Uptake and Impact of Microplastic on Aquatic Macroinvertebrates in Morecambe Bay

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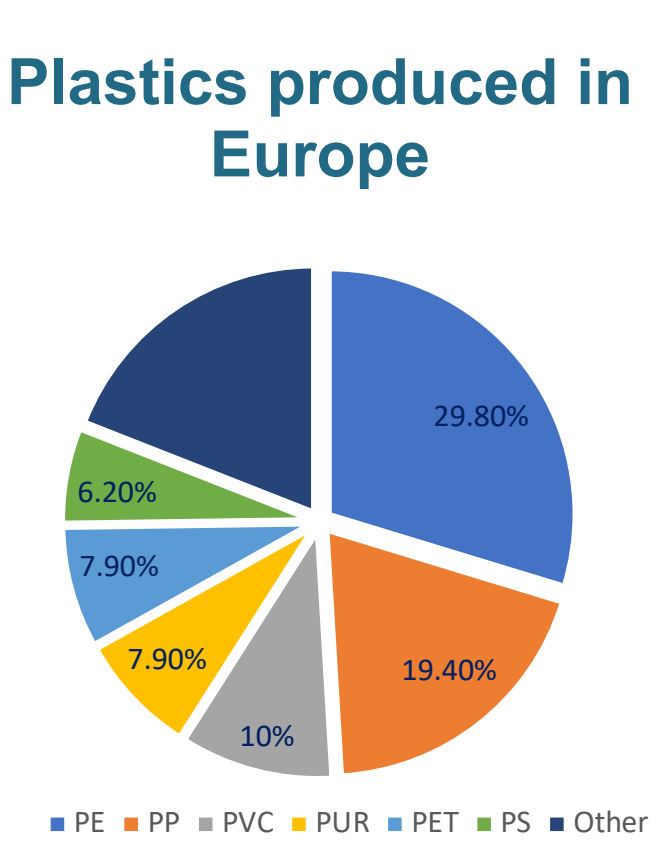
- Impacts of microplastics on invertebrates health
- Other research going on

Plastics

Plastics - Production

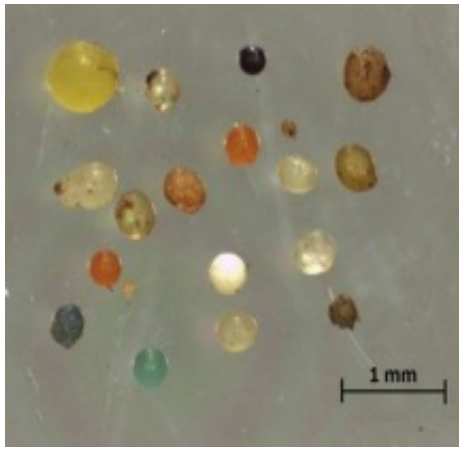


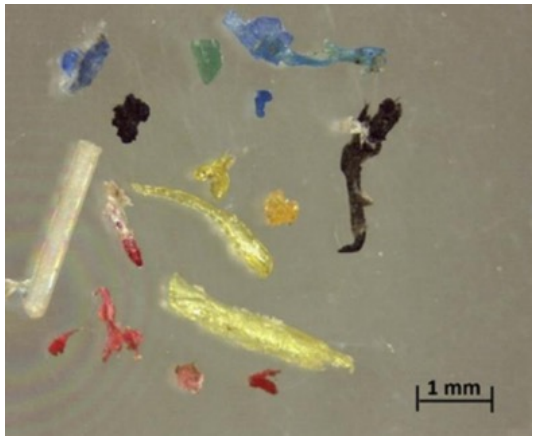
- **400 million tonnes of plastic produced yearly (globally)**
- **50% of manufactured plastics are for single use**
- **Globally 32% of plastic is recycled**

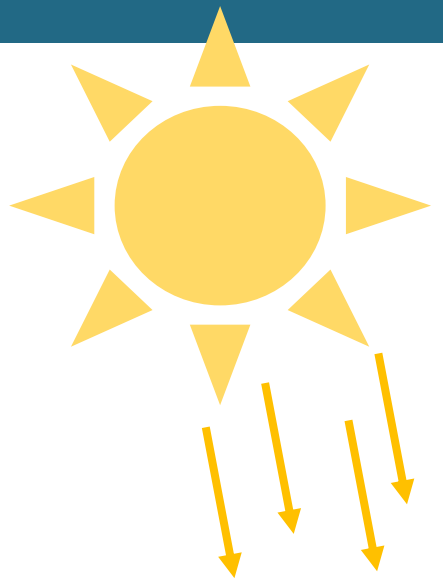
(Plastics Europe, 2020)

Plastics - Microplastics

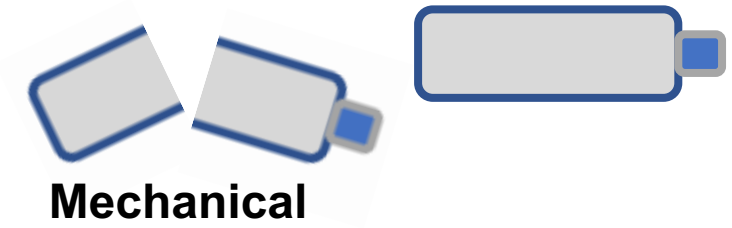
- Mechanical breakdown
- UV radiation (Photo-oxidation)
- Microfibres from clothing
- Degraded tyre and road markings
- Primary microplastics (Banned)







