Literature Review

Possible solutions to microplastic fibre pollution from textiles

Fauna & Flora International's work on marine microplastic pollution dates back to 2009, with a particular focus on microplastics. Our work to date on microplastic fibres has involved researching the available scientific literature and determining where we see the most practical, scalable and effective solutions to this source of microplastic pollution on a global scale. The table overleaf summarises our findings and continues to be updated as we engage with relevant stakeholders on this topic.

While this research specifically addresses pollution from microplastic fibres shed during washing, we are also very aware that the plastic-based textile supply chain is another potentially major microplastic fibre pollution source, and intend to investigate this further.

Please email plastics@fauna-flora.org if you would be interested to work with us on this issue, or have any questions.

Summary | Possible solutions to microplastic fibre pollution from textiles

INTERVENTION POINT	INTERVENTION/ FACTOR	LITERATURE AGREEMENT	FEASIBILITY OF APPLYING SOLUTION
BRAND AND RETAILER	Yarn construction	MEDIUM	HIGH
	Type of fabric	MEDIUM	MEDIUM
	Age of garment and/or washing frequency	MEDIUM	LOW
WASHING MACHINE	Detergents and conditioners	INSUFFICIENT DATA	LOW
	Temperature	INSUFFICIENT DATA	LOW
	Filter	INSUFFICIENT DATA	MEDIUM
	In-wash products	INSUFFICIENT DATA	LOW
WASTEWATER TREATMENT PLANTS (WWTP)	Investment in filtration systems	MEDIUM	LOW

Brand and Retailer | Yarn Construction

RESEARCH FINDINGS TO DATE	IMPLICATIONS	LITERATURE AGREEMENT	FEASIBILITY OF SOLUTION	MAIN REFERENCES
• Continuous filament yarns (which are longer) shed less than incontinuous staple yarns (which are shorter). High filament number in yarn results in more shedding than low filament number. • Higher gauge (i.e. tighter knit) results in more shedding than lower gauge (i.e. looser knit), although MERMAIDS findings contradict this. • Fabric structure is very important to shedding risk, although terms need to be standardised to avoid results that appear conflicting/incomparable. • Polyester fabric showed a great variety in amount of fibres shed depending on construction. • When melting and spinning pre-production pellets into fibres, lower and graduated temperatures can maximise tensile strength, reducing likelihood of microfibre formation.	Would need to investigate whether continuous filament yarn (instead of incontinuous staple yarn) and loose gauge can be applied to a range of different fabric purposes. These fabrics would need to be audited for shed risk and researched under different washing conditions, especially as Mermaids result was contradictory to other studies on gauge.	MEDIUM	HIGH	Almroth et al. 2017 Åström 2016 Mermaids. Ocean Clean Wash Petersson & Roslund 2015

Brand and Retailer | Type of fabric

RESEARCH FINDINGS TO DATE	IMPLICATIONS	LITERATURE AGREEMENT	FEASIBILITY OF SOLUTION	MAIN REFERENCES
• Fleece/microfleece sheds more than other materials, but Petersson & Roslund 2015 have conflicting results (researchers caution that this result may have been affected by fleece quality). • Polyster is the most common synthetic fibre in garments. • Recycled polyester appears to shed less than virgin polyester. • Polyester-cotton (i.e. synthetic-natural) fabric blends observed to shed less than pure synthetic fabrics. • No significant difference in shedding between similarly constructed acrylic, polyester, and nylon.	Potential to address shed risk through recycled synthetic fabrics and synthetic-natural fabric blends. These fabrics would need to be audited for shed risk and researched under different washing conditions.	MEDIUM	MEDIUM	Pirc et al. 2016 Bruce et al. 2015 Hartline et al. 2016 Browne et al. 2011 Napper & Thompson 2016 Almroth et al. 2017 Åström 2016

