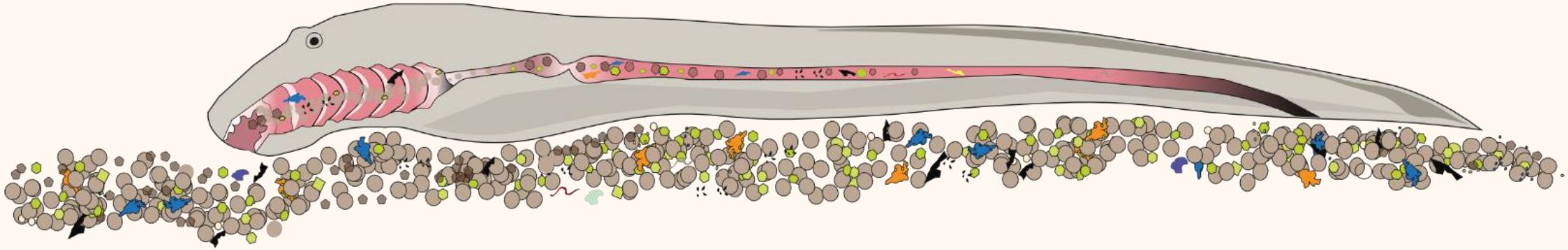
From the Environment Into the Biomass: Microplastic Uptake in a Protected Sediment Dwelling Species



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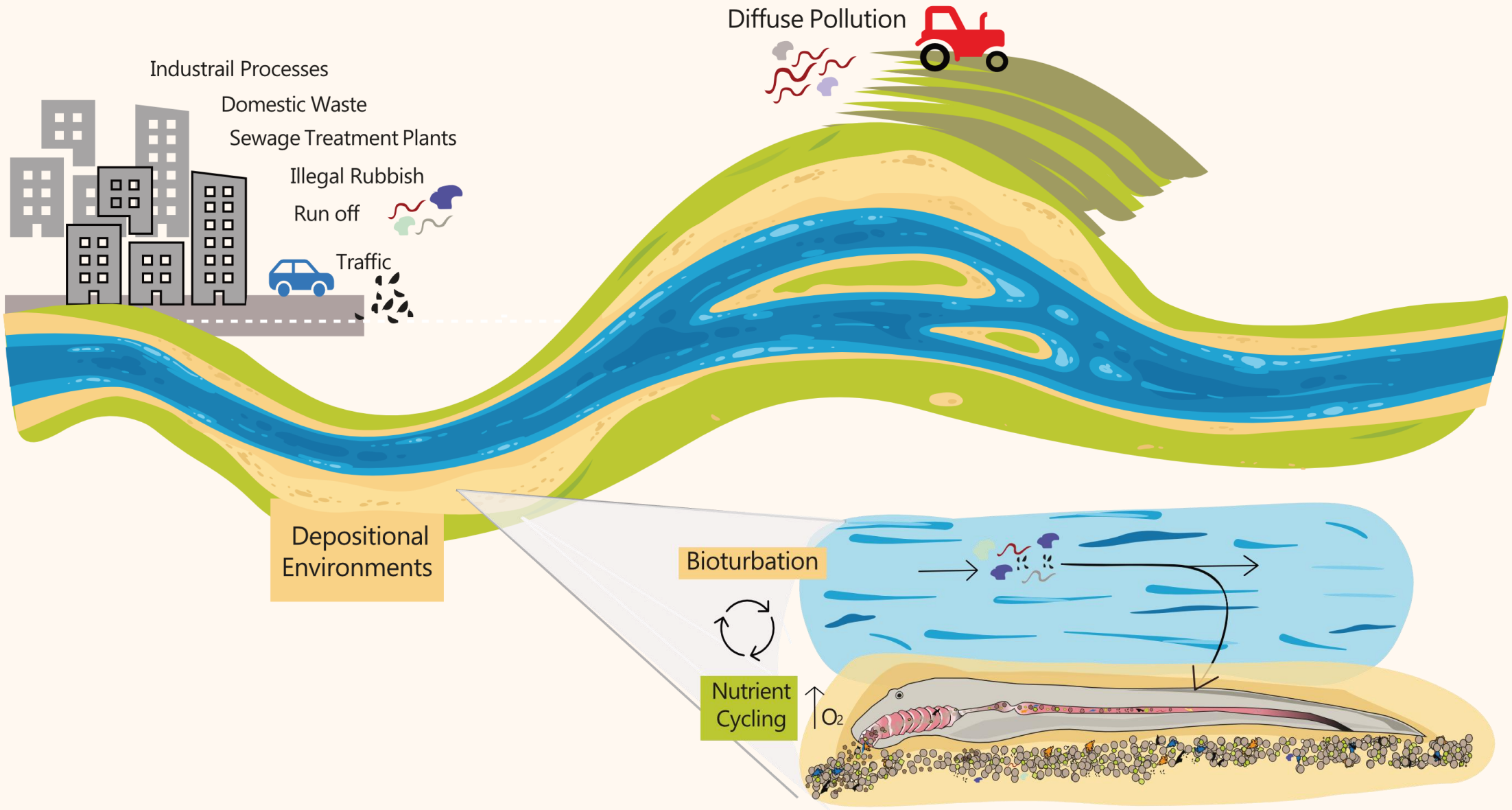
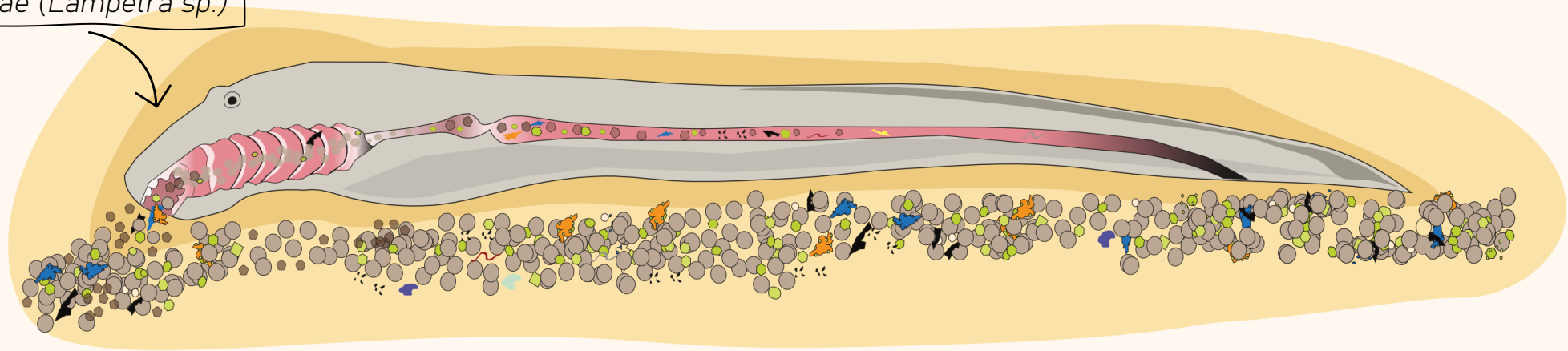

Diffuse Pollution
Industrail Processes
Domestic Waste
Sewage Treatment Plants
Illegal Rubbish
Run off
Traffic
Depositional Environments
Bioturbation
Nutrient Cycling
O2

Protected species in UK

Detritivores

Freshwater species

Lamprey larvae (Lampetra sp.)



