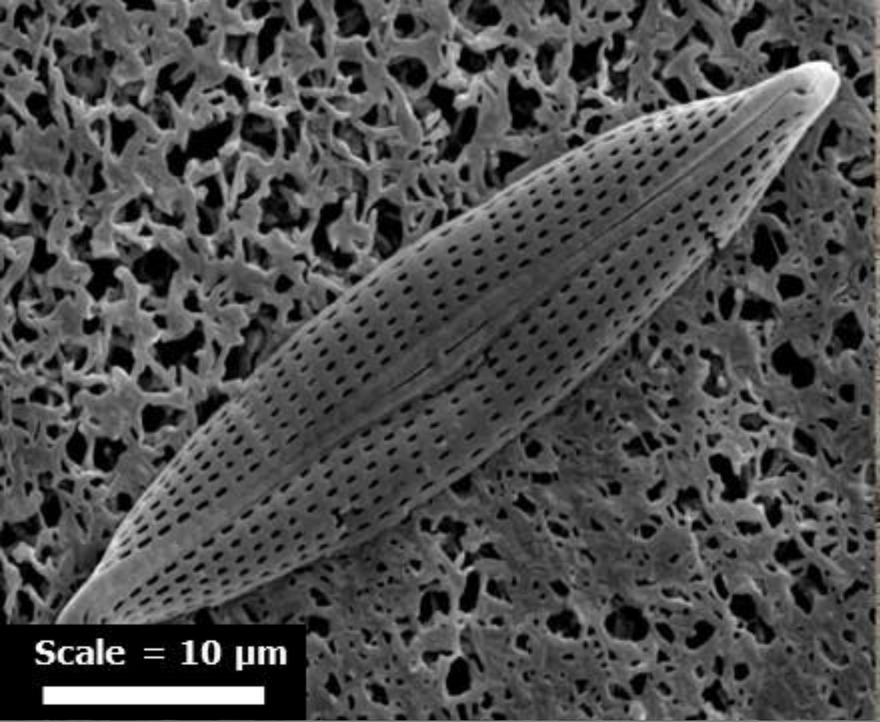

Role of Biofilms in filtering MPs

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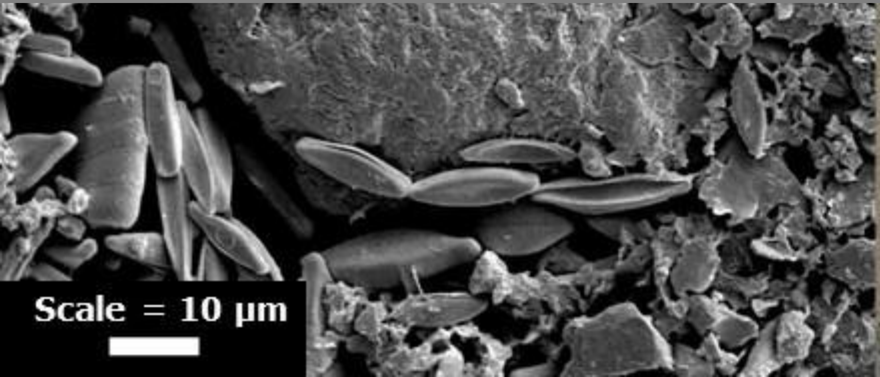


