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Innovative Community Engagement for Building Effective Resilience and Arctic Ocean Pollution-control Governance in the Context of Climate Change

Frameworks supporting beach clean-up in the Arctic

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A policy paper prepared by the ICEBERG project, presenting background information on various elements relevant to pollution governance in the Arctic.

January 2026

Funded by the European Union

Disclaimer: ICEBERG project has received funding from the European Union's Horizon Europe Research and innovation programme under grant agreement No 101135130.

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Funded by the European Union

THIS FACTSHEET IS BASED ON A POLICY PAPER WRITTEN AS A PART OF THE ICEBERG PROJECT

Frameworks Supporting Beach Clean-Ups in the Arctic

Arctic beach clean-ups are essential for reducing plastic pollution and generating data for informed policymaking, yet current efforts are limited by harsh conditions, fragmented governance, and lack of coordination and funding. Strengthening regulatory frameworks, harmonizing methods, and empowering communities are key to improving outcomes.

CURRENT GOVERNANCE - KEY ISSUES

No dedicated beach clean-up legislation: multiple international and national policies address marine litter, but none specifically regulates or support beach clean-ups in Arctic coastal areas (e.g., MARPOL, UNCLOS, OSPAR, national pollution acts).

Complex multilevel responsibilities: responsibilities are split across national agencies, municipalities, and protected-area authorities. In practice this leads to inconsistent execution, especially in remote zones.

Greenland: Beach clean-ups rely on broad environmental legislation and municipal responsibility, with limited coordination, sparse implementation capacity, and inadequate waste-handling infrastructure in remote areas.

Iceland: the Marine and Coastal Anti-Pollution Act prohibits sea dumping and provides structure for acute pollution events – but not for routine beach clean-ups. There is limited coordination of clean-up actors, and NGOs, volunteer groups and locals often plan overlapping efforts. Moreover, limited sewage treatment outside major cities contribute directly to coastal litter.

Svalbard: it has a strong formal governance framework, centred on the Svalbard Environmental Protection Act and strict regulations for protected areas. There is clear leadership by the Governor of Svalbard through the Clean Up Svalbard program – but it produces limited data and relies heavily on seasonal volunteers. Moreover, there is high logistical dependence on government-organized transport, leaving NGOs and external research actors with little autonomy.

THE MAIN GOVERNANCE GAPS

Lack of a harmonized Arctic-wide clean-up framework: No shared protocols exist for planning, monitoring, or reporting beach clean-ups across regions, meaning most clean-ups yield little scientific data.

Insufficient, unstable funding mechanisms: Clean-up operations in remote areas are expensive and highly seasonal. Current funding (e.g., municipal budgets, ad-hoc grants, tourism taxes) is inconsistent and often doesn't include waste handling and disposal costs.

Insufficient coordination among actors: NGOs, municipalities, research teams, and community groups often plan parallel clean-ups with little information-sharing. No shared system exists for reserving specific beach areas for clean-ups, causing duplication and inefficient use of resources.

Indigenous and local communities are essential contributors, drawing on deep knowledge of local ecosystems, long-standing cultural connections to coastal areas, and the ability to mobilize community members. However, many remain unaware of the cumulative impacts of beach litter and lack the stable funding, institutional support, and training needed to lead data-driven clean-up efforts.

EXAMPLES OF GOOD PRACTICE

• Clean Up Svalbard covers waste-handling costs for clean-ups, provides structured governance through the Governor's Office, and coordinates logistics in remote protected areas – a model for other Arctic regions with tourism-based funding potential.

• Arctic Coastal Cleanup, project coordinated by PAME, which seeks to build a transnational network of community-led clean-up activities across the Arctic region. Its aim is to organize and support clean-up efforts along Arctic beaches and coastlines, remove litter, and prevent further pollution. The project further emphasizes data collection and research: they use a protocol adapted for the Arctic to record what kind of litter is found, where it comes from, and how widespread pollution is – turning clean-ups into opportunities for citizen science.

FURTHER READING & CONTACT

Read the full policy paper at arctic-iceberg.eu/publications

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ICEBERG project

Climate change and pollution, including plastics, ship emissions and wastewater, pose threats to human health and the ecosystems of the Arctic region.

From 2024-2027, ICEBERG project funded by the EU under Horizon Europe programme studies pollution and its impacts on the ecosystems and communities in the European Arctic, focus on three regions: southern Kalaallit Nunaat (Greenland), Northern Iceland and Svalbard.

ICEBERG project integrates natural and social sciences with Indigenous and local knowledge. Researchers employ an ethical, multi-actor and gender-sensitive approach to assess the impacts, risks and vulnerabilities of local communities. The project applies the One Health approach, which recognises the interconnectedness and interdependence of the health of humans, animals, plants and entire ecosystems.

The aim is to mitigate the impacts of pollutants in the Arctic. The project investigates the sources, types and distribution of pollutants, such as plastics, ship emissions, wastewater and heavy metals, by using simulations, remote sensing and observations. On a practical level, the project develops, for example, automatic marine litter detection tools using drones, AI and citizen science. The toxicological impact of microplastics, nanoplastics and persistent organic pollutants (POPs) on human digestive health is being evaluated. The impact of pollution emissions on the marine food web is assessed.

Researchers work together with the communities and stakeholders to co-develop pollution monitoring, mitigation and adaptation strategies, as well as policy recommendations for multilevel pollution-control governance.

Policy papers

The series of policy papers outlines the main elements of the governance framework relevant to pollution control in the Arctic areas of the North Atlantic, with a focus on the three ICEBERG study sites.

Each paper starts with an introduction on the specific policy area or economic sector relevant for Arctic pollution governance, then proceeds to discuss regulations in the national three ICEBERG study sites, as well as to provide an overview of international law, European Union policies and legislation, Arctic Council actions and corporate governance. Governance gaps and selected best practices are presented.

The policy papers produced and published on the ICEBERG website are:

- Cruise tourism
- Solid waste & wastewater management
- Microplastics and plastics pollution
- Frameworks for Arctic beach clean-ups
- POPS and heavy metals
- Pollution related to mining activities

The policy paper does not constitute a formal deliverable of the ICEBERG project.

