Marine Microplastics in an International Context

With a focus on occurrence and implications for aquatic organisms and food safety

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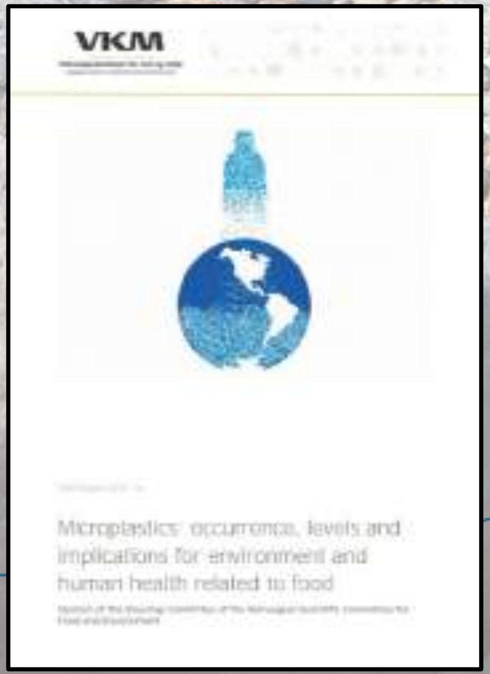
  - **- plus > 20 international experts**

- **GESAMP WG 40**

- **Norwegian Scientific Committee for Food and Environment (VKM)**











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1890s:

Bakelite

1909:

Synthetic plastics

1946:

Tupperware

1962:

Plastic bags

1976:

Plastic is world's most used material

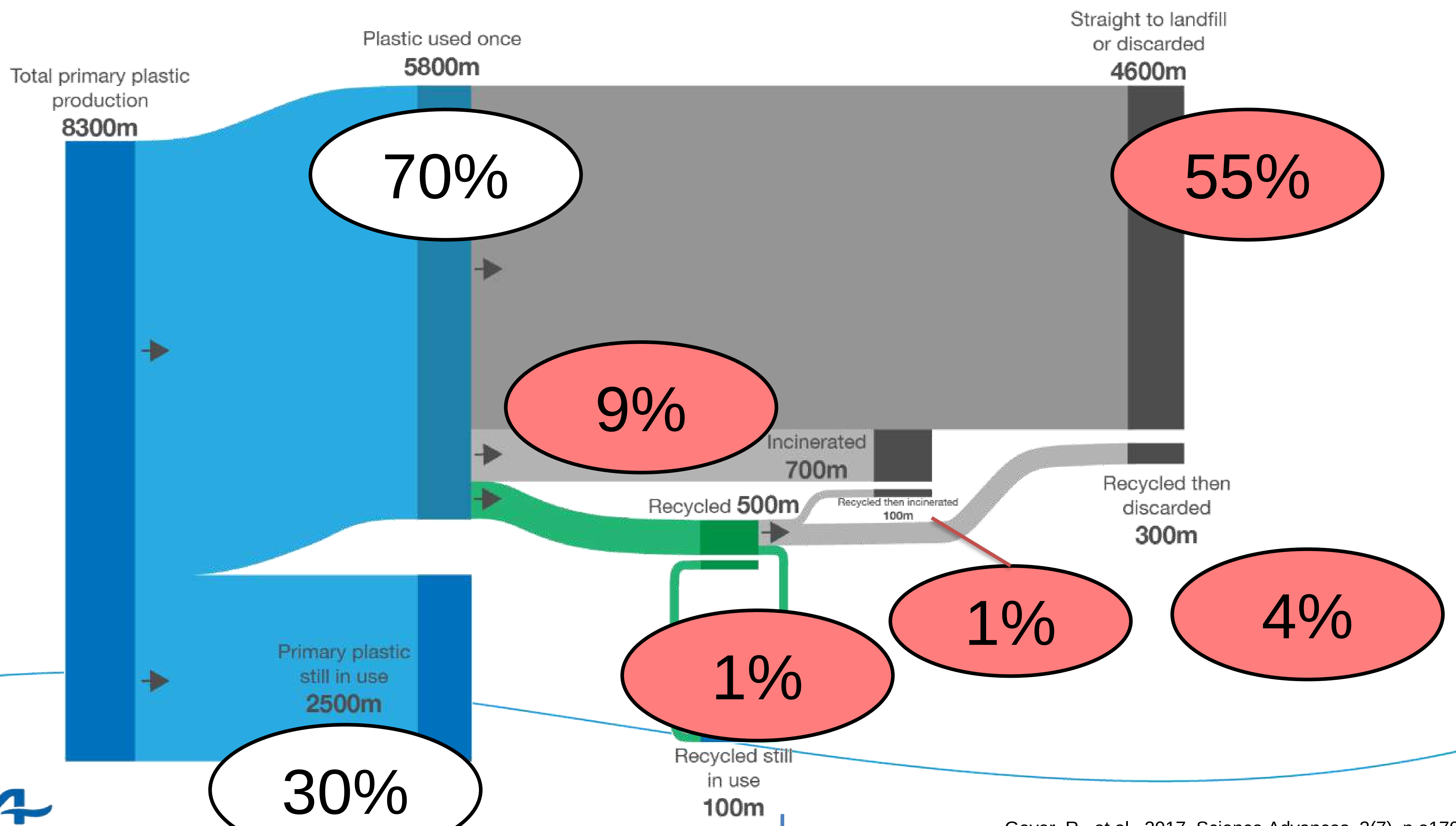
Global production:

2018: 359 mn tonnes

2050: 1 800 mn tonnes

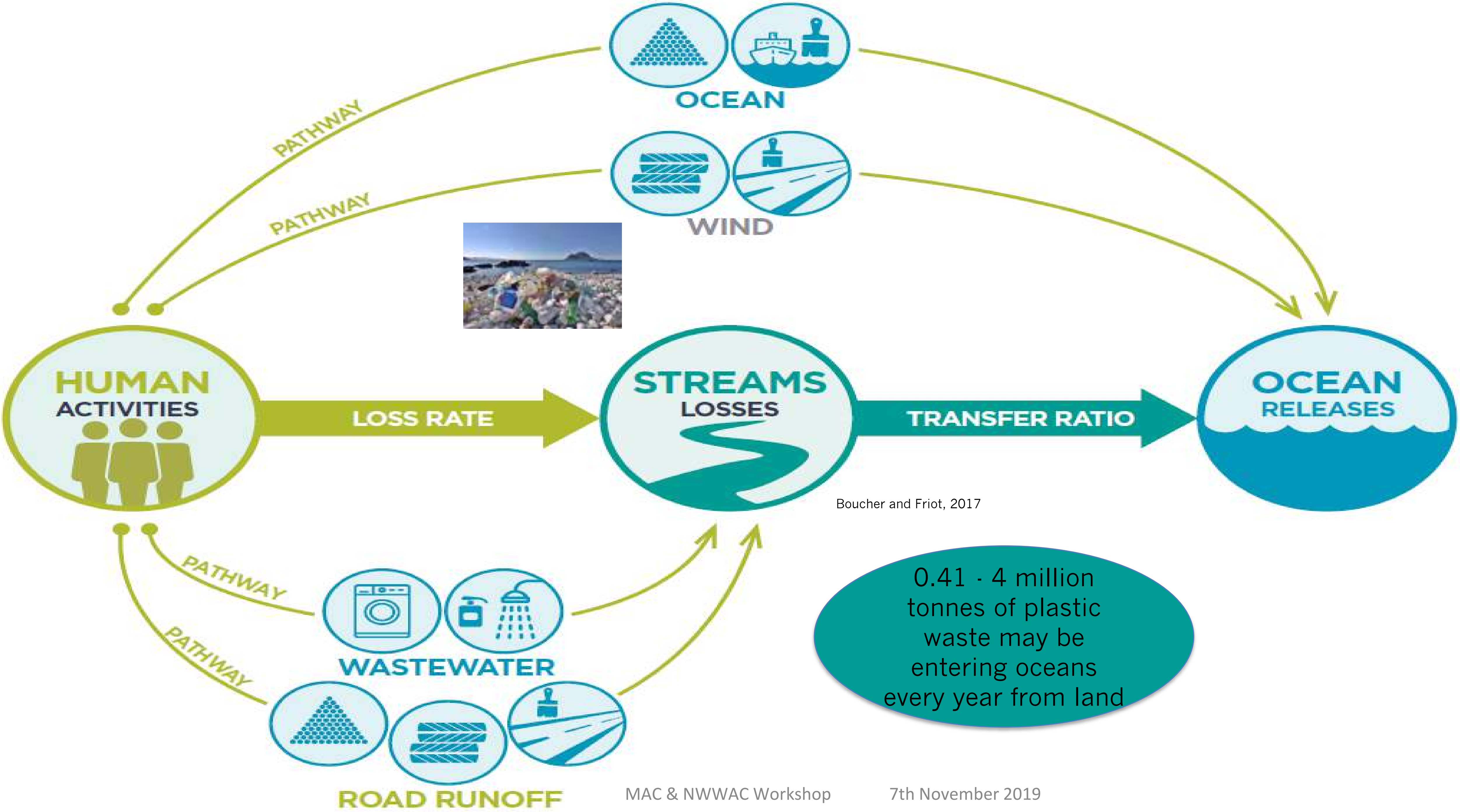
Balance of plastic production and fate (m = million tonnes)

8300m produced → 4900m discarded + 800m incinerated + 2600m still in use (100m of recycled plastic)



Geyer, R., et al., 2017. Science Advances, 3(7), p.e170078


Globally, recovery rates of plastics are about 6% of what is produced.
Brian Cliff Olguin for The New York Times



Boucher and Friot, 2017

0.41 - 4 million tonnes of plastic waste may be entering oceans every year from land

Fisheries and Aquaculture: Plastics are everywhere

- Plastic materials have widespread use across both sectors
- Fisheries use nets and lines with buoys, pots and traps
- Packaging in plastic crates and boxes (often EPS)
- Mariculture structures are kept afloat by buoys and held in place with lines and ropes
- Infrastructures including hatcheries, feeding systems all have substantial plastic components
- Plastic components in paints

Salmon farming cages in Torskefjorden, Torsken, Senja, Troms, Norway in 2014 August. © WikiCommons

Crab pots, Inis Meáin, Ireland © A. Lusher

Fishing in North Atlantic, RV Celtic explorer © H. Keogh

Fisheries survey, Ireland, © A. Lusher

www.newfoodmagazine.com

Fisheries and Aquaculture: Plastics are everywhere

- Abandoned, lost or otherwise discarded fishing gears (ALDFG) are another source of marine debris
- These can be unintentionally lost, but also deliberately discarded
- Spatial variability in abundance:
    - Beaches
    - Floating in the ocean
    - On the seabed
- Plastics can travel far from sources of input:
    - Coastal - may be able to identify local sources
    - Offshore fishing grounds - harder to interpret sources

