



D5.5 Roadmap

Roadmap of future development beyond the project. Future analysis on the NETTAG+ solutions considering the new reality and change of paradigm in fisheries, after the project implementation and the needs in the medium to long-term. Medium to long-term R&I roadmaps, performed in collaboration with the advisory board and main stakeholders, around the three solutions of NETTAG+, resulting in a revised action plan to be developed with funding strategies and timelines for each of the solutions.



Document Information

Grant Agreement no. 101112812

Call ID	HORIZON-MISS-2022-OCEAN-01
Project Name	Preventing, Avoiding and Mitigating Environmental Impacts of Fishing Gears and Associated Marine Litter
Project Acronym	NETTAG+
Project Website	https://nettagplus.eu/
Deliverable ID	D5.5
Work Package Reference	WP5
Due Date of Deliverable	30/04/2026
Submission Date	29/04/2026
Dissemination Level	Public
Lead Partner	CIIMAR
Participating Partner	All

Quality information and Revision History

Version	Authors	Date
1	Lisa Sousa, Sandra Ramos, Marisa Almeida, Sabrina Rodrigues, Maria Francisca Espincho and NETTAG+ consortium	29/04/2026

Summary NETTAG+ Project

NETTAG+ aims to provide a portfolio of three innovative smart and sustainable solutions to address the negative impacts of abandoned, lost or otherwise discarded fishing gear (ALDFG) on marine life and habitats. NETTAG+ will be based on synergistic activities between the fisheries industry, scientists and NGOs to develop three solutions to PREVENT, AVOID and MITIGATE the harmful impacts of ALDFG.

NETTAG+ will PREVENT marine litter derived from fisheries activities, AVOID loss of fishing gears, and MITIGATE harmful impact by removing existing ALDFG. These three solutions will jointly contribute to reduce ALDFG and marine pollution, namely by: reducing the introduction of hazardous chemicals and microplastics originating from ALDFG; reducing ghost fishing, bycatch and entanglements of sensitive or endangered species on ALDFG; and improving mapping, tracking and recovery technologies to retrieve ALDFG.

NETTAG+ aims to upgrade and upscale the integrative preventive approach that started in the previous NetTag project, and aims to replicate it in Mediterranean regions, providing the fisheries industry with three smart and environmentally-friendly solutions to reduce ALDFG and prevent the environmental impacts of fishing gears. The three solutions will be developed to maturity (TRL 7-8) by the end of the project, and will be tested, validated and demonstrated in real conditions in Atlantic and Mediterranean countries, namely Portugal (PT), United Kingdom (UK), Spain (SP), Italy (IT), Croatia (HR) and Malta (MT). NETTAG+'s ambition is to change the paradigm of the fisheries industry, aspiring to transform the societal perspectives about the role of fishers as Guardians and Cleaners of the Ocean. NETTAG+ will empower the sector to take effective actions to address marine pollution, promoting their role as key actors to tackle marine pollution.

Contents

Executive Summary	5
1 Context.....	6
2 PREVENT marine litter derived from fisheries activities	8
2.1 Awareness Actions	8
What is the solution?	8
Where are we now?	9
What comes next?	13
2.2 Litter Management at Ports.....	15
What is the solution?	15
Where are we now?	15
What comes next?	16
2.3 Fisher Reward Program.....	19
What is the solution?	19
Where are we now?	19
What comes next?	21
3 AVOID the loss of fishing gear	23
3.1 Acoustic Tags.....	23
What is the solution?	23
Where are we now?	23
What comes next?	25
3.2 IRIS robotic system.....	28
What is the solution?	28
Where are we now?	28
What comes next?	30
4 MITIGATE the harmful impacts of existing ALDFG	32
4.1 High-resolution sonar image systems coupled with AI Detection Algorithms.....	32
What is the solution?	32
Where are we now?	32
What comes next?	34
4.2 Environmental harmfulness of fishing gear and ALDFG.....	36
What is the solution?	36
Where are we now?	36
What comes next?	37
References.....	38

Figures

Figure 1. Overview of NETTAG+ objectives per solution www.nettagplus.eu	6
Figure 2. Structure of the NETTAG+ roadmap	7
Figure 3. Pictures of the materials used during the participatory workshops with fishers.....	9
Figure 4. Locations of NETTAG+ participatory workshops	10
Figure 5. Pictures of NETTAG+ workshops with fishers in Spain, Italy, Croatia, Malta and Portugal (from left to right, top to bottom).....	11
Figure 6. Pictures from the Clean Ocean Day events	11
Figure 7. Pictures of the English version of the handbook.....	12
Figure 8. Example of the awareness postcards in Italian.	12
Figure 9. Example of the final infographic summarising marine litter management within the fisheries sector.....	13
Figure 10. Location of the ports analysed and number of interviews conducted with port authorities and managers per country.	15
Figure 11. First page of the Policy Brief (left) and map illustrating the locations and key characteristics of the fishing ports analysed (right).....	16
Figure 12. Location of the workshops and interviews conducted to support the qualitative study on Fisher Reward Programs.	20
Figure 13. Participants experiencing the virtual reality activity at public events (left and middle,) and an example of the experience simulating a fishing vessel setting (right).	21
Figure 14. Components of MyGearTag: acoustic tag (left), SLU (middle), and mobile application (right).24	
Figure 15. Location of MyGearTag field trials.....	25
Figure 16. IRIS robotic system being deployed (left), computer interface (middle), and approaching a tagged fishing net (right).	28
Figure 17. Location of IRIS field trials.	29
Figure 18. Imaging sonar target characterisation tests conducted in a tank (left); machine learning algorithms for ALDFG detection (middle), and acoustic sensor integrated into the IRIS robotic system. .33	
Figure 19. Locations where the acoustic sensors and IRIS were tested under real environmental conditions.....	33
Figure 20. Picture of the net submerged in the mesocosms experiments (left) and in situ experiments at Póvoa de Varzim fishing harbour (middle); fishing net surface after immersion in seawater under environmental conditions (right).	36
Figure 21. Location of the in-situ experiments.....	37

Executive Summary

This roadmap presents a forward-looking framework to support the continued development, uptake and replication of the solutions developed within the NETTAG+ project. Building on the project's results and stakeholder engagement processes, it identifies priority actions and opportunities to further advance technological and social innovations aimed at addressing fisheries-related marine litter and ALDFG.