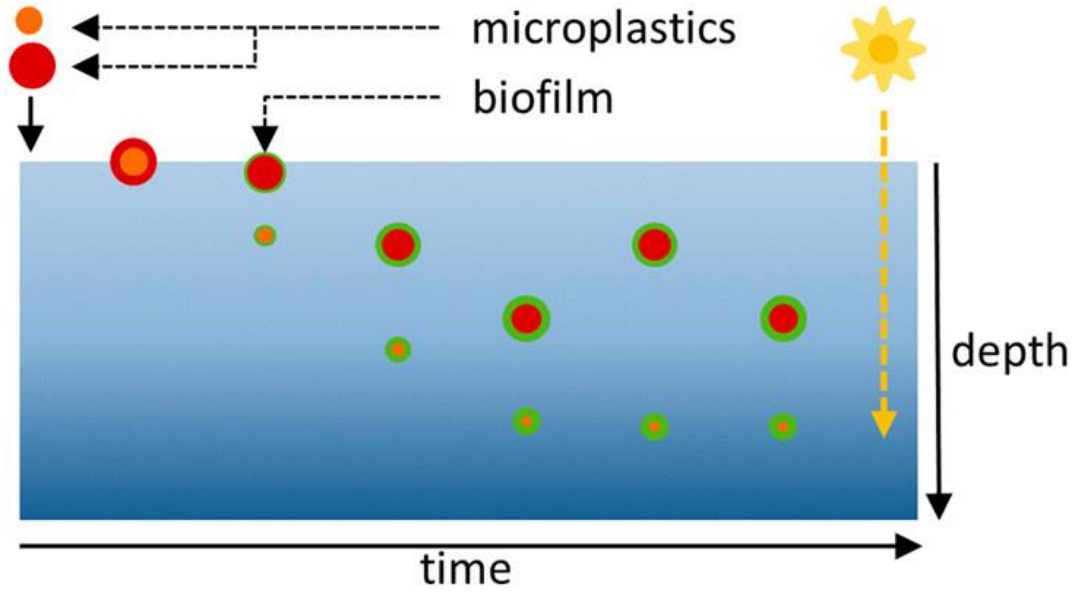
Benthic Microbial Biofilms

We do not fully understand what influences microplastic transport & distributions

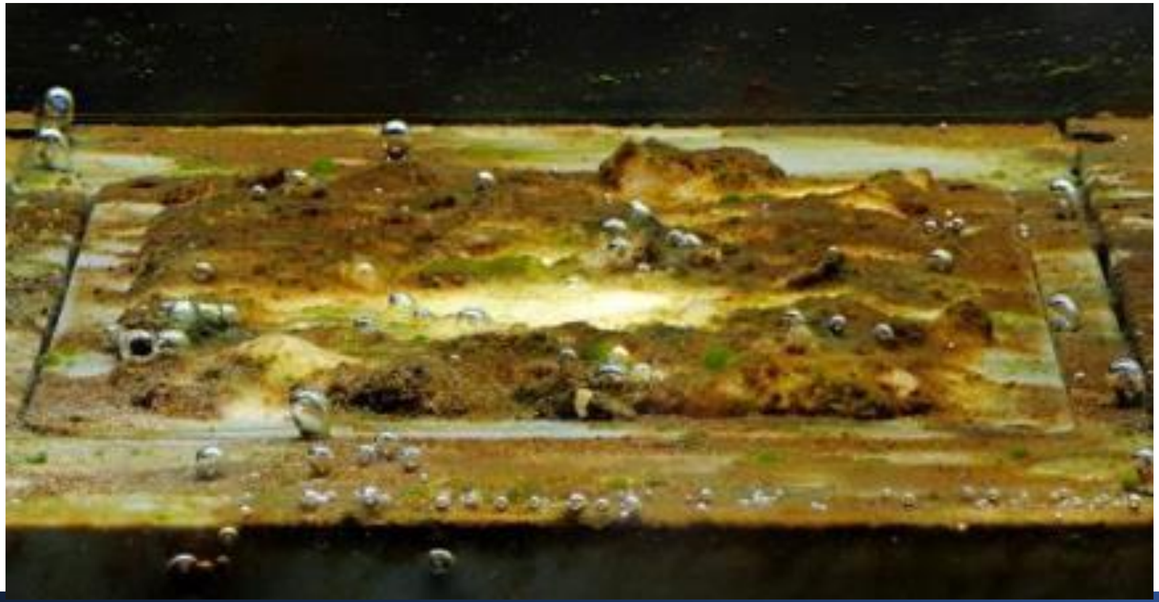
Biofouling can cause MPs to aggregate with other particulates influencing deposition & behaviour

Benthic microbial biofilms are known to trap and bind fine sediments and contaminants

