Marine Microplastics in an International Context

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

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Norwegian Institute for Water Research

Acknowledgments

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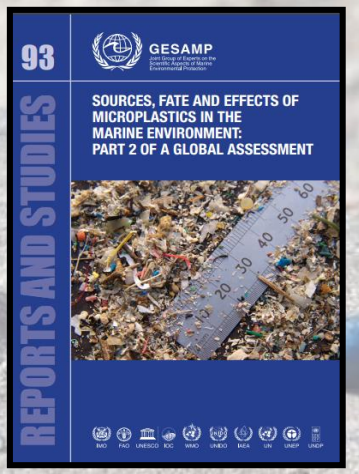
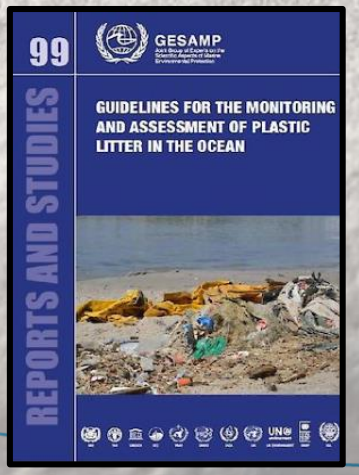
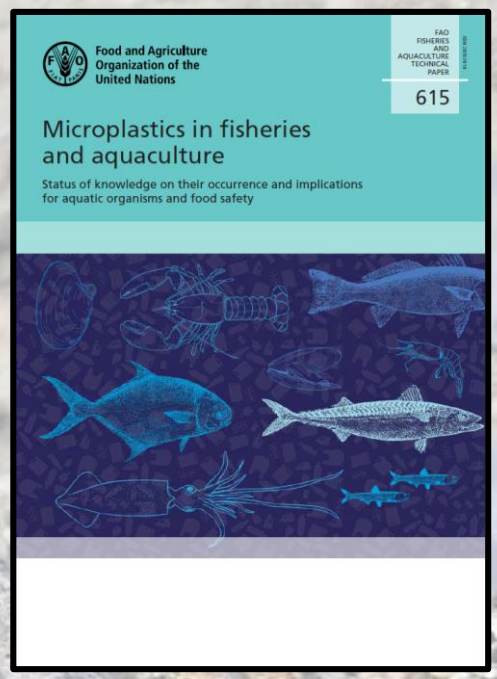
  - **Peter Hollman, Jeremy Mendoza-Hill**
  - **plus > 20 international experts**

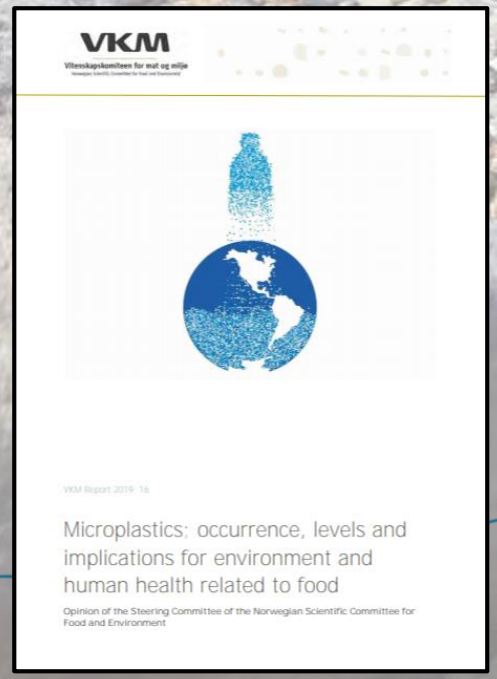
- **GESAMP WG 40**

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

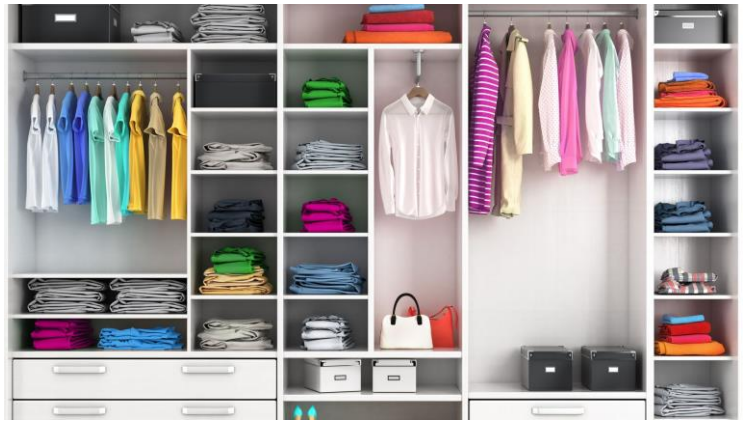
















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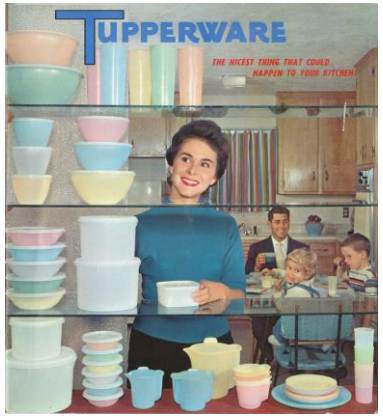
1890s:

Bakelite

1909:

Synthetic plastics



1946:

Tupperware

1962:

Plastic bags

1976:

Plastic is world's most used material

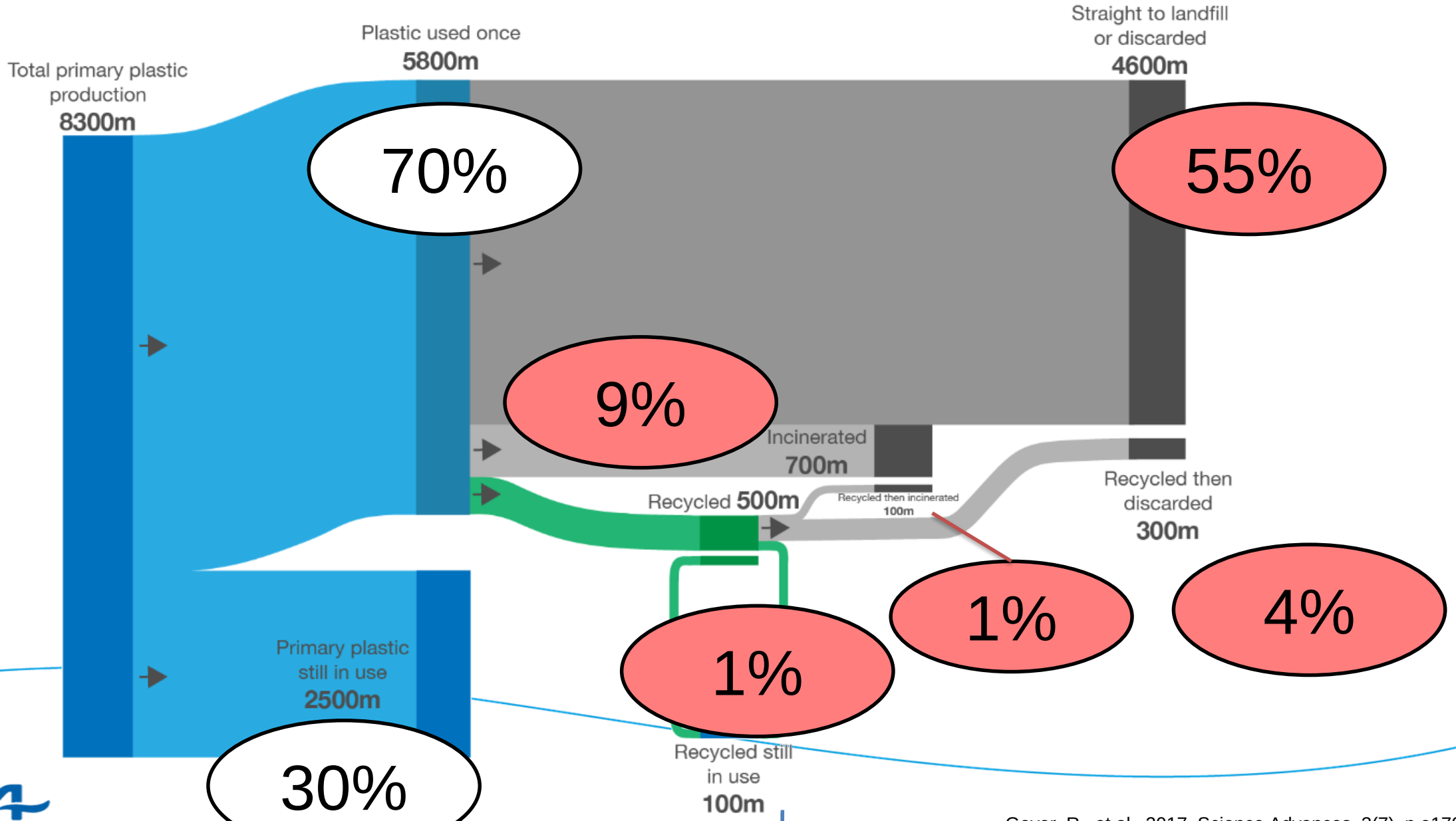
Global production:

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

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

Crab pots, Inis Meáin, Ireland
© A. Lusher

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

Fisheries survey, Ireland,
© A. Lusher

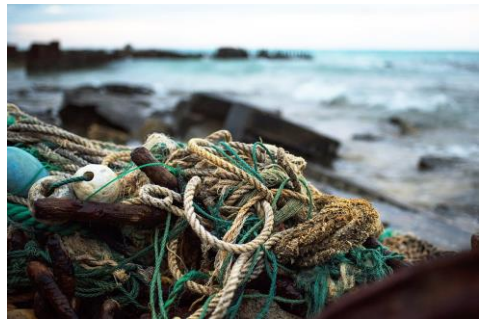
Fishing in North Atlantic, RV Celtic explorer © H. Keogh

