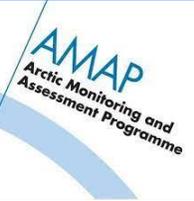




Monitoring microplastics in the Arctic: multi-matrix approaches provide a more complete picture

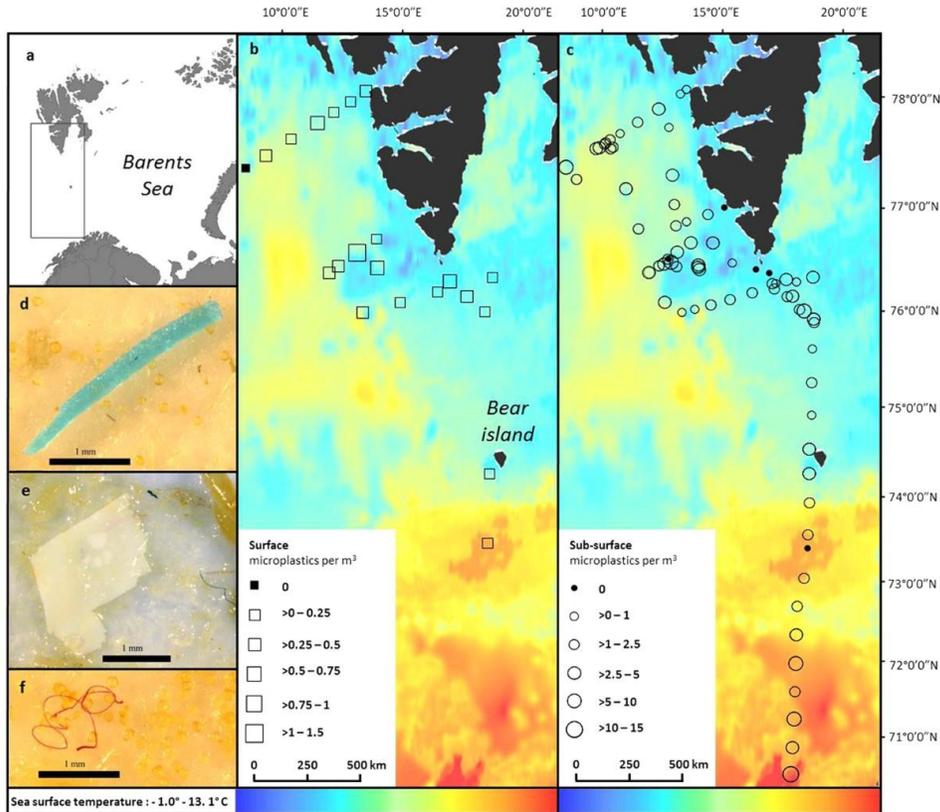
Dr. Amy L. Lusher
Senior Research Scientist (Forsker 1)

