UK Centre for Ecology & Hydrology

# Deposition of airborne microplastics to vegetation

Felicity Hayes, Ruairidh Cox, Richard Cross, Alexandra Howard, Mike Perring, Sarah Roberts, Katrina Sharps

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# Overview

Adapted from a long-established moss biomonitoring programme looking at airborne deposition of metals, N, and POPs across Europe

UK survey (52 sites)

European survey (~90 sites, preliminary results)

# Sampling Strategy

Sampling sites are at least 300 m from main roads and 100 m from any road or single house – focus on rural atmospheric deposition.  - but a couple of exceptions including some semi-urban country parks

Branched ‘feathery’ mosses that do not take material from the substrate

Material representing the last 2-3 years growth segments are used for analysis

Pleurozium schreberi


Hylocomium splendens

# (unplanned) Citizen science – type collection

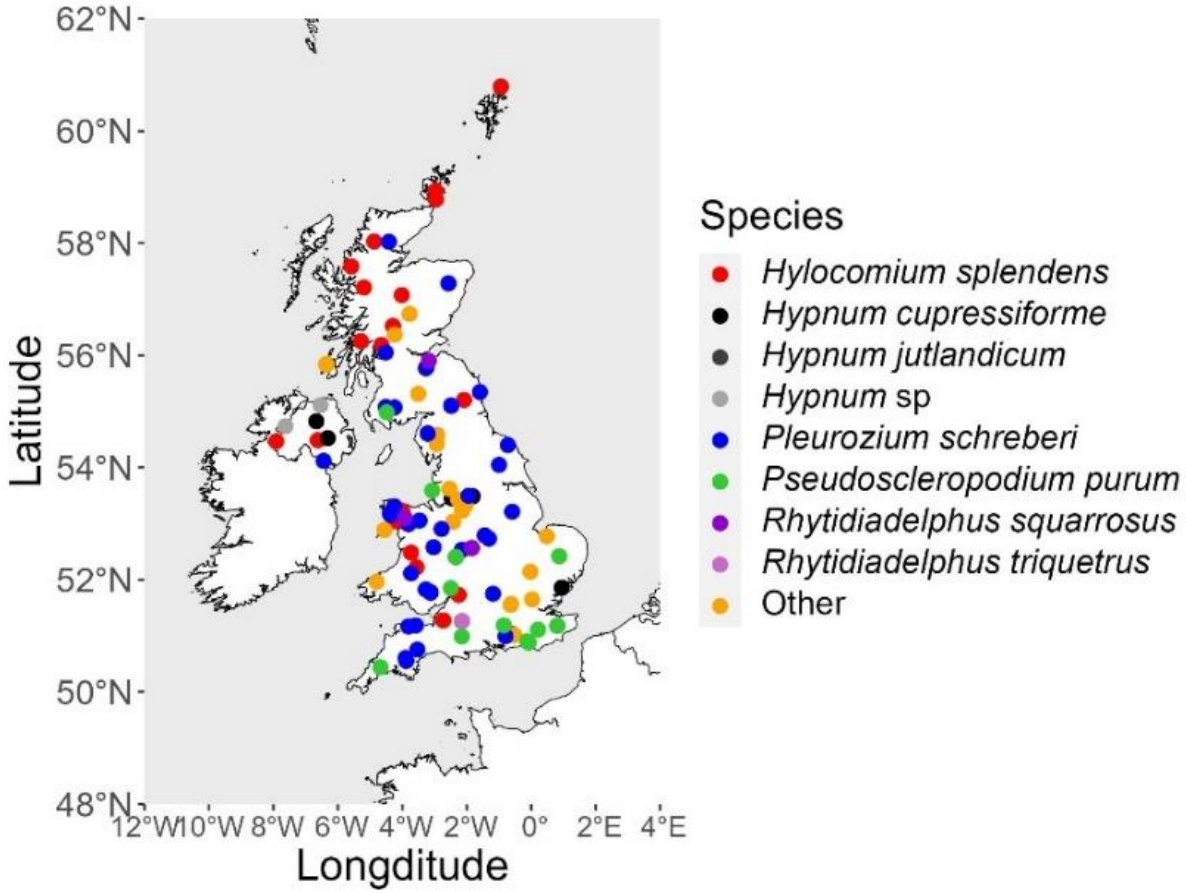
Reliance on local collectors

Some samples could not be used

Some regions weren't fully covered

Some areas better covered

More variety in moss species



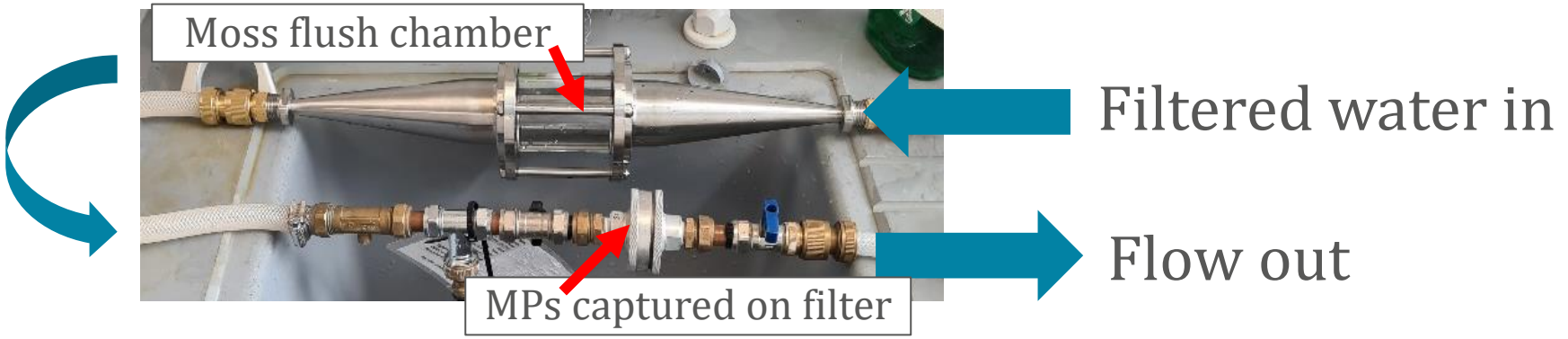