The roadmap was developed through a critical analysis of the NETTAG+ outputs, complemented by discussions among project partners and insights gathered during the NETTAG+ Innovation Board analysis meetings, which involved members of the Advisory Board and main stakeholders. It provides an overview of: the current status of the solutions developed by the NETTAG+ project ("What is the solution?"); the progress and achievements reached during the project ("Where are we now?"); and suggestions for future actions for further development, validation, uptake or replication for further development, validation, uptake or replication ("What comes next?").

The roadmap analyses the main solutions developed within the NETTAG+ pillars PREVENT, AVOID and MITIGATE, including awareness actions, litter management at ports, the Fisher Reward Program, acoustic tags, the IRIS robotic system, high-resolution sonar imaging systems coupled with AI detection algorithms, and research on the environmental harmfulness of fishing gear and ALDFG.

1 Context

ALDFG is recognised as one of the most harmful and persistent forms of marine litter, estimated to account for ca.10% of all plastic in the Ocean (Drinkwin, 2022). Predominantly composed of plastic, ALDFG can persist in the marine environment for long periods, posing several adverse environmental and socio-economic impacts.

Although fisheries are a source of sea-based marine litter, they are also among the activities most affected by marine litter. Marine debris can damage catches, fishing gear, and vessels, and compromise navigational safety. It is estimated that marine litter costs the EU fishing fleet approximately €61.7 million per year (Acoleyen *et al.*, 2013). Impacts extend beyond fisheries, also affecting other key coastal economic activities, namely tourism. Addressing ALDFG therefore requires integrated and innovative strategies that combine technological and social solutions.

The NETTAG+ project responds to these challenges by developing and demonstrating three complementary and innovative solutions to **PREVENT** the marine litter derived from fisheries activities, **AVOID** the loss of fishing gear, and **MITIGATE** the harmful impacts of existing ALDFG (Figure 1).

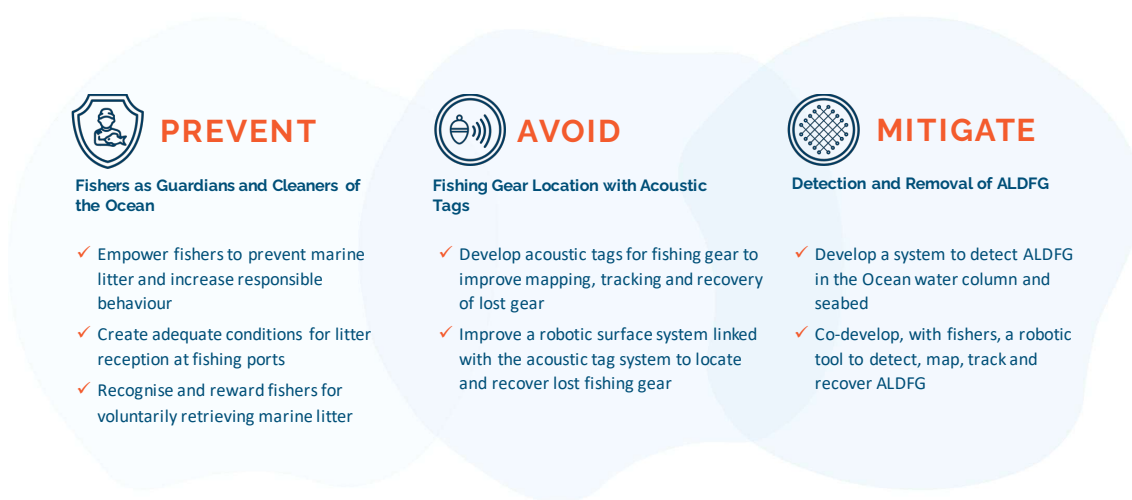


Figure 1. Overview of NETTAG+ objectives per solution www.nettagplus.eu

Across all these three solutions, NETTAG+ adopted a multi-stakeholder, co-design approach involving researchers, fishers, technology developers, research organisations, NGOs, fisheries industry, port authorities, fisheries managers, and policymakers. These solutions were developed in close collaboration with fishers and the fisheries industry and tested, validated and demonstrated under real conditions.

While the project has delivered a range of validated technological and social outputs, effectively addressing fisheries-related marine litter requires continued action beyond the project lifetime. This roadmap summarises the main activities of the NETTAG+ project and presents a forward-looking perspective on further development, uptake and replication opportunities, contributing to the objectives of the EU Mission *Restore Our Ocean and Waters by 2030*, particularly those related to preventing and eliminating Ocean and sea pollution.

The roadmap presented in this report builds on a critical analysis of the NETTAG+ outputs, and on discussions held among project partners during the Analysis Meetings with the NETTAG+ Innovation Board (Advisory Board and main stakeholders), carried out within the Knowledge Management and Transfer Methodology (KMKT) led by ERINN Innovation (for more details please see D5.2 and D5.4). For the development of this roadmap, all Key Exploitable Results (KERs) and other Knowledge Outputs (KO) were considered.

The roadmap is organised around the three NETTAG+ solution pillars: PREVENT, AVOID and MITIGATE (Figure 2). For each solution, it provides: i) a short description of the solution and its objectives (“What is the solution?”); ii) an overview of the progress and achievements reached during the project (“Where are we now?”); and iii) an outline of suggestions for future actions for further development, validation, uptake or replication (“What comes next?”).



Figure 2. Structure of the NETTAG+ roadmap

2 PREVENT marine litter derived from fisheries activities



PREVENT

Fishers as Guardians and Cleaners of the Ocean.

The **PREVENT solution** aims to reduce marine litter originating from fisheries by empowering professional fishers as '*Guardians and Cleaners of the Ocean*' and promoting the adoption of responsible practices for waste management both on board vessels and in fishing ports. The approach combines awareness actions with fishers, assessment of litter management at ports, and the design of fisher reward programs.

2.1 Awareness Actions

What is the solution?