Fishing For Litter

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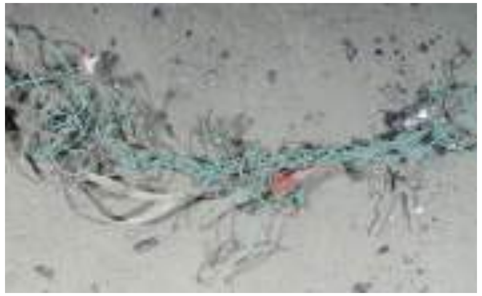
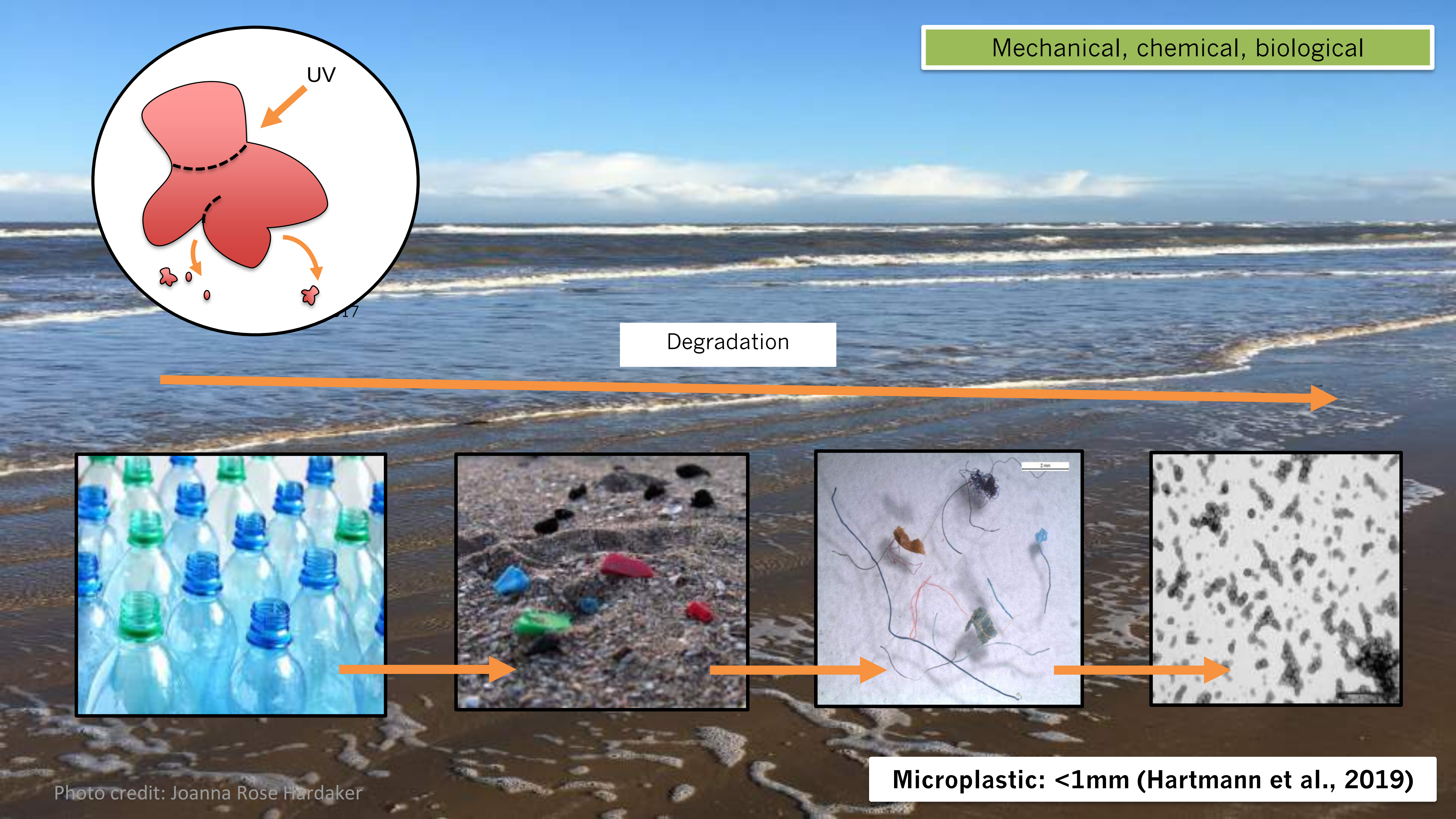
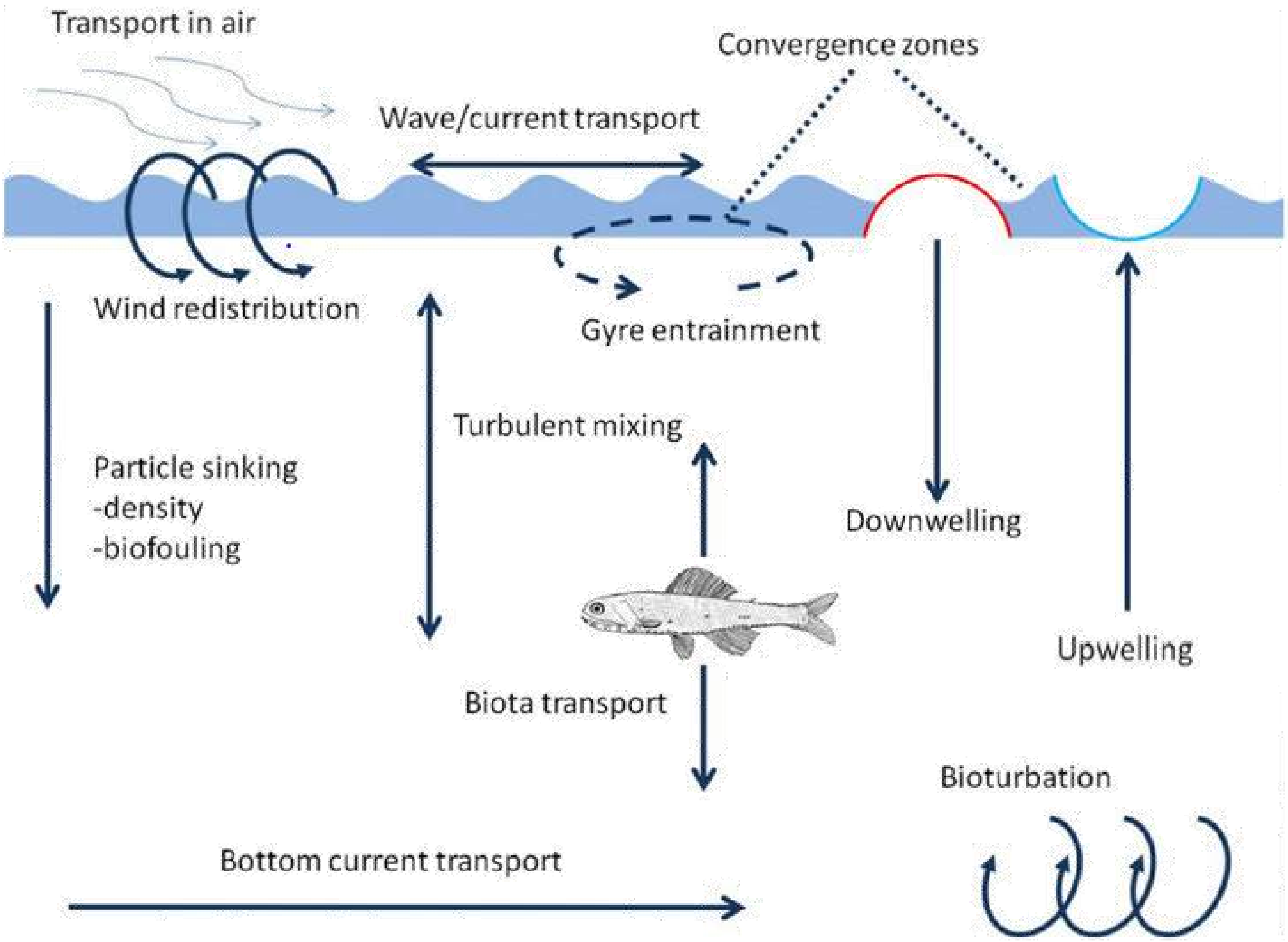