UV + Oxygen



Mechanical

Plastics - Size

Macroplastics

≥ 5 mm and <2.5 cm

Mesoplastics

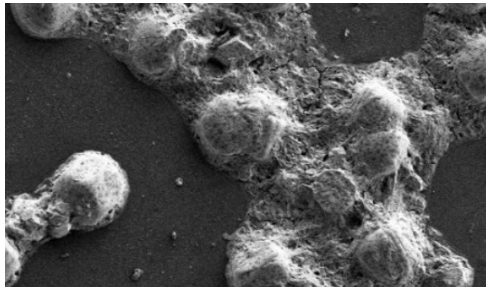
5–10 mm

Microplastics

less than 5 mm

Nanoplastics

1-100nm

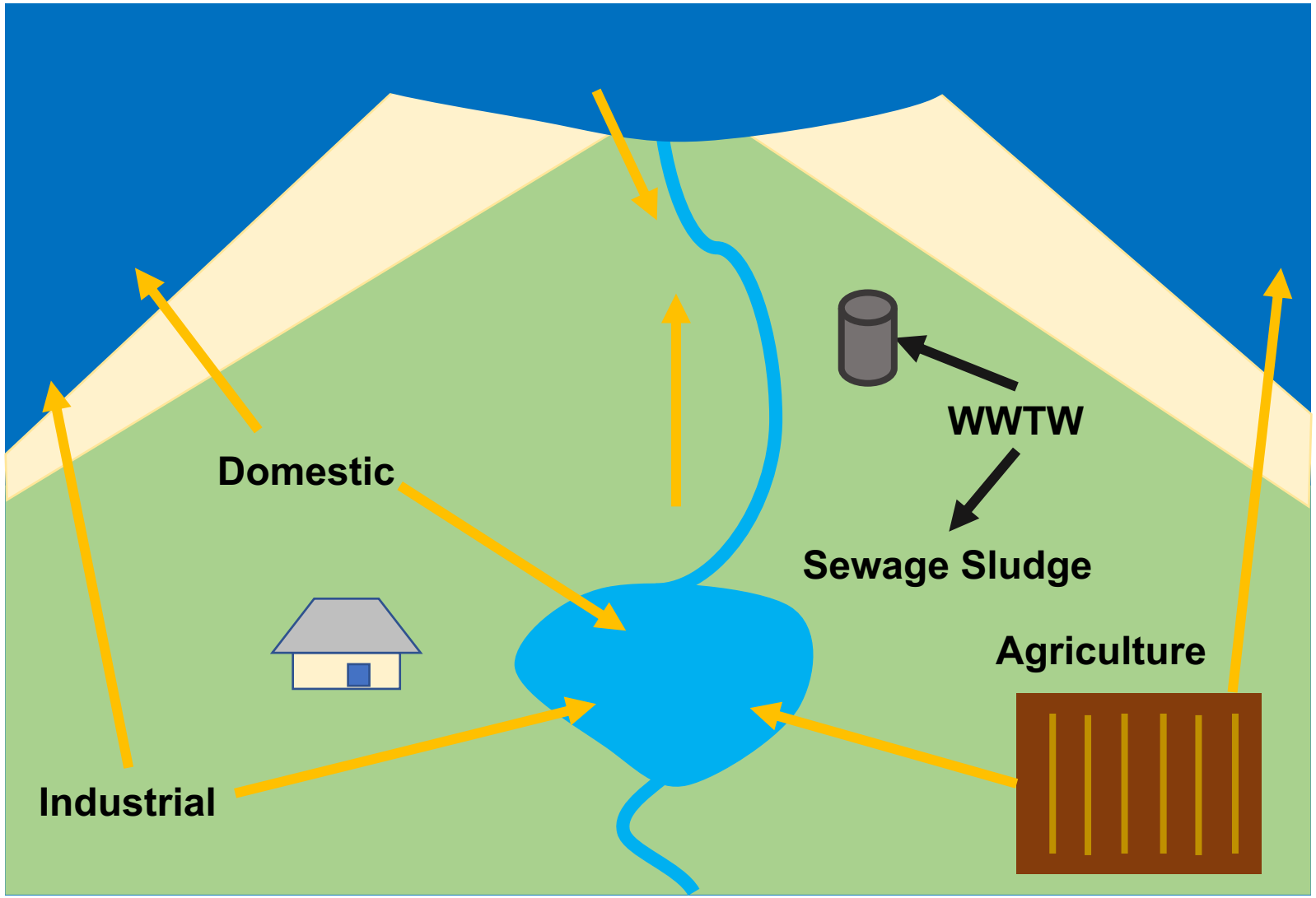


Microplastics - Transport

Manufacture of synthetic textiles

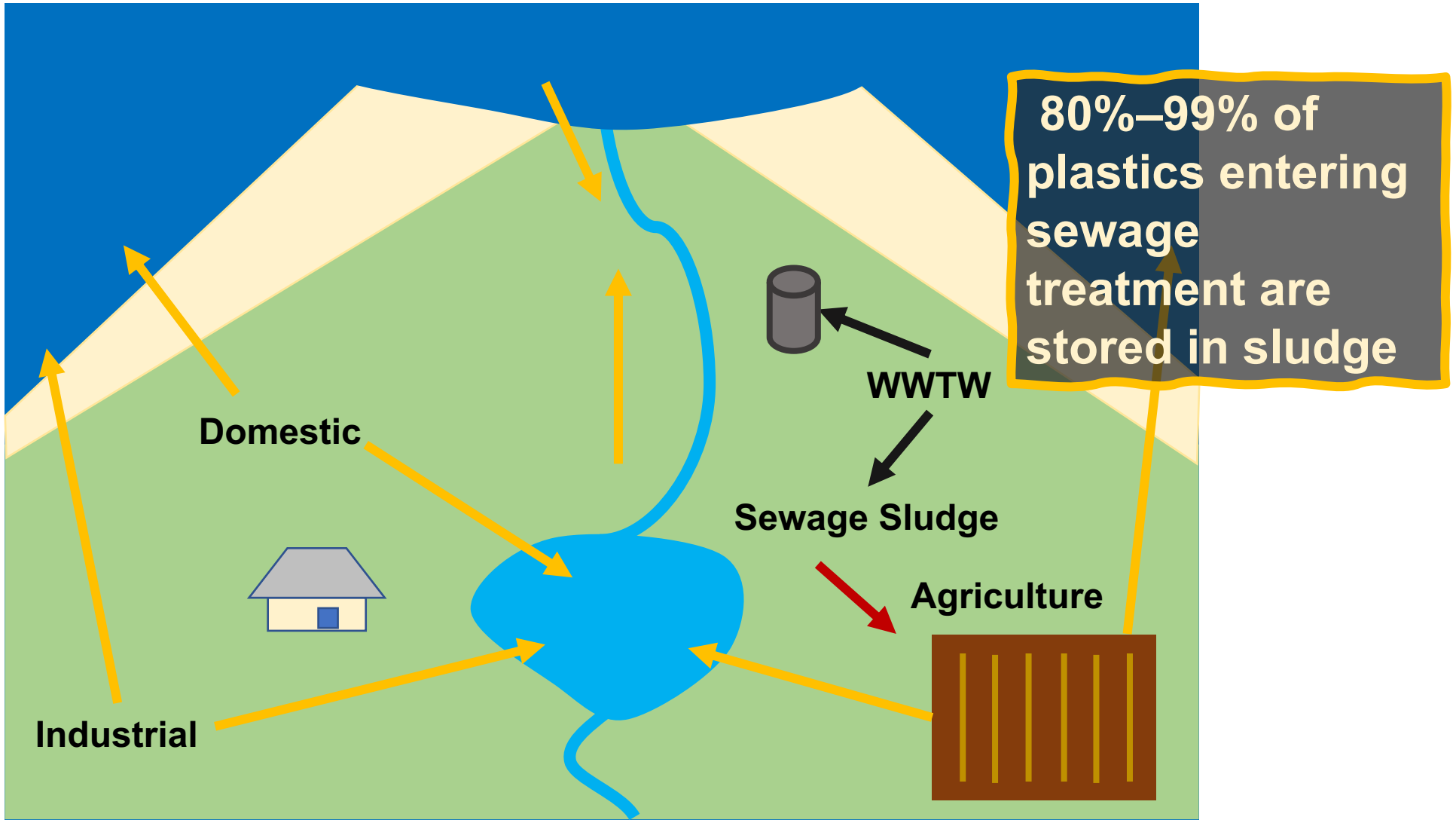
Manufacture of macroplastics

Manufacture of microplastics



(Horton et al., 2017)

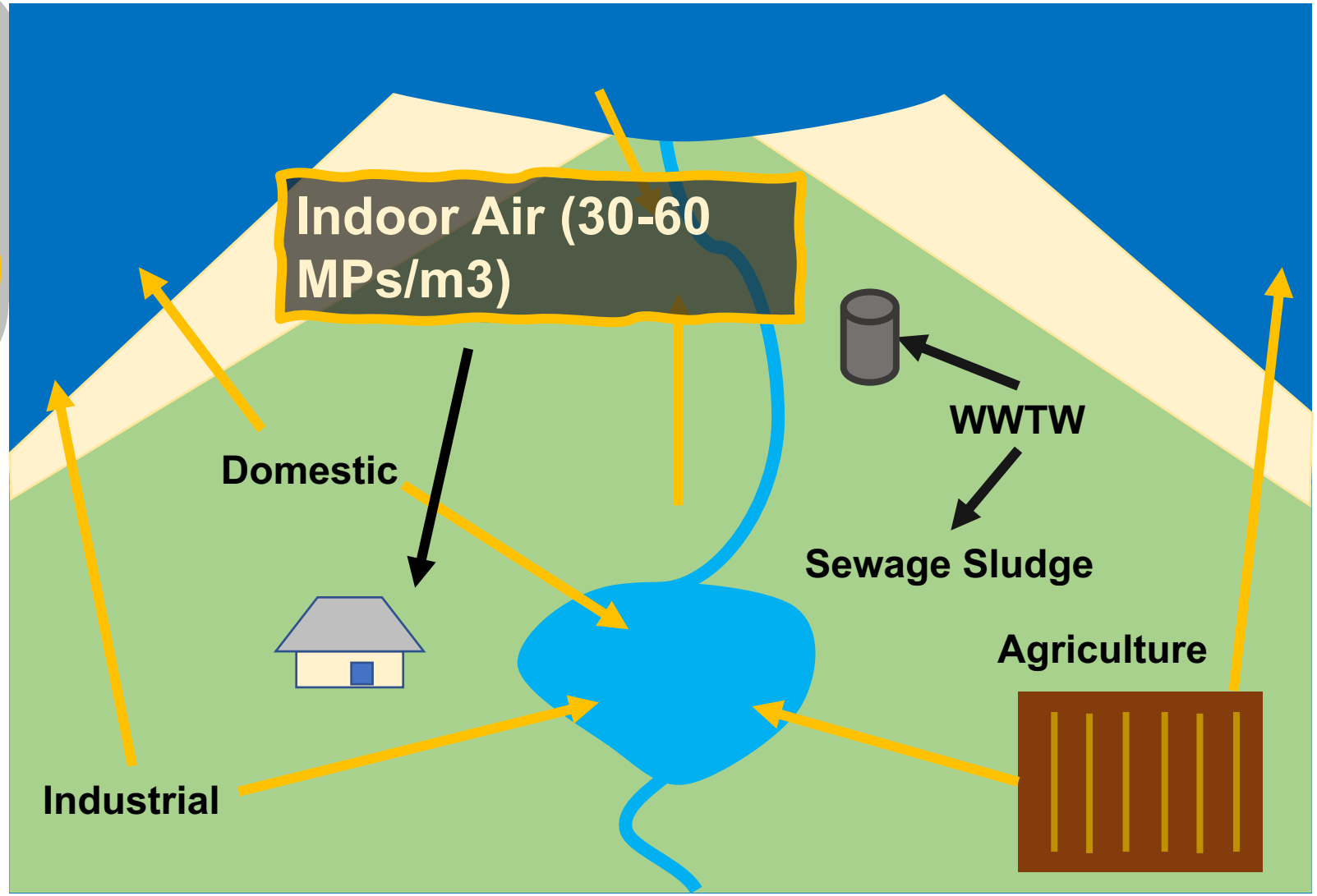
Terrestrial



(Horton et al., 2017)

Atmosphere

lower atmosphere (0.3–1.5 MPs/m3)



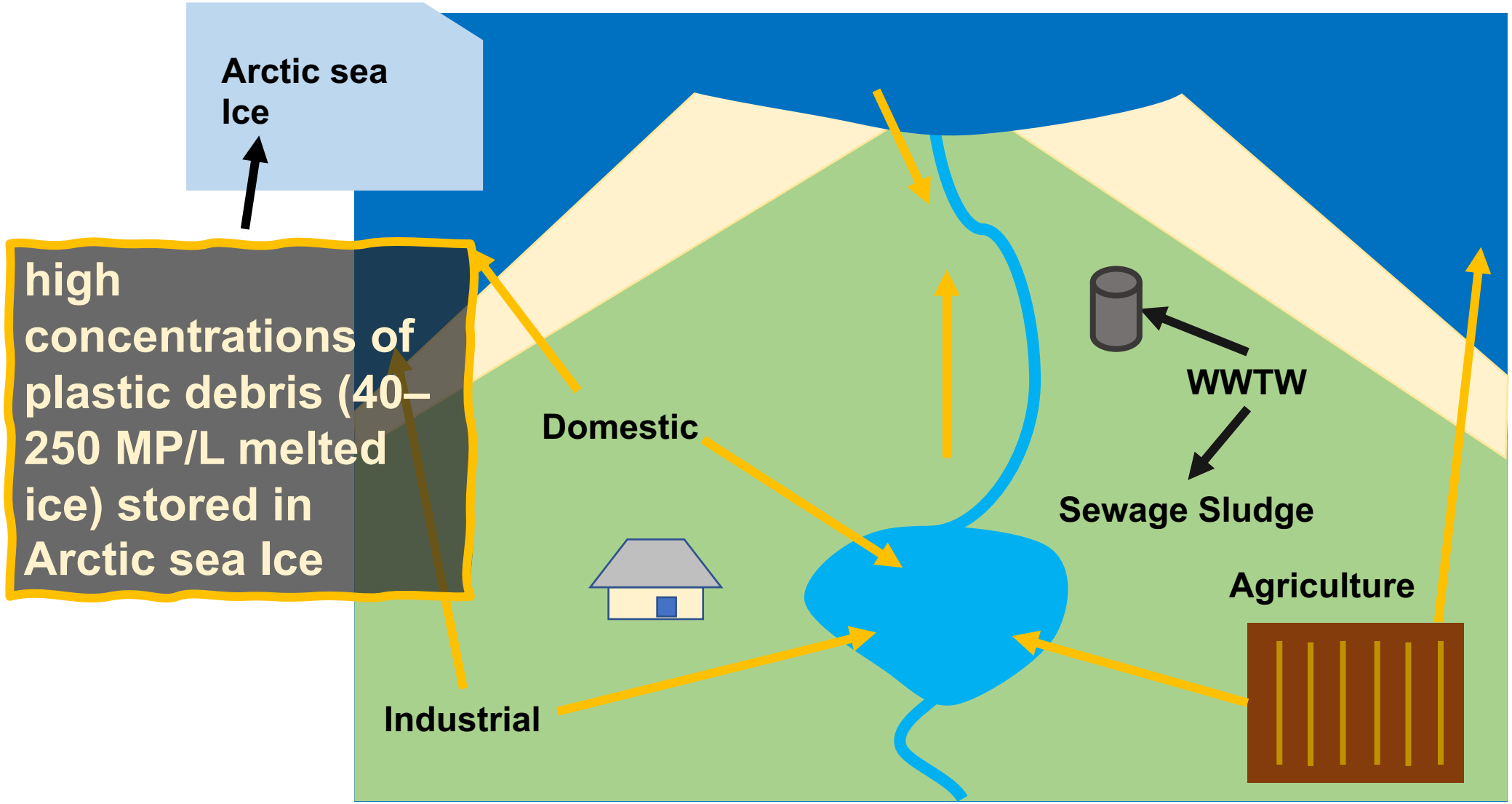
Polyurethane

Polypropylene

Polystyrene

(Horton et al., 2017)

