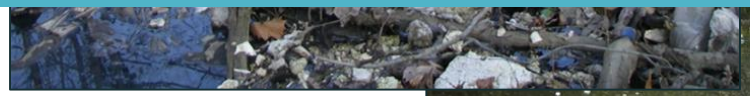


Plastics in the environment

NOAA

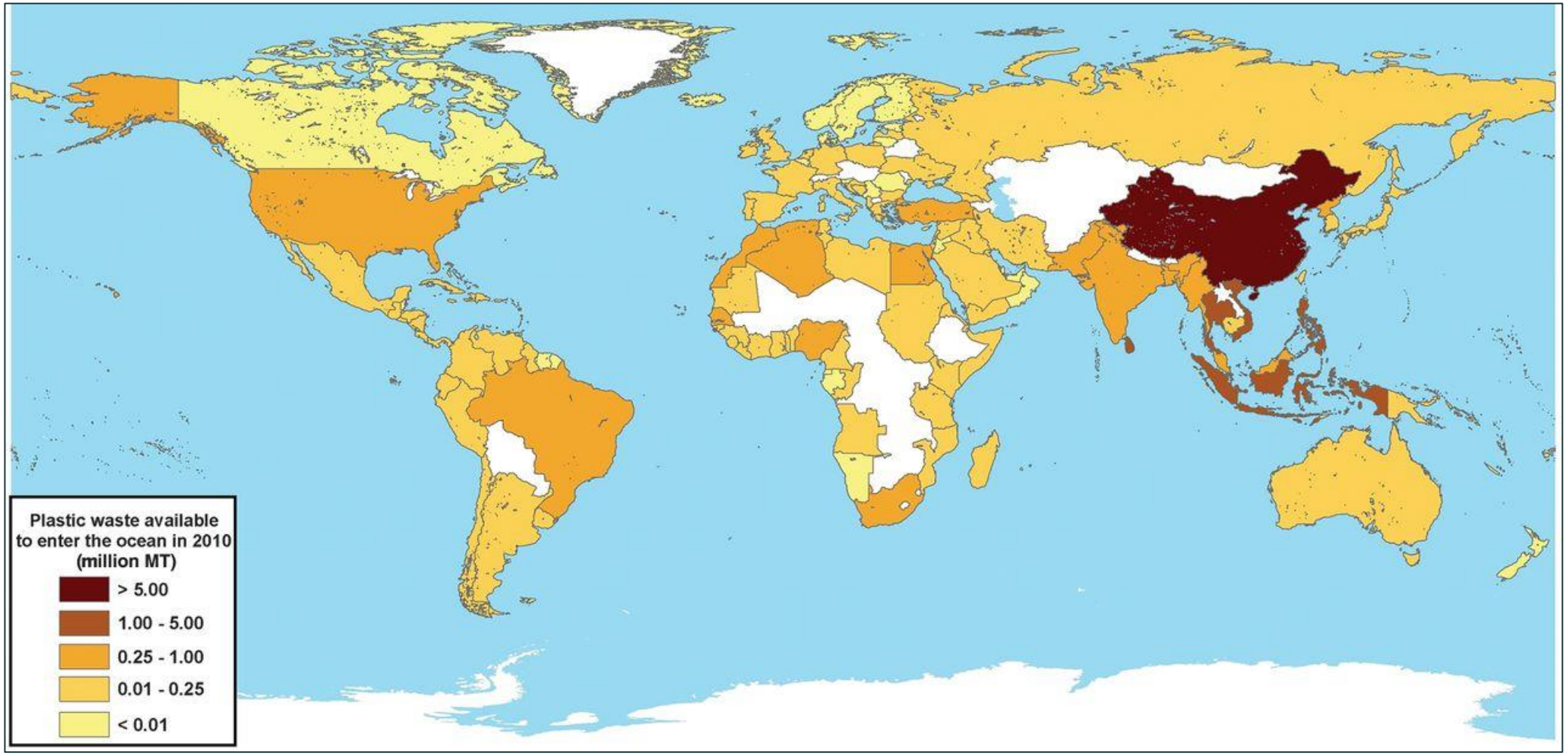


Majority of plastics in the environment are from land-based sources
→ Local and global problem