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Key insights:

This policy paper explores the existing frameworks supporting beach clean-up efforts in the Arctic, identifying key challenges and opportunities for improvement. The analysis highlights the following key findings:

1. **Regulatory Gaps and Overlaps** – there are multiple international and regional agreements that address marine litter, but not beach clean-ups in particular; gaps in enforcement and coordination limit their effectiveness in Arctic coastal areas.
2. **Logistical and Environmental Challenges** – the extreme Arctic environment, including seasonal ice cover and limited infrastructure, as well as access restrictions (in protected areas) and considerable transport costs, complicate clean-up operations and waste disposal.
3. **Data Gaps and Monitoring Needs** – Improved tracking and scientific assessment of marine litter sources and impacts are necessary to inform policy decisions and prioritise action.
4. **Community Engagement is Essential** – Indigenous and local communities play a vital role in beach clean-ups, yet they often lack sufficient funding, institutional support and methodological training.
5. **Methodology** - for clean-ups to generate useful, comparable data, a harmonised methodology should be developed (minimum required data).
6. **Private Sector and NGO Involvement** – Partnerships with industry stakeholders and environmental organisations are needed to scale up clean-up efforts.

These findings underscore the need for a more coordinated approach, integrating policy support, funding mechanisms, scientific research (i.e. generation of comparable data) and local participation to enhance the effectiveness of beach clean-ups in the Arctic.

1. Introduction and background

Marine litter pollution, particularly plastic waste, is a critical global environmental issue with widespread consequences for biodiversity, ecosystems, and coastal communities. While much of the research on marine litter focuses on densely populated and industrialised regions, the Arctic has emerged as a significant recipient of marine debris ([1]). Due to ocean currents, atmospheric transport, and sea ice dynamics, the Arctic acts as a sink for plastic pollution originating from distant sources.[2] Additionally, local contributors such as fisheries, tourism, landfill mismanagement and inadequate waste management systems exacerbate the issue. An extra factor is the inability to effectively enforce pollution-related rules, which are already in place (regarding, for example, litter dumping at sea). The accumulation of the presence of microplastics and toxic chemicals in plastics poses significant risks to human health, and plastic debris threatens fragile Arctic ecosystems, disrupts traditional livelihoods of Indigenous communities, and poses challenges for local governance ([3]).

Although prevention is the first priority, clean-up or removal of marine litter is also important and should be prioritised as close to the source as possible, where the litter is considered to be a threat to human health, wildlife, and coastal ecosystems and where costs are considered acceptable. This holds particularly for marine litter coming from land-based sources, and not for fishing-related litter (e.g. fishing nets, buoys, fish boxes, strapping bands), which constitute the majority of litter found in many Arctic regions ([1]) (fishing nets and other items bear no brand names or other identification markings, making it difficult to say whether it originates from local or more distant sources).

Beach clean-ups serve multiple functions beyond mere waste removal. Organised and spontaneous beach clean-ups promote citizen participation and raise awareness about marine pollution, encouraging behavioural change and responsible waste disposal ([4]). Also, with ocean clean-ups being economically, technically and environmentally unfeasible in the Arctic context, targeting stranded marine litter seems like the only viable way to address the problem. Moreover, beach clean-ups are crucial for reducing future microplastic pollution (with secondary microplastics coming from the degradation and fragmentation of plastic litter in the environment). Many Arctic beach clean-ups incorporate scientific research, enabling data collection on marine debris sources, composition, and accumulation rates. This information informs policy decisions and enhances marine pollution monitoring programs ([2]).

Beach clean-ups in the Arctic present distinct challenges compared to those in other regions. Arctic coastal areas are remote and difficult to access, and harsh weather conditions limit the operational window for clean-up activities ([4]). Studies confirm that part of the plastic pollution found on Arctic beaches originates from outside the region, making local intervention insufficient without broader

[1] Marthe Larsen Haarr et al., 'Beach litter in the European Arctic: Accumulation patterns, likely sources and pathways', *Marine Pollution Bulletin*, vol. 209, part B, 2024, 117187, https://doi.org/10.1016/j.marpolbul.2024.117187
[2] Kjersti Opstad Strand et al., 'Potential sources of marine plastic from survey beaches in the Arctic and Northeast Atlantic', *Science of The Total Environment*, vol. 790, 2021, 148009, https://doi.org/10.1016/j.scitotenv.2021.148009
[3] Mark L. Mallory et al., 'Anthropogenic litter in marine waters and coastlines of Arctic Canada and West Greenland', *Science of The Total Environment*, vol. 783, 2021, 146971, https://doi.org/10.1016/j.scitotenv.2021.146971
[4] Melanie Bergmann et al., 'Citizen scientists reveal: Marine litter pollutes Arctic beaches and affects wildlife', *Marine Pollution Bulletin*, vol. 125, issues 1–2, 2017, pp. 535–540, https://doi.org/10.1016/j.marpolbul.2017.09.055

international cooperation ([2]). Many Arctic communities lack proper waste management and disposal facilities, leading to the reintroduction of collected waste into the environment ([1]). Indigenous and local communities, along with NGOs and local municipal authorities, play a critical role in Arctic beach clean-ups. However, these initiatives often lack sustainable funding and governmental support ([5]).

While clean-ups are crucial, they do not address the root causes of marine litter. Sustainable policy solutions should focus on preventive measures, such as reducing plastic usage and importation, improving waste management infrastructures, and enforcing stricter regulations on waste disposal in the Arctic.

2. National/local governance

At the national/local level, several countries have adopted regulations and community programs to manage beach litter and pollution.

2.1. Greenland

While there isn't a specific national law dedicated solely to beach clean-ups, the existing legislative and policy frameworks collectively support efforts to maintain and protect Greenland's coastal environments.

- **Environment Protection Act (No. 9 of 2011)**: This act aims to safeguard the environment by establishing rules to prevent pollution of air, water, ice, rock, and soil.

- **Action Plan to Reduce the Use of Plastics (2021)**: In May 2021, the Government of Greenland adopted an action plan to reduce the use of plastics. There is also an action plan on the reduction of lost fishing gear.

- **Environmental Fund (Miljøfonden)**: Established in 2018 by the Inatsisartut (Parliament of Greenland), this fund aims to enhance plastic recycling and manage fisheries waste. In 2019, allocations were made specifically for addressing plastic pollution and cleaning up abandoned or lost fishing gear ([6]).

