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An Assessment of the Scope and Effectiveness of Soft Measures to Handle Plastic Pollution in the Baltic Sea Region

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Abstract

As a semi-closed sea, the Baltic Sea is especially vulnerable to human activities and pressures, such as tourism, industry, and increasing population size, which is also associated with increasing levels of plastic pollution. Apart from legal frameworks and technical solutions (e.g., waste management infrastructure), one of the means to address the problem is the use of soft measures, understood as non-compulsory, non-infrastructure, low-investment and low-effort measures that can be implemented in a way that is less complicated and costly than technical solutions. Based on the perceived need to further understand this matter, this paper discusses the role of soft measures in tackling plastic pollution. This paper combines a multi-methods approach consisting of a review of the literature on the topic, complemented by concrete examples of soft measures from different countries across the Baltic region. Drawing from the experiences gathered, it provides some suggestions aiming to maximise the impacts of soft measures and encourage their use as one of the tools that can be deployed to handle plastic pollution in the Baltic Sea Region and beyond.

1. Introduction: plastic pollution in the Baltic Sea Region

Global trends project that emissions of plastic waste into aquatic ecosystems have nearly tripled, from some 9-14 million tons per year in 2016 to 23-37 million tons per year by 2040 (UNEP, 2021). Marine litter and plastics present a serious threat to all maritime life and indirectly affect human health. Plastic pollution can be classified as macroplastic (large pieces of plastic materials), microplastic (< 5 mm), and nanoplastic particles (size < 1 µm) (Li et al. 2021). The source of microplastic particles can be from direct terrestrial surface discharge, for example, of treated wastewaters as well as from the disintegration of larger plastic particles. Plastic pollution also multiplies climate change and other stressors, leading to a loss of resilience to extreme events. The economic costs of marine plastic pollution and cleaning with respect to its impact on tourism, fisheries, and aquaculture make a serious impact on the livelihoods of coastal communities (Carney Almroth and Eggert, 2019).

The main sources of marine litter and plastic pollution are land-based. The report on marine litter in Europe presents an integrated assessment of marine litter and plastics from source to sea (ETC/ICM, 2022). The pathways and degradation of plastics as well as the behaviour of microplastics in marine environments have been reported in numerous publications (Andrady, 2011; Hidalgo-Ruz et al., 2012; Xu et al., 2020, Vivekanand et al., 2021).

The Baltic Sea is an epicontinental sea with a drainage area of almost 2 million km² and more than 84 million inhabitants. The unique geographical and environmental characteristics of the Baltic Sea, including its shallow depth, limited water exchange and complex currents, pose challenges for the clean-up and remediation of plastic pollution. Due to low salinity, fluctuating water temperatures, and limited oxygen levels in deeper areas, the marine environment is particularly vulnerable to the effects of plastic pollution, and its effects can be observed in many parts of the Baltic Sea (Christensen et al., 2023). Plastic pollution has been found to be present in the surface waters of the Baltic Sea, as well as in its sediments. In addition, plastic debris can be found in the stomachs of fish and other marine organisms (Białowas et al., 2022). The sources of plastic pollution in the Baltic Sea are complex and include direct discharges from land-based sources, such as sewage outfalls, wastewater treatment plants, and landfill sites (Hogland et al., 2014; Schernewski et al., 2021). In addition, plastic pollution is also thought to be the result of the accumulation of plastic items that are lost or discarded at sea. These discarded items include fishing gear, shipping containers, and packaging materials (Mazurkiewicz et al., 2022).

The Regional Action Plan for Marine Litter in the Baltic Sea was adopted by the Baltic Marine Environment Protection Commission (HELCOM, 2015). One of the concerns expressed by the authors of the Action Plan regards the very slowly degradable marine plastics that transform

into micro fragments and nanoparticles. The Plan foresees regional and voluntary national actions to reduce the input and presence of plastics in the Baltic Sea.

In order to address the issue of plastic pollution in the Baltic Sea, a number of initiatives have been implemented. These include efforts to reduce plastic waste at its source, as well as initiatives aimed at increasing public awareness about the issue (Van Oosterhout et al., 2022). In addition, various clean-up campaigns have been launched to remove plastic debris from land and sea (Frantzi et al., 2021; Khedr et al., 2021). Finally, legislative measures have been introduced in some countries in the region to regulate the use of certain types of plastic and to encourage the use of more sustainable alternatives (Da Costa et al., 2020). Despite these trends, plastic pollution still poses a major threat to the Baltic Sea and urgent measures are needed in order to address it (Białowas et al., 2022; Lau et al., 2020).

The research to find suitable solutions and measures to reduce the environmental impact of plastic pollution and plastic waste has intensified significantly especially in the last decade.

According to the Web of Science (WoS) database, the number of publications in the period 2000-2023 show a rather sharp increase (Fig. 1). The search was carried out by using the terms plastic waste OR plastic pollution AND solutions AND measures. A total of 4,243 publications from the years 2000-2023 were found in the WoS Core Collection database accessed on 21.09.2023, of which 4,159 are in English.

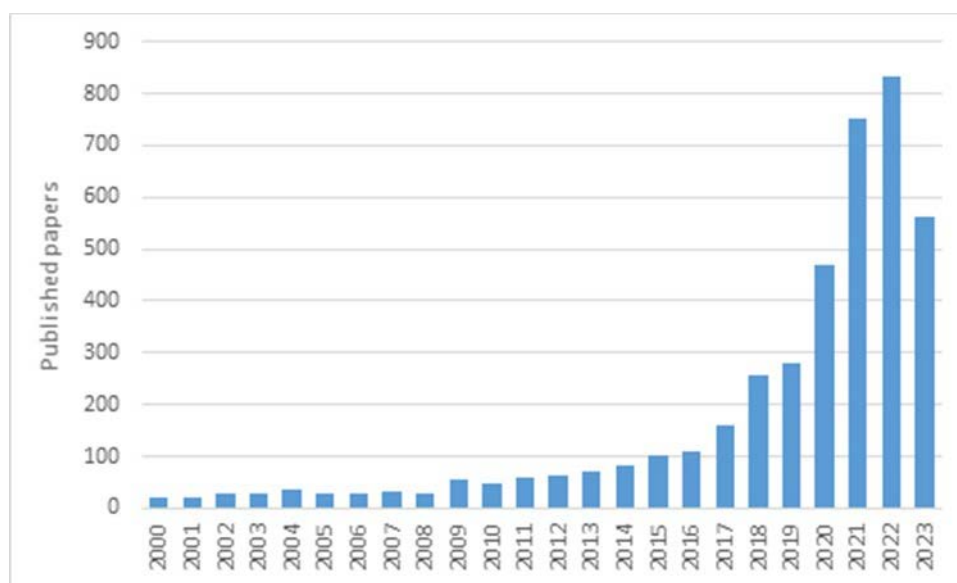


Figure 1. Number of publications related to solutions and measures to plastic waste and pollution in the period 2000-2023.

