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Biota & microplastics interactions - A Humber case study

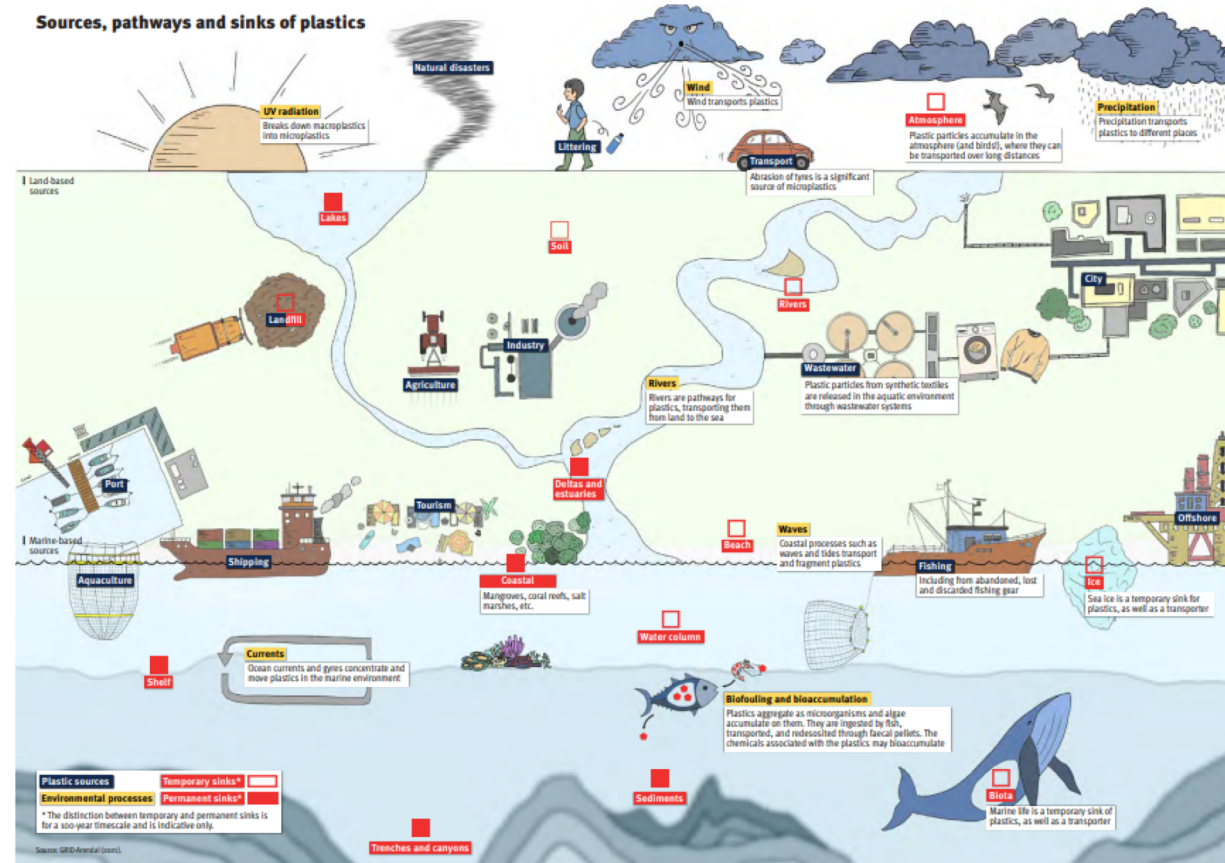
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The issue



- Plastics transported from land to sea
- Microplastics accumulating in estuaries
- Sediments a sink



Key questions?



1. How are plastics transported through the Humber estuary (How, What, When & Where)?
2. How do plastics interact with key sediment biota in the Humber?

By answering these questions, we believe we will be able to understand the potential to utilise Biota to capture isolate microplastics in targeted locations.



