Monitoring microplastics in the Arctic: multi-matrix approaches provide a more complete picture

Dr. Amy L. Lusher
Senior Research Scientist (Forsker 1)

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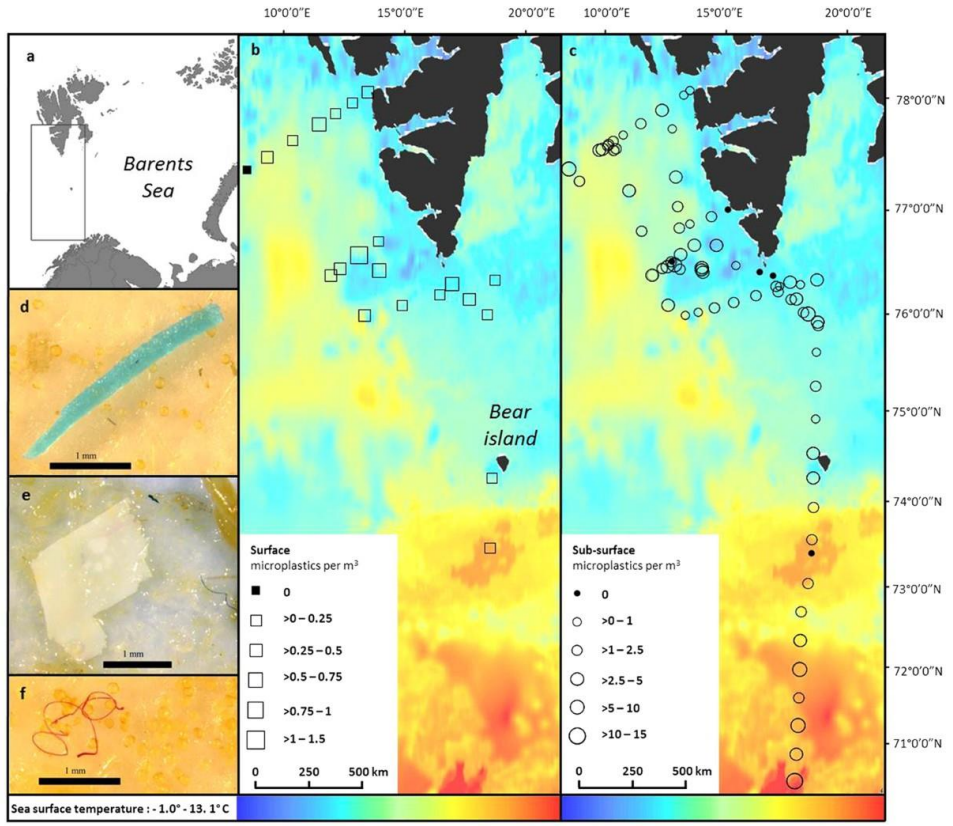
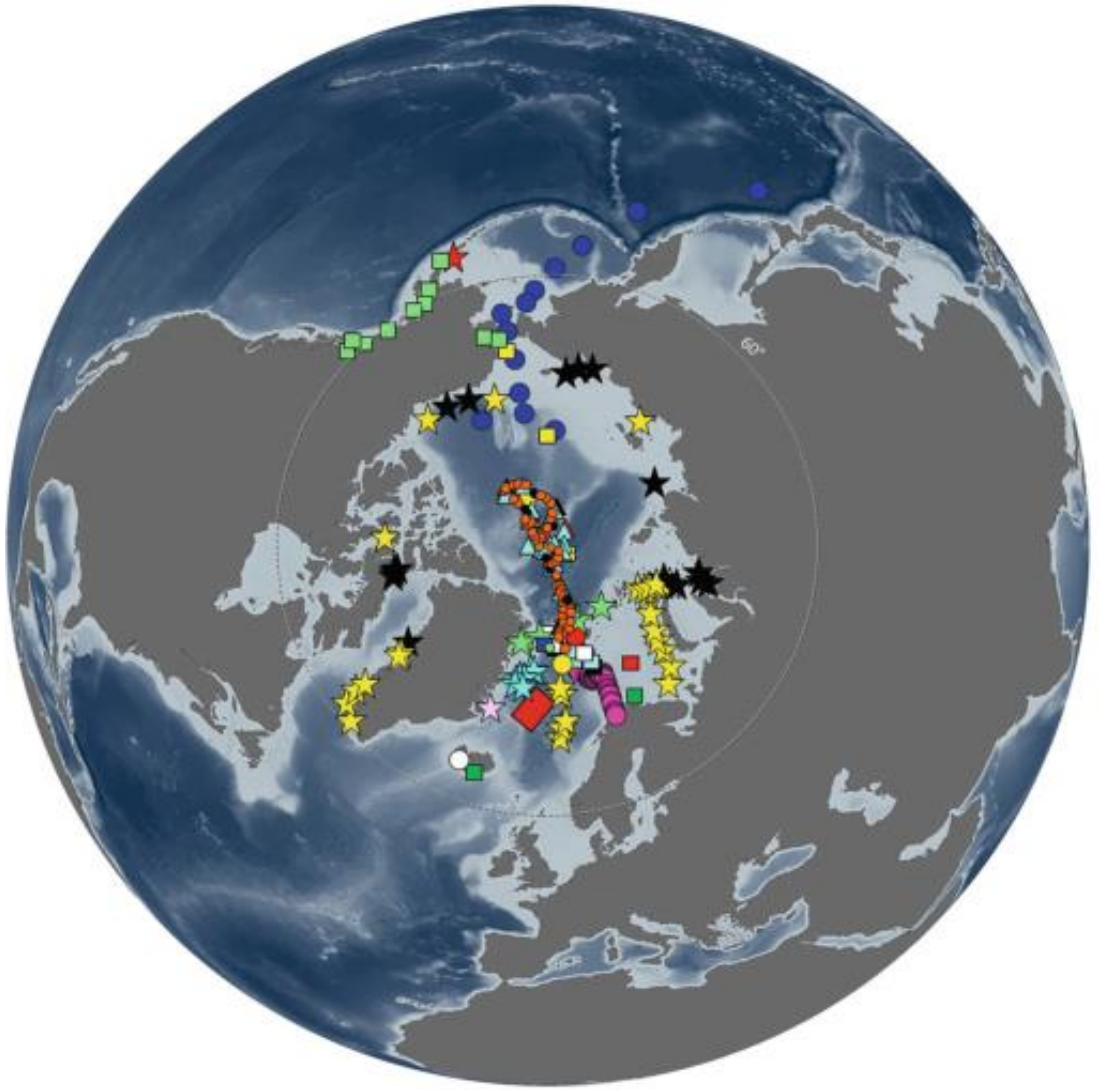
Norwegian Institute for Water Research