- Copenhagen Agreement (2022a): Municipalities are responsible for coastal and port clean-up efforts, and the *Nature Agency (Naturstyrelsen)* oversees clean-up operations in protected areas. Pollution control efforts often involve collaboration between state and municipal authorities. In cases of severe accidents, a special authority body—the *Emergency Committee*—is established under the *Ministry of the Environment and Energy*. For large-scale control and clean-up operations at sea and along the coast, the *Minister of Defence* may take the lead (Copenhagen Agreement,

[5] PAME. (2021). Regional Action Plan on Marine Litter in the Arctic. http://hdl.handle.net/11374/2649

[6] Jannie F. Linnebjerg et al., 'Review of plastic pollution policies of Arctic countries in relation to seabirds', *FACETS*, vol. 6, 2021, pp. 1–25, https://doi.org/10.1139/facets-2020-0052.

2022). Routine beach cleaning is financed through municipal budgets. Some municipalities have placed litter boxes along the coast to encourage public participation. In the event of acute oil or chemical pollution, municipalities remain responsible for clean-up but can receive national budget reimbursement ([7]).

Clean-up efforts in Greenland are sparse, which is most likely due to harsh conditions and a sparse population. However, NGOs contribute to beach cleaning and marine litter management. For example, CSR Greenland conducts beach clean-ups in cooperation with The Nordic Coastal Cleanup (NCC). Additionally, efforts are also made by WWF Greenland and Group Plastic Not So Fantastic to reduce plastic pollution. *Havmiljøvogterne*—a network of nearly 30,000 sailors, divers, and surfers—supports the *Danish Navy* with environmental surveillance and clean-up. Other organisations, such as Hold Danmark Rent (HDR), the Race for Oceans Foundation, and Plastic Change (an international organisation based in Denmark), also participate in clean-up efforts and awareness-raising initiatives.

2.2. Iceland

While there is no specific national law covering solely beach clean-ups, there are legislative and policy frameworks that collectively support efforts to maintain and protect Iceland's coastal environments:

- Act on Marine and Coastal Anti-Pollution Measures (No. 33/2004): This legislation aims to protect Iceland's oceans and beaches from pollution and activities that could harm human health or the environment. The Act explicitly prohibits discharges of objects and substances into the sea. In principle, the law also makes Icelandic legislation in line with the MARPOL convention with respect to marine pollution. It defines acute pollution as incidents that occur suddenly and require immediate action, providing a framework for responding to such events. The 2012 Regulation on Response to Acute Pollution of Seas and Beaches complements the 2004 Act ([8]).

- Nature Conservation Act (No. 44/1999): This act directs human interaction with the environment to prevent harm to the biosphere, geosphere, air, sea, or water. It ensures that Icelandic nature can develop according to its own laws and conserves its exceptional or historical aspects ([9]).

- Environmental Protection and Pollution Control Legislation: In addition to the legislation and policies addressing beach litter in a more direct manner, Iceland has adopted numerous pieces of legislation aimed at limiting the use and disposal of plastic waste, partly following the EU's regulatory framework. Please consult the paper on solid waste and wastewater for details. Relevant legislation includes: 1998 Sanitation and Pollution Act (amended in 2020 to introduce EU restrictions on single-use plastics), the 1989 Act on Measures against Environmental Pollution Caused by Disposable Packaging for Beverages and the associated 2017 Regulation on the Collection, Recycling and Return Fee for Disposable Beverage Packaging, the 2003 Act on Waste Management with 2023 Waste Management Regulations, the 2002 Act on the 'Processing Fee'. The latter covers the responsibility of fishers (represented by the Icelandic Association of Fisheries

[7] Michael Mannaart, Magnus Engelbrektsson and Arabelle Bentley, *Acute Plastic Pollution: Causes, problems and solutions* (Nordic Council of Ministers, 2023), https://pub.norden.org/temanord2023-524/index.html
[8] https://www.lhg.is/media/arsskyrslur/Act_33_2004.pdf
[9] https://www.ust.is/library/Skrar/Atvinnulif/Log/Enska/The_Nature_Conservation_Act.pdf

Companies SFS), which is of particular importance as a big part of marine litter originates from fishing activities. This policy area is also specifically addressed with the 2020 Regulation on the Marking of Fishing Gear and Lost Fishing Gear, which introduces an obligation to attempt retrieval and report any lost gear. In addition, as apart from the capital area and Akureyri (partly), there is no primary processing (removal of larger items and particles) of wastewater with outflows into the sea, in contrast to wastewater released to freshwater ecosystems. Sewage, therefore, can constitute an important source of marine litter and beach litter.

In addition to these laws, Iceland has implemented policies targeting marine litter and plastic pollution:

- **Action Plan on Plastics** (2020-2025): Adopted by the Government of Iceland, this plan includes measures such as coordinated research on marine plastic pollution, improved sewage treatment, reduction of microplastic discharge with surface water, restrictions on marketing cosmetics containing microplastics, cleaning Icelandic beaches, and better recovery of lost fishing gear. The 2020 Action Plan included a – rather unattainable - ambition to clean up marine litter from all Icelandic beaches by 2025. A new Action Plan on Plastics is currently being developed.
- **Coastal Cleanup Grants**: As part of the Action Plan on Plastics, the Icelandic government supports coastal preservation by offering grants to organise clean-up efforts, maintain cleaned beaches, and raise public awareness about the importance of coastal cleanliness. This funding empowers local and voluntary initiatives through the national coastal clean-up program. One beneficiary is the *Icelandic Clean-Up Project* by *Ocean Missions* (Ocean Missions Clean-Up Project). Thanks to this support, the organisation can provide transport and food for volunteers, making participation both accessible and inclusive. To further raise awareness and educate the public, *Ocean Missions* also organizes sailing trips where tourists actively participate in litter collection, contribute to environmental research, and learn about critical ecological issues. The government attempts to bring together clean-up actions, albeit with limited coordination.

In addition, several NGOs contribute to beach cleaning and marine litter management. For example, the Blue Army (https://blaiherinn.is/english/), and the WorldWide Friends (https://wf.is/). Among the most common pieces of plastic found during beach clean-ups are bottles and caps, fishing nets and general fishing-related items as well as food wrappers and straws. Iceland has also joined the Global Ghost Gear Initiative, which aims to mitigate the effects of abandoned, lost or otherwise discarded fishing gear (ALDFG).

