MARINE POLLUTION FROM MICROPLASTIC FIBRES

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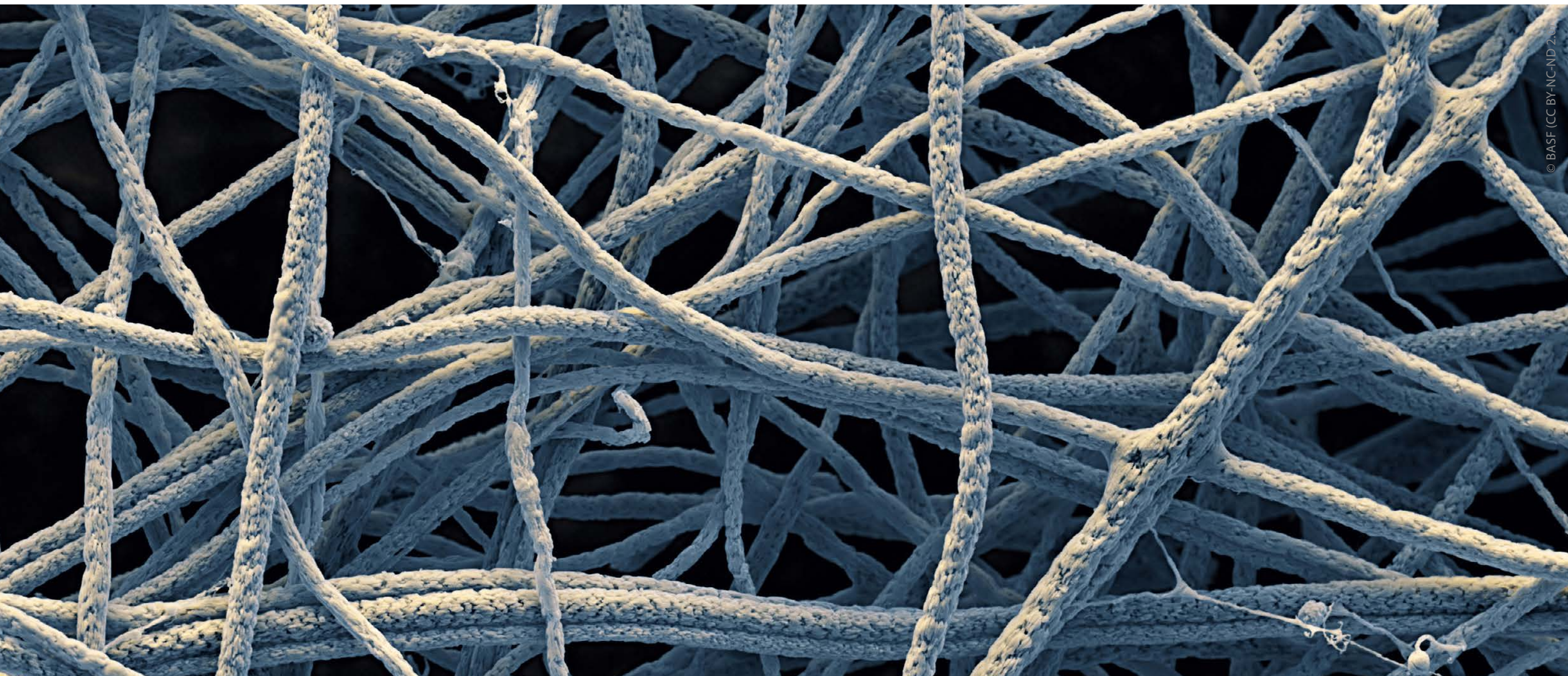
THE PROBLEM?

Increasingly, marine and freshwater habitats are found to be contaminated by tiny plastic fibres (also termed "microfibres" or microplastic fibres), an issue first described in 2011[1]. Classed as a microplastic due to their size and shape (i.e. less than 5mm long), microplastic fibres recorded in the environment are generally derived from common polyesters, polyamides (e.g. nylon), polyacrylonitrile (e.g. acrylic), and polypropylenes[2].

