

Best practice examples and a Mitigation Roadmap for Wider Adoption

Report

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Report on practical measures and best practices for reducing riverine plastic pollution

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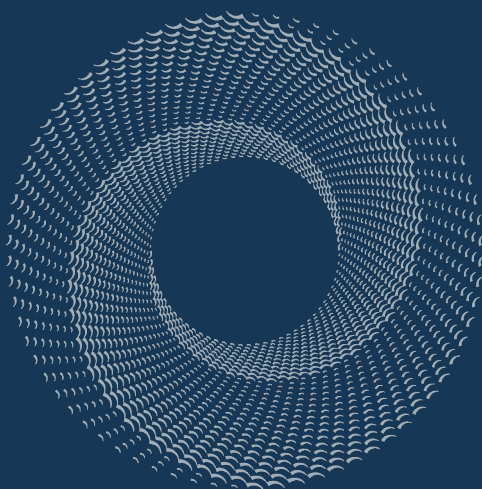
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1. Introduction



1. Introduction

Rivers are an important pathway through which land-based (plastic) pollution can enter coastal and marine environments. Urban rivers are particularly relevant because they receive litter inputs from densely used urban areas, stormwater and runoff systems, recreational waterfronts and harbour-related activities, and can transport this litter further downstream towards coastal and marine waters, including the Baltic Sea (EEA, 2023; González et al., 2016; Tasseron et al., 2023; WISE Marine, 2025).

Litter found in rivers and along riverbanks is therefore not only an environmental problem, but also a practical management challenge. Effective reduction requires cooperation between municipalities, water managers, waste management authorities, harbour actors, local businesses, civil society and other stakeholders. This is particularly important in urban river systems, where litter inputs are often linked to multiple activities, land uses and responsibilities (Corbau et al., 2025; Tasseron et al., 2023; WISE Marine, 2025).

Monitoring provides the evidence base for targeted mitigation. Information on litter quantities, dominant litter item categories, hotspot locations, seasonal patterns and possible pathways helps identify where action is needed and which measures are likely to be effective. However, monitoring alone does not reduce pollution. Its main value lies in supporting practical decisions on how litter inputs can be prevented, reduced or better managed (González-Fernández and Hanke, 2017; MSFD TSG ML, 2023; WISE Marine, 2025).

Within the Circular Ocean-bound Plastic (COP) project, monitoring activities, desk research, on-site observations and stakeholder exchange have generated knowledge on riverine litter pollution in South Baltic city contexts. These project results provide the basis for developing a mitigation roadmap that links observed litter patterns with practical prevention and reduction measures.

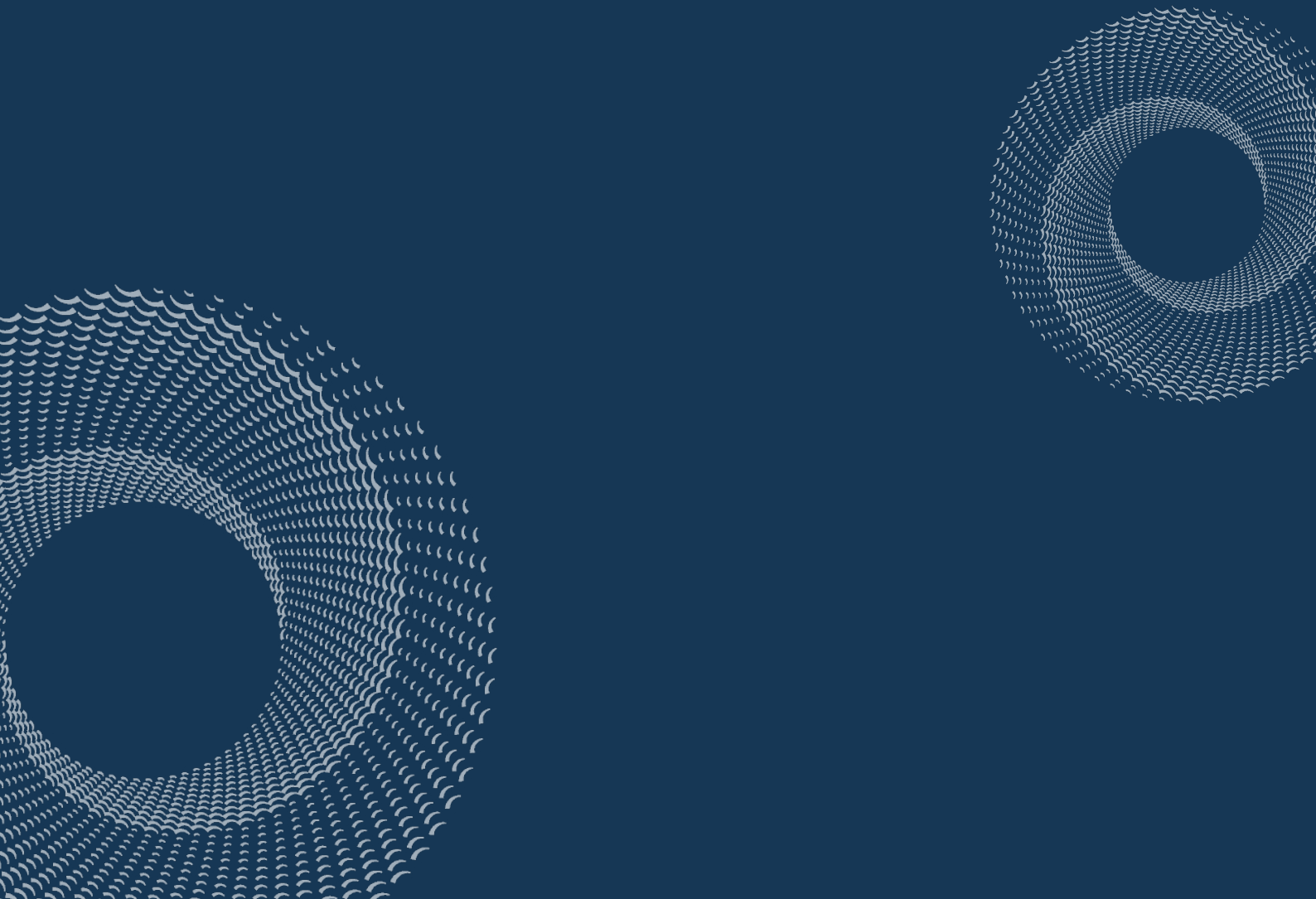
This report therefore focuses on mitigation and wider adoption. It translates the knowledge gathered in the COP project into a practical roadmap for stakeholders and decision makers in Baltic areas. The emphasis is on measures that prevent litter from entering the river system at the source, while also considering clean-up routines, technical retention options, stakeholder engagement and follow-up monitoring. This source-oriented approach is consistent with regional and international guidance that links litter reduction to source-to-sea management, land-based and sea-based source control, removal of litter already present in the environment, education and outreach, and coordinated implementation of measures (European Commission, 2018; HELCOM, 2021; UNEP, 2025).

The roadmap is intended to support the selection of suitable measures depending on the type of river or waterbody, dominant litter item categories, litter quantities, seasonal or event-related pollution patterns, available budget and implementation capacity. By linking monitoring evidence with best practice examples and practical decision criteria, the report aims to support wider adoption of effective riverine litter mitigation measures in the Baltic Sea region. This reflects the need to connect monitoring data, source and pathway identification, stakeholder knowledge and preventive measures when designing programmes of measures against litter pollution (Addamo et al., 2017; HELCOM, 2021; Veiga et al., 2016).



2.

Purpose and Scope of the Mitigation Roadmap



2. Purpose and Scope of the Mitigation Roadmap

The purpose of this mitigation roadmap is to support the selection and implementation of practical measures to reduce riverine plastic pollution in Baltic cities and river systems. The roadmap is not intended to prescribe one fixed set of measures for all locations. Instead, it provides a flexible decision-support framework that can be adapted to local conditions, monitoring results, stakeholder structures and available resources.

The report builds on knowledge generated within the Circular Ocean-bound Plastic (COP) project, including information on litter quantities, dominant litter item categories, possible sources and pathways, hotspot locations, seasonality and practical experience from partner cities. It also complements the COP report **'Spatial Assessment of Litter Pollution Along Urban Riverfronts'** and the COP Roadmap for the **'Implementation of Monitoring and Sampling of Riverine Litter in South Baltic Sea Rivers'** by focusing on how monitoring results and spatial hotspot information can be translated into prevention, mitigation and reduction measures. See links below.

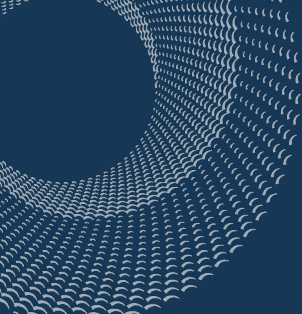
- [Spatial Assessment of Litter Pollution Along Urban Riverfronts](#)
- [Implementation of Monitoring and Sampling of Riverine Litter in South Baltic Sea Rivers](#)

The roadmap is primarily designed for municipalities, local and regional authorities, environmental agencies, water managers, harbour operators, waste management companies, NGOs, schools, citizen-science groups, local businesses and other stakeholders involved in reducing litter inputs into urban river systems. It aims to support both cities that already have monitoring data and cities that are still at an early stage of developing riverine litter management activities.

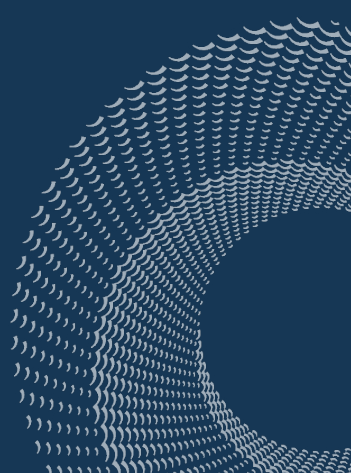
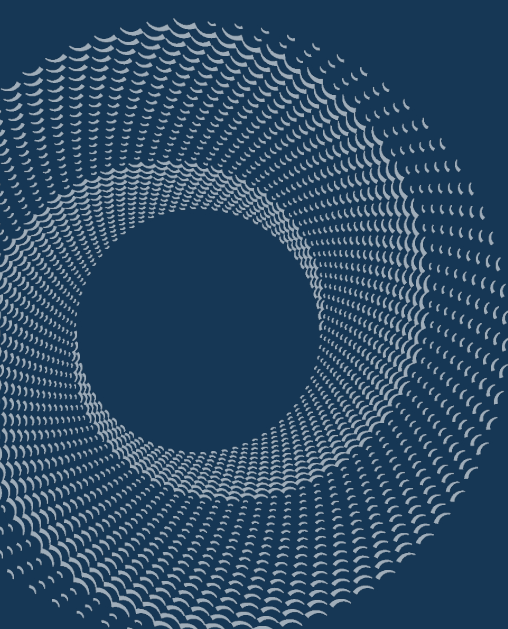
The scope of the report is focused on visible macro-litter (> 25 mm) and especially plastic litter in and along rivers. These fractions are directly relevant for local management because they can often be linked to specific sources, behaviours, locations or infrastructure gaps. The roadmap therefore gives priority to measures that prevent litter from entering the river system at the source. These include improved waste infrastructure, targeted measures at recreational hotspots, event-related waste management, better cleaning routines, stormwater-related interventions, awareness activities, stakeholder agreements and, where appropriate, technical retention systems. The report also considers measures for removing or retaining litter that has already entered the water, such as litter traps, booms, port bins, surface collectors or organised clean-up activities. These measures can be useful at hotspots and accumulation zones, but should complement rather than replace source-prevention measures.

The roadmap does not provide a detailed technical design for every possible mitigation measure. Instead, it provides a structured approach for selecting suitable measures depending on local conditions. Important decision criteria include the type of river or waterbody, dominant litter item categories, litter quantities, hotspot locations, seasonal or event-related pollution patterns, available budget, maintenance requirements and stakeholder responsibilities.

The overall objective is to help stakeholders move from general awareness and clean-up activities towards targeted, evidence-based mitigation. By linking monitoring results with best practice examples and practical decision criteria, the roadmap supports wider adoption of effective riverine litter mitigation measures in the Baltic Sea region.



3. Evidence Base: From Monitoring Data to Mitigation Needs



3. Evidence Base: From Monitoring Data to Mitigation Needs

Effective mitigation should be based on evidence. Monitoring data help identify how much litter is present, which litter item categories dominate, where litter accumulates and when inputs are highest. This information is essential for selecting measures that address the actual problem rather than applying general clean-up or awareness activities without a clear link to local sources.

The COP monitoring roadmap 'Implementation of Monitoring and Sampling of Riverine Litter in South Baltic Sea Rivers' provides the methodological basis for collecting comparable information on riverine macro-litter (> 25 mm). It recommends two practical core methods:

- Visual surveys of Riverine Floating Macro-Litter (RFML)
- Riverbank surveys of macro-litter

RFML surveys provide information on floating litter transported on the river surface, while riverbank surveys identify deposited litter, accumulation zones, hotspots and potential local sources. Together, these methods provide the evidence needed to understand both transport and accumulation processes in urban river systems.

For mitigation planning, monitoring results should be interpreted according to four main questions:

1. Where is action needed?
2. Which litter item categories should be targeted?
3. Which sources and pathways are likely responsible?
4. Which measures are realistic under local conditions?

The first question relates to spatial patterns. Hotspot information helps identify locations where litter repeatedly accumulates or enters the river system. These may include recreational waterfronts, parks, stormwater outlets, harbour areas, event locations, informal meeting points, bridges, embankments or other areas. Spatial information is important because mitigation measures are often most effective when they are targeted to specific locations rather than applied uniformly across a whole city.

The second question relates to litter composition. Total litter piece counts show the level of pollution pressure, but the distribution of pieces across litter item categories provides more useful information for mitigation. For example, cigarette butts, food wrappers, bottles, cups, plastic bags, industrial pellets or fishing-related items point towards different behaviours, sources and management responses. A site dominated by cigarette butts requires different measures than a site dominated by industrial packaging, stormwater-related litter or illegal dumping.

