A synopsis of BLASTIC results

Final Report

Project	BLASTIC - Plastic waste pathways into the Baltic Sea
Work package	A synopsis of BLASTIC results - Final Report
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Contents

1. Executive Summary

This document is prepared within the BLASTIC project (Plastic waste pathways into the Baltic Sea). The project was supported by EU Interreg Central Baltic (2016-2018). The overall aim of the project was to demonstrate how plastic waste in urban areas finds its ways to the Baltic Sea and becomes marine litter.

Plastic litter is a prominent environmental problem as almost everywhere, not only in urban environments, you can find plastic debris in some form. Marine plastic litter is anthropogenic plastic waste that has been discharged into the coastal or marine environment. Marine plastic litter have been shown to have a great potential to harm marine wildlife and ecosystems. Its negative effects on the marine environment have prompted not only governments but also, environmental groups and citizens to take action.

The main outputs of the project were a new methodology and approach for mapping marine litter sources and pathways in combination with monitoring methods that has potential for being used in other regions and countries. Guidelines together with a list of identified and prioritized measures to reduce litter streams from land to sea was also produced to help municipalities in the work of creating local marine litter action plans. Knowledge bank was made available on the project website to increase knowledge and increase awareness on the environmental (plastic, micro plastics and hazardous substances) together with a socioeconomic report looking at impacts of marine litter.

This report includes excerpts from the different reports and documents that have been prepared by the BLASTIC project and its partners.

BLASTIC FACTS	
Lead Partner:	Keep Sweden Tidy
Partners:	Keep the Archipelago Tidy (Finland)
	Estonian Institute For Sustainable Development/Stockholm Environment Institute Tallinn Centre (Estonia)
	IVL Swedish Environmental Research Institute (Sweden)
	Foundation for Environmental Education Latvia (Latvia)
	Finnish Environment Institute (Finland)
	City of Turku (Finland)
	Tallinn City Government (Estonia)
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Partly financed by:	Central Baltic Interreg IVA Programme
Project Reports & tool:	Background report prepared by SEI Tallinn
	Checklist, methodology for mapping the sources and pathways of marine litter, prepared by SEI Tallinn
	Guidelines for the BLASTIC riverine plastic litter monitoring method, prepared IVL
	Overview of available methods to monitor marine plastic litter, prepared by IVL
	Results and experiences from the plastic litter monitoring in the BLASTIC pilot areas, prepared by IVL
	BLASTIC LMLAP guidelines document prepared by FEE Latvia
	Cost-effective combination of measures to reduce the loads of plastic marine litter in urban areas: Case Turku region, prepared by Finnish Environment Institute

2. Background and aim of BLASTIC

The accumulation of plastic waste in the oceans is a global, rapidly growing problem. The impacts of marine litter are environmental, economic and social. Marine litter knows no boundaries and can end up far from its original source. It threats the growth and reproduction of marine fauna from fish, marine mammals and seabirds to invertebrates due to entanglement and ingestion. The physical impacts are far reaching with loss of aesthetical values (i.e. tourism) and costs related to cleaning. Marine litter in Central Baltic constitutes of plastic (60%) and packaging material is the dominating fraction (MARLIN, 2013). This plastic litter will persist in the Baltic Sea and affect the ecosystem for hundreds of years. Besides physical harm, plastics may also leak hazardous substances to the marine environment and absorb organic pollutants. Land-based sources count for 80% of the marine litter. Littering, shortcomings in the sewage systems/storm water, waste management and cleaning routines are likely contributors. Urban areas are important sources and rivers believed to be major pathways of marine litter. The major cities around the Baltic Sea are coastal and/or situated by a river.

BLASTIC focused on how plastic waste in urban areas finds its ways to the Baltic Sea and becomes marine litter. The approach to achieve this was to collect information through mapping the potential sources and pathways of marine litter in urban areas and to introduce and design methods of field monitoring. Beach litter monitoring is more commonly practiced in many EU-countries, but methods for monitor floating litter or seabed litter are under development and not yet existing in any country. BLASTIC therefore combined the two methods (mapping of sources/pathways and field monitoring) as a new approach in order to tackle the issue of marine litter. The major sources and pathways of litter from land to sea can by using this approach be identified and provide useful information for the implementation of local, national and regional marine litter management strategies and actions in order to stop marine litter to enter the aquatic environment. Less marine plastic litter means less leakage of hazardous substances to the Baltic Sea.