The awareness actions consist of **educational materials** and **participatory workshops** designed for professional fishers to increase understanding of the adverse environmental and socio-economic impacts of marine litter and abandoned, lost or discarded fishing gear (ALDFG). These actions aim to promote the adoption of practical solutions and best practices related to waste management on board, the handling and landing of litter passively collected in fishing gear, and broader sustainability considerations such as emissions reduction and bycatch mitigation.

A central component of the approach is the organisation of **participatory workshops with professional fishers**, following a '*from fishers to fishers*' methodology. These workshops create a space for discussion, knowledge exchange, and the co-design of practical solutions based on fishers' operational experience.

Complementing these activities, **Clean Ocean Day events** were organised as demonstration initiatives to illustrate and quantify the role of fishers in addressing marine litter. These events occur on regular fishing days, where participant vessels carry on board two distinct bags to store litter: one to store all passively fished waste; and another bag for the litter produced by the fishing vessel. At the end of the day, the litter of the two bags were quantified and characterised to assess the litter produced by the fishing vessel *versus* the litter it retrieved from the Ocean.

These events highlight the dual role of the fisheries sector: while fishing activities can contribute to marine litter generation, fishers also regularly retrieve litter during routine fishing operations stressing their key role in tackling marine litter.

Where are we now?

A structured package of **six workshop briefs and supporting materials** was co-developed for professional fishers (see deliverable [D2.1](#) for detailed information). These materials target fisheries communities in the North-East Atlantic (Portugal, Spain) and the Mediterranean (Spain, Italy, Croatia, Malta). The workshop series covers the following themes:

- Workshop #1 - Seminar on marine litter
- Workshop #2 - Marine litter produced on board
- Workshop #3 - Marine litter collected by fishing gears
- Workshop #4 - Sustainable practices: bycatch reduction and marine conservation
- Workshop #5 - Reducing fisheries footprint
- Workshop #6 - NETTAG+ solutions

All workshop materials (Figure 3) have been translated into the languages of the participating countries and are publicly available through the project website (<https://nettagplus.eu/resources/#education-materials>).



Figure 3. Pictures of the materials used during the participatory workshops with fishers

Between September 2024 and July 2025, **six participatory workshops** were organised across eight locations in Portugal, Spain, Italy, Croatia, and Malta (Figure 4 and Figure 5). In total, 259 participants attended the workshops, including 238 professional fishers representing both small- and large-scale fishing fleets (see deliverable [D2.3](#) for further details).



Figure 4. Locations of NETTAG+ participatory workshops

Fishers played an active role by sharing insights from their daily work at sea. Their contributions demonstrated a high level of environmental awareness and willingness to adopt more sustainable practices, while also highlighting persistent structural barriers. These include limited port infrastructure for waste management, unclear disposal procedures for litter landed in ports, and economic constraints affecting the adoption of new technologies.



Figure 5. Pictures of NETTAG+ workshops with fishers in Spain, Italy, Croatia, Malta and Portugal (from left to right, top to bottom)

During NETTAG+ project, seven **Clean Ocean Day events** were organised in Portugal, Spain, Italy, Croatia, and Malta, with a total of 71 fishing vessels and 224 participating fishers (Figure 6).

Across all countries, the weight of passively fished waste was higher than the litter produced on board the fishing vessels. Plastics were the dominant material in both categories, representing more than 50% of the collected items. These events showed that, when supported by adequate port reception facilities, waste-management systems and awareness initiatives, fishers can play a significant role in preventing and mitigating marine litter.



Figure 6. Pictures from the Clean Ocean Day events

Based on workshop discussions and identified needs, several **awareness materials** were also developed to support fishers and facilitate the wider dissemination of best practices (Figure 7, Figure 8 and Figure 9). These include:

Handbook 'Fishers as Guardians of the Ocean: Best Practices for Waste Management'

Designed for use on board fishing vessels, the handbook provides practical guidance on on-board waste management, the landing of marine litter passively collected in fishing gear, and responsible disposal practices in ports. Its content was informed directly by discussions with fishers during the workshops.



Figure 7. Pictures of the English version of the handbook.

Infographics and cards

Awareness postcards highlighting the main insights from the workshops.



Figure 8. Example of the awareness postcards in Italian.

An **infographic series** summarising key findings from the workshop reports and the assessments of port litter management plans and facilities.

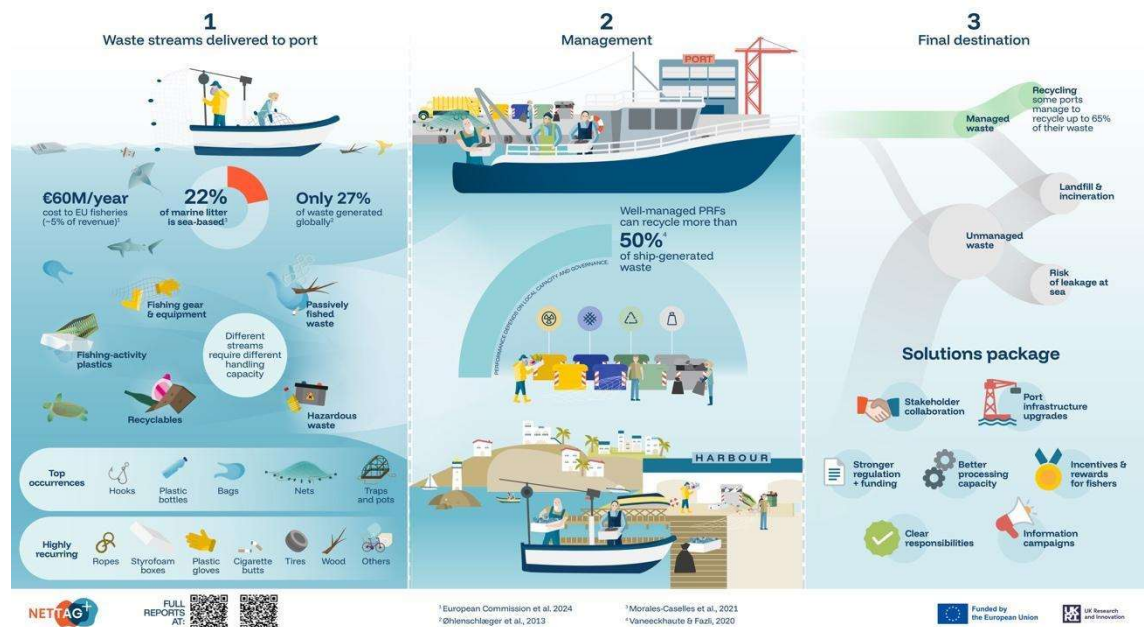


Figure 9. Example of the final infographic summarising marine litter management within the fisheries sector.