Brand and Retailer | Age of garment and/or washing frequency

• Some evidence that most significant shed of fibres happens on first wash. • Some evidence that fibre shedding stabilises over time, although: • Older/more worn and washed garments shed more than new garments.	Pre-washing garments has been suggested to reduce the initial bulk shedding. This would require robust mechanisms to catch pre-wash fibres at industrial scale.	MEDIUM	LOW	Mermaids. Ocean Clean Wash Petersson & Roslund 2015 Bruce et al. 2015 Hartline et al. 2016 Almroth et al. 2017 Åström 2016

Washing Machine | Detergents and conditioners

RESEARCH FINDINGS TO DATE	IMPLICATIONS	LITERATURE AGREEMENT	FEASIBILITY OF SOLUTION	MAIN REFERENCES
• Use of detergents and conditioners increase fibre shedding. • According to Mermaids, liquid detergent may be less abrasive than powder detergent.	This relies on consumer willingness.	INSUFFICIENT DATA	LOW	Mermaids. Pirc et al. 2016 Napper & Thompson 2016 Almroth et al. 2017 Åström 2016

Washing Machine | Temperature

• Contradictory results regarding the effect of washing temperature on fibre shedding. • Although lower temperatures seem may reduce shed risk, other factors such as fabric composition, detergent, garment age, etc. appear to have more prominent effects on shed risk.	This relies on consumer willingness.	INSUFFICIENT DATA	LOW	Napper & Thompson 2016 Mermaids. Ocean Clean Wash

Washing Machine | Filter

• Relatively large filters (e.g. 200µm) are likely to catch the majority of shed fibres, while reducing the likelihood of filter blockage with detergent/softenever. • Wexco Filtrol 160 (£115/filter)	Would only be added to new washing machines, unless company/consumer had obligation to retrofit washing machines (v. unlikely). Limited scalability for washing machines already in use. Current options expensive.	INSUFFICIENT DATA	MEDIUM	Pirc et al. 2016 Wexco Environmental 2017

Washing Machine | In-wash products

RESEARCH FINDINGS TO DATE	IMPLICATIONS	LITERATURE AGREEMENT	FEASIBILITY OF SOLUTION	MAIN REFERENCES
• Guppy Friend (£25/bag) • Coral Ball (£15/ball)	Relies on consumer buying and removing fibres from product, suggesting limited scalability. Currently expensive. Products are made of plastic - does Cora Ball (made from recycled plastic) abrade and Guppy Friend (made from polyamide) shed fibres? If Guppy Friend does not shed, application of its fibre and textile construction directly to synthetic (and non-synthetic) clothing should be explored to minimise textile shedding.	INSUFFICIENT DATA	LOW	Imogen Napper (University of Plymouth) is currently researching Guppy Friend's and other products'/tequniques' efficiency in capturing shed fibres.

WWTP | Investment in filtration systems

RESEARCH FINDINGS TO DATE	IMPLICATIONS	LITERATURE AGREEMENT	FEASIBILITY OF SOLUTION	MAIN REFERENCES
• OECD countries 80% wastewater through WWTP, but globally only 15-20% wastewater through WWTP. • WWTP with primary and secondaty treatment can remove up to 99% microplastics. • Studies across eight European countries' WWTP have found % of microplastic particles captured in sewage sludge ranges from 24 – 100%. • Several tertiary treatment technologies (e.g. rapid sand filter, dissolved air flotation) reportedly remove ≥95% of microfibres.	Expensive and not currently a solution for all countries given WWTP absence. All caught plastics remain in sewage sludge, with current disposal options of landfill, incineration, and fertiliser for agriculture. All of these have serious caveats. Some sewage sludge still disposed of at sea. Long-term solution requiring infrastructure change. Given the sheer amount of shedding, even 99% removal of fibres at WWTP represents a very high level of microfibre pollution to the marine environment. WWTP technology needs to be developed alongside textile production and washing machine filters to minimise shedding. Sewage overflow, e.g. during storm surges, remains an issue.	MEDIUM	LOW	Talvitie et al. 2017 Mintenig et al. 2014 Sherrington et al. 2016 Houses of Parliament 2016