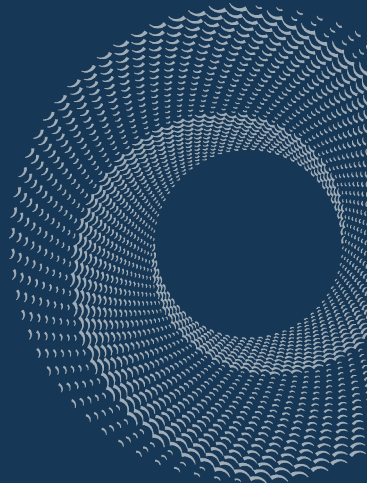
The third question relates to sources and pathways. Monitoring data alone may not always identify the exact source of litter, but they can provide strong indications when combined with site knowledge, stakeholder input and information on land use, weather, events, cleaning routines or hydrological conditions. Increased litter after rainfall may indicate stormwater-related pathways, while seasonal peaks may be linked to tourism, public events or recreational use. Repeated accumulation at the same riverbank section may point to local littering, wind transport, flooding or poor waste infrastructure.

The fourth question relates to feasibility. Suitable measures depend not only on the pollution problem, but also on available budget, staff capacity, maintenance requirements, permissions, stakeholder responsibilities and long-term sustainability. Low-cost measures such as improved bin placement, targeted signage or local clean-up routines may be suitable for some hotspots, while technical retention systems, stormwater interventions or larger infrastructure changes require more planning, investment and maintenance.

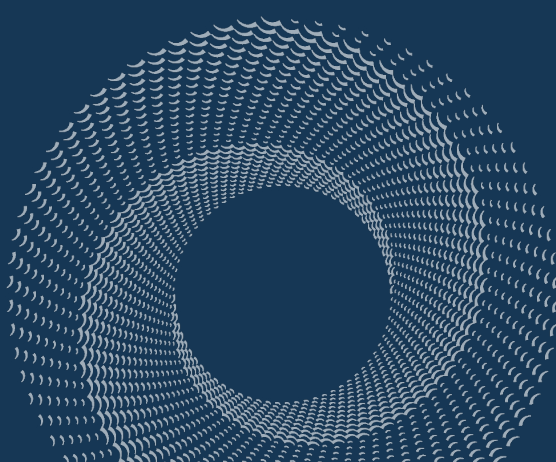
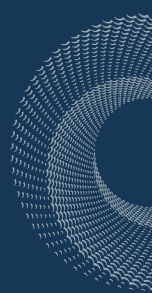
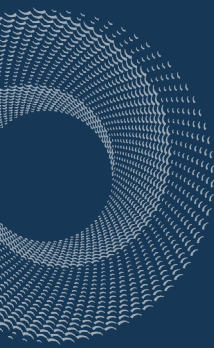
Monitoring results should therefore be translated into a simple mitigation logic: litter abundance and hotspots show where action is needed; dominant litter item categories indicate what should be targeted; source and pathway analysis helps identify who should be involved; available budget and capacity determine which measures are realistic; and follow-up monitoring shows whether the measures are effective.

This evidence-based approach creates a direct link between monitoring and mitigation. It allows cities to move from general observations towards targeted action, and from isolated measures towards an adaptive management cycle in which measures are selected, implemented, evaluated and improved over time.

However, action does not always need to wait until a formal monitoring programme has been established. Where litter repeatedly occurs at the same location and the dominant litter item categories, sources or pathways are already clearly visible, municipalities and local stakeholders can start with practical measures, such as those described in this report. These actions should still be documented and, where possible, followed by simple before-after observations to assess whether the situation improves.



4. Main Sources, Pathways and Indicator Litter Item Categories



4. Main Sources, Pathways and Indicator Litter Item Categories

Riverine litter can originate from many different sources and reach rivers through several pathways. In urban areas, litter inputs are often linked to recreational use, food and drink consumption, stormwater runoff, public events, harbour-related activities, illegal dumping, construction activities, poorly managed waste infrastructure or wind transport from streets, bins and open areas. Once litter has entered the river system, it may be transported downstream, accumulate along riverbanks, be retained in vegetation or harbour basins, or be remobilised during high water, rainfall events or strong wind conditions.

For mitigation planning, it is useful to distinguish between sources, pathways and accumulation areas. A source describes where or through which activity litter is generated, such as recreational use, take-away consumption, smoking, construction work or harbour operations. **A pathway** describes how litter reaches the river, for example through direct littering, wind transport, stormwater runoff, sewer overflows, or flooding. Accumulation areas are locations where litter is repeatedly retained, such as riverbanks, reed belts, embayments, harbour basins, bridges, quays, stormwater outlets or vegetated sections.

The identification of likely sources and pathways should be based on a combination of monitoring data, site observations and stakeholder knowledge. Monitoring data provide information on litter quantities, dominant litter item categories, hotspots and temporal patterns. Site observations can help identify nearby land uses, waste infrastructure, stormwater outlets, access points, recreational areas or cleaning routines. Stakeholder knowledge is important because municipalities, waste managers, harbour operators, NGOs, and local users often know where litter problems occur and which activities may contribute to them. A more detailed description of how monitoring data, site observations and stakeholder knowledge can be combined for source analysis is provided in the COP monitoring roadmap '**Implementation of Monitoring and Sampling of Riverine Litter in South Baltic Sea Rivers**'. That report explains how dominant litter item categories and local stakeholder input can be used to identify likely sources to translate monitoring results into targeted mitigation needs.

Dominant litter item categories can provide useful indications of likely sources. Cigarette butts may point towards smoking hotspots, benches, public transport stops, waterfront promenades, event areas or insufficient disposal options. Food wrappers, cups, bottles and take-away packaging may indicate recreational use, public events, tourism, markets or insufficient waste-bin capacity. Plastic

bags, lightweight packaging and films may be linked to wind transport, open bins, street litter or poorly secured waste storage. Industrial pellets, paraffin wax, oil residues or other specific pollution indicators may require more targeted source investigation. Fishing-related items, ropes or fragments of nets may indicate recreational or commercial fishing activities, harbour areas or water-based use.

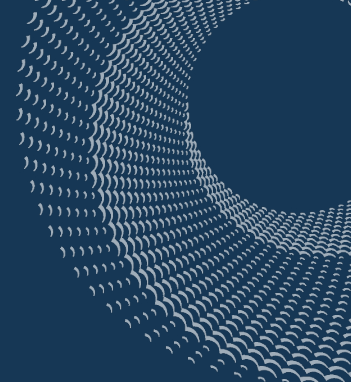
However, litter item categories should not be interpreted as direct proof of a specific source. The same item category can have several possible origins, and litter may be transported before it is recorded.

Seasonality and event-related patterns are also important for mitigation planning. Increased litter after rainfall may indicate runoff or stormwater-related pathways. Higher litter abundance during summer may be linked to recreational use, tourism or outdoor events. Peaks after festivals, markets or public gatherings may indicate insufficient event-related waste management. Accumulation after flooding or high water may show where floating litter is deposited along riverbanks. These patterns can help determine whether measures should be permanent, seasonal or event-based.

For practical mitigation planning, sources and pathways can be grouped into a small number of management-relevant categories such as:

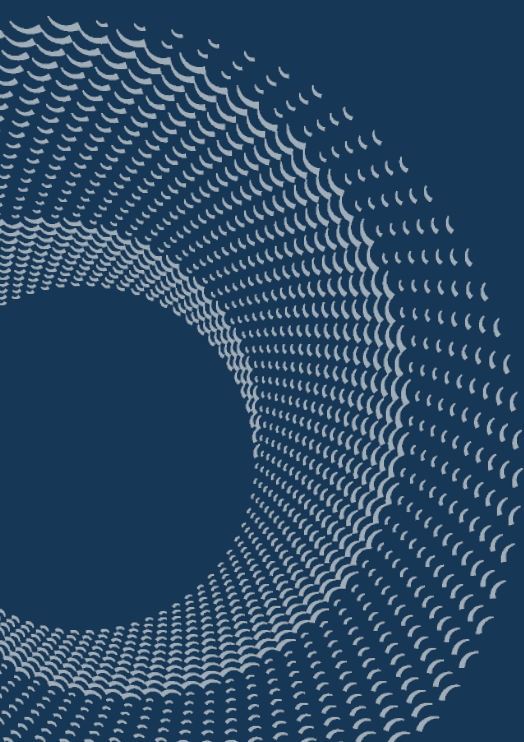
- recreational waterfront use and public spaces;
- food and drink consumption areas;
- cigarette butt hotspots;
- public events and seasonal visitor pressure;
- stormwater and runoff pathways;
- harbour, marina and water-based activities;
- illegal dumping and poorly managed waste collection points;
- construction, industrial or transport-related sources;
- riverbank accumulation zones and remobilisation areas.

These categories provide the basis for selecting suitable mitigation measures. Each category is linked to different actors, responsibilities and possible interventions. The mitigation roadmap therefore uses source and pathway categories as a practical bridge between monitoring results and action. Instead of applying the same measures everywhere, cities should identify which source-pathway combinations are most relevant at each site and select measures accordingly. This increases the chance that mitigation is targeted, feasible and effective.



5.

Mitigation Principles for Riverine Plastic Pollution



5. Mitigation Principles for Riverine Plastic Pollution

Mitigation measures for riverine plastic pollution should follow a small number of guiding principles. These principles help ensure that measures are linked to monitoring evidence, local sources and pathways, stakeholder responsibilities and long-term feasibility. The overall aim is to move from general clean-up and awareness activities towards targeted, source-oriented and adaptive mitigation.

The first principle is prevention at source. Measures that prevent litter from entering the river system should be prioritised over measures that only remove litter after it has already reached the water. Source prevention may include improved waste infrastructure, better bin placement, event-related waste management, stormwater-related interventions, awareness activities, stakeholder agreements and targeted enforcement where necessary. This approach is consistent with source-to-sea and marine litter action frameworks, which emphasise reducing pollution before it reaches freshwater, coastal and marine environments.

The second principle is evidence-based measure selection. Mitigation should be guided by monitoring results, desk research, on-site observations and stakeholder knowledge. Total litter piece counts indicate the overall pollution pressure at a site, while dominant litter item categories show what should be targeted. Hotspot locations indicate where action is needed, and temporal patterns can show whether measures should be permanent, seasonal or event-based.

The third principle is source and pathway matching. Each measure should be linked to the most likely source or pathway of litter. Recreational litter, stormwater-related inputs, event-related pollution, harbour-related litter or illegal dumping require different responses and different responsible actors. Matching measures to sources and pathways increases the likelihood that mitigation is effective and accepted.

The fourth principle is combining prevention, removal and retention. Although prevention at source should be the priority, some litter will still enter river systems. Mitigation strategies should therefore also consider measures for removing or retaining litter that is already present in the river or along riverbanks. These may include organised riverbank clean-ups, improved maintenance routines, litter traps, booms, port bins, or other technical retention systems. Such measures can be useful at hotspots, river-mouth areas, or accumulation zones, but they should complement rather than replace prevention measures.

The fifth principle is stakeholder involvement. Many riverine litter sources are linked to behaviour, land use, infrastructure management or specific local activities. Therefore, mitigation measures should involve the actors who can influence the source or pathway. Relevant stakeholders may include municipalities, waste management companies, harbour operators, event organisers, local businesses, NGOs, citizen-science groups and local residents. Early involvement helps clarify responsibilities, identify practical barriers and improve acceptance.

The sixth principle is feasibility and maintenance. A measure should only be selected if it can realistically be implemented, maintained and financed over time. Low-cost measures may be suitable for many locations, while technical measures often require permits, installation, maintenance, frequent waste disposal and long-term funding. A measure may fail if responsibilities are unclear or if maintenance is not secured.

The seventh principle is adaptive management. Mitigation should be understood as a cycle rather than a one-time intervention. Measures should be planned, implemented, monitored and adjusted based on results. Follow-up monitoring is essential to assess whether litter abundance, hotspot intensity or specific litter item categories decrease after implementation.

The mitigation roadmap therefore applies a stepwise logic. First, monitoring data are used to identify hotspots and dominant litter item categories. Second, likely sources and pathways are assessed using site observations and stakeholder knowledge. Third, suitable measure categories are selected. Fourth, feasibility, expected effectiveness, cost, maintenance needs and responsibilities are checked. Fifth, measures are implemented at priority sites. Finally, follow-up monitoring is used to evaluate whether the measures reduce litter inputs, accumulation or specific litter item categories, and to adapt the approach where needed (Figure 1).

