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Challenges and recommendations for marine waste management in European fishing ports

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The fishing sector plays a crucial role in the effective management of marine litter, emphasising the importance of facilitating waste collection for fishers and ensuring its subsequent management in port reception facilities (PRFs). EU Directive 2019/883/EU provides a unified sector-specific legal framework for managing ship-generated waste within EU ports, but harmonising PRFs and waste management remains challenging across Member States. Key areas for improving waste management include streamlining the regulatory framework (policies and processes), enhancing economic viability, fostering partnerships, promoting knowledge sharing, improving infrastructure, and increasing stakeholder awareness. The measures taken should consider the context, including port characteristics and the country in which it operates.

KEYWORDS
Croatia, Italy, Malta, marine litter, port reception facilities, Portugal, Spain

1 Introduction

Marine pollution is one of the most pressing environmental crises of our day (Chang and Saqib, 2025). The proliferation of marine waste over the last half-century is closely tied to the dramatic rise in plastic production, maritime transport, and extractive activities at sea (OECD, 2022). Plastics constitute up to 80% of all marine waste (Morales-Caselles et al., 2021), and cumulatively between 86 and 150 million tonnes of plastic are estimated to be present in the oceans (Jang et al., 2015), with most ending up on the seafloor (Madricardo et al., 2020; Morales-Caselles et al., 2021).

At least 22% of all marine litter is estimated to originate from sea-based activities, including fishing, aquaculture, and shipping (Morales-Caselles et al., 2021). The fishing activity is especially important, as it is estimated that more than half (61%) of the plastic items found in the open ocean consist of synthetic ropes, strings, threads, buoys, and nets from lost or discarded fishing gear (Morales-Caselles et al., 2021). Although quantifying the precise contribution of fishing vessels to marine litter is challenging - due to methodological limitations, underreporting, and a lack of empirical data from at-sea operations (Delft, 2017; Deshpande et al., 2023; IMO, 2021) - the fishing sector is identified as playing a critical role in effectively managing marine plastics globally (Morales-Caselles et al., 2021).

The rise in environmental concerns about marine litter resulted in the International Convention for the Prevention of Pollution from Ships (MARPOL) implementing limitations on ship-generated waste (Annex V) in 1988. MARPOL prohibits the discharge of all forms of plastic into the sea and strictly regulates the disposal of other ship-generated waste (IMO, 1978/2017). Still, around a decade ago, it was estimated that only about 27% of global ship-generated waste was delivered to port reception facilities (PRFs)[1] for handling and proper disposal (Øhlenschlæger et al., 2013). In the European Union (EU), Directive 2019/883/EU aims to prevent marine pollution and mandates that ships deliver their waste to PRFs. These facilities need to be adapted to the operational needs of port users, capable of receiving all MARPOL-designated waste categories, and to employ simple, fast processes. The practical application of these standards is often highly diverse due to differences in national legislation, port size, available infrastructure and technology, administrative capacity and human resources. Despite the lack of recent data on the quantity of ship-generated waste delivered to PRFs, Richardson et al. (2021) and Özkaynak and İçemer (2024) verified that in many regions (e.g, Belize, Iceland, Indonesia, Morocco, New Zealand, Peru, the United States of America, Turkiye and Europe) facilities are either inadequate or insufficient to receive waste, or are poorly adapted to the operational needs of fishing vessels, especially for small-scale fleets (Richardson et al., 2021). This leads to disparities in the quality of waste reception services, the level of fees charged, and the implementation of indirect fee systems and regulatory incentive schemes for the delivery of passively fished waste and EOL fishing gear within and across countries (Directive 2019/883/EU of the European Parliament and of the Council of 17 April 2019 on port reception facilities for the delivery of waste from ships, n.d., Art. 8; Verdesoto et al., 2025).

PRFs play a pivotal role in collecting passively fished waste, including litter and derelict gear retrieved during fishing operations, thereby contributing to the circular economy and reducing the ecological footprint of fisheries (Directive 2019/883/EU of the European Parliament and of the Council of 17 April 2019 on port reception facilities for the delivery of waste from ships, n.d.). However, in many regions PRFs are inadequate or absent, incentivising illegal disposal and further complicating efforts to monitor and manage marine waste (Richardson et al., 2017).