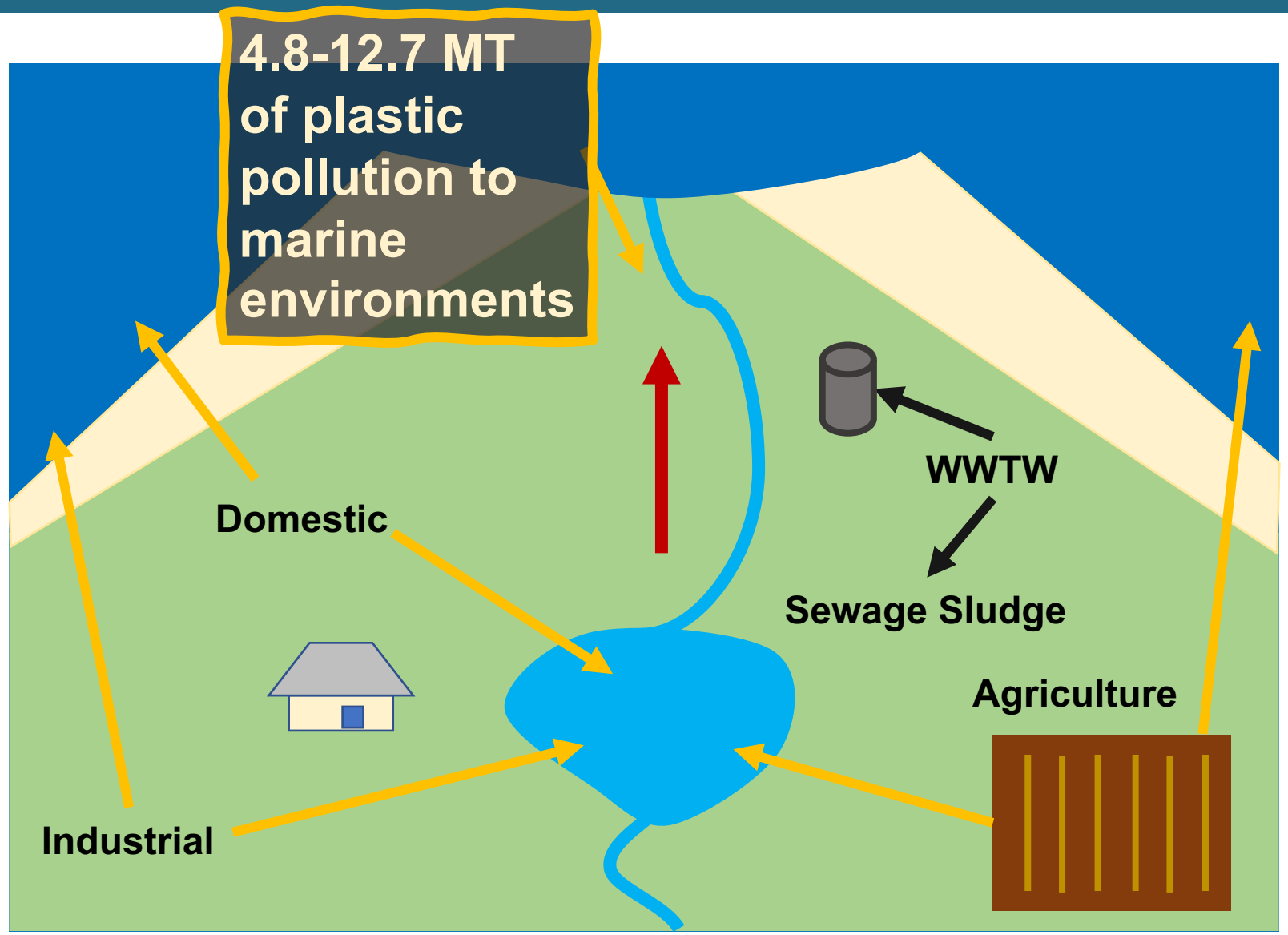
Cryosphere



(Horton et al., 2017)

Marine

50% of human population live less than 19 miles from the coast

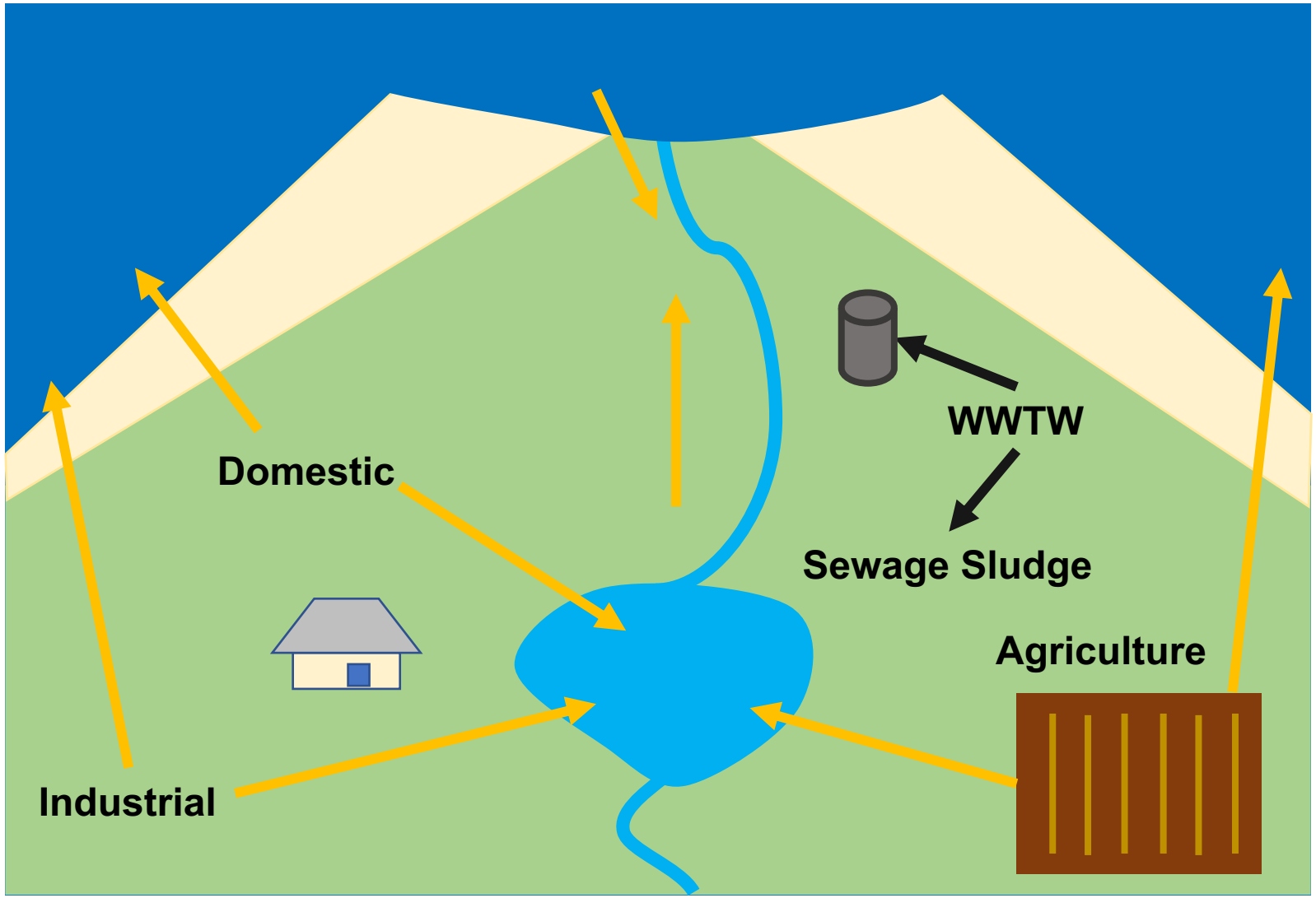


(Horton et al., 2017)