Plastic microfibres are ranked as the third largest primary source of microplastic pollution (by weight) in the ocean[3]. According to some estimates, there could already be 1.4 quadrillion microplastic fibres in the ocean[4]. They can be released into the environment from the breakdown (shedding) of fibres used in plastic-based textiles and garments either during production, use, or maintenance (i.e. predominantly via wastewater expelled from domestic and industrial washing machines). Abrasive action on synthetic fishing gear and marine ropes also results in release of microplastic fibres[5]. These two sources of microplastic pollution from fibres are discussed separately below.

Wastewater treatment facilities currently in operation in the UK were not designed to capture particles of this size and all types of microplastics, including microplastic fibres, are known to pass through wastewater sewage treatment and enter waterways and oceans[6,7]. Even those that are caught at wastewater facilities become part of the sewage sludge that is often employed as fertiliser, resulting in microplastic fibre pollution of the soil. Soil run-off can then carry these microplastic fibres back into waterways, and ultimately into the marine environment[8].

FIBRES ARE THE THIRD LARGEST SOURCE OF MICROPLASTIC POLLUTION



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BIODIVERSITY & HUMAN HEALTH IMPACTS

There is direct evidence that marine organisms at the base of the food chain are ingesting microplastic fibres[9,10,11], and growing evidence that these microplastic fibres can accumulate in guts and tissues[12,13]. In addition, and in common with other types of microplastic pollutants, microplastic fibres are known to concentrate hydrophobic pollutants present in the marine environment, and may also include other toxic additives such as polychlorinated bromides (PCBs) that are often incorporated into the plastics during production[14,15,16].


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There is compelling evidence that microplastic fibres (with the associated pollutants) negatively impact on filter, suspension, and detritus feeders following ingestion. Recorded impacts include a reduction in growth[17,18], reduced fecundity[19], weakened immune systems[20], impaired feeding ability[21,22,23] and, as a result, reduced energy stores[24,25,26]. Additionally, ingested microplastic fibres may irritate internal organs, cause physical blockages, make animals feel full (thus reduce feeding), and mediate the transfer of pollutants.


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As these animals form the base of key food chains, there are concerns about the potential of animals retaining the ingested plastics and associated pollutants in their tissues (bioaccumulation)[27,28,29,30] and of concentration of chemical pollutants up the food chain, affecting larger animals (biomagnification[31,32]), including potential risks to human health[33,34].

Microplastic fibres have been found within commercially important marine species, including fish, crustaceans (such as prawns), and molluscs (such as mussels)[35,36,37,38,49,40,41] raising further concerns about human health and potential sub-lethal impacts on these stocks. All plastics recovered from animals in deep sea experimental trawls were found to be microplastic fibres[42].

There is also emerging evidence of the presence of microplastic fibres in freshwater systems and drinking water[43], food and drink (e.g. beer[44], honey[45], salt[46,47]), soils[48] and potentially in the air[49]. The potential impact of microplastic fibres in these systems is still being established.

MICROPLASIC FIBRE POLLUTION FROM TEXTILES

It has been stated that over 60% of all clothing on the globe is made from polyester[50,51]. It is estimated that ca. 40 million tonnes of plastic fibres are produced annually[52].

There is a growing evidence base for the extent of microplastic fibre loss into the environment, with recent studies estimating that single synthetic textiles can lose between 0.7g and 1.3g of microplastic fibres per wash[53] or over 100,000 microplastic fibres per wash[54]; the loss from a typical load of laundry has been estimated as 700,000 microplastic fibres[55].

In Sweden alone, research suggests that between 1.4–17 tonnes of microplastic fibres reach the sea via wastewater per annum[56]. In recent years, innovation within the clothing and outdoor apparel industry has resulted in a number of items such as fleeces, swimming trunks, and sports kits being made from recycled plastic (PET) bottles. While valuable in terms of repurposing post-consumer plastic waste and incentivising the recapture of plastic items from waste streams, so-called eco-clothing may simply result in such garments re-releasing microplastic fibres into the environment in due course through washing.