Fishing gear and plastic strips on Arctic seafloor. © Alfred-Wegener-Institute/Melanie Bergmann/OFOS


Mechanical, chemical, biological
UV
Degradation
Microplastic: <1mm (Hartmann et al., 2019)
Photo credit: Joanna Rose Hardaker

SOCIETY OF ENVIRONMENTAL TOXICOLOGY AND CHEMISTRY

Welden, N.C & Lusher, A.L. (2017). Impacts of changing ocean circulation on the distribution of marine microplastic litter. Invited Commentary



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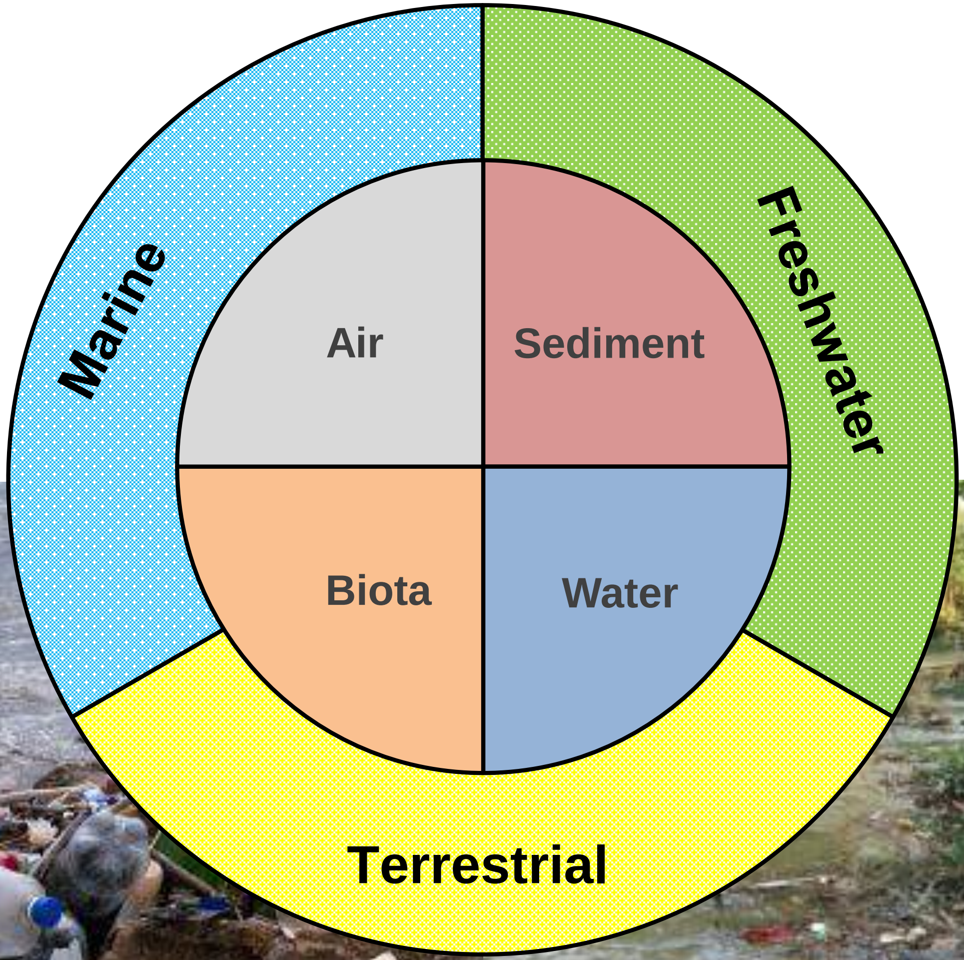
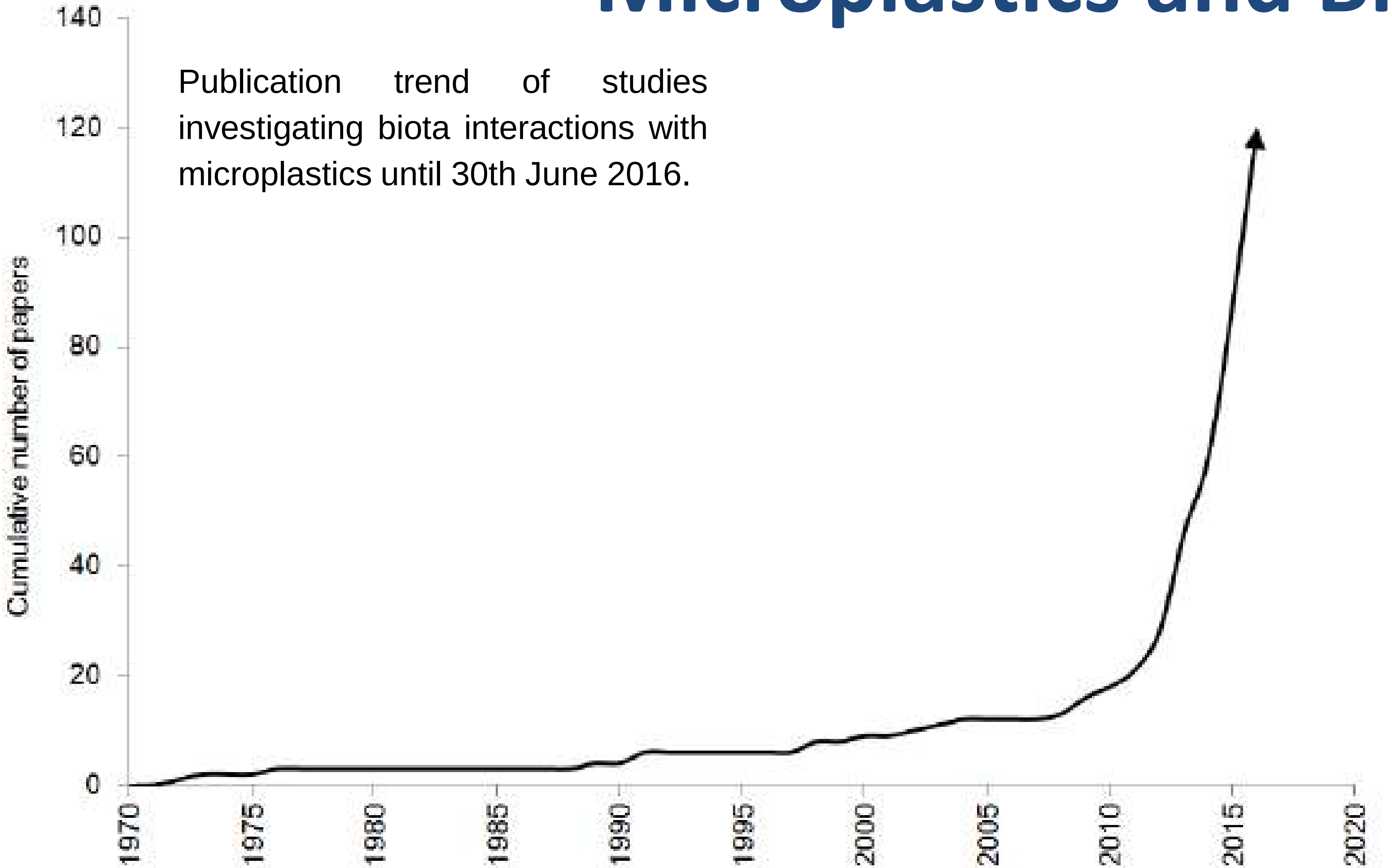
Scientists have found microplastics everywhere



Microplastics and Biota



Publication trend of studies investigating biota interactions with microplastics until 30th June 2016.