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



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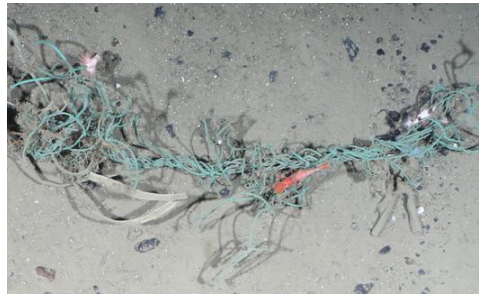
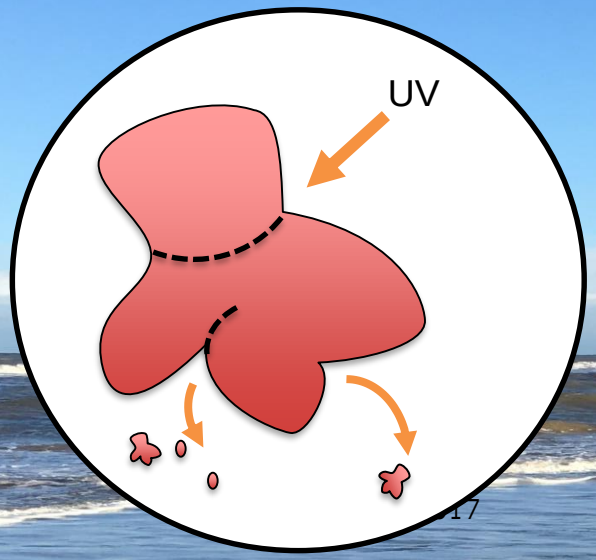
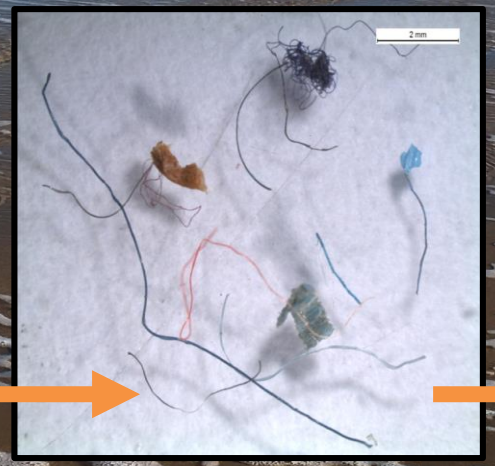


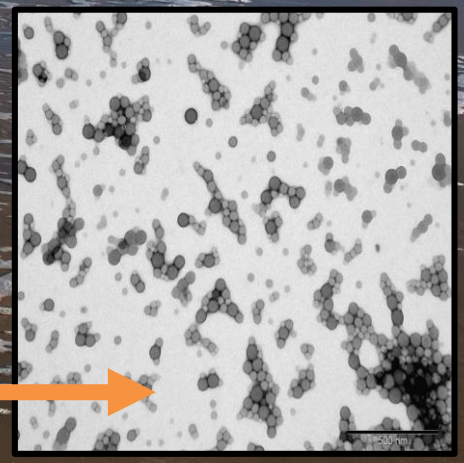
Fishing gear and plastic strips on Arctic seafloor. © Alfred-Wegener-Institute/Melanie Bergmann/OFOS



