circnets

WP2 REPORT

D.2.1.1 Analysis of gaps and possibilities of current end-of-life fishing gear disposal systems

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Contents

GLOSSARY

Derelict fishing gear. Derelict fishing gear, sometimes referred to as "ghost gear," is any discarded, lost, or abandoned fishing gear in the marine environment. This gear continues to fish and trap animals, entangle and potentially kill marine life, smothering habitat, and act as a hazard to navigation (National Ocean Service, 2024).

End-of-life fishing gear: Fishing gear and gear accessories (e.g. ropes, floats, sink weights and other attachments) that are no longer actively used by fishers. These gears can be old, redundant, retired, disused, damaged or discarded (Stolte et al., 2019).

Fishing port. A port that is mainly used by fishing vessels, i.e. vessels that are used to catch fish or other living natural resources mainly commercially.

Plastic containing fishing gear; “means any item or piece of equipment that is used in fishing or aquaculture to target, capture or rear marine biological resources or that is floating on the sea surface and is deployed with the objective of attracting and capturing or of rearing such marine biological resources”. (Directive (EU) 2019/904)

ACRONYMS AND ABBREVIATIONS

ALDFG	Abandoned, lost or discarded fishing gear
BAT	Best available technology
CIRCNETS	Blue Circular Nets project
EEA	European Economic Area
EOL	End-of-life
EPR	Extended producer responsibility
EU	European Union
FFL	Fishing for Litter campaign
NPA	Northern Periphery and Arctic
SUP	Single-use plastics
SUPD	Single-use plastics directive (2019/904/EC)
WFD	Waste Framework Directive (2008/98/EC)

1. INTRODUCTION

Blue Circular Nets (CIRCNETS) is an INTERREG project funded by the Northern Periphery and Arctic 2021–2027 (NPA) program, which addresses marine litter issues (https://www.interreg-npa.eu/projects/circnets/home/). Project partners include organisations from Finland, Iceland, Ireland, Norway, and Sweden (**Figure 1**). Single-use plastics and fishing gear are significant sources of marine plastic litter in Europe, among other continents (Kasznik & Łapniewska , 2023). Consequently, the European Union is taking substantial steps to try and tackle these threats to the aquatic environment. Many single-use plastics (SUP) products have been banned and replaced with products made from more sustainable materials, but a similar approach is not yet possible with plastic-containing fishing gear. Therefore, a different angle has been taken. End-of-life (EOL) fishing gear, nets and aquaculture gear, which are approaching their lifespan, should be collected separately and recycled to prevent them from ending up in oceans and contributing to marine plastic pollution.

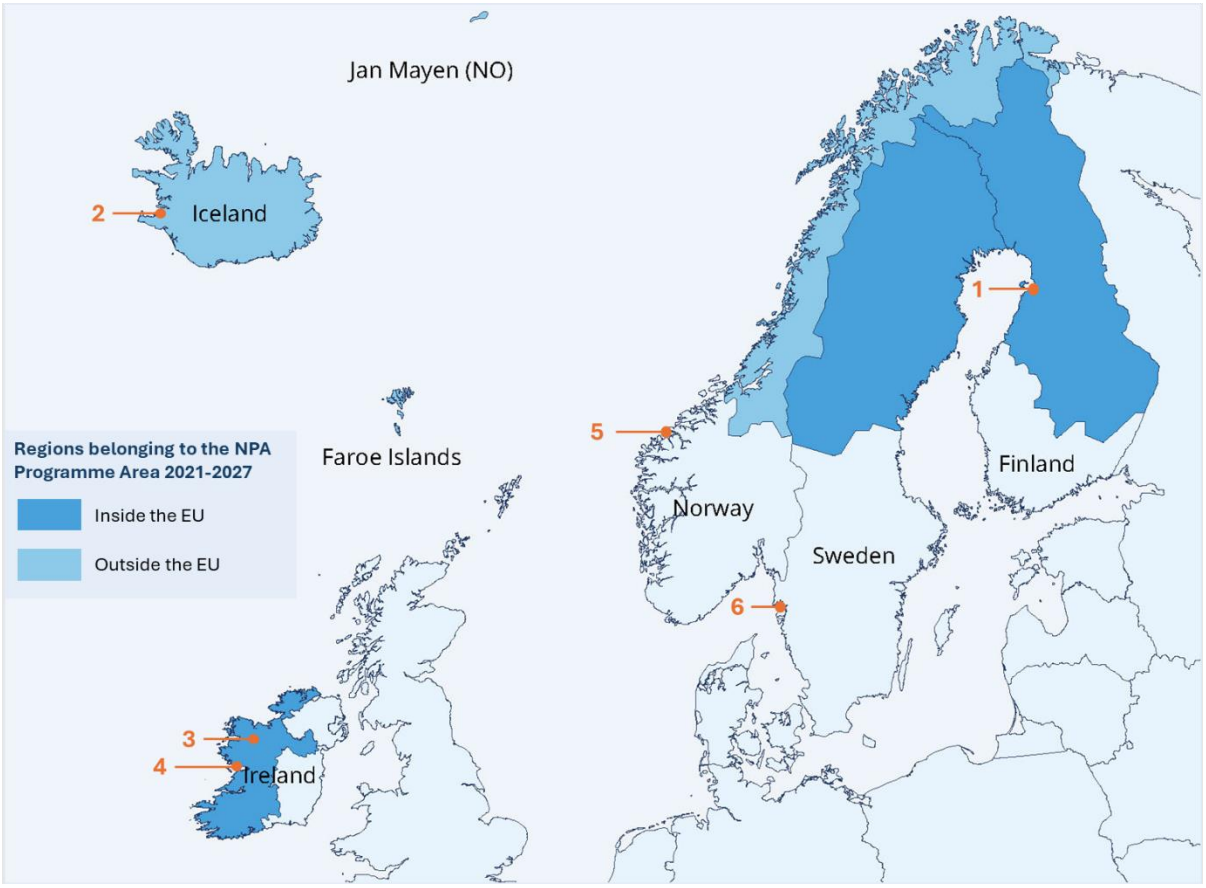

Figure 1: Map of the NPA area of the countries participating in the CIRCNETS project and their respective organisations. 1) University of Oulu (Finland); 2) Marine Ecological Solutions-

MarEco (Iceland); 3) Western Development commission-WDC (Ireland); 4) University of Galway (Ireland); 5) Norwegian University of Science and Technology-NTNU (Norway); 6) Municipality of Sotenäs-SYMBIOS (Sweden). Figure adapted from https://www.interreg-npa.eu/media/ervomyno/interregnpa_map-inbrief.jpg.

One of the main problems for the recycling of EOL fishing and aquaculture gear lies in the design and materials used in their manufacture. A wide variety and often a combination of high-strength materials are used in the design and manufacture of fishing gear, including plastic polymers, metals (e.g., lead and steel), wood and natural twines and fibres (e.g., cotton twine). Typical raw polymer used for the manufacture of fishing nets include nylon or polyamide (PA), low-density and high-density polyethylene (LDPE and HDPE), polyethylene terephthalate (PET), and polypropylene (PP). However, modern fishing nets can be designed with various combinations of these polymers and other materials. Ropes are usually composed of PP or polyester (PES). Floats, buoys, bait boxes, and food service equipment are often made of polystyrene (PS), polyurethane (PU), and PET. In aquaculture, net pen cages are usually made of HDPE (Sala, 2023).

The complex design of fishing and aquaculture gear poses difficulties in their waste management, specially at the sorting stage. Fishing and aquaculture gear made from a combination of different materials should be disassembled and sorted to ensure proper recycling. These sorting activities are costly and labour-intensive, resulting in significant constraints to the proper design of collection and recycling schemes. In addition, important gear components, such as nets and ropes, can be treated with copper-based and other biotoxin anti-fouling coatings (Basurko et al., 2023), thus complicating and sometimes prohibiting recycling and other environmentally friendly methods of reuse or disposal.

The specific aim of CIRCNETS is to support the setting up of a collection system for EOL fishing/aquaculture gear in the NPA region that tackles all the barriers to the proper treatment of this waste stream. The EU SUP directive (2019/904/EC) requires producers and importers of plastic containing fishing/aquaculture gear in all EU member countries to organise the collection of EOL fishing/aquaculture gear based on the extended producer responsibility (EPR) principle. To understand how collection can be organised regionally in the most efficient and economical way; while adhering to the “do no significant harm" principle, it is necessary to look for solutions in other regions that have already taken steps towards this. However, the collection of fishing/aquaculture gear opens the possibility of moving towards a more circular economy and finding ways to recycle the collected materials on a regional scale.

The waste management practices of fishing and aquaculture gear present in each partner country have been described in report D.1.1.1. (https://www.interreg-npa.eu/media/fpwbl2nw/circnets_wp1_report-d111.pdf). This report provided an overview of the fishing and aquaculture industry and the collection and disposal practices of EOL fishing/aquaculture gear at ports and aquaculture facilities falling within the NPA region of each partner country. Overall, D.1.1.1. described the similarities and differences between existing collection systems in each country, identified good practices, and highlighted the gaps that need to be addressed. Building upon the results from D.1.1.1., the aim of D.2.1.1. report is to conduct a more detailed analysis of the gaps and future possibilities of the collection, disposal and recycling practices present in each partner country. In addition, a review of best practices and best available technologies (BATs) for the collection, disposal and recycling of EOL fishing/aquaculture gear are presented, which serve as practical examples and recommendations that can be applied to set up future collection and recycling schemes or improve existent ones.

2

MATERIALS AND METHODS

2. Materials and methods

For the development of this report, a series of methodologies were used and are explained as follows.

Section 3 sets the baseline by comparing the existing collection and disposal practices in the partner countries. The comparison was based on the results and information provided in the D.1.1.1 report. Further information was gathered through discussion with the partner's organisations and relevant fishing/aquaculture industry representatives, as well as literature review to have a complete overview of the situations in each country. In section 3, the main gaps and possibilities of the collection and disposal practices are presented. These gaps and possibilities were identified from the results and information gathered in the D.1.1.1. report. In the case of Iceland, Ireland, Norway and Sweden, extra information was obtained through literature review based on progress reports from existing collection and recycling schemes/practices of EOL fishing gear (SFS, 2024), (BIM 2020), (Johnsen and Narvestad, 2023) (Björkman, Wehner, and Eriksson, 2022).

Section 4 compiles a series of best practices and BATs case studies on the collection, reuse, recycling and disposal of EOL fishing/aquaculture gear. The case studies presented are operating outside the NPA region of some partner countries (i.e., Ireland, Sweden and Norway) and in other European and non-European countries. Among the partner countries, Iceland is exempted as the whole country falls within the NPA area.

Section 5 is a critical analysis of the gaps and possibilities of each collection system. The best practices and BATs discussed in section 4 will feed into this analysis by discussing how these alternative solutions and new technologies can be applied to fill the gaps and improve partner countries' collection and disposal systems. Finally, the conclusions summarise the key points, findings, and recommendations provided for developing efficient and economically viable collection systems for the collection, reuse, recycling and disposal of EOL fishing and aquaculture gear.

3

COLLECTION AND DISPOSAL PRACTICES FOR EOL FISHING GEAR IN THE CIRCNETS PARTNER'S COUNTRIES: A COMPARISON

3. Collection and disposal practices for EOL fishing gear in the CIRCNETS' partner countries: a comparison

To conduct a critical analysis on the collection systems and disposal practices for EOL fishing gear in each partner country, it is important to understand how these systems work in the first place. To this end, this section compares existing collection systems and disposal practices in the partner countries, along with a brief description of each (**Table 1**).

After understanding the management of EOL fishing gear and aquaculture equipment in the partner countries through collection and recycling schemes (Iceland and Sweden) or other disposal practices (Finland, Ireland and Norway), this sections also describes the systems' gaps, limitations and possibilities.

In terms of legislation, Table 1 summarises the main actions taken within each partner country. The EU member countries (Finland, Ireland and Sweden) have agreed on national implementation of the SUP Directive. The national legislations of the above countries have set minimum collection levels of EOL fishing gear, but there is also a lot of historical fishing gear waste (i.e., fishing gear disposed of in the past and stored at the ports premises), to which the EPR directive does not apply. Norway and Iceland, as members of the EEA, have also agreed to implement the SUP Directive in their own countries. However, the parts of the directive linked to EOL fishing gear have not yet been implemented.

Table 1: Summary of End-of-Life fishing and aquaculture gear disposal systems of each CIRCNETS partner's countries.