Effective management of PRFs is therefore vital to international and European maritime environmental policy, directly supporting efforts to reduce marine waste and promote sustainable fisheries and ocean health (Directive 2019/883/EU of the European Parliament and of the Council of 17 April 2019 on port reception facilities for the delivery of waste from ships, n.d.; MARPOL Annex V, IMO (1978/2017). The adequacy, accessibility, and management of PRFs (implemented through waste management processes described in port waste management plans) are especially significant for the fisheries sector, where operational constraints and economic pressures can challenge compliance with best environmental practices. Despite the existing literature on EU PRFs (Deja et al., 2019; Di Vaio et al., 2019; Perez et al., 2017), there is a lack of studies focusing on PRFs in fishing ports and the disposal of marine litter by fishing vessels. As such, fishing litter management in ports across Croatia, Italy, Malta, Portugal and Spain has been examined by focusing on fisheries waste management policies, practices, infrastructure, and the economic and social implications of these systems. Key obstacles and the capacity and willingness of port authorities to enhance management were also investigated, including recycling and circular economy activities. This policy brief presents recommendations for waste management in European fishing ports.

2 Assessment of litter management in European fishing ports

Semi-structured interviews were conducted with 15 representatives of port authorities and managers from selected fishing ports in five European countries: Portugal (5), Spain (5), Croatia (2), Italy (2) and Malta (1) (Figure 1). Respondents were selected based on: being actively involvement in overall port management; representing a diversity of port sizes (small, medium, large ports); representing ports where the fishing sector is present together with (or without) other sectors (tourism, commercial shipping) (high, medium, low importance of these sectors); and representing ports with a variety of port infrastructures, ensuring a grounded perspective on the handling and reception of fishing-related waste under different practical and institutional circumstances. Ports were grouped based on information on port size and capacity gathered from official government sources (National Statistics Office, 2023; Porti dello Stretto, 2023; Puertos del Estado, 2024; AMT, 2023) and where this data was lacking for one port in Croatia, we sought expert knowledge from Croatian management authorities.

Each respondent provided information about activities within the port under their direct management, except the respondent from Malta, who reported on five ports, since they were the sole representative with adequate knowledge and experience to discuss the topic. Interviews were conducted between November 2024 and April 2025 in the respondent's native language and audio recorded to capture their full content and nuances. Interviews collected information about: (1) port infrastructure, procedures and policies related to marine litter; (2) strengths and challenges dealing with marine litter and ALDFG produced by fisheries; (3) possible solutions and incentives to motivate fishers to deliver marine litter and ALDFG, as well as the capacity of ports regarding the implementation, economic cost and benefit of these solutions.

3 Challenges to collect and manage fisheries-related litter

Our analysis identified several important categories of challenges (Figure 2) encountered by port authorities when managing the collection of fisheries-related marine litter and abandoned, lost or discarded fishing gears (ALDFGs), many of

1 PRFs are critical port infrastructures designed to receive ship-generated waste at ports, helping prevent the direct discharge of pollutants into the marine environment (IMO, 2021, 1978/2017: MARPOL Annex V).