Freshwater

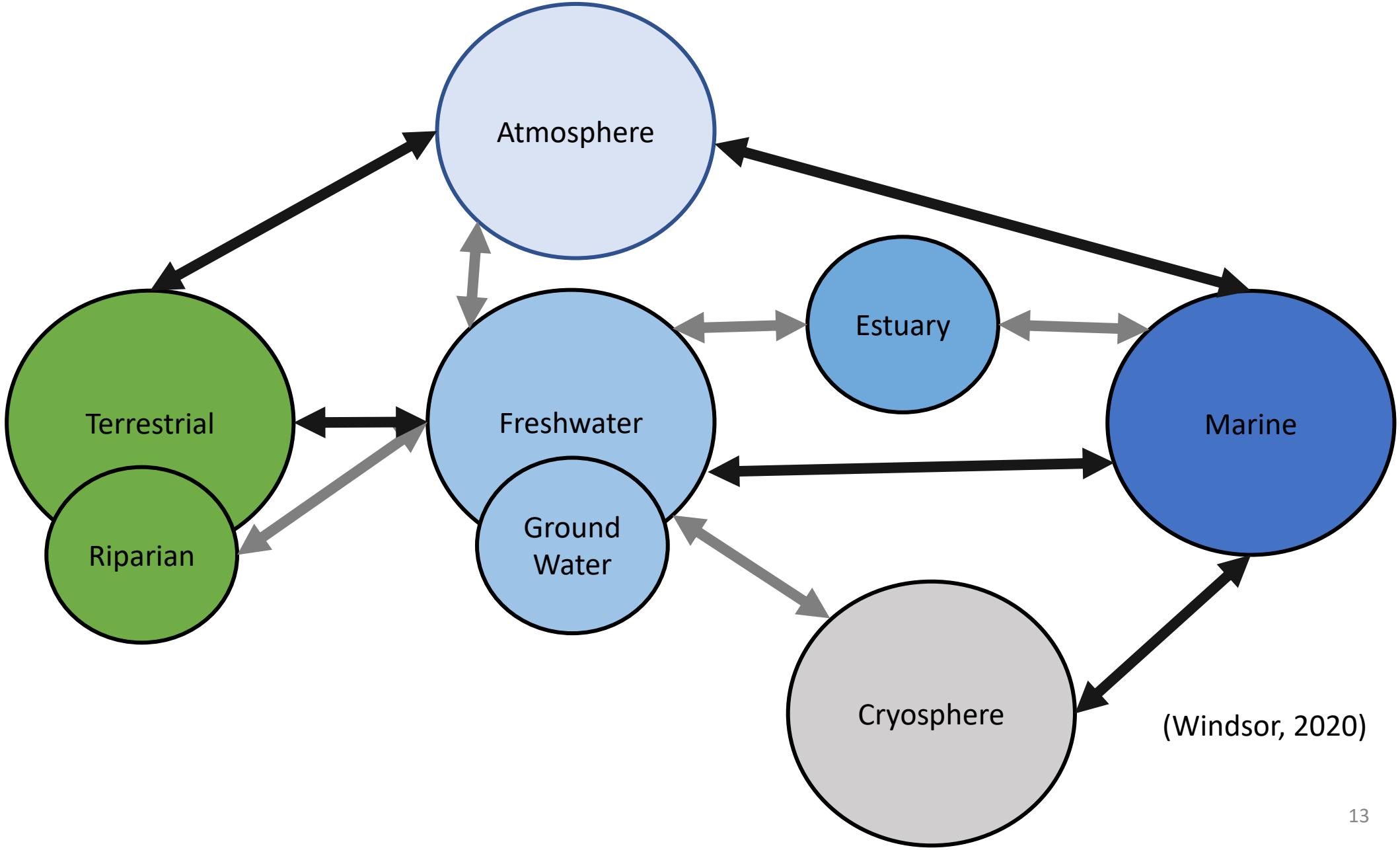
River characteristics

Microplastic characteristics



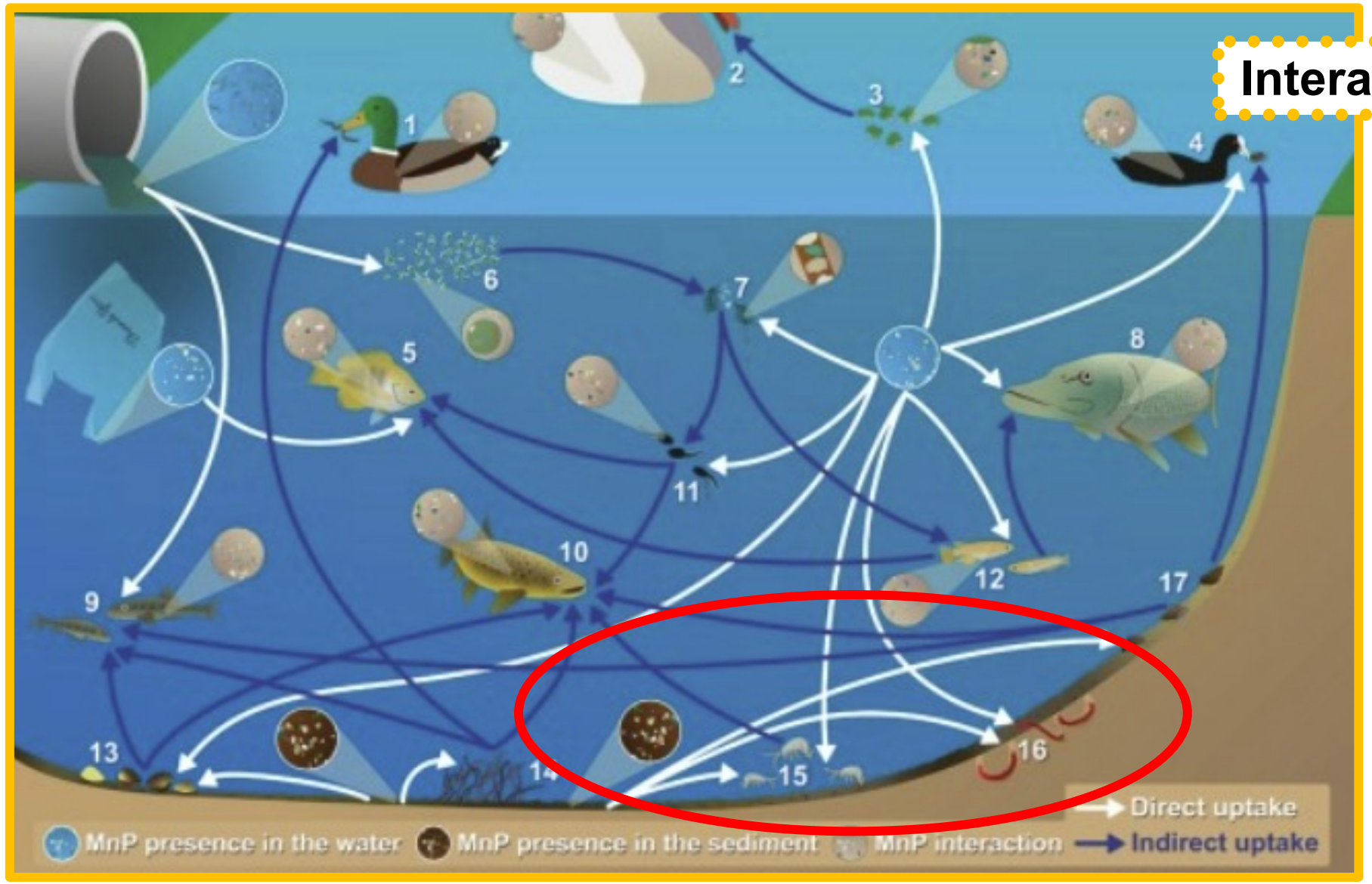
(Horton et al., 2017)

Fluxes of microplastics in the environment



(Windsor, 2020)

Biota Interactions with microplastics

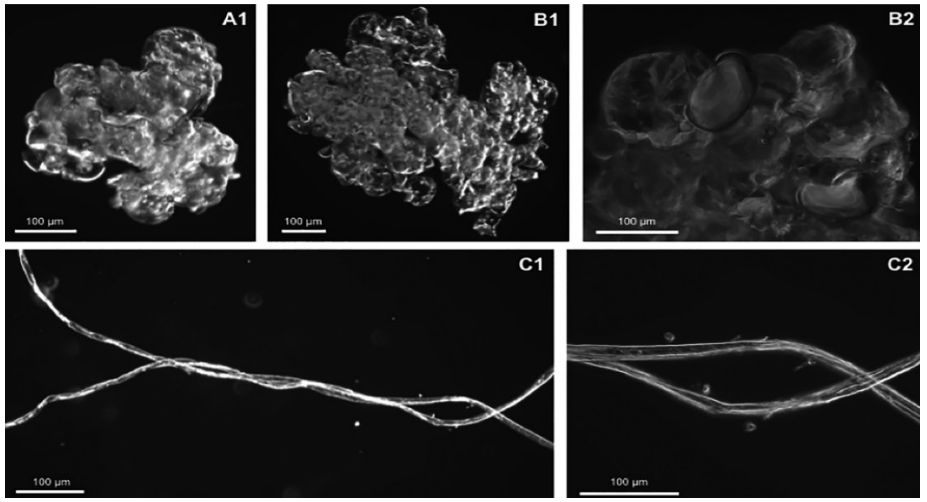


Interactions with Biota

Literature Overview

Microplastic Uptake

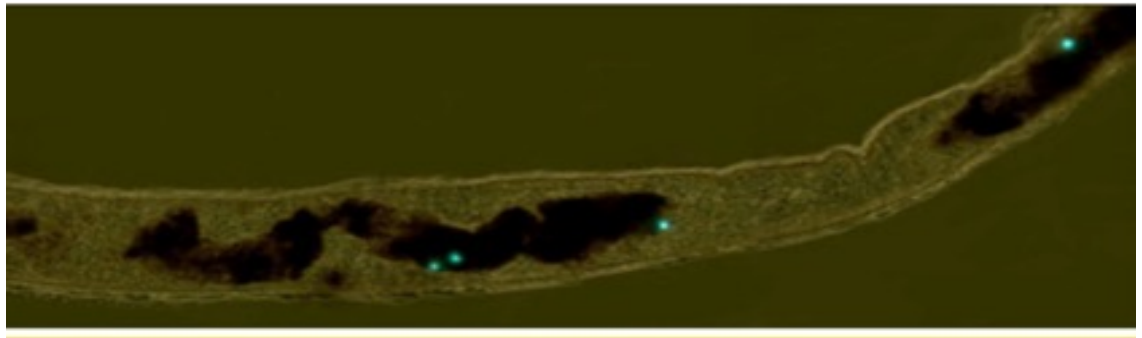
- Microplastic **ubiquitous** in freshwater and marine habitats
- Plastic uptake mainly governed by particle **size and morphology**
- Depends upon animal feeding type



(Windsor et al., 2019).

- Selective uptake by biota (mistaking plastics for food), due to **microorganisms colonizing plastic**

- Aging of microplastics **promotes ingestion**

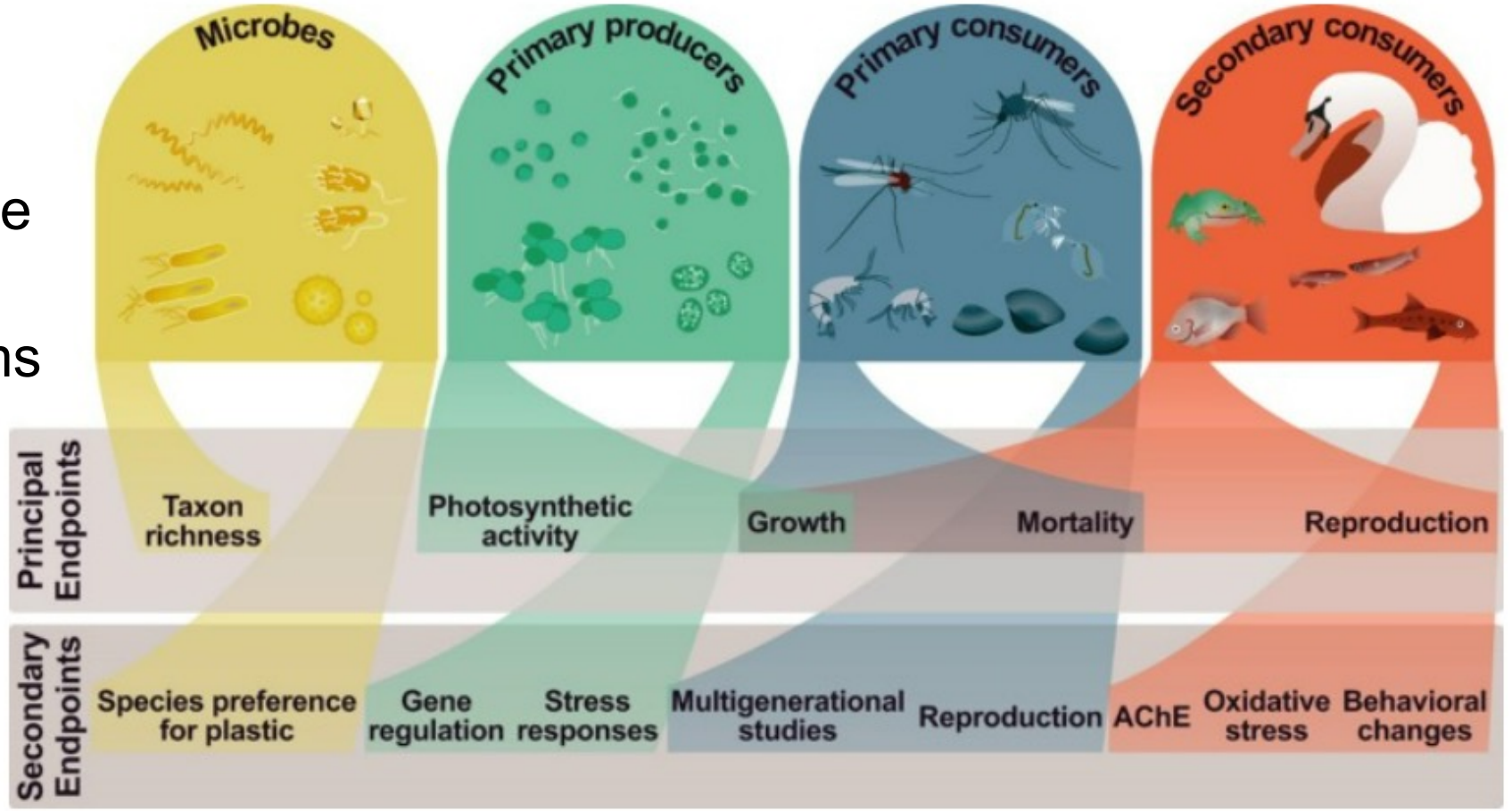


(Setala et al., 2015)

Literature Overview

Life History Impacts

- Negative impacts of **growth, survival, reproduction** and **generational** for some organisms
- But for most organisms the impacts are **unknown**



Additives

Endocrine Disrupting Chemicals

- Plasticizers - Phthalates
- Hardeners – Bisphenol A (BPA) & BPF & BPS
- Flame Retardants – Polybrominated diphenyl ethers (PBDE)