European Polar Science Week
Copenhagen 4th September 2024

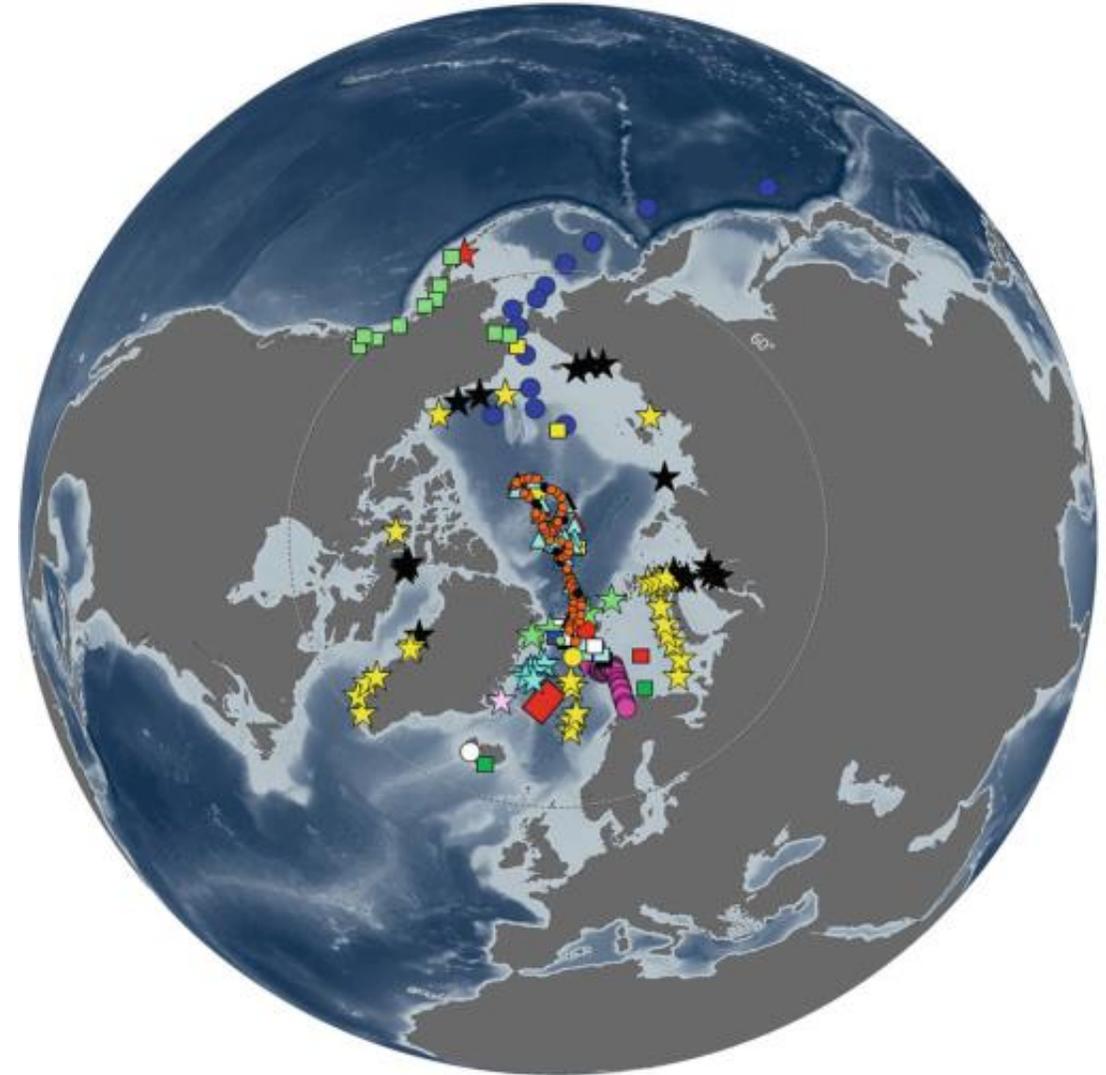


Norwegian Institute for
Water Research

The Arctic is not free from (micro)plastic pollution

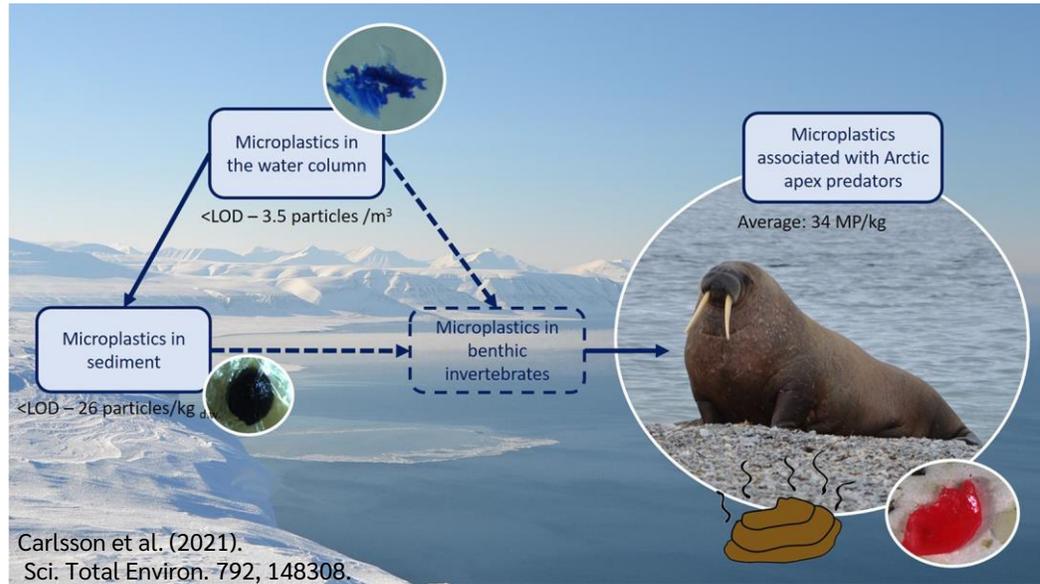


Lusher, A.L., Tirelli, V., O'Connor, I., & Officer, R. (2015). *Microplastics in Arctic polar waters: the first reported values of particles in surface and sub-surface samples*. Scientific Reports, 5, p. 14947