2.3. Svalbard

The primary legal framework is the **Svalbard Environmental Protection Act** of 2001, designed to safeguard Svalbard's natural environment. Under this Act, the Regulations Relating to Pollution and Waste in Svalbard, established in 2020, aim to prevent and reduce environmental harm from waste and pollution. These regulations apply to the entire land area of Svalbard and its territorial waters.

In alignment with these regulations, the Governor of Svalbard has been actively involved in organising beach clean-up initiatives since 2000. The mission *"Clean Up Svalbard"* (https://aeco.no/projects/environment/clean-up-svalbard/) focuses on remote and isolated areas,

and it mobilises trained volunteers to heavily polluted beaches that are otherwise inaccessible. Transported by boat and helicopter, these volunteers remove waste while adhering to strict environmental and safety regulations. The Governor's Office oversees accommodation and logistics, ensuring proper waste disposal and data collection. This structured leadership not only sustains long-term environmental efforts but also inspires further volunteer initiatives. *Clean Up Svalbard* is supported by the digital tool **Rent Hav** (https://www.miljodirektoratet.no/tjenester/rent-hav/), which enables participants to register new beaches in need of cleaning, record the amount of waste removed, and indicate whether the clean-up was organised in affiliation with the Association of Arctic Expedition Cruise Operators (AECO). The tool is available for use throughout Norway; however, it is not very user-friendly, and the provided information lacks clarity (forScience pers. comm.). Despite being a relevant in situ initiative, Clean-up Svalbard generates very little data. Sometimes it is no more than the overall litter mass per season ([10]). If recommended forms are used, data includes location (start/end point), litter mass and/or number of pieces ([11]), and no qualitative data is collected.

Hold Norge Rent (Keep Norway Beautiful) is one of the NGOs working on cleaning the country and combating plastic pollution. Together with the Norwegian Centre against Marine Litter (MARFO), HNR has initiated a platform called Rydde ([12]). MARFO works under the Ministry of Climate and Environment with the aim to reduce marine litter and prevent marine-base source of plastic pollution ([7]). Rydde is a tool where clean-ups can be registered, including information about what was found, and which area was cleaned. The Norwegian Retailers Environmental Fund (Handelens Miljøfond) is a major source of funding for pollution-related projects. The money in the fund comes from plastic bags sold in stores in Norway. This initiative was started in 2017 instead of imposing a tax on plastic bags.

Additional comments regarding Svalbard (forScience):

- Taking advantage of Svalbard's unique status (Svalbard Treaty), other actors are also active within the archipelago in the context of beach litter pollution mitigation and research, including the forScience Foundation.
- Clean-up projects currently carried out in Svalbard include Rydd i Tide Svalbard: https://handelensmiljofond.no/rydd-i-tide/regioner/rydd-i-tide-svalbard
- Clean-up coordination is sometimes problematic, with several actors planning clean-ups and/or marine litter research in overlapping areas. There is no single tool that would enable an organisation to "book" an area and be certain that no one else starts a clean-up there while fieldwork is being organised. This is especially problematic in remote areas, where fieldwork preparation is both costly and time-consuming, and where potential overlap may compromise clean-up objectives or research results.

[10] https://www.sysselmesteren.no/contentassets/a70708481d8a49d4b3eb79e06b9cfb9a/clean-up-svalbard.pdf
[11] https://www.sysselmesteren.no/siteassets/miljovern/forurensing/strandryddeveileder-svalbard_engelsk-18.10.24.pdf
[12] Jannike Falk-Andersson et al., *Development of a Norwegian monitoring program for Macroplastic and Litter* (Norsk institutt for vannforskning, 2022), https://niva.brage.unit.no/niva-xmlui/handle/11250/3040319

3. Supra-national governance (international, Arctic, EU)

On a global level, a few binding as well as non-binding policies targeting plastic pollution have been established. Four policies provide a foundation for international legislation regarding plastic pollution and general pollution issues ([6]). These policies are the London Convention and Protocol, the International Convention for the Prevention of Pollution from Ships (MARPOL), the United Nations Convention on the Law of the Sea (UNCLOS) and the Basel Convention ([6]). For more detailed information on these policies, please consult the papers on solid waste and wastewater, and microplastics.

3.1. Arctic Council

The Arctic Council (AC) plays a pivotal role in shaping policy, issuing recommendations, and evaluating environmental challenges in the Arctic. In recent years, its focus on tackling plastic pollution has intensified, particularly through the Marine Litter – Regional Action Plan (ML-RAP), adopted in 2021. Led by the Protection of the Arctic Marine Environment (PAME) Working Group, this initiative offers a structured approach to addressing marine litter from both ocean and land-based sources. It proposes strategies to minimise pollution from fisheries, shipping, and offshore industries while also emphasising the need to enhance waste management systems in Arctic communities. Furthermore, the plan advocates sustainable material use, the removal of marine debris from coastlines, expanded research and monitoring efforts, and greater public awareness through education and international partnerships. Since 2021, PAME has also been responsible for the Arctic Coastal Cleanup project, which seeks to build a transnational network of community-led clean-up activities across the region. The network itself is managed by the NGO Keep Norway Beautiful (Hold Norge Rent), organising cleanups in Norway, Greenland and Iceland with local partners, while the NGO Ocean Conservancy similarly coordinates cleanups in Alaska. The Network consists, among others, of NGOs, local communities, as well as (local) governmental actors. As part of the Arctic Council, the Project is funded by the Norwegian Ministry of Climate and Environment through PAME. The project focuses not only on removing plastic waste but also on identifying sources of pollution to support science-based management. Data collected from the clean-up efforts contribute to a broader understanding of Arctic marine pollution. By integrating citizen science and structured waste monitoring, the Arctic Coastal Cleanup plays a critical role in raising awareness of the sources, the distribution and the impacts of plastic pollution in the Arctic. In 2025, Norway proposed to extend the project until 2027.