What comes next?

The awareness actions developed within NETTAG+ are ready for use and available on open-access repositories to facilitate the dissemination of educational materials across different regions. These solutions are suitable to be implemented in different sea basins and fisheries communities. The educational materials are also part of the Key Exploitable Results (KERs); further details on their impact pathways are provided in [D5.4](#).

Replication areas

In the short- and medium-term, efforts should prioritise the **replication of participatory workshops in additional fisheries communities**. The approach is already being extended through the EU [PHAROS project](#) (Grant Agreement No. 101157936), within the Fisher Guardian Program, where the workshop materials are being further refined to integrate lessons learned from previous workshops (e.g. reducing writing-intensive activities and time, strengthening the balance between information delivery and interactive discussion) and adapt to local fisheries contexts.

Medium- and long-term actions should focus on **institutionalising awareness activities within fisheries governance and education frameworks**. This involves integrating the materials into training programs and capacity-building actions for fishers, programmes delivered by fishers' associations, cooperatives or fisheries organisations, maritime/port authorities, and environmental NGOs. Institutionalisation will be key to ensuring continuity, enabling these actions to move from project-based activities to standard practice within fisheries management and marine litter prevention efforts.

Target end-users and adopters

The primary end-users of the awareness actions are **professional fishers of small and large-scale fisheries**, who can apply improved waste management practices on board and contribute to the proper landing and management of marine litter collected during fishing activities. **Fisheries authorities/managers and port authorities** can also benefit by increasing their awareness of marine litter and the need of collaborative efforts to address them, while promoting the role of Fishers as Guardians and Cleaners of the Ocean. **NGOs and academic organisations** may further support the replication of the approach by integrating the materials and workshop methodology into training and capacity-building programmes, outreach activities and future marine litter initiatives. **Fishers' associations, cooperatives, fisheries organisations** can act as key multipliers by organising awareness sessions and disseminating best practices among their members.

Potential funding

Several funding mechanisms could support the continuation and scaling of awareness actions. Public funding programmes such as the **European Maritime, Fisheries and Aquaculture Fund (EMFAF)**, **regional fisheries funds**, and **national marine-environment programmes** could finance awareness campaigns with fishers. Additional support could come from **Horizon Europe** or **Mission Ocean and Waters** initiatives focusing on ocean literacy and pollution reduction. Collaboration with NGOs, fisheries organisations and private sector actors could also help mobilise resources for awareness campaigns and capacity-building initiatives within fisheries communities.

2.2 Litter Management at Ports

What is the solution?

Fishing port reception facilities (PRFs) play a central role in preventing marine litter pollution and supporting the transition towards more sustainable fisheries and circular economy practices. Adequate port infrastructure and management systems are essential to ensure that waste generated on board fishing vessels, as well as marine litter passively collected in fishing gear, can be properly managed.

Within this context, NETTAG+ project produced the Policy Brief ***‘Litter management plans and facilities at ports: An assessment of challenges and recommendations for marine waste management in European fishing ports’***. This document is based on an assessment of fishing-related litter management practices and PRF across several European fishing ports.

Where are we now?

The [Policy Brief](#) is based on an assessment of litter management practices and port reception facilities in selected fishing ports across Croatia, Italy, Malta, Portugal and Spain (Figure 10).



Figure 10. Location of the ports analysed and number of interviews conducted with port authorities and managers per country.

The analysis examined fisheries waste management policies, operational practices, infrastructure availability, and the economic and social implications of current systems. The study also explored the capacity and willingness of port authorities to strengthen waste-management systems, including opportunities related to recycling and circular economy initiatives (see deliverable [D2.2](#) for further details).

The Policy Brief (Figure 11) identified several recurring challenges faced by port authorities when managing fisheries-related marine litter and fishing gear. This highlights the complexity of marine litter management in ports and the need for comprehensive, tailored solutions that address both logistical and economic barriers. 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 in terms of streamlining policies and processes – especially those relating to the circular economy, modernising PRF infrastructure and investing in end-user education.



Figure 11. First page of the Policy Brief (left) and map illustrating the locations and key characteristics of the fishing ports analysed (right).

What comes next?

The Policy Brief is one of the project's a Key Exploitable Results (KERs); further details on its impact pathways are provided in [D5.4](#).

Replication areas

Further work is needed to strengthen litter management systems in fishing ports and support the effective implementation of port reception facilities for fisheries-related waste.

Short- to medium-term actions include **expanding the analysis to a larger number of fishing ports** across different European sea basins (e.g. Baltic Sea, North Sea) in order to better understand differences and identify replicable good practices. Building on this evidence base, more detailed policy recommendations can be developed to support improvements in port infrastructure, operational procedures and waste monitoring systems.

Future actions should also focus on **improving regulatory clarity and alignment** between EU and national legislation related to port reception facilities, fisheries waste management and marine litter monitoring. Strengthening guidance for ports and fisheries operators could help reduce administrative complexity and improve compliance. These efforts are also aligned with the recently launched **EU Ports Strategy**, which highlights the importance of strengthening the role of ports in supporting environmental sustainability, circular economy initiatives and pollution reduction across the maritime sector.

Additional efforts should aim to **reinforce collaboration** between ports, fisheries organisations and other stakeholders. This may include organising workshops, training sessions and knowledge-exchange activities to raise awareness among fishers and port operators about proper waste management practices and available disposal mechanisms.

In the longer term, actions should focus on **strengthening the circular economy potential** of fisheries-related waste, including recycling and reuse initiatives for fishing gear, and the **establishment of funding mechanisms** that encourage fishers to land marine litter retrieved during fishing operations. **Monitoring and evaluating the long-term institutionalisation** of these practices within port management systems will also be important.