The Arctic is not free from (micro)plastic pollution

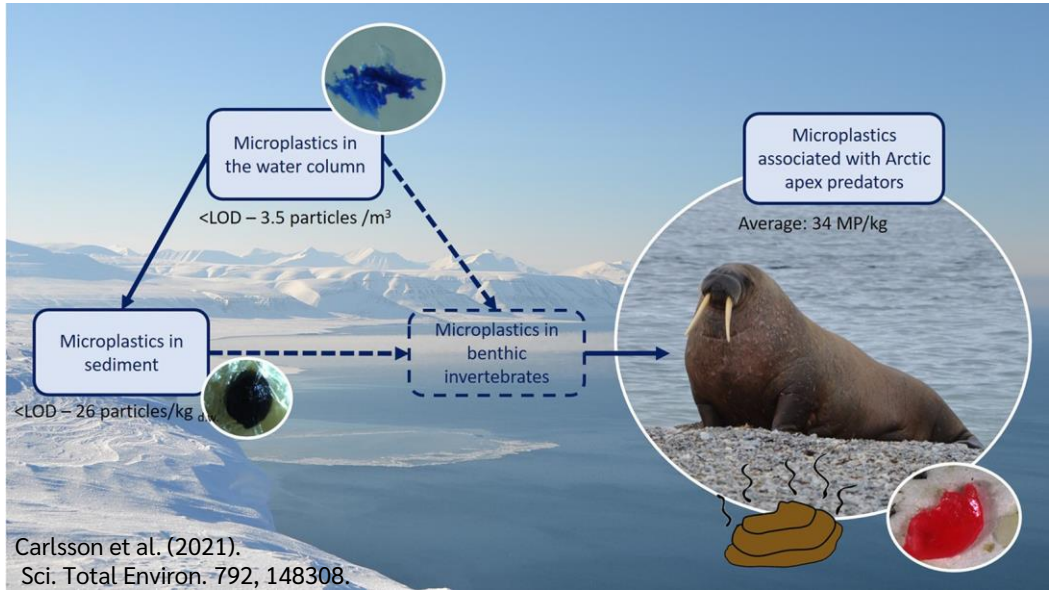


Lusher, A.L., Tirelli, V., O'Connor, I., & Officer, R. (2015). ***Microplastics in Arctic polar waters: the first reported values of particles in surface and sub-surface samples***. Scientific Reports, 5, p. 14947