3. Mapping marine plastic litter sources

The aim of the work was to develop a checklist for mapping the sources, flows and pathways of plastic litter as well as perform the mapping in pilot areas based on the developed checklist. A desktop study to compile a background overview for the development of the checklist and tool in excel format for mapping the sources and pathways of marine litter at the local level was also done.

The background report provided the basis for the checklist and defined the sources and pathways that was used. This list of sources and pathways of marine litter that was concluded in the background report was kept simple in order to be applicable by municipalities in the work with preparing and develop local marine litter action plans and making measures to reduce and avoid marine litter to reach the aquatic environment.

The methodological checklist was developed based on the background information gathered in the desktop study. The checklist allows for easy mapping of the potential sources, flows and sinks of plastic litter in specific urban areas. It includes the identification and understanding the local conditions that might influence the plastic litter streams in the regions, such as the geography of the region, the pressures that might influence the plastic litter streams in the urban areas/regions, decision support tree, waste management treatment description, policy documents, and other relevant issues. Finally, the mapping of each pilot area was performed based on the checklist developed together with the partner municipalities.

3.1. Summary of Background report

The desktop study was based on the information found in relevant literature on the sources and pathways of marine litter. The proposed classification was mainly based on the three studies, ARCADIS study Pilot project – plastic recycling cycle and marine environmental impact – Case-studies on the plastic cycle and its loopholes in the four European regional seas areas (2012), The Feasibility study – Litter Pathways to the Aquatic Environment by Sherrington and Darrah (2014) and Study on Land-Sourced Litter (LSL) In The Marine Environment by Mehlhart and Blepp (2012).

Sources are more relevant for different activities or economic sectors and locations where the littering takes place. Understanding the sources allows better planning and implementation of appropriate prevention measures. Information about related pathways gives a knowledge how the litter finds its way to the sea, which is important for the development of the monitoring and abatement measures.

The selection of the main land-based sources based on these assumptions and related to specific activities as well as possible pathways relevant for municipalities is presented in Table 1.

Table1. The main land-based sources related specific activities/locations, and pathways relevant for municipalities.

Sources	**Related activities and locations**	**Pathways**
Recreation and tourism	Littering - shoreline and recreation activities, such as events, visits, fishing, camping, picnics, etc. to the public and other beaches or by the riversides Smoking Boating and sailing (small harbours)	Human direct Wind Drains and rivers
General littering	Littering on streets, roadsides and public areas Smoking	Human direct Run-off from streets and roadsides Discharge via sewerage system (sewer overflows) Drains and rivers
Sewerage	Waste water collection and treatment system – discharges of treated and untreated waste water (including stormwater and sewer overflows)	Discharge via sewerage system including sewage overflows
Waste collection/treatment system	Municipal waste collection and treatment system (Plastic) packaging waste collection system Illegal dumping and flytipping Illegal dumpsites or poorly managed former landfills and existing waste treatment facilities close the coast or river banks	Human direct Wind Drains and rivers Run-off from waste collection and treatment areas
Cleaning of public spaces	Cleaning of streets and other public areas	Wind Drains and rivers

	Snow removal from streets and storage close to coast/river banks or dumping directly to the sea	Run-off from streets and public areas
Industry and commercial sector	Industrial areas – industrial discharges and spills (e.g. plastic resin pellets, particles, packaging waste) Construction and demolition sites Industrial and commercial waste management system Accidental losses during transport Activities at port territories – cargo handling and transport Waste management services at ports	Human direct Run-off from industrial territories or from port territory Wind Drains and rivers
Agriculture	Use of agricultural film	Wind Drains and rivers

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3.2. Checklist of mapping the potential sources of marine litter and prioritization tool

The checklist allows for easy mapping of the sources and pathways of marine litter in municipalities and assessing the potential for marine litter generation from the listed sources and pathways. It includes the identification and understanding of the local conditions that might influence the litter streams in the municipal area.

The checklist is divided into topical areas based on the selection of sources and pathways that may be the most relevant for municipalities. It has been taken into consideration that the sources and pathways are relevant in the context of developing the marine litter monitoring programme and action plan (measures) for reducing marine litter. Sources are more relevant for different activities within the municipality's responsibility area (e.g. waste management, street cleaning, waste water treatment) or economic activities (tourism and recreation, industrial and commercial activities, agriculture) where the litter is generated. Information about related pathways provides knowledge on how the litter from each source finds its way to the sea, which is important for the development of the monitoring and abatement measures.