The literature reviews revealed gaps of soft measures; in other words, research needs to be done. Soft measures are defined here as non-compulsory, non-infrastructure, low-investment and low-effort measures that can be implemented easily (the so-called "low-hanging fruits") for the reduction of plastic pollution in municipal entities and businesses. They contrast with hard measures, which include laws, regulations, penalties, bans and taxes, as well as technical measures such as infrastructure for solid waste management (e.g., waste recycling). Soft measures refer to social and behavioural change and comprise the reduction of single-use plastics, recycling plastics when possible, encouraging the use of alternative materials/plastics, and providing education/communication processes to encourage a shift towards zero plastic emissions.

The aim of this study is to identify and assess soft measures for plastic prevention and reduction in the Baltic Sea Region countries and provide recommendations for effective schemes that turn knowledge into action.

2. The role of soft measures in handling plastic pollution in the Baltic Sea Region

Combating the plastic pollution problem requires a multifaceted approach that goes beyond hard/technical measures alone. Several studies (Leal et al., 2019; Rhein and Schmid, 2020; Miguel et al., 2024) have indicated that focusing only on technical measures and relying on legally binding recycling targets is not enough to promote a circular plastic system and solve the problem of plastic pollution. While technical solutions, including recycling, play a crucial role in managing end-of-life plastic waste, a comprehensive approach should also address upstream issues such as plastic production/design and consumption and encourage plastic prevention, awareness, and behavioural issues. Combining legal, technical, and soft measures/strategies provides a more holistic and effective solution to the plastic waste problem.

Integrating soft measures such as prevention and awareness-raising efforts is crucial for several reasons:

- **Behavioural Change:** Technical measures alone may not be sufficient if individuals, businesses, and communities continue to engage in unsustainable practices. Raising awareness helps instigate behavioural changes by informing people about the environmental impact of plastic waste and encouraging responsible consumption habits.
- **Community Engagement:** Awareness campaigns foster community engagement and participation in plastic waste reduction initiatives. When local communities are informed and actively involved, they are more likely to adopt sustainable practices, participate in recycling programmes, and contribute to the overall success of waste management efforts.
- **Policy Support:** Public awareness creates a supportive environment for policymakers to implement and enforce regulations to reduce plastic waste. Governments are more likely to pass and enforce legislation when there is a well-informed and concerned public demanding action.
- **Education and Empowerment:** Prevention measures are more effective when accompanied by education. Informing people about the life cycle of plastic, its environmental consequences, and alternative sustainable choices empowers individuals to make informed decisions that contribute to waste reduction.
- **Lifestyle Changes:** Awareness campaigns can inspire broader lifestyle changes, such as reducing single-use plastic consumption, choosing eco-friendly alternatives, and embracing a more sustainable way of living. These lifestyle changes, when adopted by a significant portion of the population, can have a substantial impact on overall plastic waste generation.
- **Market Forces:** Increased awareness can influence market demand, encouraging businesses to adopt environmentally friendly practices and develop sustainable products. Consumer preferences for plastic-free or less plastic options can drive the market towards more sustainable solutions, accelerating the shift away from plastic.
- **Long-Term Cultural Change:** Sustainable practices need to become ingrained in culture to achieve long-term success. Soft measures contribute to the cultural shift needed to prioritise environmental sustainability, making it a societal norm to reduce, reuse, and recycle.

While technical measures are vital for managing plastic waste, prevention and awareness-raising efforts play a complementary role by addressing the root causes of the issue. By changing behaviours, educating the public, and creating a supportive environment for sustainable practices, the prevention and awareness efforts contribute to a more comprehensive and effective approach for tackling the plastic waste/pollution problem.

In order to achieve a successful move into a circular economy within the Baltic Sea region and eventually globally, approaches that advertise the benefits of the circular economy need to be considered. Most importantly, it is necessary to carefully convey the risks of plastic packaging consumption that lead to the creation of plastic waste and plastic pollution in the Baltic Sea. Single-use plastics (SUP), like carrier bags, beverage bottles, coffee cups, and packaging, are a big part of the issue.

One of the important soft measures to cope with SUPs are campaigns. Human needs and preferences must be understood and evaluated when creating campaigns to spread awareness of the issue surrounding plastic waste. Campaigns created to combat this issue need to motivate the target audience to take the opportunity/challenge within the campaign to change their behaviour. This can be done by using six effective strategies: customising the campaign to fit the specific audience; using social norms to promote good behaviour since people imitate each other; specifying an action to be done; catalysing commitments to challenge people to make further commitments; tapping into positive emotions; and showing the topic matters by providing results of the effects of the issue, however small.

In order to illustrate the role of these measures, 15 campaigns running successfully within the BSR region were identified (Table 1).

Table 1. Best campaigns that were successful globally and within the Baltic Region

Campaign	Distribution	Results of Campaign
1. #UnplasticThePlanet	Global	The campaign website indicates that nearly 100,000 actions were taken for this campaign between 2019 and 2020.
2. Be ready to change	National	The video has been seen nearly 5.5 million times on YouTube as of 15 June 2020.
3. Plastic Free July	Global	In July 2019, an estimated 250 million people, in 177 countries, took part in the challenge: 29 percent of the people were aware of the campaign; almost half of those took part in 2018; and 90 percent of the participants made changes that have become habits or a way of life.
4. Open your eyes	Global	The video on YouTube has been seen more than 267,000 times, and the same video on the Plastic Pollution Coalition's Facebook page has been viewed 1.2 million times between 2016 and 2020.
5. Ridiculous Packaging	Global	1,868,122 people had signed the petition as of 15 June 2020. Many people had posted using the hashtag #ridiculouspackaging and #breakfreefromplastic but it was difficult to ascertain a number
6. Stop Sucking	Global	"Our organic #StopSucking content saw a social reach of 74 million with an equivalent media spend of \$515k...We saw commitment from people too: the #StopSucking work earned over 50,000 pledges from people across the country to stop using plastic straws. These pledges resulted in 29.21 million plastic straws kept out of the waste stream based on average use."
7. Unforgettable Bag	National	As of November 2018, more than one million unforgettable bags have been sold, and customers on average have reused their bags up to four times since the beginning of the campaign.
8. Break Up with Plastic	Global	The Caribbean video has been seen more than 3,000 times on YouTube as of 15 June 2020. The Spanish language version of the video has been seen nearly 50,000 times. Most others have been viewed hundreds of times.
9. Nix the 6	Global	Social media posts received a little over 1,000 engagements. The pledge had 5,195 signatories as of 12 July 2020. Results/traffic of other assets is unknown.
10. Pass on Plastic	Global	47.8 million people were made aware of the campaign to #PassOnPlastic.
11. Planet or Plastic	Global	As of 5 June 2020, commitments had been made to avoid using more than 333 million pieces of plastic (National Geographic 2020).
12. Refuse Disposable Plastics	Global	The celebrity videos on YouTube have received engagement of around 10,000 views at the top end. Other results are not known.
13. One Bag One Habit	National/Sweden	The profits from the 2017/2018 business year came to SEK 2.1 million (USD 230,000). The reduction in plastic bags used over time is not known.
14. Beat Plastic Pollution	Global	4.2 million people had watched the music video (in Hindi) as of 25 June 2020.