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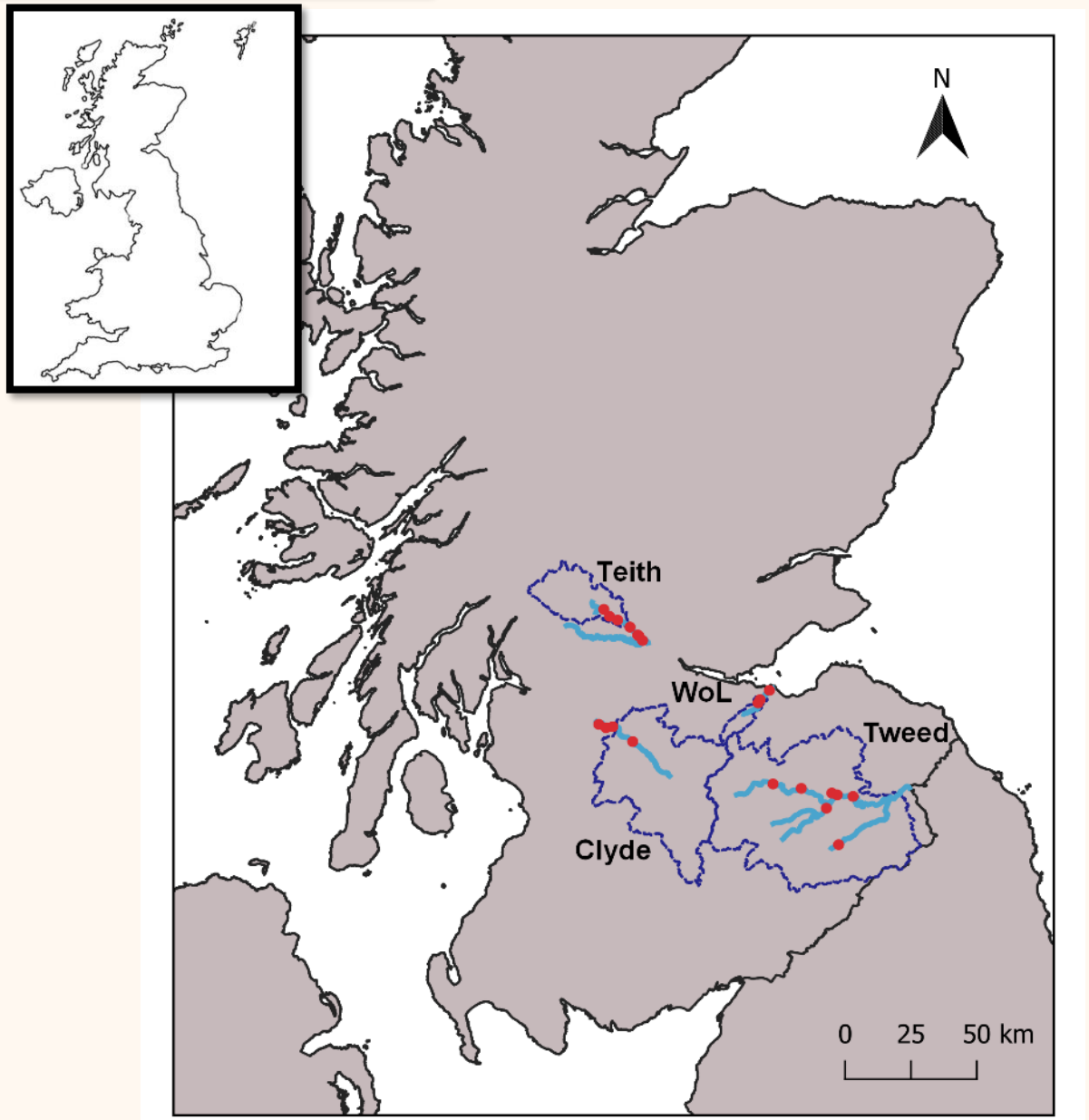
Depositional habitat