The aim of the prioritisation is to choose the most critical areas that need to be addressed in the local action plan for reducing marine litter. This prioritisation tool is recommended, but any other method may be used if such is in place in the municipality.

Find the whole checklist together with prioritization tool at www.blastic.eu

4. Plastic litter monitoring in the aquatic environment

The monitoring of marine plastic litter is important not only in order to acquire knowledge about know how much plastic is already in the marine environment, but it is also important in order to know how much plastic is being discharged into the oceans. The idea within BLASTIC was to develop a cost efficient, flexible and scalable method for monitoring of riverine plastic discharge. The methodology for riverine litter monitoring was developed and tested at four different pilot areas, Södertälje Sweden, Tallinn Estonia, Turku and Vantaa in Finland, within the BLASTIC project.

The amounts of retrieved marine litter during the development of the riverine plastic litter monitoring method was below the target of around 100 kg that was stated in the application. But the use of the methodology on a longer timeline would support and ultimately contribute to the reduction of marine plastic litter entering the aquatic environment.

4.1. Summary of guidelines for the riverine plastic litter monitoring method

The method of floating litter booms was chosen as litter booms are flexible in both size and positioning and that they collect the floating litter which then can be quantified, categorised and analysed, which is considered to be a major strength of this method. It was designed with the intention of producing high quality, robust data sets while being flexible in regard to the purpose of the monitoring.

While the litter boom monitoring method is relatively low tech and doesn't require much experience from the personnel handling the booms and retrieving the captured litter, there are still some variables that need to be considered if the monitoring is to produce a high-quality data set. If the results are to be compared between e.g. different repeats, seasons and other sites then it's important to calculate the relative results (e.g. kg/m^3). To obtain good relative results frequent samplings and multiple flowrate measurement are recommended. The flowrate measurements might be the most complicated part of the monitoring, however depending on the purpose of the monitoring the flowrate measurements can be scaled accordingly.

Before monitoring with litter booms is considered it is important to examine if there are sites with suitable physical conditions where the monitoring can be performed, as this is crucial for successful measurements with the floating litter booms. Based on the experiences from the monitoring in the pilot areas the conclusion by the project members is that the floating litter boom methodology is suitable in narrow rivers with a continuous water flow; however, in wide rivers river this monitoring method might not be the best option. Being able to block the entire width of the river is recommended, find sites that are easily accessed and check with the relevant authorities if monitoring is allowed at the site.

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4.2. Summary of the results and experiences from the plastic litter monitoring

The project partners had different experiences and the floating litter booms worked better in some sites than others. The physical conditions of the monitoring site are of great importance when monitoring with floating litter booms. All monitoring was in some way affected by either the width of the river, weather conditions such as wind and/or water flow rate/direction. Based on the experiences from the monitoring in the pilot areas the conclusion by the project members is that the floating litter boom methodology is suitable in narrow rivers with a continuous water flow. However, in wide rivers river this monitoring method might not be suitable.

4.2.1. Pre-monitoring recommendations

Before starting to monitor in a specific area there are several factors that needs to be considered when defining the monitoring sites in order to succeed with the monitoring. The physical conditions of a monitoring site are of great importance when monitoring with floating litter booms. The monitoring is affected by the width of the river, weather conditions such as wind and/or water flow rate/direction.

The recommendations for site selection are:

- A site where relevant authorities allows monitoring.
- A site with minimal influence of the tidal currents or counter currents as these can push away already captured litter and compromise the moorings of the boom. Examine the flow pattern and speed of the water before performing any monitoring. If the flowrate is too slow or the flow direction is unstable then another site or method should be considered.
- The method (boom/net collection) is more suitable for narrow rivers. Chose a narrow river or a site that is located at a narrow part of the river.
- A site where a large part (preferably the entire width) of the river can be blocked by the boom. If this is not possible due to e.g. boat traffic, then it's recommended to sample both sides of the river. The more of the river that is blocked the more reliable results can be obtained.
- A site where the litter is not exposed to wind, as captured litter can be blown away and the shape of the litter boom can be changed in a negative way.
- The site selection also could depend on available information on potential litter emitters or convenience of the sampling locations.
- A site with easy access to simplify both deployment/retrieval of the boom and litter collection.
- A site where at least one fixed mooring point is available is recommended.

4.2.2. During-monitoring recommendations

While performing the monitoring there are several things to consider in order to simplify the monitoring and in order to save as much time as possible when preparing and deploying/retrieving the booms.