Stepwise logic of the mitigation roadmap

From monitoring results to mitigation and follow-up evaluation

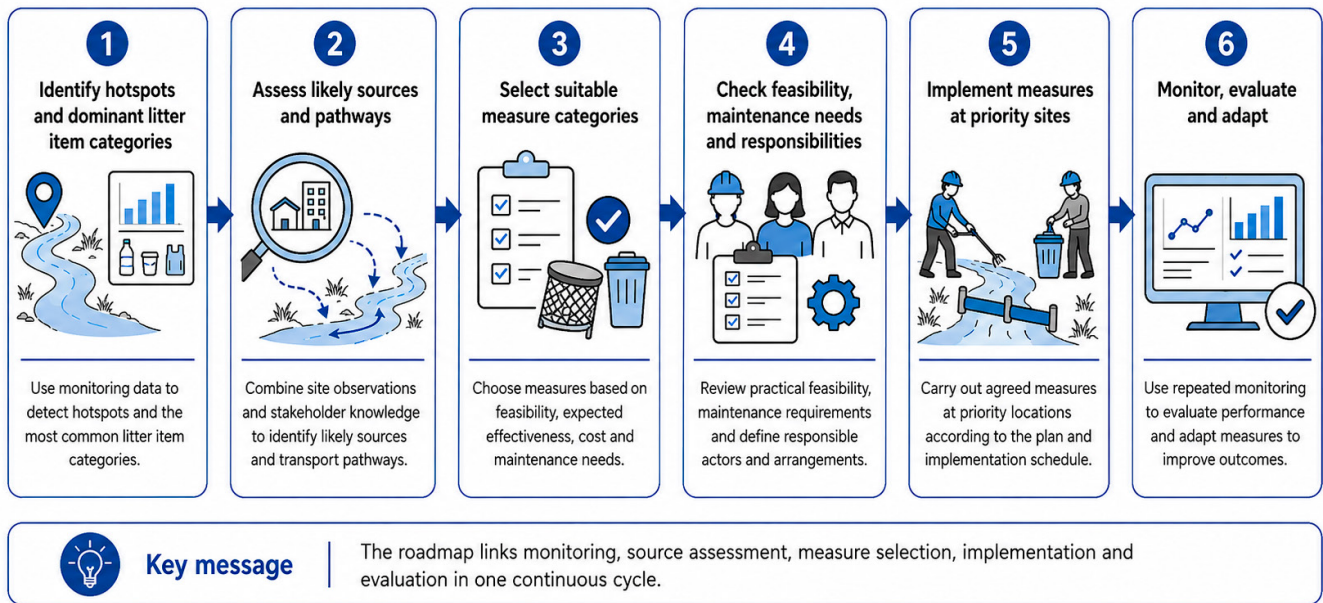
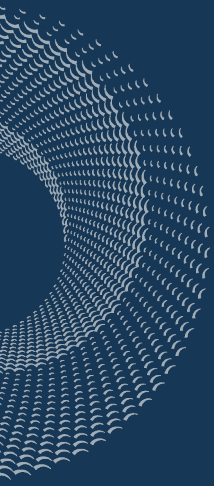


Fig. 1 Stepwise logic of the mitigation roadmap, showing the six main steps from hotspot identification and source/pathway assessment to measure selection, feasibility check, implementation and follow-up monitoring. Final illustration generated with the help of AI and revised by the authors.

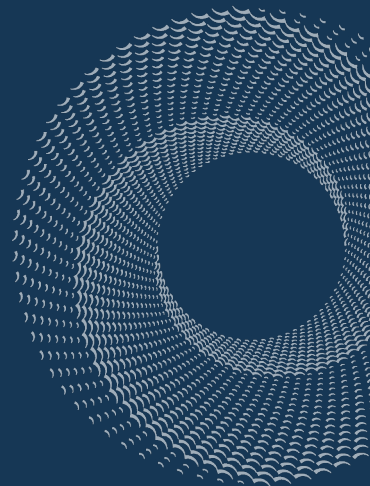
These principles provide the basis for the stepwise mitigation roadmap presented in Chapter 7, which translates them into a practical process for selecting, implementing and evaluating measures.





6.

Mitigation Measure Profiles and Best Practice Examples



6. Mitigation Measure Profiles and Best Practice Examples

The mitigation roadmap uses a catalogue of measure profiles to support the practical selection and wider adoption of riverine litter reduction measures. The aim is not to present a complete list of all possible interventions, but to provide a structured overview of practical measures that can be adapted to different Baltic river and city contexts.

The measure profiles are designed as decision-support tools for municipalities, local authorities, NGOs, harbour actors, water managers, waste management companies, event organisers and other stakeholders. If possible, they should be used together with monitoring results, site observations and stakeholder knowledge. A measure should be selected based on dominant litter item categories, hotspot locations, likely sources and pathways, available budget, maintenance requirements and implementation responsibilities.

The profiles build on the wider COP knowledge base. The **'Spatial Assessment of Litter Pollution Along Urban Riverfronts'** in Aarhus, Gdańsk and Rostock provides a strategic basis for identifying potential litter input areas linked to human activity, using GIS-based hotspot identification, a 100 m river buffer, points of interest and stakeholder knowledge. The COP roadmap **'Implementation of Monitoring and Sampling of Riverine Litter in South Baltic Sea Rivers'** provides the complementary monitoring and governance basis, including RFML surveys, riverbank surveys, harmonised litter item categories, local monitoring teams, coordination structures and a monitoring-to-mitigation cycle. Together, these outputs support a practical transition from hotspot identification and monitoring towards targeted mitigation.

The following measure profiles provide a practical starting point for wider adoption in Baltic river systems and are grouped into six broad categories:

- Source prevention
- Hotspot / public-space management
- Stormwater, wind and other pathway-related measures
- Removal or retention of litter already in the water
- Awareness / education activities
- Stakeholder / governance measures

In practice, these measures should not be seen as isolated options. Many sites will require a combination of measures, for example improved waste infrastructure, targeted communication,

cigarette butt reduction, stakeholder agreements and follow-up monitoring.

The overview (Table 1) shows examples of different measures addressing different stages of the litter pathway. Source-prevention measures aim to avoid litter generation or leakage before items enter the environment. Hotspot and public-space management measures target places where littering repeatedly occurs. Stormwater, wind and pathway-related measures prevent litter that is already present in public space from entering the river. Removal and retention measures collect litter that has already reached the water. Awareness measures support behavioural change, while governance measures create the structure needed for coordinated implementation.

Table 1 Overview of mitigation measure profiles and best practice examples

Category	Measure profile	Main target	Suitable context	Key point / limitation
1. Source prevention	RECUP/REBOWL – Reusable or Deposit Systems	Single-use cups, bowls and take-away packaging before they become litter	Events, markets, harbour festivals, outdoor gastronomy and waterfront hotspots	Strong source-prevention potential, but requires vendor participation, return logistics and visitor acceptance
2. Hotspot / public-space management	Place-based Riverbank Improvement at Litter Hotspots	Local littering at frequently littered riverbank or waterfront sites	Riverbanks, slopes, paths, benches, informal meeting points or poorly maintained public spaces	Targets local littering behaviour, but is not intended for sites where litter is mainly deposited by river flow, flooding or upstream transport
2. Hotspot / public-space management	Cigarette Butt Reduction Measures / Warnow-Ascher	Cigarette butts and partly other smoking-related litter before they enter riverbanks, drains or the water	Smoking and waiting hotspots such as ferry stops, bus stops, benches, entrances or event waiting areas	Most effective where people stop or wait; less effective along pure transit routes without dwell time
3. Stormwater, wind and other pathway-related measures	K.R.A.K.E. Trashstopper – Stormwater, Wind and Pathway Management	Street and promenade litter before it is washed or blown into the water	Railings, drainage edges, promenades, quays or sloped surfaces close to rivers	Interrupts the pathway to the river, but retained litter must be removed manually or with street-cleaning machines
4. Removal or retention of litter already in the water	SeaProtectorOne (SPO) – Floating Macro-litter Retention and Monitoring	Floating macro-litter before discharge to harbour or coastal waters	Narrow urban rivers, canals, river-mouth sections or harbour entrances	Effective for continuous collection and monitoring, but requires high investment, permissions and maintenance
4. Removal or retention of litter already in the water	PortBins / Floating Surface Collectors in Harbour Basins	Floating litter already present in sheltered harbour basins or calm water areas	Small harbour basins, marinas, or calm urban water areas	Highly site- and maintenance-dependent; can be overwhelmed by organic debris and requires frequent emptying and cleaning

4. Removal or retention of litter already in the water & 5. Awareness / education activities	EkoKajak - Kayak-based River Litter Collection and Awareness	Floating macro-litter and litter accumulated near banks, reeds and sheltered river sections	Slow-moving urban rivers, canals, harbour basins and recreational waterfronts with safe kayak access	Seasonal and weather-dependent; limited to safely reachable litter; results depend on route, effort and participant numbers
5. Awareness / education activities	Targeted Awareness and Behaviour-change Activities at Riverfront Hotspots	Littering behaviour linked to dominant local litter item categories	Riverfront hotspots, events, recreational areas, bins, benches, drains or public access points	Low-cost supporting measure, but should be combined with infrastructure, cleaning, enforcement or other practical measures
6. Stakeholder / governance measures	Local River Litter Action Plan / Stakeholder Agreement	Coordinated local action and shared responsibilities for river litter prevention and reduction	City-level river systems with several actors and unclear responsibilities	Useful as a strategic framework, but only effective if responsibilities, budget, authority and follow-up are clearly defined

The following sections present the individual measure profiles in a standardised format. This makes it easier to compare the measures and to identify which options are suitable for different riverine contexts in the Baltic Sea region.

6.1 RECUP/REBOWL - Reusable or deposit systems for events

Source-prevention measure for event-related cups, containers and take-away packaging

Summary: RECUP/REBOWL is an example for a reusable deposit system for take-away drinks and food. It can be used as a practical model for events, markets and waterfront areas where disposable cups, bowls or containers could otherwise become litter. Visitors receive a RECUP cup or REBOWL container against a deposit, return it after use, and the item is washed and reintroduced into the reuse cycle.



Fig. 2 RECUP reusable deposit cups as an example of a reusable system for take-away drinks and event-related source prevention.
Photo: Greta RECUP, Wikimedia Commons, CC BY-SA 4.0, cropped.

Measure type	Main target	Effort / cost	Transferability
Source prevention	Single-use cups, bowls and take-away packaging before they become litter	Medium effort and cost; medium logistics need	High, where local partners and return points are available
Short description	RECUP/REBOWL provides reusable cups and bowls within a deposit-based system. Drinks are served in RECUP cups and food in REBOWL containers instead of disposable packaging. The system is mainly established for gastronomy and take-away, but the same approach can be used at events, markets or riverfront food-and-drink hotspots.		
Technical / Practical Details	The basic system is simple: users pay a deposit, use the cup or container, return it to a participating partner, and receive the deposit back. RECUP cups are issued with a €1 deposit; REBOWL containers with a €5 deposit. Cups and bowls are cleaned like normal dishes and returned to the system. RECUP states that a RECUP cup can withstand around 1,000 washing cycles and a REBOWL around 500 washing cycles. RECUP/REBOWL is available through a large network of issuing and return points in Germany.		

Main target / mitigation logic	Prevention of event- and take-away-related packaging litter at source by replacing single-use cups, bowls and containers with reusable items that remain in a deposit-return cycle.
Suitable application context	Gastronomy, waterfront events, harbour festivals, markets, city festivals, sports events, concerts, outdoor gastronomy areas and take-away hotspots close to rivers, canals, harbour basins or coastal waters. The measure is most useful where food and drink consumption is high and disposable packaging is likely to become litter.
Target litter item categories	Single-use cups and lids, food containers, trays, bowls, plates, wrappers and mixed food-and-drink packaging. The measure is especially relevant where monitoring shows high numbers of cups, lids, food wrappers or other take-away related litter item categories.
Source / pathway addressed	Event-related and take-away-related littering, overflowing bins, wind-blown packaging, litter left after public gatherings, and packaging transported by runoff or cleaning activities towards stormwater systems, riverbanks or water surfaces.
Key actors and responsibilities	Municipality, event organiser, local vendors, gastronomy businesses, RECUP/REBOWL or another reusable-system provider, waste management company, cleaning contractor and, where relevant, NGOs or volunteers. Responsibilities should cover system selection, vendor participation, deposit handling, return points, washing logistics, communication and follow-up.
Implementation requirements	The system should be considered not only for events, but also for regular gastronomy in waterfront areas, including outdoor seating areas, take-away outlets, cafés, kiosks and markets close to rivers. For events, it should be included early in event planning, permitting or procurement. For regular gastronomy, implementation requires cooperation with participating businesses, suitable return options and integration into daily service routines. Requirements include agreement with vendors or gastronomy operators, sufficient reusable stock, visible return points, clear signage, communication with customers, washing logistics, temporary storage and staff training. Bin provision and clean-up routines are still needed for other waste fractions.
Expected effort and cost level	Effort: Medium. Cost: Medium, depending on event size, reusable stock, service provider, washing logistics and staffing. Maintenance need: Medium during events, especially for return points, storage and redistribution of reusable items.
Strengths	Targets common top litter items at source, especially cups and lids, food containers, bowls, trays, wrappers and other take-away packaging. By replacing disposable items with reusable alternatives, the measure reduces the number of litter-prone objects that can be left behind, overflow from bins, be wind-blown or enter stormwater pathways. The deposit logic is easy to communicate and can be combined with awareness activities, event permits and monitoring.
Limitations / risks	Effectiveness depends on good organisation, enough return points, vendor participation and visitor acceptance. Poorly designed systems may lead to queues, low return rates, item loss or hygiene concerns. The measure mainly addresses cups, bowls and food containers, while accompanying items such as single-use cutlery, napkins, straws, stirrers or small sauce packaging may not be covered unless they are explicitly included in the system.
Monitoring and evaluation	Effectiveness can be evaluated by recording the number of reusable items issued and returned, return rates, remaining event waste, before-after litter piece counts, and changes in target litter item categories during riverbank or hotspot surveys. Clean-up data after events can show whether additional return points or communication are needed.
Best practice example	RECUP/REBOWL is presented as Germany's largest reusable system for gastronomy and is available at around 20,000 issuing and return points. The system uses a simple deposit logic for cups and bowls and can therefore serve as a transferable model for event-related source prevention. In riverfront settings, monitoring can show whether cups, lids, bowls or food packaging are relevant target categories.
Transferability	Transferability is high, especially for cities with event areas, waterfront gastronomy, take-away outlets, cafés, kiosks or markets close to rivers. Similar reusable deposit systems already exist in several countries, so the concept can be adapted to local regulations, existing gastronomy networks and return logistics.

Sources

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6.2 Place-based Riverbank Improvement at Litter Hotspots

Hotspot / public-space management measure for frequently littered riverbanks and waterfronts

Summary: This measure improves the quality, maintenance and visibility of riverbank or waterfront sites where litter is repeatedly left by local users, passers-by or nearby activities. It uses place-based improvements such as cleaning, mowing, planting, lighting, seating, bins, ashtrays or clear access design to signal that the area is cared for and monitored. The measure aims to reduce local littering behaviour and should be applied where litter mainly originates from use of the site itself, not where litter is primarily deposited by river flow, flooding or upstream transport.

Place-based Riverbank Improvement at Litter Hotspots



Fig. 3 Conceptual before-after illustration of place-based riverbank improvement at litter hotspots. The figure shows how low-cost measures such as cleaning, mowing, basic waste infrastructure, signage and visible maintenance can improve site quality and help reduce local littering behaviour. Final illustration generated with the help of AI and revised by the authors.

