SUMMARY

Tackling microfibre pollution
through science, policy, and innovation

A framework for Canadian leadership

OCEAN DIAGNOSTICS

RAINCOAST CONSERVATION FOUNDATION

Anna M. Posacka, Peter S. Ross. 2024. Tackling microfibre pollution through science, policy, and innovation: A framework for Canadian leadership. https://doi.org/10.70766/47.9973

About Ocean Diagnostics

Ocean Diagnostics is a Canadian environmental impact company tackling microplastic pollution and biodiversity loss through innovative technologies, cutting-edge laboratory analysis services, community science and education.

www.oceandiagnostics.com

About Raincoast Conservation Foundation

Raincoast is a team of conservationists and scientists empowered by our research to protect the lands, waters, and wildlife of coastal British Columbia.

www.raincoast.org

This project was undertaken in partnership with
Ce projet a été réalisé en partenariat avec

Environment and Climate Change Canada
Environnement et Changement climatique Canada

Summary: Tackling microfibre pollution through science, policy, and innovation

A framework for Canadian leadership

2024 November 12

Full report citation

Anna M. Posacka, Peter S. Ross. 2024. Tackling microfibre pollution through science, policy, and innovation: A framework for Canadian leadership. DOI:10.70766/47.9973

Affiliations

Anna M. Posacka, Strategic Advisor
Ocean Diagnostics Inc
Victoria BC Canada

Peter S. Ross, Senior Scientist
Raincoast Conservation Foundation
Sidney BC Canada, W̱SÁNEĆ Territory

Acknowledgements

We would like to thank Marie Noël, Liliane Stewart, Sean Yang, Iselle Flores Ruiz, Sherwin Arnott, Alex Harris, Ashleigh Erwin, Brooke Thorn McGowan, Anne Clarisse Ndjou'ou, Vanessa Evans, Joel Chung, and Eric Corneau for their contributions to this report.

This summary report, alongside a comprehensive report, was made possible through the financial support of Environment and Climate Change Canada. It is now freely available for governments, industry and consumers, and provides a list of recommended actions to reduce microfibre releases into the environment and protect the health of Canadians and the environment.

We thank Sriram Gopal (Association of Home Appliance Manufacturers) and Anna Bateman and Kelly Sheridan (The Microfibre Consortium) for their insights.

We are grateful for the expert reviews from the following:

Farida Bishay, Metro Vancouver
Kelly Drennan, Fashion Takes Action
Lisa Erdle, 5Gyres
Douglas Gilliand, EU Joint Research Centre
Joel Mertens, Cascale
Rhiannon Moore, City of Victoria
Catrin Norris, Flora & Fauna
Chelsea Rochman, University of Toronto
Jesse Vermaire, Carleton University

Ocean Diagnostics acknowledges with respect the Lekwungen peoples on whose traditional territory our office stands, and the Songhees, Esquimalt and WSÁNEĆ peoples whose historical relationships with the land continue to this day.

Key messages

Microfibre pollution has emerged as a global conservation and public health threat, prompting a wave of research related to its source, transport, fate and effects, as well as the design of mitigation strategies. This summary report accompanies an extended report; together, these reports highlight the following key elements of the microfibre pollution challenge in Canada and internationally:

1. Microfibres are widespread global contaminants that threaten human health and the environment.
2. Microfibres in the environment (environmental microfibres) originate largely - but not exclusively - from synthetic and natural clothing and other textiles (commercial microfibres).
3. Microfibre releases remain largely uncontrolled and unregulated.
4. Microfibres are generated during textile production and use.
5. Household and commercial washing and drying of textiles releases microfibres into wastewater, biosolids and the atmosphere.
6. Strategic interventions across the lifecycle of textiles provide opportunities to significantly reduce microfibre releases to the environment.

We present here highlights from our report on a solution-oriented framework that addresses microfibre pollution with the latest scientific findings, information gaps and opportunities. We examine a wide range of solutions and advances identified or applied internationally along the microfibre journey from material design to manufacturing to use to fate in the environment.

MICROFIBRES DOMINATE MICROPLASTIC POLLUTION PROFILES IN CANADA

What percentage of microplastic pollution consists of microfibres?