They also mediate sediment transport dynamics



Kooi et al. 2017. *ES&T.* 51:14

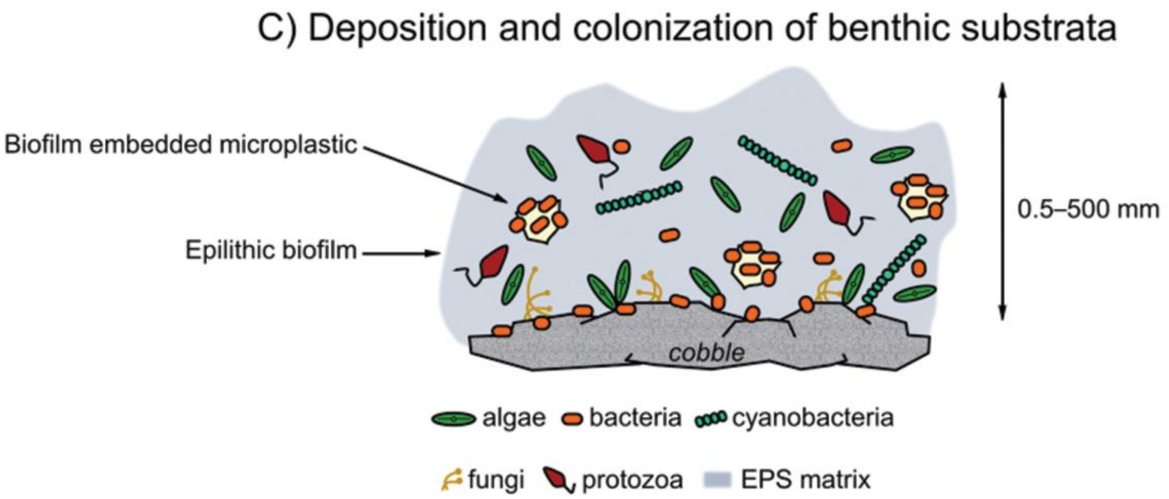


Biofilm trapping of MPs

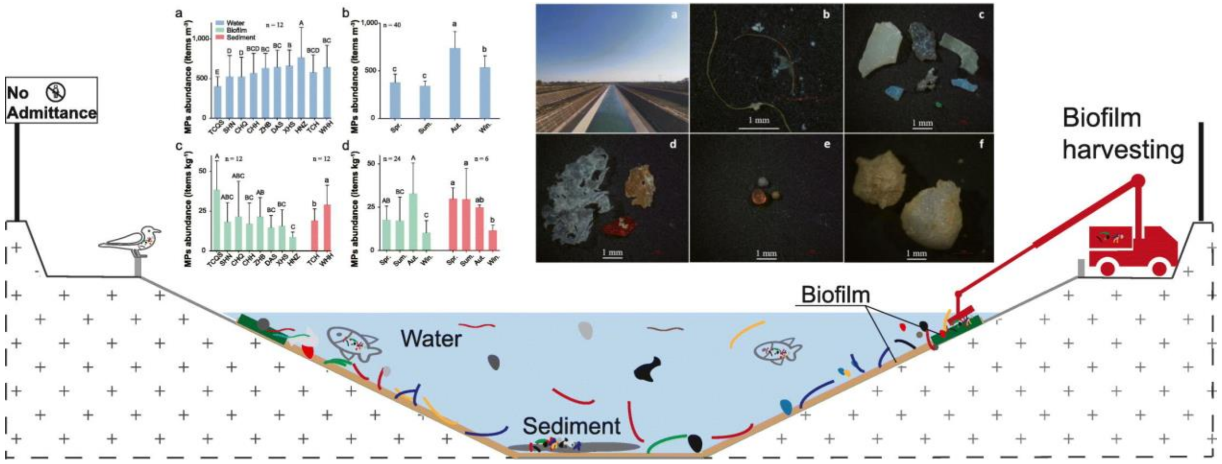
Biofilm mediation has been discussed, but it remains understudied

However, MPs concentrated in canal biofilms retain 20 MPs kg^{-1} wet biofilm (Huang et al. 2021)

Biofilms on sandy/muddy intertidal flats could mediate MP dynamics within estuaries



Guasch et al. 2022 *Fres. Sci.* 41:3



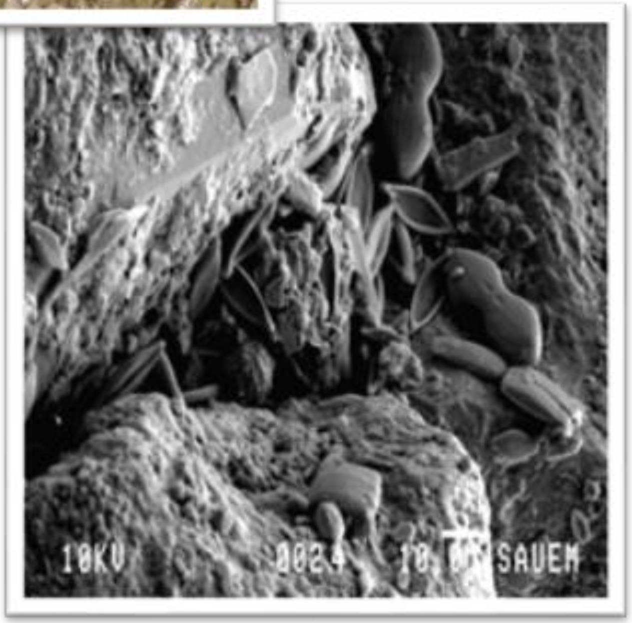
Huang et al. 2021.*STE 789*

How do benthic biofilms affect MP capture & retention?

Can biofilms filtering capacity be exploited?

Can biofilms potentially be used to remove MPs from estuarine waters?