	Finland	Iceland	Ireland	Norway	Sweden
Presence of collection/recycling system	Not available (To be established on January 1, 2025)	Yes	No	No	Yes
Name of the collection/recycling system	N.r.	Icelandic Recycling fund and the Association of Fisheries Companies (SFS) system	N.r.	N.r.	Fiskereturen project
System funding (private or/and public)	Private	Private and public	N.r.	N.r.	Public
Separate collection of EOL fishing gear in ports	Yes	Yes	Yes	Yes	Yes (tested under Fiskereturen project)
Separate collection of EOL aquaculture gear in farms	Yes	Yes	Yes	Yes	Yes
Type of EOL fishing gear discarded in ports	Nets, fyke nets, anchors, weights, miscellaneous pieces	Any fishing gear made of synthetic materials	Trawl nets, ropes, gill nets, long lines	Fyke nets, lines, nets, seine nets, pots, trawl nets and historical nets.	Any fishing gear made of synthetic materials and historical fishing gear
Type of EOL aquaculture gear discarded	Net, net pens, ropes and floats (historical)	Any aquaculture gear made of synthetic materials (e.g., cage nets)	Cage nets, cage structure, floats, rings, ropes, oyster farming bags	Ropes, lines, plastic structures of rearing containers, net pens, nets, floats/pontoons	Ropes, plastic structures of rearing containers, net pens, collection bags and plastic tubs
Volumes of discarded EOL fishing gear (kg year $^{-1}$)	N.d.	2,170,000[a]	103,300[b]	183,200[c]	200,000[f]
Volumes of discarded EOL aquaculture gear (kg year $^{-1}$)	100,000-150,000	Included in fishing gear volumes	>50,000[d]	>50,000 [d]	N.d.
Volumes of recycled or reused EOL fishing gear (kg year $^{-1}$)	N.d.	1,184,000[a]	N.d.	54,000[e]	N.d.
Volumes of recycled or reused aquaculture gear (kg year $^{-1}$)	N.d.	Included in fishing gear volumes	N.d.	N.d.	N.d.

EU legislation implemented:	Waste framework (2008/98/EC) Single-use plastics (2019/904) Waste management facilities at ports (2019/883) Passively fished waste (2022/92)	Single-use plastics (2019/904) without fishing gear directives.	Waste framework (2008/98/EC) Single-use plastics (2019/904) Waste management facilities at ports (2019/883)	Single-use plastics (2019/904) without fishing gear directives.	Single-use plastics (2019/904)
National legislation implemented:	Waste Act (646/2011) Government degree on plastic containing fishing gear (1319/2022)	Federation of Icelandic Fishing Vessel Owners (LÍÚ), and Recycling Fund (Úrvinnslusjóður) agreement on processing fishing gear waste mande of synthetic materials. Enforced on 01-01-2006. Approved environmental plan applies in accordance with regulation no. 1200/2014 on the reception of waste and cargo residues from ships arriving at port.	Sea-Fisheries (Community Control System) Regulations 2016 (S.I. No. 54/2016)	Recycling and treatment of waste (Avfallsforskriften, 2004) Pollution control act (Forurensingsloven, 1983) Restriction on the use of chemicals and other products hazardous to health and the environment (Produktforskriften, 2004) Limitation of pollution (Forurensingsforskriften, 2004) Ship safety and security act (Skipssikkerhetsloven, 2007) Environmental safety for ships (Forskrift om miljømessig sikkerhet for skip mv., 2012) Marine Resources act (Høstingsforskriften, 2022)	Regulation (1980:789) on measures against pollution from ships Waste Regulation (2020:614)

Notes: EU: European Union; EOL: end of life; N.d.: no data; N.r.: not relevant; a: Collected and recycled volumes include fishing gear, aquaculture equipment and coastline fishing gear waste (SFS, 2024); b: Volumes estimated from the % of EOL fishing gear (6.8%) and the total volumes (190 tonnes) of waste collected through the Fishing for Litter initiative in 2019 (BIM, 2020); c: Volumes estimated from the % of soft plastic including

fishing gear (85%) and the total volumes (229 tonnes) of waste collected through the Fishing for Litter initiative in 2023 (Johnsen and Narvestad, 2023); d: Volumes of discarded EOL aquaculture gear based on D.1.1.1. survey results from a national perspective; e: Volumes of recycled EOL fishing gear based on Johnsen and Narvestad, (2023); f: Discarded volumes include historical fishing gear and fishing gear collected through the Fiskereturen project in 2023.

3.1. Iceland

Iceland has a centralised collection scheme for EOL fishing gear that has been operating for about 20 years. This scheme arose out of awareness and concern about the large quantities of fishing gear waste generated in ports, its impact on marine plastic pollution and the urgency of addressing this problem. Consequently, in 2005, the scheme agreement was signed between the Icelandic Recycling Fund and the Association of Fisheries Companies (SFS)[1]. The collection and handling of fishing gear waste containing plastic is assumed and financed by SFS in exchange for collection processing fees for fishing gear placed on the market. EOL fishing gear reception points are available in 14 major ports nationwide and at fishing gear manufacturers. In this way, the system automatically approaches the main fishing ports, where the use of and demand for fishing gear is the highest. At the collection points, 90 % of the collected EOL fishing gear comes from Icelandic fishing vessels, members of SFS; however, foreign entities or their representatives depositing synthetic waste fishing gear from foreign vessels (e.g., Russia, Portugal, Eastern Europe, Norway and India) or unknown vessels must pay the contractor directly (SFS, 2024). All Icelandic legal entities can use the system, regardless of whether they are customers of the relevant fishing gear manufacturer or members of the SFS.

The agreement signed in 2005 established the objective of recycling at least 45% of the estimated 1,100 tonnes of fishing gear waste generated. A year later, 50% of the collected waste was recycled, and in 2008, at least 60% of the collected EOL fishing gear was recycled. The 60% goal was achieved in the following years, with some years recording 90% or higher recycling rates (**Figure 2**). Consequently, in 2021, a new reception and processing system for fishing gear was established based on the social policy of the fishing industry and the law on the circular economy. This new agreement set an 80% recycling rate based on the average import of fishing gear containing plastic over the last four years (SFS, 2024).

1. SFS: https://www.sfs.is/en

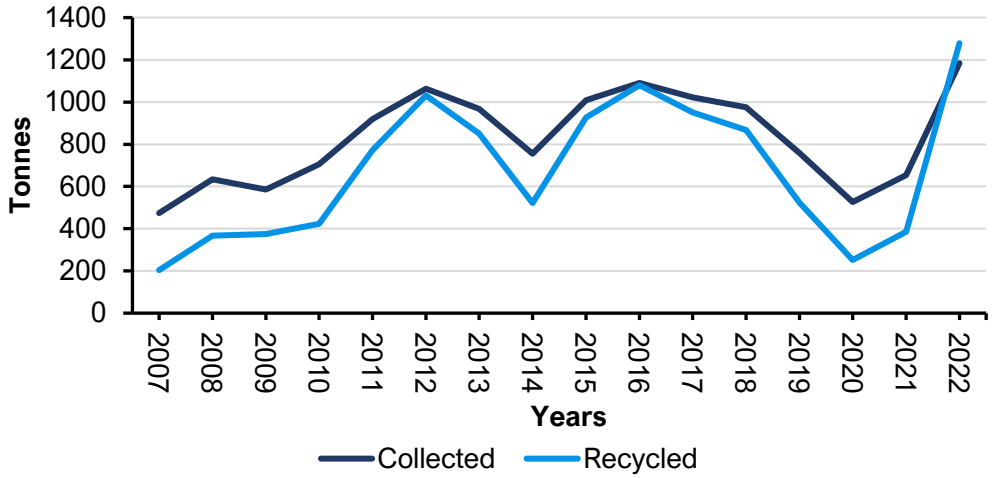

Figure 2: End-of-Life fishing gear collected and recycled by the Icelandic collection and recycling scheme between 2007 and 2022. Graph based on the values from SFS, (2024).

In terms of volumes, 2,172 tonnes of fishing gear, aquaculture gear and coastline fishing gear waste were collected in 2023. The collected materials are then transported to foreign recycling plants located in Lithuania (Polivektris, PA-plastic), Norway (Polynord, PE and PP-plastic), Denmark (Plastix, PE-plastic), the Netherlands (Granuband, gum) and Slovenia (Aquafil, nylon). Transport is made in collaboration with Eimskip (an international shipping company), Hampiðjan (International fishing gear manufacturer), Ísfell (Icelandic fishing gear manufacturer), Egersund (Norwegian transport company), G.RUN (Icelandic seafood producer), Skinney-Þinganes (Icelandic seafood producer) and the Fishing Equipment Service. In 2023, 1,463 tonnes of plastic, 425 tonnes of rubber and 167 tonnes of metal waste were sent for recycling. The remaining volumes of fishing/aquaculture gear waste were reused (16 tonnes), used for energy production (62 tonnes) or landfilled abroad (39 tonnes) (Jónssyni, 2024; SFS, 2024).

3.1.1. Gaps and limitations

Disposal fee for fishing gear: under the Icelandic collection and recycling scheme, fishing gear and aquaculture equipment discarded at collection points are accepted free of charge if waste meets the acceptance conditions and come from Icelandic fishing companies involved in the agreement. It is irrelevant whether the fishing gear is Icelandic or foreign-made. Only foreign entities depositing synthetic fishing gear waste from foreign vessels are required to pay the disposal fee. Therefore, the disposal fee measure might pose some limitations, as foreign vessels wishing to dispose of EOL fishing gear might be reluctant to do so to avoid the cost

fee. Consequently, the overall collection of fishing gear waste could be affected, leading to the appearance of abandoned or ghost fishing gear at sea. In addition, Iceland controls the fishing grounds surrounding the island, where the only foreign fleets with fishing permits are those from the Faroe Islands. Therefore, this limitation is expected to not be a major problem for the scheme, although it should be considered to avoid the emergence of abandoned fishing gear.

Information coordination: another aspect that needs further improvement in the Icelandic collection and recycling scheme is related to the transfer and coordination of information. According to the assessment conducted by SFS on the Icelandic scheme (SFS, 2024), information on the waste management of fishing gear is delivered by different parties to the Environmental Agency. On one hand, information on the amount of fishing gear that ends up in landfills comes from landfill operators. Meanwhile, information on fishing gear waste made from synthetic materials that are sent outside for recycling is usually provided by the Recycling Fund and is based on information from SFS. However, in special circumstances, this information may be received from other operators. This variety of sources could lead to a lack of consistency in the information coming from the SFS and the Environmental Agency. On the other hand, SFS does not specifically manage fishing gear waste that is not recyclable, does not fall under the contract or, for other reasons, does not come in for reception by SFS. In addition, the figures reported by the Environment Agency do not distinguish between fishing gear waste that falls within or outside the agreement (i.e. whether it is fishing gear made of synthetic materials or not). Therefore, fishing gear waste could be disposed of with other operational waste, resulting in bigger volumes.

3.1.2. Future possibilities

Recycling rate improvement: the positive recycling trend represents a breakthrough in the collection and recycling practices for EOL fishing/aquaculture gear in Iceland. These recycling rates (i.e., 80%) are expected to increase or remain stable in the coming years. Overall, these figures show how the Icelandic collection and recycling system can be considered an efficient model and a reference for the implementation of future systems in other partner countries and beyond.

Lack of national recycling centres: according to the Recycling Fund, fishing gear waste made from synthetic materials was recycled both in the country and abroad during the first years of the agreement. The waste was recycled nationally at Læk in Ölfus and later at PM Recycling in Gufunesi. However, neither of those companies are operating today. In the years 2019–2022, the waste was sent for recycling by SFS and fishing gear manufacturers to Lithuania

(Polivektris), Norway (Polynord), Denmark (Plastix), the Netherlands (Granuband) and Slovenia (Aquafil). Good results have been achieved with that arrangement, and the production goes, for example, to the electronics and car industry or the furniture and high fashion industry. Recycling companies in Iceland are relatively small and do not have the facilities to take care of EOL fishing gear, as the volumes are large and it is a labour-intensive recycling process compared to other materials like domestic plastic (e.g., Purenorth recycling centre). Therefore, fishing/aquaculture waste is processed in specialised foreign recycling plants.

Reduction of ghost fishing gear at sea: to prevent the occurrence of ghost fishing gear, the SFS wants to implement several measures, such as limiting the use of fishing gear in high-risk areas and times, marking and identifying fishing gear, storing it safely, and reporting lost gear and indicating where it was lost. In addition, SFS is also working on education and prevention actions to reduce plastic pollution at sea and on beaches, ambitious collection targets, and the provision of clear and regular information and monitoring. In order to promote better return and recycling, SFS has also called for good cooperation with the Icelandic Ports Association to direct materials to suitable reception points throughout the country (SFS, 2024).

Reduction of landfilled materials: to reduce the volumes of fishing/aquaculture gear waste landfilled, SFS aims to maximise the cycle of fishing gear and prevent it from ending up in open harbour containers and landfills. However, not all fishing gear is recyclable. Therefore, work has been done in the last term to significantly increase the recyclability of fishing gear by adding new recycling methods to the system.