# Rational behind the sample analysis

Moss stomata are <10 µm in diameter (e.g. Caine et al., 2020)

The FTIR routinely runs at a resolution of 25 µm

Therefore, we are targeting microplastics that have deposited onto the moss and are entangled and within the superstructure of the moss, not within moss tissues

This allows us to use high flow displacement with water, rather than digestions to flush large masses of moss (~10 g) whereas digestion can only handle <1 g → more representative samples



# Sample processing overview

| 1. Moss flushed (100L filtered water) | 2. Combined with agitation flush | 3. Fenton's reaction | 4. Density separation | Material removed via density separation | 5. Deposited on silver membrane |
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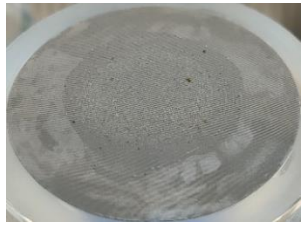
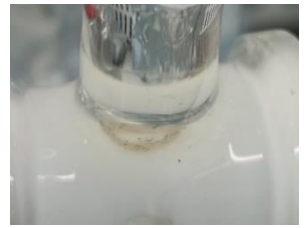
|  |  |  |  |  |  |

| 6. Whole deposited area of silver filter imaged used FTIR (25 µm pixel size) | 7. Analysis of infrared FTIR scan using Purency Microplastics Finder | |
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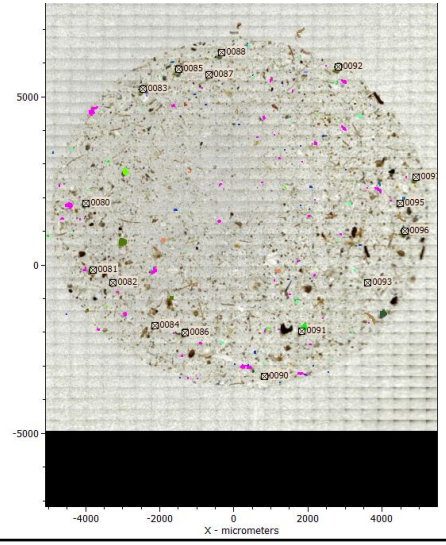
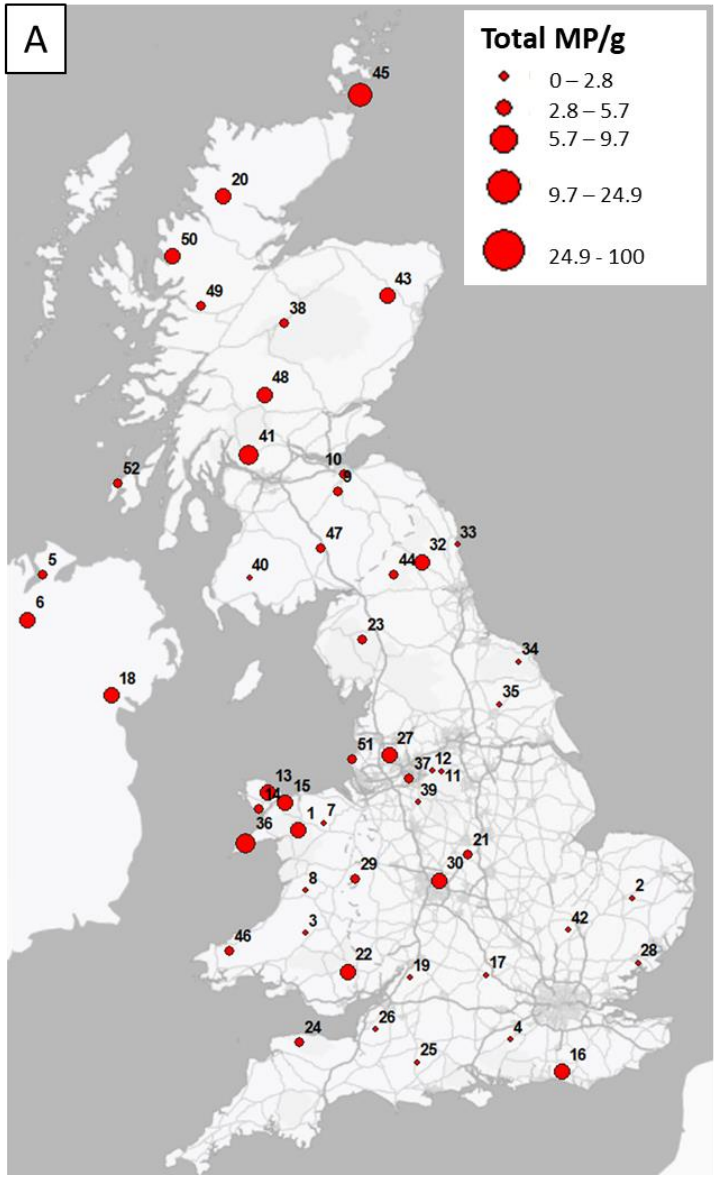
|  | Purency |  |