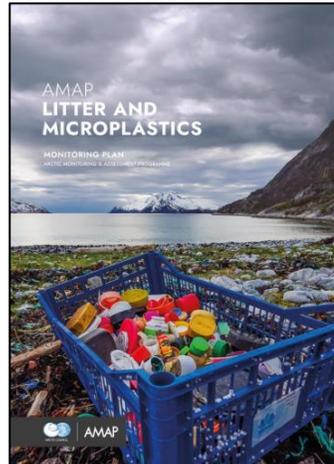
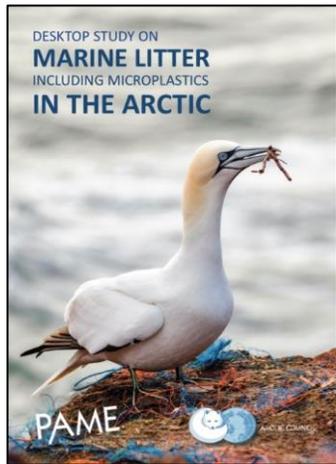


Tirelli V., Suaria G., Lusher, A.L. (2022). *Microplastics in Polar Samples*. In: Handbook of Microplastics in the Environment (pp. 281-322.). Springer, Cham.

The Arctic is not free from microplastic pollution



- 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

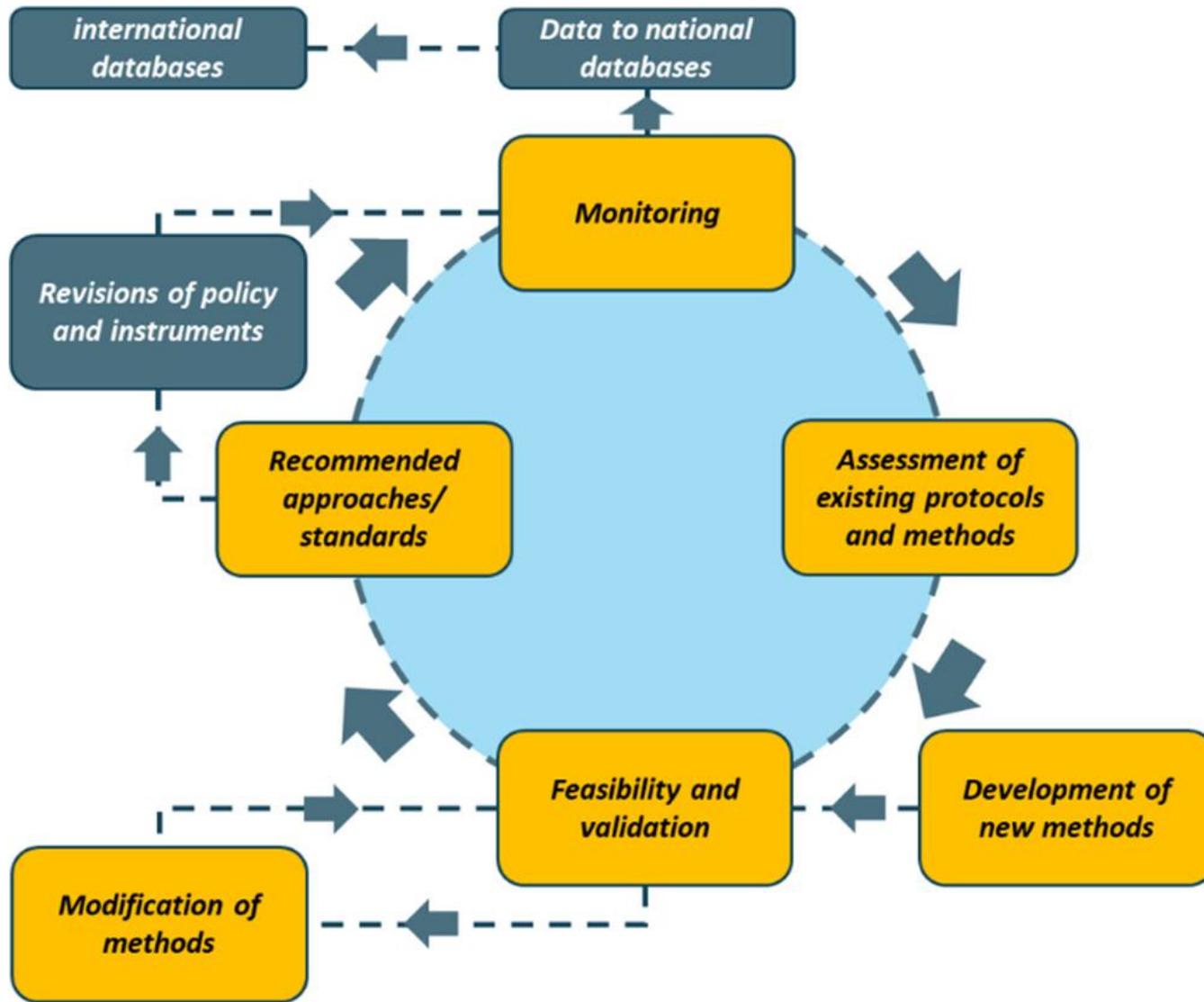
Motivation behind developing a pan-Arctic monitoring programme