Collection of historical fishing gear: SFS and fishing gear manufacturers, in collaboration with Eimskip, are working to clean up historical fishing gear throughout the country. SFS have requested information from the Icelandic Harbor Association about where such fishing gear can be found, and in many places, the cleaning has been completed (SFS, 2024).

3.2. Sweden

Sweden also has a national collection scheme for EOL fishing gear. This scheme originates from The Fiskereturen project (Fiskereturen – Återvinn fiskeredskapen)[2], funded by The Swedish Agency for Marine and Water Management and the government. Since the end of 2019, Fiskereturen has collected EOL fishing gear on the country's east, west, and south coasts. Fiskereturen features four main participating organisations: 1) FF Norden: primarily collects EOL fishing gear in Bohuslän and down the west coast; 2) Båtskroten: responsible for the collection of EOL fishing gear in and around Stockholm's archipelago; 3) The municipality of Sotenäs: where all the collected EOL fishing gear is sorted at the Marine Recycling Centre (SMRC); and 4) Håll Sverige Rent: responsible for the communication effort. In contrast to Iceland, the Swedish collection scheme does not cover the entire country, although new plans are being made to reach the north coast by 2024.

The collected fishing gear is transported to SMRC, where waste materials are sorted and pretreated into individual material fractions. The sorted materials are sent to other facilities for recycling (e.g., Plastix-Denmark and Stenametall-Sweden). In 2023, Fiskereturen collected approximately 200 tonnes of EOL fishing gear. Besides collecting EOL fishing gear generated annually, the project also started collecting historical fishing gear resting in the port facilities (FF Norden, 2021). Due to Sweden's lack of aquaculture industry, aquaculture equipment has not been included in the scheme. However, some aquaculture companies have been handling their waste fractions separately. More information on the scheme can be found in Section 4.4., where a more comprehensive description is given as a best practice case study for Sweden.

3.2.1. Gaps and limitations

Problems with fixed collection points: the collection scheme set up through the Fiskereturen project in Sweden established a number of fixed collection points on the country's west, east and south coasts. The collection of fishing gear waste in Stockholm County is coordinated by Båtskroten. According to Båtskroten, the volume of fishing gear left per unit of time in this area is so low that it is not efficient to leave gear regularly at fixed collection points. Since Båtskroten started collecting used fishing gear in the Stockholm archipelago, much of the collection has been done through outreach activities. The Stockholm archipelago is characterised by unique fishing locations spread over several islands and localities.

2.Fiskereturen project:
http://www.symbioscentrum.se/projekt/fiskereturen20.4.56d98330185ecd03d7c20fe6.html

Therefore, the collection of used fishing gear is clearly decentralised and challenging to implement with fixed collection points. It should be noted that Båtskroten has been, and is, dealing almost exclusively with historical fishing gear originating from retired fishermen and places where commercial fishing is no longer practised. In this context, it can be expected that Stockholm County is a region where the amount of "new" fishing gear to be collected under the upcoming producer responsibility will be low (Björkman, Wehner, and Eriksson, 2022).

Fixed collection points can also be problematic for collecting and managing recreational equipment. The quantities are so small that management becomes unconscionable. In addition, fixed containers are problematic if they are not managed properly, as other materials are disposed of in them.

Standardised collection and transport of fishing gear: the Fiskereturen project has encountered challenges in collecting and transporting EOL fishing gear used in commercial and recreational fishing. Commercial fishing gear is a complex fraction in which products vary greatly in size and weight, feature different materials and have a design that makes them bulky, difficult to dismantle and tend to become entangled, making them difficult to handle at larger stages (e.g., pretreatment). Therefore, it is not easy to establish a standardised collection and transport system. Regarding recreational fishing gear, collection and transportation of these materials is less labour intensive due to the low volumes generated; however, its design also causes entanglement and makes it challenging to handle. To date, collection has, to some extent, been carried out in a standardised way, where big bags are considered the best load carrier and bulky fishing gear, such as trawls and large nets, are usually loaded on pallets with collars and may even undergo some disassembly to be loaded and transported in this way (Björkman, Wehner, and Eriksson, 2022).

Low profitability of recycling EOL fishing gear materials: the collected fishing gear is sorted into individual material fractions at Sotenäs Marine Recycling Centre, which is also responsible for managing the transport of the materials to recycling facilities. At the moment, SMRC is only involved in sorting the materials, but not in recycling them, as it is a labour-intensive process, and there are insufficient funds to cover the costs of recycling and manufacturing new products.

In the early years of the Fiskereturen project, SMRC collaborated with small companies and start-ups to develop prototypes of recycled fishing gear; however, it was challenging to move from a prototype to a final product and make it profitable. Only one company called Impossible Plastics[3] has managed to build some industry in Sweden. Impossible plastics thermoform recycled plastic pallets from "bad" plastic. They can process EOL fishing gear material from SMRC. However, as impossible plastics is now a small-scale industry, they can only buy small quantities of these materials.

Finding more outlets for marine plastic is currently being investigated through the test bed at the SMRC in Sötenas. However, as long as there are no plans in Sweden to recycle the material or prepare it for material recycling, EOL fishing gear is transported to recycling actors outside the country.

Quality of historical EOL fishing gear: according to the Municipality of Sotenäs, another limitation to fishing gear recycling, specifically the historical one, is the quality of the materials collected and the information available. The following aspects pose constraints for recycling:

1. **Historical fishing gear is not clean:** most material contains sand or biological matter that is hard to wash and remove from the plastic material. Usually, in order to be able to process plastic materials for recycling, they need to be of high quality and properly clean.

2. **The origin of the material is unknown:** it is difficult to know where the materials come from, the type of material used, the paint used, etc. In the future, the reporting method should be improved, including the origin of the fishing gear and its characteristics, to avoid these gaps.

3. **It is crucial to find the best process to recycle EOL fishing gear:** depending on the material, different processes could be used. However, no universal method can guarantee that any type of plastic material from EOL fishing gear can be recycled with high quality and efficiency. One recycling plant that is testing new methods of recycling is Aquafil (Italy). They have developed a chemical recycling process for nylon materials coming from textiles and fishing gear.

3.impossible plastics: https://www.impossibleplastics.com/

3.2.2. Future possibilities

Collection requirements: The SUP directive 2019/904 requires that ”Member States that have marine waters shall set a national minimum annual collection rate of waste fishing gear containing plastic for recycling and monitor and report fishing gear placed on the market as well as waste fishing gear collected”(Article 8, paragraph 8). Sweden has set a collection target of 20% compared to the amount of materials put on the market annually. Based on the volumes of fishing gear collected through the Fiskereturen project, one or more collection points will, individually or together, fulfil the collection requirements. This implies that, in Sweden, the scheme should focus on the areas where the largest quantities of fishing gear per unit of time and geographical area are expected to occur. On the other hand, these requirements are somewhat unrealistic from a cost-effective point of view of recycling. Considering the volumes collected at the moment, a collection target of 20% results in only 60 tonnes of collected material, which processing is unlikely to be economically viable.

Importance of historical fishing gear: The collection of historical fishing gear was the foundation of the Fiskereturen project, which allowed the financing of the scheme and provided a starting point for materials to be collected and processed for recycling. It is important to note that fishing gear has a long lifespan, so the collection of recent EOL fishing gear is not feasible, as the volumes are too small. Therefore, historical and recent EOL fishing gear should be collected in parallel for the future implementation of collection and recycling schemes in other countries. However, it should be noted that in the upcoming EPR legislation, historical fishing gear is not covered, and it is sometimes difficult to find funding for it. Therefore, although it is an important fraction to take care of, its management is challenging.

Pre-sorting procedures: Båtskroten is investigating the possibility of conducting pre-sorting procedures to avoid shipping components and parts of fishing gear that are handled by energy recovery to SMRC. Instead, the energy recovery processes can take place locally, thereby reducing the number of transport kilometres and freeing up space for materials that need special handling in Sotenäs. This can also increase the efficiency of the collection stage and increase the climate benefit of the recycling scheme by reducing the need for transportation. This first sorting procedure has not yet been implemented but is a future consideration towards developing a national collection system (Björkman, Wehner, and Eriksson, 2022).

Need for pretreatment methods: SMRC facility’s operations focus primarily on dismantling and sorting to provide the right conditions for the recycling and waste treatment of the materials. To optimise and reduce the costs of the collection and recycling processes, it is

important to establish efficient pretreatment methods. To this end, it is crucial to strive for and reduce the time of such activities by, for example, performing them to avoid entanglements between materials and facilitate sorting. At the same time, the cost of a refined collection should not offset the cost reduction that this can bring in relation to pretreatment. Balancing costs is difficult, but in a future collection system, it will be important to keep records and statistics to understand better where and how trade-offs may need to be made between the various options.

The future of fishing gear volumes in Sweden: The Swedish fishing fleet has decreased over time in several vessels and landing quantities. Between 2003 and 2015, the landed volumes decreased from about 230,000 to 200,000 tonnes. During the same period, the number of vessels decreased by 18%. This decrease in vessels registered has happened mostly among larger vessels (over ten metres), while the number of smaller vessels has remained unchanged (Bergenius, et al., 2018). From 2011 to the end of 2020, the number of vessels in the Swedish fishing fleet decreased from 1,366 to 1,047 (HaV, 2020a; HaV, 2020b). These data imply that if the trend continues, a reduction in the amount of EOL fishing gear can also be expected in the near future.

Reuse before recycling: According to the waste management hierarchy, the reuse of materials should be prioritised over recycling. At SMRC, lobster boxes coming from commercial and recreational fishing gear have a high reuse potential. They are sold in a second-hand store in Kungshamn. Lobster boxes are reused mainly due to their high demand among professional and recreational fishermen and the good condition in which it arrive at the pretreatment centre. On the other hand, FF Norden also reuses floats in good condition for new trawl production and carries out fishing gear repair activities, promoting the reuse of these materials and avoiding discards. It is unknown whether reusing other recreational fishing gear (e.g., nets and fishing lines) is possible. It would be desirable to explore and/or initiate this, and it could gain momentum through dedicated stores and retailers.

3.3. Ireland

Although Ireland does not have a national collection scheme in place, this country has taken actions to support the collection of marine debris from the oceans and the separate collection of fishing gear in ports. These activities have undertaken within the framework of the Fishing for Litter (FFL) project; an international initiative launched by KIMO International[4] in 2004. The aim of the FFL project is to reduce the impact of marine litter in the oceans by involving the fishing industry. Fishing boats are provided with big bags to collect the plastics, ghost gear, and other debris that gathers in their nets during normal fishing activities. When the fishing boats come into port, they can unload the bags of litter. These bags are collected regularly, and the waste is recycled or disposed of via landfill. This initiative not only helps in the removal of rubbish from the sea, but it also raises awareness among fishers of the impact of marine litter and changes fishers' waste-related behaviours while out at sea (KIMO International, 2021).

The FFL project in Ireland was established in 2015 and is supported by the European Maritime and Fisheries Fund and is part of the Clean Oceans Initiative program of Bord Iascaigh Mhara (BIM)[5]. To date, 12 major fishing ports and 244 boats/vessels have joined the FFL initiative in Ireland. By the end of 2019, 95% of Irish trawlers were registered members of the scheme. In total, 409 tonnes of litter have been recovered from the seas since the FFL project was established in Ireland. According to a 2019 study on the assessment of waste management in Irish ports and the "Fishing for Litter" characterisation, almost 70% of the total waste collected is from fishing gear, and 6.8% of the total comes from discarded/EOL fishing gear (BIM 2020). In terms of the management of EOL fishing gear collected through this initiative, there is still no national net management scheme in place to ensure the reuse or recycling of these materials. Regarding aquaculture, differences exist in EOL aquaculture equipment waste management between sectors. In the shellfish sector, waste production is relatively small, and most of the materials have a long lifespan or, in the case of floats, are reused from other aquaculture sectors. Therefore, a separate collection of EOL aquaculture material in the shellfish sector is not possible, but all the disposed materials are landfilled for the time being. On the other hand, in the finfish aquaculture sector, one of the largest salmon producers in Ireland has recycling facilities where all discarded materials are dismantled for future recycling. As for the cage nets, they are frequently repaired and reused to avoid waste production.

4. KIMO International: https://www.kimointernational.org/

5. BIM: https://bim.ie/

3.3.1. Gaps and limitations

Waste management and infrastructure: Most of the Irish ports have waste reception facilities, especially for the management of general waste and galley waste. As for EOL fishing gear, the only system in place dealing with this waste fraction is the FFL campaign, which was primarily aimed at retrieving ghost gear and marine litter from the sea; however, it has also been used to manage EOL fishing gear in Irish ports. Although this initiative seems to provide positive results in collecting and recycling EOL fishing gear, it has led to management problems. On the one hand, fishermen find it difficult to distinguish between EOL fishing gear and derelict fishing gear, which results in these two waste fractions being mixed in the same container (BIM, 2020). If collected and sorted correctly, EOL fishing gear can be easily recycled. However, due to biological, soil matter, and entanglements, derelict fishing gear tends to end up in landfills. To promote the recycling of EOL fishing gear, it is necessary to provide different containers and train fishermen to dispose of and manage waste fractions correctly.