ONGOING RESEARCH:

Following the unprecedented 2011 scientific publication that highlighted the presence and ingestion of microplastic fibres in the marine environment, research has evolved significantly. Microplastic fibre studies have attempted to quantify the scale of the problem in terms of release rates and concentrations of fibres in different water bodies. Increasingly, scientists are researching the impacts of microplastic fibres on marine and human life.

In addition, there is emerging research into how the properties and weave of fabrics and washing techniques can affect the degree of shedding. Initial research indicates that fleece fabric may lose the most fibres[57], but also age of clothes, detergent and conditioner, washing temperature, and type of washing machine can affect fibre loss.[58].

A range of suggestions have been made for adapting fibre and textile design, manufacturing processes, garment treatments, and washing conditions[59]. Despite advances in scientific research in the field of microplastic fibre pollution, the complexity of this issue means that it may be some time before there are fully consistent recommendations as to how best to prevent future contamination, however a number of potential solutions and areas for further targeted research are already being identified.


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SOLUTIONS & CURRENT ACTION:

- **Textile production:** There is growing recognition that changes in fibre and fabric/textile design will be key to long-term reduction in microplastic fibre pollution. However, this will need wide-scale shifts in design and sourcing practices across the global garment industry. Research and innovation into fibre and textile design is already underway (for example with the announcement of the first no-shed fleece fabric - Ecopile[60]). Whilst some retailers, manufacturers and industry associations (notably the European Outdoor Industry Association, but also brands such as Patagonia, H&M, Arc'teryx, Polartec, Vaude, and Adidas) are taking the issue seriously by promoting research and development in fabric design and finishing options or considering internal audits of shed-risk clothing, this is not yet widespread across the industry. Given that many budget retailers and brands rely on plastic-based materials, solutions are likely to come from improved textile design or finishing processes. Much more research is needed at fibre and textile level to develop cost-effective solutions to this issue (without other environmental consequences), and incentives will be needed within the garment industry to change to low-shed (and eventually no-shed) materials.

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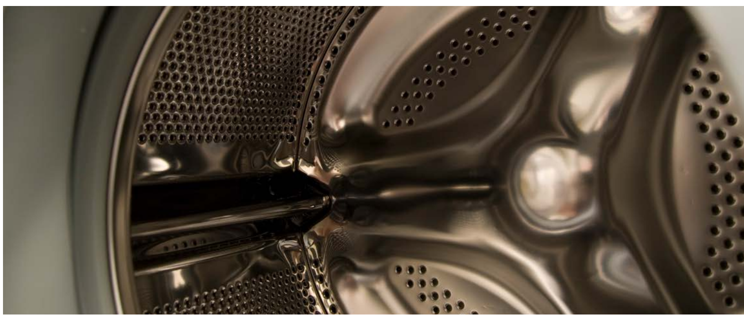
- **Washing machine design:** Although the garment/textile industries should be responsible for the environmental consequences of fibres shed by their products, redesign of industrial and domestic washing machines to include a filter to capture microfibres should be recommended as a parallel solution. Innovative filters will not address the design of existing washing machines (although external filters can be fitted at personal expense) and will not cover all washing methods (such as hand washing), thus necessitating a reduction in shedding from source garments as well. Other in-wash solutions to capture microfibres are in development[61,62] but most are not yet readily available, rely on changing consumer behaviour, and can be time consuming and/or expensive. As a result, large-scale mainstream uptake is unlikely.

- **A two-pronged solution?** Minimising the shed risk from clothing and improving washing machine design to capture any remaining fibres would be the ultimate best long-term solution. Recognising that both the clothes and the washing process are the root cause of microplastic fibres entering the environment, movement from both these industries should be encouraged (thus avoiding a stand-off where each devolves responsibility to the other). Joint initiatives between garment and textile producers, retailers, washing machine manufacturers, and product designers are to be encouraged.