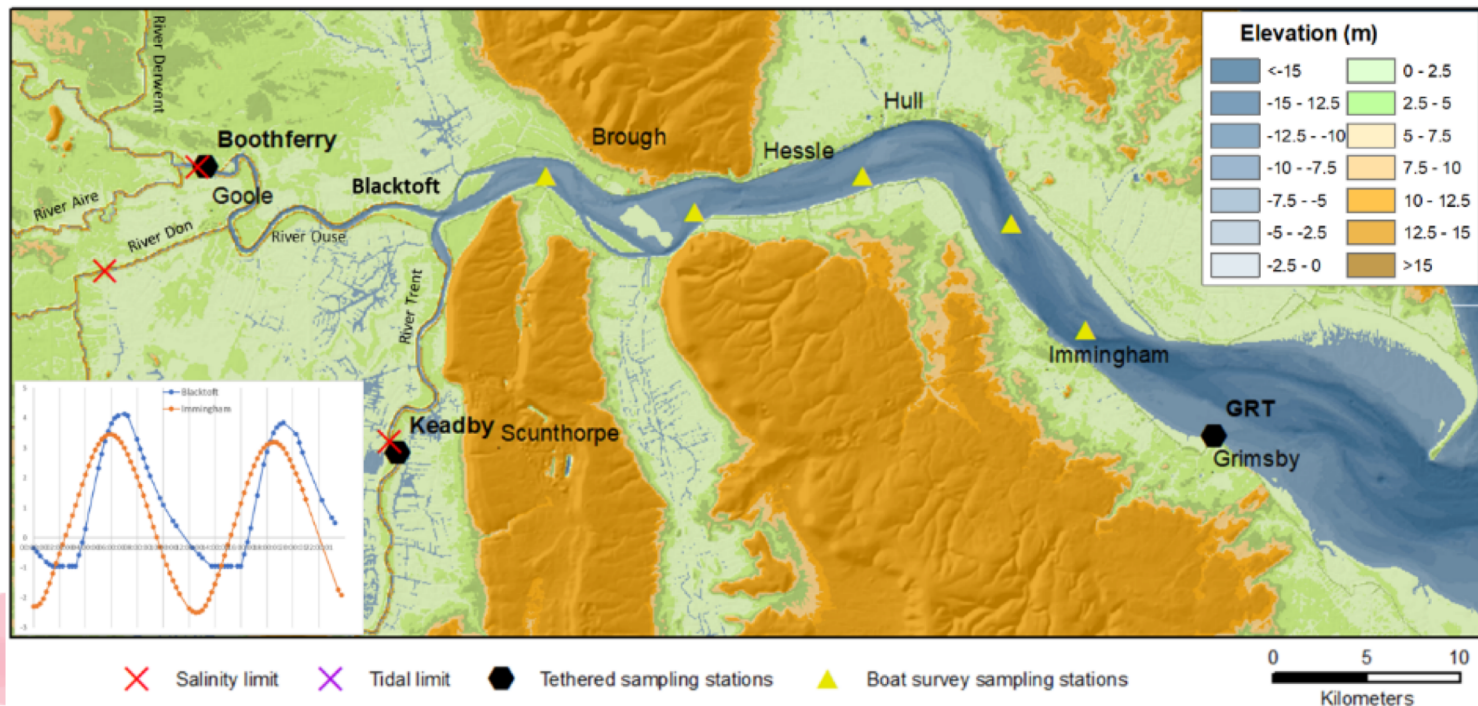
1. How are plastics transported through the Humber estuary (How, What, When & Where)?