Mechanisms of interaction:

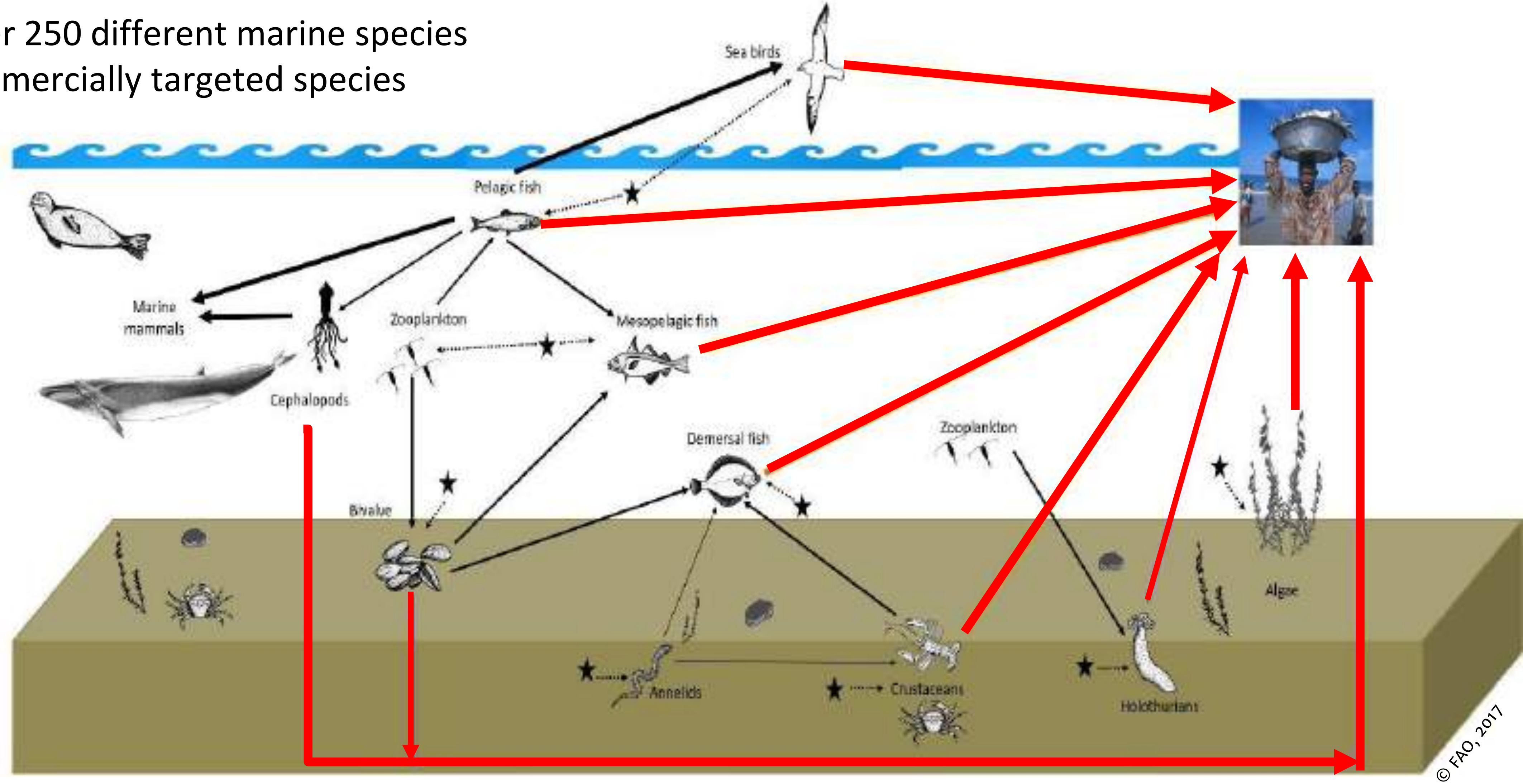
- Up/intake
- Ingestion
- Adhesion
- Egestion
- Trophic transfer

Lusher, A.L., Welden, N.A., Sobral, P. and Cole, M., 2017. Sampling, isolating and identifying microplastics ingested by fish and invertebrates..

Microplastics: Interacting with biota on a global scale

Ingestion by over 250 different marine species

- 58% commercially targeted species



Current state of knowledge: Fish

- 2013: First study of MPs in fish from the English Channel
- 2016: Made the headlines in UK
    - 10 species of fish (504 individuals)
    - 36.5% ingestion
    - Polyamide (35.6%), semi-synthetic, rayon (57.8%)
    - No significant difference between pelagic and demersal fish
    - Ingestion appears to be common, in relatively small quantities irrespective of feeding habitat
- Further work needed to establish the potential consequences.