# Mapping the UK

Of 52 sites, only 3 did not find any microplastics >LOD

Total abundance only differed by 2 orders of magnitude, with min = 0.3 MP/g and max 24.9 MP/g moss

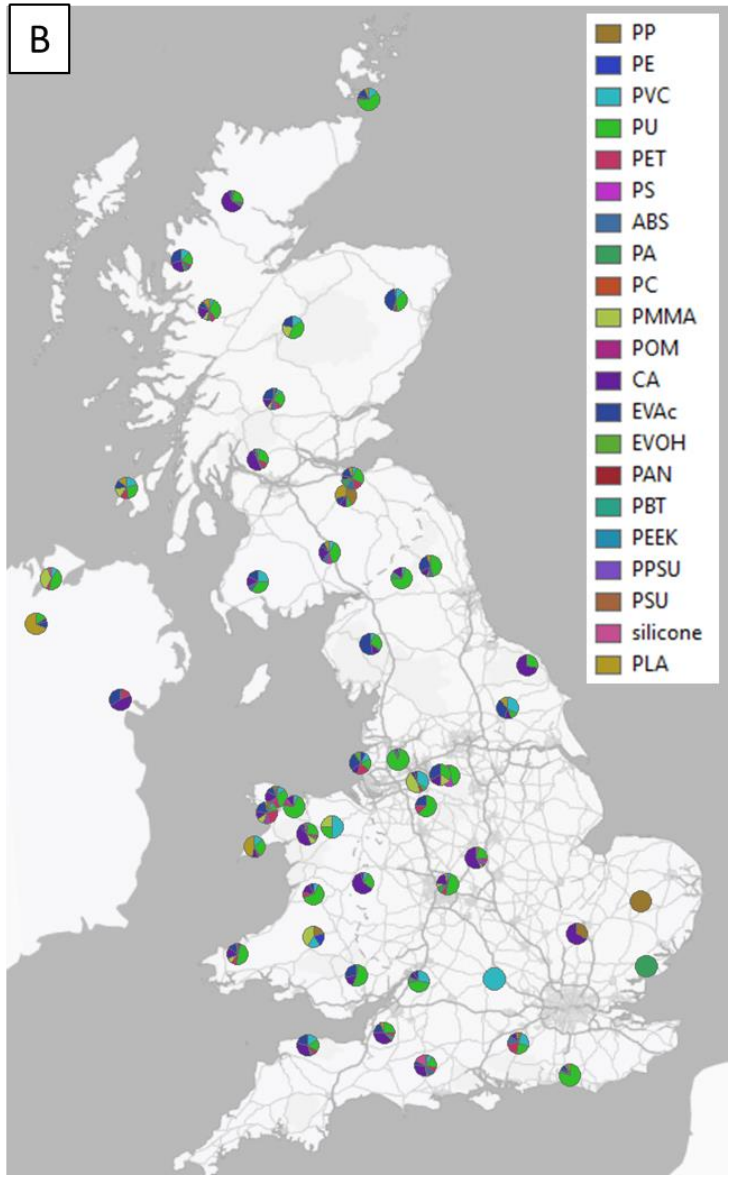
No obvious trends for relationships with latitude, major cities, urban-ness (within 10km)