3.2. OSPAR

The most important Nordic policy regarding plastic pollution is OSPAR, the Convention for the Protection of the Marine Environment of the North-East Atlantic that entered into force in 1998 ([6]). The Oslo-Paris Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) covers fully Icelandic and Svalbard waters as well as the East Greenlandic marine environment. The OSPAR Commission's Marine Litter Action Plan targets Arctic waters, emphasising monitoring, clean-up, and prevention strategies. OSPAR has facilitated knowledge-sharing on best practices for beach clean-ups in northern Europe. OSPAR has set ambitious targets, such as a 70%

reduction in the prevalence of all beach litter, reflecting its commitment to significantly decreasing marine litter levels. To achieve this, OSPAR has developed Regional Action Plans focusing on preventive measures and, where necessary, clean-up activities. These plans emphasise that while prevention is paramount, removal of existing litter is also crucial, especially when it poses threats to human health, wildlife, and coastal ecosystems. Additionally, OSPAR has developed a beach litter monitoring guideline ([13]). The methodology, however, is much too time-consuming to be followed during larger-scale beach clean-ups.

Unfortunately, the Arctic is not sufficiently represented in OSPAR. There are only three OSPAR survey sites in Svalbard (all located in the north-western part of the archipelago), and even these do not seem to be surveyed anymore (last data from 2020): (https://beachlitter.ospar.org/map). Moreover, Svalbard isn't included in recent OSPAR statistics: (https://odims.ospar.org/en/maps/?layers=ospar_outer_boundary_2023_01_001,ospar_median_total_counts_beach_2022_05_001,ospar_inner_boundary_2016_01_002).

Besides, the focus on count (rather than mass) data is problematic in the Arctic, where large litter items dominate (fishing-related litter items). Providing litter data in the number of litter items gives little idea of the scale of the problem, no indication of the actual amount of plastic in the environment, etc.

3.3. EU

While EU policies are primarily implemented within member states, their influence extends to the Arctic.

EU Marine Strategy Framework Directive: Descriptor 10: Marine Litter

In 2020, experts agreed that the amount of litter on the coastline should not exceed 20 items (larger than 2.5 cm) for every 100 metres of coastline. In the Arctic context, this would allow for considerable pollution levels (as a single item may well be a 100-kg industrial plastic container or fragment of fishing net measuring several metres by several metres).

Single-Use Plastics Directive

Adopted in 2019, this Directive targets the ten single-use plastic items most frequently found on European beaches, as well as fishing gear containing plastics. Measures include bans on specific products, consumption reduction efforts, design requirements, labelling obligations, and extended producer responsibility schemes. By addressing these prevalent sources of marine litter, the directive aims to significantly reduce plastic waste entering marine environments, thereby decreasing the volume of litter that could be transported to Arctic regions.

Circular Economy Action Plan

The CEAP, introduced in 2015 and updated in 2020, outlines a comprehensive strategy for sustainable resource use within the EU. It emphasises the entire lifecycle of products, promoting design for longevity, reuse, repair, and recycling. By fostering systemic changes that minimise waste generation and encourage sustainable material use, the CEAP contributes to reducing the overall

[13] OSPAR Commission. (2010). *Guideline for Monitoring Marine Litter on the Beaches in the OSPAR Maritime Area.*

production of plastic waste. This systemic reduction lessens the potential for plastic debris to reach and impact distant ecosystems, including the Arctic.

3.4. UN SDG

SDG 14. "Life Below Water" specifically focuses on the conservation and sustainable use of oceans and emphasises the need to reduce marine pollution of all kinds by 2025, identifying the density of plastic debris as a key indicator of progress. Additionally, SDG 6 (Clean Water and Sanitation), SDG 11 (Sustainable Cities and Communities), and SDG 12 (Responsible Consumption and Production) indirectly address marine litter by promoting waste reduction, improved waste management, and pollution prevention in inland waters.

3.5. MARPOL Annex V

MARPOL Annex V, established by the International Maritime Organization (IMO), plays a crucial role in mitigating marine pollution by regulating the disposal of garbage from ships. This annex prohibits the discharge of all plastics and other forms of garbage into the sea. However, there are serious enforcement issues. The forScience team regularly finds litter items which have clearly been dumped from vessels (such as bundles of strapping bands, chunks of melted plastic, etc.).

4. Gaps, shortcomings, current policy discussions and best practices

In order to be able to address the efficiency of cleaning effort, data has to be available about types of plastics in the environment, sources and quantity, which can be provided by monitoring programs ([14]). Plastic pollution monitoring programs, however, often only include the number of items collected or found and not the mass of the pieces ([12]). This can distort the picture given for certain areas, since, for example, a small piece of plastic, or a bottle cap, counts as much as a big fishing net (12), which tends to be very heavy and, in addition, may have an impact on a larger area than a single bottle cap will have. Recording mass would thus change impressions about the abundance of certain plastics in the environment.

The lack of harmonised methodology (due to which clean-ups seldom generate useful data) is another major pitfall of beach clean-up initiatives that need to be addressed.

One option preventing plastic pollution is the tagging of gear, especially in the fishing industry, which can help prevent loss of fishing nets since it makes locating and thus the retrieval of lost gear easier ([15]). The majority of fishing-related litter collected and analysed by the forScience team in 2024 was not labelled in any way.

[14] Ingrid L. Pollet et al., 'Monitoring litter on Arctic and subarctic shorelines: current status and next steps for monitoring programs', *Arctic Science*, vol. 9, no. 4, 2023, pp. 807–824, https://doi.org/10.1139/as-2022-0047
[15] Marcus Eriksen et al., 'Mitigation strategies to reverse the rising trend of plastics in Polar Regions', *Environment International*, vol. 139, 2020, 105704, https://doi.org/10.1016/j.envint.2020.105704

The use of alternative materials is tempting but often proves difficult ([16]). A lot of these materials are not as durable as plastic and are more expensive, which makes these solutions challenging to fund and implement.

Another path to reducing plastic pollution is the Circular Economy (CE), which "aims to minimise plastic waste and subsequent environmental contamination by addressing the entire value chain" ([17]). This means CE can aid in a more sustainable life cycle of plastics, improving from its production and design as well as recycling and waste management ([17]). Ideally, this means plastic is used more often, which aids in limiting the production of new plastics. However, even CE has its limits since recycled plastic is more difficult to work with and reuse ([17]).