- Prepare as much as possible on land (if the boom is to be deployed off shore). It is more time efficient to attach net curtains, grapnels, marking buoys etc. on land where space is available.
- A minimum of two persons are recommended to prepare and handle the booms. If deployed and retrieved with a boat then three persons are recommended: two to handle the booms and a third person maneuverer the boat.
- If anchors are be used to moor the booms to the river bed, make sure they are securely fastened to the bottom. If an anchor is not secure then both winds and currents can change the position of the boom. Booms have to be fixed and set-up in a proper way (preferably by anchoring the middle of the boom as well).
- Investigate the upcoming weather conditions. Strong winds increase the risk of changing the shape and position of the booms and litter can be blown away from the boom. Rain and other precipitation can affect the results if there is an increased flow of storm water. Rough weather might also limit the possibility to deploy and retrieve the booms.
- Timing: periods with heavy water discharge (early spring an autumn) are associated with much organic material in the water. Leaves, branches and other organic material will get trapped in the boom and might clog net curtains. This could overflow the litter booms and it can result in difficulties to separate the litter from the organic material. However, frequent litter collection from the booms can reduce this issue.
- Use a landing net to capture floating litter
- When retrieving the booms from the water one must be careful that litter doesn't come loose and float away with the current. If a net curtain is used it is preferably folded over the boom to capture the litter.

4.2.3. Post-monitoring recommendations

After the monitoring has been performed there are a few things to consider when quantifying data. It is very important to separate absolute and relative results. A high-quality data set will be more comparable between repeats, seasons and other sites. In addition, we would like to assess in real terms, what is the contribution of different sources to riverine litter. Doing this with compositional data alone and acquiring any degree of accuracy is impossible as it is not standardized in any way to litter abundance. For this reason, the preferred method is to characterize, weigh and count the litter sampled in the river; use the protocol developed in BLASTIC when doing this. The litter should be dried before weighing, and any significant silt or algae deposits should be removed.

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5. Guidelines of Local Marine Litter Action Plan

To ensure that the process of developing local marine litter action plans in the municipalities is based on similar methodology and that knowledge for further decision making is available the BLASITC project produced guidelines together with a list of identified and prioritized measures to reduce litter streams from land.

The guidelines were done based on similarities and outcomes of the individual LMLAP documents produced from the 4 different pilot areas Södertälje in Sweden, Turku in Finland, Tallinn in Estonia and Liepaja in Latvia. It contains 38 best practice of targeted actions introduced in European cities and beyond. It also provides explanation of necessity for focusing on LMLAP at a local level.

Despite being one region, there are additional factors that should be taken into account when starting work on tackling marine litter issues and elaboration or implementation of Local Marine Litter Action Plans for municipalities. Main factors we identified were:

- Waste management policy in different countries sets different roles for municipalities. Therefore, not always the municipalities have power to take actions on individual level as the regulations might differ with decision making and management decisions being placed in different levels (regional or national)

- Level of advancement with regards to previous work in the marine litter area of municipalities also differs. There are some municipalities with previous experience and ambitious activities already implemented.

- Investment priorities in waste water management and waste management infrastructure also differs from country to country. In order to successfully tackle marine litter issues several prerequisites must be met like adequate and up-to-date systems of communal waste water treatment and waste management (accessibility and density of receptacles etc.). Unfortunately, that is still not always the case around the Baltic Sea where Finland, Denmark, Sweden and Germany are in more advanced situation in comparison to Baltic States, Poland and Russia.

- Availability of data for decision making – when using the mapping tool in pilot areas, it was identified that there is still a lack of available sociological and research data with respect to the marine litter situation.

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6. Knowledge base on the impact of marine plastic litter

In the project extensive information was gather on marine plastic litter and its impacts on marine life, and economical costs. This information was condensed to a knowledge bank that was made available to stakeholders and the general public through the BLASTIC website. The gathered knowledge was also used by the project partners in several different ways in order to raise awareness regarding marine litter and its impacts, for example infographics was produced and displayed during monitoring, public events like litter installations and on social media.

A report looking at a cost-effective combination of measures to reduce the loads of plastic marine litter in urban areas was also produced. In the report the Turku region was used as a case area and the marine litter data that the study is based on was collected by beach litter surveys on Ruisssalo beach in Turku.