- It has also been suggested than an additional long-term solution might be redesign of sewage treatment works[63] to include "Potable Reuse" infrastructure, including ultrafiltration to capture even microplastic fibres. At this stage we would not recommend prioritising this solution as it is potentially a very costly and unwieldy large-scale infrastructural solution, which passes the burden of cost of clean-up onto water companies and/or the taxpayer. This would also fail to address the issue of reuse of sewage sludge, which is commonly applied as fertiliser.

- Consumer behaviour change is often a key part of suggested microplastic fibre pollution prevention programmes, but at present it is not wholly feasible or scalable without industry-led changes in garment composition and washing machine functionality. There is a lack of consumer choice on this issue, beyond choosing clothes made from non-synthetic fibres, changing textile washing practices, and/or installing external washing machine filters. These are not mainstream solutions and will not effectively prevent microplastic fibre pollution entirely. To drive change at the pace needed and effectively prevent ongoing pollution, key systematic changes are necessary within the textile and washing machine industries.



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PRIORITY RECOMMENDATIONS:

- There is a need for all concerned parties to work together. Whilst an approach of "extended producer responsibility" would make the producers and retailers of the clothing that sheds the microplastic fibres ultimately responsible for their environmental fate, it is also the washing machine manufacturers whose wastewater carries the microplastic fibres (and the government/water companies who treat the effluent). The danger is that inaction results from different sectors "passing the buck" to others. FFI believes that all vested stakeholders have a role to play, and that a collective approach is needed.

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  FFI supports all efforts to unite stakeholders to seek common or aligned solutions to the issue of microplastic fibre pollution and as an initial measure we promote a multi-stakeholder summit that launches this process. Looking to the future, policy intervention could facilitate the wider uptake of identified best practices developed by cross-sector industry leaders on this issue.

- In parallel there is an urgent need for additional research into the causes and especially potential solutions for this issue, and this should be included as a priority within statutory research funding (i.e. via Research Councils) as well as within all elements of responsible industries. We are seeing the necessary collaborations between government, NGOs, academia, and industry to identify potential solutions, such as the recent Mermaids programme[64] and the new "Textile Mission" initiative[65], but more ongoing research will be essential, and all concerned sectors have a role to play in promoting this.

- FFI's position is that the garment and textile industries hold ultimate responsibility for the shedding of microplastic fibres from the clothes and fabrics they produce – and the potential for long-term environmental damage and economic cost resulting from this pollution. However, we also recognise the time needed for adequate research and innovation around new fibres, textile design, and garment manufacturing processes to reduce the shedding burden of clothing sold in the UK. Sustained outreach efforts to raise and hold industry's awareness of this responsibility would help drive change in clothing design and sourcing, beyond the few corporations that are currently conscious of this issue and already acting to minimise their impact.

- Equally, washing machine redesign could play a powerful part of the solution. It is clear that change is needed both in washing machine design and in clothing design to fully address this problem. However, it is questionable whether the washing machine manufacturing industry should pay the full costs of redesign to address microplastic pollution problems that have grown in line with expansions and changes in garment technology and a "fast fashion" industry in which the longevity and quality of clothes has often been downplayed. It may thus be unrealistic to expect washing machine manufacturers to take unilateral action on this, without being embedded into a wider movement of change on this issue.

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OTHER SOURCES OF MICROPLASTIC FIBRES

FFI also recognises the potential impact of microplastic fibres on marine life originating from fishing ropes and nets (fragments of nylon, polyethylene, polypropylene, polyamide, and/or knotted polyester)[66,67,68].

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POTENTIAL SOLUTIONS AND CURRENT PRIORITIES:

FFI is promoting additional research and investment into such studies, and encourages efforts that would support positive engagement from fishermen and fishing associations to help develop practicable solutions to help them prevent polluting their catch with their own gear.

Solutions may include use of alternative materials, changes in fibre and rope design, changing use of chafing knots, and more regular net inspection and replacement. There is a need for wider collaboration between fishing groups, research bodies, and others to broker common solutions.

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