Other shortcomings of beach clean-up initiatives in the Arctic region are related to limited funding (high costs of initiatives), seasonal restrictions, complex stakeholder coordination ([2]), competition (rather than cooperation) between actors (forScience pers. comm.), which creates obstacles for large-scale clean-up operations.

It would also be beneficial to invest further into awareness campaigns and education. This would help in guiding people towards more sustainable and environmentally-sound decision--making.

Current policy discussions on beach clean-ups worldwide are increasingly integrated into broader strategies addressing marine pollution at its source. These discussions focus on preventive measures (e.g., reducing plastic production, promoting sustainable materials, and improving waste management systems), international treaties, national action plans, and community engagement to achieve sustainable and long-term solutions.

4.1. Best Practices

The Longyearbyen City Council (Longyearbyen Lokalstyre) has an agreement with Svalbard Environmental Protection Fund (Svalbards miljøvernfond, https://www.miljovernfondet.no/en/front-page/) under which marine litter collected in Svalbard can be received and disposed of at the local waste management facility free of charge to the clean-up organiser (the cost is covered by the Fund). The agreement is sometimes suspended, and/or other Funds take over. When no funds are available to cover the cost of marine litter disposal, clean-ups organisers must cover the costs themselves (which seems to be standard practice). This is because the city of Longyearbyen has limited funds, and the (single) local community cannot be expected to pay for the litter collected around the entire archipelago. Last year, the cost was 11,94 NOK per 1 kilogram of sorted litter, with extra fees added for litter handling, etc. Additionally, bins are placed in town for marine litter brought into town by locals and visitors.

The Icelandic Recycling Fund (IRF) has found success in using financial incentives to increase the proper disposal of waste, including the explicit funding of collection and recycling. The incentive is funded through a recycling fee on products for producers and importers, which is a model that could be scaled up or applied to other places in the Arctic. Through the IRF partnership with the

[16] Anil Hira et al., 'Plastic Waste Mitigation Strategies: A Review of Lessons from Developing Countries', *Journal of Developing Societies*, vol. 38, no. 3, 2022, pp. 336–359, https://doi.org/10.1177/0169796X221104855

[17] Elizabeth Cowan, Laila Setsaas and Vilde S. Nørstebø, 'End of life at the top of the world—Stakeholder perspectives for plastics and circular transitions in the Arctic', *Journal of Environmental Studies and Sciences*, vol. 13, no. 4, 2023, pp. 545–556, https://doi.org/10.1007/s13412-023-00845-6

fishing industry, fishermen can return gear (such as nets and ropes) to waste collection points without paying a fee. IRF then works with technology partners to recycle the gear they collect. In order to build engagement from fishermen, IRF has found it beneficial to communicate the risks that plastic pollution poses to the health of fisheries upon which their livelihoods depend. This collaboration is a promising public/private partnership addressing one of the significant sources of sea-based plastic pollution in the Arctic.

Norway's Deposit Return Scheme (https://www.tomra.com/reverse-vending/media-center/feature-articles/norway-deposit-return-scheme) is an example of how extended producer responsibility (EPR) can drive change. By charging consumers a deposit for plastic bottles and refunding them upon return, Norway has achieved an astounding 97% recycling rate, ensuring that plastic waste never reaches the ocean. It should be noted, however, that the Deposit Return Scheme works in mainland Norway, but not in Svalbard (Longyearbyen doesn't even have proper sewage treatment).

Cruise industry partnerships with local governments can leverage each other's strengths. For example, the Association of Arctic Expedition Cruise Operators (AECO) has established a Clean Seas Project, which focuses on reducing single-use plastics onboard expedition cruise vessels, while educating and motivating passengers and crew to better understand the negative impacts of plastic pollution on the sensitive Arctic marine environment. AECO brings tourists to the Svalbard area who contribute to debris removal efforts, while the Svalbard government retrieves the aggregated waste that is collected, so the cruise ship does not incur the costs of disposal. However, tourist groups can only land in a couple of dozen designated landing areas, so their contribution should not be overestimated. Tourist involvement helps increase awareness, but its positive environmental impact is limited.

The Clean Seas Guidelines and other educational materials that have been developed by AECO can be used outside of the expedition cruise industry, but they aren't being used yet. The challenges expedition vessels face are similar to those faced by larger cruise operators as they begin to expand their services in the region. Sharing of best practices and lists of alternative products could help the increasing tourism industry in the Arctic engage in more sustainable visits. Clean-up efforts can also be scaled up with the support and partnership of the local government. As the tourism industry in the Arctic grows and more cruise ships enter the region, having sustainable practices will be critical to maintaining the Arctic ecosystems that attract visitors.

The "Fishing for Litter" (https://fishingforlitter.org/norway/) program started in Norway in 2016, following the OSPAR approach used in other countries of the northeast Atlantic and the North Sea for 15 years. The program expanded from three to eight harbours in 2017, with three of them – Ålesund, Tromsø and Båtsfjord – located within the Arctic region. "Fishing for Litter" is a program under which fishing vessels deliver marine litter caught during regular fishing activity free-of-charge to assigned marinas, and it is targeted to address the challenges connected with fisheries-related waste and ghost fishing gear. From 2016-2017, a total of 92 deliveries totalling more than 118 metric tons were made in the harbours of Tromsø and Ålesund, more than 60% of which was fisheries-related waste (SALT Lofoten AS, 2017). Annual fishing gear retrieval surveys have been conducted since the 1980s by the Norwegian Directorate of Fisheries (https://www.fiskeridir.no/english/Coastal-management/Marine-litter), providing data on the scale of the problem. It must be kept in mind, however, that the surveys are based on reports of lost fishing gear and, as such, do not include abandoned or discarded items (such as net fragments and cuttings thrown overboard after net repairs). Besides, the programs and surveys do not seem to

include plastic buoys, hundreds of which are lost every year. Plastic buoys make up a significant percentage of marine litter washed ashore in Svalbard, and while they are less problematic than nets and ropes in terms of the risks they pose, they do, over time (through gradual degradation and fragmentation), exacerbate the problem of microplastic pollution. Moreover, as of 2020, approximately 380 t of plastic from fishing gear were lost at sea every year in Norway alone (and this only includes items which were registered, [2]). This shows that retrieval schemes are not enough to solve the problem.