Aquatic Trash—Plastic

Jambeck et al. 2015



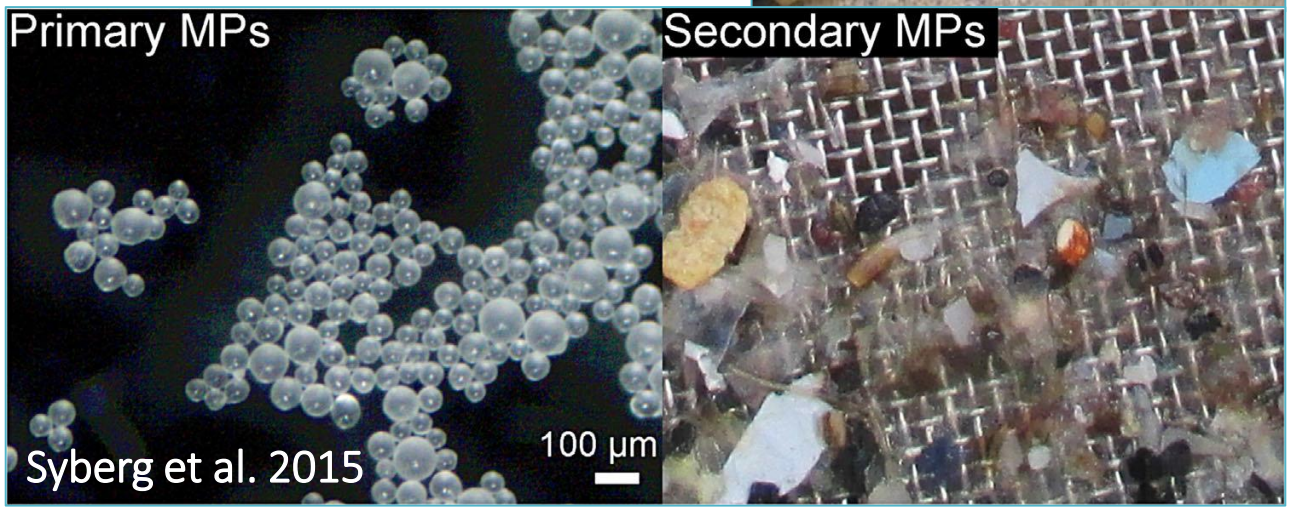
Microplastics

Plastic fragments, beads and fibers less than 5 mm in size

Primary microplastics: Commercially produced microplastics

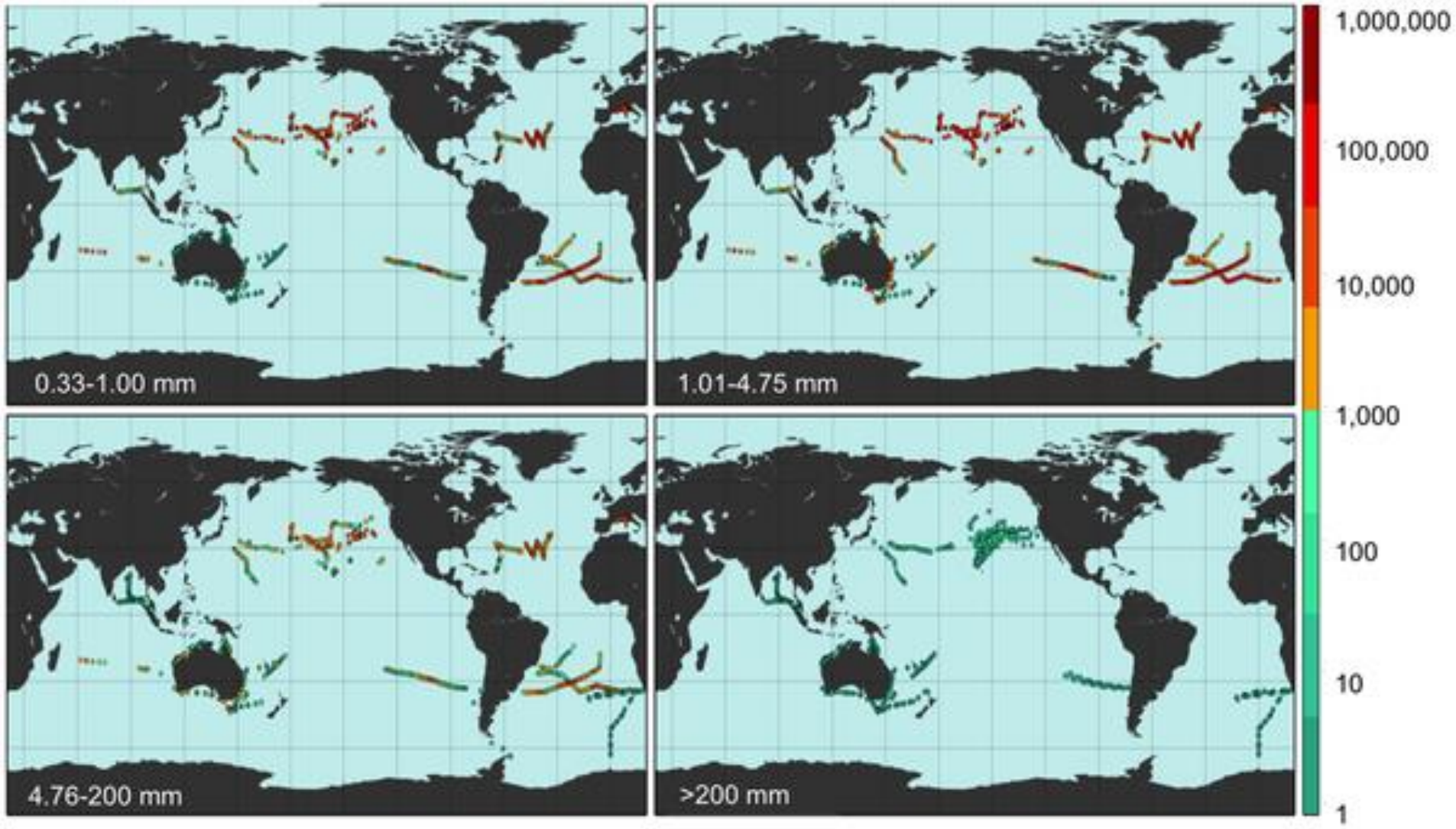
E.g. microbeads, plastic nurdles

Secondary microplastics: Formed by the breakdown of larger plastic items



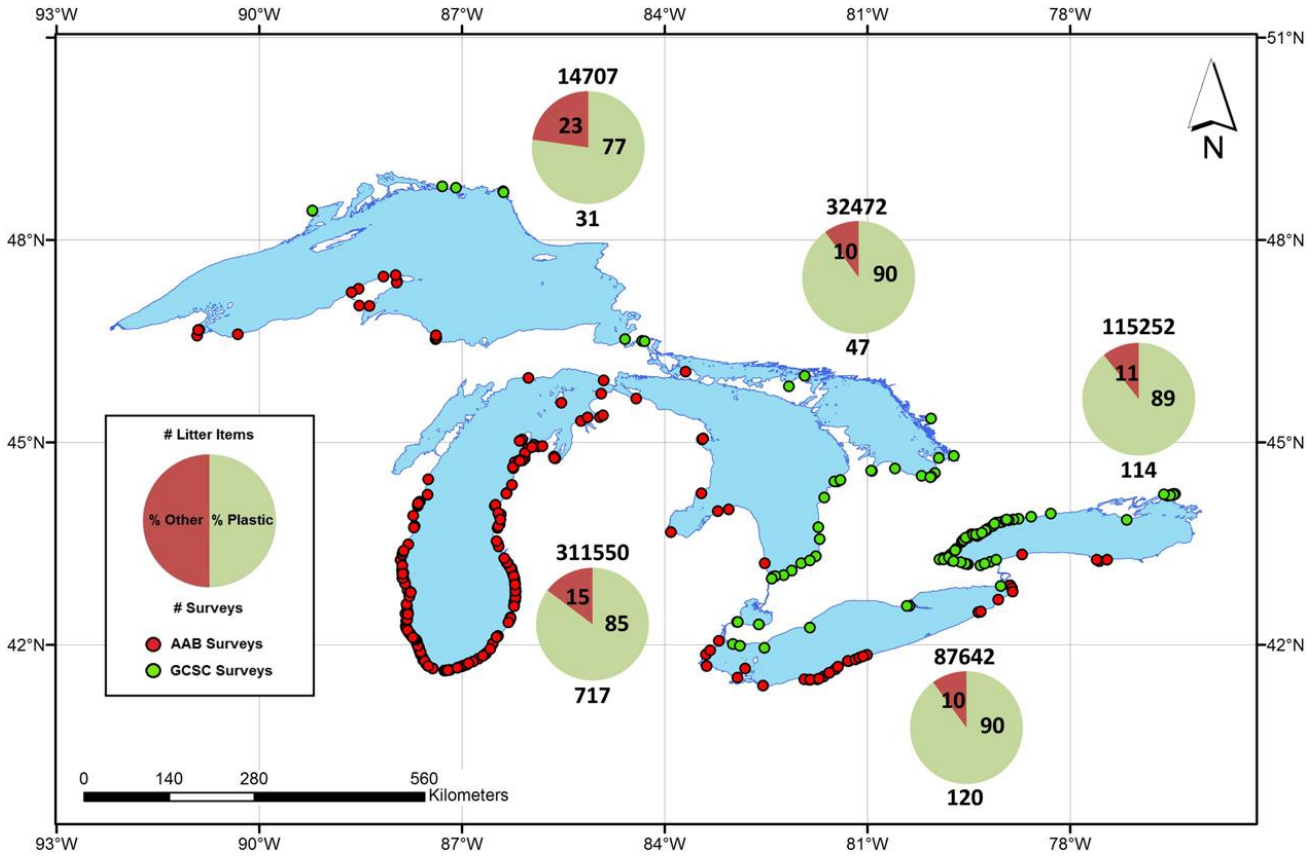
Microplastics

Eriksen et al. 2015

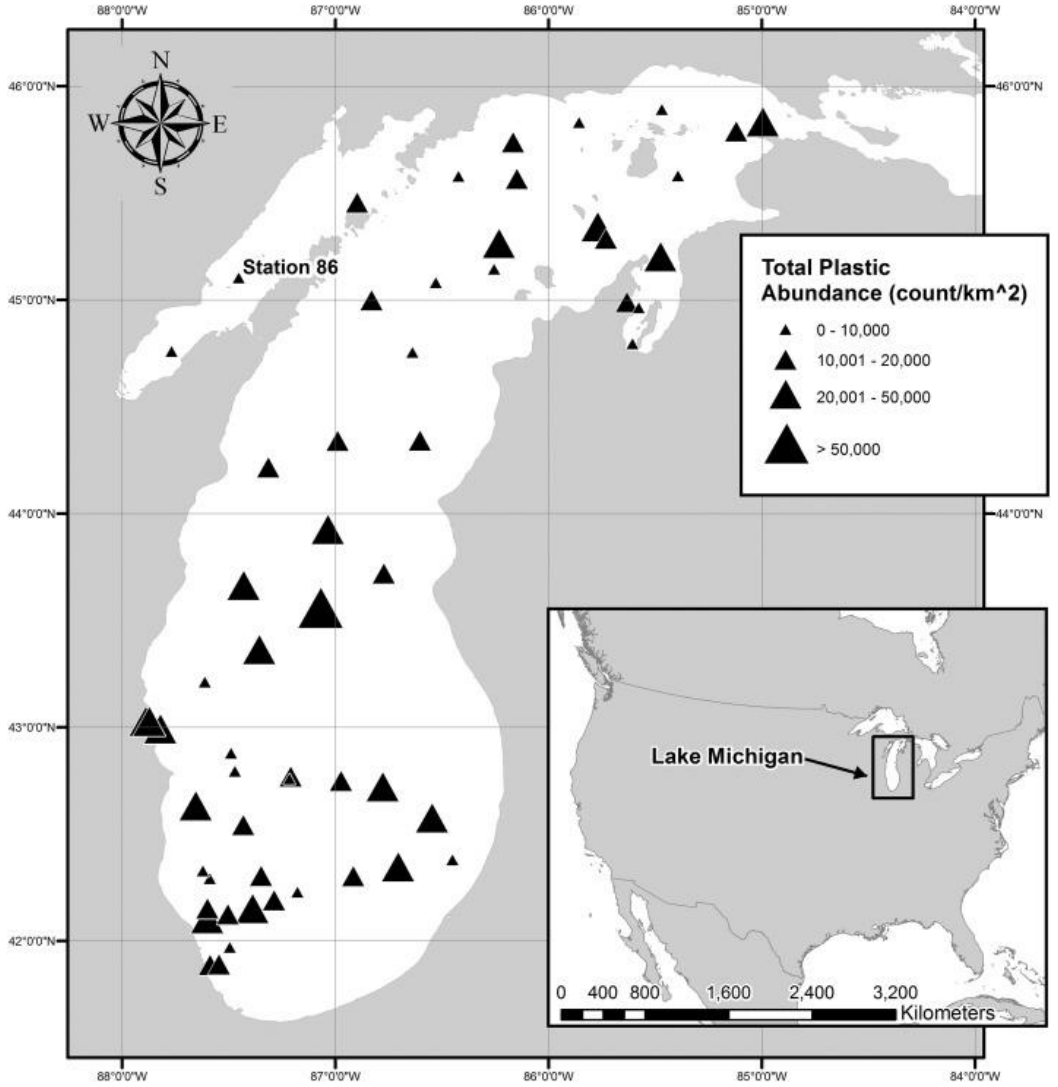


Research in the US—Great Lakes

Driedger et al. 2015

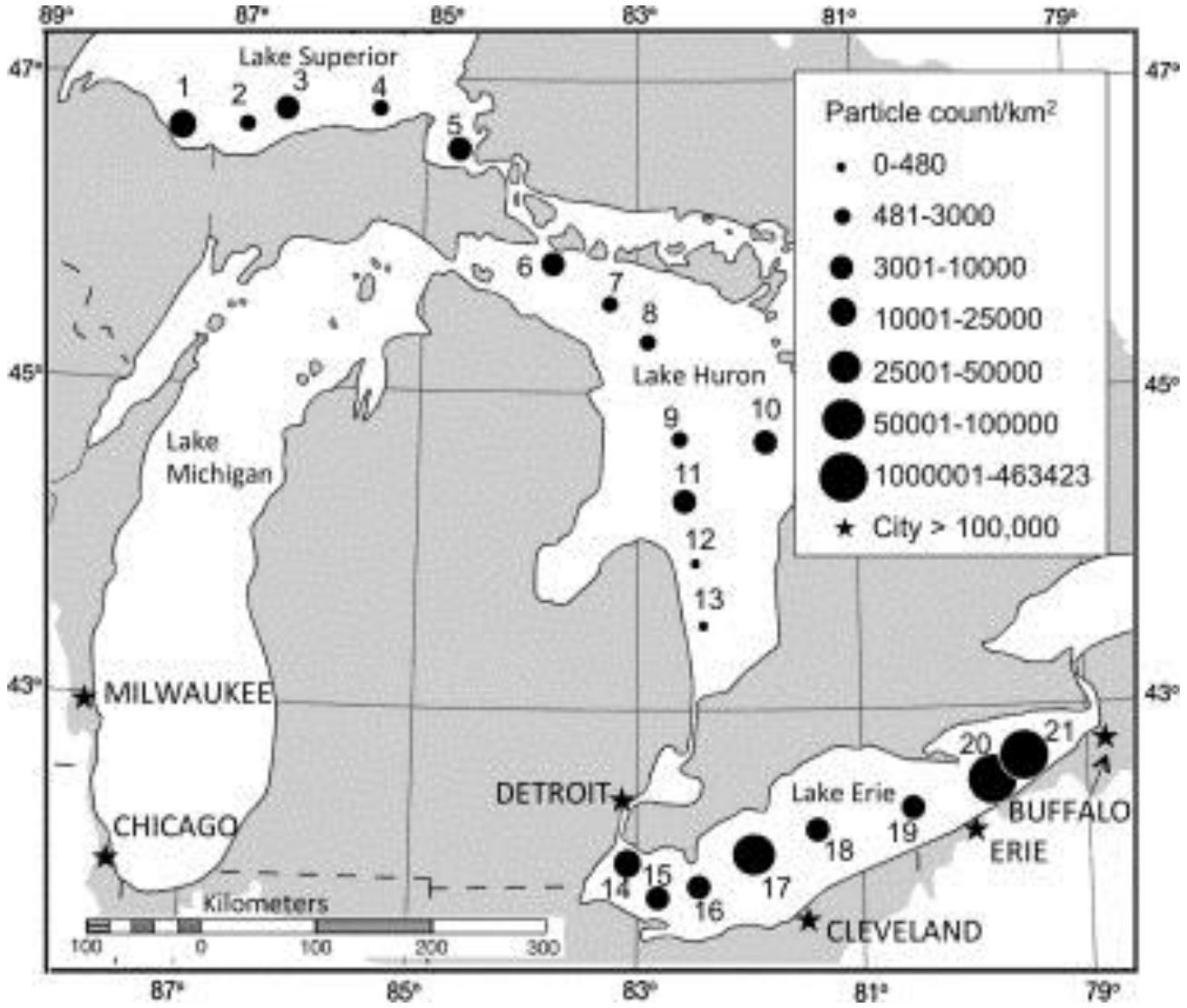


Mason et al. 2016