Target end-users and adopters

The main adopters of improved litter management systems are **port authorities and port management entities** responsible for the operation of port reception facilities and waste-management procedures.

Professional fishers represent key end-users of these systems, as they interact directly with port waste facilities and play a central role in landing and properly disposing of marine litter and fisheries-related waste.

Other relevant adopters include **fisheries organisations** that can promote best practices among their members, as well as **public authorities** responsible for fisheries management, marine environment protection and port regulation. **Environmental NGOs** and research institutions may also contribute to supporting awareness initiatives, monitoring systems and knowledge exchange across ports.

Potential funding

Several funding mechanisms could support improvements in port litter management systems and the implementation of the proposed actions. For example, at the European level, the **European Maritime, Fisheries and Aquaculture Fund (EMFAF)** could be an option, as it represents a key funding source for investments in port infrastructure, fisheries waste management and circular economy initiatives related to fishing gear.

Additional support may be mobilised through EU funding instruments such as **Cohesion Policy funds** and **InvestEU**, as well as through national or **regional fisheries development funds** and programmes. Climate-related funding instruments such as the **Green Climate Fund** may also support initiatives addressing marine pollution and coastal resilience.

Port authorities may finance improvements through port management budgets or through port fee mechanisms linked to waste reception services.

Further opportunities may arise through research and innovation programmes such as **Horizon Europe**, particularly initiatives related to Mission Ocean and Waters, as well as through partnerships with private sector actors involved in recycling and circular economy solutions for fishing gear and marine plastics.

2.3 Fisher Reward Program

What is the solution?

During routine fishing activities, fishers frequently retrieve marine litter passively collected in their fishing gear and bring it to shore. This voluntary activity often entails operational costs, including fuel consumption, time lost from fishing operations, on-board storage constraints, and the delivery of waste to port facilities. In most cases, these efforts are not recognised nor compensated, despite the fact that much of the waste originates from pollution sources outside the fishing sector itself.

Within this context, NETTAG+ project produced a **White Paper ‘Fishers’ Reward Programs for Marine Litter Collection: Evidence, Best Practices and Policy Recommendations from the fisheries sector’**. This document explores Fisher Reward Programs as a policy and governance approach to recognise, incentivise and reward fishers for their voluntary role in retrieving marine litter during fishing operations. By acknowledging fishers as Guardians and Cleaners of the Ocean, such programs aim to strengthen collaboration between fisheries stakeholders, port authorities and policymakers in addressing marine litter challenges.

In parallel, NETTAG+ developed a **Virtual Reality (VR)** experience as an engagement and awareness-raising tool. The immersive experience places users on board a fishing vessel and presents three scenarios: current conditions, a business-as-usual future, and a future shaped by the adoption of NETTAG+ solutions. The VR experience is accompanied by empathy questionnaires to assess how exposure influences users’ perceptions of fishers and their motivation to engage in marine litter mitigation.

Where are we now?

The [White Paper](#) resulted from an investigation in Croatia, Italy, Malta, Portugal and Spain (Figure 12) to explore how Fisher Reward Programs could be designed and implemented. The research focused on understanding on how different stakeholders perceive potential incentive mechanisms to recognise and support fishers’ voluntary retrieval of marine litter (see deliverable [D2.5](#) for further details).

By comparing perspectives across countries and stakeholder groups, the study identifies both context-specific differences and converging views relevant for future policy development.



Figure 12. Location of the workshops and interviews conducted to support the qualitative study on Fisher Reward Programs.

The White Paper provides an evidence-based foundation to support policymakers, fisheries authorities and port managers in designing reward-based mechanism. It outlines stakeholder expectations, identifies common constraints, and proposes guiding principles for the development of pilot initiatives that can be tested, evaluated and adapted before broader implementation.

The analysis shows that Fisher Reward Programs can be a promising instrument to encourage fishers to voluntarily collect marine litter, but only if implemented under clearly defined and well-governed conditions. Rather than functioning as standalone solutions, such programs should be integrated into broader marine litter management strategies that combine prevention measures, effective waste management systems, economic incentives and active stakeholder engagement.

The White Paper highlights the importance of developing context-specific pilot programs based on exploratory evidence, supported by stable long-term funding and embedded within existing fisheries and waste management policy frameworks. To ensure effectiveness and participation, reward programs should rely on simple administrative procedures, transparent rules and proportionate verification systems. Continuous dialogue with fishers, port authorities and

fisheries organisations is also essential to build trust, improve program design and support long-term implementation.

The **VR experience** has also been used during several EU-level and national events as both a communication and research tool (Figure 13). Stakeholders from the fisheries sector, policymakers and the general public participated in the VR-based empathy assessment. Initial responses from participants indicate that the immersive experience was positively received and contributed to increased awareness of marine litter challenges and greater recognition of fishers' role in addressing them.



Figure 13. Participants experiencing the virtual reality activity at public events (left and middle,) and an example of the experience simulating a fishing vessel setting (right).

What comes next?

The VR experience is one of the project's a Key Exploitable Results (KERs); further details on its impact pathways are provided in [D5.4](#).

The findings provide exploratory and context-specific insights that can inform future pilot initiatives and policy development at local, national, and EU levels. Future research should **expand stakeholder participation across distinct fleet segments and port types** to obtain a more comprehensive understanding of operational constraints and opportunities for reward-based mechanisms.

Building on the NETTAG+ evidence base, the next step involves **designing and implementing pilot Fisher Reward Programs**. These pilots should test different incentive mechanisms and operational models while assessing their environmental impact, economic feasibility and administrative requirements.

If pilot initiatives demonstrate positive environmental and operational outcomes, the approach could progressively be scaled to additional ports and fisheries segments. At this stage, lessons

learned from pilot implementation would inform the development of more structured policy instruments at regional, national or EU level.

Ensuring stable funding mechanisms and embedding reward schemes within broader marine litter management frameworks will be essential to support long-term uptake and policy integration.



3 AVOID the loss of fishing gear



AVOID

Fishing Gear Location with Acoustic Tags.

The **AVOID solution** addresses the unintentional loss of fishing gear through the development and testing of innovative technologies that enable fishers to rapidly locate and recover fishing gear before it becomes ALDFG. The approach combines the development and engineering of cost-effective acoustic tags and a robotic recovery system designed to support the localisation and retrieval of submerged gear.