Spatio-temporal trends of microplastics in the Humber



Samples have been collected to assess:

- spatio-temporal patterns of suspended sediment concentration
- light extinction depths
- **quantify MP concentrations and identify polymers**

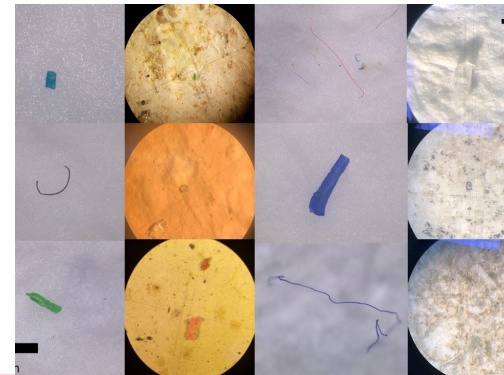


Isolation & analysis of microplastics (Humber samples)



Techniques have been developed to:

- Isolate MP from suspended sediment using filtration
- Characterise chemical composition, size and morphology of MP using IR microscopy



Isolation & analysis of microplastics (Humber samples)



Analysis will be performed to find relationships between the spatial & temporal distributions of MP and seasonal & tidal variations in the water column:

- Algae biomass (Chl a)
- Organic matter content
- Nutrients (NH_4^+ , NO_x , PO_4^{3-})
- Salinity
- Changes in rainfall
- Changes in discharge



J. Hope image



2. How do plastics interact with key sediment biota in the Humber?

Laboratory experiments to investigate the interaction between microplastics and :

- Benthic biofilms
- Benthic infauna (invertebrates).

What are benthic biofilms?

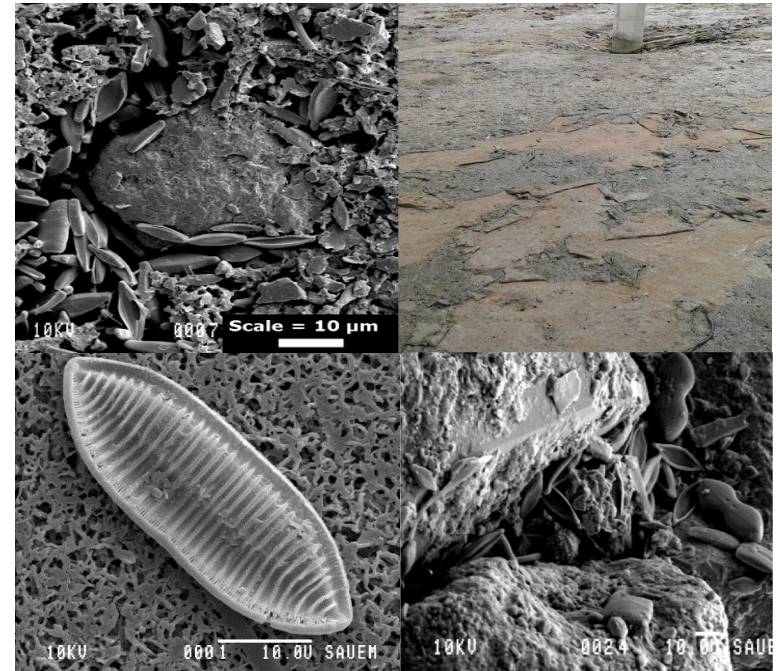


A matrix of:

- Microphytobenthos (MPB) or microalgae
- Carbon-rich Extracellular Polymeric Substances (EPS).

Biofilms play fundamental roles in estuary ecosystems, they:

- Protect underlying sediments from erosion
- **Can trap and bind fine particles & pollutants on the bed**
- **Provide a food source for benthic infauna.**