Mechanical, chemical, biological

Degradation



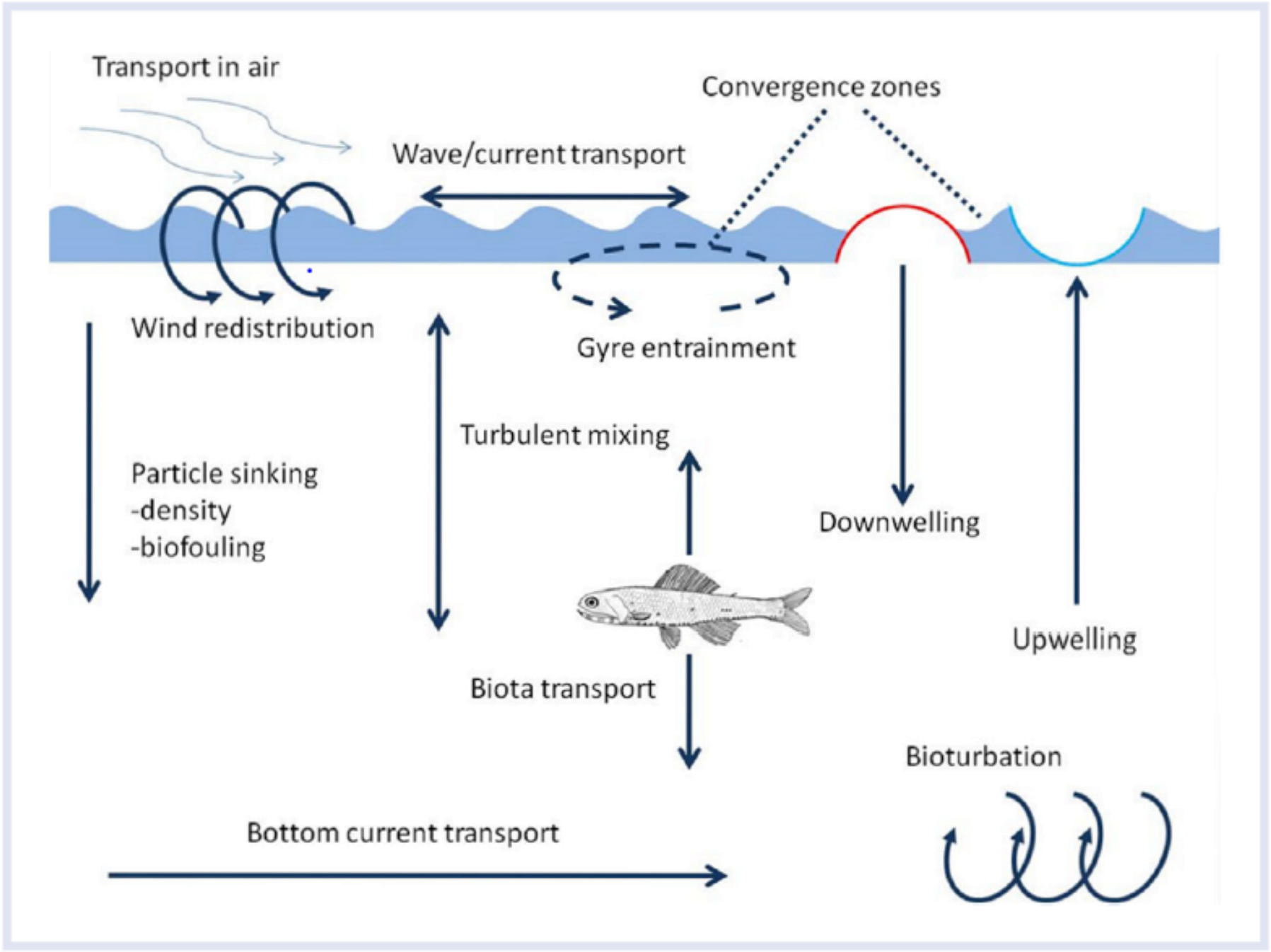


Microplastic: <1mm (Hartmann et al., 2019)