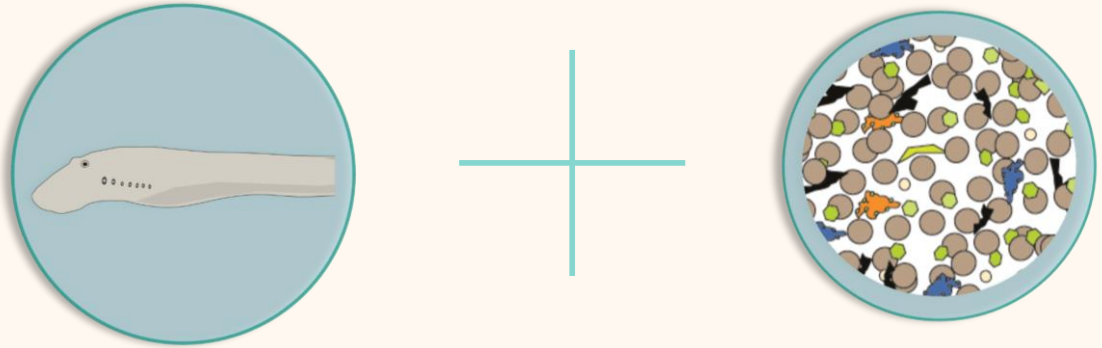
Lengthy benthic residence times

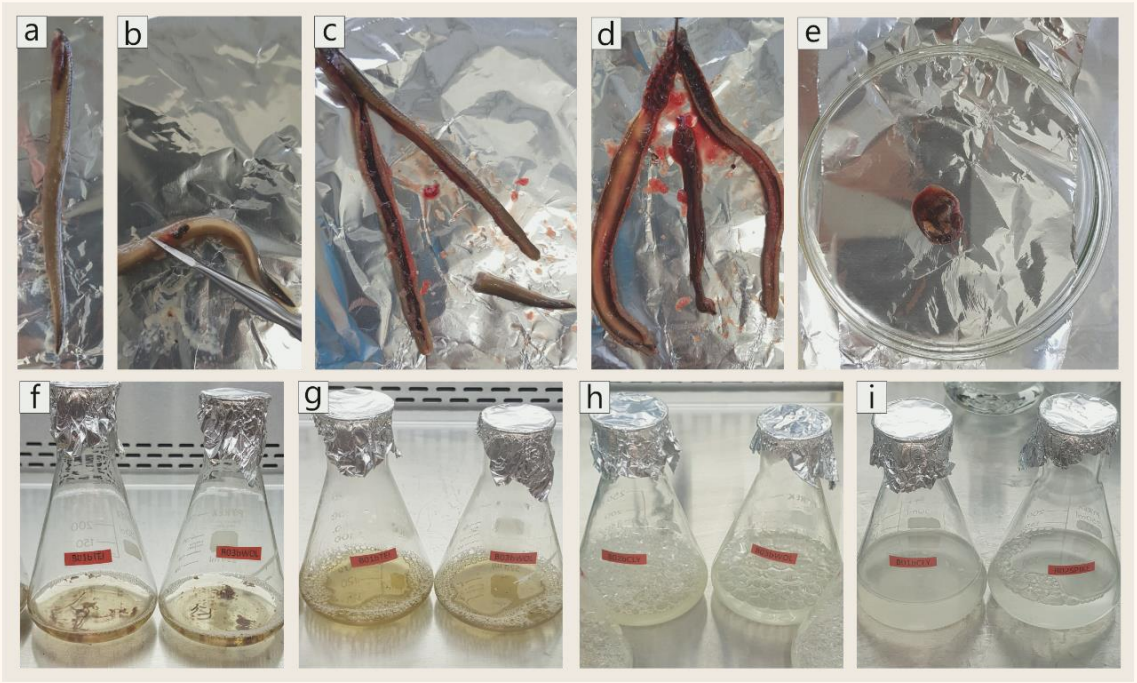
Passive particle selection

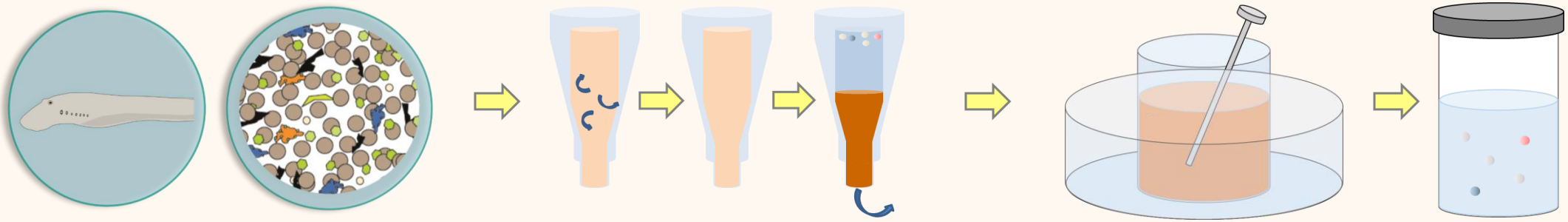
Objectives of the work:

- Document microplastics in **sediment** and **lamprey** from both **urban sites** and **special areas of conservation**
- Analyse the microplastic **particle count, polymer type and size**
- Identify whether there is a **relationship** between **number and type of microplastics** found in **lamprey and the sediment they inhabit**