Lack of specialised staffing: considering the large volumes of EOL fishing gear discarded annually and the work effort involved, the staff available in ports is insufficient for properly collecting and managing this waste stream. Consequently, most fleets have developed net dismantling services where available (especially for nylon nets); however, these practices are not sufficient, resulting in large volumes of gear waste accumulating in port facilities or ending up in general waste containers. To implement an effective collection and recycling scheme, additional and specialised staff are necessary to establish good communication with fishing fleets and avoid conflicting messages on gear waste management (BIM, 2020).

3.3.2. Future possibilities

The future of the 'Fishing for litter' campaign: The FFL campaign can serve as a starting point for the implementation of a national EOL fishing gear collection and recycling scheme in Ireland. On the one hand, the ports collaborating in the FFL campaign could be used as collection points. In the vast majority of ports, the staff are already experienced in waste management, and port facilities have sufficient space for the handling and sorting of these materials. However, this does not apply to all ports, so investment in infrastructure and specialised personnel is essential for managing EOL fishing gear. The FFL campaign has also raised awareness among fishermen about the environmental impact of ghost gear and marine litter. Building on the knowledge gained to promote the collection and sorting of EOL fishing gear in the future is crucial, as this will be required by law under the EPR directive.

National recycling opportunities: At the moment, materials collected through the FFL campaign (i.e., derelict fishing gear, EOL fishing gear, and marine litter) are not sent for recycling but are deposited in landfills. Currently, no national recycling plant specialises in EOL fishing gear, so if a collection and recycling scheme is implemented, all materials are expected to be sent to foreign recycling plants (e.g., Plastix and Aquafil). Given that the Irish fishing industry is one of the largest in Europe, thus resulting in large volumes of EOL fishing gear discarded yearly, investment in a domestic recycling plant could greatly benefit the country. The Irish economy could enter the market for recycled products while promoting the implementation of a sustainable and cost-effective collection and recycling system, avoiding high transport costs and emissions.

Recycling of aquaculture gear: Irish aquaculture companies seem to be more prone to recycling materials as they are market-driven. On one hand, the cage nets used by MOWI (one of Ireland's largest salmon producers) are not treated with anti-fouling chemicals. This allows the nets to be reused, as they only need to be washed and repaired, and once they have met their useful life, it is possible to recycle them (**Figure 3**). This can be considered a good and effective practice for other finfish producers to promote the recycling of cage nets. In the shellfish sector, as explained above, the recyclability of materials is low due to their long lifespan and the low volumes of waste generated annually. In addition, the shellfish aquaculture sector tends to use second-hand materials (e.g., floats). On the other hand, in the oyster industry, oyster bags are the main plastic material used in the cultivation of these bivalves. Oyster bags are made of high-density polyethylene (HDPE), a plastic material that can be recycled ten times without losing its characteristic strength. A study conducted by Thornberry (2019) assessed different options for the reuse and recycling of oyster bags. In this study, three Irish companies (i.e., Stuart Nets Ireland/Green Marine, Muster polymers and ROC Recycling) showed their interest in accepting EOL oyster bags for further processing and recycling, either in Ireland or abroad. In terms of reuse, IFA aquaculture explored the option of reusing the oyster bags as parking lanes in temporary parking lots for events such as outdoor festivals.

Figure 3: Salmon cage net being inspected for repair at MOWI's net recycling facility.

3.4. Norway

In Norway there are several initiatives and organizations involved in the collection and recycling of lost and discarded fishing gear. The best known is the Fishing for litter campaign in Norway, which will be explained in more detail in this section. However, the Norwegian Environment Agency has delegated the task of collecting and recycling discarded fishing gear to several organizations such as SALT, the University of Tromsø and Ocean Space Acoustics (which stems from SINTEF, Norway's largest research institution).

In Norway, the FFL project has been running since 2015, with SALT being the main organisation administering the program with funding from Norway's Directorate for the Environment and the grant scheme for marine litter measures. Throughout the FFL project, the following eleven reception points have been established: Hvaler, Egersund, Karmøy, Austevoll, Måløy, Ålesund, Tromsø, Båtsfjord, Stamsund, Myre and Havøysund. By the end of 2023, 178 deliveries were registered, and almost 229 tonnes of waste was collected. According to Deshpande & Tippett (2023) estimates, approximately 4,000 tons of EOL fishing gear and ropes are collected annually in Norway. Of this, 51% is recycled (mainly abroad), 22% is landfilled, 19% incinerated and 8% lost or discarded at sea. Due to the limited availability of data on collected volumes of end-of-life fishing gear and its recyclability in Norway, the data presented above are estimates; however, from next year onwards, producers will have to report exact figures, as the EPR directive will be implemented to fishing gear made of plastic.

Within the waste fractions, soft plastic is the most dominant type of material (85% of the total weight of fishing waste). This category is mainly composed of nets, various types of trawls, ropes, barbs and fishing lines. Vessels participating in the program sort waste into two categories: recyclable waste and other waste (residual waste). The collected and sorted waste from FFL is managed in collaboration with Nofir[6] and local waste companies. In the case of Nofir, they are responsible for the waste management of ropes, nuts and threads. Close to 54 tonnes of waste were delivered to Nofir in 2023, which will then be transferred to national and foreign recycling facilities (Johnsen and Narvestad, 2023). In terms of aquaculture, the volume of EOL aquaculture equipment generated annually varies between aquaculture companies, ranging from 0-999 kg to >50,000 kg. Sixty percent of the companies surveyed in the CIRCNETS report D.1.1.1 reported a separate collection of EOL aquaculture equipment, which is either sent to Oceanize[7] (plastic recycler and processer), to Nofir for recycling, or returned to suppliers for reuse. In some cases, used equipment is also delivered to a waste management company.

3.4.1. Gaps and limitations

Waste management and infrastructure: as explained above, EOL fishing gear is also managed through the FFL campaign in Norway. Over the years, this campaign has taken positive actions to retrieve ghost gear and marine litter from the oceans. EOL fishing gear is not supposed to be covered by this initiative; however, it has been the only way to manage this waste fraction in Norwegian ports. Consequently, several waste management problems have arisen, such as the fact that EOL fishing gear and derelict fishing gear end up in the same containers, making it difficult to sort out the materials and facilitate their recycling. The combination of improved sorting routines and labelling could strengthen the effect of the scheme and increase the recycling rate of recovered waste (Johnsen and Narvestad, 2023).

Coverage of ports: Another issue to consider is the coverage of ports in the FFL campaign. To date, 11 ports have participated in the FFL campaign as collection points, all of them large ports in Norway. Meanwhile, the Norwegian coastline features 4,443 ports in total (including smaller ones). In addition, about 70 major ports in the NPA area of Norway and 150 ports all over Norway present port officials. Deshpande & Tippett (2023) found that about 1,514 ports have port reception facilities and, after a follow-up survey in 2024, 3,029 ports were found to have a waste management plan (i.e., about 66%).

6. Nofir: https://nofir.no/en/

7. Oceanize: https://oceanize.no/en/

Although waste management activities in Norwegian ports are improving, greater efforts are needed to cover as many ports as possible to increase the collection and recycling of EOL fishing gear and to avoid the appearance of ghost gear in the oceans.

The collection system is market-driven: all materials collected and sorted through the FFL campaign and the equipment collected through other organisations in Norway are sent to private recycling companies, resulting in a market-driven collection system. However, these companies only select materials that are more profitable (e.g., soft plastics). This selective recycling results in less desirable materials being landfilled or incinerated. To reduce the amount of materials being sent to landfill and encourage recycling of EOL fishing gear, it is important to find reuse or recycling alternatives for all the materials collected.

3.4.2. Future possibilities

Potential of a national collection and recycling scheme: In Norway, there is great potential for the implementation of a national collection and recycling scheme for EOL fishing gear. On the one hand, due to the large commercial fishing and aquaculture industry, the volumes of EOL fishing/aquaculture gear generated annually are big enough to meet the collection requirements from the EPR directive. On the other hand, the FFL campaign has already set up port collection points that can be used in the future scheme, in addition to creating awareness of the impact of ghost gear and the need to recycle fishing gear materials. Another aspect that can facilitate the implementation of this scheme in Norway is the presence of national recycling companies such as Nofir, Oceanize and Polynord[8]. In this way, most of the materials collected can be recycled within the country, reducing dependence on foreign recycling plants.

Good practices in the aquaculture industry: the Norwegian aquaculture industry has also made great achievements in terms of recycling EOL aquaculture equipment. Oceanize is the leading recycling plant that actively collaborates with aquaculture companies to recycle aquaculture materials (i.e., cage rings). More information about this organisation can be found in Section 4.3. If this collaboration continues in the future, it is expected that the aquaculture industry in Norway will enter the circular economy.

8. Polynord: https://neec.no/organization/polynord-as/

3.5. Finland

Compared to the other partner countries, Finland lags in waste management practices for EOL fishing gear. Due to the country's low fishing and aquaculture activity, a plan for collecting and recycling fishing and aquaculture gear has not been established. However, a pilot collection was started in November 2024 and the national scheme will gradually expend. By 1st of May 2025 there will be 150 permanent or mobile collection points for EOL fishing and aquaculture gear (Suptuottajat.fi., 2024).

This future scheme will be based on EPR requirements and will be privately funded. For aquaculture gear collection, 10 to 20 larger collection terminals will be established. Some of these collection points will be located at ports. However, most of the collection will take place in stores or at the premises of private service providers, where gear waste will be collected as a mobile collection. In terms of collection volumes, it is estimated that 100-150 tonnes of aquaculture gear will be collected per year. As for fishing gear, no estimates are available at this time. According to the results in D.1.1.1, the volumes of discarded fishing gear and aquaculture equipment are small, ranging from 0-999 kg per fisherman/company. In the fishing ports, the primary type of fishing gear used is nets (90.9%), followed by fyke nets (72.7%). Notably, more than half of the fishing ports surveyed (53.9%) were unaware of the volumes of fishing gear waste generated in port facilities. This lack of information is related to the fact that the municipalities mainly own fishing ports, while fishing companies and professional fishermen operating in the ports are responsible for collecting and transporting their operational waste to the treatment facilities. Therefore, fishermen and fishing companies are not entitled to use the waste collection facilities provided by the municipalities, resulting in fishermen being unaware of the volumes of waste generated in the ports. As for the aquaculture survey, 70% of the fish farms had no EOL fishing gear stored in their facilities. Meanwhile, the remaining 30% had historical waste in their facilities, mainly nets and net pens.

3.5.1. Gaps and limitations

Low volumes of EOL fishing/aquaculture gear waste generated and information gaps: Finland's relatively small commercial fishing and aquaculture industry translates into low volumes of fishing gear/ aquaculture EOL waste generated annually. Furthermore, according to the survey's results of D.1.1.1. report, some Finish ports are unaware of the volumes of fishing gear waste generated at the premises. These aspects could pose limitations to

implementing a national collection and recycling scheme. On the one hand, Finland has set a collection rate of 10% fishing gear compared to the amount of materials put on the market annually. Considering the low volumes of EOL fishing gear waste generated in Finland, these may not be sufficient to meet these requirements. Moreover, knowledge gaps around the volumes of EOL fishing gear waste generated at Finnish ports and the amounts of fishing gear put on the market make it difficult to determine the starting point for establishing a national collection and recycling scheme.

Lack of waste reception facilities in ports and waste management issues: fishing ports in Finland do not have reception facilities for EOL fishing gear. One of the ports interviewed under D.1.1.1. previously featured a collection point for fishing gear waste; however, the container eventually attracted non-fishing gear waste, which led to the cessation of the collection initiative. In addition, there are divergent opinions on the separate collection of fishing gear waste in ports: some ports consider it a good practice, while others think it is a waste of time and money. The lack of proper facilities, poor fishing practices, and lack of funding pose challenges to properly disposing of EOL fishing gear in Finland.

Difficulties in disposing of aquaculture equipment: Aquaculture companies are storing EOL cage nets on their premises due to difficulties in waste management, mainly for economic reasons. Aquaculture companies could deliver their waste to the Finnish waste management system as mixed waste as long as they pay the mixed (or hazardous) waste treatment fees. Since aquaculture equipment, especially cage nets, is heavy, the costs can amount to hundreds of euros per piece of equipment. As such, companies end up storing EOL aquaculture gear in their premises/yards. In addition, most of the cage nets used in Finish aquaculture farms are treated with water-based anti-fouling material containing heavy metals. Consequently, disposing of old cage nets is challenging, as the heavy metal content makes them unsuitable for regular waste management. Other historical waste that cannot be taken to a landfill or waste incineration plant is also stored at the facilities.