Measure type	Main target	Effort / cost	Transferability
Hotspot / public-space management	Frequently littered riverbank and waterfront hotspots	Low to medium for small upgrades; medium to high for redesign	High, if local ownership and maintenance are secured

Short description	This measure improves the design, maintenance and perceived care of riverbank or waterfront hotspots where littering repeatedly happens. It does not rely on one single intervention, but combines practical upgrades such as cleaning, mowing, planting, lighting, seating, bins, ashtrays, signage and better access management.
Technical / Practical Details	Implementation should start with hotspot selection based on monitoring, spatial assessment and local knowledge. A clean baseline is created through litter removal and, where relevant, mowing or vegetation management. The site can then be upgraded with visible maintenance cues such as planting, lighting, bins, ashtrays, benches, clear paths, signs or small design elements that show the place is cared for.

Main target / mitigation logic	Reduction of direct littering at riverbank hotspots. The measure changes environmental cues: clean, maintained and visible places can strengthen social norms against littering, while neglected places may encourage further littering.
Suitable application context	Riverbank sections, waterfront areas, slopes, paths, benches, informal meeting points or poorly maintained public spaces where litter is repeatedly left by users, passers-by or nearby activities. The measure is not intended for sites where litter is mainly deposited by river flow, flooding or hydrodynamic accumulation.
Target litter item categories	Mixed public-space litter, especially food wrappers, cups and lids, bottles, cans, cigarette butts, small plastic and paper items, take-away packaging and litter linked to informal gatherings or passers-by.
Source / pathway addressed	Local littering at riverbank and waterfront hotspots, especially from passers-by, recreational users, nearby food-and-drink consumption, informal meeting points or poorly maintained public spaces. The measure addresses litter that is left directly at the site.
Key actors and responsibilities	Municipality, park or green-space department, waste management service, local businesses, waterfront operators, NGOs, community groups, schools, residents and, where relevant, harbour or water authorities. Responsibilities should cover site selection, permissions, installation, maintenance, cleaning, communication and follow-up monitoring.
Implementation requirements	Requires hotspot evidence, landowner or authority permission, safety assessment, agreement on maintenance, small infrastructure or planting material, bin or ashtray placement where needed, and a realistic maintenance plan. Lighting may require permits, power supply and checks for safety, nuisance and ecological impacts.
Expected effort and cost level	Effort: Low to medium for cleaning, mowing, planting, signage or small public-space upgrades; higher for lighting or redesign. Cost: Low to medium for small interventions; medium to high for larger redesign. Maintenance need: Medium, because visible care is central to the measure.
Strengths	Targets recurring hotspots where litter is linked to poor maintenance, low visibility or weak social control. The measure is visible, locally adaptable and can be combined with clean-ups, bins, ashtrays, awareness and stakeholder agreements. It can also improve the recreational value of riverbanks while reducing litter risk.
Limitations / risks	Effects depend on regular maintenance and local ownership. If planting, lighting or design elements are not maintained, the site may again appear neglected. Lighting can create nuisance or ecological concerns if poorly planned. The measure may not address upstream inputs, illegal dumping, stormwater litter or litter generated outside the hotspot. The measure is most relevant where litter results from local littering behaviour. It is less suitable for sites where litter is mainly deposited by river flow, flooding or wind-driven accumulation from upstream areas.
Monitoring and evaluation	Evaluation should use riverbank surveys before and after implementation, including litter pieces per meter or square meter, top 10 litter item categories, hotspot locations, photo documentation and cleaning status. Maintenance logs, clean-up data, weather notes and short stakeholder feedback can help interpret changes.
Best practice example	Nakamata et al. (2025) tested structural changes at the Naebo River in Japan using action research with local stakeholders. Flowers, illumination, clean-up and mowing were used to signal maintenance, visibility and social attention. Littering decreased significantly in intervention blocks during the intervention and the reduction persisted after removal. For South Baltic cities, COP spatial assessment outputs can help identify candidate hotspots, while the COP monitoring roadmap supports before-after evaluation and adaptive management.
Transferability	High. The approach can be transferred to many Baltic riverfronts because most cities have small, recurring litter hotspots along paths, benches, parks, bridges or promenades. Local adaptation is needed for land ownership, safety, vegetation, lighting, maintenance capacity, community involvement and dominant litter item categories.

Sources

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6.3 Cigarette Butt Reduction Measures at Riverfront Hotspots

Hotspot / public-space management measure for smoking-related litter

Summary: This measure reduces cigarette butts and smoking-related litter at riverfront hotspots by providing visible and easy-to-use disposal options, such as fixed ashtrays, ballot bins or site-specific cigarette bins. The Warnow-Ascher installed at Rostock Stadthafen provide a practical example that was implemented as part of the COP project. Such measures are most effective where smokers naturally stop or wait, for example at ferry piers, bus stops, benches, viewpoints, entrances or event waiting areas. They are less suitable if installed randomly along routes where people only pass by.



Fig. 4 Warnow ashtray installed at a ferry stop in Rostock Stadthafen to reduce cigarette butt litter at a smoking and waiting hotspot.

Measure type	Main target	Effort / cost	Transferability
Hotspot / public-space management	Cigarette butts at smoking hotspots and waiting points before they enter drains, riverbanks or the water	Low to medium cost; medium maintenance need	High, if placed at locations where people stop, wait or smoke regularly
Short description	The measure targets cigarette butts at riverfront locations where smoking-related litter is repeatedly found. It combines visible disposal options, such as fixed ashtrays, ballot bins or site-specific cigarette bins, with targeted placement, cleaning and communication. The key principle is that ashtrays should be located where smokers naturally stop, wait or gather, rather than distributed randomly along a riverfront.		

Technical / Practical Details	Practical options include ashtrays attached to bins, railings or benches; freestanding cigarette bins; ballot bins; temporary event ashtrays; and pocket ashtrays. In Rostock, five specially designed Warnow-Ascher were installed at the Stadthafen between the ferry pier Am Kabutzenhof and the Haedgehalbinsel as a COP pilot measure. Where possible, a small information poster or sign should be placed above or next to the ashtray to explain the environmental harm of cigarette butts and encourage correct disposal. The devices require regular emptying and proper disposal by waste management services.
Main target / mitigation logic	Reduction of cigarette butt litter at source or very close to the source by making correct disposal visible, convenient and socially expected at places where smokers pause or wait.
Suitable application context	Ferry piers, bus and tram stops, benches, viewpoints, harbour promenades, waiting areas, entrances, event areas, outdoor gastronomy zones and other places where people smoke while waiting or spending time. The measure is most relevant at clearly identified smoking hotspots and less effective along pure transit routes where people do not stop.
Target litter item categories	Cigarette butts and filters, partly cigarette packaging.
Source / pathway addressed	Smoking-related littering at local hotspots. Cigarette butts are often dropped directly on the ground, left near benches, railings or waiting areas, or transported by wind, runoff or cleaning activities towards drains, riverbanks or the water.
Key actors and responsibilities	Municipality, waste management or cleaning services, harbour or ferry operators, public transport providers, local businesses, cafés and bars, event organisers, NGOs and monitoring partners. Responsibilities should cover site selection, installation, emptying, maintenance, communication and follow-up monitoring.
Implementation requirements	Start with hotspot mapping and baseline counts of cigarette butts. Select visible locations where people actually stop or wait, such as ferry piers, bus stops, benches or event waiting areas. Ensure easy access, clear design, a short information sign explaining the environmental harm of cigarette butts, regular emptying, vandalism checks and integration into existing cleaning routines. If the measure is part of a pilot, define comparison sites with and without ashtrays.
Expected effort and cost level	Effort: Low to medium for installation; medium for maintenance and engagement. Cost: Low to medium, depending on the type and number of ashtrays. Maintenance need: Medium, because ashtrays must be emptied regularly and kept clean and visible.
Strengths	Targets a frequent, small and easily transported top litter item category at specific hotspots. Placement at waiting points increases convenience and visibility, because smokers can dispose of cigarette butts at the moment when disposal is needed. The measure is relatively low-cost, easy to communicate and can be combined with cleaning routines, awareness messages and before-after monitoring.
Limitations / risks	Effectiveness depends strongly on placement, visibility, emptying and user acceptance. Ashtrays may have little effect if installed where people only pass by, where smokers do not wait, or where the device is not visible at the moment of disposal. The measure does not address other litter item categories and should be combined with cleaning, broader waste infrastructure and source-prevention measures.
Monitoring and evaluation	Evaluate before-after changes in cigarette butt counts at hotspot level, pieces per meter or square meter during riverbank surveys, and counts in comparison areas with and without ashtrays. Additional indicators include the number of cigarette butts collected in ashtrays, and cigarette butts found in adjacent water or riverbank areas.
Best practice example	In Rostock, Warnow-Ascher were installed at the Stadthafen as a COP pilot measure after monitoring showed cigarette butts as a major litter item. During surveys between June and August 2024, 5,613 litter pieces were collected along the Stadthafen, including 822 cigarette butts. Cigarette butts ranked second after sweet wrappers. The effectiveness of the Warnow-Ascher is being evaluated by comparing areas with and without installations and by assessing changes before and after implementation.

Transferability

High. The approach can be transferred to many Baltic riverfronts because most cities have small, recurring litter hotspots along paths, benches, parks, bridges or promenades. Local adaptation is needed for land ownership, safety, vegetation, lighting, maintenance capacity, community involvement and dominant litter item categories.

Sources

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6.4 K.R.A.K.E. Waterfront Litter Stopper

Pathway-related measure for wind-blown and runoff-transported litter at riverfront edges

Summary: The K.R.A.K.E. waterfront litter stopper is a simple physical barrier installed along the lower edge of a riverfront railing or promenade edge. It is designed to stop litter that is already lying on paved public surfaces and would otherwise be blown, washed or moved downslope through railing gaps and into the river. In Cologne, K.R.A.K.E. e.V. installed a 30 m pilot section at the Rhine promenade near the Musical Dome; during the first two days, 41 litter pieces were stopped and could be collected.



Fig. 5 K.R.A.K.E. Trashstopper installed at the riverfront promenade in Cologne to prevent litter from being washed or blown into the Rhine. Photo: K.R.A.K.E. e.V., used with permission.

Measure type	Main target	Effort / cost	Transferability
Stormwater, wind and other pathway-related measures	Street and promenade litter before it is washed or blown into the river	Low to medium cost; low to medium cleaning need	High for suitable railings, quays and promenades

Short description	The measure consists of a simple barrier installed at the lower edge of a riverfront railing, quay or promenade. The barrier stops litter that is already on the street or promenade surface from moving through gaps, under railings or over the edge into the water. Retained litter remains visible and accessible and can be removed manually or with street-cleaning machines.
Technical / Practical Details	In the Cologne pilot, the installation consists of a perforated metal strip along a 30 m section of the Rhine promenade. The perforated design is intended to allow rainwater to continue draining while preventing litter from falling into the river. The measure should be adapted to local railing design, slope, drainage needs, safety requirements, cleaning routines and accessibility. Corrosion-resistant material, secure fixing, smooth edges and compatibility with street-cleaning equipment are important practical aspects.
Main target / mitigation logic	Interruption of the pathway between urban public-space litter and the river. The measure does not prevent littering itself, but prevents already deposited litter from being blown, washed or moved downslope into the water.
Suitable application context	Paved riverfront promenades, quays, harbour edges, bridges, viewing platforms or waterfront walkways where litter repeatedly accumulates near railings or edges and can enter the water through gaps. Particularly suitable where there is a slope towards the water, strong wind exposure, intensive public use or direct connection between public space and river.
Target litter item categories	Lightweight public-space and take-away litter, including food wrappers, cups and lids, plastic bags, bottles, cans, cigarette butts, small plastic pieces and mixed packaging. Very small items may pass through depending on perforation size.
Source / pathway addressed	Littering and insufficient waste disposal in public spaces, followed by wind transport, rainfall runoff, surface slope, cleaning activities or direct movement through railing gaps towards the river. The measure addresses the pathway from street or promenade surface to river entry.
Key actors and responsibilities	Municipality, public-space or promenade owner, water authority, railing or infrastructure owner, waste management company, street-cleaning service, local NGOs such as K.R.A.K.E. e.V., and, where relevant, harbour or navigation authorities. Responsibilities should cover installation permission, design approval, regular cleaning, waste disposal, safety checks and monitoring.
Implementation requirements	Identify repeated riverfront litter hotspots and check whether litter enters the water through railings, gaps or promenade edges. Implementation requires permission from the responsible authority, a site-specific technical design, drainage and safety checks, installation by qualified staff, a regular cleaning schedule and a simple monitoring protocol to document retained litter.
Expected effort and cost level	Effort: Low to medium for planning and installation; low to medium for routine cleaning and monitoring. Cost: Low to medium, depending on length, material, fixing method and permissions. Maintenance need: Low to medium, because retained litter must be collected regularly to avoid visible accumulation and remobilisation.
Strengths	Low-tech and easy to understand; directly targets a visible pathway from public space to river; allows water drainage while retaining litter; can be piloted on short sections; creates immediate evidence because retained litter can be counted and classified; and supports communication on the responsibility for litter before it reaches the water.
Limitations / risks	Does not prevent litter generation or littering at source and should be combined with bins, cleaning and awareness measures. If cleaning is not frequent enough, the installation may create visible litter accumulation. The design must not block drainage, create trip or injury risks, interfere with accessibility, damage infrastructure or fail during heavy rainfall, flooding, high winds or vandalism. Very small items may pass through depending on perforation size.
Monitoring and evaluation	Evaluation can include the number of litter pieces retained per meter and per day or week, material composition, plastic share, top litter item categories, observations after rainfall or strong wind, and before-after comparison with similar untreated sections. Cleaning logs and photos can document whether the barrier reduces direct litter entry into the water.
Best practice example	K.R.A.K.E. e.V. installed a 30 m pilot section of the Trashstopper at the Rhine promenade in Cologne at the end of June 2024. According to K.R.A.K.E., 41 litter pieces were stopped during the first two days. The organisation describes the measure as a simple perforated metal strip that allows water to drain but prevents litter from falling into the Rhine, so that it can be collected and evaluated.