3.1 Acoustic Tags

What is the solution?

This technological solution consists of an affordable and easy-to-use subsea acoustic transponder technology designed to enable fishers to rapidly locate submerged fishing gear in case of loss.

The system integrates three main components: an acoustic tag to be attached to the fishing gear, a Surface Locator Unit (SLU) to be deployed from the vessel, and a user-friendly mobile application that guides the user through the localisation process.

Where are we now?

Building on a concept first demonstrated in the earlier NetTag project¹, the acoustic gear location system was further optimised and validated within the NETTAG+ project. During the project lifetime the system reached Technology Readiness Level (TRL) 9 and is suitable for routine fishing operations without requiring specialised scientific or technical expertise.

The technology is already in the market being commercialised with the brand [MyGearTag](#) (Figure 14). The system enables rapid, targeted recovery operations at distances of up to 2.5 km

¹ 'NetTAG: Tagging fishing gears and enhancing on board best-practices to promote waste free fisheries'.

Funded by European Union European Maritime and Fisheries Fund (EASME/EMFF/2017/1.2.1.12/S2/02/SI2.789121).

and certified operation at depths beyond 650 m, with structural integrity testing performed down to 1,400 m. Power management optimisation allows a battery lifetime exceeding six months.

Each acoustic tag is registered to a unique user ID, ensuring that only the owner can actively locate the tagged gear while allowing voluntary sharing of access or the activation of a public 'discovery' mode if the gear is considered irretrievably lost. Unlike conventional pinger-based systems that continuously emit acoustic signals, the tag remains silent until actively interrogated, significantly reducing acoustic disturbance in the marine environment (see [D3.1](#) and [D3.3](#) for detailed information).

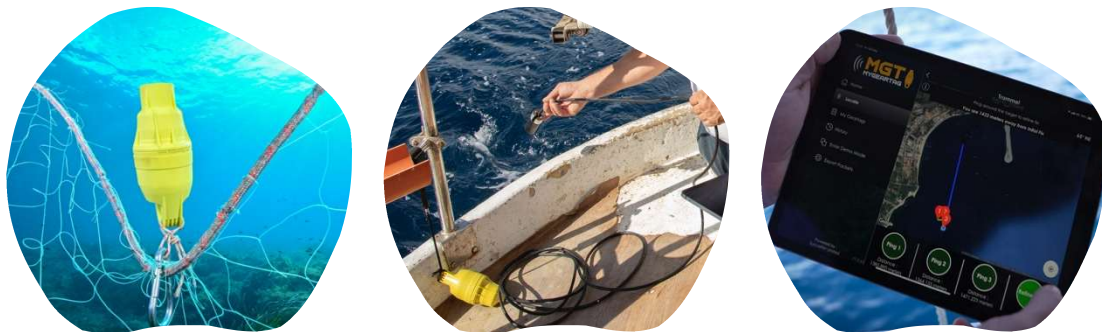


Figure 14. Components of MyGearTag: acoustic tag (left), SLU (middle), and mobile application (right)

MyGearTag was developed in close collaboration with fisher communities, which helped define operational requirements, including low cost, ease of use, long battery life, and the ability to assign a unique identification to each device and thus ensuring that only owners can detect the tags. Moreover, the fisher's collaboration was essential to ensure MyGearTag compatibility with fishing operations without compromising the fishing efficiency of gear.

MyGearTag has been extensively tested and demonstrated under real conditions in several regions, including North Sea, Mediterranean Sea, and North Atlantic (Figure 15). Field trials and demonstration activities with fishers were conducted to validate the system performance and assess operational usability (see [D3.5](#) for further details). The technology was tested across different fishing gear types, including trammel nets, gillnets and longlines, as well as traps and trawl nets.

The environmental impact of the acoustic tag was also assessed through a long-term mesocosm experiment in which the tag remained submerged in seawater for one year. No release of contaminants such as microplastics or metals was detected, indicating that the technology has

no relevant environmental impact under prolonged aquatic exposure and can be safely employed.



Figure 15. Location of MyGearTag field trials.

Beyond gear localisation, extended features **of the acoustic tag have been explored** (see [D3.2](#)), including prototype mechanical release systems currently under further development, and passive acoustic monitoring algorithms for cetacean detection. New pre-production cetacean detection boards have been produced and deployed in the North Sea for testing, with further trials expected to continue beyond the project duration.

What comes next?

The acoustic tag technology and its extended features are Key Exploitable Results (KERs); further details on their impact pathways are provided in [D5.4](#).

Scaling-up

Although the acoustic localisation system has reached TRL9 and is already commercially available, further efforts are required to facilitate large-scale adoption and explore additional functionalities.

Priorities include **scaling up manufacturing capacity and transferring production to higher volumes** in collaboration with industry partners. Further **integration with fishing vessels** can also be pursued, including **permanent installation of transducers on vessels** (hull/pole mount) and **direct interfaces with onboard navigation systems**.

The technology could be **expanded to support the localisation of other underwater assets**, such as scientific instruments, aquaculture infrastructure, diving operations or offshore windfarms. **Additional sensing capabilities**, including environmental monitoring sensors, may also be integrated into the acoustic tags.

Further development and commercialisation of **dolphin detector** and **ropeless fishing** technology will continue with additional UK funding and aid from Horizon Booster. Passive acoustic monitoring technologies may also find applications in areas such as **security subsea infrastructure**.

In addition to technological development and deployment actions, wider adoption of gear localisation technologies will also depend on **enabling regulatory and economic conditions**. Efforts should therefore focus on strengthening policy frameworks and incentives that support the use of gear-tracking systems. For example, this could include promoting gear marking requirements within regional fisheries management organisations, introducing financial incentives that encourage fishers to adopt acoustic tags.

Target end-users and adopters

Professional fishers represent the primary end-users of the acoustic tag system, as the technology enables rapid localisation and recovery of fishing gear, reducing both economic losses and environmental impacts. **Public authorities** and **environmental agencies** may also adopt the technology as part of programmes aimed at reducing ALDFG and improving marine monitoring.

Other potential end-users include **aquaculture operators, scientific institutions, diving operators** and **offshore wind farms** that require reliable localisation of underwater equipment.