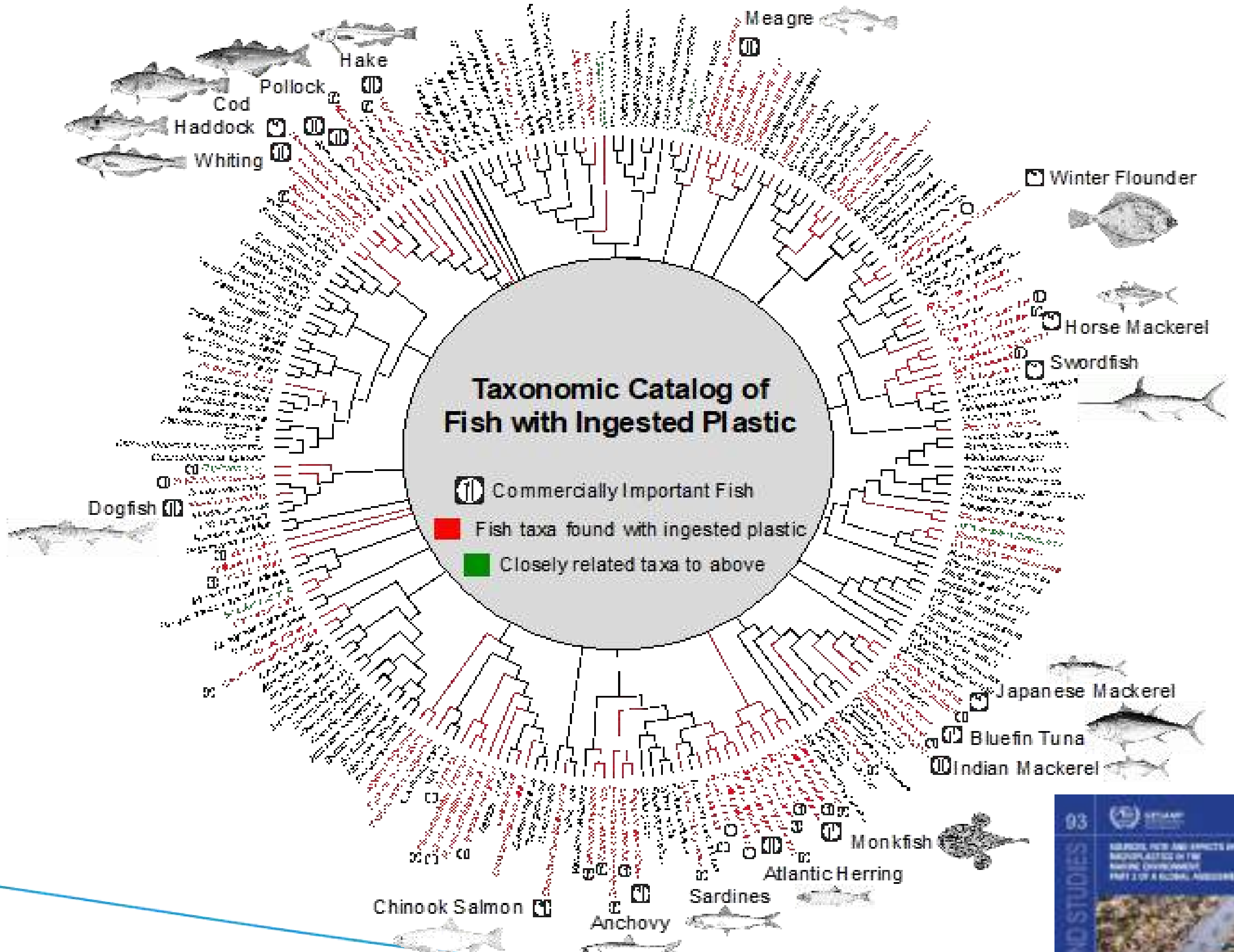
Lusher, A. L., Mchugh, M., & Thompson, R. C. (2013). Occurrence of microplastics in the gastrointestinal tract of pelagic and demersal fish from the English Channel.

Current state of knowledge: Fish

- Since 2013, many more studies on MP in fish published
- Primarily focused on plastic ingestion
- Samples obtain by two primary methods:

    1) wild caught for scientific purposes

    2) purchased from commercial outlets otherwise destined for human consumption



Current state of knowledge: Fish

- Fewer studies have explored the consequences of interactions between microplastics and fish
- Even less have considered trophic transfer and bioaccumulation
- Currently limited field evidence. This does not mean that transfer does not occur
  - Welden et al., 2018**,** field observations – fish to fish
  - Nelms et al., 2018, in captivity – fish to seals

- *Methods often not comparable between studies*
- *Quality of studies has been questioned (VKM, 2019; Hermsen et al., 2018).*

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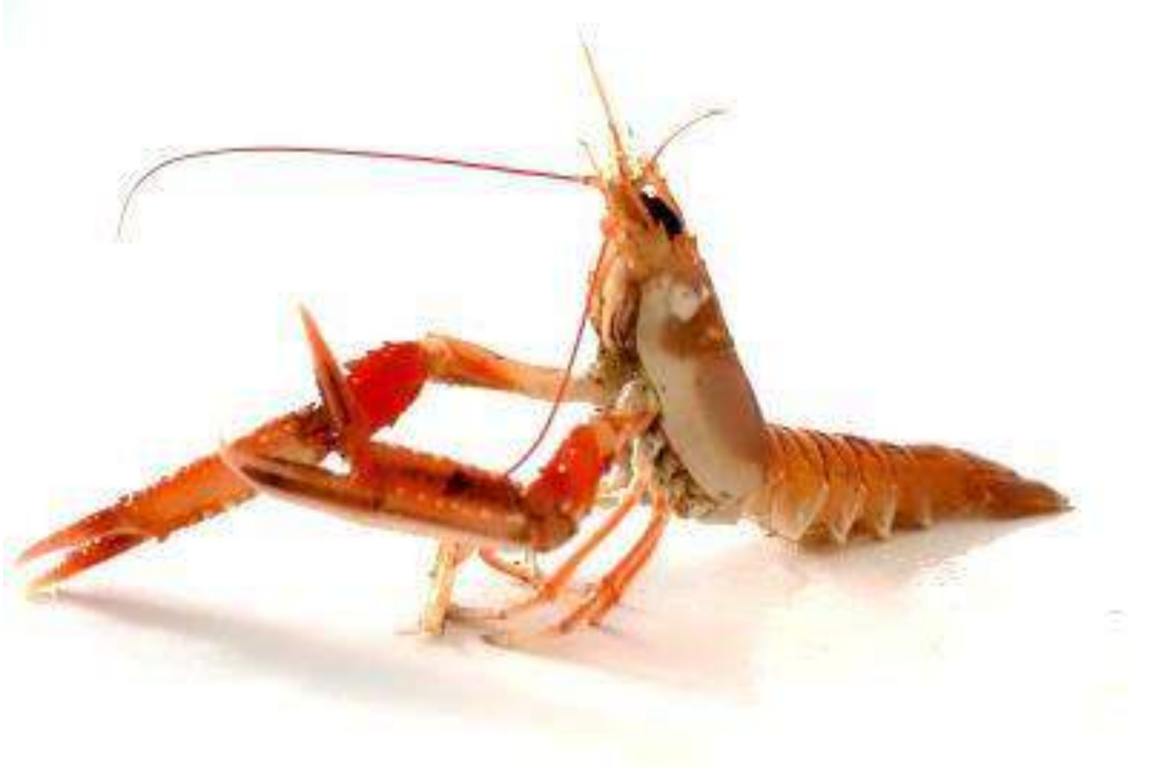
Current state of knowledge: Shellfish