Beach litter surveys are an important foundation for management decisions as they can contribute to knowledge about the magnitude of the problem, monitor its development over time, and identify the main sources and management target levels of litter presence along the coastline. However, monitoring approaches need to be refined. In order to provide information on key litter categories at the level necessary for taking informed management decisions, the "deep dive" methodology ([18]) was developed within the MARP and Arctic Marine Litter Project. This methodology has been developed to provide detailed insight into the origin, sources and underlying behaviour, processes and policy framework(s) that may have contributed to litter ending up in the marine environment, as well as identifying potential solutions. The idea behind the beach litter "deep dive" tool is that with the help of sector experts, detailed management-relevant information can be collected. Engaging stakeholders in the collection of data and its analysis facilitates the establishment of a management-oriented dialogue with these actors that contribute and often also receive the impacts of marine litter. However, the methodology is not actively used. A modified version of the Deep Dive was carried out by the forScience Foundation under the project ICEBERG in 2024 and will be continued in 2025.

4.2. Future needs

The problem of plastic pollution in the Arctic is sufficiently understood to know that it poses a risk to marine ecosystems. However, there are gaps in knowledge of the abundance and distribution of Arctic marine plastic from these different sources. These gaps can make it more challenging to assess how to best target interventions. ([14]) The next steps for litter monitoring programs:

1. Harmonised Monitoring:

• Conduct surveys on a regular, but realistic calendar. Arctic beach clean-ups are possible only from July to September (with additional restrictions applicable in protected areas, such as bird reserves). Adding to it logistical challenges and high expedition costs (not to mention carbon footprint), surveys twice a year are not feasible. Surveys once every two years sound much more doable, especially if remote, uninhabited areas are also to be taken into account. Bearing in mind that much of the high Arctic is remote and uninhabited, leaving such areas out is unjustified and may lead to serious misinterpretations of the marine litter pollution problem.

• Harmonising methods (generating comparable data) would be good enough and much easier to work out.

[18] https://salt.nu/assets/projects/1033-Svalbard-Beach-litter-deep-dive.comp_.pd

2. Community and Indigenous Involvement:

• Community priorities may not reflect environmental priorities. Marine litter clean-ups and monitoring should also (if not primarily) take place in remote, uninhabited areas (such as national parks and bird reserves), with restricted access, where growing pollution levels compromise conservation goals.

• When possible, integrate community-based monitoring and crowdsourced science to leverage local knowledge and increase engagement.

• Support training and capacity building to empower local communities in data collection and reporting. A prerequisite for community training is the development of harmonised, relevant data collection methods. Otherwise, the effort put in by the community may have little scientific value, which may be frustrating and make communities less likely to actively participate in other citizen science initiatives.

3. Data Sharing and Accessibility:

• Regularly publish survey results and make them accessible through open databases. At the moment, there seem to be as many databases as there are projects, none are internationally accessible (language) or comprehensive enough, and none ensure data comparability.

• Encourage international collaboration to track marine litter pathways and sources.

4. Tailored Approaches for Arctic Conditions:

• Implement flexible approaches that accommodate seasonal variations and environmental constraints. Flexible approaches are easier to implement with respect to regular clean-ups (collecting marine litter only). Monitoring clean-ups (collecting litter and litter data) allows for much less flexibility, as any variations reflect on the data.

5. Policy Recommendations:

• Develop a comprehensive Arctic beach cleanup framework that integrates local and regional monitoring programs.

• Promote international cooperation to tackle transboundary marine litter issues.

• Ensure consistent funding for long-term monitoring and community involvement.

• Promote data-focused clean-ups (approach adopted by the forScience Foundation) to ensure that beach clean-ups generate relevant, up-to-date data to verify law enforcement and inform further policy decisions.

• Improve enforcement of existing rules and regulations (instead of introducing new, stricter ones).

Lastly, communities in the Arctic are distinct from one another. The challenges of bringing technology to scale in the Arctic are magnified by the remoteness of some communities. The same technological solution that may work well for one community, may not work for another. Besides, the issue of marine litter pollution is also acute in uninhabited areas, where implementing technological solutions (e.g. using UAVs) may not be viable due to practical and environmental restrictions.

A better understanding of the interaction of voluntary initiatives and legally binding approaches to combat plastic pollution is also necessary, in how far and under what conditions they effectively complement each other.

5. Best international practices

Several international initiatives are stepping up to address the challenge of marine debris that arrive to coastal communities. From grassroots movements to corporate accountability and technological breakthroughs, beach clean-ups are evolving into a global movement.

5.1. Community-Led Clean-Ups

One of the most impactful initiatives, **Ocean Conservancy's International Coastal Cleanup** (https://oceanconservancy.org/trash-free-seas/international-coastal-cleanup/), has mobilised millions of volunteers since 1986. Every year, people gather along coastlines to remove trash while collecting vital data that informs marine conservation policies. Over 158 thousand metric tons of waste have been removed so far, making it one of the largest and most influential environmental movements in history. However, an analysis of ICC statistics shows serious drawbacks (e.g. an average volunteer collects only 7.9 kg of litter). Additionally, the ICC data cards have little relevance for the Arctic (unsuitable litter categories), which may lead to serious misrepresentation of the litter situation in the region.

A relevant opportunity would be to use traditional ecological knowledge to supplement and/or complement monitoring schemes (not applicable in Svalbard, though, no indigenous population). As an example, in the United States, the National Park Service has done work to integrate traditional ecological knowledge (TEK) into nearshore modelling of ocean current patterns as they relate to oil spill dispersion, debris deposition and sources. Currently, there is work in Canada using local Indigenous Knowledge to assess how microplastics may be concentrated around seabird colonies. The synthesis of Indigenous Knowledge regarding where plastic is most likely to be found is a potential area for further study. Similar traditional and local knowledge may be available and useful to gather and integrate from other communities in the Arctic.

There are several examples of successful school-based beach cleanup initiatives from around the world that have made a notable impact both environmentally and educationally. The Arctic region is no exception. Students on Ice – Arctic and Sub-Arctic Education (Canada & Greenland) runs educational expeditions to the Arctic that include youth from Canada and around the world, focusing on ocean health and environmental stewardship (https://soifoundation.org/en/). Students participate in coastal cleanups in Arctic communities like Pond Inlet and Iqaluit (Nunavut). The collaborations with Inuit youth, elders, and scientists foster cross-cultural learning. In Greenland, beach cleanups often happen as part of Earth Day and school-led environmental weeks. Youth groups in towns like Nuuk and Sisimiut organise cleanups in fjords and coastal zones. Collaborations with Danish and Greenlandic NGOs like Natur & Ungdom (Nature & Youth) promote youth-led environmental stewardship.