# Mapping the UK

Polymer diversity shows weak but positive correlation with total abundance

No clear spatial pattern / clustering for particular polymer types



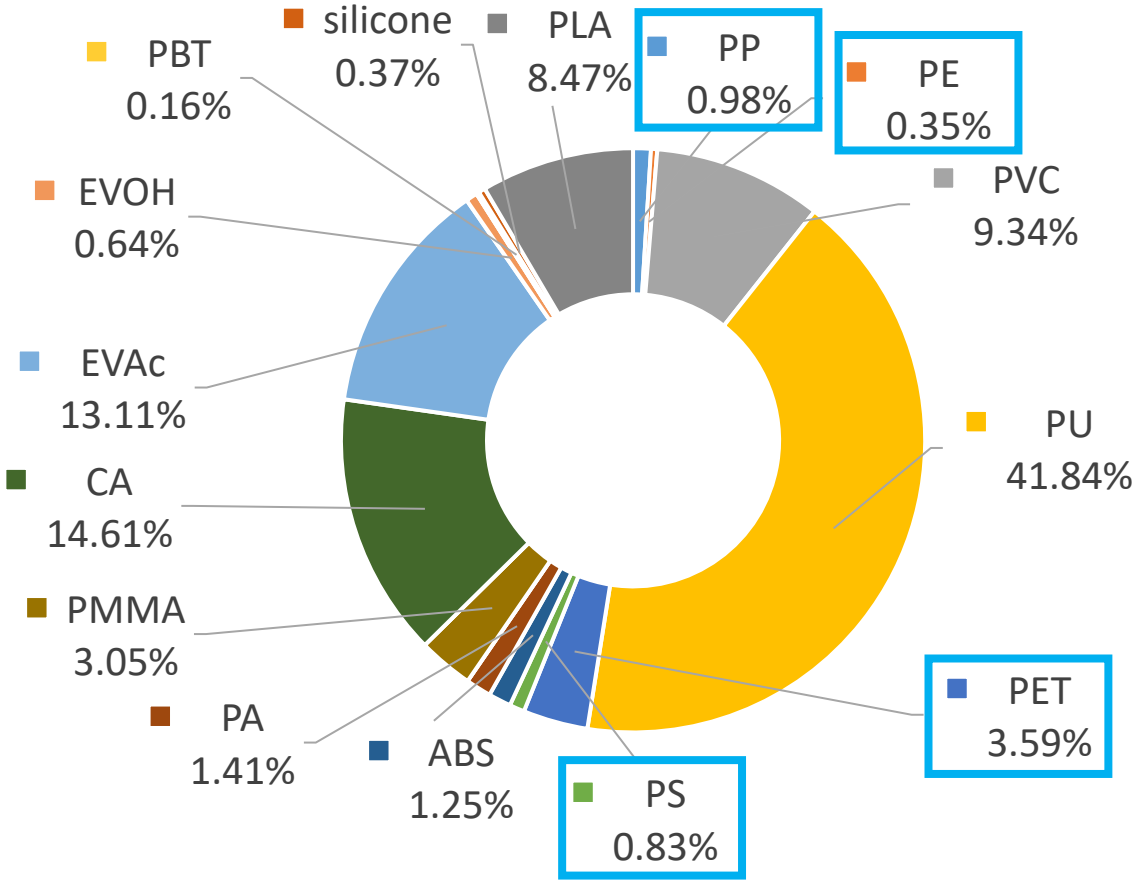
# Results from the UK

PU, CA, PVC and EVAc dominate the microplastic fragment signal.

Common **packaging material** (PE, PP, PS, PET) present but not so abundant (<6%).

PET (packaging and textiles) is quite common (3.5%)