Can we target biofilm-rich sediments in management of estuaries?



GAPS IN KNOWLEDGE

Hypotheses

i) Higher biofilm growth on the sediment surface will capture more MPs

ii) Higher biofilm growth on sediment will retain more MPs under flow

iii) Copper and Lead additions will influence biofilm structure & function and therefore MP retention ability of the biofilm

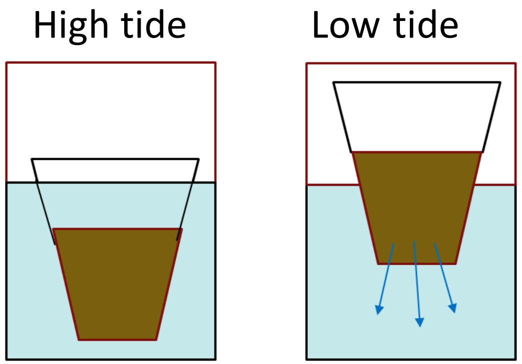
More biofilm,
More MPs

Experimental set up

Total of 36 tidal mesocosms were filled with natural sediment and seeded with biofilm at three levels of growth

i) Control (microorganisms killed)
ii) Low biomass
iii) High biomass

Mesocosms set up on a simulated tidal cycle for 14 days to allow biofilm to develop.



MP treatment

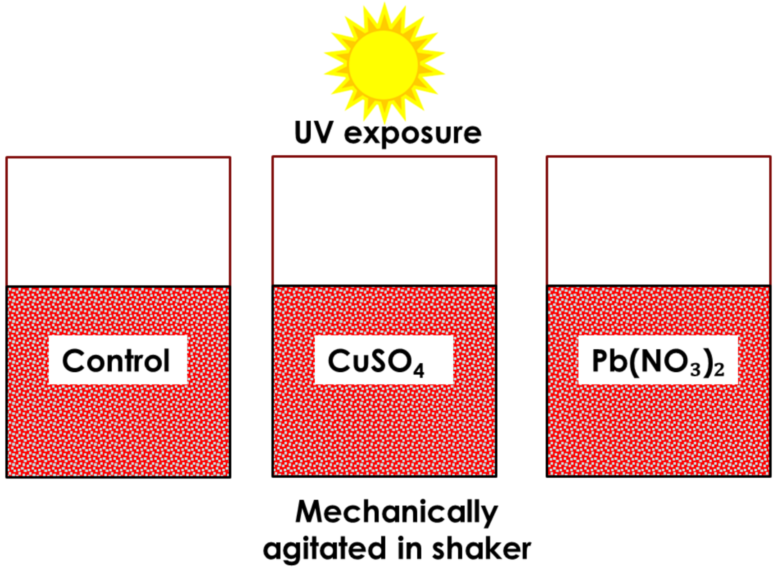
High density (polyamide) MPs (500µm) were mildly UV and mechanically aged

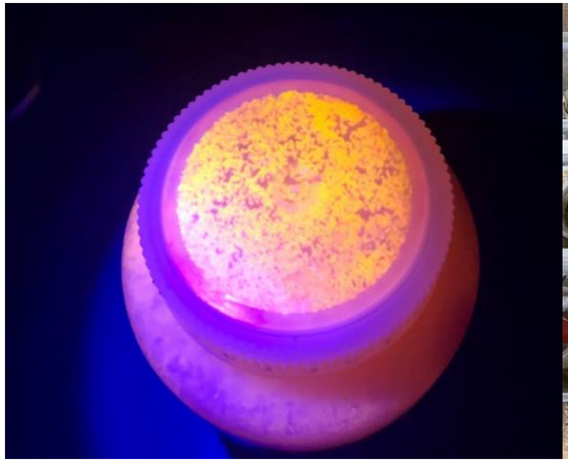
Exposed to heavy metals

i) Control (no metals)
ii) Copper (Cu) addition
iii) Lead (Pb) addition

MPs fluorescently stained and added to the surface of the pots during ‘high tide’