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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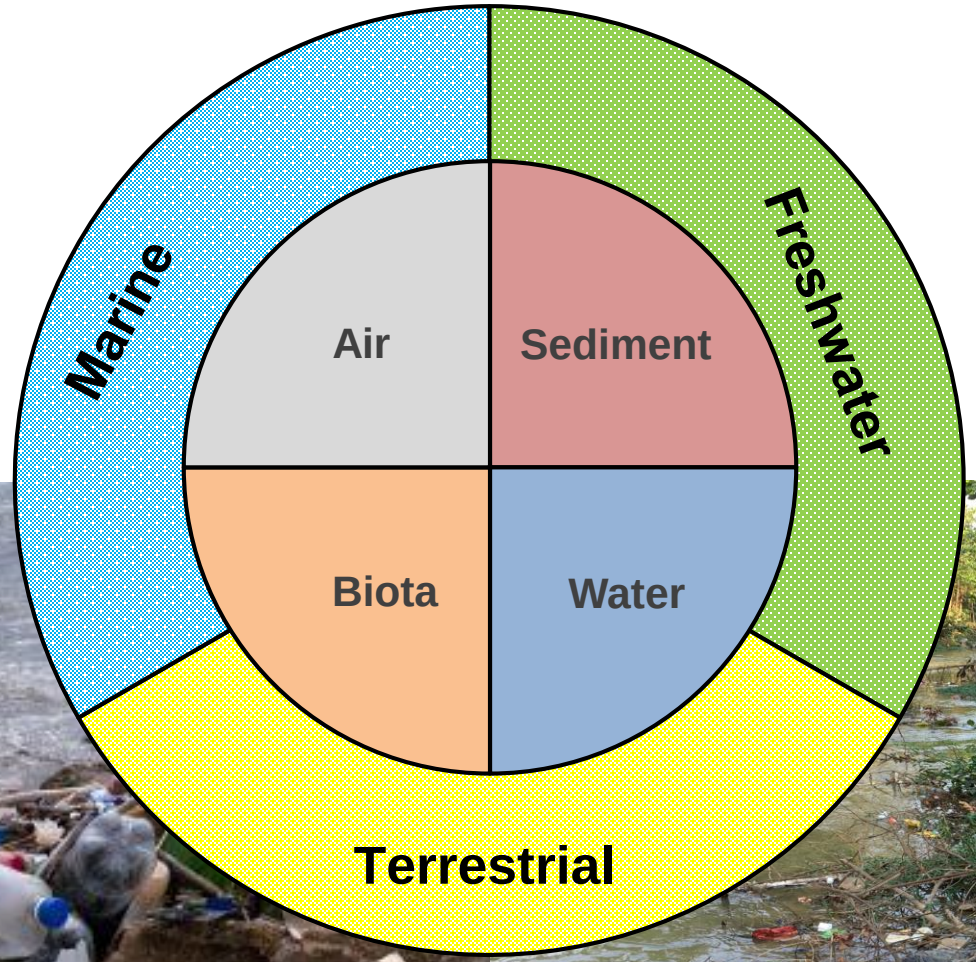
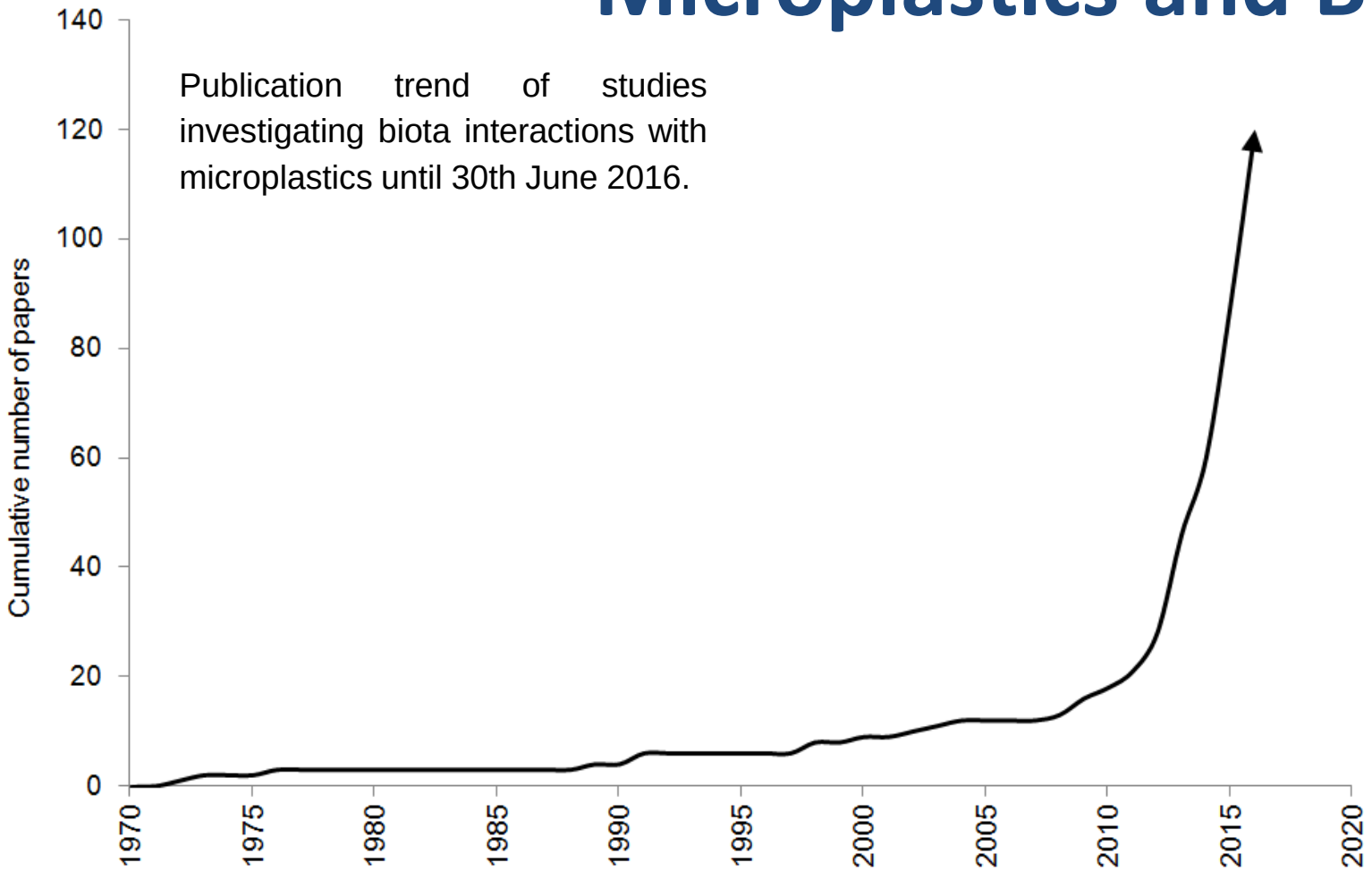
Scientists have found microplastics everywhere



Microplastics and Biota

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



Mechanisms of interaction:

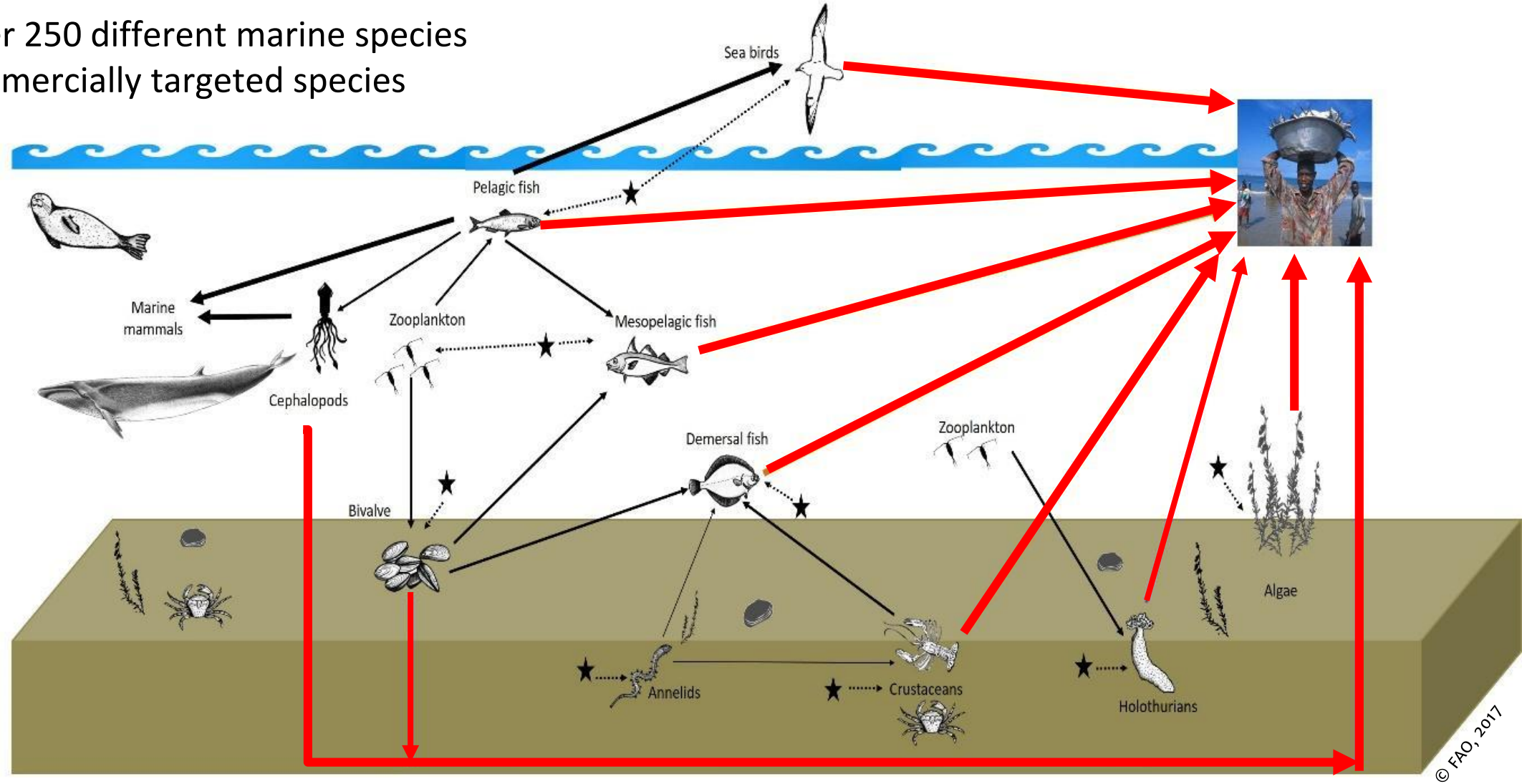
- Up/intake
- Ingestion
- Adhesion
- Egestion
- Trophic transfer

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.

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Revealed: Plastic is found in a THIRD of fish caught in Britain because of toxic microbeads used in shower gels, toothpastes and beauty products

- Major study found contamination of cod, haddock, mackerel and shellfish
- Plastic from microbeads used in gels, toothpastes and beauty products
- Plastic fragments or residues detected in 83 per cent of UK-caught scampi
- The Daily Mail launched campaign calling for action on use of the beads