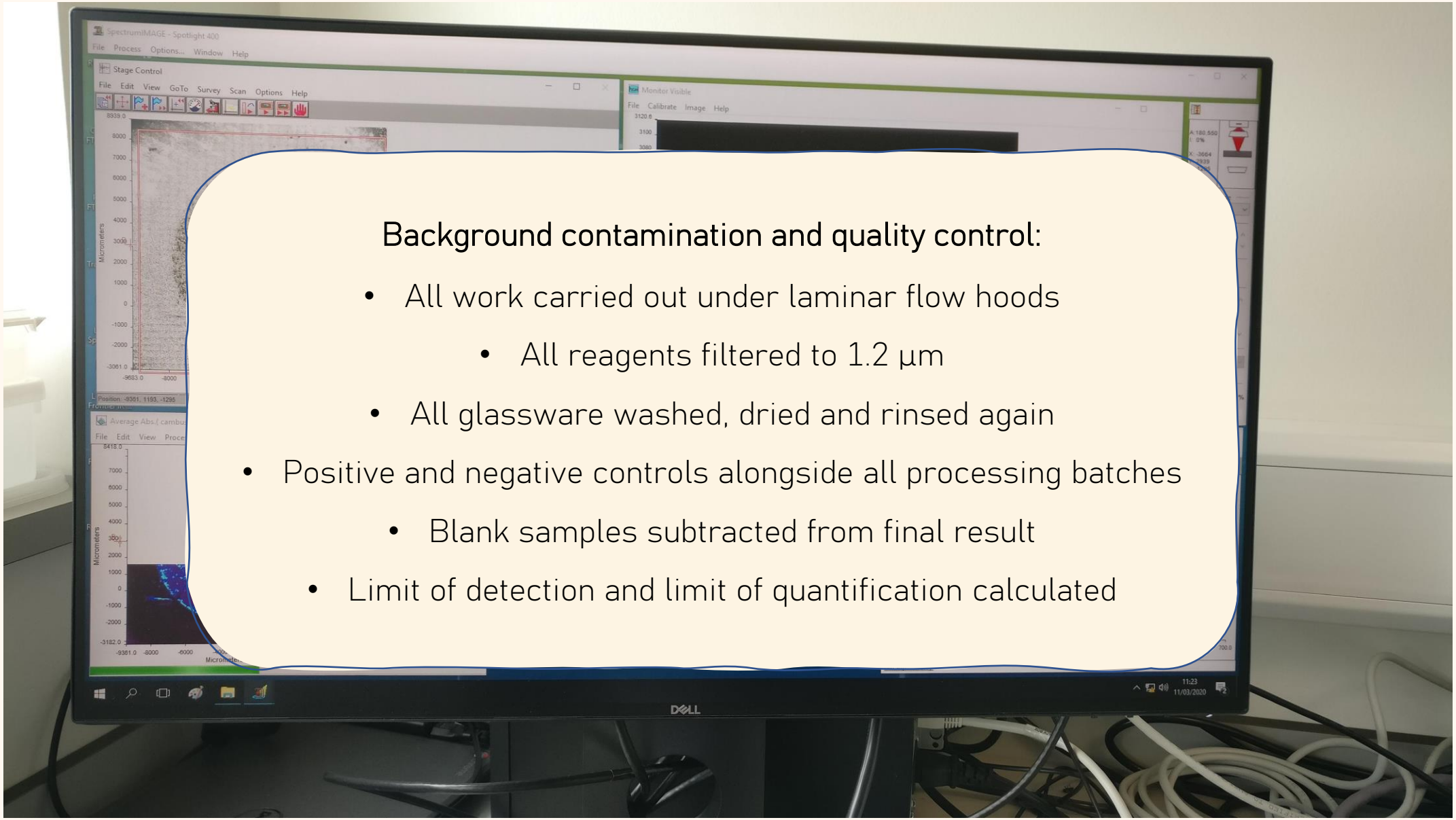

N
Teith
WoL
Tweed
Clyde
0 25 50 km




a
b
c
d
e
f
g
h
i

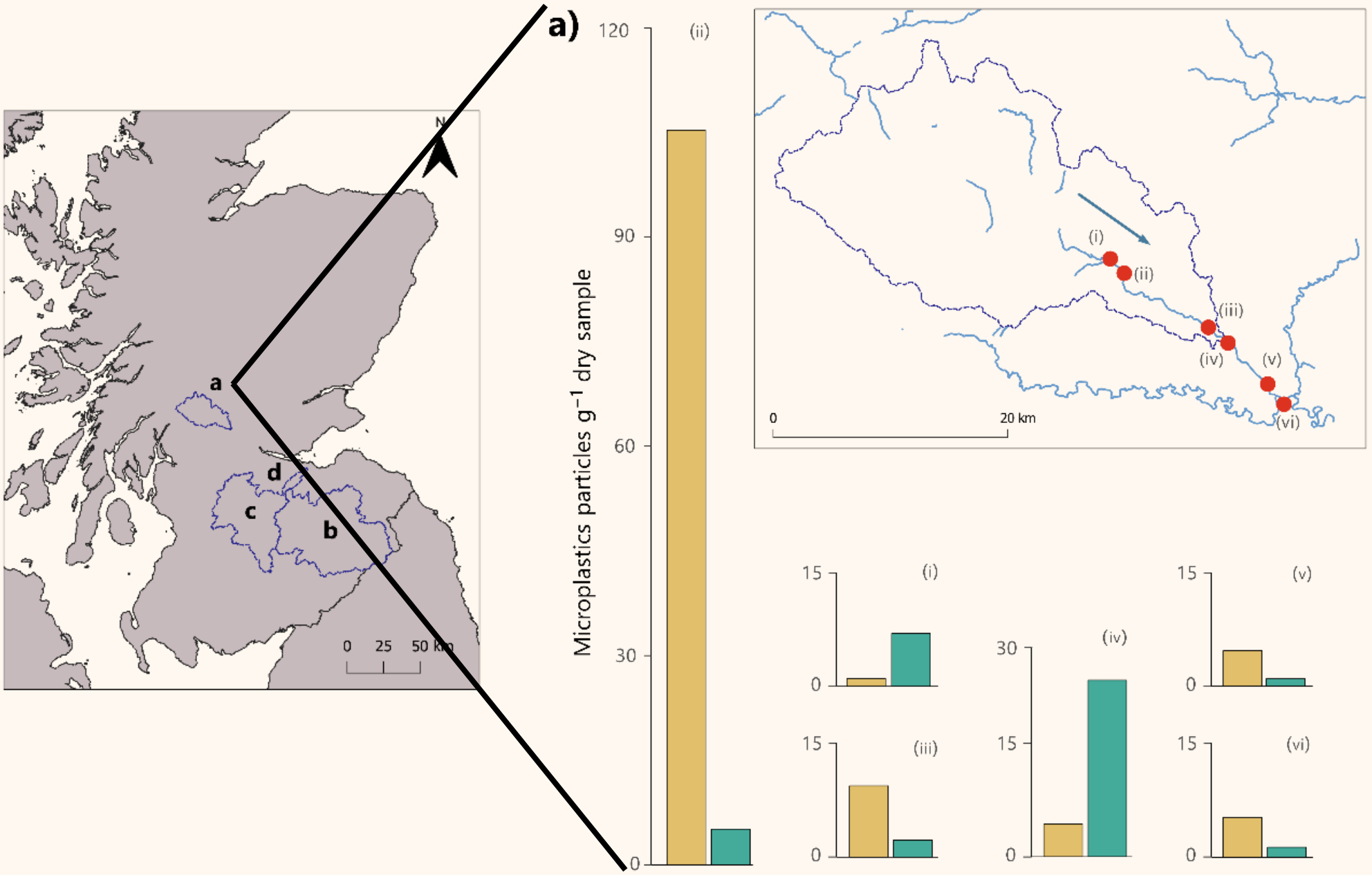


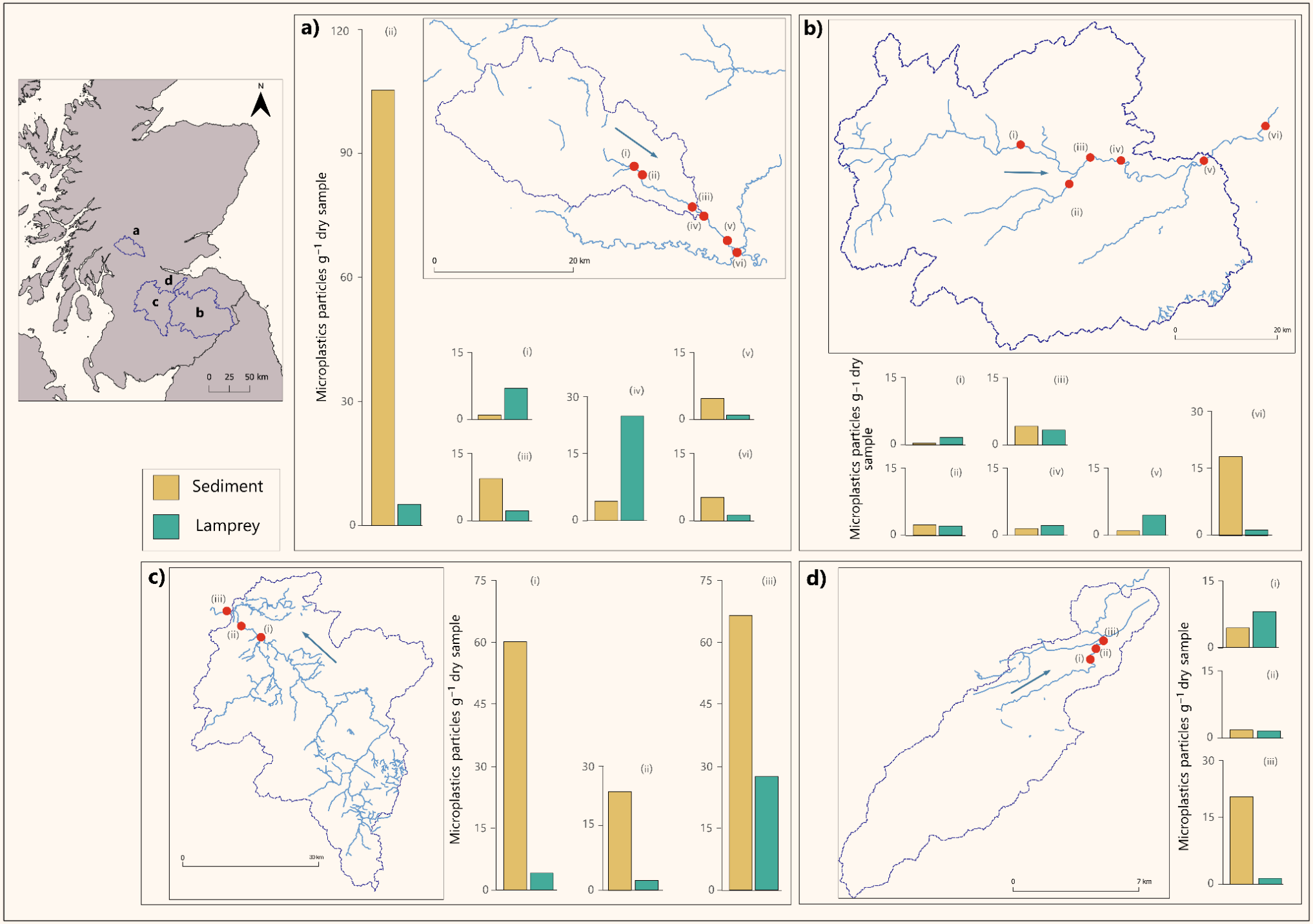

SØ2TW
SØ1WOL
SØ3WOL
SØ1TWF
SØ1TW
SO3TEI
SO5TW
SO4TW



Background contamination and quality control:

- All work carried out under laminar flow hoods
- All reagents filtered to 1.2 µm
- All glassware washed, dried and rinsed again
- Positive and negative controls alongside all processing batches
- Blank samples subtracted from final result
- Limit of detection and limit of quantification calculated

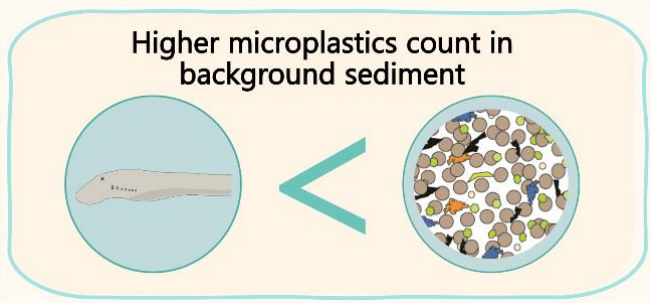

a)
N
a
b
c
d
0 25 50 km
Microplastics particles g^{-1} dry sample
120
90
60
30
0
(ii)
(i)
(ii)
(iii)
(iv)
(v)
(vi)
0
20 km
15
0
30
Sediment
Lamprey


a
b
c
d
N
0 25 50 km
Sediment
Lamprey
Microplastics particles g^{-1} dry sample
120
90
60
30
0
(i)
(ii)
(iii)
(iv)
(v)
(vi)
0 20 km
Microplastics particles g−1 dry sample
15
30
0 30 km
75
45
0 7 km

Key findings

Particle count

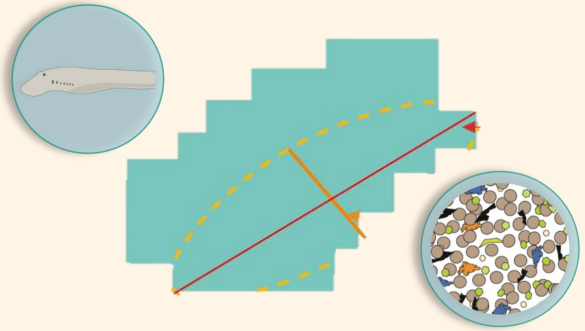
Different patterns within sites



UBIQUITOUS

Particle Size

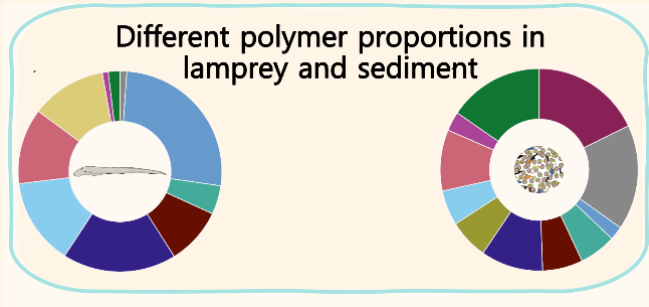
Similar patterns between sediment and lamprey



NOT SELECTIVE

Polymer type

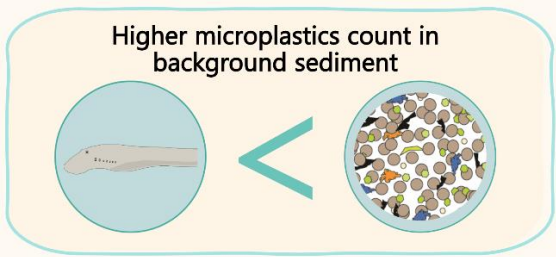
Different patterns within sites



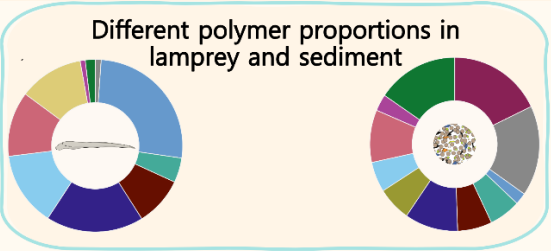
DIFFERENT UPTAKE?

Why do we see different patterns between sediment and larvae?

Particle count



Polymer type



(1) Downstream drift of lamprey larvae (White and Harvey, 2003)

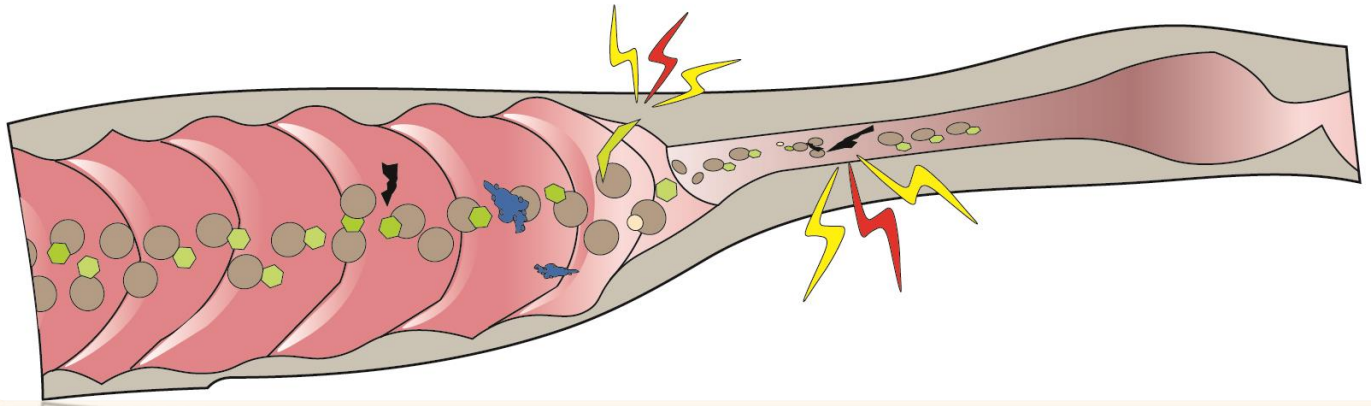
(2) Gut passage time (Evans, Bellamy and Bauer, 2019)

(3) Microplastic characteristics (Borges-Ramírez et al., 2020)

(4) Retention of specific microplastic types (Lahive et al., 2022)

So what?

Could microplastic contamination of this level have physiological impacts?