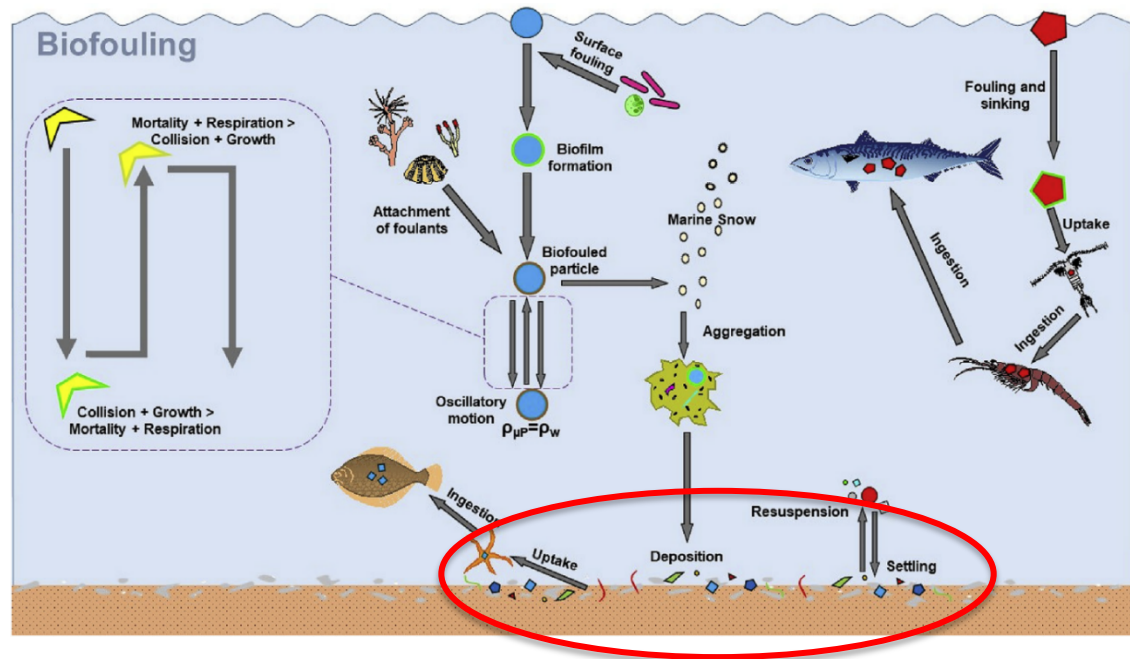
J. Hope images

Interactions of microplastics with benthic biofilms

Biofouling can impact
MPs settling to the bed

But...

Benthic biofilms may
influence when and
how MPs are
captured and re-
suspended from the
bed



Coyle et al., 2020.

Planned experiments (1)



1. Understand the role of biofilms in trapping microplastics and pollutants

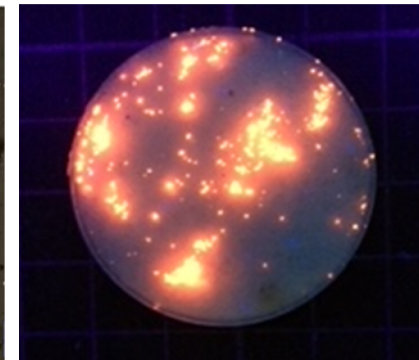
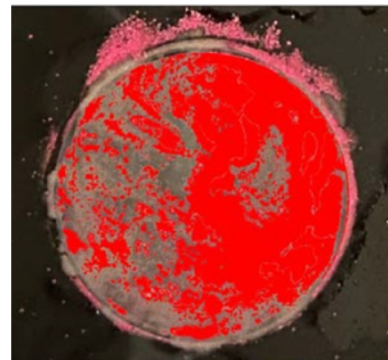
- Harvest sediment & remove animals
- Grow biofilms in the laboratory controlled conditions
- Introduce MP to biofilms lowered in/ out water to simulate tidal cycle



J. Rimmer images

2. Do biofilms trap plastics on sediment surfaces?

- Biofilms are cycled through water containing fluorescently stained MP
- Fluorescent imaging used to track captures MP