49% fibres

IN BELUGA WHALE DIGESTIVE TRACTS

BEAUFORT SEA

(Moore et al., 2018)

91% fibres

IN SEAWATER

ARCTIC AND THE NORTH POLE

(Ross et al., 2021)

68% fibres

IN ZOOPLANKTON

BRITISH COLUMBA

(Desforges et al., 2015)

57% fibres

IN SEDIMENTS

HUDSON BAY AND EASTERN NUNAVUT

(Huntington et al., 2020)

66% fibres

IN TREATED MUNICIPAL WASTEWATER EFFLUENT

BRITISH COLUMBIA

(Gies et al., 2018)

IN BIOSOLIDS

86% fibres

PRAIRIES

(Sivarajah et al., 2023)

IN FISH

65% fibres

THE GREAT LAKES

(Munno et al., 2021)

97% fibres

IN INTERTIDAL SEDIMENTS

NOVA SCOTIA

(Kelly et al., 2024)

What are microfibres?

Microfibres have been detected throughout the environment - in Canada and around the world - and have been reported in air, freshwater, marine water, sediments, fish, invertebrates, marine mammals and people. Our awareness of microfibre pollution grew out of broader studies on microplastics, the latter of which include synthetic fragments, foam, sheets, pellets and fibres smaller than 5 mm. A large body of research demonstrates that microfibres dominate the composition of environmental microplastics.

There are growing concerns that microfibres may harm human health and the environment, due to how easily they can be ingested, the risk of blockage, inflammation and/or uptake into the circulatory system, and the toxic additives they may contain.

Microfibres generally comprise small fibres shed from textiles and other products during their production and use. Microfibres are lost from textiles during laundering, releasing millions of particles into wastewater. Microfibre pollution occurs at every stage of the textile life cycle, including production, use, wastewater discharge, biosolids application and textile disposal. It is estimated that 60 per cent of global annual commercial fibre production is associated with fashion and clothing (Niinimaki et al., 2020). Other sources of environmental microfibres include fishing gear, cigarette filters and face masks.

The technical definitions of microfibres vary, reflecting first, the extraordinary array of sizes and chemical formulations underlying textile production; and second, the distinction between the commercial design and manufacturing needs for specific textile products (*commercial microfibres*), and the protocols and instrumentation required to sample, identify and enumerate microfibres from all sources and products in the environment (*environmental microfibres*). We present here an inclusive definition to enable comparable data and study designs for Canadian researchers, natural resource managers, regulators and industry concerned with microfibres in the environment.

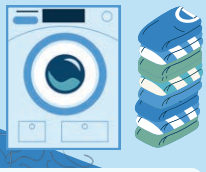
Microfibres in the environment

Microfibres dominate the composition of microplastics in environmental samples (environmental microfibres) and include natural microfibres like cotton or wool. Environmental microfibres originate largely from textile products like clothing or carpets.

TEXTILE MICROFIBRES IN CANADA BY THE NUMBERS

Every year, 1,465 tonnes of microfibres - the equivalent weight of 5,426 grizzly bears - are released into the Canadian environment from home laundry.

MICROFIBRES



Electric Dryers

Air

371 tonnes

MICROFIBRES

Homes

1,920 tonnes

released during laundry

MICROFIBRES

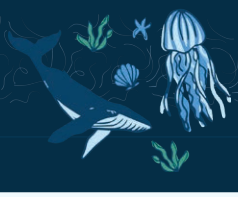
Wastewater Treatment Plants

MICROFIBRES

Incineration and Landfill

827 tonnes

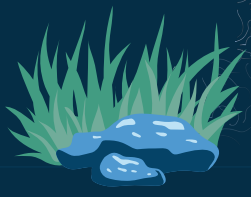
from biosolids



Lakes, Rivers, Oceans

264 tonnes

from treated wastewater



Farms, Forestry, and Land Reclamation

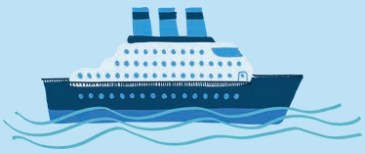
795 tonnes

from biosolids

DATA GAPS

There's a lot we don't know about microfibre pollution from these sectors.

COMMERCIAL LAUNDRY



MARITIME EFFLUENTS

TEXTILE MANUFACTURING

CONVERSION KEY

1 TONNE = 1,000 Kg

1 GRIZZLY BEAR ≈ 270 Kg

Home laundry emissions estimated from Vassilenko et al. (2021) at 219 cycles per household per year (NRC, 2011). Air emissions estimated from Tao et al. (2021). Release estimates from a WWTP retention rate of 86% (Sun et al., 2019), and proportions of biosolid treated, used and disposed (CH2MHill Canada, 2000). Estimates of environmental releases include additional untreated wastewater releases of approximately 35 tonnes. See our full report for details: *Tackling microfibre pollution through science, policy, and innovation: A framework for Canadian Leaders*. DOI: 10.70766/47.9973.