15. A Million Acts of Blue for a Plastic-free Future	Global	More than 10,000 people had viewed the A Million Acts of Blue video on YouTube as of 13 July 2020.
16. Cukmens (Pig Man)	National/ Latvia	Regular activities informing society on plastic pollution risks and the need to change behaviour <u>Cūkmens - Sākums (cukmens.lv)</u>

The goal of these campaigns was to channel positive emotions from their audience (pride, hope, optimism, etc.) instead of negative emotions (fear, guilt, shame, etc.), which further burdens the general public and lead to little or no action because there is no associated “feel good” factor. Using humour is also likely to make people view a campaign multiple times and share its contents, which spreads the information further and eventually leads to some action. The main target group of most of the campaigns is youth. Most campaigns think that convincing the targeted audience to be altruistic is the right approach, when in reality the encouragement, challenge, empowerment, and suggestion of personable solutions to your audience is much more effective since people tend to think of themselves first. So, by making the problem more personal, people are more willing to take up the challenge. Overall, if people feel that the scope of a campaign is attainable at an individual level, they are more likely to accept the challenge posed by the campaign and practise the provided resolutions towards change.

3.Methods

3.1 Data collection

Data collection for this study involved gathering case studies on soft measures to handle plastic pollution. Soft measures, as defined in this study, refer to non-compulsory, non-infrastructure, low-investment, and low-effort strategies that can be easily implemented to reduce plastic pollution in municipal entities and businesses. These measures are often referred to as "low hanging fruits" due to their relative ease of implementation. The case studies were sought to provide insights into successful initiatives and practices that have been implemented to address plastic pollution at the local/municipal level. The focus was on identifying measures that are practical and feasible and that have shown positive outcomes in mitigating the impacts of plastic waste.

The data collection process involved accessing relevant literature sources such as academic journals, reports, and publications that discussed soft measures and their effectiveness in combating plastic pollution. Additionally, local websites specific to Baltic Sea countries were explored to gather information on ongoing initiatives, projects, and campaigns related to plastic waste reduction. To ensure the comprehensiveness of the data, case studies were collected in both English and the local languages. In cases where the data was available only in the local languages, translation was performed to make it accessible for analysis.

The following parameters were collected: title of the measure, spatial extension, type of plastic item targeted, stakeholder groups addressed, and a short description of the measure (Table 2).

Table 2. Data collection parameters.

Title of the measure	Spatial extension	Type of plastic item targeted	Stakeholder groups addressed	Barriers/challenges
Example	Municipality, National, Regional OR International	Single use plastics, plastic packaging, other plastics, cigarette butts, fishing and aquaculture gear OR all plastic litter	General public, school children, businesses, municipality workers, policy makers, households	barriers and challenges found during implementation of the measure

Through the data collection process, the study aimed to capture a diverse range of soft measures implemented in European countries, with a particular focus on the Baltic Sea region. However, due to potential limitations in the availability of comprehensive data from literature and websites, an additional step was taken to enhance the data collection process. Municipalities in the Baltic Sea region were contacted for interviews to gather information on best practices of soft measures implemented in their respective regions. The interviews were conducted to directly gather detailed insights from municipalities, specifically targeting those that had successfully developed and implemented solutions to tackle plastic pollution.

3.2. Analysis

The analysis involved evaluating the number of countries surveyed, assessing the number of case studies per country, and categorising the soft measures into different types. For the categorisation, a classification of soft measures for tackling plastic pollution was developed following the classification by Chen, 2015 (Table 4). The analysis aimed to identify the most commonly used types of measures and the types of plastic items that were most frequently targeted. The categorised best practices were analysed concerning the challenges or barriers faced in the implementation process, including financial constraints, lack of public support,

inadequate infrastructure, and the possibility of replicability. Additionally, opportunities to overcome existing barriers were suggested.

The findings will contribute to understanding successful approaches in preventing and reducing plastic pollution and providing recommendations for future interventions in the Baltic Sea region and beyond.

Table 4 Classification of soft measures.

Type of measure	Definition
Prevention	Preventive measures focus on avoiding the generation of plastic waste. They include measures that encourage the reduction of plastic consumption by using alternatives or promoting the reuse of plastic items whenever possible.
Mitigation	Mitigating measures inform and steer (information, labels and instructions, promoting social norms, enforcement) individuals and businesses to adopt more sustainable behaviours regarding plastic usage and waste management practices.
Removal	Removing measures focus on actively removing existing plastic waste from the environment and engaging individuals, communities, and organisations in these efforts. This also raises awareness about the environmental impact of plastic pollution and fosters a sense of responsibility and stewardship among these groups.
Education and Behaviour-Change	Education and behaviour-changing measures seek to raise awareness and knowledge to influence behaviour so that people engage in activities that help prevent and reduce plastic waste. Behaviour-changing measures are cross-cutting and aid the development and implementation of the above-mentioned three types of measures.

4. Results and Discussion

4.1. Collection and characterisation of soft measures for the prevention and reduction of single used plastic in BSR

All measures implemented in the BSR municipalities were first related to the prevention of plastic use through the increased reduction of plastic consumption and promoting reuse. Secondly, they confronted mitigation by promoting informative labelling and instructions for sustainable behaviour towards plastic use. Thirdly, they addressed the removal of plastic waste through various cleaning initiatives. Finally, education and behaviour-change-related measures, which are cross-cutting and supportive in awareness-raising and educational initiatives, were primarily aimed at creating a positive shift in human behaviour towards consuming less single-use plastic, proper plastic sorting and recycling, collection of plastic litter, and providing education for moving towards zero plastic emissions.

A total of 28 soft measures to prevent single-use plastic and improve plastic litter collection and treatment were collected and assessed/evaluated (Table 5).

Table 5. The number of soft measures collected in the Baltic Sea Region countries.

Country/Region	Number of measures
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BSR	2
Germany	8
Sweden	6
Finland	6
Estonia	5
Latvia	1
Total	28

Categorised best cases across the BSR of single-use plastic reduction and prevention are presented in Table 6.

Preventive measures have mostly been adopted in eastern BSR countries such as Estonia and Latvia, as well as in northern countries like Germany and Sweden. These measures mainly focus on the promotion of reusable plastics during events and celebrations, and in some examples, they involve avoiding single-use plastics in schools and municipalities.

In promoting informative labelling and instructions, the most successful countries were northern ones like Germany, Sweden, and Finland. They focused on providing informative materials for plastic litter reduction in schools and public places (beaches) and utilising web resources.