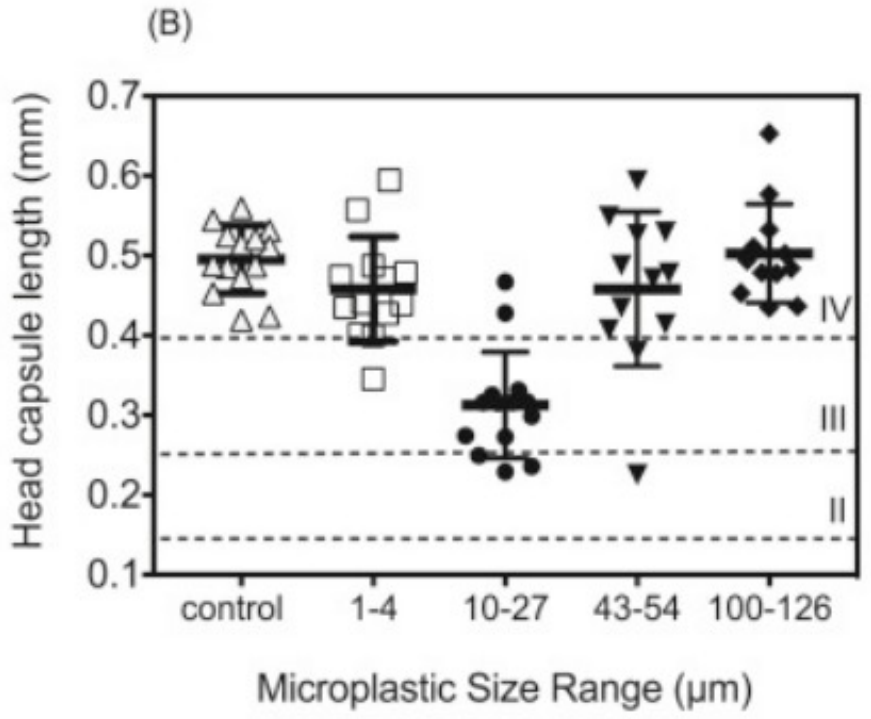
Other Additives

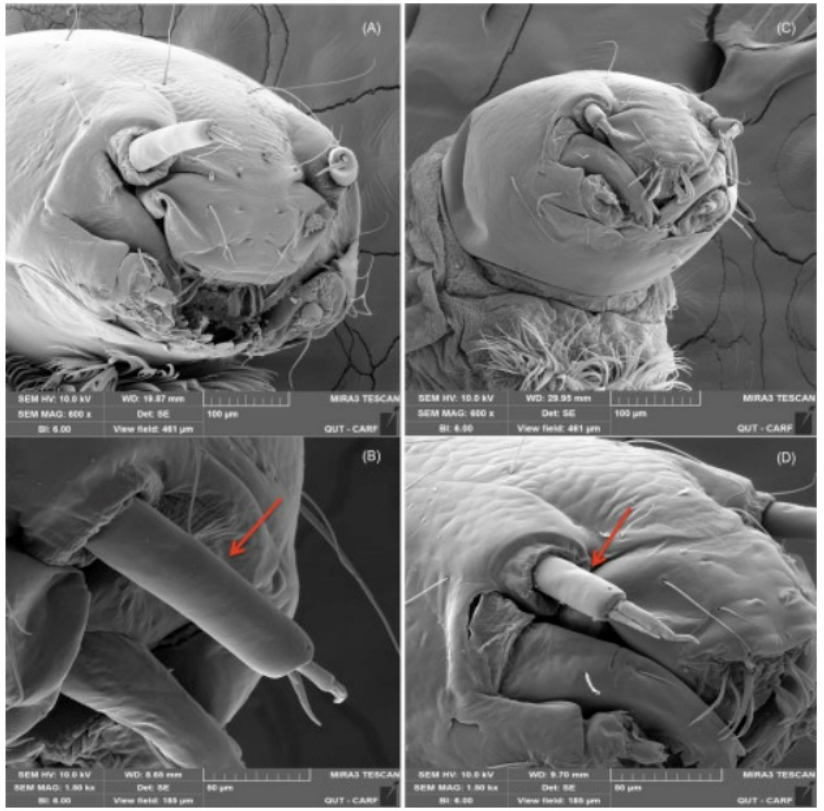
- Surfactants
- Synthetic Dyes

Pristine plastics

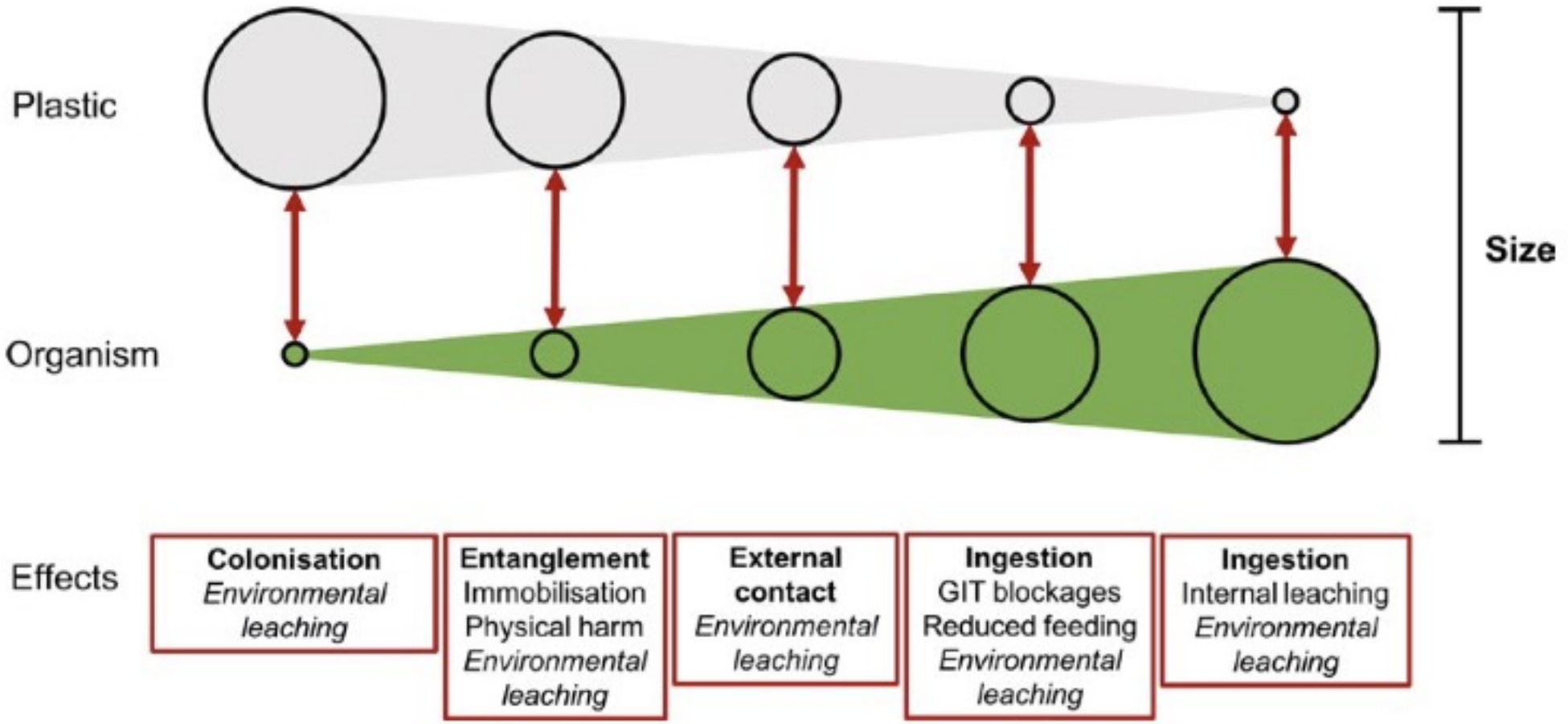
Environmentally relevant concentrations of polyethylene microplastics negatively impact the survival, growth and emergence of sediment-dwelling invertebrate

Shima Ziajahromi, Anupama Kumar, Peta A. Neale, Frederic D. L. Leusch (2019)



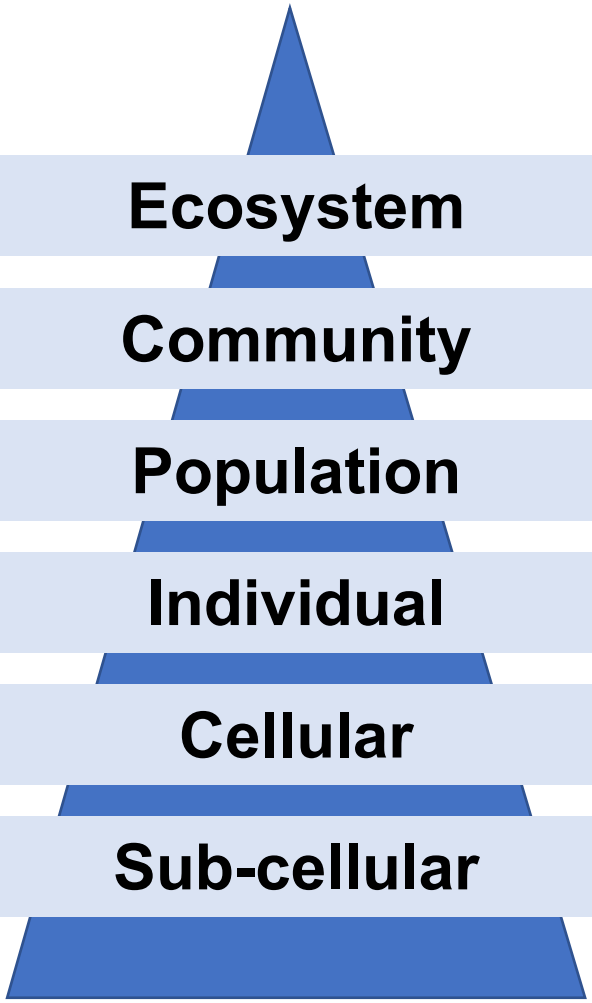


Size



(Windsor et al., 2017).

Scale	Processes		Effects
Ecosystem	Colonisation		**Ecosystem Structure** (diversity and composition)
Community	Entanglement	→	**Population demography** (growth and decline)
Population	Physical blockage	→	**Mortality** **Growth** **Immune Response**
Individual	Abrasive damage	→	
Cellular	Uptake across membranes	→	**Oxidative stress** **Enzymatic process**
Sub-cellular	Chemical Leaching		



Effect Pathway

(Windsor et al., 2017).

Debate?

Uncertainty in the science?

Part 2 – Morecambe bay project

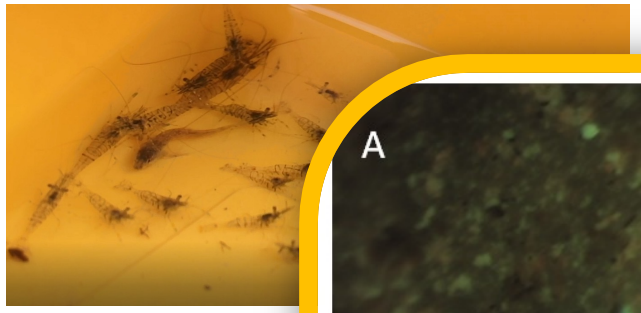
1	Investigate the uptake of microplastics by aquatic macro-invertebrates across a salinity gradient in Morecambe Bay	
2	Investigate the interactions between microplastic biofilms and aquatic macro-invertebrates in Morecambe Bay	
3	Investigate the 'Life History' impacts of environmentally relevant microplastics on aquatic macro-invertebrates	

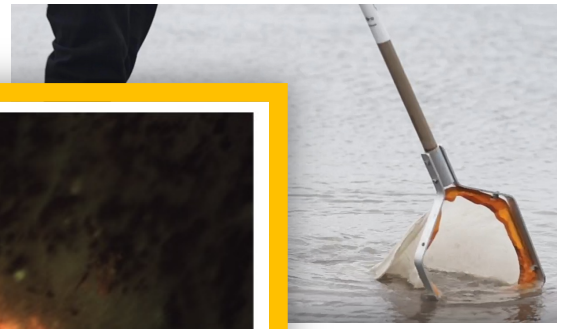
Objective 1 – Microplastic uptake in Morecambe Bay