Pre-requisite for internal tissue damage and food dilution

(Koelmans et al., 2020; Usman et al., 2021; Amariei et al., 2022)

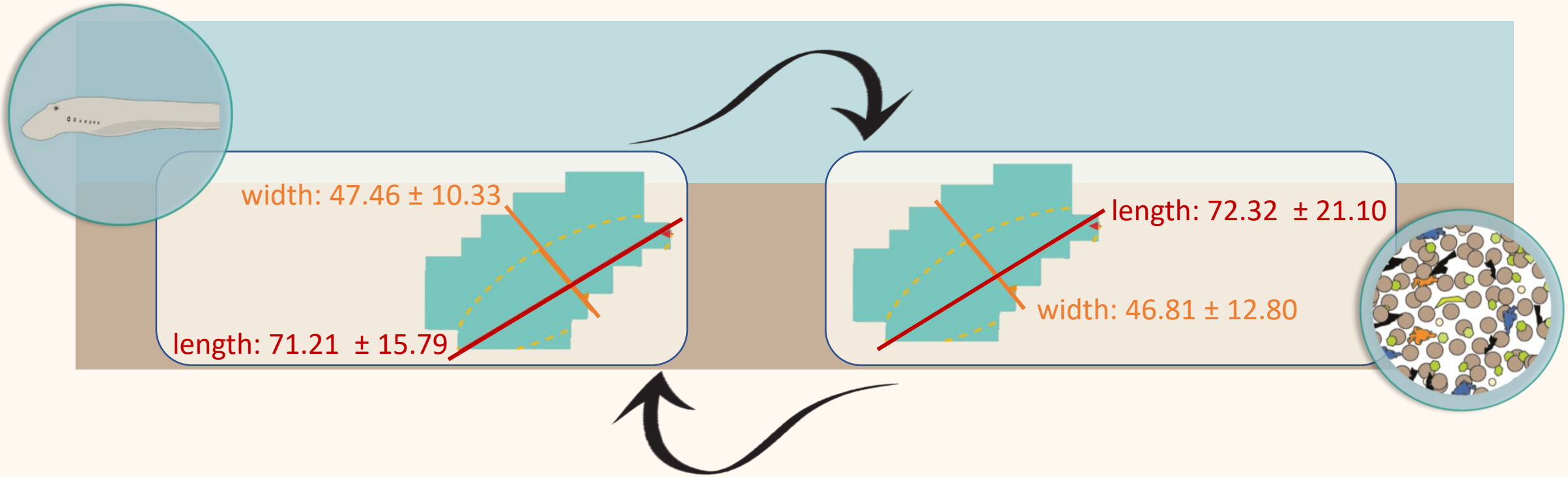
At greatest level of exposure 0.13 % intestine occupied by microplastics

Volume very low compared to the total cavity volume of the gut

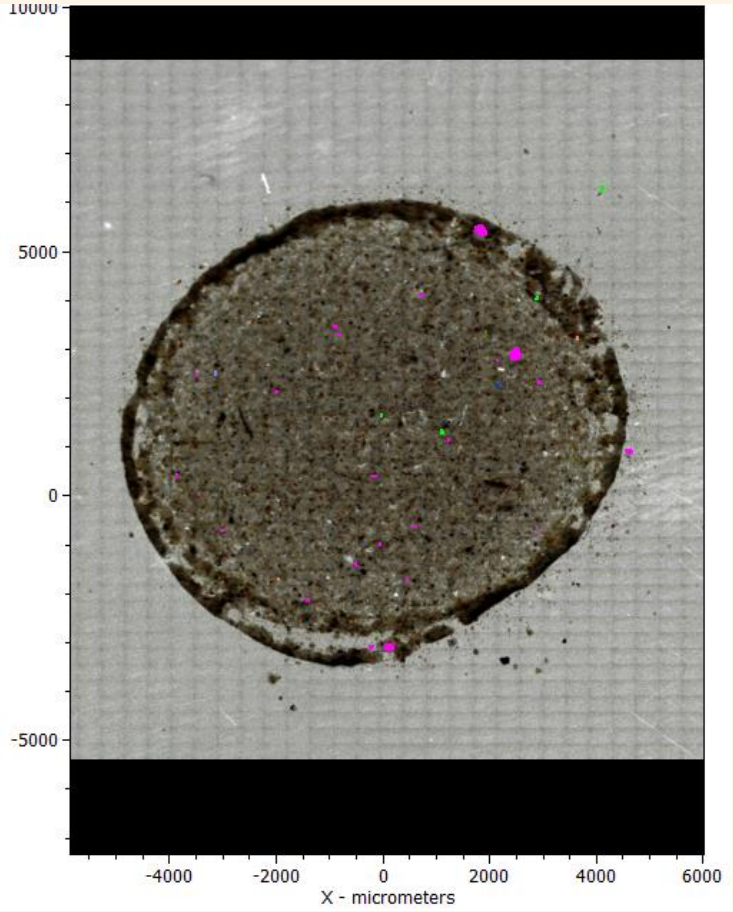
Ubiquitous presence demonstrated, but currently there is uncertainty around the risks

What have we learnt?

Lamprey larvae ingest microplastics
They are **not selective in the size** of microplastics ingested
Some **selectivity for polymer types** that may affect risk



Challenges in quantifying microplastics in environmental and biota samples



No one technique can identify and quantify all microplastics

- Size range varies
- Material type – polymer databases

Complex organic matrices

- Reduce organic material to a minimum to allow identification of synthetics

Contamination control and documentation is extremely important

- Clean, specified areas to work i.e. laminar flow hoods
- Glassware and equipment cleaning
- Blanks, blanks, blanks + blank correction + limit of detection + limit of quantification

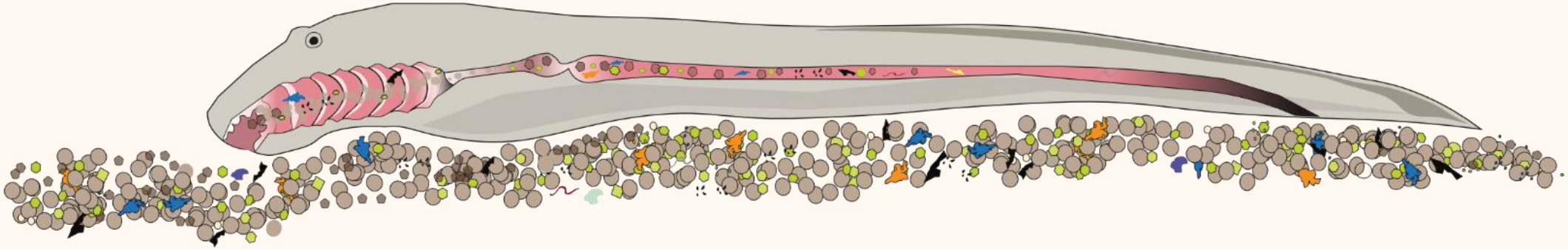
How many microplastics are we retaining through the sample processing?

- Densities of polymers
- Losses with sample filtration
- Document with positive spiked controls with varying density polymers

Knowledge gaps and future work

- What are the ecotoxicological impacts of microplastic ingestion for lamprey larvae?
- What are the roles of lamprey larvae in the movement of microplastics between sediment layers?
- Does microplastic ingestion impact ecosystem services that lamprey larvae provide?

Thank you, any questions?



Many thanks go to my supervisory team and all those who have offered valued advice.

Thanks also to local fisheries boards, landowners, the Forth Rivers Trust and the Water of Leith Conservation Trust.