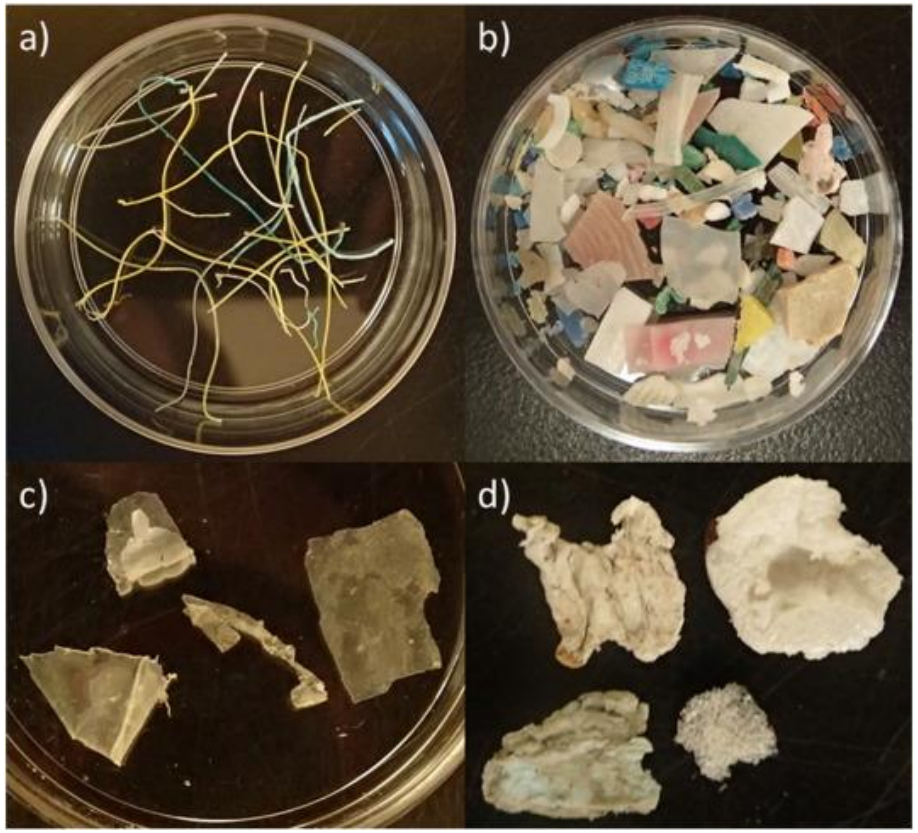
Great Lakes microplastics

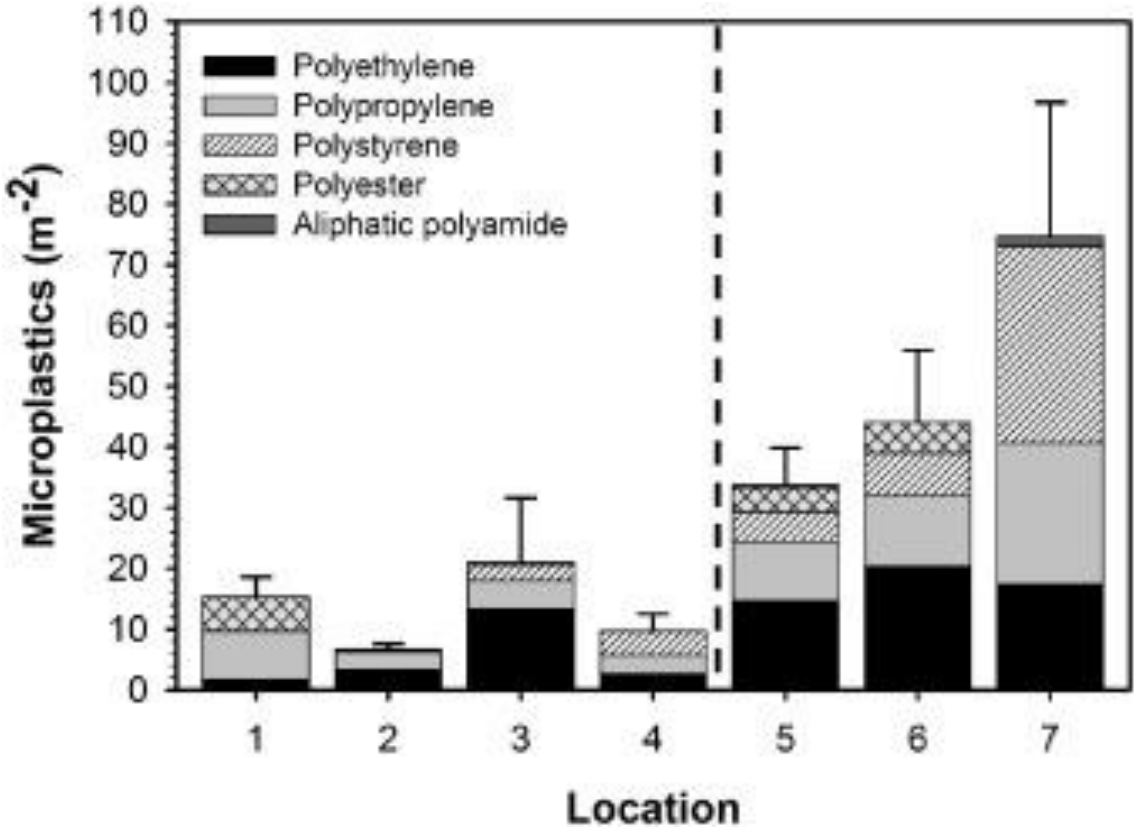
Eriksen et al. 2013



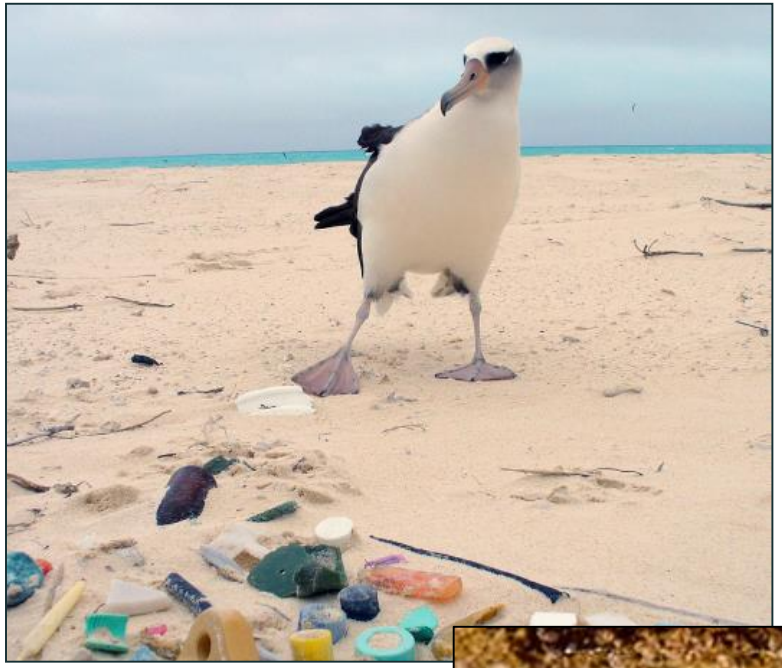
Gulf of Mexico estuary—Alabama

Wessel et al., 2016





What are the impacts?




NOAA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Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

Using expert elicitation to estimate the impacts of plastic pollution on marine wildlife

Chris Wilcox [a], Nicholas J. Mallos [b], George H. Leonard [c], Alba Rodriguez [b], Britta Denise Hardesty [a,*]

Wilcox et al. 2016

Item	Rank of Expected Impact			