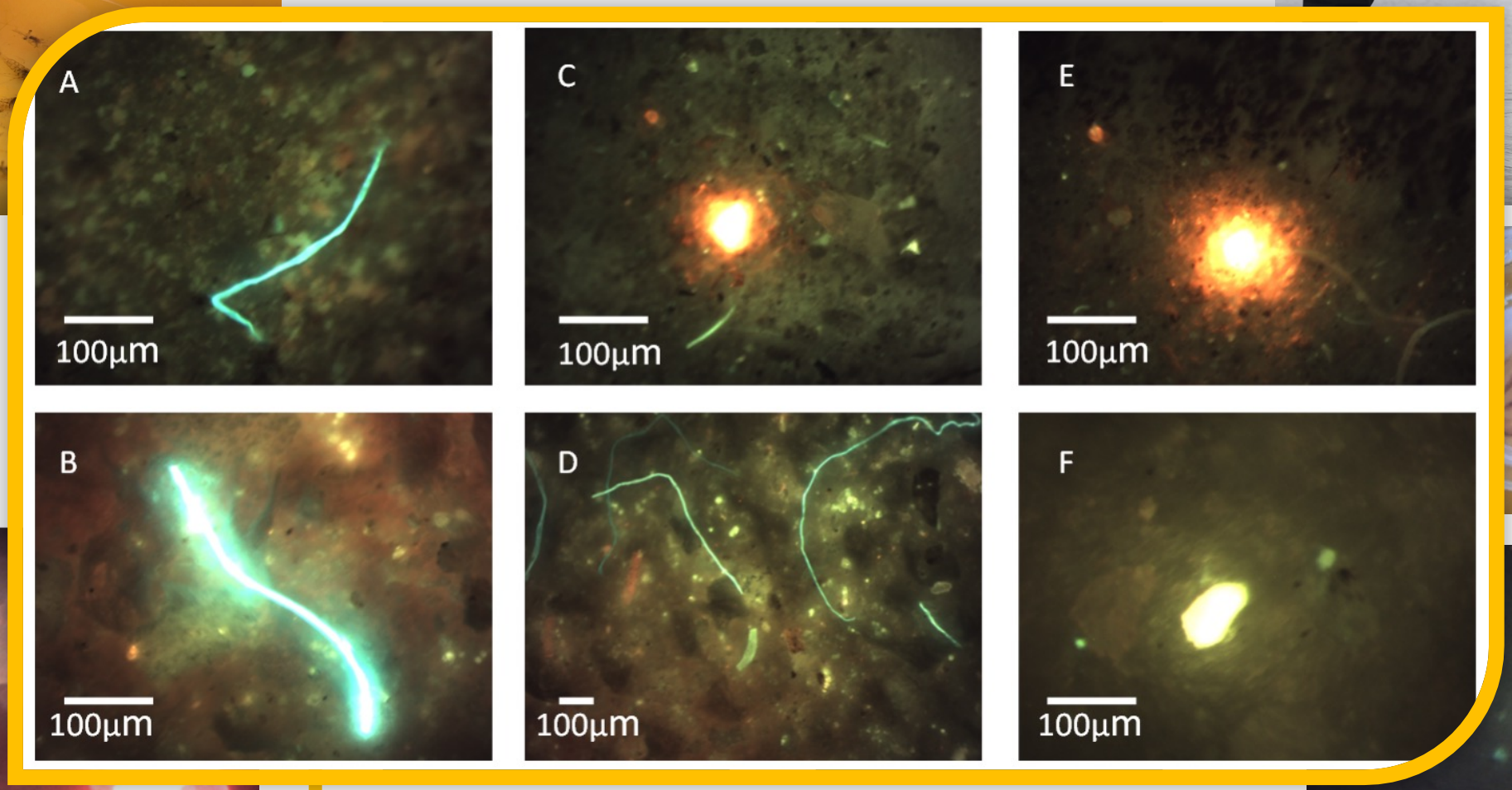
Location of Study Area and Sample Sites In Morecambe Bay

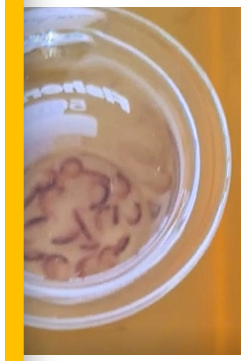
- 4 Rivers/Estuaries:
  - Leven river/estuary (LE)
  - Kent river/estuary (K)
  - Lune river/estuary (L)
  - Wyre river/estuary (W)
- 765 individual Macro-Invertebrates
- 11 different families of Macro-Invertebrates
- Marine/Brackish/Freshwater sites

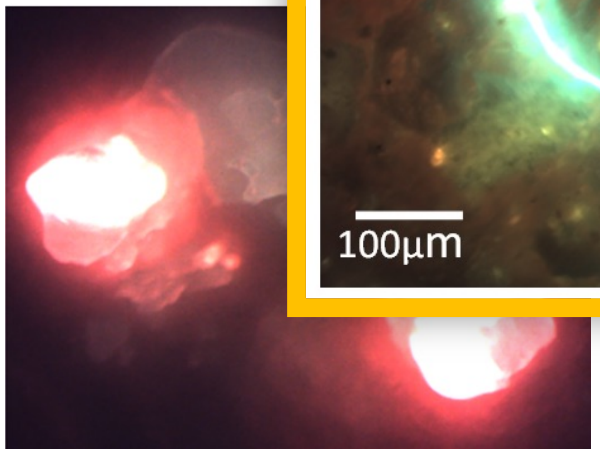
Method

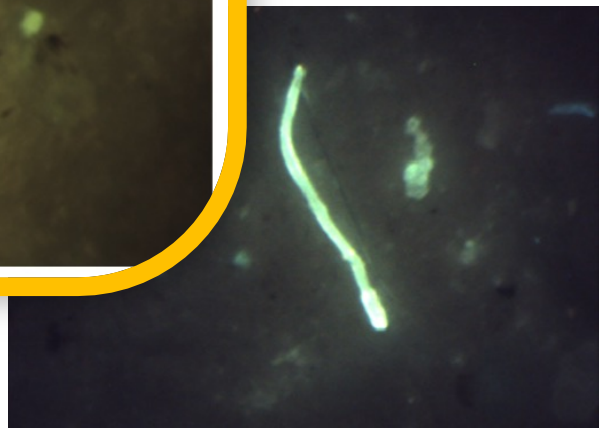








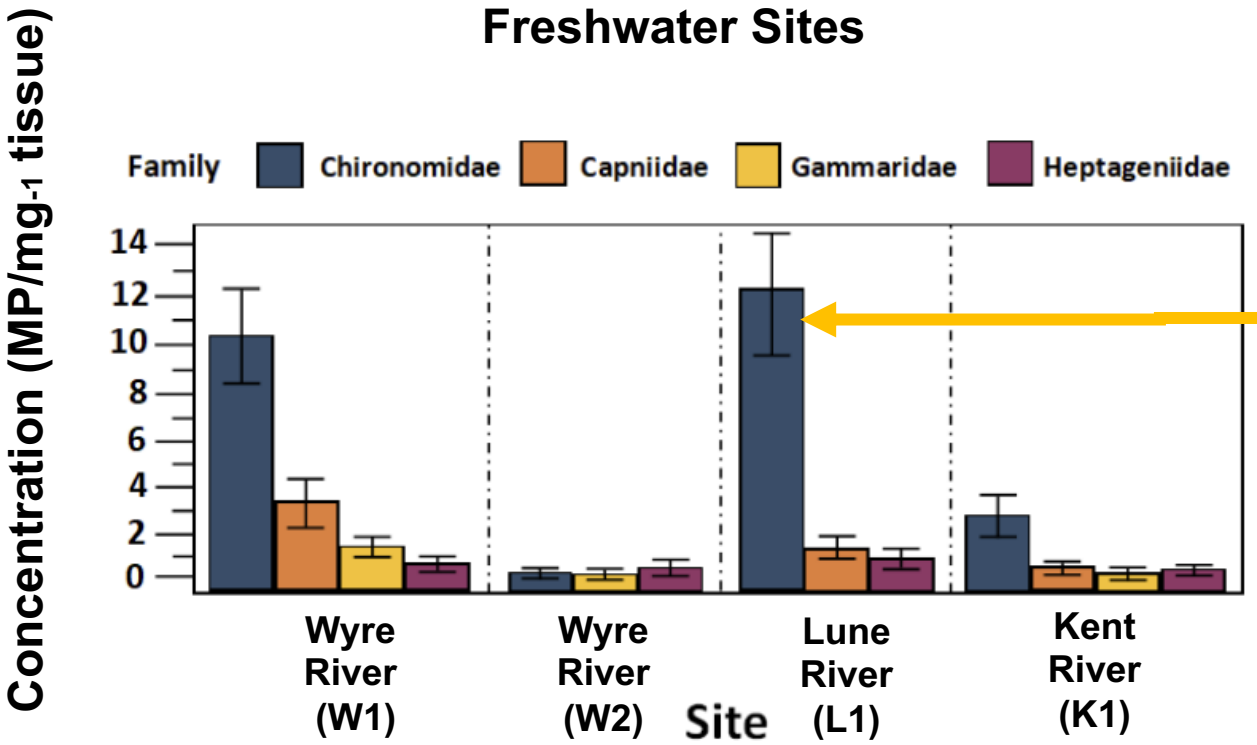




Identification

FT-IR

Field Study



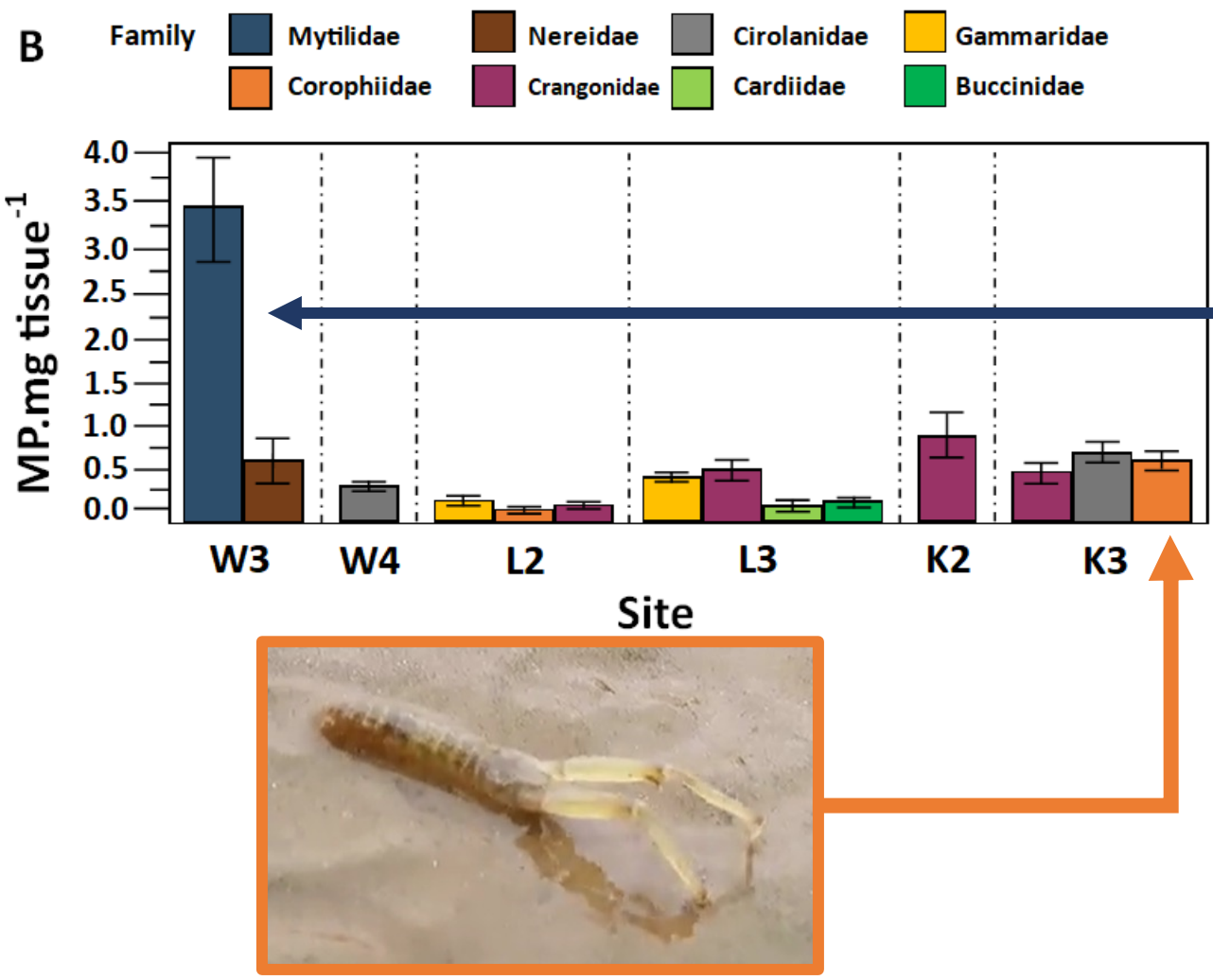
- ***Chironomidae*** had a **significantly higher** concentration of MP than all other organisms
- **All** sampled **organisms** contained plastic particles