6.1. Summary of Cost-effective combination of measures to reduce the loads of plastic marine litter in urban areas: Case Turku region

The objective of this study was to define a cost-effective combination of marine litter reduction measures to reduce the loads of plastic marine litter in Turku area. Turku is a city on the southwest coast of Finland, with approximately 189 000 inhabitants and a long coastline. The river Aura divides the city centre into two parts which are connected by several bridges. Turku also attracts a lot of coastal tourism especially in summer and hosts several summer festivals that take place close to the river or coast. The marine litter data that this study is based on, was collected by beach litter surveys on Ruissalo beach in Turku. It is a popular beach located 3 km from Turku center, and it is also a destination of marine litter from nearby shipping routes and urban runoff including stormwater and river runoff.

This study shows that marine litter education or awareness campaigns are among the most effective ways to reduce litter. It is backed up by the fact that such campaigns can reduce litter production at the source and thus the impacts of such campaigns are not affected by litter reduction measures that take place later on the litter pathway. Further, well planned litter education or awareness campaigns can reduce multiple litter types, whereas for example bans or taxes on certain products such as plastic bags or cigarettes can be targeted to reduce certain types of litter[1].

According to the results, debris interception devices and improved waste management in Ruissalo are effective measures to reduce plastic marine litter. However, as already stated, the littering and litter reduction that take place in Ruissalo beach, where the beach litter surveys were conducted, is emphasized in this study. If we want to study the measures to reduce overall marine litter, the reduction measures that target Ruissalo beach are likely not as effective as the results imply. Therefore, it could be fruitful to study litter sources independently or by excluding the littering that takes place in Ruissalo and its vicinity. Albeit litter found on beaches has often been used as an indicator of overall marine litter, it may overemphasize the given beach and its vicinity as a litter source, especially when assessing the cost effectiveness of marine litter reduction measures.

In future research, cost effectiveness analysis could take better into account the temporal scope of different measures as well as the probabilities that reduction goals are met for certain litter types could

[1] Oosterhuis, F., Papyrakis, E., Boteler, B. 2014. Economic instruments and marine litter control. Ocean & Coastal Management 102: p. 47-54.

maybe be integrated in the analysis as input parameters in the optimization. Furthermore, some of the measures, such as those related to sewerage system improvements, likely have impacts beyond marine litter reduction which are not included in our optimization procedure. These impacts should be taken into account in the analysis since their inclusion would affect the measure costs allocated to litter removal.

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7. Conclusions

The ocean is rapidly filling up with plastic products but with all the attention this environmental problem has got during the last years, the world has woken up and realised that it is time for action. Many initiatives have been taken, both on a local level as well as global agreements and on every level in between. Regional action plans of marine litter and new EU directives has been developed and already implemented in some cases. When the idea of the BLASTIC project came up, municipalities was chosen as stakeholders because preventive measures against marine litter in the municipalities has a potential to have large effect. Land-based litter is largely generated in cities and in cities we often find waterways connecting to the sea.

The project has shown that by introducing the methodology in the municipalities, it enables knowledge acquisition and raises awareness of the problem. It increases the understanding in employees regarding sources, pathways and underlying causes for land-based litter entering the marine environment. It also increases the knowledge of many different measures. The municipalities that has taken part in the project has also highlighted the positive effect when staff (and decision makers) at a local level meet, which makes it possible to share knowledge and experience. The results from the mapping and measure prioritisation will be a basis for future measures both in the short and long term.

8. Recommendations to municipalities

The tool and the guideline are intended to facilitate the process of the development of a Local Marine Litter Action Plan in the municipality. Before starting the work there are a few recommendations on the way:

1) Find out if your municipality already has an ongoing preventive work against general littering. What is in the local waste plan? When should the waste plan be updated? Coordination may be achieved and contribute to more cost-effective measures.

2) The method is based on gathering knowledge and experience from employees at a local level who can answer the questions in the mapping tool. Read through the questions and think broadly - who has knowledge, who is responsible? It should preferably cover all potential litter sources. It is a benefit to invite both employees that work practically and those who work more theoretically. Ask yourself if decision makers / politicians need to be invited to the workshop. Even decision makers if possible. It could also be valuable to think about how the municipality work between the administrations and appoint a responsible project manager.

3) Find a good balance between the number of participants and the time that people can spend on the work.

4) Remember that the action list is not meant to be a complete list of all solutions available. It is intended to inspire the municipality to be able to find solutions that are suited to their own conditions.

5) If your municipality do not have the resources or suitable conditions for monitoring marine litter in riverine waters, land-based monitoring of litter on city streets or in parks/squares can be considered and not already done. It does not give all the information you get when performing monitoring in riverine water, but it can provide a picture of litter hot-spots, number of litter and from which categories as well as trends over time.