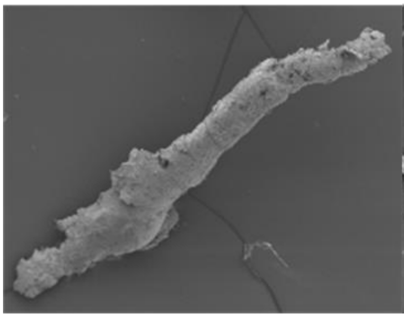
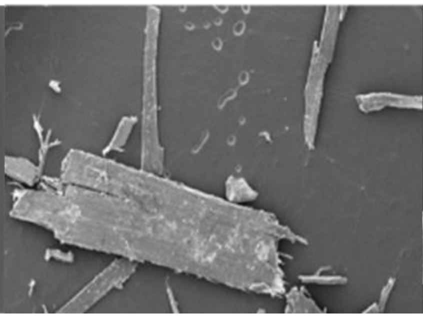
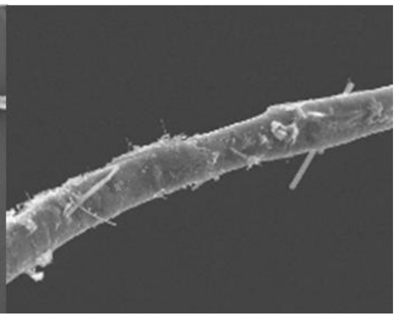
# Investigating the sources and pathways of synthetic fibre and vehicle tyre wear contamination into the marine environment



Tyre wear particle



Fragments of abraded rope



Synthetic fibre

Department for Environment Food & Rural Affairs

This report has been prepared for the Department for Environment Food and Rural Affairs under the project code **ME5435**.



**Authors**

Florence N. F. Parker-Jurd (University of Plymouth), Imogen E. Napper (University of Plymouth), Geoffrey D. Abbott (Newcastle University), Simon Hann (Eunomia), Stephanie L. Wright (King's College London), Richard C. Thompson (University of Plymouth).

**Contact**

Professor Richard Thompson

University of Plymouth

Drake's Circus

Plymouth

PL4 8AA

**Suggested citation**

Parker-Jurd, F. N. F. Napper, I. E. Abbott, G. D. Hann, S. Wright, S. L. Thompson, R. C. (2020). *Investigating the sources and pathways of synthetic fibre and vehicle tyre wear contamination into the marine environment.* Report prepared for the Department for Environment Food and Rural Affairs (project code ME5435).

We wish to acknowledge the landowners and water service companies who enabled sampling to take place. We would also like to thank the technicians at the University of Plymouth's Marine Biology and Ecology Research Centre. Particular thanks also go to Paul Donohue (UoN), Aaron Barrett (UoP), and Luka Wright (UoP). Lastly, we also wish to gratefully acknowledge the University of Plymouth's Electron Microscopy Centre for their support and assistance in this work.

Picture credits. Tyre wear particle collected from roadside drain material, Plymouth, UK, fragments of abraded rope, and synthetic fibres collected from atmospheric deposition beside an urban roadway, Plymouth UK. Plymouth Electron Microscopy Centre, University of Plymouth., 2019.

*Executive summary*

Microplastics are small pieces of plastic debris (<5 mm) that have accumulated either because of the fragmentation of larger items of plastic in the environment or have entered the environment directly as particles of less than 5 mm. It is widely accepted that microplastic contamination is widespread and increasing. Recent reports indicate that associated negative consequences could become widespread within the next 50 – 100 years unless current rates of contamination are reduced. It has been suggested that microplastics generated during use, for example from the wear of textiles and tyre tread are potentially the major sources of microplastic, yet empirical evidence on their pathways to the environment are lacking. The principal aims of this study were therefore to investigate the sources and pathways of synthetic fibre and tyre wear contamination to the marine environment. Some data exist on the sources of synthetic fibres, and it is clear they are widely distributed in the marine environment. However, data on the pathways for tyre wear particles from roads to the marine environment is sparse, and for that reason much of our environmental sampling was focused around roadways.