Several cleaning initiatives were adopted across the BSR. For example, in Estonia, the cleaning initiative 'Let's do it' is known throughout the entire country. Within this initiative, every year the whole country participates in a large cleaning event for garbage collection. Similar initiatives are also run in the neighbouring countries of Finland and Sweden. Some initiatives are connected with the collection of marine litter, including plastics from beaches and shoreline of the Baltic Sea.

The most popular soft measures implemented in the BSR are associated with awareness campaigns for plastic prevention and reduction, including educational exhibitions and programmes for school children and the general public.

Table 6. Classification of analysed soft measures.

Type of measure	Description
Prevention	<ol style="list-style-type: none"> Measures to prevent single-plastic use at the Valmiera city festival in Latvia include an integrated campaign promoting eco-friendly celebrations, plastic waste reduction tips, and discouragement of releasing helium balloons. Type of waste targeted: Single-use plastic Stakeholder group: General public Campaign 'Dirt Angel' aims to encourage people in Bonn, Germany, to switch from conventional plastic bags to reusable ones and from single-use plastic bottles to

	<p>refillable ones. This initiative focuses on raising awareness, particularly among school children, through creative activities and the introduction of the 'Dirt Angel' concept. Type of waste targeted: Single-use plastic Stakeholder group: General public, school children</p> <p>3. The 'Plastic Diet' campaign in Västerås, Sweden involves various measures, including educational initiatives, inventory and exchange of plastic items, and the elimination of plastic cups in City Hall. Type of waste targeted: Single-use plastic Stakeholder group: Municipality workers</p> <p>4. The Plastic-Free City initiative in Rostock, Germany, aims to reduce the consumption of single-use plastic through various actions, such as reducing consumables in offices and hotels, offering food and drink in reusable containers in catering businesses, etc. Type of waste targeted: Single-use plastic Stakeholder group: Businesses, general public, policy makers</p> <p>5. Unverpackt ("Unpackaged") Store (Germany nationwide) sells various food and articles in bulk, thus without packaging. Type of waste targeted: Single-use plastic, plastic packaging Stakeholder group: General public</p> <p>6. Various awareness campaigns in Tallinn, Estonia, aim to encourage the general public to consume tap water instead of bottled water. Type of waste targeted: Single-use plastic Stakeholder group: General public</p>
Mitigation	<p>7. Awareness campaign 'Bites made of plastic' in Helsinki, Finland, utilises colourful stickers on manhole covers and positive imagery to address misconceptions about waste disposal, engaging diverse urban audiences. Type of waste targeted: Single-use plastic, cigarette butts Stakeholder group: General public</p> <p>8. Awareness campaign 'The Sea Starts Here' in Tallinn, Estonia, marked over 1,000 drainage holes in major cities, highlighting the connection between urban spaces and marine pollution, with a particular emphasis on the impact of cigarette butt litter. Type of waste targeted: Single-use plastic, cigarette butts Stakeholder group: General public</p> <p>9. General tips for the public on reducing plastic consumption, emphasising sustainable plastic use, are provided on the website of the municipality of Västerås, Sweden. Type of waste targeted: Single-use plastic Stakeholder group: General public</p> <p>10. Ostseeascher (Warnemünde, Germany) eye-catching ashtrays and information boards on various sections of the beach to promote the environmentally friendly disposal of cigarette butts and other trash. Type of waste targeted: Single-use plastic, cigarette butts Stakeholder group: General public</p> <p>11. Litter Explorer website (Germany) created a database of collected litter during clean up campaigns, provides information and tools for litter counting and classification, and provides class materials for schools.</p>

	<p>Type of waste targeted: plastic litter Stakeholder group: General public, school children</p> <p>12. The Marine Litter Round Table in Rostock, Germany, has developed action guidelines on best practices and legal options for municipalities to reduce plastic waste generation in the North Sea and the Baltic Sea regions, educational concepts for different age groups, as well as guidance on conducting environmentally sound coastal trash pick-up events. Type of waste targeted: Single-use plastic, ghost nets, fishing gear Stakeholder group: General public, school children, fisheries</p>
Removal	<p>13. In Estonia, the cleaning initiative 'Let's Do It' started in 2008, mobilising over 50,000 people to clean up the entire country. This campaign is based on the initiative of volunteers to clean up the environment, with contributions not only from companies engaged in waste management but also from private businesses, local self-governments, politicians, and cultural representatives. Garbage collection takes place in suburban areas, parks, woodlands, riversides, and other urban areas that are rarely handled by municipal services. Type of waste targeted: Plastic litter Stakeholder group: General public</p> <p>14. The campaign 'Garbage Collection Days' is conducted annually in several Swedish municipalities, engaging schools and youth associations in practical exercises connected to sustainable development education. Type of waste targeted: Plastic litter Stakeholder group: General public, school children</p> <p>15. The cleaning initiative "All of Sweden Pick Up Trash", organised in numerous Swedish municipalities, encourages widespread participation in on-land and marine litter collection. Type of waste targeted: Plastic litter Stakeholder group: General public</p> <p>16. In Finland, the SATAKOLKYT project for cleaning the Helsinki Baltic Sea shoreline from litter, including plastic litter, was initiated by concerned youth. It mobilises residents to clean up the city's 130 kilometres of open Baltic Sea shoreline. Launched in 2019, the initiative has witnessed widespread participation, transforming simple beach trips into powerful environmental actions. Type of waste targeted: Plastic litter Stakeholder group: General public, school children</p> <p>17. Marine litter collection during Baltic Sea Day is conducted annually in Baltic Sea countries. This event includes various rallies and activities that foster appreciation for the sea and encourage coastal trash pick-up. Type of waste targeted: Plastic litter Stakeholder group: General public</p> <p>18. The Nordic Coastal Clean-up initiative in the Nordic countries for picking up litter from beaches along the coast and inland along rivers and lakes is another example of international cooperation in the collection of marine litter, and it has attracted nearly 200,000 participants, with up to 88% of the collected marine litter consisting of plastic. Type of waste targeted: Plastic litter Stakeholder group: General public</p>