Incubated for further 7 days on tidal cycle



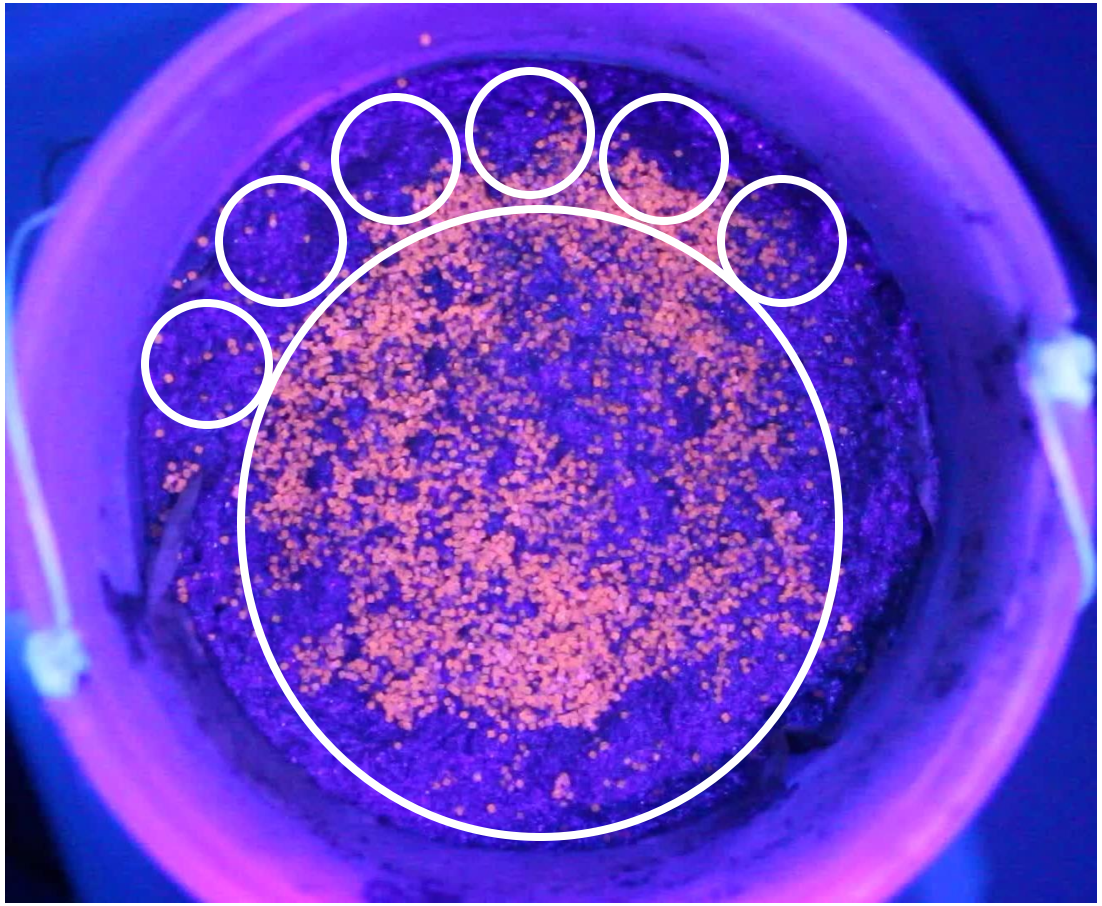


Biochemical analysis

Surface sediments were removed with 1cm ID cut-off syringe cores (6 x 0.5mm depth)

Cores were frozen and later analysed for:

- Chlorophyll a content (algal biomass)
- EPS content
- Grain size
- Microbial DNA
- Diatom ID (Microscopy)