Tirelli V., Suaria G., Lusher, A.L. (2022). ***Microplastics in Polar Samples***. In: Handbook of Microplastics in the Environment (pp. 281-322.). Springer, Cham.

The Arctic is not free from microplastic pollution



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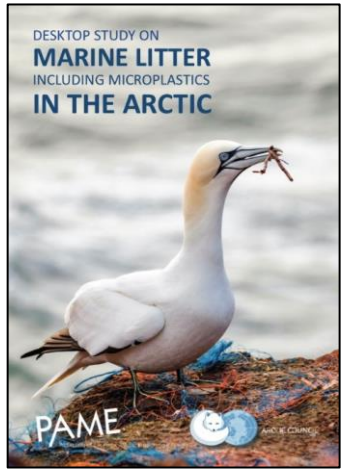
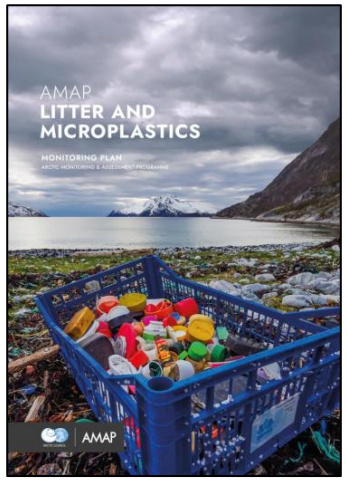
Sci. Total Environ. 792, 148308.





- Efforts to track litter and microplastics – uncoordinated
- Sporadic investigations – incomplete picture of the spread of contamination
- Wide spectrum of methods – limits comparisons

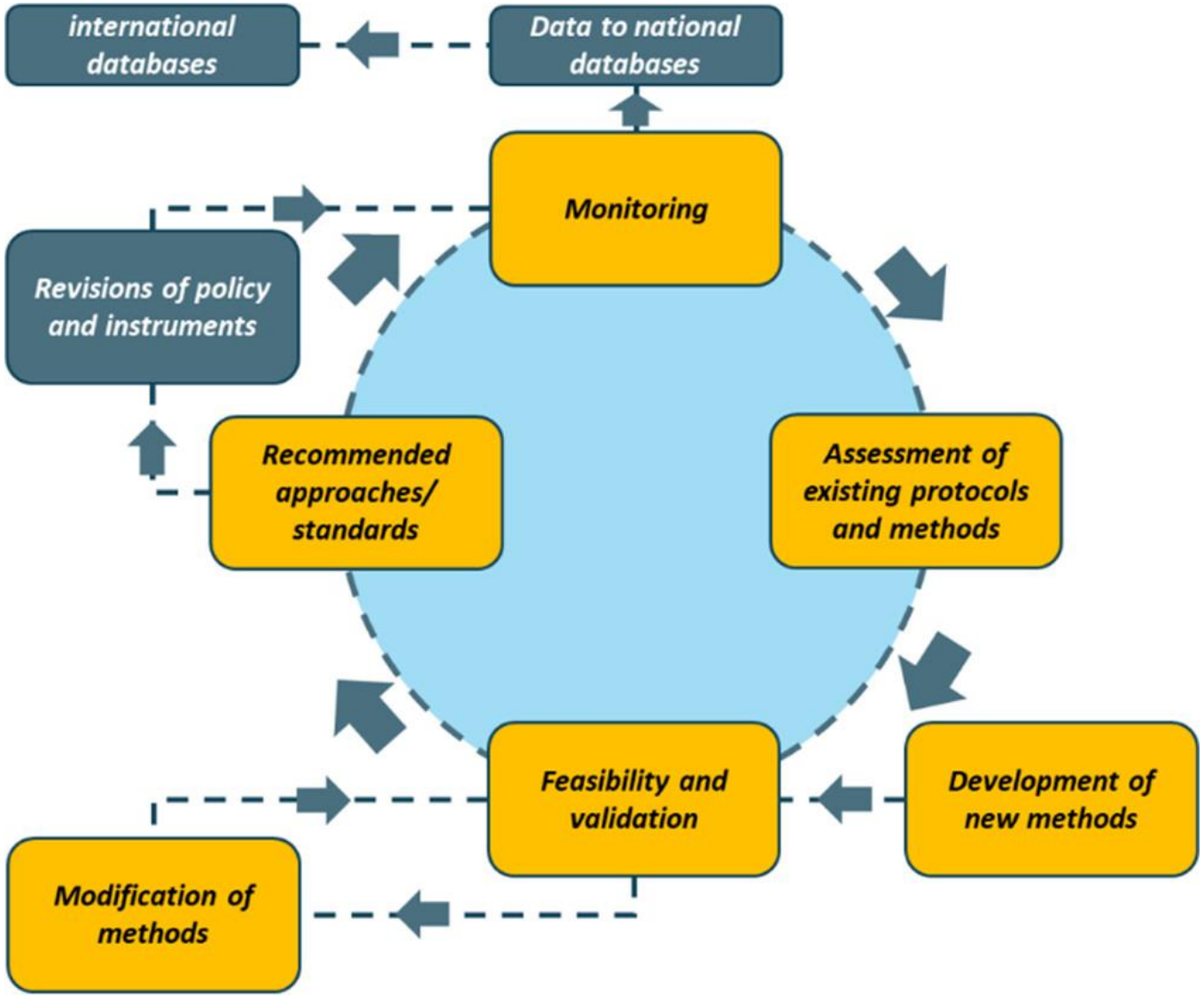
	Water		Sediment	
	Freshwater	**Marine**	**Freshwater**	**Marine**
SOURCES	Limited data	Limited data	Limited data	Limited data
INSHORE	Limited data	Limited data	Limited data	Limited data
OFFSHORE	-	Data available	-	Data available

