Factsheet

UK Centre for Ecology & Hydrology

Microplastics

Key facts and figures

- Microplastics have been found in every part of the world including Antarctica.
- Up to 10 times more plastic waste is deposited on land than in seas globally
- Wastewater plants filter out around 99% of particles larger than 0.025mm

Q What are microplastics and where do they come from?

A Microplastics are small particles of plastic with a diameter of less than 5mm.

Most of the microplastic waste in the environment is made up of fragments from large pieces of litter such as plastic bags, bottles or packaging as they naturally disintegrate.

These are known as secondary microplastics.

Primary microplastics are items that have intentionally been manufactured in a small size, such as microfibres from clothing, microbeads, rubber crumb and plastic pellets (also known as nurdles).

Plastic particles from cosmetics, clothing, industrial processes and packaging get into our air, soils, rivers and seas.

They can be transported through the environment and be further broken down into smaller fragments, spread over a wider area, thereby increasing the risk of organisms' exposure to them.

Particles get washed up on beaches

Microplastics have been found in every part of the world, including remote locations and even within snow in Antarctica.

Once released into the environment, microplastics are practically impossible to remove and will remain there for hundreds of years.

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Q How do plastic particles get into our rivers, seas and soils?

A

Plastic waste gets into water courses by:

- Direct littering and later fragmentation
- Wastewater effluent
- Surface runoff (eg from roads and farmland) into soils, lakes and rivers.
- Transportation by wind and water
- Maritime activities (fishing, shipping)

via lost fishing gear, cargo and other litter. A 2016 study by the UK Centre for Ecology & Hydrology provided the first evidence of microplastic particles in UK freshwaters, with major sources being synthetic fabrics (largely from washing machine wastewater), packaging products and road-marking paints. Although there is a lot of focus on plastic in oceans, significantly more waste enters terrestrial environments – possibly as high as 10 times the amount globally a

Photo: Pixabay

year. Sources include direct littering, atmospheric deposition, agriculture waste (such as mulch films, fleece and silage wrap), fertilisers, treated sewage sludge, and some forms of compost. Plastic litter and microplastics have been detected in soils, while chemical additives associated with these particles have been found not only near hotspots by roads and landfill sites but also in rural woodlands.

There are various estimates for total leakage of microplastics to land and seas, ranging between 10-40 million tonnes a year.

Q How is UKCEH improving our understanding of microplastics?

A

While the majority of global research to date focuses on microplastics in the marine environment, UKCEH scientists are providing improved understanding of their existence, fate and impact in terrestrial and freshwater habitats.

Our researchers investigate the points at which plastics first enter the environment, how they are transported and transform in the environment (eg degrade, break apart or become covered by microorganisms such as bacteria and fungi) and how they affect terrestrial and freshwater organisms.

This includes studying the impacts of microplastics on survival and fertility rates among freshwater and soil invertebrates.

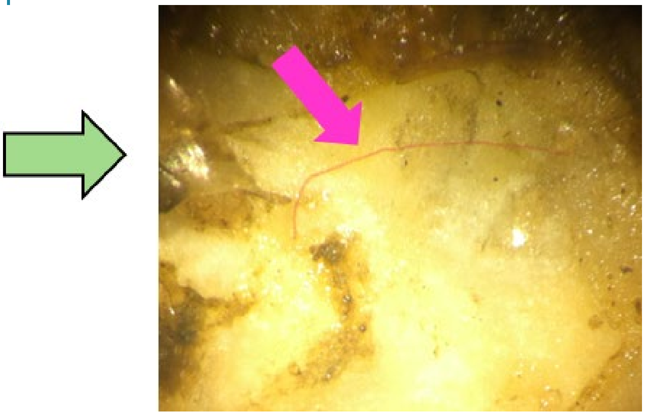
UKCEH scientists have been continually improving analytical methods for finding microplastics in environmental samples, using state-of-the-art infrared, spectroscopy and electron microscopy equipment to investigate the type, composition, shape, size and toxicity of particles.

Typically, the finer the resolution, the more particles are found.

Q

What is the impact of microplastic on wildlife and ecosystems?

A



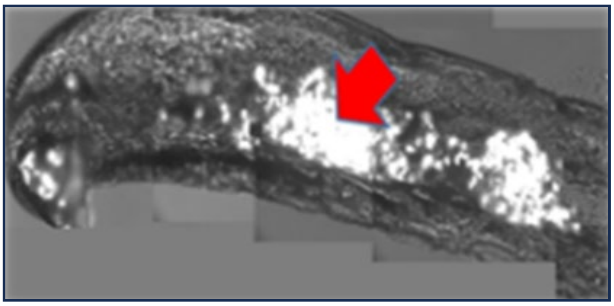
Microplastics can affect the digestive tracts of fish, above, and worms, below.

Globally, studies have shown that many species are ingesting microplastics, including research by UKCEH which found fibres in the gut of freshwater fish in the River Thames and fragments in the guts of threatened Lamprey species in Scotland.

It is known that microplastics can be passed up the food chain when predators eat prey that have ingested particles.