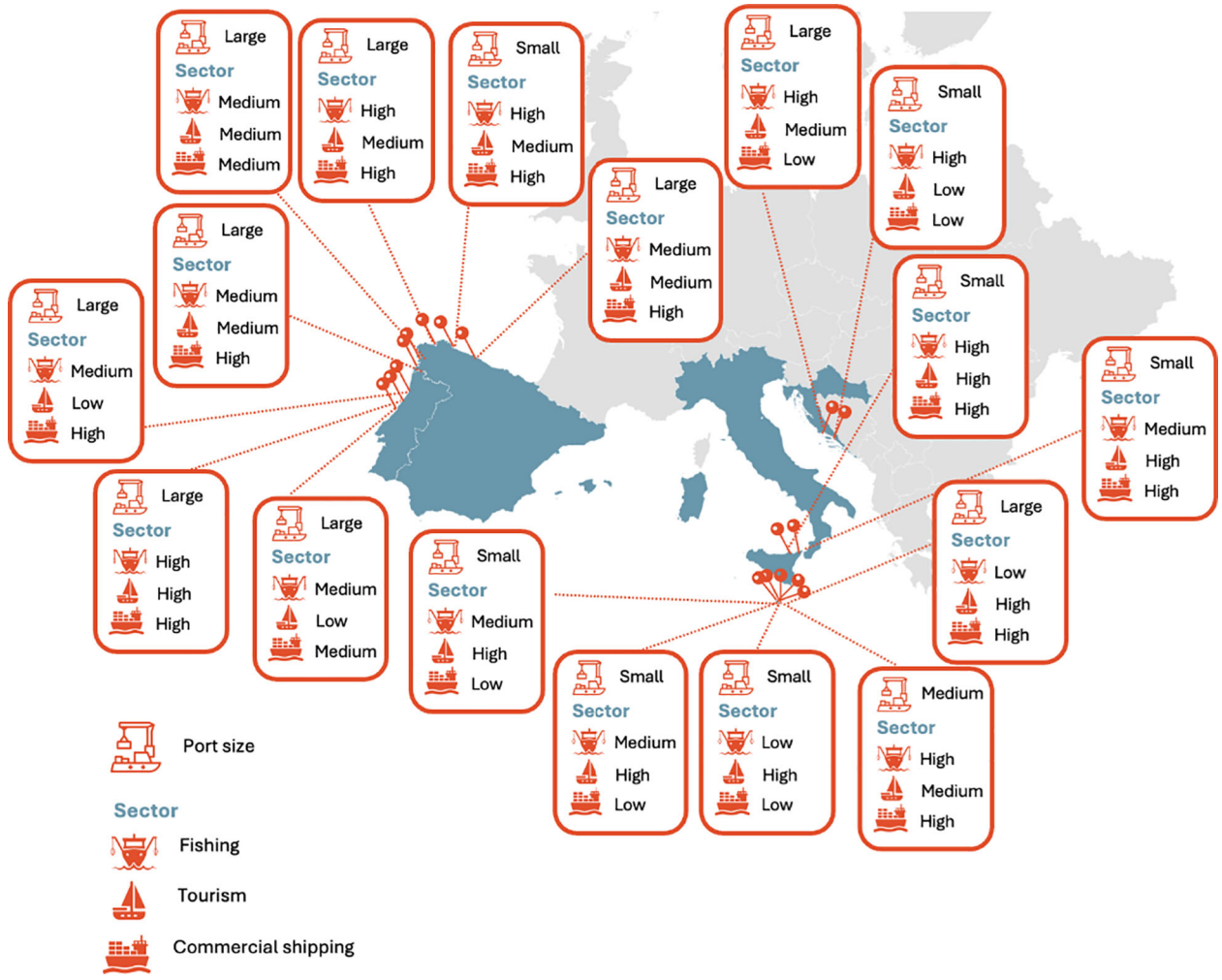

FIGURE 1
Locations and characteristics of ports managed by the respondents who took part in the study.

which were common in different locations. Our research also showed that the implementation of policies varies by port size and national frameworks. This highlights the complexity of managing marine litter in ports and the need for comprehensive, tailored solutions that address both logistical and economic concerns. The challenge of fisheries waste management is further compounded by the need to balance the economic sustainability of ports with the goal of maximising waste delivery. The key challenges identified by port authorities are summarized as follows (identifying the country where each was mentioned):

1. Lack of clear regulation and harmonisation: In some locations, there is a lack of clarity regarding the distribution of responsibilities for waste management among various stakeholders and ministries (Croatia). Related national and EU policies are not targeted at fishing vessels or aligned with international marine conventions like MARPOL (Malta). The absence of harmonised regulations and standardised practices across ports has led to inconsistent implementation of relevant EU regulations (Spain, Malta, Croatia).
2. Financial constraints: The costs of implementation, maintenance, managing and processing marine waste, especially end-of-life (EOL) fishing gear, require significant funding in some locations, which often outweighs the economic value of the recovered materials (Spain, Malta, Italy, Croatia). To add to this, ports often face budget constraints, lacking mechanisms to cover these costs long-term (Spain, Malta, Croatia). All these factors discourage many companies from engaging in waste management activities.
3. Lack of ownership and responsibility: The absence of clear delegation of responsibility for providing and managing PRFs in some locations, especially in areas where fishers don't pay berthing fees, often creates uncertainty about who should bear the costs and manage the facilities (Malta).
4. Inadequate capacity in ports: Many ports lack infrastructure, facilities, and human resources to effectively collect, sort and manage waste (Spain, Portugal, Italy, Croatia). Smaller ports are especially problematic, as they often lack infrastructure or may struggle to implement comprehensive systems, leading to improper waste disposal (Spain, Malta).