3.5.2. Future possibilities

Presence of historical fishing gear: most ports and 30% of the aquaculture companies surveyed under D.1.1.1 reported the presence of historical fishing/aquaculture gear on their premises. Although the legislation does not require the collection of old historical waste under the EPR, these volumes can serve as a starting point for establishing a national collection and

recycling scheme. One of the ports interviewed was willing to act as a pilot to implement a temporary collection point for this old fishing waste.

Large representation of recreational fishing: in contrast to commercial fishing, recreational fishing in Finland is well represented in the country. The number of recreational fishermen is estimated at 1.5 million, approximately one-third of the entire population (Natural Resources Institute Finland, 2023). These numbers could translate into large amounts of gear waste from recreational fishing. Recreational fishing gear has also been included in the planning to establish a collection and recycling scheme for EOL fishing gear. However, it is important to note that, due to their seasonal nature, design and size, legislation allows them to be collected slightly different than professional equipment. According to the plans, recreational fishing equipment will be collected seasonally and in collection points at stores and retailers' events.

Environmental impact awareness: Finnish fishermen are aware of the environmental impact of ghost gear and the effort needed to recover it. This open and conscious mentality could facilitate the implementation of a collection and recycling scheme. The predisposition of the fishermen, in conjunction with good practices, allows the collection of fishing gear to occur efficiently.

4

BEST PRACTICES AND BATs CURRENTLY IN USE IN THE COLLECTION AND RECYCLING OF EOL FISHING GEAR

4. Best practices and BATs currently in use in the collection and recycling of EOL fishing gear

This section presents and summarises a number of best practices and BATs operating in partner countries (i.e., Ireland, Norway and Sweden) and other European and non-European countries related to collecting and recycling abandoned, lost and discarded fishing gear. Regarding best practices from partner countries, these should operate outside the NPA region; however, due to the limitations this entails, the described best practices operate on a national scale. In addition to the case studies presented below, a comprehensive database of best practices and BATs for collecting and recycling fishing and aquaculture gear was developed (**Appendix, Table 1**).

4.1. Mobile shredding unit (BIM) Ireland

Description

As part of the 'Fishing for Litter' scheme, **BIM** acquired a custom-built U-45 mobile shredder from **Ulster Shredders Ltd** (Magherafelt, Co. Derry, Northern Ireland) to process all fishing and aquaculture gear collected from the **FFL** activities (**Figure 4**). The shredder accepts a wide range of soft and hard plastic waste, such as polyethylene nets, floats, polypropylene ropes, fish boxes, nylon cage net frames, hard plastic equipment, plastic boats, mussel barrel floats and oyster bags. This shredding and compacting process allows for easier and cheaper transport, storage and recycling of EOL fishing gear.

Facts and figures

The shredder is powered by a generator on the low-loading platform, making it a 'stand-alone' unit. The shredder and generator can be transported on a 4-axle flatbed truck with a remote controlled 55 tonne m^{-1} telescopic crane. The crane enables on-site set- up and transfer of the bagged material to a close storage point. The shredder is transported to the Irish fishing ports participating in the FFL scheme (i.e., from Donegal to Cork), where the machine will process all the collected plastics over two days. After shredding, the processed materials are transported to recyclers and third parties that can convert them into new and useful products. When fishermen want to dispose of EOL fishing nets, they remove the reusable ropes and buoys. The discarded nets are shredded and pelletised for subsequent recycling into fishing boxes.

Figure 4: U-45 shredder unit custom-bult by Ulster Shredders at Killary Harbour, used to process mussel floats. The picture includes members from the mussel farm, BIM and Green Marine Recycling. Image retrieved from Mulligan, (2019) on 11 Jun. 2024.

Success and novelty

In 2012, BIM, Green Marine Recycling, GEOLINE Lining Systems Ireland and Centriforce (Liverpool, UK) developed a pilot project for recycling fishing gear equipment such as polyethylene nets, ropes and twine. Out of this project, **187 metric tonnes** of polyethylene-based bulk gear and equipment were processed, resulting in **74 tonnes of marketable polyethylene feedstock** (Mulligan, 2019; Ulster Shredders, 2018).

Best practice/BAT websites:

BIM: https://bim.ie/

Ulster Shredders: https://ulstershredders.com/

FFL: https://fishingforlitter.org/ireland/

4.2. NET 360

Ireland

Description

The "NET 360" project is a partnership between **Verifact** (company that provides software solutions for product safety and sustainability) and **Novelplast** (plastic recycler in Co.Meath, Ireland), which aims to track EOL fishing nets through the recycling process back into commercial use (**Figure 5**). The project arose from the inadequate management of fishing gear waste in Ireland, as these materials are eventually sent to landfill. However, the SUP Directive requires the registration and reporting of disposed fishing nets. To solve this problem, "NET 360" aimed to develop a blockchain-based traceability system that would track the nets from the fishing vessels, through the recycling process, to the final product made from the pellets.

Facts and figures

During the pilot phase, the project worked with **10 tonnes of EOL fishing nets** collected in Greencastle, Co. Donegal, which were transported to Novelplast to be sorted, shredded and pelletised. The pellets produced were used for the manufacture of new products, including in automotive and clothing manufacturing. In this way, these nets, which previously ended up in landfills, were repurposed and reused.

Figure 5: NET 360 logo. Image retrieved from Verifact, (2022) on 11 Jun. 2024

Success and novelty

Thanks to the traceability system developed by Verifact, the final product carries a QR Code that consumers can scan to learn the verified history of the product. This product history is crucial, as it creates added value to the end product and enables knowledge of what fishing gear materials can be recycled. The data collected during the project supports compliance reporting (which will be shortly mandatory) relating to the disposal of the fishing nets. The project raises awareness of the Circular Economy and empowers consumers to make responsible and informed decisions regarding their purchases (Verifact, 2022).

Best practice/BAT websites:

Verifact: https://vfact.com/case-studies/net360

Novelplast: https://www.novelplast.ie/

4.3. Oceanize

Norway

Description

Oceanize is a plastics processing, recycling and production company located in Ottersøya, Norway. Oceanize aims to recover plastic from the fishing and aquaculture industries for reuse in Norway, eliminating the need for disposal. To this end, Oceanize connects plastic waste owners, the plastic waste industry, and consumers of recycled plastic as the foundation for circular plastic circuits. Oceanize is Norway's primary system for tracing industrial plastics and contributes to addressing climate impacts (Oceanize, 2023a). By being the only traceable cycle for industrial plastics in the country, it makes it easier for industrial players to ensure that plastics are part of a responsible and transparent system (**Figure 6**).

Figure 6: Oceanize collection and recycling model. Image retrieved from https://oceanize.no/en/sporingssystem/ on 11 Jun. 2024

Facts and figures

Oceanize collects fisheries and aquaculture plastic waste, such as discarded fish cages, feed pipes and ropes. **Between 2017 and 2021, 10,000 tonnes of aquaculture plastic were collected and recycled**.

The plastic waste comes from plastic consumers and waste reception centres across Norway. Customers can choose to deliver their plastic equipment directly to Oceanize's facility or request Oceanize to collect it from them. If desired, Oceanize can handle the entire process as long as the equipment is transported to a suitable location on land.

At Oceanize's facilities, the plastic undergoes sorting, washing, and grinding processes to turn it into small plastic granules (i.e., HDPE100, PE, and PP granules). The finished plastic granules undergo quality testing in Oceanize's laboratory and are then transported to the **Nopla factory** (leading Norwegian manufacturer of recyclable, injection-molded plastic products) in Leksvik. Finally, the plastic is injection moulded into various products such as shopping baskets, seating furniture, serving trays, and industrial products for the construction industry (**Figure 7, A,B & D**). Any other fractions of plastic or other materials are disposed of responsibly (Oceanize, 2023b and Oceanize, 2023c).

Success and novelty

Oceanize has also taken part in other best practices initiatives, such as investigating possibilities for the recertification and re-use of ropes in collaboration with ScaleAQ, and Sinkaberg Hansen. Oceanize has also collaborated in the construction of the world's first fish farm cage made from 100% recycled plastic, launched on the Helgeland coast (**Figure 7, C**). This fish farming cage is constructed from recycled plastic obtained from old, discarded fish farming cages. It is the result of the "Fish farming cages made from recycled plastic" project, a collaboration between **Oceanize, AKVA group** (Aquaculture materials and services supplier), **Helgeland Plast** (pipes and PE plastic products manufacturer), and **Plasto** (Automated production of injection moulded components in thermoplastic). Oceanize's primary role in the project is to supply recycled plastic granules from decommissioned cages, enhance the quality of the recycled plastic by adding additives, work closely with Norner, and actively contribute knowledge and ideas throughout the process (Oceanize, 2023d).

All the initiatives and work done by Oceanize demonstrate proactive efforts to comply with waste management legislation and the new EPR scheme for fishing gear by integrating sustainable practices, promoting circularity, and reducing environmental impact in line with current regulatory requirements.

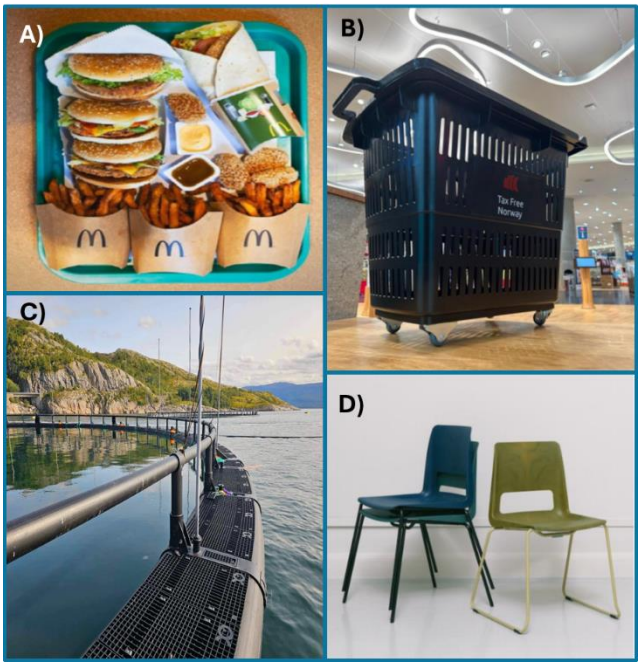

Figure 7: A) serving trays: B) shopping baskets; C) aquaculture cage and D) furniture made from Oceanize recycled plastic granules. Images provided by Oceanize and retrieved from Oceanize (2023c) and Oceanize (2023d) on 11 Jun. 2024.

Best practice/BAT websites:

Oceanize: https://oceanize.no/en/

4.4. Sotenäs Marine Recycling Center (SMRC)

Sweden

Description

The municipality of Sotenäs established in 2018 the **Sotenäs Marine Recycling Center (SMRC)**, a sorting and recycling centre where EOL fishing gear materials collected from the **Fiskereturen project** are transported and sorted into small fractions (**Figure 8, A & C**). The project is funded by the Swedish Marine and Water Management. The Fiskereturen project supports the collection and sorting of discarded fishing gear and historical gear. The establishment of the SMRC enabled the collection and sorting of this waste fraction, allowing the fishing gear materials to enter a circular value chain for reuse, upcycle and recycling. The Fiskereturen project and the SMRC have generated knowledge on the composition of fishing gear and how to sort and recycle the materials.

SMRC has also been the starting point of many projects related to circular design of fishing gear, the "Testbed Marine Waste" project and preventative measures. The SMRC also collects ghost gear from other municipalities, which is retrieved by fishermen and divers.

Facts and figures

The SMRC receives approximately **200 tonnes of EOL fishing gear collected per year.** The type of plastics sorted are: PP, PE, PET and PA. Meanwhile, the metals sorted are: lead, aluminium, copper, lead ropes, and stainless steel. Rubber and floats are also sorted. Some percentages of the floats collected are reused in the production of new trawls. PP and PE are recycled at Plastix in Denmark. PA and PET do not have recyclers yet, but the fractions are sorted at the SMRC for future recycling. Metals are recycled at Stena Metal in Sweden (**Table 2**).

Table 2: Percentages of EOL fishing gear and other plastic materials collected and sorted at SMRC under the Fiskereturen project in 2023

Of 176 tonnes of sorted EOL fishing gear in 2023	
Materials	**%**
Plastic	56
Metal	33
Other materials (wood, stone and electronics)	10
Of 99 tonnes of sorted plastic	
Materials	**%**
PP	19
PE	15
PA	10
PET	3
Floats (PP, PE, PA)	5
Incineration	50 (including rubber = 30)

PP: polypropylene; PE: polyethylene; PET: polyethylene terephthalate; PA: polyamide (nylon).