A definition of microfibres to guide Canadian science, innovation and policy

Microfibres are solid, fibrous strands of anthropogenic origin, with a length that is significantly greater than the width (ratio of >3) and <15 mm.

They are composed of synthetic polymers (e.g. polyester, nylon, and acrylic) or chemically modified natural or semi-natural polymers (e.g. cotton, cellulose acetate, wool).

This definition is technically consistent with the US IMDCC[1] and EU Water Directive microplastics methodology[2] definitions.[3]

---

1. Interagency Marine Debris Coordinating Committee (IMDCC). (2024). Report on Microfiber Pollution. 149 pp.

2. European Commission. (2024, March 11). Commission Delegated Decision supplementing Directive (EU) 2020/2184 of the European Parliament and of the Council by laying down a methodology to measure microplastics in water intended for human consumption.

3. The caveat: Published scientific data derived to document microfibers may or may not fully capture all microfibers as per this definition due to different methods employed in a given study. Documenting detailed sampling, processing and instrumental methods applied is strongly recommended to enable comparisons across studies.

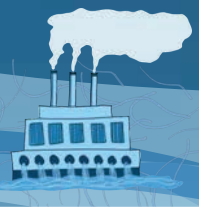
MICROFIBRE POLLUTION SOLUTIONS

There are many opportunities to reduce microfibre pollution.

UPSTREAM

Textile Industry

Textile design & manufacturing



Industrial Effluents

Textile effluents

SOLUTIONS

- ✓ Sustainable design
- ✓ Sustainable production
- ✓ Material choices
- ✓ Effluent treatment

CONSUMER

Domestic

Electric Drying
Wear and Tear
Laundry

Commercial

Healthcare
Hospitality
Workwear

SOLUTIONS

- ✓ Source control and best practices
- ✓ Consumer choices and product care
- ✓ Appliance filters

ENVIRONMENTAL MANAGEMENT

Treatment Plants

Biosolids

Maritime

Storm Water

SOLUTIONS

- ✓ Treatment technology
- ✓ Green infrastructure
- ✓ Discharge permits and regulations
- ✓ Remediation and cleanups
- ✓ Environmental quality guidelines

PROTECT WHAT WE LOVE

Humans & Wildlife

Lakes, Rivers, Oceans

Soil

Air

Opportunities to tackle the global microfibre problem

Microfibre pollution requires a collaborative effort to address leakage and loss along the source-to-sink continuum. By understanding the processes along this journey, we can identify critical intervention points.

Our proposed framework categorizes solutions into three strategic intervention areas: upstream, consumer and environmental management interventions. This holistic approach facilitates lasting global microfibre pollution reductions and creates a model that engages industry, consumers and governments in shared action to address this growing challenge.

1. Upstream interventions

A. Textile design. Studies show that microfibre releases are influenced by fibre and yarn selection, fabric construction methods and finishing techniques. Material and product design that reduces microfibre loss is a key intervention opportunity.

B. Textile manufacturing techniques. The garment-making process involves yarn tufting, weaving, knitting and dyeing to produce fabrics that are then cut, sewn and finished before being distributed. Investing in innovation and process improvements represents a key opportunity for both manufacturing companies and brands. Examples include excess fibre removal from finished fabrics at production facilities, dyeing protocol modifications and low water usage technologies.

C. Textile effluent treatment. Industrial fabric dyeing involves extensive use of material, water and abrasive processes that all contribute to the release of microfibres into factory wastewater. Effective industrial wastewater treatment is key to addressing the microfibre pollution problem.

2. Consumer interventions

A. Filters in domestic and commercial laundry machines. Built-in and after-market washing machine filters can reduce microfibre loss from domestic and commercial operations by up to 95 per cent, highlighting an important means to reduce liquid wastewater stream contamination.

B. Product care. Water temperature, the type of washing machine, detergent used, and the frequency and intensity of wash cycles can significantly influence the number of microfibres shed during laundering. Promoting cold water wash, gentle cycles and less frequent washing are valuable intervention opportunities for the general public. See, for example, Switch to Cold program at Metro Vancouver.