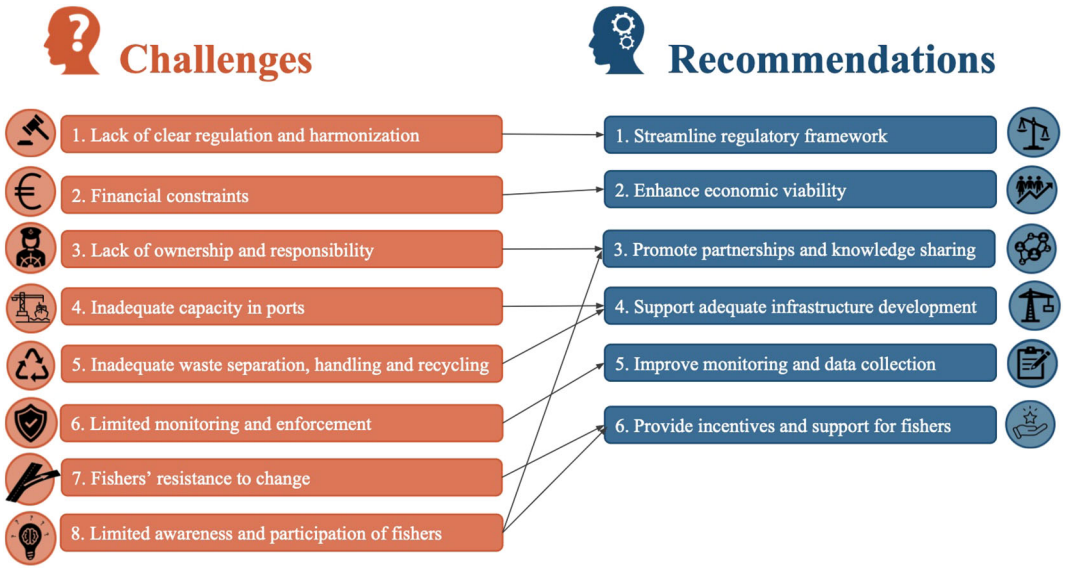

FIGURE 2
Key challenges and recommendations for managing marine litter and abandoned, lost, or discarded fishing gear (ALDFGs) as identified by respondents.

5. Inadequate waste separation, handling and recycling: Some ports struggle to manage different types of waste (Spain, Portugal). The complex mix of materials in fishing nets and the degraded condition of marine plastics (e.g., plastic waste from fishing activities, such as plastic film used to cover fish, hard plastics, and polystyrene boxes) further complicate sorting and increase processing costs (Spain).
6. Limited monitoring and enforcement: In some locations it was pointed out that there is a lack of effective supervision at sea and in ports (Portugal, Malta).
7. Fishers' resistance to change: A certain resistance to changing established practices amongst fishers was also identified and that attempts to impose practices without engagement may lead to pushback (Portugal, Croatia).
8. Limited awareness and participation of fishers: The need to raise and maintain awareness among fishers about proper waste management practices was mentioned in several locations. This requires better and continued education and awareness campaigns, as well as daily engagement with fishers, to ensure consistent participation in litter collection (Spain, Portugal, Croatia).

Although EU directives mandate the free disposal of marine litter for fishers, a lack of harmonisation and challenges in enforcement persist across regions, affecting the effectiveness of waste management. Our research identified inconsistent application of fee structures for waste delivery across the study countries. Some ports charge direct variable fees; others use flat fees or exemptions. Many lack clarity on fees, leading to mixed perceptions about effectiveness and showing scope for improvement, including the development of reward programs for fishers and better alignment of PRF management with MARPOL regulations.

4 Actionable recommendations

Although ports are attempting to comply with EU and national regulations on fisheries waste management and have many successful strategies in place, there is significant room for improvement.

Respondents identified potential solutions to address the challenges of managing marine litter and ALDFG (Figure 2), which resulted in the following recommendations:

1. Streamline regulatory framework: There is a need to harmonize and clarify regulations across ports and countries regarding marine litter management. A more unified regulatory framework with clear guidelines could help standardize practices and make implementation easier across different ports, ensuring consistency and ease of compliance by fishers who operate in multiple locations. This harmonization could extend to the EU level to create a more unified approach, while also recognizing that different ports may have different needs and challenges, and allow for some flexibility in implementing waste management strategies while maintaining overall consistency. There is also a need for national policies to define clear roles and responsibilities for various stakeholders and ministries. Policies should support the implementation of the indirect fee system introduced by European legislation, which includes waste disposal costs in a fixed fee paid by vessels to incentivise proper waste disposal without additional charges.
2. Enhance economic viability: Establish sustainable funding mechanisms that combine government/EU funding to finance marine litter and ALDFG management (and in many locations, these funds are already being used). For example, government funds (e.g., European Maritime,

Fisheries and Aquaculture Fund (EMFAF), Global Environment Facility, Green climate Fund, World Bank Blue Economy), industry contributions (e.g., Fisheries Development Fund or port and harbour development funds), port fees, and extended producer responsibility schemes (a policy approach that makes producers responsible for their products along the entire lifecycle[2]). National environmental and climate funds could also be accessed, such as environmental protection funds, plastic tax/waste levy funds, or Blue Economy/Growth funds. Policies should also promote research and innovation to encourage the transformation of fishing waste into valuable resources, creating economic incentives for proper waste management. Additionally, procurement criteria for selecting waste management companies should be revised to prioritise service quality over lower cost.