- Uptake has been observed in lab exposed individuals, those wild caught for scientific purposes, purchased from commercial outlets otherwise destined for human consumption
- In laboratory trials microplastic concentrations and mass routinely exceed values observed in field
  - Acute exposure with high conc. over short time frame
  - sample size small, limited to one life history stage/size class
  - limited plastic types (shapes, size, polymer)
  - cannot be reliably compared to wild populations



© Natalie Welden

Current state of knowledge: Shellfish

Microplastic ingestion has been seen to result in:

- retention of particles in the digestive tract
- transfer to hemolymph and lysosomal system
- inflammatory response

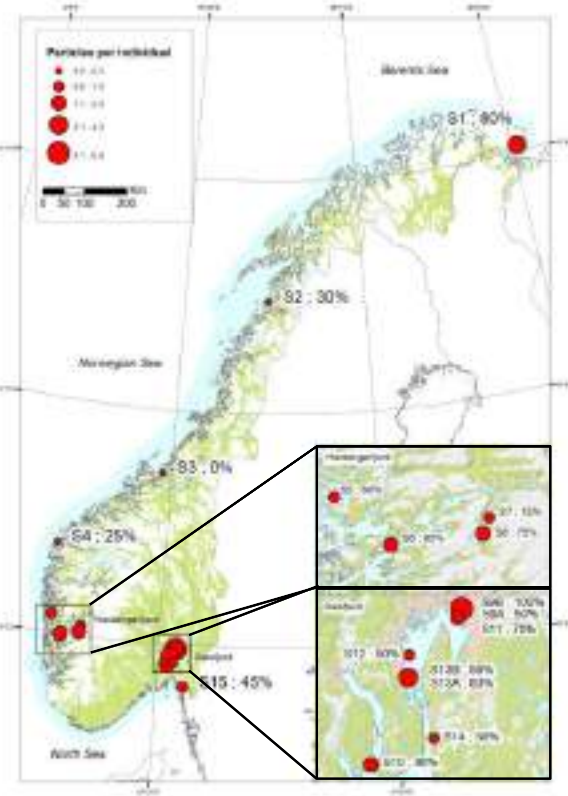
Additional cellular effects include:

- immunological responses
- neuro-toxic effects
- genotoxicity

Intergenerational effects include reduced reproductive capacity and larval development

"The toxicokinetics of nano- and microplastics remain ***largely unknown****"* (VKM 2019)

Shellfish for biomonitoring?



Biomonitoring can be used to investigate biotic impacts of MPs

Suitable bioindicators:

- Global and broad distribution
- vital ecological niches
- susceptibility to microplastic uptake
- close connection with marine predators and human health.

"Consequently, we propose the use of mussels as target species to monitor microplastics and call for a uniform, efficient and economical approach that is suitable for a future large-scale monitoring program".

Li, J., Lusher, A.L., et al.,(2019).
Using mussel as a global bioindicator of coastal microplastic pollution

Bråte, I.L.N., et al., and Lusher, A., 2018.
Mytilus spp. as sentinels for monitoring microplastic pollution in Norwegian coastal waters

Seafood quality vs. contamination

- Health benefits and nutritional composition
- Significant levels of contaminants from the environment
  - some fish products may be potentially harmful depending on the amount consumed.

17% of animal protein intake by world population

*"**The ubiquitous presence of microplastics raises concerns regarding interaction with biota and potential contamination of the human food supply.** This concern has led to a number of exposure and toxicological studies under laboratory conditions." (FAO, 2017)*

*"VKM concludes that **available information does not provide sufficient basis to perform a high quality characterisation of risk** to the environment by nano- and microplastics." (VKM 2019)*

Consequences for humans?

Exposure to MPs in seafood is reduced by:

- Depuration of bivalves
- Removal of digestive tracts in fish

Probably not a big source of contamination to humans

Assuming max 30 particles per mussel

Intake
225g portion of mussels

↓

Assuming average size 25 µm, 0.92 g/cm3

900 microplastic particles

↓

7 µg of plastics
(0.1 µg/kg b.w., 70kg human)

↓

< 0.1% of the total dietary exposure of chemical compounds

MPs contribute very small fraction of total dietary intake of contaminants

Summary:

Microplastics have many sources and can be found everywhere

- limited evidence that microplastics ingestion has negative impacts

Seafood safety will need to look more towards nano-toxicity over physical effects

- Consider applying environmental risk assessment approaches
- Recognize potential impacts but also lack of data
- Cost-effective and targeted monitoring
- Communicate hazards and risk management

Importance of accurate methodological approaches, data generation and results dissemination

Thank you

Norsk institutt for vannforskning

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Vitenskapskomiteen for mat og miljø
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