- 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



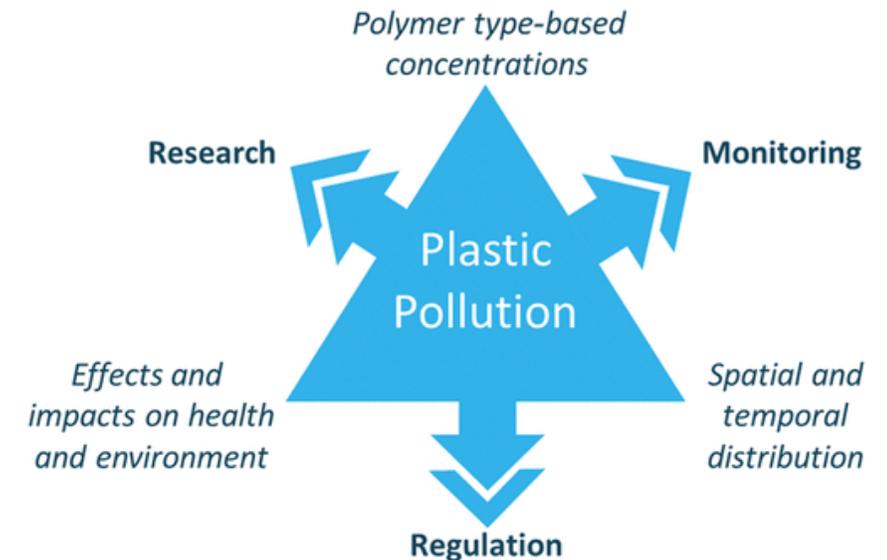
Developing methods to fit research or monitoring aims is a key step in (micro)plastic pollution control and management in the Arctic.

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



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*

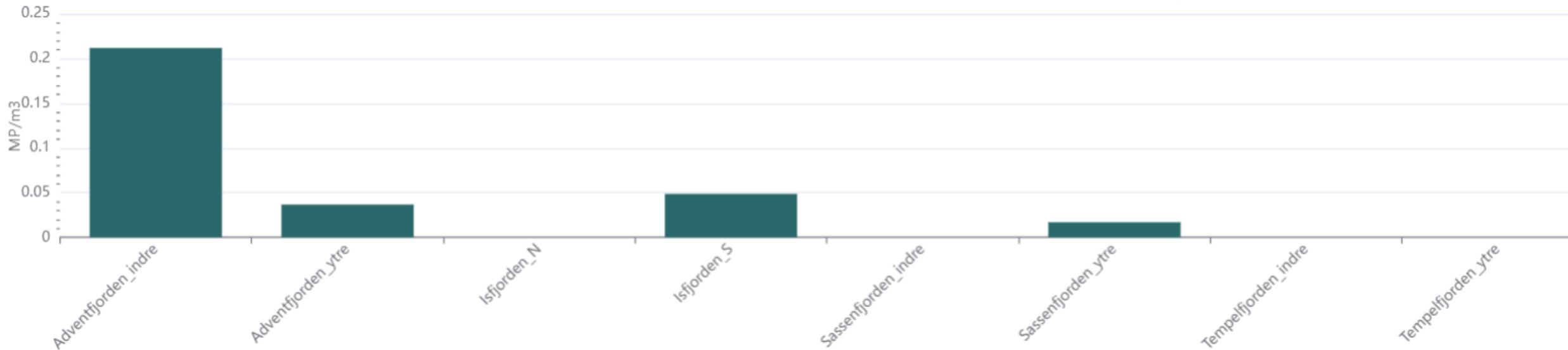
Consideration of contamination

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

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

Neuston Net Svalbard 2022

300 µm net, fibres excluded
Data displayed as average (n=3-5)



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

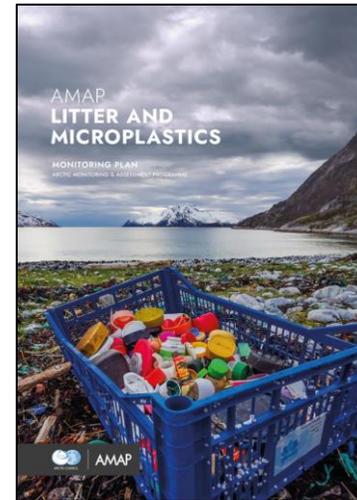
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Pictures kindly provided by: J. Falk-Andersson, S. Pakhomova, B. Hamilton