Transferability

High for Baltic cities with paved waterfront promenades, quays, harbour areas or bridges where litter repeatedly moves from public spaces into rivers or harbour basins. Local adaptation is required for railing design, edge geometry, drainage, flood risk, cleaning routines, permits, accessibility and public safety.

Sources

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6.5 SeaProtectorOne (SPO) - Floating Macro-litter Retention and Monitoring

Technical removal / retention measure for floating macro-litter before discharge to harbour or coastal waters

Summary: The SeaProtectorOne is a technical retention system for collecting floating macro-litter from rivers, channels and streams. In Aarhus, it was installed around 100 meters upstream of the river mouth, where it has been collecting floating litter continuously since 2022. The example shows how a technical retention system can combine litter removal with detailed monitoring data, but it should complement - not replace - source-prevention measures.



Fig. 6 SeaProtectorOne installed in the Aarhus River, Denmark. The device spans most of the channel width and intercepts floating macro-litter close to the river mouth before discharge into Aarhus Harbour and Aarhus Bay.

Measure type	Main target	Effort / cost	Transferability
Removal / retention of litter already in the water	Floating macro-litter before discharge to coastal waters	High initial cost; medium to high maintenance need	Medium to high, if local hydraulic and operational conditions are suitable

Short description The SeaProtectorOne (SPO) is a floating macro-litter collection device. A boom with a conveyor belt and filtration unit is lowered into the water, skims the surface layer and transports collected material into a land-based container. In the Aarhus case, the system covered 9.5 m of a 10 m wide artificial river channel and was supported by a guide arm directing floating litter towards the device.

Technical / Practical Details	Aarhus set-up: 35 × 60 mm grid; skimming of the surface layer to around 30 cm depth; installation about 100 m upstream of the wider harbour basin. The boom operates automatically: once a defined amount of litter or other floating material has accumulated, the system lifts the boom out of the water and transfers the material via conveyor belt into a litter container. When sensors detect ice, boats or other water users, the boom automatically lifts and rotates parallel to the riverbank to keep the channel passable. The SPO is modular and can be adapted to different river widths. In narrow channels, one unit may cover most of the river width, as in the Aarhus case. In wider rivers, units can be installed on both sides or in staggered configurations to increase coverage while still allowing vessel passage.
Main target / mitigation logic	Retention and removal of surface-floating macro-litter before it reaches downstream harbour or coastal waters.
Suitable application context	Narrow urban rivers, canals, harbour entrances or river-mouth sections where floating litter can be guided to one collection point. Wider rivers may require paired or staggered installations on both riverbanks to increase coverage while maintaining vessel passage. Suitable sites require power supply and compatible flow conditions.
Target litter item categories	Floating macro-litter larger than the effective capture size, including cups and lids, plastic bags, sweet wrappers, paper bags, paper food trays and wrappers, cans, bottles and mixed public-space litter. Very small, submerged or sinking litter may not be fully captured, depending on grid size, buoyancy and flow conditions.
Source / pathway addressed	Floating litter transported through urban river channels towards harbour or coastal waters. In the Aarhus case, dominant litter item categories and temporal patterns indicated strong links to urban social and recreational activities, take-away consumption and weekend or seasonal use of the riverfront.
Key actors and responsibilities	Municipality or water authority; harbour or river manager; technical provider; waste management company; maintenance team; monitoring or research partner. Responsibilities should cover installation, operation, emptying, maintenance, waste sorting or disposal, data recording, safety and communication with river users.
Implementation requirements	Feasibility assessment of river width, flow velocity, water depth, water-level variation, boat traffic, debris load, ice risk, access and safety. Implementation also requires permits, technical installation, routine maintenance, regular emptying, procedures for handling collected litter and a monitoring protocol if the system is also used for data collection.
Expected effort and cost level	Effort: High for planning and installation; medium to high for operation and maintenance. Cost: High initial investment; medium to high running costs. Maintenance need: Medium to high, depending on litter load, organic debris, weather, ice, boat traffic and emptying frequency.
Strengths	Removes floating litter before it reaches downstream harbour basins or coastal waters; can operate continuously (24/7); generates detailed data when collected litter is counted and classified; supports before-after evaluation of prevention measures; and is highly visible for communication and awareness raising.
Limitations / risks	Does not prevent litter generation at source and should therefore be combined with prevention measures. Capture efficiency depends on location, grid size, hydrology, maintenance, boat traffic and the buoyancy or size of litter pieces. The system mainly captures surface litter and may miss submerged, very small or bottom-transported items. Long-term funding and maintenance responsibilities are essential.
Monitoring and evaluation	Collected litter can be counted and classified using harmonised litter item categories, preferably the EU Joint List. Evaluation can include total litter pieces collected, pieces per day or week, material composition, plastic share, top 10 litter item categories, seasonal or weekday patterns, maintenance downtime and changes after local prevention measures.
Best practice example	The SPO collected 63,035 litter pieces in 2021/22 and 18,725 pieces in 2024/25. Plastics were dominant in both periods, accounting for about 60% of all litter, followed by paper/cardboard at about 23%. Single-use plastics represented around 50–55% of collected litter pieces. The device operated around 98% of the time, and the data showed strong weekend and seasonal patterns as well as an overall reduction of about 70% between the two monitoring periods. Previous tests showed the SPO collects ~90% of all floating litter.

Transferability

Medium to high. The concept can be transferred to other Baltic cities where floating litter is concentrated in a manageable river-mouth, harbour or channel setting. Transfer requires local adaptation to hydraulic conditions, river width, navigation, permits, maintenance capacity and expected litter load.

Sources

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6.6 PortBins / Floating Surface Collectors in Harbour Basins

Removal / retention measure for floating litter already present in sheltered urban water areas

Summary: PortBins are small floating surface collectors designed to remove floating litter from calm harbour basins, marinas or sheltered urban water areas. In the Rostock pilot, the devices collected litter when wind pushed floating material into the narrow harbour basin, but they were often dominated and clogged by organic material such as reed, algae and plant debris. The measure can therefore be useful at small predictable accumulation points, but only where frequent emptying, cleaning and maintenance can be secured.



Fig.7 PortBin performance under contrasting wind conditions in the Rostock harbour basin. Under offshore wind conditions (left), only small amounts of litter and organic debris entered the PortBin. Under onshore wind conditions (right), wind pushed larger amounts of litter and organic material into the basin, quickly exceeding the PortBin’s collection capacity and leaving floating material around the device.

Measure type	Main target	Effort / cost	Transferability
Removal / retention of litter already in the water	Floating litter in sheltered harbour basins or calm urban water areas	Medium installation cost; high maintenance need under high debris load	Medium, if organic load and maintenance capacity are suitable

Short description PortBins are compact floating collectors that draw in surface water and retain floating material in a small collection basket or container. They are intended for calm water areas where floating litter accumulates close to quays, pontoons or harbour structures. In urban harbour basins, they can remove litter already present in the water, but they do not prevent litter generation at source.

Technical / Practical Details	The Rostock pilot used PortBins in a sheltered harbour basin. Operation depends strongly on wind direction, basin geometry, floating debris load and maintenance. When wind pushed floating material into the basin, the PortBins collected litter but also large amounts of organic material. During high-load situations, the basket filled rapidly and would have required very frequent emptying. In addition, the device needs to be lifted out of the water every few months for thorough cleaning, including removal of barnacles and fouling organisms; otherwise, performance can decline strongly.
Main target / mitigation logic	Removal of floating litter already present in sheltered harbour basins or other calm urban water areas. The measure works by collecting surface-floating material at locations where wind and water movement concentrate debris.
Suitable application context	Small, sheltered harbour basins, marinas, pontoons or calm urban water areas where floating litter repeatedly gathers at predictable points and where staff can empty and maintain the device regularly. The measure is less suitable where large amounts of reed, algae or plant debris accumulate, or where floating material loads exceed basket capacity.
Target litter item categories	Floating public-space litter such as cups and lids, bottles, cans, plastic bags, wrappers, films, paper packaging and mixed lightweight packaging. Capture depends on item size, buoyancy, water movement and the relation between litter load and basket capacity.
Source / pathway addressed	Floating litter already present in harbour basins or calm water areas, often transported by wind from waterfront areas, quays, promenades, nearby public spaces or upstream inputs. The measure addresses removal at the accumulation point, not the original source of litter.
Key actors and responsibilities	Municipality, harbour operator, marina manager, waste management company, maintenance staff, technical provider and monitoring or research partner. Responsibilities should cover installation, electricity supply, routine emptying, removal of organic material, technical maintenance, biofouling cleaning, waste sorting and data recording.
Implementation requirements	Before installation, sites should be checked for water depth, power supply, access for emptying, wind exposure, expected litter load, organic debris load, safety, permissions and waste disposal logistics. A realistic maintenance plan is essential, including routine basket emptying, cleaning after high-load events and periodic removal from the water to clean fouling organisms.
Expected effort and cost level	Effort: Medium for installation, high for operation under high debris loads. Cost: Medium initial cost; medium to high running cost depending on staff time. Maintenance need: High where organic material frequently enters the device or where barnacle growth reduces performance.
Strengths	Can collect floating litter in sheltered harbour basins or other calm urban water areas; is relatively visible and easier to install than larger retention systems; may be useful at small predictable accumulation points; and can provide local information on floating litter and organic debris loads if collected material is recorded.
Limitations / risks	The system can be quickly overwhelmed when large amounts of organic debris, such as reed, algae or plant material, are pushed into the basin together with litter. In the Rostock pilot, organic material often dominated the collected material, and floating debris remained around the PortBin even when the basket was full. The 30-litre capacity was too small during high-load situations, and emptying would have been required very frequently, in some cases approximately every 30 minutes. This means that the system may be most maintenance-intensive under the conditions when it is most needed.
Monitoring and evaluation	Evaluation should record operating hours, emptying frequency, downtime, approximate basket filling, litter pieces collected, material composition, organic fraction, maintenance effort, biofouling status and visible floating material remaining around the device. Monitoring should compare onshore and offshore wind situations and assess whether the device reduces visible floating litter at the target site.
Best practice example	In the Rostock pilot, PortBins were tested in the Haedge harbour basin during summer and autumn 2024 and 2025. When wind pushed material into the narrow harbour basin, the devices collected litter, but the collected material often consisted mainly of organic debris, in some cases around 80%. Under offshore wind conditions, less organic material entered the PortBin, but litter loads were also lower. The pilot showed that the measure is highly site- and maintenance-dependent and should be used only where debris load and emptying capacity are compatible.

Transferability

Medium. PortBins can be transferred to other Baltic harbour basins, marinas or sheltered waterfronts if local conditions are suitable. Transfer requires careful assessment of wind patterns, organic debris load, basket capacity, electricity supply, access, staff availability and maintenance frequency.

Sources

- COP Rostock PortBin pilot observations, Haedge harbour basin, June–November 2024 and May–October 2025
- Spilltech, 2026. PortBinTide Solutions for Ports. <https://portbin.no/PortBin-Tide-Solutions-for-Ports#PortBin-Tide-Standard> (accessed 30 July 2026).

6.7 EkoKajak - Kayak-based River Litter Collection and Awareness

Removal of litter and awareness measure in Gdańsk, Motława River and Oplyw Motławy, Poland

Summary: EkoKajak is a guided, free-of-charge kayaking action in which residents and visitors collect floating macro-litter from the Motława River and its channels. The measure combines manual removal of litter already present in the water with environmental education, hotspot observation and the recording of collected litter items. Repeated trips can help remove litter before it sinks, accumulates along banks or is transported further downstream towards coastal waters



Fig. 8 EkoKajak participant collecting floating litter from the Motława River in Gdańsk.
Photo: Jacek Klejment / Gdańsk Sports Centre material around the device.

Measure type	Main target	Effort / cost	Transferability
Removal / awareness	Floating macro-litter and litter accumulated near banks, reeds and sheltered river sections	Effort: Medium Cost: Low-Medium Maintenance: Low-Medium	High Requires safe navigable water, equipment, a coordinator and local waste handling