Education	<p>19. Educational exhibition "The Story of Plastic" (Espoo, Finland) Type of waste targeted: Single-use plastic Stakeholder group: General public</p> <p>20. Exhibition and educational materials "The Journey of Plastic" (Pori, Finland) Type of waste targeted: Single-use plastic Stakeholder group: General public</p> <p>21. Traveling exhibition and educational programme "Let's Go to Zero" in Tallinn, Estonia. Type of waste targeted: Single-use plastic Stakeholder group: General public</p> <p>22. The environmental education programme "Developing the habit of preventing and reducing waste generation, reusing and recycling and sorting waste by type" for kindergarten and school children (Tallinn, Estonia) Type of waste targeted: Single-use plastic Stakeholder group: kindergarten and school children</p> <p>23. The educational programme "Masters of Minimization", offering an 8–12-month challenge to households across Sweden. The programme aims to raise awareness of waste management and promote waste reduction. Type of waste targeted: Single-use plastic Stakeholder group: households</p> <p>24. The citizen science project known as a "mass experiment" in Swedish municipalities. In 2022, the 'Plastic Experiment' project took place. Type of waste targeted: Single-use plastic, plastic litter Stakeholder group: school children, general public</p> <p>25. Recycled plastic workshops are organised for the general public to create new plastic items using shredded waste plastic (Espoo, Finland). Type of waste targeted: plastic litter Stakeholder group: general public</p> <p>26. Organisation of thematic days/weeks dedicated to plastic sorting in schools (Espoo, Finland). Type of waste targeted: plastic litter Stakeholder group: school children</p> <p>27. Plastic Pirates project (Germany, nationwide) for raising awareness about plastic pollution among young people through educational programmes and research during beach clean-up campaigns. Type of waste targeted: plastic litter Stakeholder group: school children</p> <p>28. Ostseeprogramm (Schleswig-Holstein, Germany) educational programme for people of all ages to explore the sea beneath the surface. Type of waste targeted: plastic litter Stakeholder group: general public</p>
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4.2. Feasibility and replicability assessment of the collected soft measures

Collected and categorised soft measures for the prevention and reduction of single-use plastic in the BSR were assessed using feasibility and replicability approaches. The feasibility

assessment included the evaluation of the challenges/barriers connected with *financial* and *technical* constraints (where applicable) that appeared in the preparation and implementation of the measures, and *social acceptability*, including public involvement and satisfaction. Additionally, the *replicability* of the measures was evaluated.

Prevention measures

Financial constraints for preventive soft measures may be connected with the requirement to invest in the implementation of measures, such as procuring reusable plastic alternatives or implementing infrastructure changes (such as installing water refill stations or purchasing reusable containers for green events or school awareness campaigns). Additionally, transitioning to reusable plastics may entail additional costs for cleaning, maintenance, and storage of reusable items, which could strain limited budgets. For educational campaigns targeting kindergartens and schools, costs connected with the development of training programmes and production of informational materials can arise.

Technical burdens may be associated with the lack of supportive infrastructure for the implementation of soft solutions, including installing water refill stations or establishing collection points for reusable items. Another concern may be associated with problems related to the appropriate sorting of plastics during green events and the use of the appropriate waste bins. For example, this issue was addressed by Valmiera municipality during the green festival events.

The *social acceptability* of single-use plastic preventive initiatives, such as the Valmiera city festival's campaign and the 'Dirt Angel' campaign in Bonn, Germany, is very likely to be well-received by the general public due to their engaging and volunteer-oriented approaches. In contrast, the 'Plastic Diet' campaign in Västerås, Sweden, and the Plastic-Free City initiative in Rostock, Germany, may receive positive perception only from environmentally conscious individuals and organisations, but not necessarily from those who are less inclined to change their usual lifestyle. Similarly, the "Unpackaged" Store concept in Germany is very likely to be popular among environmentally conscious consumers seeking eco-friendly options but might not appeal to the general public who may prefer purchasing goods in plastic packaging as is their usual practice.

The social acceptability of measures, such as the tap water consumption awareness campaigns in Tallinn, Estonia, may also be hindered by mistrust and cultural constraints towards tap water consumption.

All described measures offer replicable strategies for raising public awareness and encouraging behaviour change regarding plastic waste reduction. However, challenges in *replicating* these measures lie in the potential need for financial and human resources, especially for campaigns such as the Plastic-Free City initiative in Rostock, Germany, and the "Unpackaged" Store concept in Germany, as well as human mistrust, as seen in the tap water consumption campaign in Tallinn, Estonia.

Mitigation measures

Some *financial constraints* may arise during the production of informative materials, labels, and stickers. Expenses may be related to printing, design, and distribution. Additionally, web resources for disseminating information may require some investments, including website development, continuous maintenance, and hosting, such as in website utilisation in Västerås municipality, Sweden, or the Litter Explorer website in Germany.

Some *technical challenges* may arise in monitoring and evaluating the impact of informative labelling initiatives, including tracking changes in behaviour and assessing the effectiveness

of educational programmes. This requires expertise in data collection, analysis, and interpretation. Additionally, as reported from the awareness campaign 'Bites made of plastic' in Helsinki, Finland, the stickers have partly detached or been removed by citizens, which may affect the implementation capacity. On the other hand, the usage of warning labels can provide important information about the risks associated with plastic waste and can have a positive effect on consumer behaviour (Van Asselt et al., 2022)

The *social acceptability* of awareness campaigns like "Bites made of plastic" in Helsinki and "The Sea Starts Here" in Tallinn may be hindered by people's misperception of the messaging and conflicts with their inner values or motivations. Additionally, cultural differences and attitudes towards waste disposal practices, particularly regarding cigarette butt litter, may affect the social acceptability of these initiatives across different regions.

Challenges in the *replicability* of measures, such as the placement of eye-catching ashtrays in Ostseescher or the development of educational databases like the Litter Explorer website, require certain financial and human resources, which might be difficult for some regions. Additionally, the development of stakeholder networks, as seen in The Marine Litter Round Table in Rostock, Germany, demands coordination, collaboration, and strong commitment from interested parties, which might be challenging to replicate in other regions with people holding different values and knowledge.

Removal measures

For the removal measures, it is essential to have funding to support the implementation of the cleaning initiatives across the BSR as presented in Table 5. Funding may be required for organising events, purchasing necessary equipment, and covering logistical expenses such as transportation and waste disposal. Additionally, some *financial constraints* may occur in relation to the availability of resources, including hiring staff, acquiring cleaning supplies, and maintaining equipment used for garbage collection and disposal.

For cleaning activities related to marine litter collection and cleaning of the shoreline from plastics, some *technical constraints* may occur related to the infrastructure needed to support effective waste collection and disposal. This includes having appropriate waste management facilities, transportation networks, and recycling centres in place to handle the collected garbage, especially in remote or coastal areas. Secondly, the lack of access to or affordability of equipment such as boats, nets, and specialised machinery needed for shoreline clean-up and marine debris removal may hinder the garbage removal process.

The described plastic litter clean-up initiatives are likely to be positively accepted by people across the BSR, especially among young and educated individuals. The challenges in *social acceptability* might arise from people's differing values and motivations, as well as from a misunderstanding of the plastic litter problem. Some individuals may not fully acknowledge their own responsibility in contributing to the plastic litter problem and thus, may be hesitant to participate in cleaning initiatives (Dilkes-Hoffman L.S et al., 2019). The success of participation, as seen in the 'SATAKOLKYT' project in Helsinki or the 'Let's Do It' in Estonia, relies heavily on community engagement and public awareness. Some studies (Willis et al., 2018; Xanthos and Walker, 2017) have shown that educational programmes offered by municipalities increase citizen knowledge and lead to less littering on the coastline.