By SEAN POULTER CONSUMER AFFAIRS EDITOR FOR THE DAILY MAIL and PHILIP HOARE FOR THE DAILY MAIL

PUBLISHED: 02:03, 26 August 2016 | **UPDATED:** 11:46, 2 September 2016

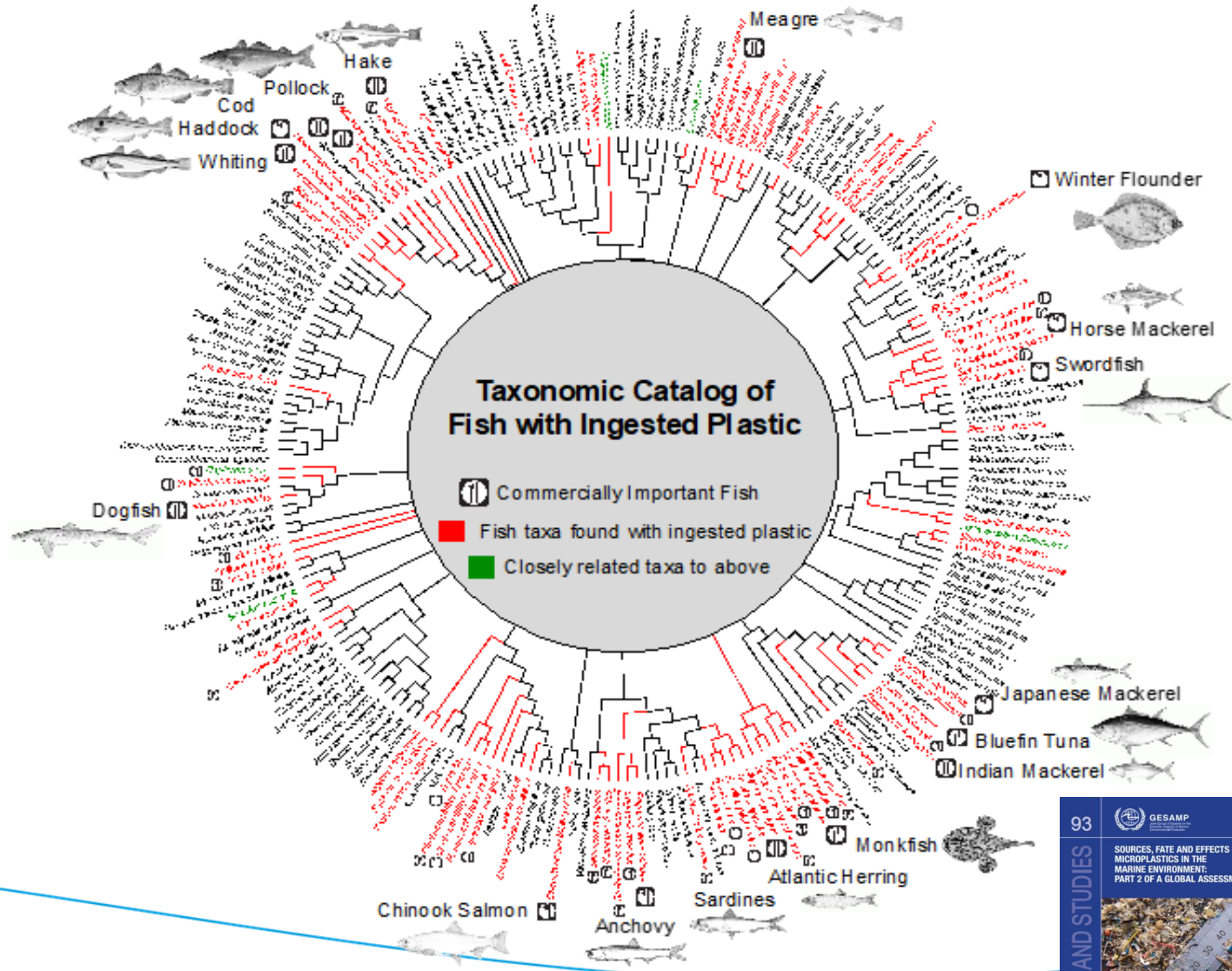
Lusher, A. L., Mchugh, M., & Thompson, R. C. (2013). Occurrence of microplastics in the gastrointestinal tract of pelagic and demersal fish from the English Channel.

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

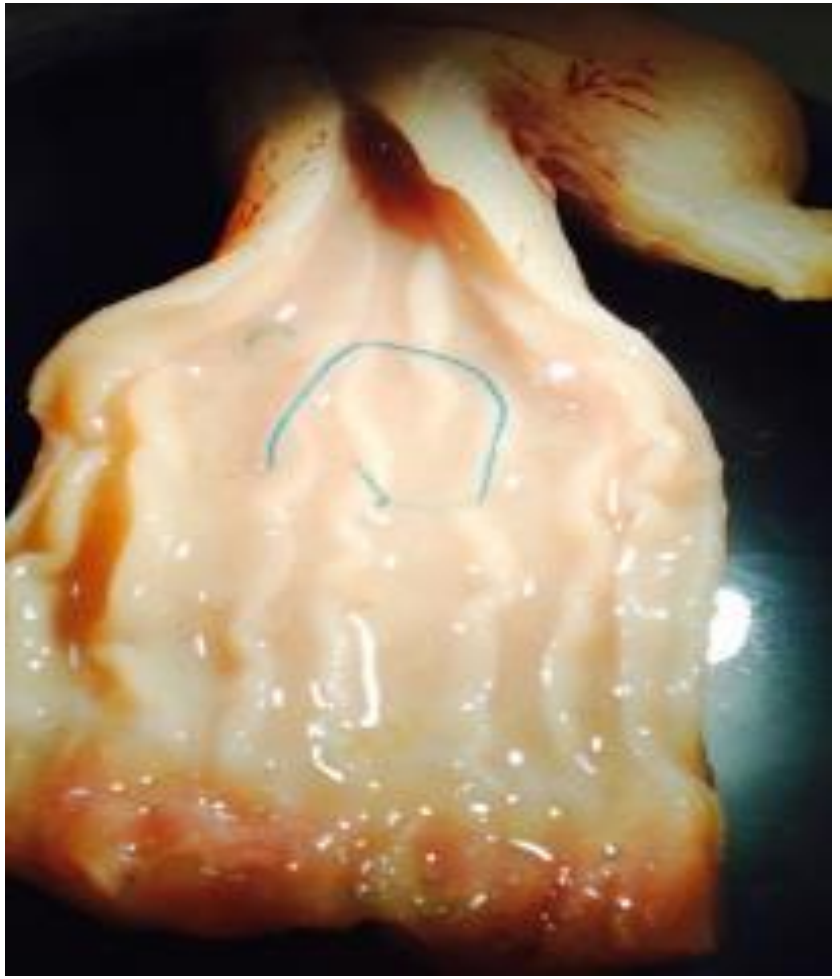
  2) purchased from commercial outlets otherwise destined for human consumption