Short description	Participants paddle a designated urban river route and manually collect visible litter from the water, reeds and accessible bank edges. After returning to the marina, the collected litter is sorted, weighed, counted and recorded. The action removes floating macro-litter while engaging residents and visitors in practical environmental protection.
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Technical / Practical Details	Trips start and finish at Żabi Kruk Marina and last approximately two hours, with additional time for briefing, sorting and equipment return. Gdańsk Sports Centre provides kayaks, buoyancy aids, litter pickers and bags; participants register in advance and follow the instructions of a coordinator. In 2025, the limit was six participants per trip. Activities are weather-dependent and take place repeatedly during the summer season. Collected litter is separated into appropriate waste streams; plastics can be retained for further identification and analysis.
Main target / mitigation logic	Combination of manual removal, awareness raising and hotspot observation. The measure removes litter already present at the water surface or trapped near banks and reeds, while engaging participants and generating simple location-specific information on litter accumulation.
Suitable application context	Slow-moving, safely navigable urban rivers, harbour basins, canals and recreational waterfronts, especially routes with visible accumulation near reeds, banks, quays and sheltered corners. The measure is most suitable where a marina, water-sports operator or municipal partner can provide equipment, supervision and a waste-sorting point.
Target litter item categories	Plastic bottles, plastic bags, food packaging, aluminium cans, glass bottles, cups and other lightweight mixed public-space litter that can be safely reached from a kayak. Hazardous, very heavy, sharp, contaminated or submerged objects require specialist handling and are outside the normal collection scope.
Source / pathway addressed	Litter entering or accumulating in the river through direct littering, wind transport, stormwater runoff, harbour and boating activities, nearby public spaces, outdoor gastronomy, insufficient bin management or local water circulation. The measure mainly addresses litter already present in the water or trapped in reeds and along riverbanks before it sinks or moves downstream.
Key actors and responsibilities	Gdańsk Sports Centre: organisation, equipment, registration, safety arrangements, communication, waste handling and data management. Trip coordinator: briefing, route supervision, collection guidance and recording. Participants: safe collection and return of collected litter. Municipal waste services and research partners: further segregation, treatment and, where applicable, material analysis.
Implementation requirements	Access to a marina and suitable kayaks; buoyancy aids, bags, litter pickers and optional gloves; a trained coordinator; registration and participant information; route and weather assessment; emergency and safety procedures; containers for separate collection; staff time for weighing, counting and documentation; and arrangements for lawful waste transfer. Local navigation or site permissions should be checked where required.
Expected effort and cost level	Effort: Medium Cost: Low-Medium Maintenance need: Low-Medium. The measure can use existing marina and kayak infrastructure, but repeated delivery requires a coordinator, booking administration, equipment cleaning and maintenance, safety management, waste handling and consistent recording after every trip.
Strengths	Combines recreation with visible environmental action; attracts residents and visitors; reaches litter in shallow or bank-side areas; generates location-specific information on accumulation zones; supports environmental education through direct experience; is easy to communicate; and complements fixed technical devices, riverbank clean-ups and underwater clean-ups.
Limitations / risks	Seasonal and weather-dependent; limited to litter safely reachable from the water surface or bank-side areas; small group capacity; results depend on route, trip frequency and participant attendance; sharp, contaminated or heavy waste creates safety risks; and collected mass alone is not comparable between years if routes or operating effort change. The measure removes existing litter but does not replace source prevention.
Monitoring and evaluation	Record for every trip: date, route, duration, participant number, collected mass, item count, material categories, hotspots and unusual items. Compare results per trip, per route, per trip duration and per participant, not only annual totals. Photo documentation and route maps can support hotspot assessment. Participant feedback can be used to assess awareness and communication effects.
Best practice example	In 2024, 160 participants completed 33 trips and collected 144.44 kg / 1,490 pieces. In 2025, 218 participants completed 40 trips and collected 97.25 kg / 959 pieces. The 2025 route shifted from the central Motława towards the quieter Opyw Motławy, so the lower collected mass should not be interpreted as proof of reduced pollution. Frequently found items included bottles, cans, plastic bags and packaging, with litter often trapped in reeds and along banks.

Transferability

High. The model can be adopted by Baltic cities with safe kayak-accessible waterways and a local operator. Adaptations should cover navigation conditions, seasonality, water temperature, group size, local safety rules, waste classification, insurance, accessible participation options and coordination with municipal waste services. A common monitoring sheet would improve comparison between cities.

Sources

- Gdańsk Sports Centre: EkoKajak announcements and results for 2024–2025, available at sportgdansk.pl; presentation 'Monitored and implemented waste collection methods at the Gdańsk Sports Centre'; photo and monitoring data: Gdańsk Sports Centre. Contact: ekokajak@sportgdansk.pl.

6.8 Targeted Awareness and Behaviour-change Activities at Riverfront Hotspots

Awareness / education measure linked to local hotspots, target groups and dominant litter item categories

Summary: Targeted awareness and behaviour-change activities use place-specific communication to reduce littering at riverfront hotspots. Messages should be linked to local monitoring results, dominant litter item categories and visible pathways to the river. The measure is most useful when it supports practical actions such as improved bins, ashtrays, reusable systems, cleaning routines or stakeholder agreements.



Fig. 9 Conceptual illustration of targeted awareness and behaviour-change activities at riverfront hotspots. The measure links site-specific messages, visible waste infrastructure and monitoring feedback to dominant local litter item categories in order to reduce littering behaviour. Final illustration generated with the help of AI and revised by the authors.

Measure type	Main target	Effort / cost	Transferability
Awareness / education activities	Littering behaviour at riverfront hotspots, especially linked to dominant local litter item categories	Low to medium cost; medium effort for design, placement and repeated engagement	High, if messages are adapted to local hotspots, target groups and litter item categories

Short description	The measure uses targeted communication and education at riverfront hotspots to reduce littering behaviour. Instead of general awareness raising, it focuses on specific places, behaviours, target groups and litter item categories observed locally.
Technical / Practical Details	Activities can include hotspot signs, ground markings, drain or riverbank messages, temporary event communication, school or citizen-science activities, public display of collected litter, QR-code information, social media linked to hotspots, and feedback boards showing monitoring or clean-up results.
Main target / mitigation logic	Reduction of littering behaviour by making the river connection visible, reinforcing social norms against littering and showing that the site is monitored and cared for. The measure should motivate correct disposal and support other practical interventions.
Suitable application context	Riverfront promenades, parks, benches, bridges, event areas, take-away hotspots, smoking areas, informal meeting points, stormwater drains and riverbank sections where local littering is repeatedly observed.
Target litter item categories	Dominant local litter item categories identified through monitoring or clean-up data, such as cups and lids, food wrappers, bottles, cans, cigarette butts, plastic bags, packaging films or mixed public-space litter. Messages should target a limited number of priority items.
Source / pathway addressed	Direct littering and incorrect disposal at riverfront hotspots, including litter left after recreation, events, food-and-drink consumption or smoking. It also addresses litter that can be blown, washed or carried from adjacent public spaces into drains, riverbanks or the water.
Key actors and responsibilities	Municipality, schools, NGOs, citizen-science groups, waste management company, local businesses, event organisers, harbour or water authority, communication teams and monitoring partners. Responsibilities should cover message design, permissions, installation, maintenance and follow-up.
Implementation requirements	Identify priority hotspots and target litter item categories using monitoring, clean-up results, spatial assessment and stakeholder knowledge. Define the target group, select clear messages, agree permissions, install or deliver communication material, maintain it and combine it with practical measures where needed.
Expected effort and cost level	Effort: Low to medium for small campaigns; medium for repeated engagement or school activities. Cost: Low to medium, depending on design, printing, installations and staff time. Maintenance need: Low to medium, especially if signs, markings or feedback boards need refreshing.
Strengths	Can directly address the behaviours and litter item categories observed at a hotspot; is relatively low-cost and flexible; makes monitoring results visible to the public; supports other measures such as bins, ashtrays, reusable systems or clean-up routines; and can involve schools, NGOs and local communities.
Limitations / risks	Awareness activities alone are often not sufficient if waste infrastructure, cleaning routines or responsibilities are inadequate. Generic messages may have limited effect, and repeated exposure can reduce attention. The measure should therefore be refreshed and combined with practical interventions.
Monitoring and evaluation	Evaluation can use before-after riverbank or hotspot surveys, RFML observations where relevant, clean-up data, changes in target litter item categories, photo documentation and simple engagement indicators such as participants, QR-code use or feedback-board responses.
Best practice example	Within COP, the spatial assessment of urban riverfronts in Aarhus, Gdańsk and Rostock can help identify hotspots and likely source areas for targeted communication. The COP monitoring roadmap provides the complementary basis for selecting indicators and checking whether target litter item categories decrease after implementation.
Transferability	High. The measure can be adapted to many Baltic riverfronts, but messages should be locally specific. Transfer requires adaptation to language, culture, hotspot type, target group, dominant litter item categories and available communication channels.

Sources

- Haseler, 2025. Spatial Assessment of Litter Pollution Along Urban Riverfronts in the Baltic Region -: A comparative study of Aarhus, Gdańsk and Rostock.
- HELCOM, 2021. HELCOM Recommendation 42-43/3 on the Regional Action Plan on Marine Litter: Revised Regional Action Plan on Marine Litter. <https://helcom.fi/wp-content/uploads/2021/10/HELCOM-Recommendation-42-43-3.pdf>.
- MSFD TSG ML, 2023. Guidance on the Monitoring of Marine Litter in European Seas: An update to improve the harmonised monitoring of marine litter under the Marine Strategy Framework Directive. Publications Office of the European Union. <https://doi.org/10.2760/59137>.
- Veiga et al., 2016. Identifying Sources of Marine Litter: MSFD GES TG Marine Litter - Thematic Report. Thematic Report; JRC Technical Report.
- Haseler, M., 2026. Roadmap for the Implementation of Monitoring and Sampling of Riverine Litter in South Baltic Sea Rivers. Circular Ocean-bound Plastic, Deliverable 3.6.1.

6.9 Local River Litter Action Plan / Stakeholder Agreement

Stakeholder / governance measure for coordinated prevention, mitigation and follow-up

Summary: A local river litter action plan or stakeholder agreement is a governance instrument that brings relevant actors together, sets common objectives and defines concrete responsibilities for reducing riverine litter. It links monitoring results, spatial hotspot analysis, local knowledge and stakeholder priorities with a clear set of agreed measures, timelines and follow-up procedures. The measure is especially useful where litter sources, pathways and responsibilities are distributed across several municipal departments, businesses, harbour actors, NGOs or community groups.



Fig. 10 Conceptual overview of a local river litter action plan / stakeholder agreement, showing key stakeholder groups and the stepwise process from hotspot identification and agreement of responsibilities to implementation, monitoring and improvement. Final illustration generated with the help of AI and revised by the authors.

Measure type	Main target	Effort / cost	Transferability
Stakeholder / governance measures	Coordinated local action and shared responsibilities for river litter prevention and reduction	Medium effort; low to medium cost; medium coordination need	High, if a local coordinator and committed stakeholders are available

Short description	A local river litter action plan is a jointly agreed framework for reducing litter in and along a specific river, harbour basin or urban waterfront. It translates monitoring results and local knowledge into a practical set of measures, responsibilities and timelines. A stakeholder agreement can be used as a lighter version, focusing on shared commitments between the main actors.
Technical / Practical Details	The plan should include a short problem description, priority hotspots, dominant litter item categories, likely sources and pathways, selected measures, responsible actors, implementation steps, timing, estimated effort or budget, communication needs and follow-up monitoring. It can be developed through one or more stakeholder workshops and updated regularly based on monitoring results and practical experience.
Main target / mitigation logic	Improved coordination and accountability. The measure reduces the risk that litter problems remain unaddressed because responsibilities are unclear or because monitoring, clean-up, prevention and communication activities are not connected.
Suitable application context	Urban rivers, waterfronts, harbour basins, canals and river-mouth areas where several actors influence litter sources or pathways. It is especially useful for areas with recreational use, events, gastronomy, tourism, stormwater-related inputs, harbour activities or repeated hotspots.
Target litter item categories	All locally dominant litter item categories can be addressed. The action plan should prioritise the top litter item categories identified through RFML surveys, riverbank surveys, clean-up data or hotspot observations.
Source / pathway addressed	Cross-cutting measure addressing multiple sources and pathways, including direct littering, public-space use, events, take-away consumption, insufficient waste infrastructure, wind-blown litter, stormwater runoff, harbour activities, illegal dumping and repeated riverbank accumulation.
Key actors and responsibilities	Municipality or local environmental authority, waste management company, water authority, harbour or marina operator, event organisers, waterfront businesses, gastronomy, NGOs, schools, citizen-science groups, universities and local residents. One local coordinator should be responsible for convening stakeholders, maintaining the action plan and tracking progress.
Implementation requirements	A minimum evidence base should be prepared before or during the first stakeholder meeting. This may include hotspot maps, monitoring results, clean-up data, photos, site observations and information on existing responsibilities. Implementation requires a coordinator, stakeholder mapping, agreement on priority problems, selection of measures, a responsibility table, a simple timeline and regular follow-up meetings.
Expected effort and cost level	Effort: Medium, mainly for coordination, workshops and follow-up. Cost: Low to medium for developing the plan itself; implementation costs depend on the selected measures. Maintenance need: Medium, because the plan should be reviewed regularly and responsibilities must remain active.
Strengths	Creates shared responsibility and connects data, local knowledge and practical implementation. Helps move from isolated clean-ups or awareness activities towards coordinated, evidence-based mitigation. Can combine several measure types, such as source prevention, hotspot management, stormwater/pathway measures, technical retention, awareness and monitoring. It is flexible and can start with a small number of realistic commitments.
Limitations / risks	The plan has little effect if it remains a document without clear responsibilities, budget, authority or follow-up. Stakeholder fatigue, unclear leadership or vague objectives can reduce implementation. It should focus on a limited number of priority hotspots, dominant litter item categories and realistic measures.
Monitoring and evaluation	Evaluation should use existing city-level monitoring indicators: pieces per observation or hour for RFML surveys, pieces per meter or square meter for riverbank surveys, top 10 litter item categories, hotspot locations, cleaning status and changes after implementation. Annual summaries can track completed actions, remaining hotspots and decreases in target litter item categories.
Best practice example	Within COP, the spatial assessment of urban riverfronts in Aarhus, Gdańsk and Rostock provides a strategic basis for action planning by combining GIS-based hotspot identification, points of interest and stakeholder knowledge. The COP monitoring roadmap complements this with local monitoring teams, coordination, harmonised data collection and a monitoring-to-mitigation cycle. Together, both reports can structure a local river litter action plan.

Transferability

High. The approach can be transferred to other Baltic cities because it is not tied to one specific technology or river type. Local adaptation is needed for governance structures, available monitoring data, stakeholder landscape, legal responsibilities, budget, priority hotspots and selected measures.

Sources

- Haseler, 2025. Spatial Assessment of Litter Pollution Along Urban Riverfronts in the Baltic Region: A comparative study of Aarhus, Gdańsk and Rostock.
- HELCOM, 2021. HELCOM Recommendation 42-43/3 on the Regional Action Plan on Marine Litter: Revised Regional Action Plan on Marine Litter. <https://helcom.fi/wp-content/uploads/2021/10/HELCOM-Recommendation-42-43-3.pdf>.
- Haseler, M., 2026. Roadmap for the Implementation of Monitoring and Sampling of Riverine Litter in South Baltic Sea Rivers. Circular Ocean-bound Plastic, WP3, Activity 3.6.1, Deliverable 3.6.1.

6.10 Further resources and additional examples

The measure profiles presented above represent selected examples that are particularly relevant for the COP partner cities and the wider South Baltic context. Additional technical, organisational and behavioural measures may also be relevant depending on local hydrology, litter quantities, site accessibility, maintenance capacity, budget and stakeholder responsibilities.