Relative abundance of polymers across UK

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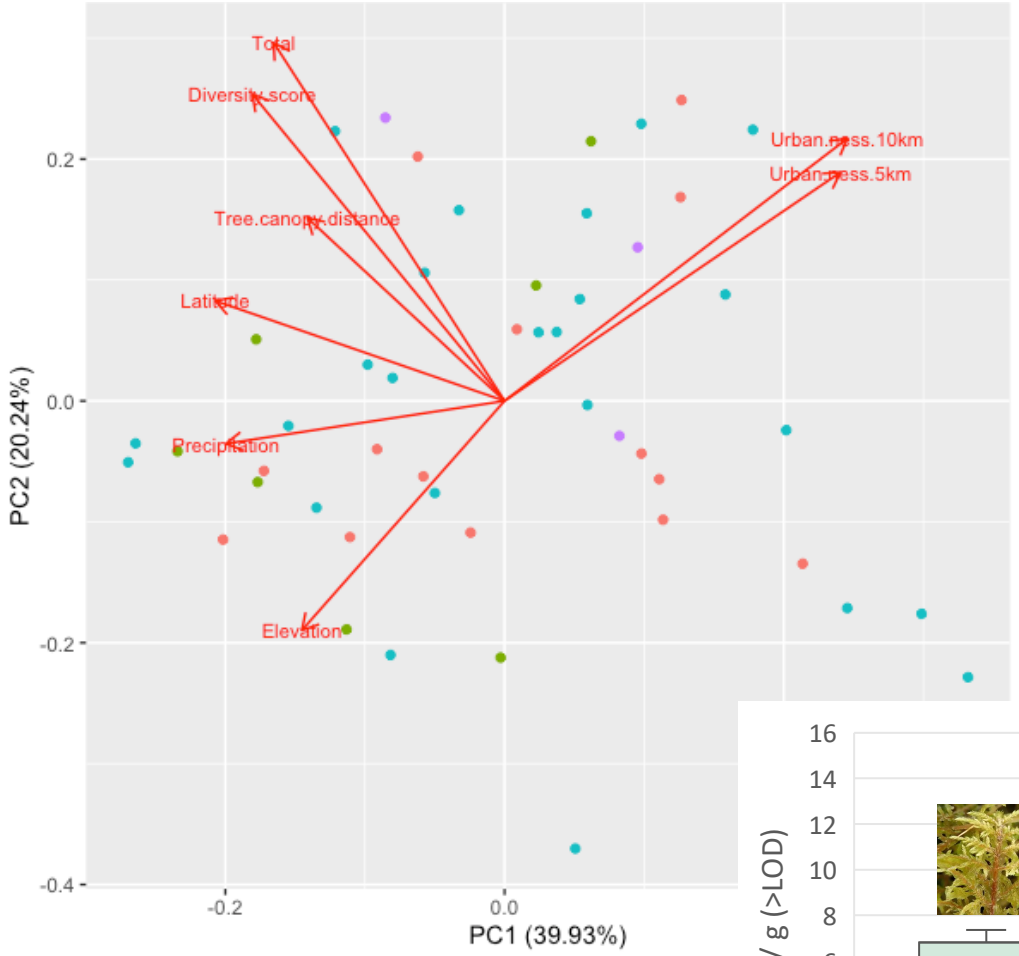
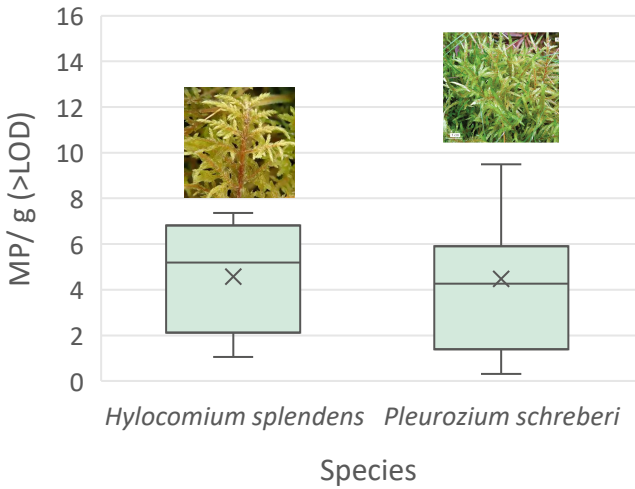
# Implications for using moss as a biomonitor

When looking at different growth types (i.e. are there differences between species we need to consider) no grouping of any particular growth type (PCA right).

No difference in MP concentration between the two most sampled species *H. splendens* and *P. schreberi* – **similar deposition mechanism and dynamics across species**?[2]