The challenges in *replicating* cleaning-up initiatives such as 'Garbage Collection Days' in Sweden or 'Let's Do It' in Estonia lie in extensive logistical planning and coordination among different stakeholders. Additionally, such initiatives require sufficient resources, including funding, manpower, and equipment, which may be difficult, particularly in areas with limited

financial or organisational capacity. Furthermore, initiatives with cross-border collaboration, such as the 'Nordic Coastal Clean-up' and 'Baltic Sea Day,' require effective coordination among multiple countries and organisations. Overcoming potential barriers related to regulatory differences, cultural diversity, and logistical complexities is essential for successful replication on an international scale.

Educational measures

Educational measures may include educational exhibitions, teaching programmes for school children, and initiatives targeting the general public. There are usually *financial constraints* related to the provision of support for them. Funding may be necessary for venue rentals, materials, staffing, and promotional activities. Also, dependency on external funding sources, such as grants or corporate sponsorships, could impact the scale and frequency of these initiatives.

Technical constraints may arise concerning the development and delivery of educational materials and programmes. Ensuring the availability of high-quality resources, such as interactive exhibits, educational materials, and curriculum-aligned content, may require technical expertise in content creation and instructional design. Some technical burdens may include challenges related to digital outreach, website development, social media management, and multimedia production to engage diverse audiences across the BSR.

The challenges in *social acceptability* of the education measures could stem from cultural attitudes and beliefs regarding the use of single-use plastic and plastic waste management. Additionally, limited accessibility of educational resources and programmes may constrain the positive impact of these measures. Encouraging active participation and engagement from various groups and communities, especially those in rural areas and marginalised populations, might also be challenging. On the other hand, Cavaliere et al. (2020), demonstrated in their study that consumer behaviour can be strongly influenced by the actions of other members of society, and motivational efforts may dissipate if not supported by others. Herweyers et al. (2023), found that habits play a crucial role in our daily lives and can be a powerful barrier to the implementation of new knowledge into practice.

The challenges in *replicating* the educational measures could lie in resource availability, such as funding, materials, and trained personnel. Additionally, coordination and collaboration among multiple stakeholders, including educational institutions, local governments, NGOs, and community groups, might pose challenges for different regions or communities. Furthermore, educational programmes and materials need to be adapted to suit the cultural context and preferences of the target audience in each region.

The results of the evaluation of soft measures related to single-use plastic prevention and reduction are presented in Figure 2. The largest impact is seen with prevention and educational measures, due to their high influence on consumer behaviour change, making it more pro-environmental or sustainable, with a focus on plastic prevention and reduction. Prevention measures have the highest level of connection with challenges and barriers, mainly due to financial and technical constraints. Educational measures were assessed as having medium complexity for implementation due to their significant relevance in increasing knowledge among the general public and school children, though they do not require resources as extensive as those for implementation. In comparison, removal measures have a moderately higher impact; however, they will face more challenges and barriers associated with their implementation. The main constraints can be connected to technical barriers, which may

hinder the implementation process. Mitigation measures were evaluated as having a medium impact and medium complexity connected to challenges/barriers for their implementation.

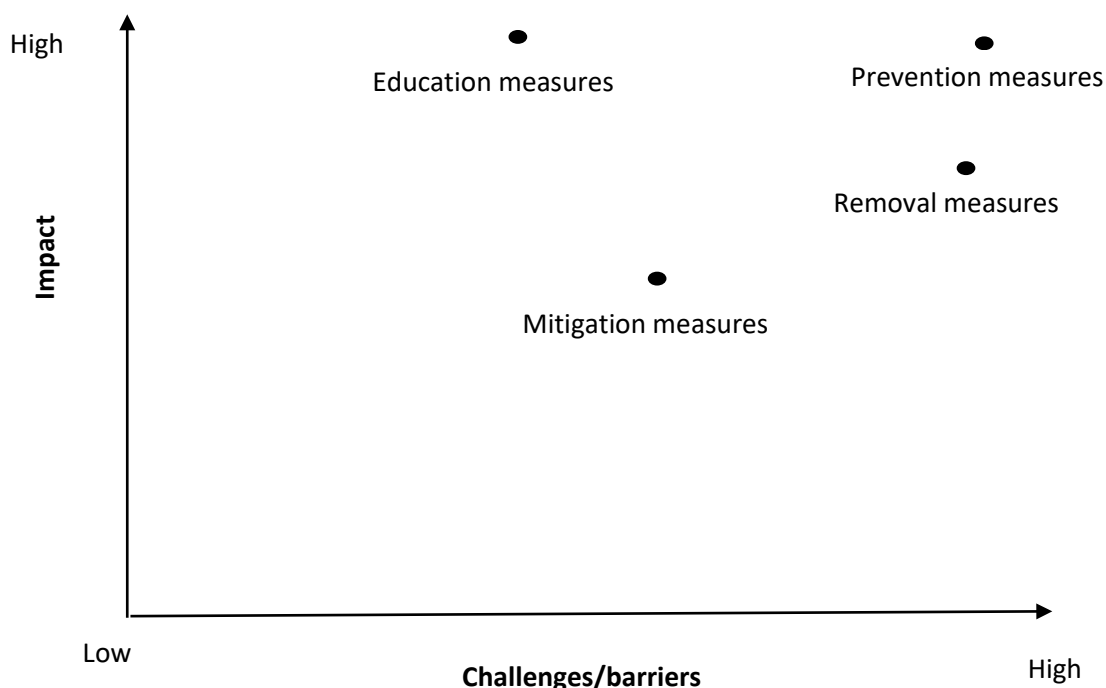


Figure 2. Evaluation matrix for proposed soft solutions for single-use plastic prevention and reduction

In general, to overcome the financial challenges, organisations can actively seek funding opportunities and grants from local or international funds. They can also establish public-private partnerships through collaboration with companies interested in plastic reduction, or implement cost-sharing initiatives where stakeholders, including businesses, schools, and community members, contribute financially to the implementation and maintenance of preventive soft measures. To mitigate technical burdens, organisations may allocate resources to invest in the necessary infrastructure and technology required to support preventive measures effectively. They can also identify and leverage existing resources, infrastructure, and technologies that can be repurposed or adapted to support preventive measures or to educate the public and provide guidance on the proper use and maintenance of infrastructure. To overcome the social challenges, targeted communications, community involvement, and alignment with local values and preferences are necessary. For example, studies (Hartley et al., 2018a; Veiga et al., 2016) have demonstrated that school education programmes targeted towards plastic pollution and prevention may lead to pro-environmental behaviour change among students. Additionally, for replicability, all these initiatives need to be assessed and adapted to suit the specific needs and funding possibilities of other communities.

5. Conclusions

This paper has shown the advantages of soft measures to handle the problem of plastic waste in the Baltic Sea Region. As explained, "soft measures" in environmental policy and management typically refer to non-structural strategies that include education, awareness campaigns, policy reforms, economic incentives, and community engagement efforts, as opposed to "hard measures" like physical clean-up operations or infrastructure modifications.