The following resources and examples are provided as further inspiration for municipalities, harbour operators, water managers, waste management companies, NGOs, event organisers and local businesses. They should not be understood as fully assessed recommendations within this report. Before implementation, each option should be checked with regard to local feasibility, permissions, expected effectiveness, maintenance needs, costs, data requirements and possible environmental side effects.

The examples (Table 2) also show that riverine litter mitigation can include small preventive actions as well as larger operational systems. Reusable and deposit-based take-away systems, incentives for bringing personal cups, public drinking-water fountains, targeted campaigns against small litter items, organised clean-up events, trash traps and pathways for handling collected plastics can all contribute to reducing litter pressure when they are connected to local source and pathway assessment.

Table 2 Further resources and examples for future consideration.

Resource / example	Main relevance for the roadmap	How it could be used	Important note
COP report: Business Opportunities (2024a) Open resource	Circular economy and business opportunities related to ocean-bound plastic waste.	Use as a reference for SMEs, innovation options, recycling and reuse pathways, and links between mitigation, collected plastic and new products.	Useful as a supporting resource to find SMEs, NGOs and companies involved in litter collection and recycling. It further presents some mitigation measure itself.
COP report: Pathways for Cleaning Collected Ocean-Bound Plastic (2025) Open resource	Post-collection handling and cleaning of collected ocean-bound plastic.	Use when discussing what happens after litter is collected, especially if plastics are intended for recycling or material recovery.	Relevant for downstream handling; it does not replace source-prevention measures.
COP report: Plastic Waste Streams into the South Baltic Sea (2024b) Open resource	Country-level overview of plastic waste streams in the South Baltic context.	Use as background information for waste-flow context, country-level comparison and the wider link between land-based waste management and riverine litter prevention.	Background resource; not a direct site-level mitigation measure.
Take Cup! / Gdańsk example (2021) Open resource	Reusable cup deposit system similar to RECUP/REBOWL.	Use as an additional example for reusable take-away systems in gastronomy and city contexts.	Can be mentioned under reusable systems; effectiveness depends on partner network, return logistics and user acceptance.

REUSEABLE / Aarhus (2024) Open resource	Citywide reusable cup system for take-away beverages.	Use as an additional example for deposit-return systems in cafés, restaurants, markets and event venues.	Closely related to the RECUP/ REBOWL measure profile; avoid repeating the full profile.
Bring-your-own cup discounts	Small incentive for source prevention in regular gastronomy.	Mention as a low-threshold complementary action where cafés provide discounts for customers bringing personal reusable cups.	Should be documented locally; works best as part of a wider reusable-cup or waste-prevention strategy.
Public drinking-water fountains / Gdańsk (2026) Open resource	Prevention of single-use beverage packaging and plastic bottles.	Use as an example of enabling refill behaviour in public space, parks, waterfronts and tourist areas.	Relevant where tap water quality and fountain maintenance are secured and communicated clearly.
Together for a Clean Aarhus (2026) Open resource	Clean-up, underwater litter removal, public engagement and awareness.	Use as an example of combining divers, SUP users, volunteers, quay-side activities, dissemination and citizen-science recording.	Collected mass should be interpreted with effort, location and event design; not directly comparable to standard monitoring.
Aarhus campaign: Small Waste - Big Problem (2023) Open resource	Targeted awareness and behaviour-change campaign for small litter items.	Use as an additional example for cigarette butts, chewing gum, nicotine pouches, hotspot communication, voting bins and waste ambassadors.	Not river-specific, but relevant for reducing land-based litter before it reaches waterways.
German Round Table on Marine Litter - products and guidance (2024) Open resource	Guidance documents, recommendations and practical materials on marine litter prevention and management.	Use as a portal for additional guidance on awareness, municipal options, harbour and boating-related litter, fishing gear and harmonised protocols.	Useful as a resource collection; select individual documents depending on the local problem.
International Trash Trap Network (2025) Open resource	Technical retention, trash-trap planning, harmonised data collection and education resources.	Use for additional guidance when cities consider litter traps, booms or other trash-trap systems and want planning checklists or data protocols.	International resource; local hydrology, permits, maintenance and ecological effects still need site-specific assessment.

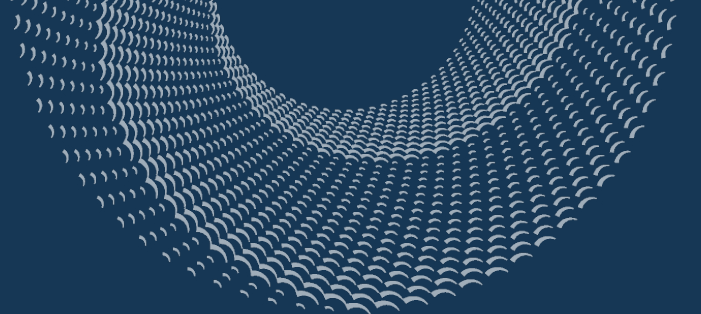
Notes on interpretation

- Reusable systems and bring-your-own cup incentives should be prioritised over single-use substitution wherever feasible, because they reduce the number of disposable items that can become litter.
- Biodegradable or compostable materials should be treated cautiously. They may reduce conventional plastic use in some settings, but they should not be presented as a stand-alone litter mitigation measure unless suitable collection, treatment and communication systems are in place. If discarded into the environment, they can still contribute to litter problems.

- Clean-up events, kayak-based collection and trash traps can remove litter already present in the environment and raise awareness, but they should complement source prevention, improved waste infrastructure and follow-up monitoring.

These further resources show that riverine litter mitigation can draw on a broad range of measures and support tools. However, the suitability of each option depends on the local problem. The following roadmap chapter therefore focuses on how cities can select appropriate measures based on monitoring evidence, source and pathway assessment, feasibility, maintenance capacity and stakeholder responsibilities.





7.

Mitigation Roadmap For Wider Adoption

7. Mitigation Roadmap For Wider Adoption

The mitigation roadmap provides a stepwise approach for selecting, implementing and evaluating riverine litter reduction measures in Baltic city contexts. It builds on the measure profiles presented in Chapter 6 and translates them into a practical decision-making process. The roadmap is intended to help municipalities, local authorities, harbour actors, waste management companies, NGOs and other stakeholders move from general awareness and clean-up activities towards targeted, evidence-based mitigation.

The roadmap follows six steps as shown in Figure 1:

1. Identify hotspots and dominant litter item categories
2. Assess likely sources and pathways
3. Select suitable measure categories
4. Check feasibility, maintenance needs and responsibilities
5. Implement measures at priority sites
6. Monitor, evaluate and adapt

This stepwise approach should be understood as an adaptive cycle rather than a one-time process. Monitoring and stakeholder knowledge are used to identify the problem, suitable measures are selected and implemented, and follow-up monitoring is used to assess whether the measure reduces litter abundance, specific litter item categories or hotspot intensity.

7.1 Step 1: Identify hotspots and dominant litter item categories

The first step is to identify where action is needed and which litter item categories should be targeted. This should be based on monitoring results, spatial assessments, clean-up data, site observations and stakeholder knowledge. Relevant information includes total litter piece counts, top 10 litter item categories, material composition, hotspot locations, cleaning status, event-related patterns and seasonal variation.

Riverbank surveys are particularly useful for identifying deposited litter, frequently littered sites and hotspots along riverbanks, promenades and waterfront areas. RFML surveys provide information on floating macro-litter transported on the river surface. Spatial assessments can complement monitoring by identifying areas with high human activity close to the river, such as cafés, bars, event areas, benches, markets, ferry stops, promenades, harbour areas or informal meeting points.

The outcome of this step should be a short list of priority sites and dominant litter item categories.

7.2 Step 2: Assess likely sources and pathways

The second step is to assess how the litter reached the river or riverbank. While dominant litter item categories can provide indications of likely sources, they should not be interpreted as direct proof. Source and pathway assessments should combine monitoring data with site observations, land use information, weather conditions, hydrology, cleaning routines, and stakeholder knowledge, if possible.

For example, cigarette butts at ferry stops or benches may indicate smoking while waiting. Cups, lids, food wrappers and take-away packaging may be linked to events, outdoor gastronomy or recreational use. Litter found below railings or along sloped promenades may indicate wind or stormwater transport from adjacent public spaces. Floating litter in harbour basins may be linked to wind-driven accumulation, local inputs or upstream transport.

If possible, this step should distinguish between litter generated at the site, litter transported from nearby public spaces and litter already present in the water. This distinction is important because different measures are required in each situation.

7.3 Step 3: Select suitable measure categories

The third step is to select the most suitable measure category. Source-prevention measures should generally be prioritised because they reduce the number of litter items before they enter public spaces, riverbanks or the water. However, source prevention alone may not be sufficient where litter has already entered the environment or where specific pathways transport litter into the river.

Hotspot and public-space management measures are suitable where littering repeatedly occurs at specific sites. Stormwater, wind and other pathway-related measures are suitable where litter is already present in public space and is transported towards the water. Removal and retention measures are relevant where litter has already entered the water. Awareness and education activities can support behavioural change, while stakeholder and governance measures help coordinate responsibilities and long-term implementation.

In practice, several measures may need to be combined. For example, a riverfront event area may require reusable cup systems, additional bins, targeted awareness, organiser obligations and follow-up monitoring. A ferry stop with many cigarette butts may require ashtrays, information signs, cleaning routines and before-after assessment.

To support this selection process, Table 3 links typical observed litter problems with likely sources or

pathways and suitable mitigation measure profiles. The table should be used as a practical decision-support tool rather than as a fixed prescription. In many cases, several measures should be combined to address both the source of litter and the pathway by which it reaches the river.

Table 3 Matching observed litter problems to suitable mitigation measures

Observed problem	Likely source / pathway	Suitable measure profile(s)	Notes for implementation / evaluation
Many cups, lids, bowls or food packaging after events	Event-related take-away consumption, outdoor gastronomy, markets or public gatherings close to the river	RECUP/REBOWL – Reusable or Deposit Systems for Events; Targeted Awareness and Behaviour-change Activities; event-related waste management	Prioritise source prevention before the event starts. Check return logistics, vendor participation and before-after changes in cups, lids, bowls and food packaging.
Cigarette butts at ferry stops, bus stops, benches, entrances or event waiting areas	Smoking while waiting, stopping or staying at defined hotspots	Cigarette Butt Reduction Measures / Warnow-Ascher	Most effective where people wait or stop. Combine ashtrays with short information posters, cleaning routines and monitoring of cigarette butt counts.
Litter washed or blown under railings, through gaps or from sloped promenades towards the river	Wind, runoff, stormwater or gravity-driven transport from adjacent public spaces	K.R.A.K.E. Trashstopper – Stormwater, Wind and Pathway Management	Useful where the pathway to the water is clear. Retained litter must remain accessible and be removed manually or with street-cleaning machines.
Repeated local littering at neglected riverbank or waterfront sites	Poor place quality, low visibility, limited maintenance, informal meeting points or local behaviour	Place-based Riverbank Improvement at Litter Hotspots	Focus on sites where litter is left locally. Not intended for areas where litter is mainly deposited by river flow, flooding or upstream transport.
Floating macro-litter before discharge to harbour, coastal waters or the sea	Riverine transport of floating macro-litter through narrow urban channels or river-mouth sections	SeaProtectorOne (SPO) – Floating Macro-litter Retention and Monitoring	Suitable where floating litter can be guided to one collection point. Requires investment, permits, maintenance and clear operational responsibilities.
Floating litter in sheltered harbour basins, marinas or calm urban water areas	Wind-driven accumulation or local water-side inputs in calm water areas	PortBins / Floating Surface Collectors in Harbour Basins	Use only where maintenance capacity is sufficient. Evaluate organic debris load, emptying frequency, biofouling and floating material remaining around the device.
Floating litter or litter trapped near reeds, banks and sheltered corners in safely navigable river sections	Local water circulation, wind transport, recreational use, boating, nearby public spaces or stormwater-related inputs	EkoKajak; PortBins; targeted awareness; local cleaning routines	Suitable where kayak access is safe and a local operator can coordinate equipment, safety, waste handling and recording. Results should be compared per route, trip duration and participant number.
Several actors are involved, but responsibilities for litter prevention and follow-up are unclear	Governance gap, unclear ownership, fragmented responsibilities or missing coordination	Local River Litter Action Plan / Stakeholder Agreement	Define priority hotspots, responsible actors, actions, budget, timeline and follow-up monitoring. Avoid broad plans without authority or implementation capacity.

Low public awareness of local litter pathways or dominant litter item categories

Behavioural or communication gap; people do not connect local littering with river and marine pollution

Targeted Awareness and Behaviour-change Activities at Riverfront Hotspots

Use site-specific messages linked to monitoring results. Awareness should support practical measures such as bins, ashtrays, reusable systems or cleaning routines.

7.4 Step 4: Check feasibility, maintenance needs and responsibilities

Before implementation, each measure should be checked against local feasibility criteria. Important criteria include available budget, staff capacity, permissions, maintenance requirements, technical constraints, safety, access, stakeholder acceptance and long-term responsibility. A measure should only be selected if it can realistically be operated and maintained over time.

This is particularly important for technical measures. Systems such as SeaProtectorOne or PortBins can remove floating litter, but they require installation, power supply, emptying, technical maintenance and clearly assigned responsibilities. Smaller infrastructure measures such as ashtrays, bins, signs or Trashstopper elements may be easier to install, but they also require regular cleaning and maintenance. Awareness activities may be low-cost, but they should be refreshed and linked to practical measures to remain effective.

The feasibility check should result in a clear decision on who is responsible for implementation, maintenance, communication, data collection and follow-up evaluation.

7.5 Step 5: Implement measures at priority sites

Measures should first be implemented at priority sites where the expected effect is highest. These may be sites with high litter abundance, dominant target litter item categories, repeated littering, clear litter sources or strong stakeholder support. Starting with priority sites allows cities to test practical implementation, learn from local experience and adjust the measure before wider roll-out.

Implementation should include clear documentation of the site, the selected measure, the installation date or start date, responsible actors, maintenance routines and communication activities. Where possible, simple before-after monitoring should be carried out to assess whether the measure leads to a reduction in litter abundance or target litter item categories.