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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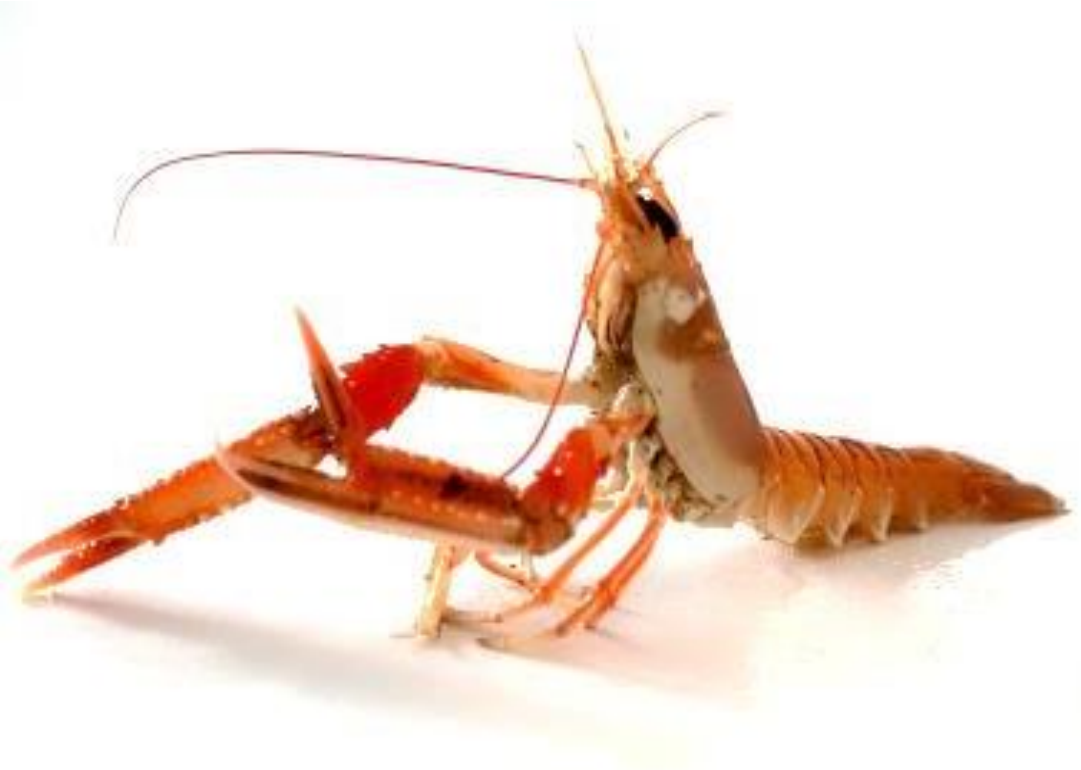
Current state of knowledge: Shellfish

- 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

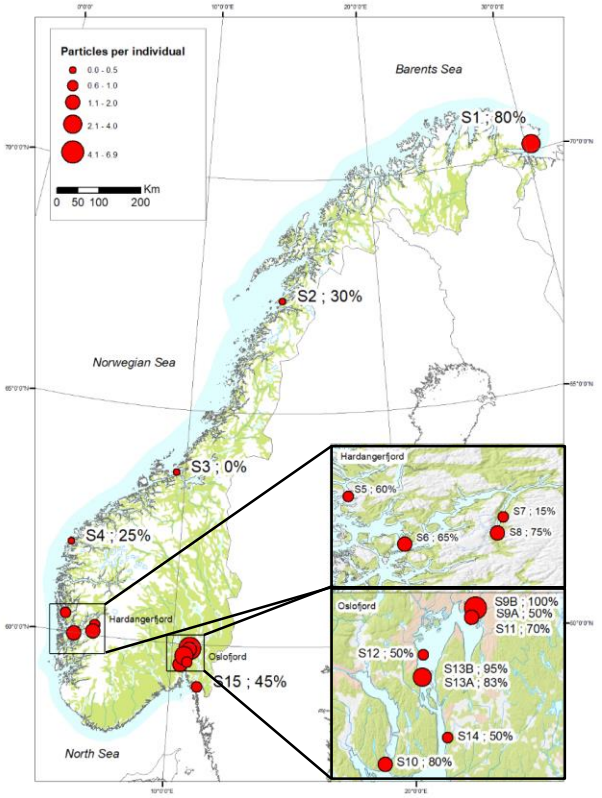
Additional cellular effects include:

- 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

Assuming average size 25 µm, 0.92 g/cm3

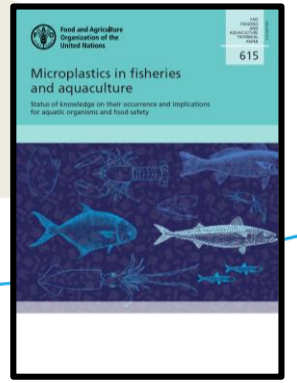
Intake
225g portion of mussels

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

Vitenskapskomiteen for mat og miljø
Norwegian Scientific Committee for Food and Environment

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