M. Chockolek images

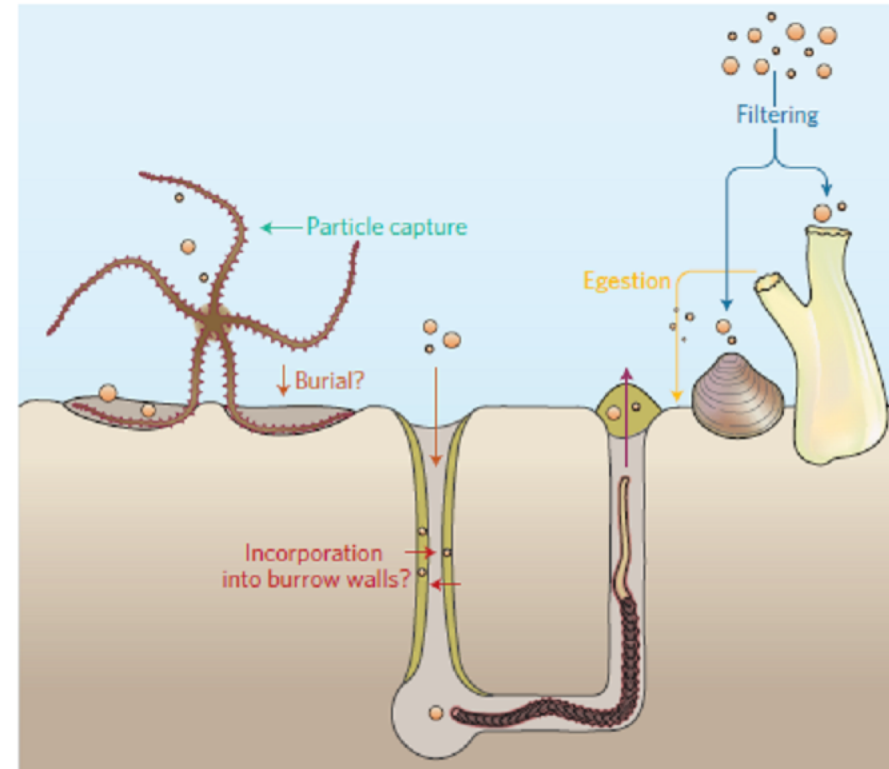
3. Do biofilms influence microplastic resuspension?

- Will perform further tests to understand the potential for MP to re-suspend into the water column after incorporation into the biofilm (erosion potential).

Interactions of microplastics with infauna

- Filter feeders draw MPs out of the water column transfer to the bed
- Deposit feeders may feed on deposited MPs and MP-rich pseudofaeces
- Infauna have been shown to ingest MPs but what affect does this have on particle fate?

Galloway et al., 2017



Will ingested MPs **become buried in the estuary bed, remain in the organism or be released into the water column?**

Potential species (all abundant locally in the Humber estuary)

Species	Habitat	Feeding type
European oysters <i>Ostrea edulis</i>	Water column, hard substrate	Filter feeder, from water column
Peppery furrow shell <i>Scrobicularia sp.</i>	In sediment	Deposit feeder, from sediment surface
Cockles <i>Cerastoderma sp.</i>	In sediment	Filter feeder, from water
Ragworm <i>Nereis sp.</i>	In sediment	Deposit feeder, burrowing
Lugworm <i>Arenicola sp.</i>	In sediment	Deposit feeder, burrowing



Feeding mode will influence MP ingestion rates, retention time and transfer to the bed (filter feeder vs deposit feeder)

The ability of different estuarine organisms to remove MPs needs to be better quantified

Planned experiments (2)