C. Electric dryers. Airborne microfibres from dryer vents are increasingly understood as a source of urban microfibre pollution. Promoting passive air drying, reducing laundry frequency and selecting sustainable textiles can all help to reduce dryer-related discharges.

3. Environmental management interventions

A. Wastewater treatment. Primary, secondary and tertiary wastewater treatment plants can retain up to 95 per cent of microfibres from the liquid waste stream. Identifying ways to remove microfibres from this waste stream through education, best practices, municipal bylaws and/or technological innovation can reduce microfibre content in both influent and effluent from wastewater treatment plants.

B. Biosolid management. Microfibres retained during the wastewater treatment plant process end up in biosolids, which are typically used as fertilizer in agriculture, forestry and land reclamation sectors. Keeping microfibres out of the influent through education, best practices or regulations, or devising techniques to remove microfibres from the influent or biosolids will reduce soil microfibre pollution at sites of biosolids application.

C. Stormwater management. Urban practices that reduce sanitary sewer overflows, eliminate combined sewer outfalls and minimize non-point source pollution offer a suite of green infrastructure opportunities that will reduce microfibre pollution.

Advances in science, measurement methods and policy

* Microfibres in the environment are likely underestimated, as past research methods have focused on synthetic, larger microplastics and applied varying approaches that hinder comparability.
* Additional research is needed to address knowledge gaps and enhance the quality and comparability of scientific and monitoring data to better understand microfibre pollution trends and impacts.
* Recent advances in methods, standards and tools internationally to quantify microfibres in discharges and the environment will enable regulatory compliance.
* Governments around the world are increasingly formulating or implementing strategies and regulations to reduce microfibre releases. For instance, the European Commission is advancing its Sustainable Textiles Strategy, which includes a proposal for standards on textile design, whereas France already mandates built-in filters.

Microfibre solution principles for Canada

Reducing microfibre pollution in Canada can be achieved with interventions that incorporate strategies across the textile life stages:

1. **Innovation in textile design and manufacturing techniques can reduce microfibre releases by both industry and consumers in Canada and internationally**. Standards or guidelines for textile design and manufacturing represent one way to reduce microfibre releases from Canadian sources. Since most textiles sold in Canada are imported, Canadian fashion brands and retailers play an important role in driving innovation in practices and processes needed to tackle microfibre contamination.
2. **Widespread washing machine filtration could dramatically reduce (up to 90 per cent) microfibre discharges from domestic and commercial wastewater effluent**. Promoting best practices for product care and further innovation by appliance manufacturers to minimize microfibre releases during laundry can offer additional benefits towards mitigating the issue.
3. **New research identifies electrical drying of clothing as a significant release of microfibres into the environment**. Most Canadian households use electrical drying for laundry, underscoring the need for targeted solutions, such as consumer education.

4. **The accumulation of microfibres in municipal biosolids illustrates the risk of widespread soil contamination when biosolids are applied to agricultural, forestry and land reclamation areas**. Reducing microfibres in liquid waste through multiple upstream strategies and new wastewater treatment technologies should be explored.

5. **A national textile circularity and sustainable fashion strategy should be a top priority for Canada**. Such a strategy would position Canada alongside other nations actively developing or implementing circular textile initiatives.

6. **Increasing awareness among industry players and the public. Surprisingly limited awareness of microfibre pollution among industry players remains a barrier to effective action in Canada**. Clear, concise and widely available information on the topic would enable solution-oriented actions and contribute to the collaborative approach required to fix the microfibre problem.

7. **Advancing knowledge through research and collaborative initiatives will enhance data quality, build consensus and contribute to decision-making across the board**. Leadership through Ottawa will aid in a better scientific understanding of microfibre pollution and position Canada as a leader in the global effort to combat plastic pollution.

Conclusions

Microfibres are now widespread throughout the world, posing risks to the safety of drinking water and food and the health of the environment. Further research will strengthen our understanding of the distribution and effects of microfibres in water, air, soil, sediments, wildlife and people.

Canada has distinct opportunities to adopt policy and regulatory measures to prevent the release of microfibres into the environment. Innovation and private sector leadership in material design, manufacturing and retail practices are crucial to preventing microfibre losses to the environment along the full length of the textile product chain.

As a global issue with no boundaries, microfibre pollution requires an international effort through environmental treaties, such as the London Convention on Disposal at Sea, the nascent Global Treaty on Plastic Pollution,the Canada-USA-Mexico Free-Trade Agreement (CANUSMA) and the Asia Pacific Economic Cooperation Forum (APEC).