UK Centre for Ecology & Hydrology

Natural Environment Research Council

NatureScot NàdarAlba

UNIVERSITY of STIRLING

IAPETUS2 Doctoral Training Partnership

University of Glasgow

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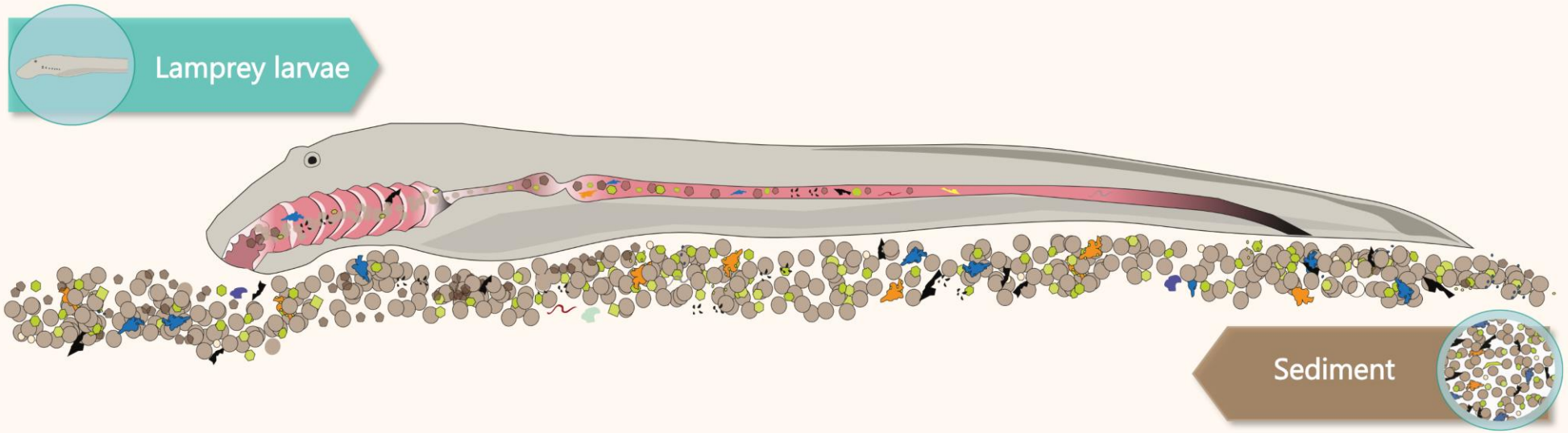
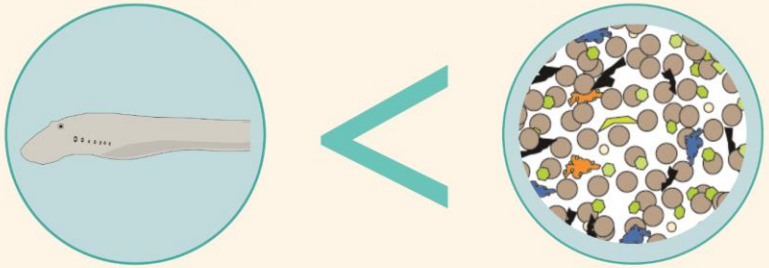
From the Environment into the Biomass

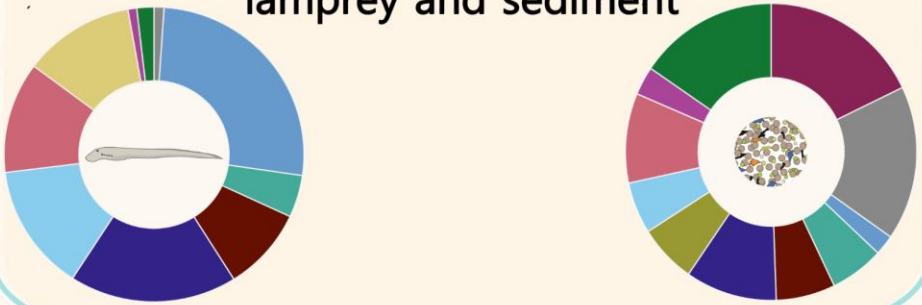
Microplastics dectected in threatened fish within Special Areas of Conservation