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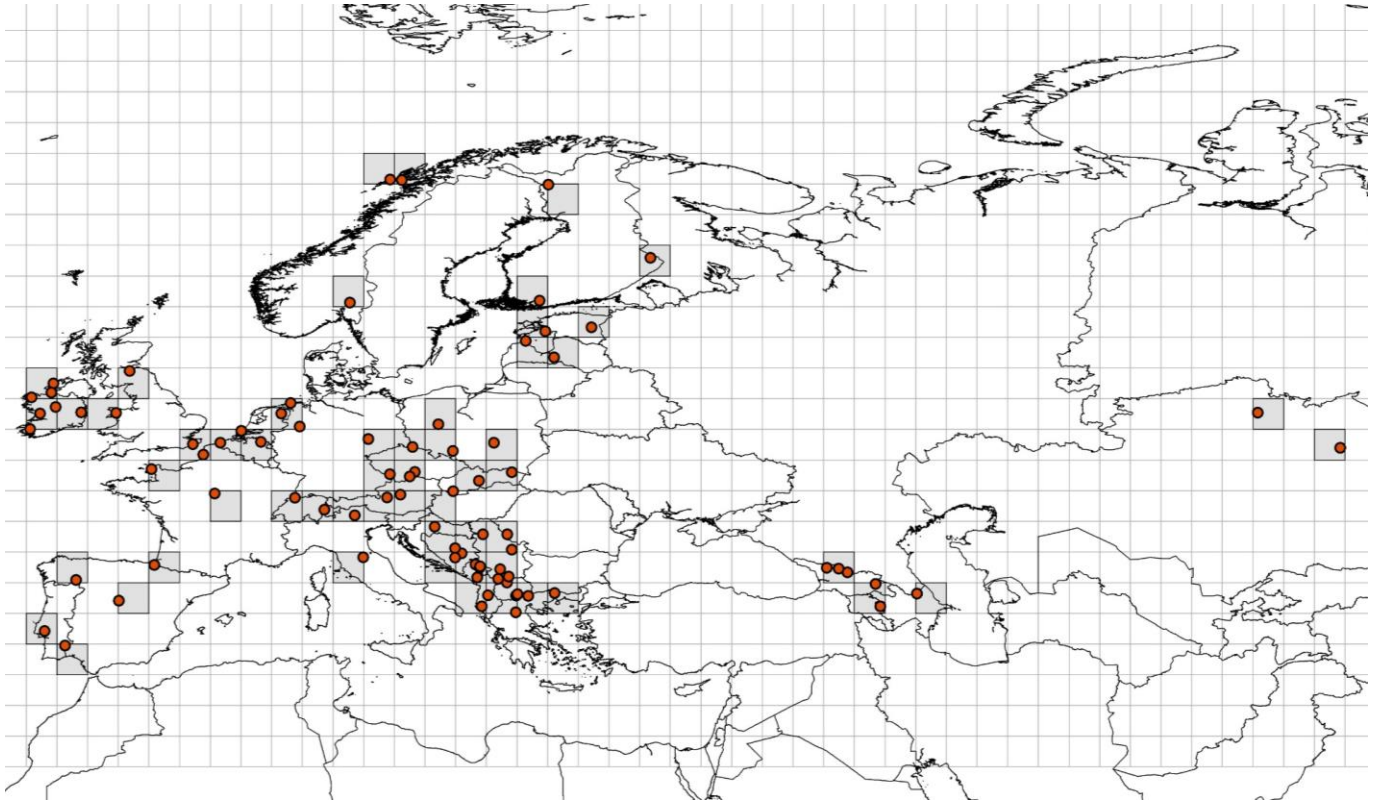
[2] Cowden and Aherne 2019. Interspecies comparison of three moss species (Hylocomium splendens, Pleurozium schreberi, and Isothecium stoloniferum) as biomonitors of trace element deposition https://pubmed.ncbi.nlm.nih.gov/30877490/

# Microplastic Atmospheric Deposition Assessment using Moss in Europe (MADAME)

*Felicity Hayes, Julian Aherne, Stefano Loppi, Carmen Wolf, Mehriban Jafarova, Jochen Tuerk, Mike Wenzel, Richard Cross*
*And participants of the ICP Vegetation*



~30 countries participating

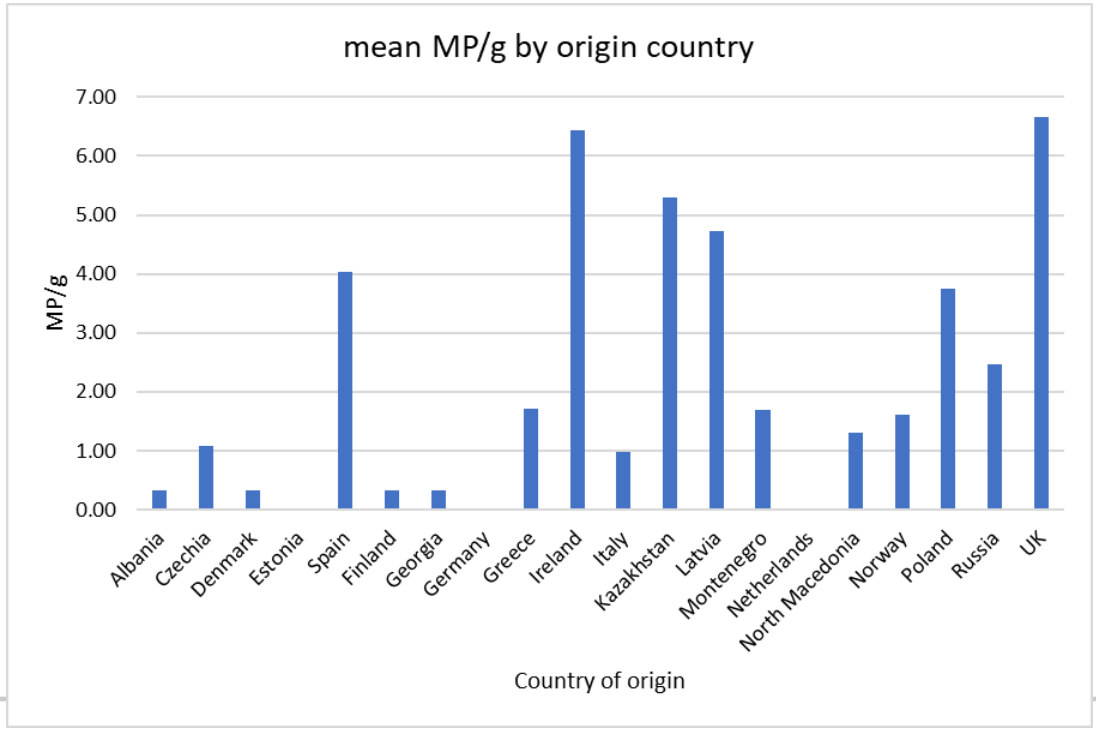
Sample preparation complete
Sample analysis underway