Motivation behind developing a pan-Arctic monitoring programme

- Focus on **linking efforts** to build an understanding of microplastic pollution from the local scale to the full breadth of the Arctic.
- How it gets there and the impact it causes.
- An accurate assessment of source contribution will allow for successful **implementation** of pollution avoidance and **mitigation measures.**

Aim: a complete picture of plastic pollution in the pan-Arctic

Different research questions, different approaches



Developing methods to fit research or monitoring aims is a key step in (micro)plastic pollution control and management in the Arctic.

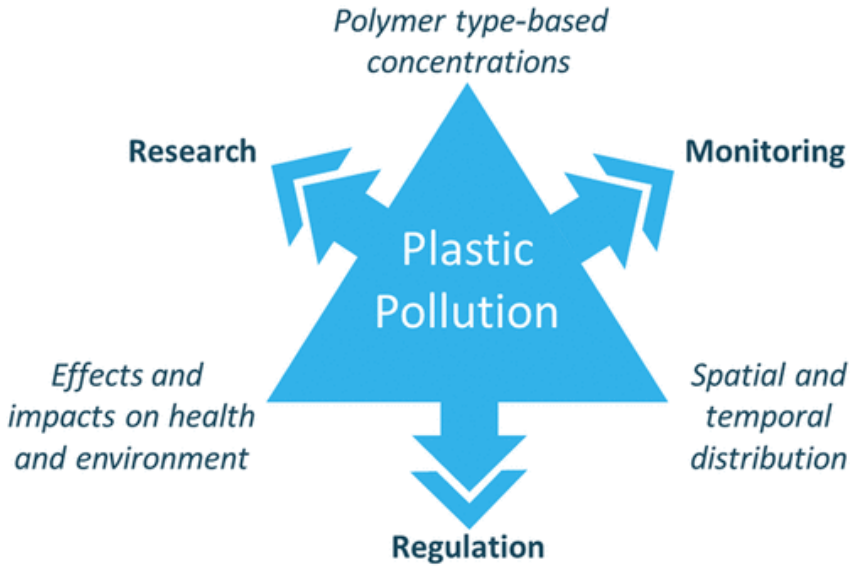
Lusher, A.L. and Primpke, S., 2023. ***Finding the Balance between Research and Monitoring: When Are Methods Good Enough to Understand Plastic Pollution***?. Environmental Science & Technology, 57(15), 6033-6039.