3. Promote partnerships and knowledge sharing: Policies should facilitate closer collaboration between various stakeholders in marine litter management (e.g., ports, environmental and local government authorities, fishing associations, fisheries producer organisations, waste recycling authorities) to develop and implement effective waste management strategies. Policies should also encourage ports to participate in networks, hubs, or partnerships focused on marine litter and ALDFG management to facilitate knowledge sharing and the implementation of best practices. Improved collaboration between ports, especially those in close proximity, would facilitate the sharing of best practices, coordinate efforts and potentially reduce costs through joint initiatives.
4. Support adequate infrastructure development: Policies should support improvements PRFs to ensure they are adequate, easily accessible and properly maintained to make it as convenient as possible for fishers to deliver marine litter. Implementing dedicated reception facilities and focusing on efficient use of available areas (e.g., creating more distinct spaces to segregate different types of waste as was suggested in Spain) would make it easier for fishers to dispose of waste properly.
5. Improve monitoring and data collection: Policies should focus on developing adequate methods to track and measure the effectiveness of waste management practices, particularly for fishing-related waste, and on proper enforcement and compliance checks to prevent abuse (e.g., the use of CCTV suggested in Malta). Also, monitoring and enforcement could be strengthened through increased presence and effectiveness of maritime authorities to ensure compliance with fishing and waste management regulations at sea. Improved waste traceability could be supported through the implementation of digital tracking systems to better track and quantify waste from individual fishing vessels and distinguish it from other port waste (e.g., via an app for recording waste generated by each vessel).
6. Provide incentives and support for fishers: Policies should ensure that the disposal of special waste remains free of charge for fishers, removing financial barriers to proper waste disposal. Waste management systems should have simple and effective procedures to ensure fisher participation. Policies should also prioritise comprehensive and ongoing education and awareness programs for the fishing sector (e.g., frequent workshops and meetings, as suggested in Croatia), focusing on environmental protection and proper waste management and targeting both local and foreign workers in the fishing industry. Additionally, reward programs for collecting marine litter could incentivise fishers to collect and properly dispose of marine litter in ports (e.g., an app to record the collection of marine litter, as suggested in Croatia).

It was recognised that these solutions would require economic investment but would also yield several long-term benefits, such as cost savings, additional revenue, new revenue streams, and reduced illegal dumping.

5 Conclusions

Despite the existence of a unified legal framework through EU Directive 2019/883/EU, significant challenges persist in achieving effective harmonisation of PRFs and waste management processes across EU Member States. One of the main challenges is the variation in how Member States transpose and implement the directive's requirements, resulting in inconsistencies in the adequacy, accessibility, and efficiency of PRFs from port to port (Directive 2019/883/EU of the European Parliament and of the Council of 17 April 2019 on port reception facilities for the delivery of waste from ships, n.d., Art. 4).

The challenges presented collectively undermine the effectiveness of international and European legal frameworks and highlight the need for improved infrastructure, harmonised procedures, and stakeholder engagement to ensure that waste is not only collected but also effectively sorted and treated in an environmentally responsible manner. Nevertheless, there is a willingness and capacity among port authorities to implement improvements to properly manage and monitor fishing litter, with several recommended solutions identified. This article demonstrates that, although ports are attempting to comply with the EU and national regulations on fisheries waste management and have many successful strategies in place, there is significant room for improvement and motivation to do so in terms of modernising PRF infrastructure, investing in end-user education, and the implementation of more standardised, aligned and advanced policies and processes.

Author contributions

CP: Conceptualization, Formal analysis, Funding acquisition, Methodology, Project administration, Supervision, Writing – original

2 https://www.unep.org/ietc/what-we-do/extended-producer-responsibility

draft. GA: Conceptualization, Formal analysis, Funding acquisition, Methodology, Writing – original draft. MA-P: Writing – original draft. PS: Writing – original draft. AG: Formal analysis, Investigation, Writing – review & editing. SV: Conceptualization, Funding acquisition, Project administration, Supervision, Writing – review & editing.

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Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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