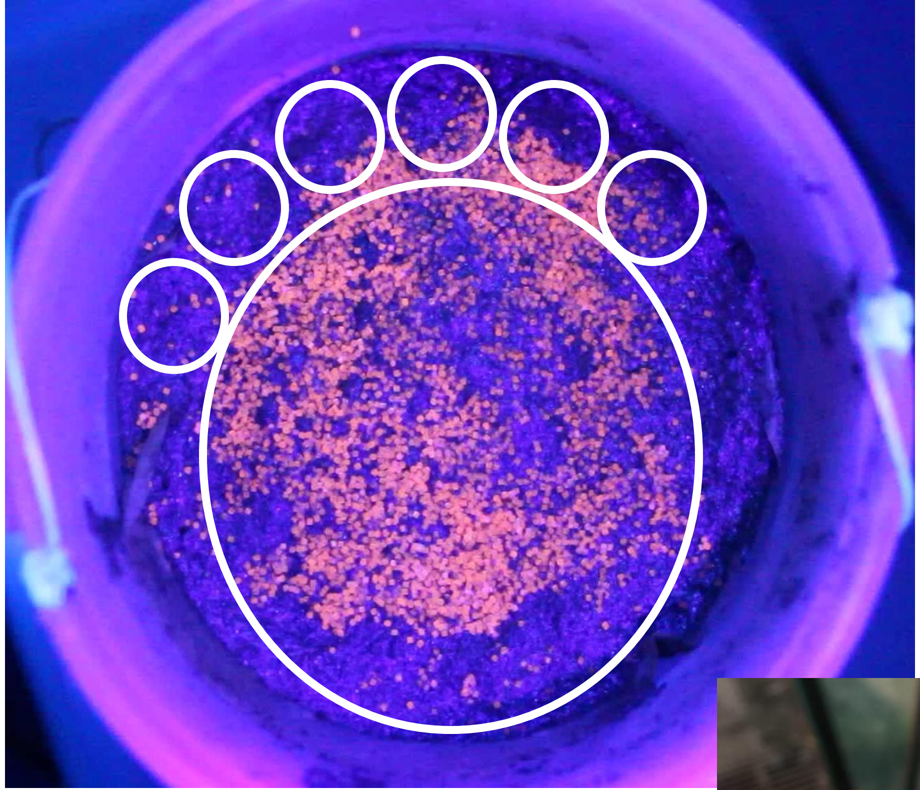


Determining MP resuspension

Mesh bottomed inner core carefully extracted

This was used as an intact core for erosion measurements

Core inserted to a recirculating flume flush with the floor



Determining MP resuspension

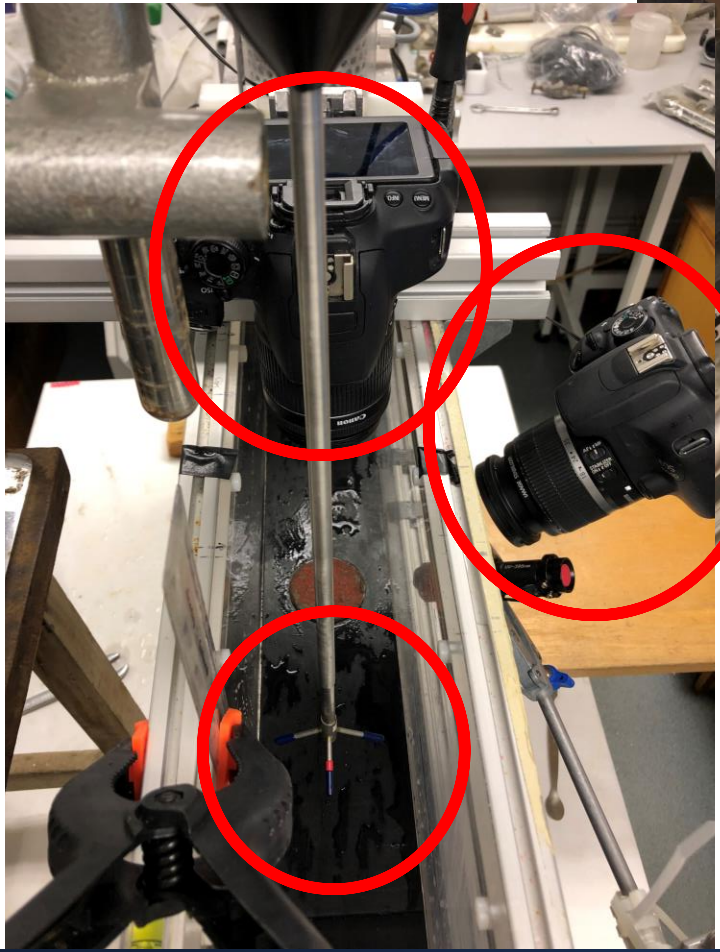
Small benchtop recirculating flume (1m x 0.25m)

2 x DLSR cameras (UV light):