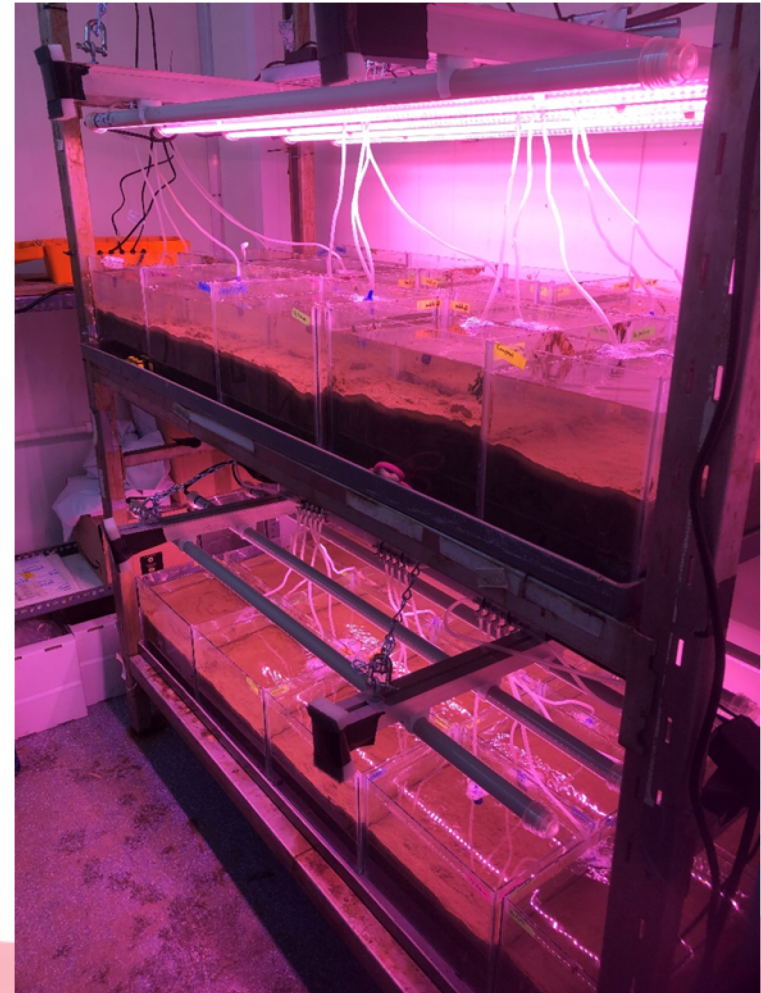
1. Laboratory based mesocosms are being developed

to support a mix of benthic fauna species collected from the Humber

2. Fluorescently stained MPs will be combined with food to encourage ingestion

3. Samples will be assessed to understand MP ingestion:

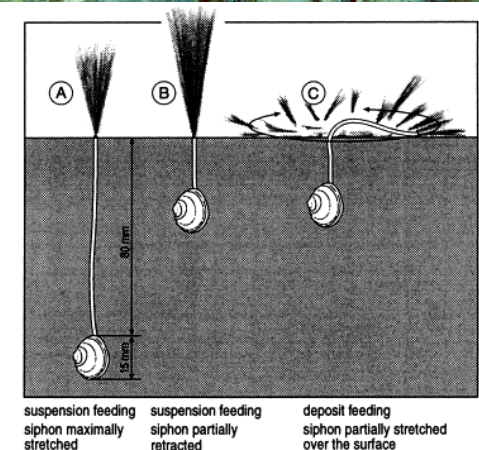
- If MP are transferred to the sediment bed
- The properties of the established biofilm
- The amount of ingestion and retention of MP (epifluorescence microscopy)



What will this tell us?



- **Quantifying the spatial temporal concentrations of MPs in different conditions** will help predict conditions for high concentration of MPs – locations for solutions
- **Understanding the role of biofilms in the capture of MPs** could provide a mechanism to remove MPs from the water column – conditions for solutions
- **Quantifying the ability of benthic fauna to ingest and transport MPs to the bed** will aid models of potential particle removal from estuaries and their burial in the bed – mechanisms to develop solutions.



Goeij & Luttikhuisen, 1998

What does this tell us?



- We believe that **biota have an influence on MP transport** within and out of estuaries, their distribution in sediments and their sequestration
- If proven, this knowledge could be used to **inform habitat creation and management solutions** to control this persistent pollutant within estuaries





Thank you for listening

Questions?

Please contact Julie Hope - j.a.hope@hull.ac.uk
Should you have any further questions