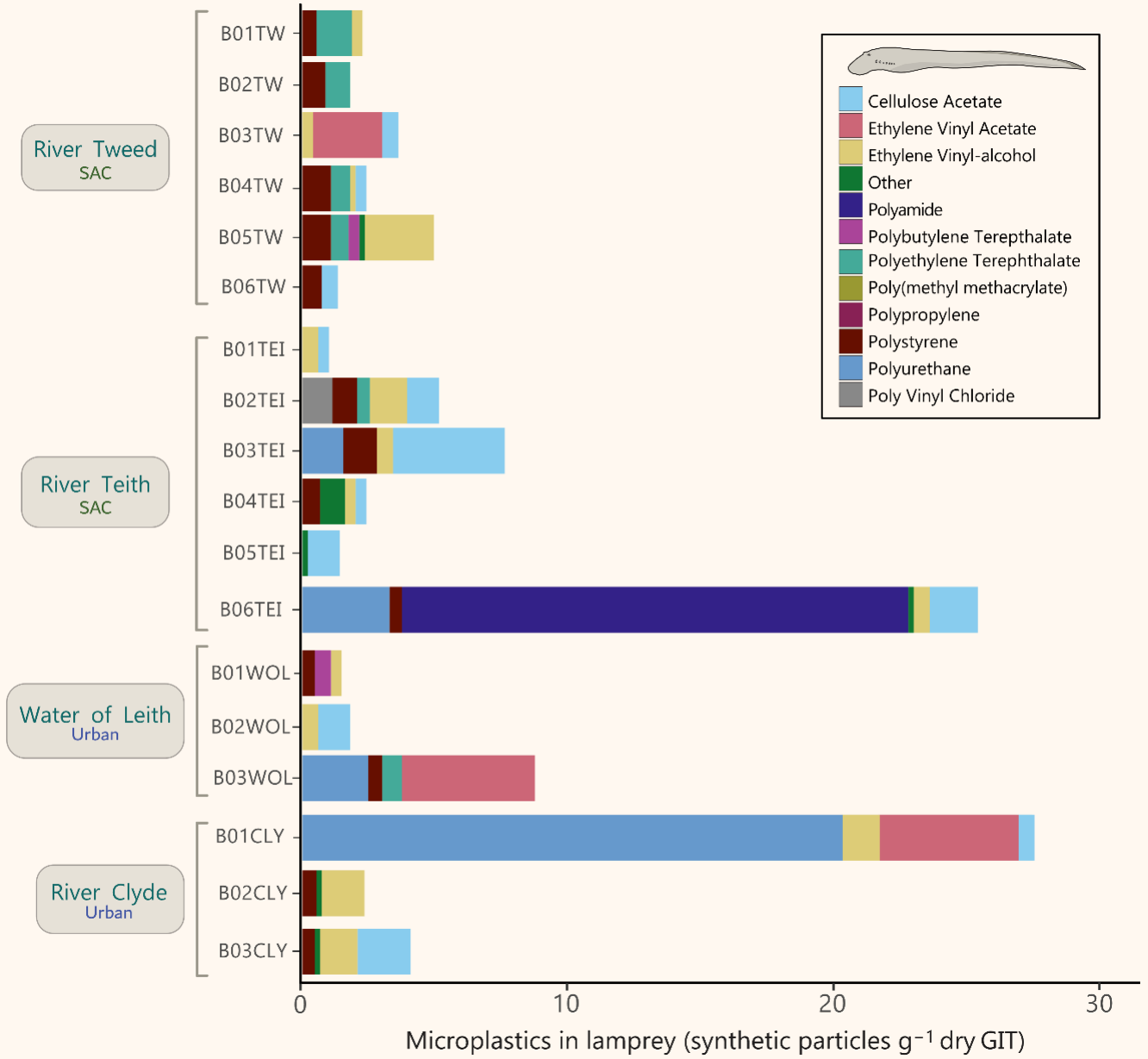


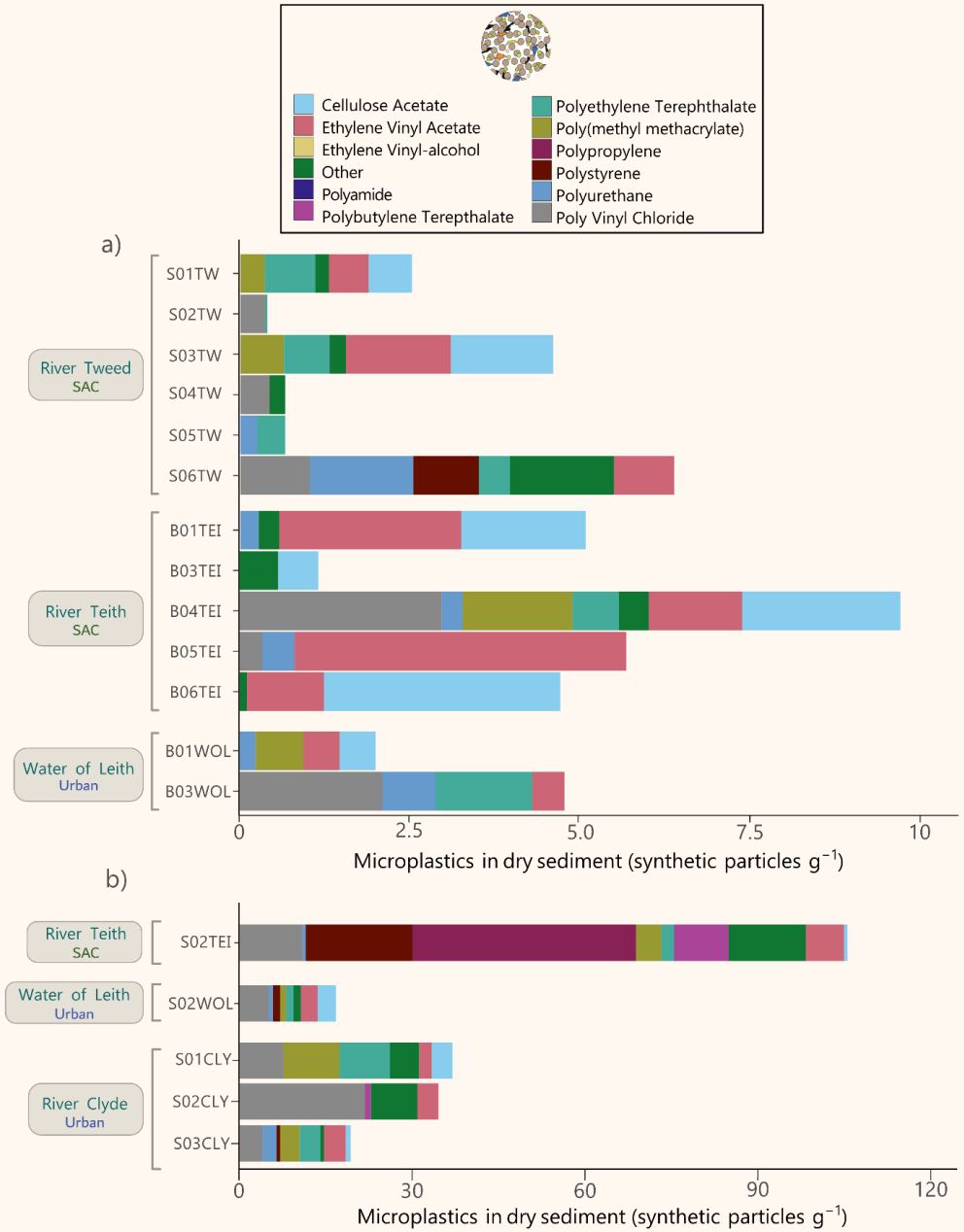
Higher microplastics count in sediment compared with lamprey



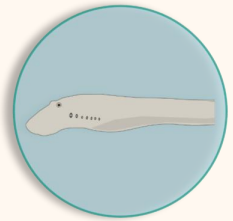
Main polymer types differed between lamprey and sediment

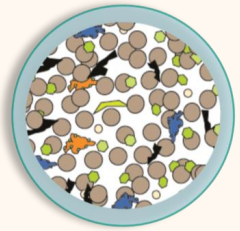



River Tweed
SAC
River Teith
SAC
Water of Leith
Urban
River Clyde
Urban
B01TW
B02TW
B03TW
B04TW
B05TW
B06TW
B01TEI
B02TEI
B03TEI
B04TEI
B05TEI
B06TEI
B01WOL
B02WOL
B03WOL
B01CLY
B02CLY
B03CLY
Cellulose Acetate
Ethylene Vinyl Acetate
Ethylene Vinyl-alcohol
Other
Polyamide
Polybutylene Terepthalate
Polyethylene Terephthalate
Poly(methyl methacrylate)
Polypropylene
Polystyrene
Polyurethane
Poly Vinyl Chloride
0
10
20
30
Microplastics in lamprey (synthetic particles g⁻¹ dry GIT)


Cellulose Acetate
Ethylene Vinyl Acetate
Ethylene Vinyl-alcohol
Other
Polyamide
Polybutylene Terepthalate
Polyethylene Terephthalate
Poly(methyl methacrylate)
Polypropylene
Polystyrene
Polyurethane
Poly Vinyl Chloride
a)
River Tweed SAC
S01TW
S02TW
S03TW
S04TW
S05TW
S06TW
River Teith SAC
B01TEI
B03TEI
B04TEI
B05TEI
B06TEI
Water of Leith Urban
B01WOL
B03WOL
0
2.5
5.0
7.5
10
Microplastics in dry sediment (synthetic particles g−1)
b)
River Teith SAC
S02TEI
Water of Leith Urban
S02WOL
River Clyde Urban
S01CLY
S02CLY
S03CLY
0
30
60
90
120
Microplastics in dry sediment (synthetic particles g−1)

Key findings





(3) The average microplastic particle count across sites will be lower in hydrometric catchments classified as SACs