References

CH2MHill Canada. Biosolids Generation, Treatment, Use and Disposal in Canada. Opportunities for Energy Recovery and Greenhouse Gas Reduction Report. Prepared for Environment Canada, 2000.

Desforges, J.-P., Galbraith, M., & Ross, P. S. (2015). Ingestion of microplastics by zooplankton in the Northeast Pacific Ocean. *Archives of Environmental Contamination and Toxicology*, 69(3), 320–330.

Ellen MacArthur Foundation. A new textiles economy: Redesigning fashion's future (2017). https://www.ellenmacarthurfoundation.org/a-new-textiles-economy 150 pp.

Gies, E. A., LeNoble, J. L., Noël, M., Etemadifar, A., Bishay, F., Hall, E. R., & Ross, P. S. (2018). Retention of microplastics in a major secondary wastewater treatment plant in Vancouver, Canada. *Marine Pollution Bulletin*, 133, 553-561.

Huntington, A., Corcoran, P. L., Jantunen, L., Thaysen, C., Bernstein, S., Stern, G. A., & Rochman, C. M. (2020). A first assessment of microplastics and other anthropogenic particles in Hudson Bay and the surrounding eastern Canadian Arctic waters of Nunavut. *Facets*, 5(1), 432-454.

Kelly, N. E., Trela, O., Gavel, H., & Vander Kuylen, A. (2024). Plastic and anthropogenic microfiber pollution on exposed sandy beaches in Nova Scotia, Canada. *Water Emerging Contaminants & Nanoplastics*, 3(1), 6.

Munno, K., Helm, P. A., Rochman, C., George, T., & Jackson, D. A. (2022). Microplastic contamination in Great Lakes fish. *Conservation Biology*, 36(1), e13794

Moore, R. C., Loseto, L., Noel, M., Etemadifar, A., Brewster, J. D., MacPhee, S., Bendell, L., & Ross, P. S. (2020). Microplastics in beluga whales (Delphinapterus leucas) from the Eastern Beaufort Sea. *Marine Pollution Bulletin*, 150, 110723.

Moore, R. C., Noel, M., Etemadifar, A., Loseto, L., Posacka, A. M., Bendell, L., & Ross, P. S. (2022). Microplastics in beluga whale (Delphinapterus leucas) prey: An exploratory assessment of trophic transfer in the Beaufort Sea. *Science of The Total Environment*, 806(Part 1), 150201.

Munno, K., Helm, P. A., Rochman, C., George, T., & Jackson, D. A. (2022). Microplastic contamination in Great Lakes fish. *Conservation Biology*, 36(1), e13794.

Ross, P. S., Chastain, S., Vassilenko, E., Etemadifar, A., Zimmermann, S., Quesnel, S.-A., Eert, J., Solomon, E., Patankar, S., Posacka, A. M., & Williams, B. (2021). Pervasive distribution of polyester fibres in the Arctic Ocean is driven by Atlantic inputs. *Nature Communications*, 12, Article 106.

Sivarajah, B., Lapen, D. R., Gewurtz, S. B., Smyth, S. A., Provencher, J. F., & Vermaire, J. C. (2023). How many microplastic particles are present in Canadian biosolids? *Journal of Hazardous Materials*, 52, 1037–1048

Sun, J., Dai, X., Wang, Q., Van Loosdrecht, M. C., & Ni, B. J. (2019). Microplastics in wastewater treatment plants: Detection, occurrence, and removal. *Water Research*, 152, 21-37.

Tao, D., Zhang, K., Xu, S., Lin, H., Liu, Y., Kang, J., Yim, T., Giesy, J. P., & Leung, K. M. Y. (2022). Microfibres released into the air from a household tumble dryer. *Environmental Science & Technology Letters*, 9(2), 120–126.

Vassilenko, E., Watkins, M., Mertens, J., Posacka, A. M., Patankar, S., & Ross, P. S. (2020). Domestic laundry and microfiber pollution: A comprehensive assessment of fiber shedding from consumer apparel textiles. *PLOS ONE*, 15(4), e0250346.

Summary: Tackling microfibre pollution through science, policy, and innovation

A framework for Canadian leadership

Anna M. Posacka, Peter S. Ross. 2024. Tackling microfibre pollution through science, policy, and innovation: A framework for Canadian leadership. DOI:10.70766/47.9973

OCEAN DIAGNOSTICS

RAINCOAST CONSERVATION FOUNDATION