Success and novelty

Although the SMRC is the first fishing gear recycling centre established in Sweden, achieving economic potential by sorting fishing gear and sending it for recycling has been challenging due to several aspects. On one hand, transportation costs are equal to the material value. On the other hand, the sorting process is very labour-intensive for the small number of SMRC employees (4 sorters and 1 facility manager). In addition, materials going to incineration have increased costs to approximately 3,000 SEK tonnes^{-1}.

The municipality launched the "Testbed Marine Waste" project, aimed to discover the economic potential and processes for production of marine plastics. Twelve different companies collaborated on the project, of which two start-ups succeeded in commercially manufacturing new products from marine litter materials. In addition, the company **Impossible Plastics** purchases "bad" plastic materials from SMRC, as they are able to recycle them into new products. Within the Fiskereturen project, a small test bed with lab-scale machineries was set up for companies to prototype marine waste (**Figure 8, B & D**). The test bed could provide economic potential for the SMRC, but there have not been many companies interested in using it. SMRC has worked closely with the Swedish government in projects related to the EPR for fishing gear to gain knowledge on the collection and classification of end-of-life fishing gear for the new EU directive and national legislation.

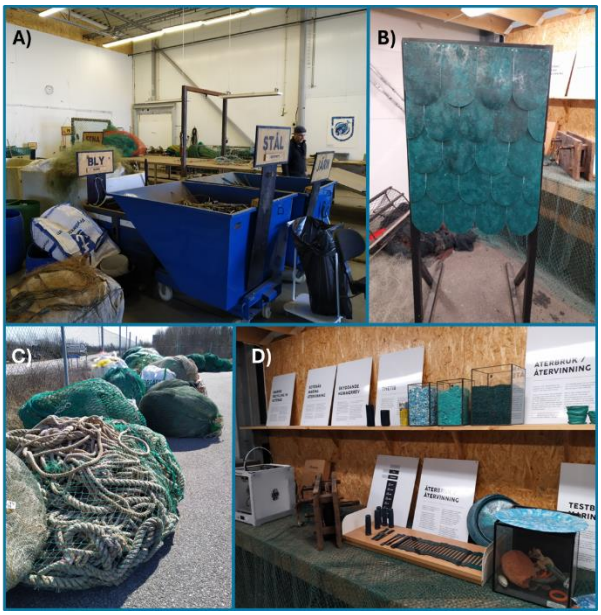

Figure 8: A) Sotenäs Marine Recycling Center (SMRC) sorting facilities; B) Plastic tiles made from recycled fishing gear at SMRC; C) Collected end-of-life and historical fishing gear at SMRC and D) Plastic pellets and prototypes made from recycled fishing gear at SMRC. Images provided by SMRC.

Best practice/BAT websites:

Symbioscentrum:
http://www.symbioscentrum.se/omsotenassymbioscentrum.4.1f39350415fe315b1ac103a7.html

4.5. Aquafil

Italy

Description

The Aquafil Group is the world leader in the manufacture of carpet yarns and one of the leading suppliers of yarns, synthetic fibres and polymers to Europe's best clothing and design brands. Founded in 1965, Aquafil has been working to achieve a circular economy. Aquafil is based in Italy but has a global presence in ten countries (Italy, Slovenia, United Kingdom, Germany, Croatia, USA, China, Thailand, Japan and Chile). Aquafil operates through four product areas: yarn for carpets, yarn for textiles, polymer and engineering. They manufacture Nylon 6 fibres, Nylon 6.6 fibres, polymers and yarn. Their flagship product is ECONYL® nylon, which is a regenerated textile yarn, produced with a chemical recycling process and closed-loop model (Aquafil, 2023).

Facts and figures

In 2011, the ECONYL® regeneration system was inaugurated at the AquafilSLO factory in Ljubljana, Slovenia (**Figure 9**). This plant regenerates pre- and post-consumer nylon 6 waste into ECONYL® nylon. The post-consumer nylon 6 waste comes from old carpets and fishing nets. Meanwhile, pre-consumer waste comes from industrial waste, including fabric waste and plastic components (Aquafil, 2017). These waste fractions are processed to obtain a raw material (i.e., caprolactam), which is then transformed into yarn for rugs, carpet flooring, and clothing at the Group's production plants (Aquafil, 2021).

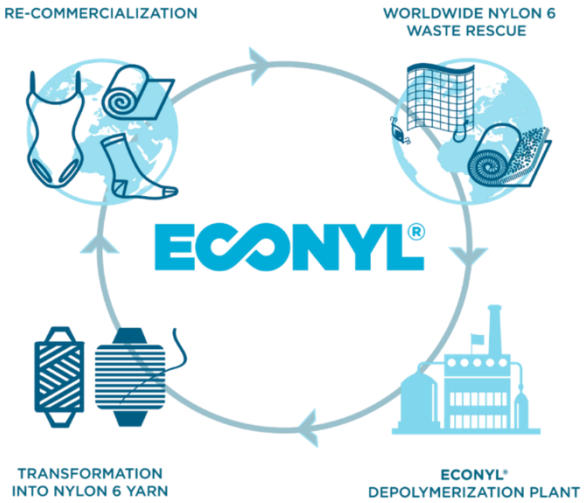

Figure 9: Econyl ® regeneration system. Image retrieved from: https://www.aquafil.com/the-group/.

Success and novelty

Aquafil has systematized the collection of post-consumer waste (mainly carpets, rugs, and fishing nets), by carrying out vertical integration operations upstream in the supply chain for the last five years. **Aquafil Carpet Collection** (Phoenix ,USA) is responsible for recovering carpets and rugs at the end of their useful life. On the other hand, Aquafil has invested in **Nofir**, the Norwegian leader in the recovery of fishing and aquaculture nets at the end of their life cycles. Lastly, the company founded **Aquafil Chile**, a centre for the recovery and dismantling of fishing nets (**Figure 10**).

Through all these initiatives, Aquafil has collected more than **16,000 tonnes** of post-consumer nylon waste annually and is expected to reach **35,000 tonnes by 2025** (Aquafil, 2023).

Related to fishing gear recovery, in 2013, Aquafil co-founded "**The Healthy Seas Foundation**", an organization dedicated to marine conservation and education. Since its foundation, it has recovered **991 tonnes** of abandoned fishing nets and other marine debris with the help of more than 150 partners, thousands of fishermen and, in 2023, 550 volunteer divers. The collected nylon waste is sent to Aquafil's production facilities where, along with other waste, it is regenerated into ECONYL® nylon (Aquafil, 2023).

Overall, Aquafil works with each of the ESG targets. For each of their 5 ECO PLEDGE® guiding principles, they have defined forward-looking objectives identifying improvement areas and launched a series of projects to reach them. Some examples include the development of the environmental policy; reporting scope three emissions; Development of ISO standard 4484-2 on microplastics development, validation and emissions; Climate change Risk and Vulnerability Assessment; and Biodiversity Impact Assessment (Aquafil, 2017).

Figure 10: Aquafil Chile facilities in Santiago, Chile. Image retrieved from: https://www.aquafil.com/the-group/.

Best practice/BAT websites:

Aquafil: https://www.aquafil.com/the-group/l

The Healthy Seas Foundation: https://www.healthyseas.org/

4.6. MARELITT Baltic

Baltic Sea area

Description

The MARELITT Baltic project aimed to develop comprehensive solutions for derelict fishing gear (DFG) retrieval, including cost-efficient, safe, and environmentally friendly cleaning, prevention, and recycling methods. The MARELITT Baltic project was operational from March 2016 to April 2019 with a total budget of €3.75 million.

In total, MARELITT produced 11 reports, with topics varying from methodologies of mapping and retrieving DFG to environmental impact assessment. For Blue Circular Nets (CIRCNETS), the most relevant output is Report 5: Recycling Options for Derelict Fishing Gear (Stolte et al., 2019), where the main findings will be summarized in this case study.

Figure 11: A) Retrieved lost fishing gear comprised of a mix of ropes, nets, lines and other materials; B) Removal of large metal items with mechanical cutting tools. Images retrieved from: (Stolte et al., 2019).

Facts and figures

Report 5 notes that when derelict fishing gear (DFG) is retrieved from the sea, the material is entangled and often contains metal anchors, chains, organic matter, and other marine litter, as well as nets, ropes, float and sink lines (**Figure 10**). Therefore, between two and four pre-processing stages (i.e., removal of large metal and organic pieces) are necessary to prepare DFG for either thermal or material recycling. Pre-processing can best be implemented in the landing harbour to avoid unnecessary weight during transport. However, the preparation of DFG for material recycling is technically challenging and elaborate, which leads to high costs for both manual labour and machinery.

Density separation should be considered a necessary step to minimise contamination with residual sediments and toxic lead fragments. Industrial friction washing works well for monofilament fibres but is less efficient for woven fibres (e.g. trawl netting).

Success and novelty

There are four dominant polymer types in fishing gear: PA6, PET, PP and PE. None of the analysed samples in the project resulted in a pure single-type polymer fraction, and all samples showed contamination with polyolefins.

To ensure material quality, pre-sorting of rope and net samples is essential. The better the level of pre-sorting, the higher the resulting material quality in terms of uniform polymer content and reduced contamination with substances listed under REACH. The report highly recommends a REACH analysis before granulation for material recycling.

The report notes that gillnet-dominated samples are the most difficult to recycle despite the comparably pure polyamide net material. Extensive pre-processing, including removing swim- and sink-lines and trapped waste such as cables, would be required to allow for polymer recycling. Even with extensive pre-processing, fine-grained sediments and the fluffy consistency of ground PA fibres might impede material recycling (**Figure 12**).

Thermal processing is recommended for DFG heavily mixed with other wastes and contaminated with lead. Especially for contaminated materials, steam reforming is found to be the best option to exploit the polymer energy content to generate synthetic gas and extract lead for metal recycling.

Large trawl net fragments and ropes provide the easiest recycling samples as they are more readily separated from trapped marine litter such as large metal items, rocks and cables. They also provide more uniform materials that might be used in small-scale production series.

Given the effort required to recycle DFG, **two requirements** were identified:

1. Retrieved DFG needs to be incorporated into the existing waste management infrastructure in fisheries harbours.
2. Retrieval and pre-processing effort by fishermen, divers or other professionals need to be financially supported by municipalities or national authorities to establish a DFG value chain.

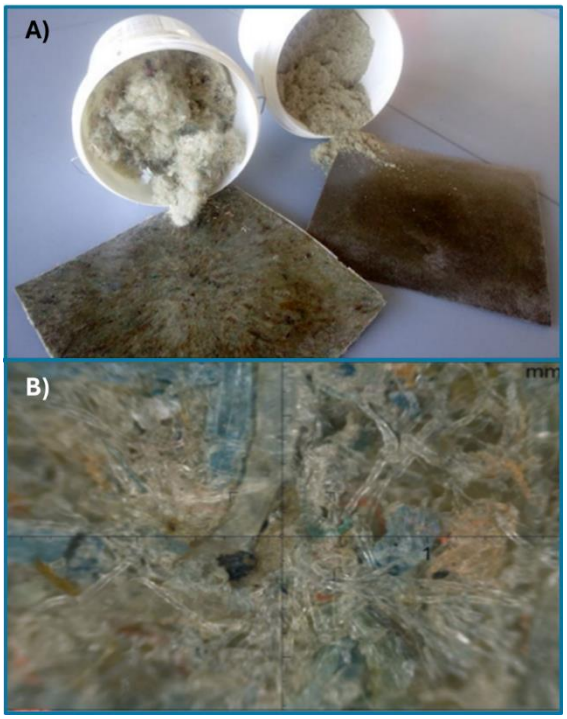

Figure 12: A) Pressed plates from gillnet fibre material in different gridding qualities; B) The microscopic image of the input material reveals a rubber fragment among the inhomogeneous fibre mix. Images retrieved from Stolte et al., (2019).

Best practice/BAT websites:

MARELITT Baltic: https://www.marelittbaltic.eu/

4.7. Global Ghost Gear Initiative (GGGI)

International

Description

The GGGI is the world's largest ghost gear collective impact alliance operating cross-sectoral to foster solutions for solving the problem of Lost, Abandoned and Discarded Fishing Gear (ALDFG). Its main strength lies in the quadruple helix type collaboration, i.e. the diversity of its participants from the fishing industry, private sector, academia, governments, intergovernmental and non-governmental organisations and their collective role in mitigating ALDFG on local, regional and global levels. The main goal of the GGGI is the improvement of aquatic ecosystem health, safeguarding human health and livelihoods, and protecting of aquatic life from harm. To achieve these goals, the initiative aims to build evidence and define best practices to inform policies and incentivise the application and replication of solutions. The GGGI funds projects all over the world to drive solutions for ALDFG (GGGI, 2024).

Facts and figures

Among other initiatives, GGGI developed two best practice frameworks on:

1. **The Management of Fishing Gear** (GGGI, 2021a)
2. **The Management of Aquaculture Gear** (GGGI, 2021b).