Stonefly larvae

Amphipod

Mayfly larvae

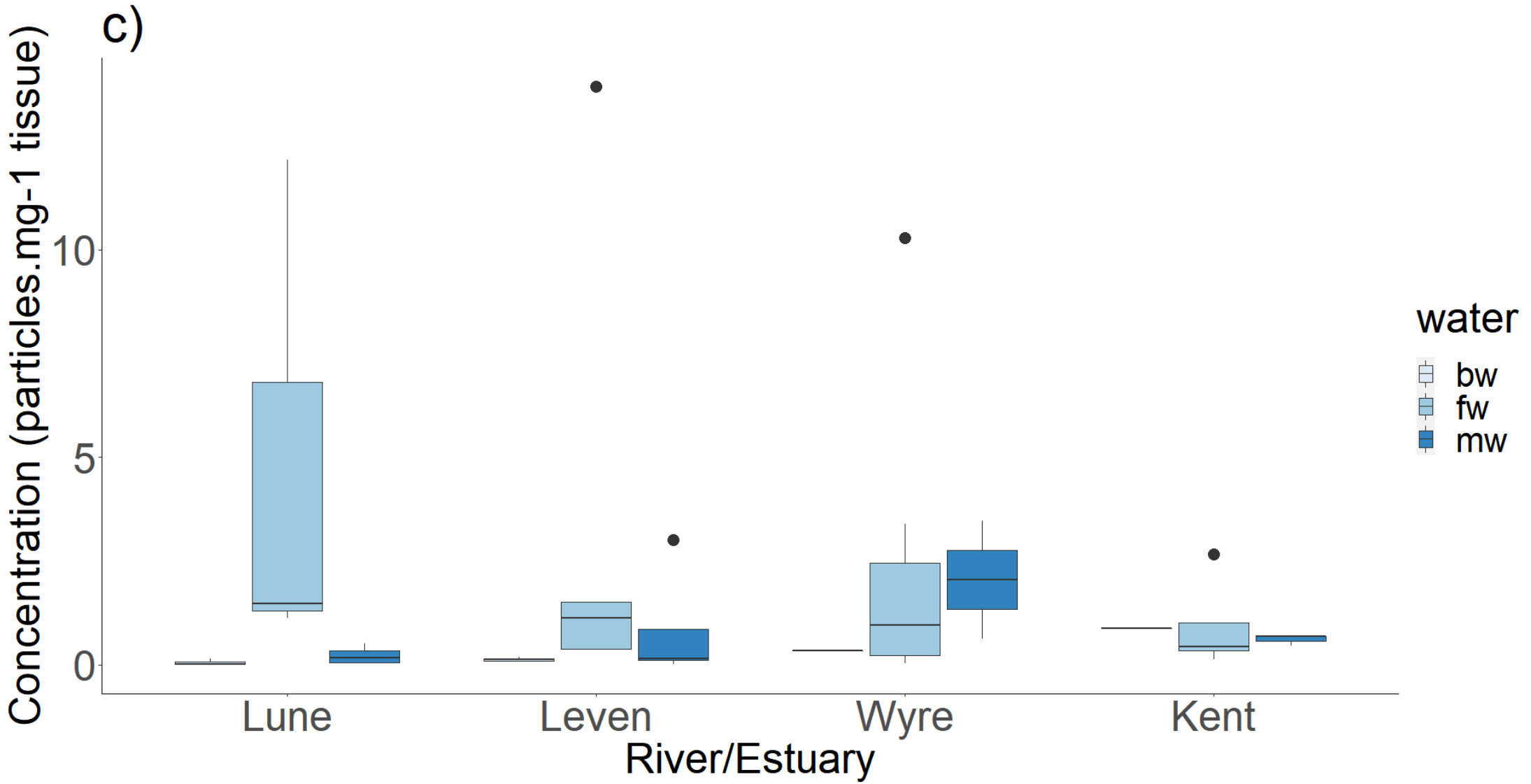
Field Study



Mussels

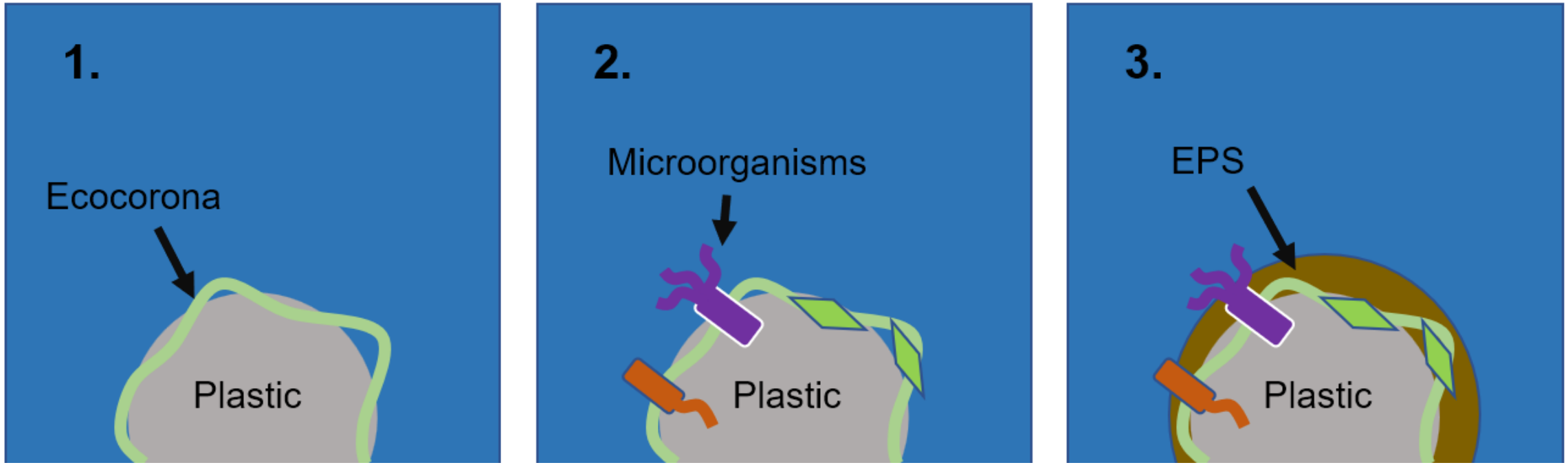
Mud Scud

Site differences

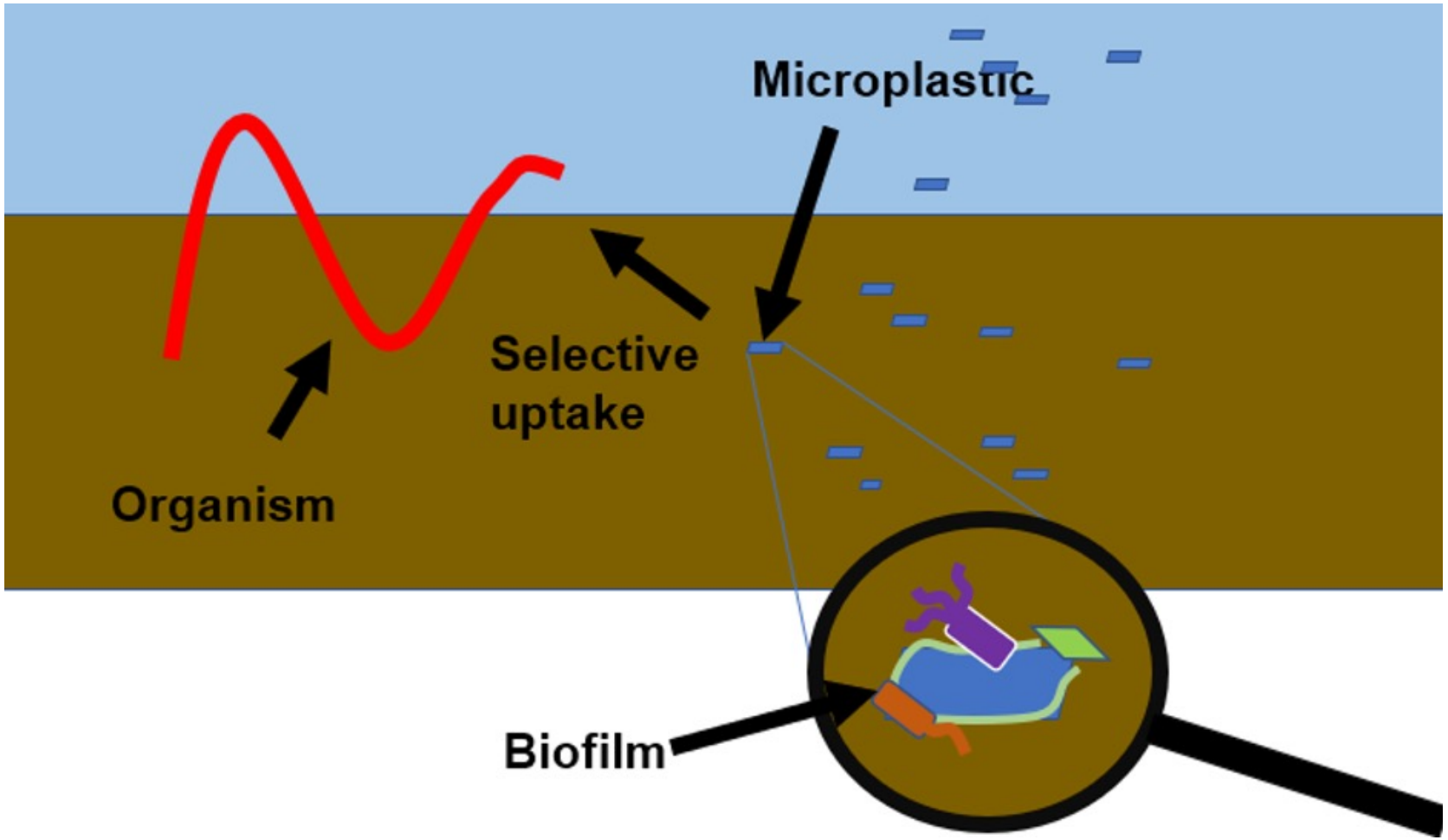


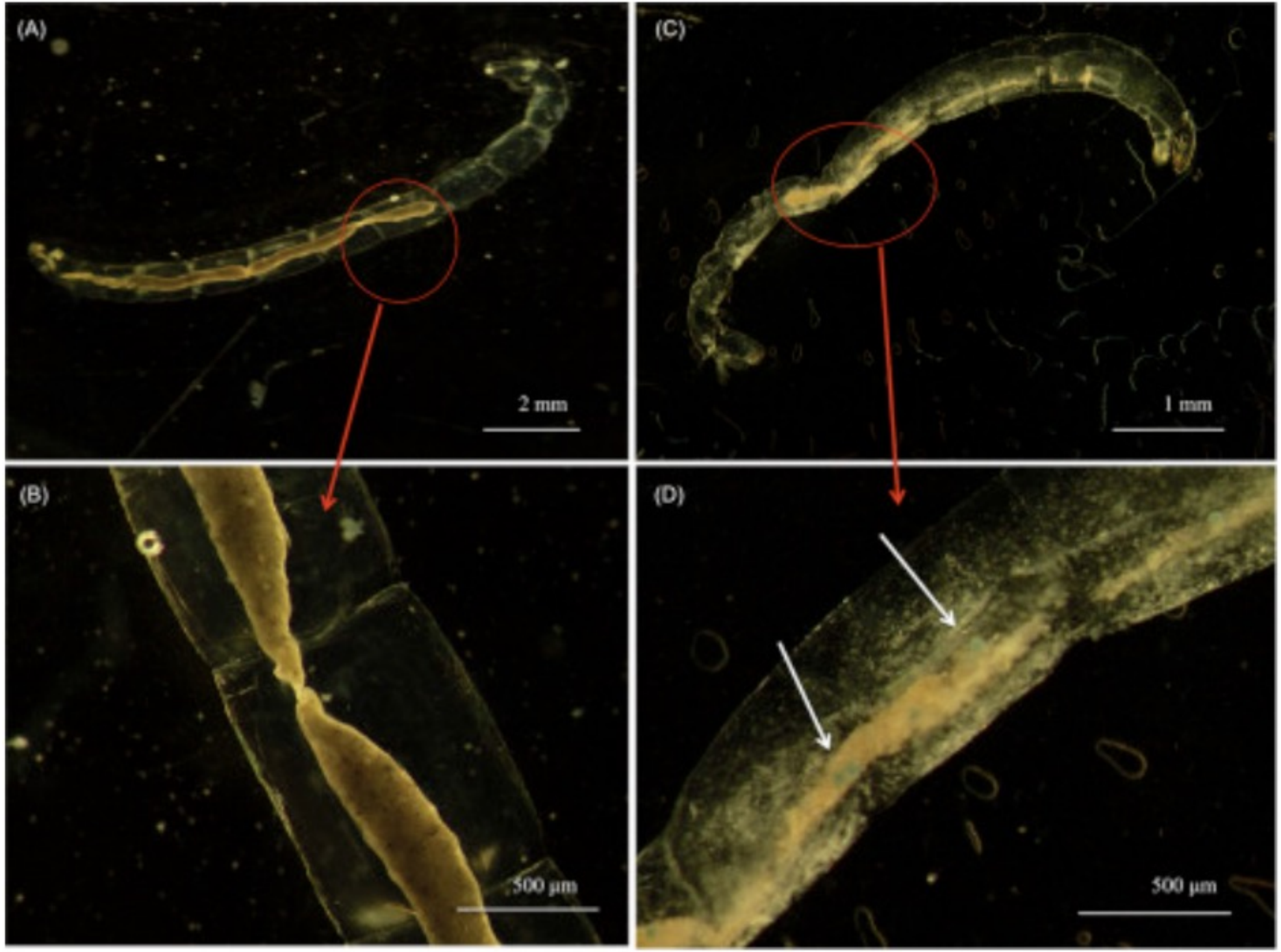
Exploring objective 2 - Microorganism colonization

Investigate the interactions between microplastic biofilms and aquatic macro-invertebrates in Morecambe Bay

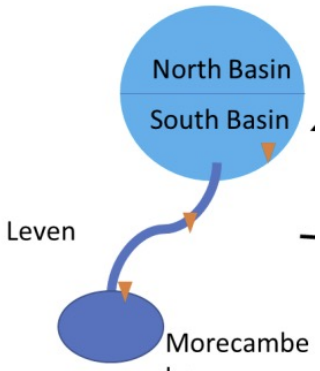


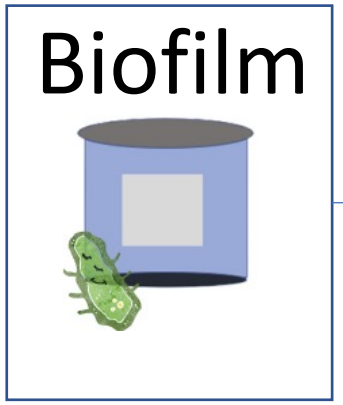
Exploring objective 2 - Microplastic Uptake

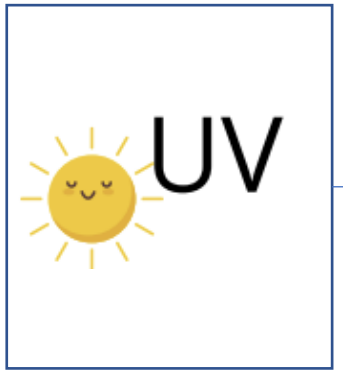



(A)
2 mm
(C)
1 mm
(B)
500 µm
(D)
500 µm

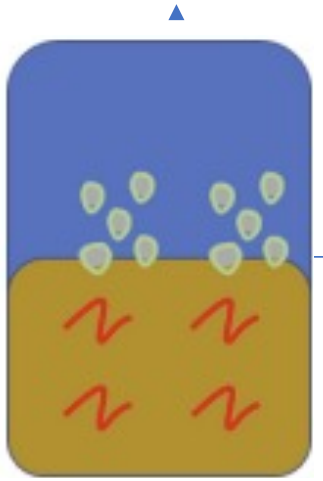
Method: Exploring objective 2







Three polymers **PET, PLA** & **Nylon**, with variation in biofilm and UV aging



Compare biofilms of different UV aged and non-UV aged polymers by 16s & 18s rRNA Sequencing & analysis using a microvolume spectrophotometer

examine the polymer surface chemistry Using X-Ray Photoelectron Spectroscopy (XPS)

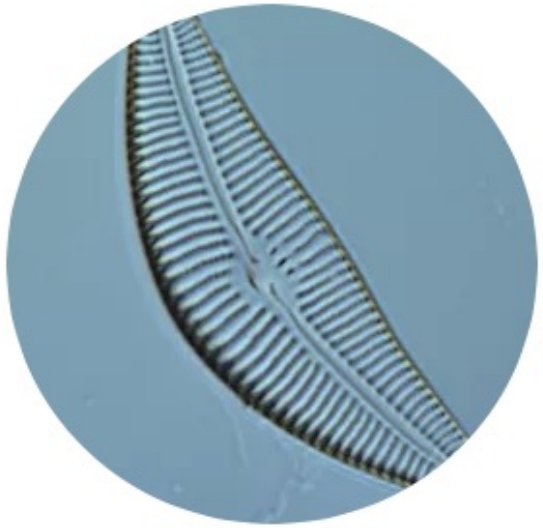
determine if all plastics are equally ingested

Investigate effects on macroinvertebrate growth

PhytoPlastic Project

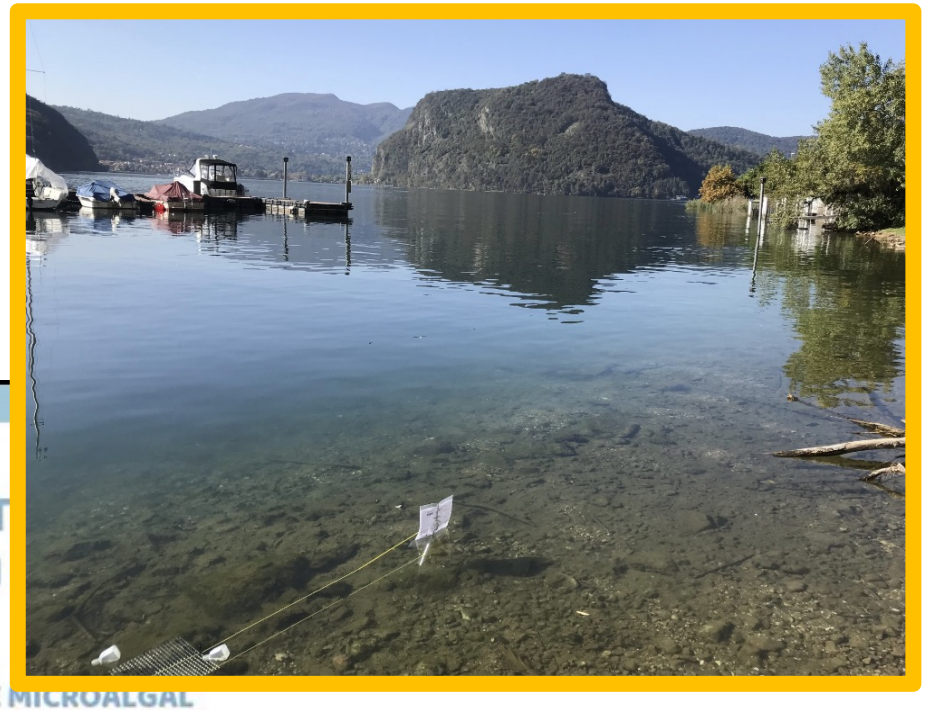
Quantify the **microalgae biomass** developed on microplastics with different polymeric composition and determine whether biomass vary significantly among substrates across a variety of aquatic systems

Identify the **microalgae species** that are able to develop on different substrates and understand whether plastics exert a strong enough selection to drive species sorting



Evaluate the **temporal and seasonal evolution** of the epiplastic community of microalgae in relation to several environmental variables

PhytoPlastic Project



TO JOIN THE 4T
AN FRESHPROJ
YTOPLASTIC"

STIC, IT'S FANTASTIC: UNRAVELLING THE MICROALGAL
F PLASTISPHERE ACROSS EUROPEAN LENTIC SYSTEMS

Following

PhytoPlastic
@PhytoPlastic Follows you

"Life in plastic, it's fantastic: unravelling the microalgal community of plastisphere across European lentic systems" - funded by @EFFS_EFYR

Summary

Part 1 – Plastics & Microplastics

- Sources – mass production since the 1950's
- Transport – move throughout all spheres in the environment
- Fate – ubiquitous in nature, organisms at the base of aquatic

Food webs interact with them

Part 2 – Macroinvertebrates & Microplastics interactions in Morecambe Bay

- All macroinvertebrates investigated ingested Microplastic in Morecambe bay
- Impacts on palatability and impacts on growth and survival
- PhytoPlastic project

Thankyou for listening

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