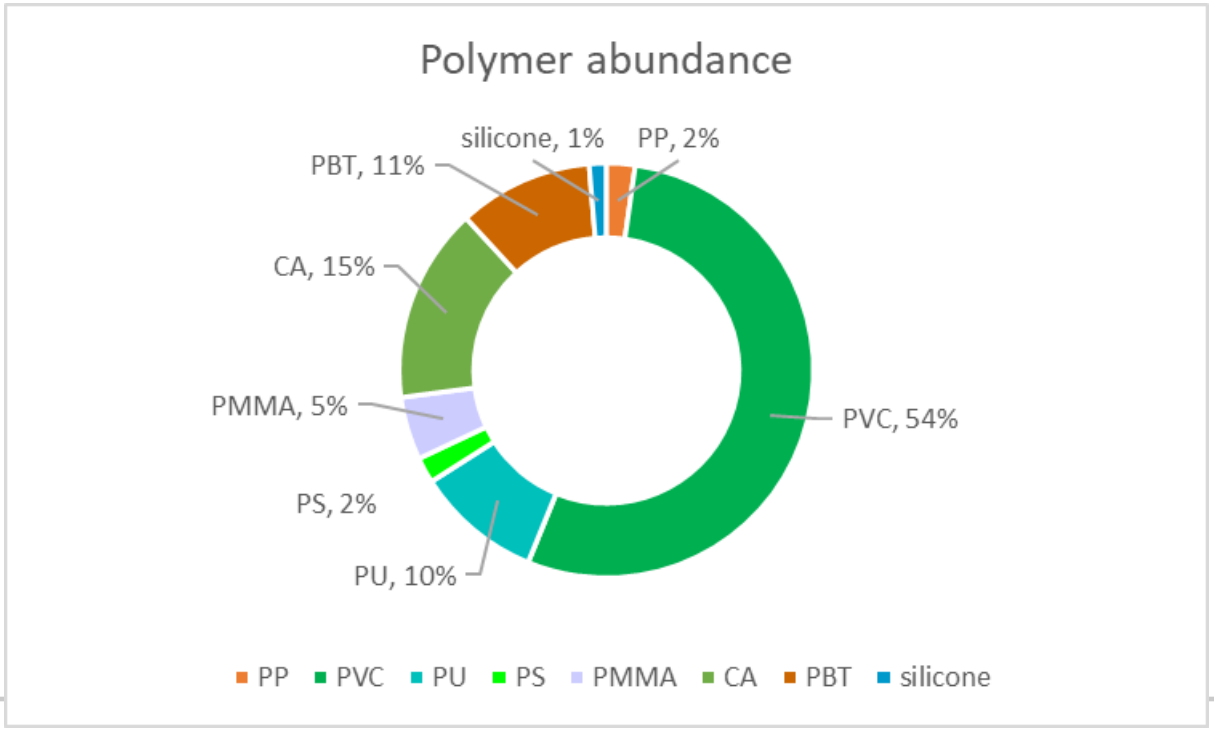
# Microplastics/g by country across Europe

Very preliminary: Processed 31 samples across 20 countries so far (in randomized order).