These frameworks are tools for stakeholder groups across the seafood supply chain to apply in order to prevent, mitigate and remediate ghost gear in the fishing sector and plastic litter in the aquaculture sector.

Both frameworks are based on risk analysis on of ALDFG by fishing gear type and of aquaculture systems based on the use of plastic types in aquaculture. The proposed management options to reduce plastic litter in fishing and aquaculture are divided into three categories: prevention, mitigation and remediation (**Table 3 & 4**).

Table 3: Key best practices actions and approaches for the management of fishing gear. Based on GGGI, (2021a).

Best practice Framework for the management of fishing gear	
Prevention	Spatial and/or temporal measures.
	Gear design to reduce whole or partial loss of the fishing gear.
	Vessel design to reduce gear and other aquatic litter discarding.
	Better making and identification of fishing gear.
	Improved end-of-life fishing gear disposal facilities.
	Education and awareness.
	Improved fisheries management regimes.
	Good practice for avoidance, mitigation and response.
Mitigation	Gear design to reduce the incidience and duration of ghost fishing.
Remediation	Lost gear reporting, location and recovery initiatives.

Table 4: Key best practices actions and approaches for the management of aquaculture gear. Based on GGGI, (2021b).

Best practice Framework for the management of aquaculture gear	
Prevention	Gear design to reduce and ease maintenance needs and improve equipment reliability.
	Development and introduce new materials that are simple to reuse and recycle.
	Build in traceability for equipment and components where practical.
	Design effective, integrated and cost-efficient equipment.
	Facilitate and promote aquaculture equipment recycling and responsible disposal.
	Move to EPR to add the environmental costs associated with a product throughout their life cycle.
Mitigation	Collaborate with aquaculture operators, industry organizations and researchers to test and improve equipment design.
Remediation	Research and develop materials and equipment designed to facilitate the recovery of lost or abandoned aquaculture gear.
	Collaborate with management authorities to assist in tracing the origin and ownership of recovered aquaculture materials.

Success and novelty

These measures have been put into practice through legislation and other regulatory approaches, voluntary actions (e.g., Code of Practices, voluntary agreements between parties), third-party fisheries and aquaculture certification, mandatory legislation, improved awareness and information. The frameworks showcases individual best practices in relevance to identified stakeholder from seafood businesses, the fishing and aquaculture industry, harbour and port operators, researchers, certification bodies, local and national authorities/governments and non-governmental organisations.

Best practice/BAT websites:

GGGI: https://www.ghostgear.org/

4.8. Anglers National Line Recycling Scheme (ANLRS)

United Kingdom

Description

The Local Independent Sea Anglers (LISA) in the UK in collaboration with the Global Ghost Gear Initiative, in 2016, developed the first line recycling project in the UK. The initiative consisted of the placement of collection bins in tackle shops in Sussex, the region where the project started, and the recycling of the fishing line. In 2018, LISA members launched the **Anglers National Line Recycling Scheme (ANLRS)** to expand the Project to all of the UK. Since 2018, over 350 shops, 185 fisheries, angling clubs, charter boats and manufacturers have signed up to the Scheme. Other organisations are supporting the Project, including the Royal Society for the Prevention of Cruelty to Animals (RSPCA), which placed ANLRS bins at their wildlife centres, and along with many of the regional Inshore Fisheries & Conservation Associations (IFCAs). ANLRS is also collaborating in beach clean-up initiatives and litter collection events to assist with the disposal and recycling of ALDFG (ANLRS, 2024a).

Facts and figures

ANLRS relies on volunteers to manage the collection of fishing lines, and then the organisation stores the collected material until there is enough to return for processing.

Figure 13: A) End-of-life fishing lines collected through the Anglers National Line Recycling Scheme (ANLRS) scheme; B) Empty plastic spools collected through the ANLRS program; C) Coastal ANLRS container for discarded fishing lines. Images retrieved from: https://www.anglers-nlrs.co.uk/ .

ANLRS collects a vast and diverse range of fishing gear (**Figure 13, A & B**), including monofilament, fluorocarbon, braids, fly fines, fly backing, plastic line spools, small plastic tackle items, like beads and lead clips, single-use plastic packaging items and metal rig components (ANLRS, 2024b). Fishing gear is collected by ANLRS at different collection points, such as the tackle shop recycling bins, fishery recycling points, and the bins located on beaches and sea venues (**Figure 13, C**).

As a recycling incentive, many stores offer discounts on the purchase of new fishing line, as well as free spool stripping or free re-spooling to customers bringing in items for recycling. Since 2018, ANLRS have collected **30 million fishing lines and 40 thousand plastic spools** (ANLRS, 2024c).

Success and novelty

In 2019, ANLRS started a collaboration with **ReFactory**, a recycling company that specialises in handling plastics deemed as unrecyclable. ANLRS sends to ReFactory the fishing lines and fishing gear collected from the bins and in beach clean-ups. The innovative process recycles, among other things, plastic spools, fishing line braids, small plastic tackle items, single-use packaging and dirty and damaged plastics recovered from waterways, verges and fields, and gives them a second life as new recycled plastic-based products (ANLRS, 2024d). All the different types of plastics that are conventionally considered unrecyclable are grinded into small pieces and then processed in a 'giant waffle machine' where the material expands inside it to create a solid and waterproof plastic panel. The panels are then used to create outdoor products and furniture that is sold by ReFactory (ANLRS, 2024b).

In 2022, ANLRS partnered with ReFactory, Waterhaul and DNA Baits, supplying the collected fishing line, for the creation of a product made from the old monofilament file.

The product is a pair of polarised fishing sunglasses, and the frame is made 100% from recycled materials, consisting of 40% monofilament and 60% commercial net material (**Figure 14, A**). DNA Baits donates £5.00 for every pair of sunglasses sold to the ANLRS. In addition, DNA Baits gives a certain number of sunglasses to be sold on the ANLRS website, where the proceedings go to raise funds for the organisation.

From an international perspective, the Initiative has been exported outside the UK, where volunteers from the Republic of Ireland and Belgium are implementing the Scheme, and a number of tackle shops in Europe have adhered to the project. The fishing gear collected from these European countries is sent to **Plastix**, a Danish clean-tech recycling company specialised in recycling fishing nets and monofilaments (ANLRS, 2024a).

Figure 14: A) DNA baits polarised fishing glasses made from recycled fishing gear materials; B) Rod holder reworked from discarded fishing lines. Images retrieved from: https://www.anglers-nlrs.co.uk/

Best practice/BAT websites:

ANLRS: https://www.anglers-nlrs.co.uk/

4.9. Net Your Problem (NYP)

United States of America

Description

Net Your Problem (NYP) is a non-governmental organization (NGO) founded in 2018 by marine biologist Nicole Baker. Based in Seattle, Washington, NYP also operates workstations in Maine, Newport, Alaska, and California. The organization focuses on creating an **economically viable pathway to recycle end-of-life fishing gear**, thereby improving waste management, contributing to the circular economy, and reducing greenhouse gas emissions from virgin plastic production. NYP provides a recycling service for fishermen using their nets and lines. After collecting enough to fill a shipping container, NYP load it up and exports the old gear to global recycling partners (NYP, 2024). The primary mission of NYP is to engage various stakeholders within the fishing sector, fishing gear industry and plastic recyclers to recycle EOL fishing gear and turn it into new plastic products.

Facts and figures

NYP collaborates with fishermen, recyclers, and sustainable brands to collect and recycle fishing gear. Collaborations with entities like the **Copper River Watershed Project** and the **Curyung Tribal Council** in Alaska have supported regional recycling efforts. The collected fishing gear through NYP includes gillnets, seines, bottom and midwater trawls, lobster and crab lines, food ropes, cable, purse lines, float lines from pot gear, and seaweed line. The collected gear is processed into raw polyethylene or nylon plastic pellets for the global plastics market. As of November 2020, NYP had recycled around **414,600 kg** of fishing gear. NYP relies on financial contributions and support from stakeholders. They are working on programs where net manufacturers incorporate a recycling fee into the sale of new nets to fund long-term recycling efforts (NYP, 2024).

Success and novelty

For the collection of EOL fishing gear, NYP sets up collection sites at major fishing ports where fishermen can drop off their EOL fishing gear instead of sending it to landfill. The collected gear is then stored and weighed to manage the recycling fee, which is comparable to landfill charges. Sorting of EOL fishing gear is done using **infrared spectrometers** to identify the different plastic types (e.g., PP, PE and nylon). The sorted materials are then processed into raw plastic pellets (**Figure 15**) that are sold to local recyclers or foreign recycling companies (e.g., Plastix). This process not only keeps gear out of landfills but also feeds back into the plastic supply chain (Card 2023; Waldrep, 2024).

NYP aims to expand its operations globally and continue to build capacity for recycling fishing gear within the United States.

They seek to involve more stakeholders in their mission to create sustainable recycling solutions and support the blue and circular economies (NYP, 2024).

Net Your Problem exemplifies best practices in recycling EOL fishing gear through innovative collection programs, stakeholder collaboration, and compliance with waste management legislation. NYP efforts contribute significantly to reducing plastic waste in the marine environment and promoting a circular economy.

Figure 15: Plastic pellets made from end-of-life fishing gear nets collected by Net Your Problem. Image retrieved from: https://aksalmonsisters.com/blogs/news/net-your-problem-earth-day-feature?srsltid=AfmBOopCmh9iNnyQR1jnlvXc

Best practice/BAT websites:

NYP:
https://solutionsearch.org/contests/entry/1006

4.10. REDUSE-II

Spain

Description

In 2022, the Spanish Fishing Confederation (CEPESCA) undertook the REDUSE-II project: “Development of Responsible Management Systems for Fishing Gear", as a follow-up to the project RED-USE: “Towards a system for responsible management of fishing gear”. CEPESCA developed the REDUSE-II project in collaboration with the Biodiversity Foundation of the Ministry for Ecological Transition and the Demographic Challenge through the Pleamar Program in its 2021 call and co-financed by the European Maritime and Fisheries Fund (FEMP).

The main objective of the REDUSE-II project was to implement a responsible management model for fishing nets and gear in Spain, incorporating the requirements of the EPR directive for the sustainable treatment and processing of fishing gear materials and promoting the participation of all the stakeholders involved in their useful life cycle.

Facts and figures

One of the achievements of this project was the implementation of 10 pilot projects for the collection and sorting of EOL fishing gear waste in Spain. These pilots aimed to generate knowledge to ensure that the waste management protocol can be scaled up with minimal operational risk and is economically sustainable. The pilot projects were stablished in 10 locations over Spain covering 8 fishing ports and 2 fishing industry companies (i.e., Redes Tambores S.L.- Alicante, Cala Ratjada port-Balearic Islands, Ibiza port- Balearic Islands, Ribiera port- A Coruña, Celeiro port-Lugo, Luanco port- Asturias, Santander port-Cantabria, Balfego & Balfego S.L.- Tarragona, Sanlúcar de Barrameda port- Cádiz and port of Carboneras-Almería) with an average duration of 27 days. Results and analysis of the pilot projects are presented in this case study (**Table 5**).

Table 5: REDUSE-II pilots results. Based on Cepesca, (2022)

Importance of waste management systems	**1.** Identify the lack of existing solution to the management (recycling or reuse) of fishing gear or other waste that is not strictly netting (e.g., ropes, wire ropes, chains, floats, hooks, etc.) in the pilot projects. **2.** Raised stakeholder’s interest in integrating waste management plans for EOL fishing gear.
Social value	**1.** Increased awareness and training of stakeholders on the problematic of fishing gear waste. **2.** Establishment of the first steps and guidelines to achieve compliance with current and future European and national regulations on fishing gear waste.

Social value	**3.** Facilitate the connection of key contacts, both internal and external (e.g., waste management and port agents, network of waste management coordinators) with ports/entities to achieve coordination in waste management practices. **4.** Creation of a new authority in ports with a large volume of waste who is takes control, manages and monitors port waste, including fishing gear waste.
Economic impact	The new management models proposed in the pilot projects involves the removal of specific fishing gear waste at zero cost, thus reducing the management cost of the entity. However, considering the total costs of implementation and kilos of net to be removed, the average value is **14.86 €/Kilo of net** to be removed according to the data collected in the ten pilots.
Environmental impact	**1.** Total amount of nets removed in the project was **18,198.0 kg** **2.** REDUSE-II calculated the carbon footprint involved in carrying out the pilot projects, especially the one associated with the transport of the waste removed. The implementation of the pilot projects is equivalent to a total of **1,343.7 Kg of CO_2 emitted.**

Success and novelty

Considering the results obtained from the pilot projects, implementation of specific protocols will address the following points:

1. The improvement of fishing gear waste collection, identification and separation according to origin.
2. The search for more sustainable raw material alternatives to manufacture fishing gear.
3. The improvement of waste logistics and processing activities.
4. Quality management.
5. Framework conditions and appropriate policies for the waste management of fishing gear.
6. Improving awareness and informing fishing gear users of the importance of the circular economy of fishing gear to reduce waste generation and increase material valorisation.