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

Amy L. Lusher¹ and Stefano Aliani²

10.1039/C5EM00183A

View Article Online

ABSTRACT Plastic pollution is an international environmental problem. There is a growing body of evidence that microplastics are emerging public health threats. It is critical to identify plastic hotspots, quantify and monitor, and manage plastic pollution. Policy-makers, researchers, and regulators are working on prevention and mitigation measures, while international, regional, and national bodies are defining monitoring requirements. Research activities are focused on reducing uncertainty by improving data and comparing methods. Policy and monitoring research is needed to understand the plastic pollution problem and to identify which methods to implement. The purpose of monitoring will differ which method is implemented. A clear and open dialogue between all actors is needed to facilitate communication on what is feasible with current methods, further research, and development needs. The example here involves the use of passive monitoring in the Arctic region, including water, snow, and ice, using existing, reliable infrastructure and individual capacity, and demonstrating its potential. This and similar research activities are needed to understand the need to answer pressing policy issues.

KEYWORDS: plastic litter, alone, environmental pollution, biomarkers, microplastics

D etails are increasingly reported in environmental science, from the global, through regional and international environmental assessment to the local, including monitoring, assessment, citizens, and pollution. Monitoring is needed to understand the extent of the problem, to identify hotspots, and to assess the effectiveness of policy. The United Nations Environment Assembly (UNEA) is the highest level of global environmental governance, with the mandate of a new legally binding global instrument on plastic pollution being the UN Environment Assembly's (UNEA) priority. The UN Environment Assembly (UNEA) is the highest level of global environmental governance, with the mandate of a new legally binding global instrument on plastic pollution being the UN Environment Assembly's (UNEA) priority. The UN Environment Assembly (UNEA) is the highest level of global environmental governance, with the mandate of a new legally binding global instrument on plastic pollution being the UN Environment Assembly's (UNEA) priority.

Arctic Science

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

Jake Martin¹, Maria Granberg², Jennifer F. Provencher³, Max Liborion⁴, Liz Pijogge⁵, Kerstin Magnusson⁶, Ingeborg Hallanger⁷, Stefano Aliani⁸, Alessio Gomiero⁹, Bjørn Einar Grøsvik¹⁰, Jesse Vermaire¹¹, Sebastian Primpke¹², and Amy L. Lusher¹³

ABSTRACT Litter and microplastic concentrations are being carried on worksheds. Arctic ecosystems are an exception and plastic pollution is high on the Arctic Council's agenda. Water and sediment have been identified as two of the primary compartments for monitoring plastics under the Arctic Monitoring and Assessment Programme (AMAP). Recommendations for monitoring both compartments are presented in this publication. Since, such samples can provide information on presence, size, and potential impacts in ecosystems. Together, the quantification of microplastics in water and sediment from the same region provides a three-dimensional picture of plastic, but only a snapshot of floating or buoyant plastic in the surface water or water column but also a picture of the plastic reaching the shoreline or nearby sediments, in lakes, rivers, and the ocean. Assessment methodologies must be adapted to the constraints of interest to generate reliable data. In its current form, published data on plastic pollution in the Arctic is sparse and collected using a wide spectrum of methods which limits the extent to which data can be compared. A harmonised and coordinated effort is needed to gather data on plastic pollution for the Pan-Arctic. Such information will aid in identifying priority regions and focusing mitigation efforts.

Key words: environmental sampling, microplastics, assessment, ecosystems, pollution, marine, freshwater, terrestrial, Arctic.

Résumé

Des évaluations des déchets et des microplastiques sont effectuées dans le monde entier. Les écosystèmes arctiques ne font pas exception et la pollution plastique figure en bonne place dans le programme de travail du Conseil de l'Arctique. L'eau et les sédiments sont deux des compartiments prioritaires pour le suivi des plastiques dans le cadre du Programme de surveillance et d'évaluation de l'Arctique (AMAP). Les recommandations pour le suivi des plastiques dans les deux compartiments sont présentées dans cette publication. Puisqu'ils fournissent des informations sur la présence, la taille et les impacts potentiels des plastiques dans les écosystèmes, la quantification des microplastiques dans l'eau et les sédiments de la même région fournit une image tridimensionnelle des plastiques, non seulement dans l'eau de surface, mais aussi dans la colonne d'eau, mais aussi sur les berges des plans d'eau.

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