	Mean	Bird	Turtle	Mammal
Buoys/traps/pots	1	1	1	1
Monofilament	2.3	3	2	2
Fishing nets	2.7	2	3	3
Plastic bags	5.7	4	9	4
Plastic utensils	5.7	7	4	6
Balloons	6.7	8	5	7
Cigarette butts	7.3	5	12	5
Caps	7.7	9	6	8
Food packaging	8.7	10	7	9
Other EPS packaging	9.7	11	8	10
Hard plastic containers	11.3	6	13	15
Plastic food lids	11.3	13	10	11
Straws/Stirrers	12.3	14	11	12
Takeout containers	15.3	15	18	13
Cans	15.7	17	14	16
Beverage bottles	16	12	17	19
Unidentified plastic fragment	16.3	16	19	14
Cups & plates	16.7	18	15	17
Glass bottles	17.7	19	16	18
Paper bags	20	20	20	20

Plastics impacts: Macro-scale

Entanglement & ingestion

→ Entanglement: energetic costs, reduced feeding, impaired behavior, injury, death

→ Ingestion: energetic costs, digestive injury/blockage, nutritional costs, death

Transport of invasive species (biofilms, pathogens?)

Habitat damage, vessel damage/navigation hazards, tourism costs

Plastics impacts: Micro-scale

Ingestion

→ Energetic costs, digestive injury/blockage, nutritional costs, death

→ Exposure to chemicals in plastics (e.g. flame retardants [PBDEs, etc.]) and sorbed onto plastics (e.g. PCBs, DDTs, etc.)

Transport of invasive species

→ Biofilms, pathogens?