7.6 Step 6: Monitor, evaluate and adapt

The final step is to evaluate whether implemented measures are effective. Evaluation should use the same indicators already applied in the monitoring programme, including total litter pieces, pieces per observation or hour for RFML surveys, pieces per meter or square meter for riverbank surveys, top 10 litter item categories, hotspot locations, cleaning status and changes after implementation.

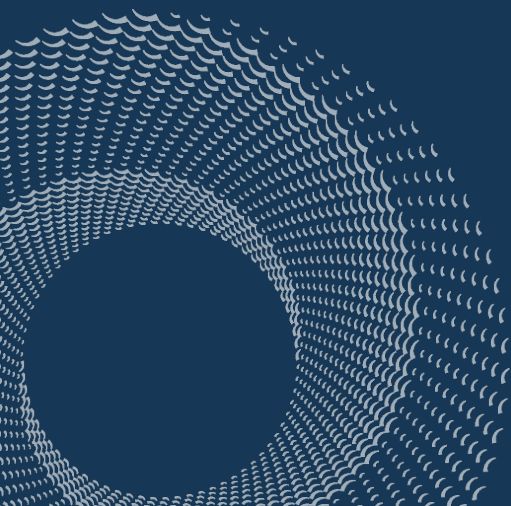
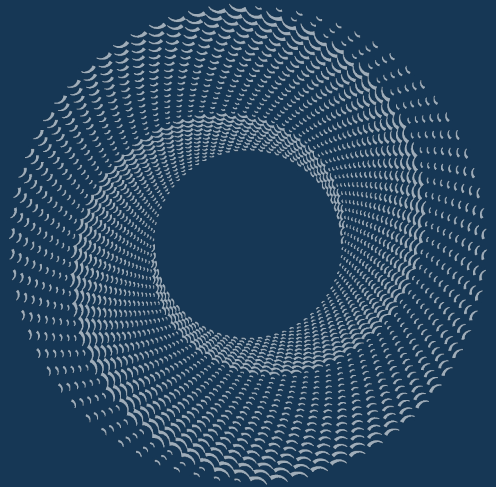
Evaluation should also consider whether the measure can be maintained, accepted and financed over time. More detailed cross-cutting evaluation criteria are provided in Chapter 8.

The results should be used to adapt the measure, improve implementation or select additional measures. This creates an adaptive management cycle in which monitoring, mitigation and stakeholder learning are connected.

Overall, the roadmap supports a practical sequence from evidence to action. Cities should begin by identifying priority hotspots and dominant litter item categories, assess likely sources and pathways, select suitable measures, check feasibility and responsibilities, implement measures at priority sites and evaluate their effectiveness over time. This approach allows mitigation to be targeted, realistic and adaptable to different Baltic river and city contexts.

8.

Monitoring, Evaluation and Adaptive Management



8. Monitoring, Evaluation and Adaptive Management

This chapter adds cross-cutting guidance on how evaluation should be interpreted across different measure types. Follow-up monitoring should use the same indicators applied during baseline monitoring wherever possible, including total litter piece counts, pieces per observation or hour for RFML surveys, pieces per meter or square meter for riverbank surveys, top litter item categories, hotspot locations and changes in specific target litter item categories.

However, evaluation should not focus only on litter reduction. The practical performance of a measure is equally important. Measures should also be assessed with regard to maintenance effort, operational reliability, stakeholder acceptance, implementation costs, required staff resources and long-term feasibility. A measure that reduces litter but cannot be maintained, financed or accepted by local actors may not be suitable for wider adoption.

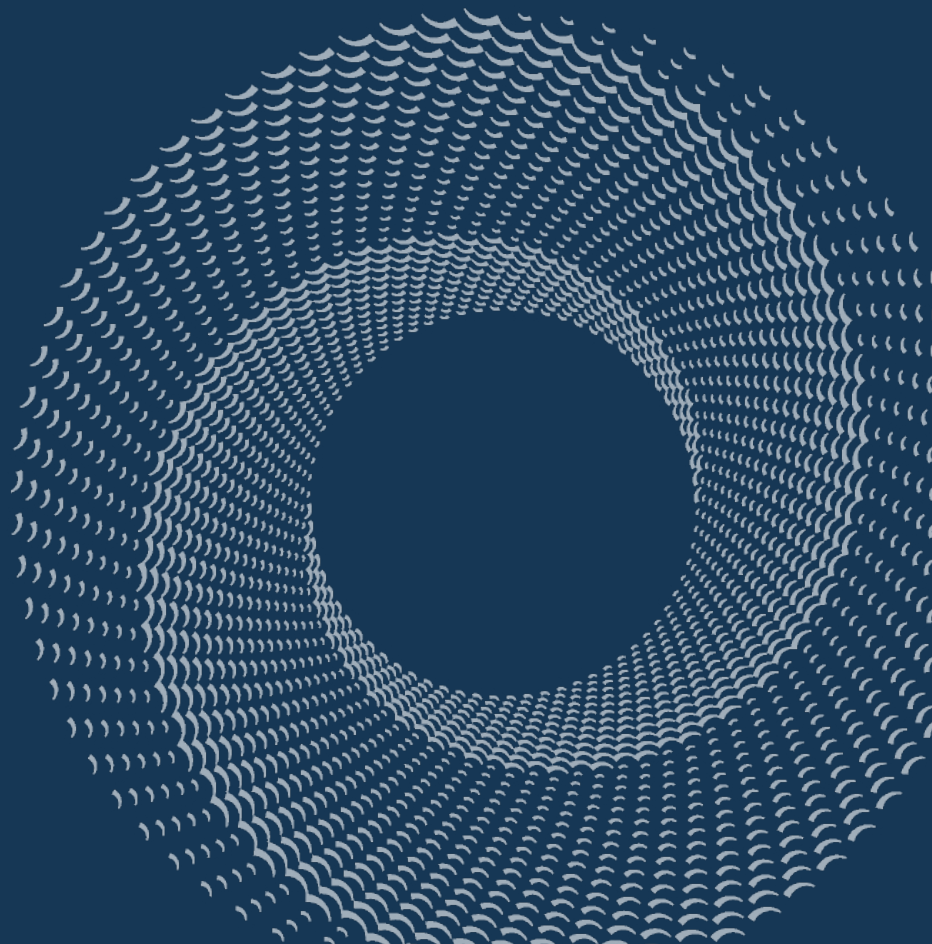
For technical retention or collection systems, evaluation should include operational uptime, emptying frequency, organic debris load, cleaning requirements, biofouling, safety, access and maintenance capacity. For source-prevention measures, such as reusable or deposit systems, evaluation should include participation of vendors, return rates, user acceptance and changes in the target litter item categories. For awareness or cigarette-butt measures, evaluation should focus on changes at the specific hotspot and on whether the communication remains visible, understandable and linked to practical disposal options.

For manual collection measures such as EkoKajak, evaluation should not rely only on annual collected mass, because results can be strongly influenced by route selection, trip frequency, trip duration and participant numbers. Results should therefore be interpreted together with route information, trip duration, number of participants, item counts, material categories and hotspot observations.

Adaptive management should be understood as a continuous learning process. Monitoring results should be reviewed regularly and discussed with relevant stakeholders. If measures do not achieve the intended outcome, they should be modified, relocated, combined with additional interventions or, where appropriate, replaced by more suitable options. The objective is not to identify one universally effective measure, but to develop combinations of measures that are appropriate for local conditions.

9.

Conclusions and Key Recommendations



9. Conclusions and Key Recommendations

This report provides a practical mitigation roadmap for reducing riverine litter in Baltic city contexts. It builds on monitoring results, spatial assessment, site observations, stakeholder knowledge and practical experience from the Circular Ocean-bound Plastic (COP) project. The roadmap is intended to support municipalities, local and regional authorities, harbour actors, waste management companies, NGOs, event organisers and other stakeholders in selecting, implementing and evaluating suitable mitigation measures.

The central conclusion is that riverine litter mitigation should be evidence-based, site-specific and realistic to maintain. No single measure will be suitable for all river systems or all litter problems. Measures should be selected according to hotspot locations, dominant litter item categories, likely sources and pathways, available budget, maintenance capacity and clearly assigned responsibilities.

Source prevention should be prioritised wherever possible because it reduces litter before it enters public spaces, riverbanks or the water. Measures such as reusable or deposit systems, event-related waste management, cigarette butt reduction and improved behaviour at local hotspots can directly reduce litter-prone items at source. However, source prevention alone is not sufficient where litter has already entered the environment or where specific pathways transport litter towards the river.

Hotspot and public-space management measures are important where littering repeatedly occurs at specific riverbank or waterfront sites. These measures can improve place quality, visibility, maintenance and waste infrastructure, and can help reduce local littering behaviour. Stormwater, wind and other pathway-related measures are useful where litter is already present in public space and would otherwise be washed or blown into the river. Removal and retention measures, such as technical collection systems, remain relevant where litter has already entered the water, but they should complement rather than replace prevention measures.

The measure profiles developed in this report show that practical mitigation requires careful matching between problem and measure. For example, reusable systems are most suitable for food-and-drink packaging, ashtrays are useful at smoking and waiting hotspots, Trashstopper elements address clear wind or runoff pathways, and technical systems such as SeaProtectorOne or PortBins require suitable hydraulic conditions. The effectiveness of each measure depends strongly on local context.

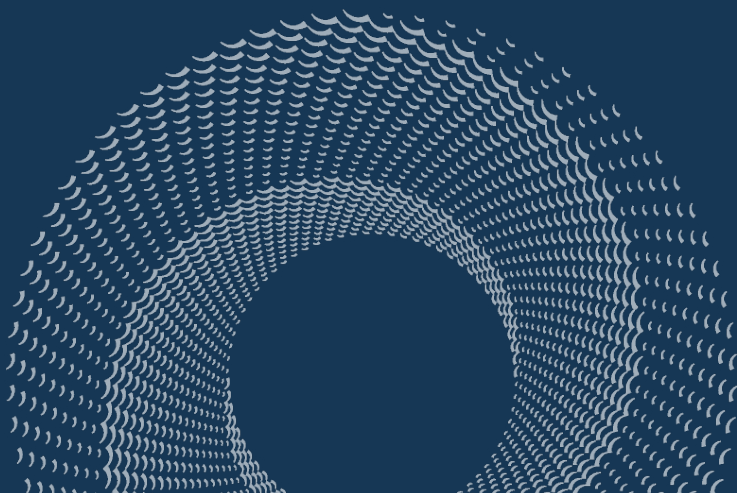
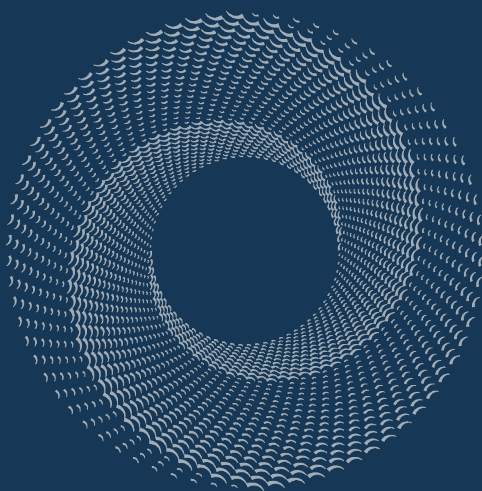
The most important recommendations are:

- Use monitoring and spatial assessment to identify priority hotspots and dominant litter item categories.
- Distinguish between local littering, pathway-related transport and litter already present in the water.
- Prioritise source-prevention measures wherever feasible.
- Select measures according to the specific problem, source, pathway and site context.
- Combine measures where needed, for example infrastructure, awareness, cleaning routines and stakeholder agreements.
- Assess feasibility before implementation, including cost, permits, access, maintenance and long-term responsibility.
- Do not install technical systems unless emptying, cleaning and maintenance can be secured.
- Use targeted awareness where it is linked to local hotspots, target groups and observed litter item categories.
- Involve relevant stakeholders early to clarify responsibilities and improve acceptance.
- Apply before-after monitoring to evaluate whether measures reduce litter abundance, hotspot intensity or target litter item categories.
- Review results regularly and adapt measures if they do not perform as expected.

A simple and well-maintained mitigation approach is more valuable than a complex set of measures that cannot be implemented or sustained. Cities should therefore start with priority sites, realistic measures and clear responsibilities, and then expand the approach once the first measures have been tested and evaluated.

By linking monitoring evidence, stakeholder knowledge, practical measure profiles and adaptive management, Baltic cities can move from general clean-up and awareness activities towards targeted, long-term and transferable riverine litter mitigation. The roadmap provides a flexible framework that can be adapted to different city contexts while supporting the shared objective of reducing litter inputs from urban rivers to the Baltic Sea.

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10. References

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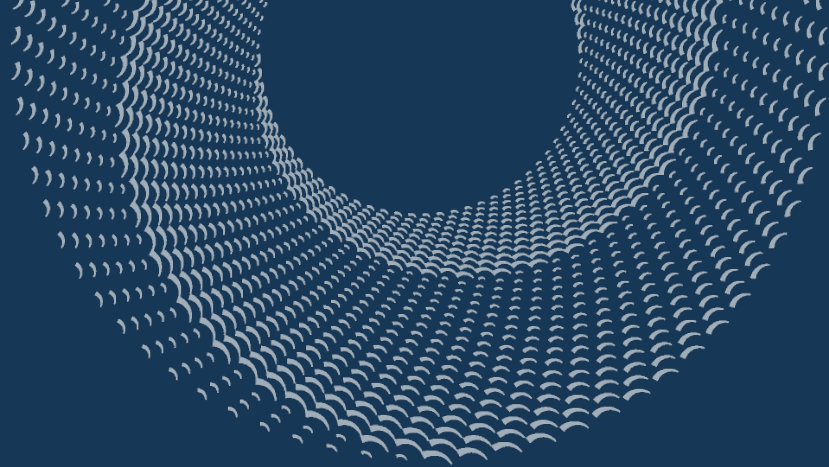
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