Methods are important for (micro)plastic monitoring

- Method choices depend on rigorous examination of the science being published
- We already have methods ready for monitoring (>1 mm, >300 µm)

Harmonisation of methods is paramount for monitoring

Balance between monitoring (nationally / regionally) and research



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Provencher, J.F., Covernton, G.A., Moore, R.C., Horn, D.A., Conkle, J.L. and Lusher, A.L., 2020. ***Proceed with caution: the need to raise the publication bar for microplastics research***. Science of the Total Environment, 748, p.141426.

Methods are important for (micro)plastic monitoring

- Require tailored methods for reliable detection and environmental enumeration
- Necessary to choose appropriate tool, or combination of tools
- Many commonly-used methods are developed south of the Arctic and ill-suited
  (Melvin et al. 2021)

Methods must be adapted to the ecosystem

Local site conditions

Proximity to anthropogenic activity

J. Falk Anderssen /NIVA

Presence of fauna

Eric Baccega/NPL

Recommendations for monitoring strategies

Must consider the policy question being addressed as well as resources available to carry it out:

- Must be cost-effective to ensure they are maintained
- Prioritisation to address significant risks and associated indicators
- Encourage cooperation
- Favour innovative and opportunistic approaches
- Build on existing monitoring activities

Harmonisation **= flexibility to adapt to scientific, logistical, environmental and ethical constraints**

Value of multi-matrix monitoring

We recommend a joint sediment and water approach is adopted.

- ✔ Can be carried out in same sampling campaign
- ✔ Provide complementary, but not overlapping, information
- ✔ Provide the most complete picture of plastic pollution

Water
– potential to track rapid fluctuations

Sediment
– spatially and temporally integrated signal

- ✘ Still biased to marine – integration of freshwater and terrestrial samples is important

Examples already exist: Hamilton et al., 2021; Huntington et al., 2020; Tekman et al., 2020

Method recommendations

Immediate trend monitoring:

- **Net sampling** –inland and coastal monitoring programs (300 µm, excl. fibres)

- **Pump sampling** – offshore (sequential filtration, 1 mm, 300 µm, 100 µm)

Immediate trend monitoring:

- **Core or grab samples –** aquatic systems (300 µm)

- **Core or grab samples -** Shoreline and surface sediment (1 mm, 300 µm, 100 µm)

Method recommendations

Source and surveillance monitoring:

- **Net sampling** - rivers and estuaries, inland water bodies

- **Pump sampling** – offshore (sequential filtration, 1 mm, 300 µm, 100 µm)

Source and surveillance monitoring:

- **Core or grab samples** - Aquatic systems – incl. rivers and estuaries

- **Core or grab samples** - Shoreline and surface sediment (1 mm, 300 µm, 100 µm)

What is needed to monitor the level of change?

Representative location
– pre-existing knowledge
– Initial screening

Variability
– understand statistical power (# stations, volume, replicates)

Cost and logistics

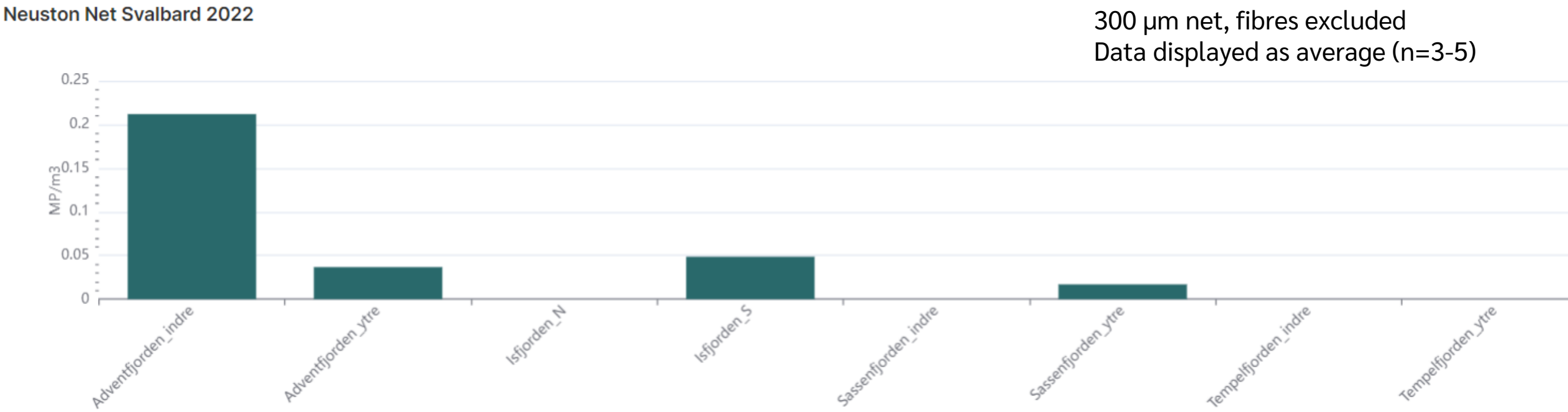
Ancillary data:

- Water masses – *properties and origins, temperature, salinity, density, wind speed*

Consideration of contamination

- Researcher derived contamination unavoidable with safety requirements – *clothing, ships, vehicles*

Methods being implemented in National Microplastic Monitoring Progamme – Norway (MIKRONOR)



Alling, V., Lund, E., Lusher, A., et al. (2023). **Monitoring of microplastics in the Norwegian environment (MIKRONOR).** Report for the Norwegian Environment Agency, M2624-2023. 103 p.

Monitoring with, by, and for Arctic Peoples

Each Indigenous group and community in the Arctic is different, yet many principles will hold across the Arctic. ITK recommend five priority areas for research in their homelands, taken from the National Inuit Strategy on Research (NISR), including:

- Advancing Inuit **governance** in research
  - *being part of funding decisions*
- Enhancing the **ethical conduct** of research
  - *strong community partnerships*
- Ensuring Inuit **access, ownership, and control** over data and information gathered in their homelands - *incl. monitoring data*
- **Building capacity** in Inuit research
  - *skill-sharing, equal partnership, and research infrastructure*

Bonnie Hamilton

Key messages

- A **harmonised and coordinated effort** is needed to gather data for the Pan-Arctic
- Understanding the full picture of (micro)plastic pollution in a region requires knowledge of both aquatic and sedimentary systems, and the links between them
- **Multi-matrix sampling** is advantageous for building a **full picture** of environmental microplastic contamination

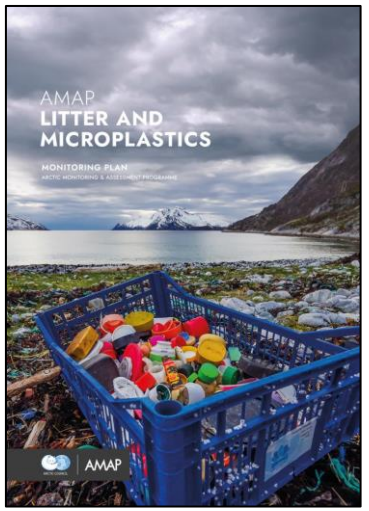
  ⟶ Aid in identifying priority regions for focused mitigation efforts.

- Future monitoring should align with **priorities of local & regional Arctic communities**
- AMAP framework illustrates how scientists, governments, and Arctic Peoples can **work together to address plastic pollution**

Co-authors and contributors in the AMAP LMEG

Amy.Lusher@niva.no

- *Jake Martin (PhD researcher), Maria Granberg (sediment chapter lead)*
- *Jenn Provencher, Max Liborion, Liz Pijogge, Kerstin Magnusson, Ingeborg Hallanger, Melanie Bergmann, Stefano Aliani, Alessio Gomiero, Bjørn Einar Grøsvik, Jesse Vermaire, Sebastian Primpke, Bonnie Hamilton*



Additional coauthors / collaborators

- *Svetlana Pakhomova, Cecilie Singdahl Larsen, Pernila Carlsson, Vanja Alling (NIVA and MIKRONOR), Valentina Tirelli (OGS)*
- *Giuseppe Suaria, Lisa Roscher, Andrea Paluseli, Jakob Strand (EUROqCHARM)*

Pictures kindly provided by: J. Falk-Andersson, S. Pakhomova, B. Hamilton

Environmental Science & Technology

Finding the Balance between Research and Monitoring: When Are Methods Good Enough to Understand Plastic Pollution?

Amy L. Lusher and Sebastian Primpke

Arctic Science

The power of multi-matrix monitoring in the Pan-Arctic region: plastics in water and sediment

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