Potential funding

Several funding and investment mechanisms could support the scaling and wider deployment of acoustic gear localisation technologies. Public funding programmes such as the **European Maritime, Fisheries and Aquaculture Fund (EMFAF)** may support the adoption of acoustic tags by fishing fleets as part of measures to reduce gear loss and marine litter. **Extended Producer**

Responsibility (EPR) schemes for fishing gear could also represent an additional funding mechanism to support gear-tagging technologies.

Research and innovation funding from programmes such as **Horizon Europe** may support the further development of extended functionalities, including environmental sensing and cetacean detection capabilities.



3.2 IRIS robotic system

What is the solution?

The IRIS robotic system is an autonomous underwater vehicle that can operate either in autonomous mode (AUV) or in remotely operated one (ROV). It is suitable for coastal depths, advanced control manoeuvres, real-time video imaging in ROV mode, acoustic tag detection, imaging sonar, and multiple payload capacity. Its compact design and light weight enhances portability and facilitates underwater manoeuvrability.

IRIS was designed to support end-to-end fishing gear recovery operations, particularly in situations where fishers are unable to retrieve tagged gear using conventional fishing vessels. In such cases, additional information on the location and surrounding conditions of the gear may be required before the recovery operations can be implemented.

IRIS is intended to be operated by port authorities or other authorised organisations capable of supporting recovery operations when they exceed the practical capabilities of fishing vessels.

Where are we now?

Building on a concept and prototype first demonstrated in the earlier NetTag project, the IRIS robotic system was further developed within NETTAG+ as an automated solution capable of locating tagged fishing gear and supporting its recovery (Figure 16).



Figure 16. IRIS robotic system being deployed (left), computer interface (middle), and approaching a tagged fishing net (right).

The system evolved from the previous prototype with several technical improvements, including enhanced navigation capabilities, additional sensors, increased payload capacity and the implementation of autonomous manoeuvres enabling the robot to approach tagged gear

without direct human control. A dedicated mechanical system for attaching a recovery line to the lost gear was also developed and integrated into the IRIS vehicle.

IRIS is equipped with two acoustic locator devices that enable it to locate and approach acoustic tags, such as MyGearTag. The robot is also equipped with imaging cameras and sonar systems that provide visual and acoustic information on the fishing gear and surrounding conditions, enabling operations in low-visibility environments.

The system has been tested in combination with MyGearTag during field trials conducted under real conditions in Croatia, Italy, Portugal and Spain (Figure 17). These demonstrations validated the robot's capability to locate tagged gear and operate in different marine environments.

IRIS was developed in close collaboration with fisher communities, which helped define operational requirements namely easy operation by small teams (two-man operable), real-time video imaging in ROV mode, and suitable for operation in coastal environments.



Figure 17. Location of IRIS field trials.

IRIS remains a prototype system (TRL 7) rather than a commercial product, serving as a technological basis for future robotic recovery systems. The robot combines compact dimensions with advanced acoustic sensing, navigation capabilities, precise localisation and a robust retrieval mechanism, enabling high operational performance during multiple real sea operational conditions.

The environmental impact of the robotic retrieval operations was assessed during field trials conducted in three different locations and involving several fishing gear types. Results indicated no modification of the water parameters investigated, including underwater sound levels, demonstrating that the technology has minimal environmental impact and can be safely deployed.

What comes next?

Scaling-up

Technical improvements are needed in the mechanism used to attach the recovery line to lost fishing gear. This includes refining the mechanical and electromechanical attachment system and improving the automatic detection of suitable attachment points on fishing nets or gear structures.

Future work should also explore the development of a fully automated grasping system, as well as additional functionalities such as integrating cutting tools to enable the controlled cutting of nets in cases of entanglement.

Finally, service delivery models for the deployment and operation of robotic recovery systems should also be explored.

Target end-users and adopters

Port authorities and **fisheries management** bodies represent key potential adopters of robotic recovery systems, as they may coordinate fishing gear recovery operations within fishing ports and coastal areas.

Additional potential users include **marine research institutions**, **environmental monitoring organisations** and **maritime industries** requiring robotic inspection or recovery capabilities.

Potential funding

Further development of robotic recovery systems could be supported through research and innovation funding programmes such as Horizon Europe, particularly initiatives focused on marine robotics, ocean monitoring and pollution reduction.

Additional support may come from EMFAF and national marine environment programmes aimed at reducing ALDFG and improving fisheries sustainability. Partnerships with robotics

companies, marine technology developers and blue economy innovation funds may also help support the transition from prototype systems to operational recovery services.



4 MITIGATE the harmful impacts of existing ALDFG



MITIGATE

Detection and Removal of Abandoned, Lost or otherwise
Discarded Fishing Gear (ALDFG).

The **MITIGATE solution** targets ALDFG already present in the Ocean through the development of new detection tools based on high-resolution sonar imaging and artificial intelligence (AI) algorithms, integrated with robotic systems to detect, map and track ALDFG in the water column and on the seabed. In parallel, the project investigated the environmental harmfulness of ALDFG and plastic-based and biodegradable fishing gear, increasing the scientific-knowledge of the environmental risk associated with fishing gear.

4.1 High-resolution sonar image systems coupled with AI Detection Algorithms

What is the solution?

ALDFG can persist in the marine environment for decades, causing impacts on marine ecosystems, while its location is often unknown. This solution addresses this challenge by integrating high-resolution sonar imaging systems and AI processing algorithms into an autonomous robotic system.

The system uses underwater acoustic sensors to capture high-resolution sonar images of the seabed and water column. These data are processed using machine-learning algorithms designed to identify acoustic signatures associated with marine litter and fishing gear. By combining advanced sensing technologies and novel detection algorithms with autonomous robotic operations, the system enables the detection, mapping and tracking of ALDFG in the water column and at the seabed.

Where are we now?

Several developments were undertaken to evaluate the potential of acoustic sensing technologies for detecting ALDFG and to integrate these capabilities into an autonomous robotic system. Multiple high-resolution sonar sensors were tested to characterise the acoustic signatures of different types of fishing gear and marine litter.