The experience gathered in the paper shows that the advantages of soft measures in this context involve several aspects. Firstly, measures such as public awareness campaigns or policy reforms can be very useful, since they do not require substantial investment in infrastructure or technology. Secondly, by focusing on education and awareness, soft measures may contribute to reducing the generation of plastic waste at the source, which is a more sustainable and long-term solution when compared to removing waste after it has already entered marine environments. Thirdly, soft measures often involve engaging local communities, stakeholders, and industries in the conversation, leading to more sustainable and locally adapted solutions to plastic waste.

Another advantage of soft measures is related to the fact that policies and educational programmes can be more easily adapted and scaled up or down based on their effectiveness, changes in societal behaviour, or emerging scientific knowledge. Moreover, through policy reforms and incentives, soft measures can address the broader spectrum of issues related to plastic waste, including production, consumption, waste management, and recycling, thereby providing a more holistic solution. Finally, raising awareness about the impacts of plastic waste on the Baltic Sea's marine ecosystem can lead to more responsible consumer behaviour and increased public support for policies aimed at reducing plastic pollution.

This paper has some limitations. The first one is the fact that it focused on soft measures and did not explore technical ones. Also, the paper limited the analysis to the Baltic Sea Region and did not consider the situation in the North Sea or the Mediterranean Sea, which face similar problems. Despite these limitations, the paper provides a welcome addition to the literature and documents some of the current experiences in Baltic Sea countries.

Some suggestions for maximising the impacts of soft measures for tackling plastic pollution in the Baltic Sea Region include a greater engagement of the key stakeholders - including local communities, businesses, NGOs, and policymakers - in the development and implementation of soft measures. Collaboration can enhance the effectiveness and reach of initiatives. In addition, targeted campaigns may help to promote behavioural change among individuals, encouraging responsible consumption, waste reduction, and proper disposal practices. It may also be helpful to establish monitoring mechanisms to track the progress and effectiveness of soft measures. Data-driven insights can inform decision-making and help refine strategies for greater impact. Finally, much can be gained by facilitating knowledge exchange and best practice sharing among Baltic Sea countries. Learning from successful initiatives elsewhere can inspire innovation and improvement. This approach is being pursued as part of the project "Baltiplast", funded by the Interreg Baltic Sea Programme and led by the Hamburg University of Applied Sciences, with partners from across the region.

By implementing these strategies and tailoring them to the specific needs and contexts of the Baltic Sea Region, soft measures can play a significant role in combating plastic pollution and promoting a cleaner, healthier marine environment.

While the advantages of soft measures are significant, it is also important to note that the most effective strategies often involve a combination of both soft and hard measures, tailored to the specific challenges and opportunities of the Baltic Sea region. This integrated approach can leverage the strengths of both types of measures to achieve a more significant impact on reducing plastic waste and its detrimental effects on marine environments.

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6. References

Almroth, B.C. and Eggert, H., (2019), Marine Plastic Pollution: Sources, Impacts, and Policy Issues, *Review of Environmental Economics and Policy*, **13**, issue 2, p. 317-326. <https://doi.org/10.1093/reep/rez012>

Andrady, A.L. (2011) Microplastics in the Marine Environment. *Marine Pollution Bulletin*, 62, 1596-1605. <https://doi.org/10.1016/j.marpolbul.2011.05.030>

Białowąs, M., Jonko-Sobuś, K., Pawlak, J., Polak-Juszczak, L., Dąbrowska, A., Urban-Malinga, B. (2022). Plastic in digestive tracts and gills of cod and herring from the Baltic Sea, *Science of The Total Environment*, Volume 822, 153333, ISSN 0048-9697. <https://doi.org/10.1016/j.scitotenv.2022.153333>.

Christensen, A., Murawski, J., She, J., & St. John, M. (2023). Simulating transport and distribution of marine macro-plastic in the Baltic Sea. *PloS one*, 18(1), e0280644. <https://doi.org/10.1371/journal.pone.0280644>

Da Costa, J. P., Mouneyrac, C., Costa, M., Duarte, A. C., & Rocha-Santos, T. (2020). The role of legislation, regulatory initiatives and guidelines on the control of plastic pollution. *Frontiers in Environmental Science*, 8, 104. <https://doi.org/10.3389/fenvs.2020.00104>

Dilkes-Hoffman, L.S., Pratt, S., Laycock, B., Ashworth, P. and Lant, P.A. (2019). Public attitudes towards plastics. *Resources, Conservation and Recycling* (147), pp.227-235.

ETC/ICM Technical Report 05/2022. Veiga, J.M., Winterstetter, A., Murray, C., Šubelj, G., Birk, S., Lusher, A., van Bavel, B., Aytan, Ü., Andersen, J.H., Sholokhova, A., Kideys, A., Smit, M.J., Arnold and M., Aydın, M. Marine litter in Europe – An integrated assessment from source to sea. European Topic Centre on Inland, Coastal and Marine Waters, 198 pp. European Environmental Agency, 2022.

Frantzi, S., Brouwer, R., Watkins, E., van Beukering, P., Cunha, M. C., Dijkstra, H., Duijndam, S., Jaziri, H., Okoli, I. C., & Pantzar, M. (2021). Adoption and diffusion of marine litter clean-up technologies across European seas: Legal, institutional and financial drivers and barriers. *Marine pollution bulletin*, 170, 112611. <https://doi.org/10.1016/j.marpolbul.2021.112611>

Garcia-Vazquez, E., & Garcia-Ael, C. (2021). The invisible enemy. Public knowledge of microplastics is needed to face the current microplastics crisis. *Sustainable Production and Consumption*, 28, 1076-1089. <https://doi.org/10.1016/j.spc.2021.07.032>

Hartley, B.L., Pahl, S., Holland, M., Alamei, I., Veiga, J.M., Thompson, R.C. (2018). Turning the tide on trash: Empowering European educators and school students to tackle marine litter, *Marine Policy*, Volume 96, Pages 227-234, ISSN 0308-597X, <https://doi.org/10.1016/j.marpol.2018.02.002>.

HELCOM (2015). Regional Action Plan for Marine Litter in the Baltic Sea. 20pp. <https://helcom.fi/wp-content/uploads/2019/08/Regional-Action-Plan-for-Marine-Litter.pdf>

HELCOM-Baltic Marine Environment Protection Commission. (2016). HELCOM Annual report on Baltic Marine Environment Protection Commission Discharges observed during aerial surveillance in the Baltic Sea 2015. Retrieved June 11, 2019. <https://helcom.fi/wp-content/uploads/2019/10/HELCOM-Activities-report-2015.pdf>

Henderson, L., & Green, C. (2020). Making sense of microplastics? Public understandings of plastic pollution. *Marine pollution bulletin*, 152, 110908. <https://doi.org/10.1016/j.marpolbul.2020.110908>

Herweyers, L., Moons, I., Barbarossa, C., De Pelsmacker, P., Du Bois, E. (2023). Understanding who avoids single-use plastics and why: A cross-country mixed-method study, *Journal of Cleaner Production*, Volume 414, 137685, ISSN 0959-6526, <https://doi.org/10.1016/j.jclepro.2023.137685>.