Once in the marine environment, tracing microplastics back to their source presents many difficulties. Therefore, our approach was to quantify both tyre particles and synthetic fibres as they enter the marine environment. Three points of entry were considered; release from treated wastewater effluent, direct release from storm water drains adjacent to roads, and deposition from the air within 50 m of roadsides. Samples were collected from replicate sites in the South West of England.

Tyre particles and synthetic fibres were detected entering the environment via all three pathways examined. Based on the sampling sites examined here, the presence of tyre particles reaching the environment, via all three pathways, appears to be substantially greater than the presence of fibres. Based on the locations sampled it would appear that storm water discharges, which pass directly from roads to aquatic environments, probably represent the most important pathway for tyre particles, whereas deposition from the atmosphere is likely to be the key pathway for fibres. Relatively low quantities of fibres and tyre particles were found in wastewater effluent.

Several intrinsic confounding factors limit the potential to make formal comparisons between pathways. For instance, while the volumes of effluent passing via wastewater treatment are documented, no such data exists for volumes of surface water runoff. Care should also be taken in extrapolating data on deposition form the air to distances greater than 50 m from roadways. It was clear, for example, that while tyre particles were abundant near to motorways and that fibres were not. This was probably because of the low number of pedestrians; it would therefore be important in

future sampling to consider locations a wider range of locations including those with high pedestrian footfall, but low traffic volumes. By contrast, it is also important to gain a better understanding of longer distance transport in the atmosphere; since fibres have recently been detected in samples from the Alps. Hence, pathways to the marine environment are likely to be more complex than the three pathways examined here.

Textile fibres are known to be widely distributed in the environment including remote locations such as the deep sea and the Arctic. Our findings indicated that tyre particles were typically denser and more heterogeneous in shape and size than textile fibres. From the perspective of transport in the marine environment, settlement velocity indicated that while a greater proportion of tyre wear particles, than fibres, were likely to settle close to their source, that some tyre wear particles had the potential to travel considerable distances. In addition, even for tyre particles that settled to the seabed the potential for resuspension was relatively high. Hence, we consider that the lack of tyre wear particles reported in previous studies, sampling the water column, sediment and biota, is likely to be caused by inadequate analytical methods rather than by an absence of tyre particles themselves.

In the case of fibre release to the marine environment we also considered, as a supplementary objective, fragmentation of rope and netting from maritime activities.  This was examined by hauling new and old ropes over a pulley, both on the deck of a vessel and in a laboratory setting. This demonstrated that substantial numbers of microplastic pieces, as opposed to fibres, are likely to be generated by activities such as hauling of fishing nets and pots. We estimate that even under very modest loading a new rope could release roughly 40 microplastic pieces per meter hauled; whereas an older rope could release over 700 pieces per meter hauled.

From the perspective of intervention, these data indicate for example, that fitting filters to washing machines could be less effective than strategies to reduce fibre emission more directly via fabric design. This is because filters will only intercept fibres entering wastewater, but will not influence release to the air which, in light of these findings and other recent work, could be a more substantial pathway. Further research to examine the efficacy of drainage sumps to collect particulates prior to their passing to water courses may also be beneficial. More research is also needed to consider a mass balance approach to evaluate a wider range of sources and transport pathways. This should consider quantifying tyre particles and fragments along their entire transport pathways and at greater distances, 1, 10 and 100 km from roads and urban areas with sampling in seawater and air. It is also important to establish the fate of fibres and tyre particles that are intercepted either in roadside drains or wastewater treatment as it seems likely that current practices allow captured material, together with any microplastics, to be returned to the environment.

In conclusion, the findings of this report support the predictions of previous desk based studies that tyre wear particles are a major direct source of microplastics to the environment. It is important to note therefore that inadequate sampling of tyre particles in previous microplastic sampling is likely to have resulted in a considerable underestimate of the total microplastic burden that has accumulated in the environment. That is to say, tyre particles represent a substantial source of microplastics that is in addition to previously reported quantities of micropalstics from other sources (fibres, fragmentation, microbeads from cosmetics).