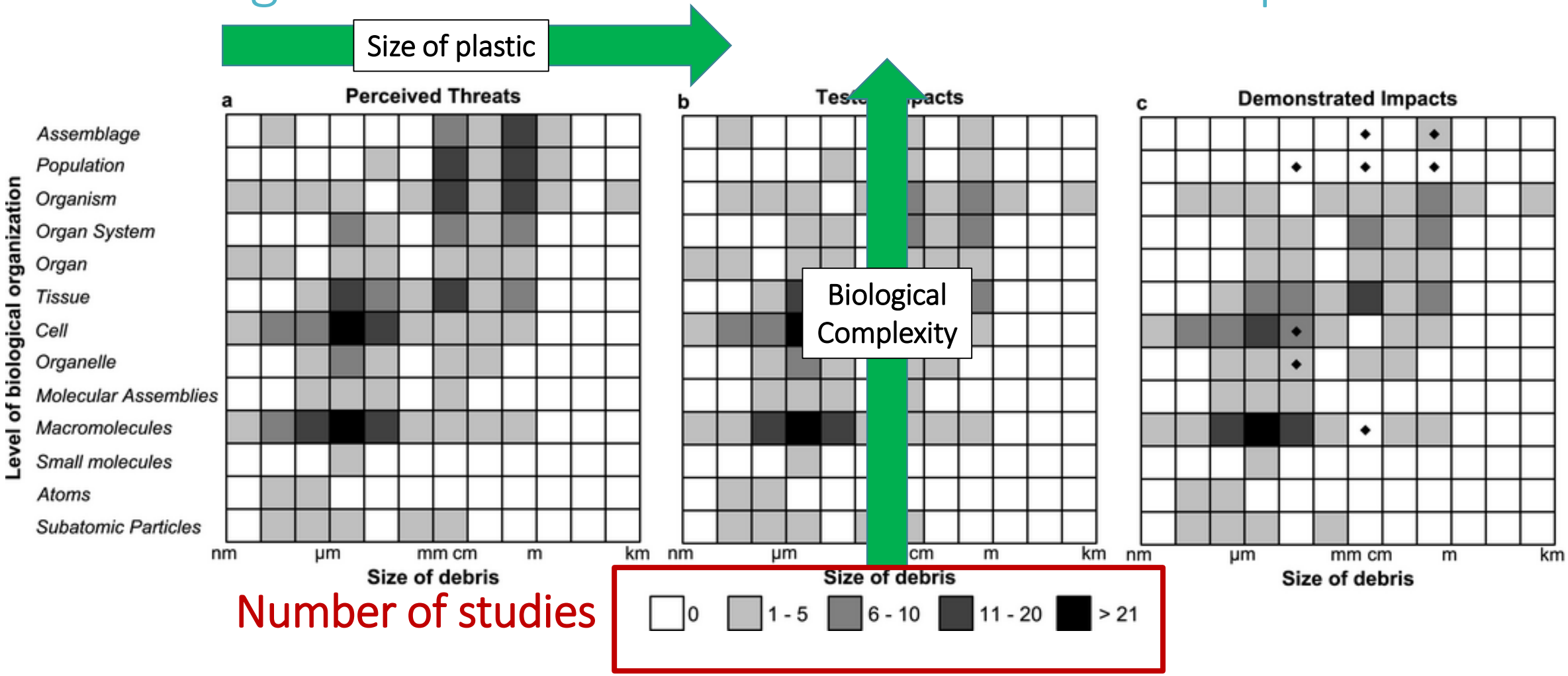
Microplastics effects studies: Overview

Microplastics have been studied in various species groups, with more studies being published every day

Focus on invertebrates and fishes

Birds and mammals are more studied for macroplastic impacts than microplastic impacts

Rochman et al. 2016: "The ecological impacts of marine debris: unravelling the demonstrated evidence from what is perceived"



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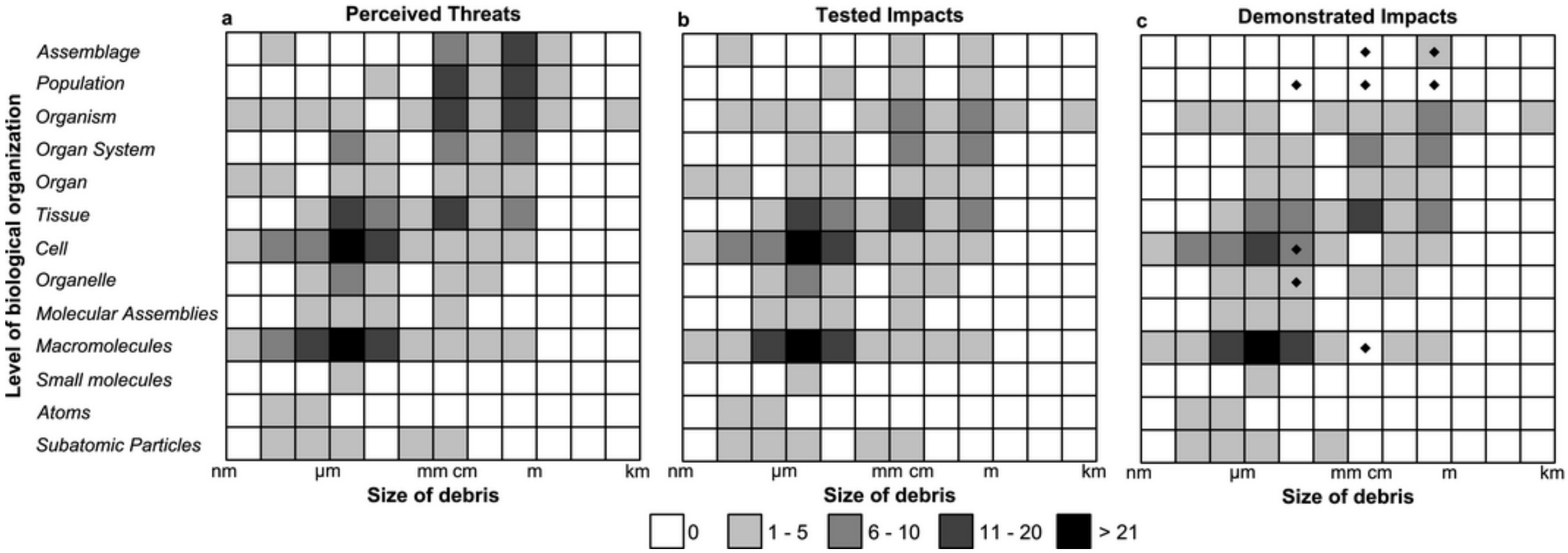


What are the uncertainties?