5.2. Extended Producer Responsibility (EPR)

While community action is vital, addressing the root cause of beach pollution requires holding producers accountable for their plastic waste. By holding producers financially accountable for the entire lifecycle of their products and by working with other producers to meet environmental outcomes set by the legislature, EPR policies provide a critical opportunity for oversight, transparency, and regulation of packaging and single-use plastics. When producers bear the costs of waste management for their packaging, they are motivated to use less material, switch to reusable, recyclable or compostable alternatives, and eliminate hard-to-recycle components (this only makes a difference when plastic waste is managed properly, and it's the management that seems to be the most problematic in the Arctic). To improve the situation in the Arctic, EPR policies should be expanded to include more than packaging (packaging makes up less than 10% of plastics stranded in Svalbard). Other possibilities include holding governments accountable for restricting the importation of products using plastics or made of plastics, and by levying taxes on countries that do not have adequate waste management services in place.

California's SB 54, known as the Plastic Pollution Prevention and Packaging Producer Responsibility Act, sets new goals to reduce plastic packaging and requires that all forms of single-use packaging be recyclable or compostable by 2032 (https://calrecycle.ca.gov/packaging/packaging-epr/).

Across Europe, the **EU Single-Use Plastics Directive** has imposed strict regulations on disposable plastics. Items such as straws, cutlery, and polystyrene containers—frequent culprits of beach litter—are now banned or require manufacturers to contribute to clean-up costs. Similarly, **Canada's Zero Plastic Waste Initiative** is forcing businesses to finance recycling programs and take responsibility for the entire lifecycle of their packaging. These policies shift the financial burden of waste management away from taxpayers and onto the corporations that produce plastic waste in the first place.

Well-crafted, comprehensive EPR policies are about much more than recycling. They are about reimagining our relationship with materials, from production to disposal, to create a more equitable and sustainable future.

5.3. Technological Solutions

In the fight against plastic pollution, technology is proving to be a game-changer. One of the most ambitious projects, **The Ocean Cleanup** (https://theoceancleanup.com/), is pioneering autonomous floating barriers to remove plastic from the Great Pacific Garbage Patch and major rivers worldwide. Since its launch, the project has extracted over 7,000 tons of plastic, preventing it from washing up on beaches and harming marine life. BUT: The Great Pacific Garbage Patch is located in the region known for relatively low biological productivity (which means relatively little marine life). The situation is very different in Arctic waters, which means that applying the same solutions in the Arctic may not be environmentally feasible.

Closer to shore, the **Seabin Project** (https://seabin.io/home) is tackling pollution in marinas and harbours. These floating bins act as ocean vacuum cleaners, filtering microplastics and oil from the water. With more than 2,000 seabins installed across 50 countries, this initiative is making a tangible difference in coastal cleanliness.

Artificial intelligence and drones are also revolutionising beach clean-ups. In the UK, **The Plastic Tide** project (https://www.zooniverse.org/projects/theplastictide/the-plastic-tide) used AI-powered drones to detect and map plastic accumulation on coastlines, allowing for targeted clean-ups. Drone monitoring programs have the potential to be used to track waste and guide policy decisions ([19]). By using machine learning to identify pollution hotspots, these technologies enable more efficient and effective clean-up efforts. Nevertheless, due to bad weather, limited range and strict local environmental regulations, drones might have limited value in the Arctic. **In Iceland and Greenland, the ICEBERG team (CAU, SCI, Task 2.1.1)** will install observation-towers equipped with time-lapse cameras, and train citizen scientists to maintain the cameras, organise data transfer and data processing; time-series data will be analysed using machine learning approaches, and labelled data will be generated. The images will be identified by Citizen Scientists and categorised into, e.g. types of marine litter. Drone data are collected with commercial drones by Citizen Scientists, who will select the 2 to 4 beaches to be monitored, every three months map seasonal trends in litter density. The project will monitor 80km of coastline each year, totalling 160km of coastline during the entire project duration. SCI trains Citizen Scientists on data acquisition and will provide two easy-to-use consumer-grade drones.

The use of Earth Observation (EO) satellite imagery to monitor floating macroplastics is also being explored. Using satellite data for macroplastic detection in the ocean has been under investigation during the last few years, and different methodologies have been proposed. Satellites have great advantages with respect to traditional survey methods because they offer regular monitoring over large areas, which can help guide cleanup, evaluate the success of plastic pollution mitigation strategies and better understand the temporal and spatial distributions of marine plastics (e.g.[20], [21]). However, to date, the resolution of satellite images is still a limitation.

While emerging technological innovations may be able to help in waste tracking, technology alone will not get us there, there must be increased awareness of environmental damage and its consequences for the ecosystems and society at large, as well as economic incentives and market signals. Moreover, policy and demand signals are needed to make it clear there is a market for recycled plastic, and economic incentives would be helpful to encourage the circularity mindset in product development. A word of caution is necessary when it comes to economic incentives - these are often abused! Example: offering financial rewards to fishing vessels for retrieving lost fishing gear may lead to fishing vessels "losing" more gear, so that they have more to retrieve (and more to earn by doing so) (forScience pers. comm.).

[19] Gil Gonçalves et al., 'Beach litter survey by drones: Mini-review and discussion of a potential standardization', *Environmental Pollution*, vol. 315, 2022, 120370, https://doi.org/10.1016/j.envpol.2022.120370
[20] Karakuş Oktay, 'On advances, challenges and potentials of remote sensing image analysis in marine debris and suspected plastics monitoring', *Frontiers in Remote Sensing*, vol. 4, 2023, https://doi.org/10.3389/frsen.2023.1302384
[21] Konstantinos Topouzelis et al., 'Floating marine litter detection algorithms and techniques using optical remote sensing data: A review', *Marine Pollution Bulletin*, vol. 170, 2021, 112675, https://doi.org/10.1016/j.marpolbul.2021.112675