There is some evidence to show microplastics can have harmful effects on organisms, hindering their ability to feed, grow, reproduce and defend themselves against predators, with effects likely to vary between types and sizes of microplastics. However, most research so far has only shown effects where very high levels of microplastics – not necessarily representative of those found in the environment – have been used, in the laboratory.

Various research in the UK has shown that microplastic particles and fibres can be ingested by earthworms leading to effects such as reduced reproduction, growth and faeces production. These all have the potential to impact the key role earthworms play as ecosystem engineers and recycling nutrients in soils, with possible knock-on impacts on the wider environment.



This includes a UKCEH study that found microplastics, at high concentrations, can reduce worms' fertility by up to 50%

As the amount of microplastics accumulates in the environment, much of UKCEH's research is focused on what is a safe level for species and ecosystems, as well as carrying out modelling to predict future pollution levels and impacts.

While it has been widely observed that animals can become caught up in plastic waste, one international study found that plankton can become entangled in microplastics.

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Q Do humans ingest microplastics and are they harmful?

A As microplastics are present throughout the environment and passed up the food chain, humans are exposed to them through diet, dust in their home, outside air or clothing. Microplastics can end up in the gut, while tiny particles less than 0.01mm in size have been detected in human blood, placenta and organs, showing their ability to pass through cells and the body. Studies have shown adverse effects on human cells but, similar to research into impacts on animals, these have been high concentrations performed under laboratory conditions. The World Health Organization has called for further research into the potential impacts.

Q Do water company treatment plants remove microplastics?

A UKCEH has carried out a series of analyses of microplastics in the water supply chain. The first comprehensive UK study of its kind, published in 2019, found purification plants – which take water from upland reservoirs, aquifers or rivers and turn it into drinking water – removed 99.9% of microplastics over 25 micrometres (µm).

Other research by UKCEH has shown that the amount of microplastics within the drinking water distribution network is low.

Meanwhile, testing at wastewater treatment plants filter out around 99% of microplastics into sewage sludge, known as biosolids, before the treated effluent is released into rivers. In the UK, most of this sludge is applied as fertilisers to agricultural land, presenting a significant input of microplastics to the environment.

Sewage and other effluent that may contain plastic particles can bypass the wastewater treatment system and enter rivers and soils during extreme rainfall events. This includes untreated effluent from combined sewer overflows (CSOs) – which stop sewage backing up into properties – and runoff from overflowing drains that may contain microplastics from road surfaces. UKCEH is working with the water industry to assess whether:

- microplastics and chemical pollutants in sewage sludge contaminate groundwater
- plastic components within treatment plants wear down and shed microplastics into wastewater
- advanced thermal treatment of sludge, to harvest energy from it, is capable of removing microplastics and other persistent contaminants.

CSOs release raw sewage into rivers. Photo: HugoTagholm CC BY-SA 4.0

Q What action is being taken to reduce waste?

A Several countries have banned microbeads in wash-off cosmetic products, including the UK. Restrictions on single-use plastics such as plastic straws and cotton buds are in force in Scotland and England, while many businesses use alternative materials to plastic packaging, plus increase the price of bags to deter shoppers buying them.

The EU has set a target to reduce microplastics pollution by 30% by 2030, involving ongoing actions. It banned loose glitter and microbeads in 2023 with restrictions on other intentionally manufactured microplastics phased in over the next few years. There is also a proposal that would require EU member states to remove microplastics from urban wastewater by 2045, with pharmaceutical and cosmetic producers providing 80% of the costs of this sewage treatment process.

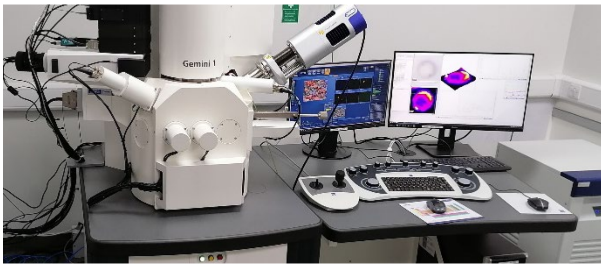
There are ongoing discussions between countries about drawing up an international legally binding United Nations treaty on plastic pollution, which would address the full life cycle including production, design and disposal.

Q What are nanoplastics and what are the concerns over them?

A This term refers to plastic particles that are extremely small – below 0.0001mm in diameter. They can also be items that are fragments of previously larger plastic items or intentionally made very small.

Their small size means some can pass across biological barriers such as the walls of the gut and start to circulate around the body, reaching other organs, with the potential to cause damage. The surface properties of nanoplastics influences how they might cause harm, and the extent of any effects.

Compared with microplastics, research is at a relatively early stage. UKCEH is improving analytical techniques because it is hard to detect these items using



existing methods. The new CORE-MIS facility (*pictured*) at UKCEH's site in Wallingford combines electron microscopy with chemical analysis, enabling analysis at the nano-scale with greater detail and complexity than ever.

Alongside advanced detection of ever smaller plastic particles in nature, our other areas of research include improving understanding of the fate and toxicity of nanoplastics. This will provide insights into their risks to the natural world.