- Aerial – short clip, each flow
- Side – continuous recording full run

ADV – 5cm above the bed, downstream

Flow incrementally increased: 5 cm s^{-1} to 30 cm s^{-1}



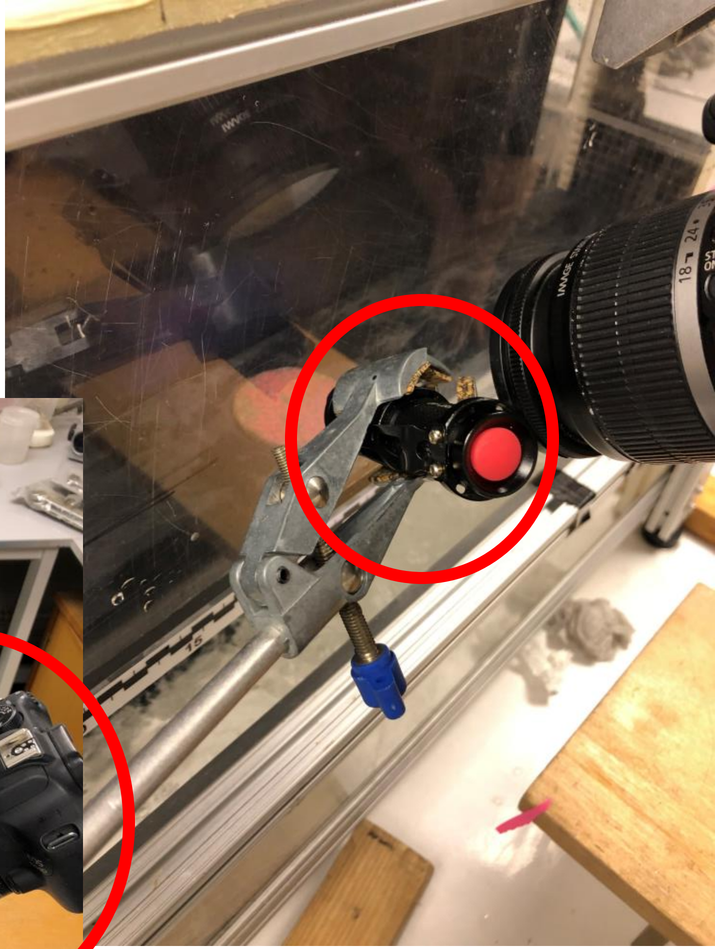


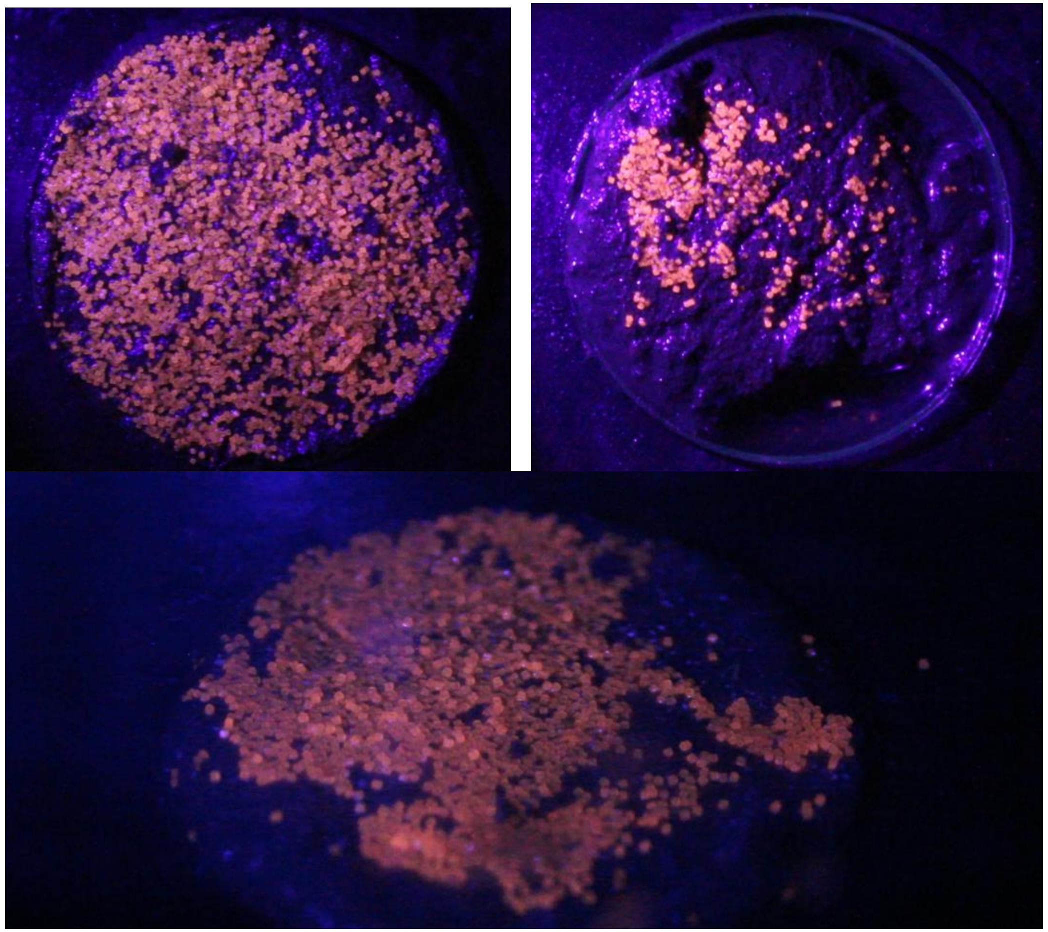
Image analysis

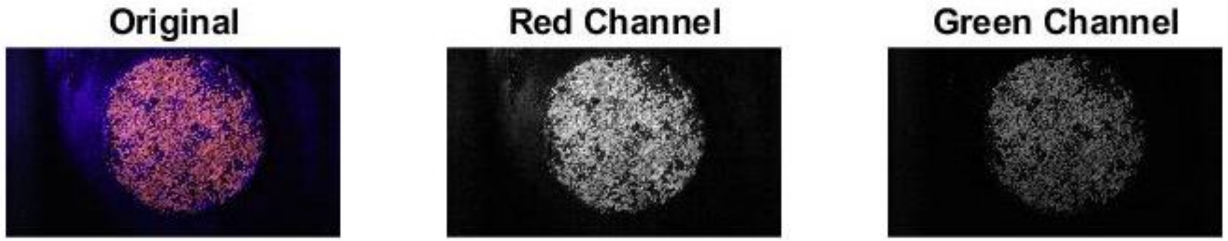
Top - pre and post run (5-30 cm s^{-1}), high biofilm

Middle - side view from camera

Bottom - aerial image analysis used to determine

- First flush MP removal (tidal inundation)
- MP erosion threshold (5% loss of coverage)
- *MP erosion rate





Microalgae biomass & Erosion threshold

Successfully inhibited biofilm growth (white)

Two levels of algal biomass
- Low – light green
- High – dark green

Higher microalgae biomass with Copper addition

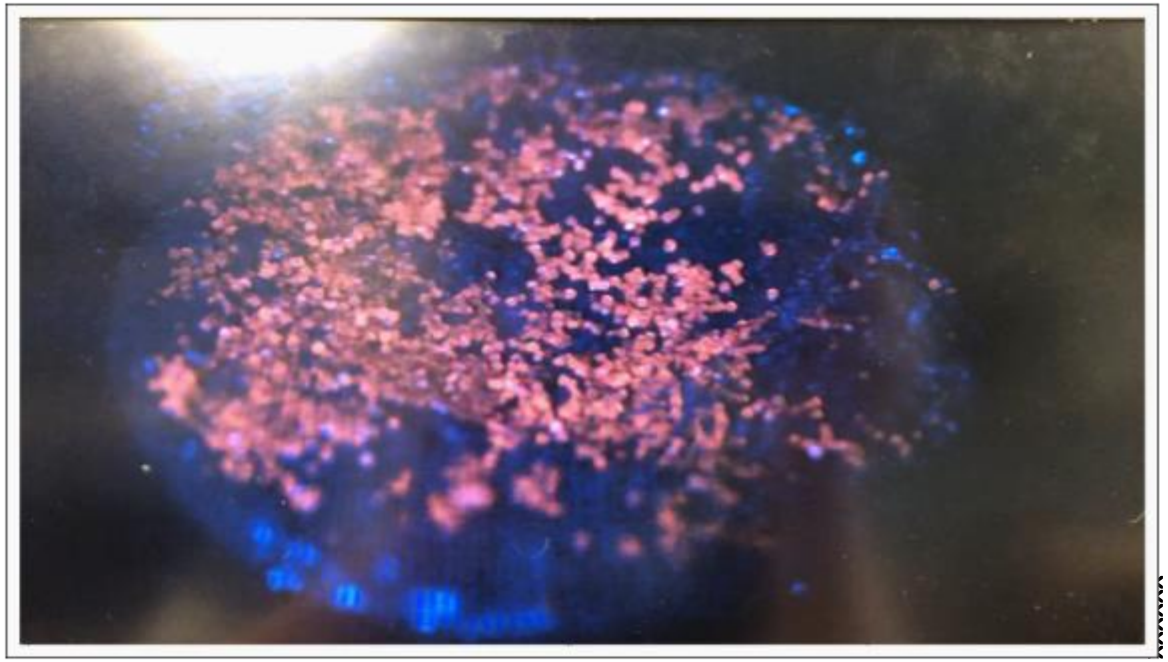
More variable with Lead additions (patchy biofilm)

Content removed

First flush

Top video – control (no biofilm)

Bottom video – high biofilm growth



MP erosion threshold

Lower erosion threshold = MPs more easily resuspended

MPs more easily resuspended from control sediments (no biofilm, white bars).

Higher flows required to resuspend MPs from biofilm rich sediments (green bars)

Content removed

Summary

Biofilm presence can trap MPs on the sediment surface.

This means higher flows are required to remobilize MPs from biofilm-rich sediments

Key biogenic habitats may accumulate MPs – these could be targeted for MP removal or avoidance.

Biofilm trapping will also influence MP ingestion and burial by fauna – these microbes are the base of the benthic food web in estuaries.

Thank you
Any questions

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