In parallel, sonar data processing algorithms and machine learning models were developed and trained to enable the automated detection of ALDFG in sonar imagery (Figure 18).

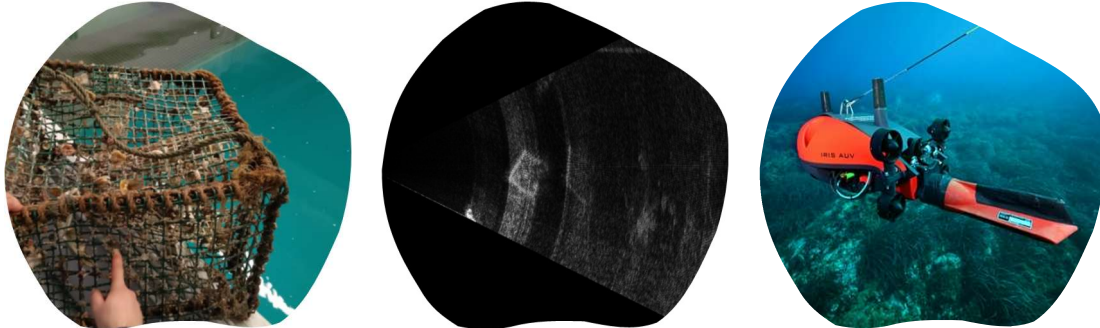


Figure 18. Imaging sonar target characterisation tests conducted in a tank (left); machine learning algorithms for ALDFG detection (middle), and acoustic sensor integrated into the IRIS robotic system.

The sensing technologies and detection algorithms were subsequently integrated into the IRIS robotic system, enabling it to survey marine areas, collect and process sonar data, and autonomously detect, localise and approach ALDFG targets (Figure 18). Tests were conducted with IRIS robotic system deploying different sensing technologies under real conditions in Croatia, Italy, Portugal and Spain (Figure 19).



Figure 19. Locations where the acoustic sensors and IRIS were tested under real environmental conditions.

Combined with its IRIS's navigation and mechanical retrieval capabilities, the system forms an integrated solution that can detect, localise and securely attach to ALDFG to support its recovery. Although these developments demonstrate promising capabilities for automated detection of ALDFG, this solution currently remains at a prototype stage (TRL 5). Further research, additional data collection and extended validation will be required to improve detection accuracy and advance the technology towards higher TRL suitable for operational deployment.

What comes next?

The ALDFG detection algorithms is one of the project's a Key Exploitable Results (KERs); further details on its impact pathways are provided in [D5.4](#).

Scaling-up

Further research and development are required to advance the detection algorithms towards higher technological readiness levels and enable their integration into operational marine litter monitoring systems.

Future actions should focus on improving the accuracy and robustness of detection algorithms through the expansion of training datasets.

Further field experiments and pilot deployments will be necessary to validate the algorithms under diverse environmental conditions.

Further work will focus on improving the integration between robotic systems, acoustic sensing systems and detection algorithms to enable more autonomous ALDFG surveying operations. This includes validating the system through additional field trials in different marine environments.

In the longer term, the robotic solution could support large-scale monitoring and mapping of ALDFG, providing operational support for targeted recovery missions.

Target end-users and adopters

Public authorities/managers and **port authorities** responsible for marine environment protection and monitoring represent potential users of this solution, as they may coordinate activities related to the detection, mapping, monitoring and retrieval of ALDFG.



Potential funding

Further development of acoustic detection algorithms of ALDFG and robotic systems could be supported through research and innovation funding programmes such as Horizon Europe, particularly initiatives focused on marine robotics, ocean monitoring and pollution reduction.

4.2 Environmental harmfulness of fishing gear and ALDFG

What is the solution?

This solution focuses on advancing the scientific understanding of the environmental harmfulness of fishing gear and ALDFG. It addresses key knowledge gaps regarding the role of fishing gear as a potential source of contaminants, namely microplastics, and/or a sink of chemical contaminants and biological hazard agents due to their sorption on ALDFG surface.

Where are we now?

Within the NETTAG+ project, gathering of information and data from the previous NetTag project as well as new experimental work was conducted to evaluate the environmental impacts and degradation processes of three types of fishing gear materials (two made from plastic polymers and one made from biodegradable material) both in laboratory/mesocosm control conditions and in-situ experiments (Figure 20, Figure 21). The assessment examined fishing gear potential to release microplastics and/or to adsorb hazardous chemicals and/or pathogenic agents. Data collected in the new experiments comprised various environmental parameters, such as water physico-chemical parameters, contaminants concentrations (including microplastics, metals, polycyclic aromatic hydrocarbons), and biological data (characterisation of microbial communities in fishing gear biofilms). This assessment contributed to advancing the scientific understanding of marine pollution caused by ALDFG and of biodegradable solutions as a potential mitigation strategy to address it.



Figure 20. Picture of the net submerged in the mesocosms experiments (left) and in situ experiments at Póvoa de Varzim fishing harbour (middle); fishing net surface after immersion in seawater under environmental conditions (right).



Figure 21. Location of the in-situ experiments.

What comes next?

Further research is needed to expand the assessment to **additional types of fishing gear and materials**, including other biodegradable alternatives and bio-based plastics. Additional **in-situ studies under different environmental conditions** (e.g. warmer and colder regions; different UV exposure; areas with different hydrodynamics) will also be required to better understand degradation processes and contaminant interactions.

Continued dissemination of the results through scientific publications and events will support knowledge exchange within the scientific community. In parallel, **communication** with fisheries authorities, regulatory bodies and other relevant stakeholders will contribute to informing future prevention strategies aimed at reducing fishing gear loss and its environmental impacts.

Potential funding

Further research on the environmental impacts of fishing gear and ALDFG could be supported through research and innovation funding programmes such as **Horizon Europe**, particularly initiatives focused on marine pollution, microplastics and sustainable materials.

References

- Drinkwin J, 2022. 'Reporting and Retrieval of Lost Fishing Gear: Recommendations for Developing Effective Programmes', Food and Agriculture Organization, Rome, Italy.
- Acoleyen et al., 2013. 'Study to support the establishment of an initial quantitative headline reduction target for marine litter - final report to the European Commission'. Final report – SFRA0025. pp. 315