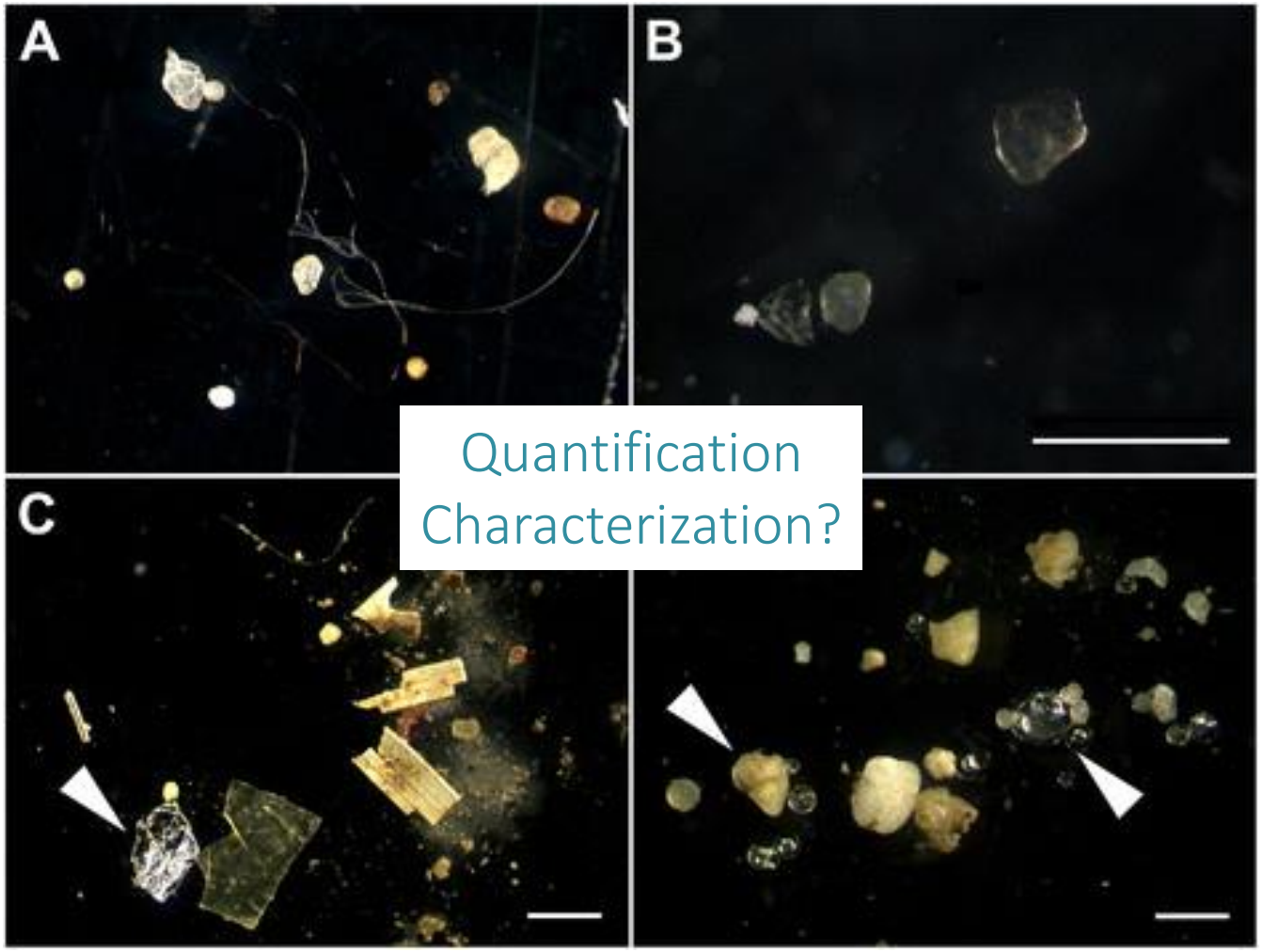
Methodology

No standardized sampling methods

No standardized methods for extraction, quantification and characterization of microplastics from any sample type