Hidalgo-Ruz, V., Gutow, L., Thompson, R. C., & Thiel, M. (2012). Microplastics in the marine environment: a review of the methods used for identification and quantification. *Environmental science & technology*, 46(6), 3060-3075.

Hogland, M., Hogland, W., Jani, Y., Kaczala, F., de Sá Salomão, A. L., Kriipsalu, M., Orupöld, K., & Burlakovs, J. (2014). Experiences of three landfill mining projects in the baltic sea area: with focus on machinery for material recovery. *Linnaeus Eco-Tech*, 1-11. <https://doi.org/10.15626/Eco-Tech.2014.014>

Khedr, S., Rehdanz, K., Brouwer, R., Dijkstra, H., Duijndam, S., van Beukering, P., & Okoli, I. C. (2021). Public preferences for marine plastic litter reductions across Europe. arXiv preprint arXiv:2107.03957. <https://doi.org/10.48550/arXiv.2107.03957>

Kramm, J., Steinhoff, S., Werschmöller, S., Völker, B., & Völker, C. (2022). Explaining risk perception of microplastics: Results from a representative survey in Germany. *Global Environmental Change*, 73, 102485. <https://doi.org/10.1016/j.gloenvcha.2022.102485>

Lau, W. W., Shiran, Y., Bailey, R. M., Cook, E., Stuchtey, M. R., Koskella, J., Velis, C. A., Godfrey, L., Boucher, J., & Murphy, M. B. (2020). Evaluating scenarios toward zero plastic pollution. *Science*, 369(6510), 1455-1461. <https://doi.org/10.1126/science.aba9475>

Leal Filho, W., Saari, U., Fedoruk, M., Iital, A., Moor, H., Klöga, M. and V. Voronova. (2019). An overview of the problems posed by plastic products and the role of extended producer responsibility in Europe. *Journal of Cleaner Production*, 214: 550-558. <https://doi.org/10.1016/j.jclepro.2018.12.256>

Li, P., Wang, X., Su, M., Zou, X., Duan, L., & Zhang, H. (2021). Characteristics of plastic pollution in the environment: a review. *Bulletin of environmental contamination and toxicology*, 107, 577-584. <https://doi.org/10.1007/s00128-020-02820-1>

Mazurkiewicz, M., Martinez, P. S., Konwent, W., Deja, K., Kotwicki, L., & Węśławski, J. M. (2022). Plastic contamination of sandy beaches along the southern Baltic—a one season field survey results. *Oceanologia*, 64(4), 769-780. <https://doi.org/10.1016/j.oceano.2022.07.004>

Miguel, I., Santos, A., Venâncio, C., Oliveira, M. (2024). Knowledge, concerns and attitudes towards plastic pollution: An empirical study of public perceptions in Portugal. *Sci Total Environ*, 906:167784. doi: 10.1016/j.scitotenv.2023.167784.

Rhein, S., Schmid, M. (2020). Consumers' awareness of plastic packaging: More than just environmental concerns. *Resources Conservation and Recycling*, 162:105063 DOI:10.1016/j.resconrec.2020.105063

Schernewski, G., Radtke, H., Robbe, E., Haseler, M., Hauk, R., Meyer, L., Piehl, S., Riedel, J., & Labrenz, M. (2021). Emission, transport, and deposition of visible plastics in an estuary and the Baltic Sea—A monitoring and modeling approach. *Environmental management*, 68, 860-881. <https://doi.org/10.1007/s00267-021-01534-2>

United Nations Environment Programme (2021). Pollution to Solution: A Global Assessment of Marine Litter and Plastic Pollution. Nairobi. <https://www.unep.org/resources/pollution-solution-global-assessment-marine-litter-and-plastic-pollution>

Van Asselt, J., Nian, Y., Soh, M., Morgan, S., Gaom Z. (2022). Do plastic warning labels reduce consumers' willingness to pay for plastic egg packaging? – Evidence from a choice experiment, *Ecological Economics*, Volume 198, 107460, ISSN 0921-8009, <https://doi.org/10.1016/j.ecolecon.2022.107460>.

Van Oosterhout, L., Dijkstra, H., Van Beukering, P., Rehdanz, K., Khedr, S., Brouwer, R., & Duijndam, S. (2022). Public perceptions of marine plastic litter: a comparative study across European countries and seas. *Frontiers in Marine Science*, 8, 2060. <https://doi.org/10.3389/fmars.2021.784829>

Veiga, J.M., Vlachogianni, T., Pahl, S., Thompson, R.C., Kopke, K., Doyle, T.K., Hartley, B.L., Maes, T., Orthodoxou, D.L., Loizidou, X.I., Alampai, I. (2016). Enhancing public awareness and promoting co-responsibility for marine litter in Europe: The challenge of MARLISCO, *Marine Pollution Bulletin*, Volume 102, Issue 2, Pages 309-315, ISSN 0025-326X, <https://doi.org/10.1016/j.marpolbul.2016.01.031>.

Veiga, J.M., Winterstetter, A., Murray, C., Šubelj, G., Birk, S., Lusher, A., van Bavel, B., Aytan, Ü., Andersen, J.H., Sholokhova, A., Kideys, A., Smit, M.J., Arnold and M., Aydın, M., (2022), Marine litter in Europe – An integrated assessment from source to sea. ETC/ICM Technical Report 05/2022: European Topic Centre on Inland, Coastal and Marine Waters, 198 pp.

Vivekanand, A. C., Mohapatra, S., & Tyagi, V. K. (2021). Microplastics in aquatic environment: Challenges and perspectives. *Chemosphere*, 282, 131151.

Willis, K., Maureaud, C., Wilcox, C., Hardesty, B.D. (2018). How successful are waste abatement campaigns and government policies at reducing plastic waste into the marine environment?, *Marine Policy*, Volume 96, Pages 243-249, ISSN 0308-597X, <https://doi.org/10.1016/j.marpol.2017.11.037>.

Xanthos, D., Walker, T.R. (2017). International policies to reduce plastic marine pollution from single-use plastics (plastic bags and microbeads): A review, *Marine Pollution Bulletin*, Volume 118, Issues 1–2, Pages 17-26, ISSN 0025-326X, <https://doi.org/10.1016/j.marpolbul.2017.02.048>.

Xu, Y., Chan, F. K. S., He, J., Johnson, M., Gibbins, C., Kay, P., ... & Zhu, Y. G. (2021). A critical review of microplastic pollution in urban freshwater environments and legislative

progress in China: recommendations and insights. *Critical Reviews in Environmental Science and Technology*, 51(22), 2637-2680.