Microplastics throughout the region, including in very rural areas (e.g. northern Scandinavia)

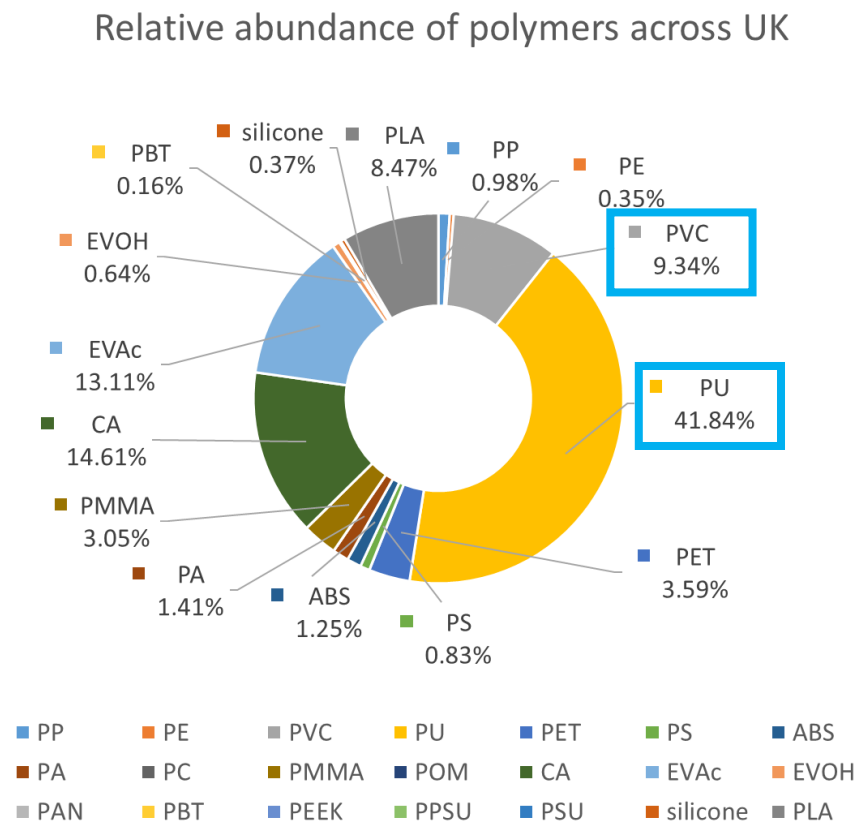
Textiles, plastic litter, foams, etc



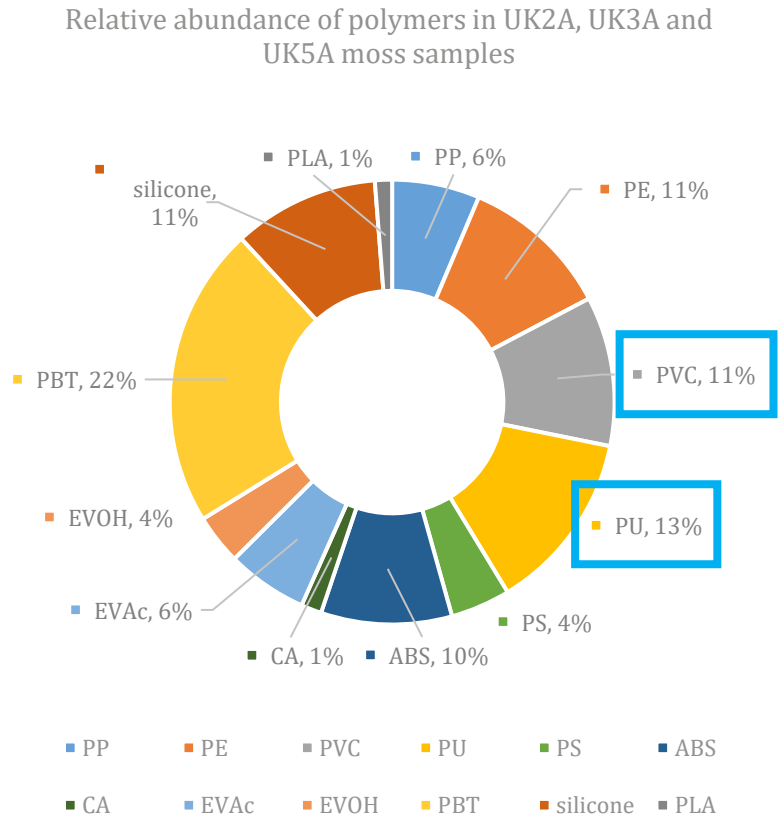



# Comparison between UK and European survey

## Previous UK survey 2022




## MADAME Survey




Common packaging materials more prevalent in MADAME Survey than previously (~20% vs 6%)

PU and PVC still abundant

Challenging to compare the polymer abundances across the two studies only at UK scale due to imbalance in samples

# Policy implications

Microplastics are airborne, so policy needs to be international to be most effective

Macroplastics degrade into smaller pieces, so reducing release of these would be helpful

‘Litter’ is only a small part of the (microplastics) problem

# Conclusions

Mosses can be used as a biomonitor for microplastics, but does cause some analytical challenges.

Widespread occurrence of microplastics in moss samples in rural areas, attributed to airborne deposition. These have been differentiated by polymer, but further work is needed to identify the sources of microplastics, and to model airborne dispersion from these sources.

Impacts on vegetation (and terrestrial ecosystems) are largely unknown.