No standardized reporting methods

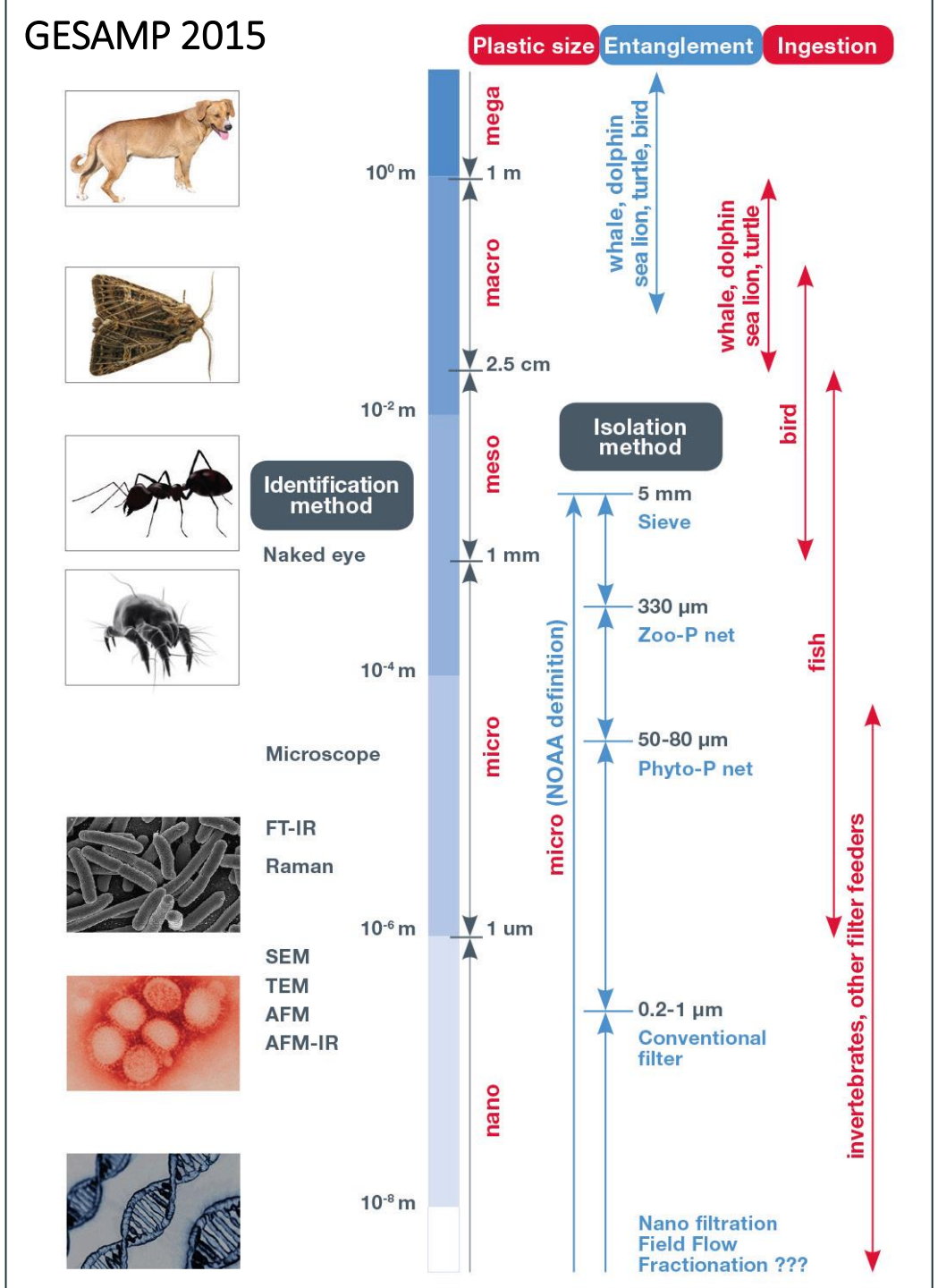
Wagner et al. 2014



Impacts across scales

Macroplastics, microplastics, nanoplastics…

Individuals, populations, species, communities, ecosystems



Human health impacts

Microplastics reported at low levels in seafood (especially shellfish), sea salt

Chemical exposure?

Impacts on human health are not known

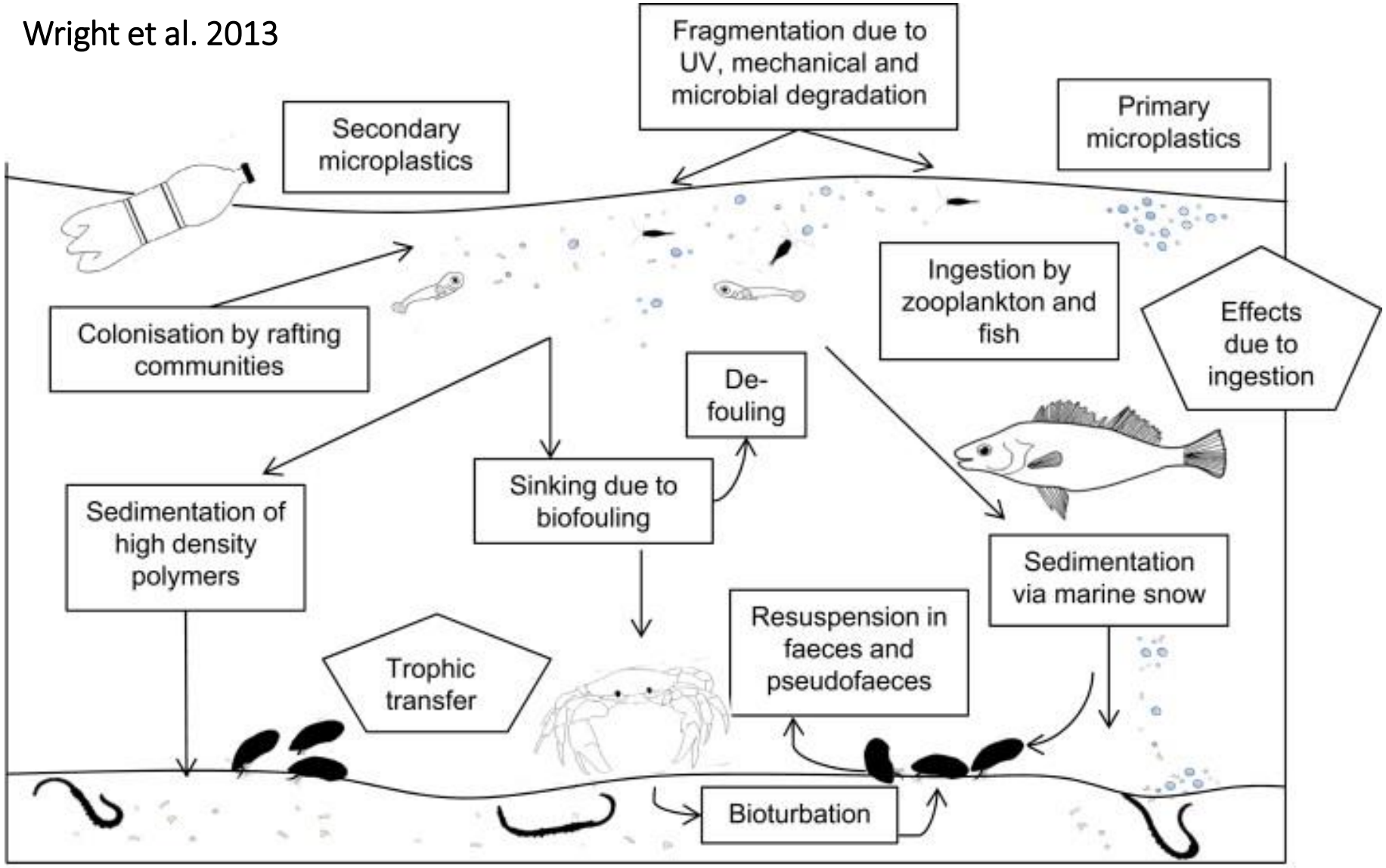
Impacts on subsistence communities in the US and globally?

Mosquito-borne diseases

What do we need to know?

1. Establish metrics and processes for data collection and analysis for microplastics
2. Understand the sources, frequency, fate and transport of plastics
3. Assess potential human health risks from microplastics
4. Evaluate ecosystem impacts of plastics at individual and population levels

Wright et al. 2013



Thank you!

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