Best practice/BAT websites:

REDUSE-II:
https://www.programapleamar.es/proyectos/reduse-ii-desarrollo-de-sistemas-de-gestion-responsable-de-artes-de-pesca

4.11. Fishery for a Clean Sea Green Deal

The Netherlands

Description

The "Fishery for a Clean Sea Green Deal" (Green Deal, 2014) supports the Netherlands in meeting its obligation under the Marine Strategy Framework Directive (MSFD) to reduce the amount of marine litter in the North Sea, and helps the Cabinet achieve its aim of transforming the Dutch economy to a circular one, by pursuing a strategy of green growth. This deal is also linked to Ship-generated Waste and the Plastic Cycle Value Chain Agreement ("Ketenakkoord Kunststofkringloop"). The Deal was signed by several parties including the Dutch government (i.e., State Secretary for Economic Affairs, Minister of Infrastructure and the Environment), the fisheries industry (i.e., VisNed), seven fishing ports and other organisations (i.e., Urk Municipality, TheHague Municipality, Hollands Kroon Municipality, KIMO Netherlands & Belgium, Maritieme Afvalstoffen Inzameling Nederland B.V., North Sea Foundation and Stichting ProSea Marine Education).

Facts and figures

The main objectives of the Fishery for a Clean Sea Green Deal are as follows:

1. Fishing vessels must keep all domestic waste, all Fishing for Litter waste, and all fishing gear and operational waste separated on board, and as far as possible must submit these three waste streams separately at Dutch fishing ports.
2. In 2016, five fishing ports will facilitate the submission of fishery waste streams in an effective way to avoid delays for fishermen. The three waste streams will be collected separately. By 2020, this method will be extended to all Dutch fishing ports.
3. By 2020, 95% of fishing gear, operational waste and Fishing for Litter waste brought to Dutch quays by fishing vessels will be recycled or put to useful application.

Success and novelty

The main actions and efforts described under the agreement are presented in **Table 6.**

Table 6: Actions and efforts to accomplish under the Fishery for a Clean Sea Green Deal. Based on Green Deal, (2014).

Waste management on board	VisNed will ensure that the deal members are aware of the waste problem and methods to solve it by promoting waste storage on board and the correct sorting of waste streams. In collaboration with the fishing sector and Port of IJmuiden, KIMO Netherlands & Belgium initiated a pilot project in 2014 to develop a standard method for storing domestic waste separately in fishing vessels, using special big bags.
Study into sustainable alternatives to dolly rope	Together with materials experts, North Sea Foundation, Dutch and foreign fishing-gear experts, VisNed shall develop affordable alternatives to be used instead of dolly rope.
Waste management at fishing ports	By 2016, the Fishing Ports should have restructured their organisations to enable the three waste streams (i.e., domestic waste, Fishing for Litter waste and fishing operational waste) to be unloaded separately after ships have moored. In 2015, the Dutch Government, in collaboration with the Fishing Ports and the fishing industry, should have drawn up a set of best practices for facilities that receive waste streams in the ports. By 2020, the Fishing Ports should have optimised their waste collection infrastructure in line with the previous best practices
Fishing for Litter	The Fishing for Litter programme will remain in place and, if possible, its scope will be expanded.
Waste processing	In 2015, the ports of Ijmuiden, Scheveningen, and Den Helder should have been provided with facilities to accept the three waste streams (i.e., domestic waste, Fishing for Litter waste and fishing operational waste) separately. As of 1 January 2015, Bek & Verburg should be responsible for the acceptance, weighing and monitoring of Fishing for Litter waste from the ports of Vlissingen, IJmuiden and Scheveningen. In collaboration with the fishing sector, the Dutch Municipality of Hollands Kroon and Coöperatieve In- en Verkoop Vereniging Den Oever (CIV Den Oever) will continue to recycle discarded fishing nets as part of the Healthy Seas project. The plan is to collect and process **30 tonnes of nets per year.**
Monitoring	The activities will be monitored under the MSFD's national beach monitoring program, which is undertaken by the North Sea Foundation. KIMO Netherlands and Belgium should have implemented a monitoring program in 2015 to measure the effectiveness of the Green Deal.

5

CRITICAL ASSESSMENT OF THE CURRENT FISHING/AQUACULTURE GEAR DISPOSAL SYSTEMS

5. Critical assessment of the current fishing/aquaculture gear disposal systems

Fishing/aquaculture gear disposal systems of CIRCNETS' partner countries

Waste management practices related to fishing and aquaculture gear vary widely among CIRNCETS partner countries. We can find exemplary systems, as in the case of Iceland, while other countries, such as Finland, do not have a collection system for these materials at all. This disparity can be attributed to different aspects, such as the volumes of fishing gear collected, the funding available to promote these systems, among other countries' peculiarities. In this section, a critical evaluation of each partner country will be made, the possibilities and limitations of each disposal system will be analysed, and recommendations for improvement will be provided.

As mentioned above, Iceland presents a successful model that can serve as a reference for the implementation of a collection and recycling scheme for EOL fishing gear in other partner countries. Due to private and public funding, the Icelandic model has been maintained and improved over the years. Despite good practices and achievements, there are still points for improvement. On the one hand, there are communication problems between the Icelandic agreement partners regarding reporting EOL fishing gear equipment. As a result, reported figures could be higher due to inconsistencies in reporting methods and irregularities in the disposal of fishing and aquaculture gear waste. Information should be coordinated among the parties dealing with the waste and verified as much as possible. In recent years, SFS has taken this communication issue more seriously to avoid ambiguity and improve transparency. All collected materials are currently sent abroad for recycling due to the lack of adequate recycling plants in Iceland. Investing in a national recycling centre could be an opportunity to promote the country as one of the pioneers in collecting and recycling EOL fishing/aquaculture gear with a sustainable approach. By recycling the materials collected in the country, Iceland can enter the market for recycled fishing gear products. In addition, the system could also operate more sustainably by reducing CO_2 emissions from international transport of materials. The green energy transition should also be considered to improve the sustainability of the model. Iceland is known for being the world's largest green energy producer per capita, where 85%

of the total primary energy supply comes from domestically produced renewable sources (i.e., geothermal, hydropower and wind power energy) (Ministry of the Environment, Energy and Climate, 2024). Therefore, collection and recycling activities could run on Iceland's green energy resources.

To ensure the proper functioning and continuity of collection and recycling systems, a sufficient volume of fishing and aquaculture gear waste needs to be collected annually. The collection requirements set by each country (e.g., 20% in Sweden and 10% in Finland collection rates compared to fishing gear materials placed in the market annually) might not be sufficient to cover the processing costs. This is particularly relevant to countries with a low fishing and aquaculture industry, e.g., Finland. Therefore, collaboration between countries may be necessary to establish an efficient collection and recycling scheme. For instance, Finland and Sweden could share a collection and recycling system for EOL fishing and aquaculture gear. The proximity between the countries allows cost-efficient transport of the materials from Finland to Sweden. In Sweden, these materials can be processed at the SMRC and sent for recycling to Plastix (Denmark). In this way, Finland avoids investment in sorting facilities, which would be a large cost considering the low volumes of EOL fishing/aquaculture gear collected annually. Meanwhile, Sweden could benefit from the materials received from Finland, as they are added to those collected in Sweden, thus increasing the total volumes and making it a more efficient system. However, to improve the cost-effectiveness of the sorting phase, more investment is needed in infrastructure and personnel, as currently only four employees deal with all the materials received at the SMRC.

In addition to the fishing and aquaculture gear waste generated annually, historical fishing gear must also be considered in collection and recycling plans. Sweden has already taken action, designing the national scheme around the collection and treatment of historical waste together with new waste materials. Therefore, historical waste can serve as a starting point for other countries. Norway and Ireland, despite not presenting national collection and recycling schemes for EOL fishing and aquaculture gear, both have great potential for the implementation of such schemes due to several aspects. On one hand, the volumes of fishing and aquaculture gear waste generated annually are large enough to sustain the schemes. In addition, both countries are taking action on the FFL campaign, which has established a series of good practices among fishermen for the collection of ADLFG materials and has set up collection points in the main fishing ports. These achievements could facilitate the implementation of national schemes by proving a baseline on which to work on. In terms of management, Norway may have more difficulties due to its extensive coastline and large

number of ports (4,443) compared to the other partner countries. To date, the FFL campaign only covers the largest ports in Norway (i.e., 11 ports), holding most of the Norwegian fishing fleet. Therefore, it is expected that large volumes of EOL fishing gear waste will be generated in these ports. However, further efforts will be needed to design an efficient system that sets sufficient collection points to cover all the fishing gear waste generated in the country. A recommendation would be to assign the 11 ports of the FFL campaign as fixed collection points, while, for the smaller ports, to establish a collection campaign (i.e., waste is collected once or twice a year), as the volumes of EOL fishing gear waste generated in these locations are smaller than in the larger ports.

Another aspect to consider for the implementation of collection and recycling systems in Norway and Ireland is the national recycling potential. Norway counts with companies and organisations dealing with the collection and recycling of fishing and aquaculture materials (e.g., Nofir and Oceanize). Nofir manages the sorting of the volumes collected in the FFL campaign for subsequent recycling abroad. Oceanize, on the other hand, is mainly involved in the recycling of fishing and aquaculture plastics (e.g., discarded fish cages, feed pipes and ropes). At present, fishing nets and aquaculture nets are not recycled nationally. However, Oceanize is making efforts to include net waste in its facilities. Ireland lags behing, as there are currently no dedicated public recycling facilities for the treatment of EOL fishing and aquaculture gear. To avoid transport costs and emissions from shipping materials abroad, further investment is needed in national recycling facilities specialising in these material fractions. A potential fishing and aquaculture gear recycling facility is Novelplast, an Irish plastics recycling plant, which has been investigating ways to better recycle nylon fishing nets by collaborating on projects such as 365 net.

Waste management of commercial fishing/aquaculture gear

Overall, commercial fishing and aquaculture gear waste should be handled according to the waste management hierarchy: Prevent, Reduce, Reuse, Recycle, Recover and Disposal. The best practice frameworks developed by GGGI: 1) Best practice framework for the management of fishing gear (GGGI, 2021a), and 2) Best practice framework for the management of aquaculture gear (GGGI, 2021b), sets out a series of actions and recommendations that could help the fishing and aquaculture industry manage these waste fractions. These frameworks are based on three principles: prevention, mitigation and remediation. Prevention and mitigation of fishing/aquaculture gear waste can be achieved through different activities, such as gear design, waste facilities design, education campaigns, etc. Regarding gear design, one example

is the case of aquaculture cage nets. Many of the nets used in salmon farming present anti-fouling materials that make recycling difficult due to contamination of the nets with these chemicals. A BAT example is MOWI, Ireland. This company uses cage nets without anti-fouling chemicals. In this way, nets can be washed and reused multiple times before the end of their useful life. Once discarded, they can be easily recycled.

If prevention and mitigation are not possible, the only option is remediation through waste collection and recycling practices. The main problem with this last step lies in the sorting phase, which is time-consuming and cost-efficient due to several aspects. On the one hand, the collected materials are often in poor condition, as they are entangled or contaminated with sand and biological material. In addition, there is a lack of information on the materials' origin and composition, making the sorting and recycling procedure even more challenging. Pre-sorting techniques are essential to facilitate the sorting and recycling of fishing and aquaculture gear materials. Innovative solutions could be applied, such as material detection employing infrared spectrometry (NYP, 2024). Another example is the mobile shredder acquired from BIM (Ireland). By shredding fishing gear waste collected at port facilities, sorting efforts are reduced, allowing for a more accessible and standardised transport of materials to recycling facilities. The lack of information can also be solved by implementing a net tracking system such as the one designed for the NET 360 project.

In terms of recycling, unfortunately, there is no universal treatment for processing EOL fishing/aquaculture gear waste. Mechanical recycling (i.e., sorting, washing, drying, grinding, melting, and re-granulating) is the primary method for fishing gear recycling due to its ability to convert any plastic materials into granulates and its economic viability. However, limitations exist, including the multistage, labour- and resource-intensive pre-processing requirements for fishing gears and the problem of contaminated and mixed polymer gears. In addition, these recycling processes are sometimes considered not truly circular due to the downgrading of the quality of the material produced (Sala and Richardson, 2023). On the other hand, chemical recycling (i.e., the process of converting any plastic polymer into its original monomers) can complement mechanical recycling by recycling fishing gears and constituent materials that cannot be recycled via mechanical processes or by producing a higher-quality end product. (Sala and Richardson, 2023). Therefore, more research and investment are needed to develop cost-effective and efficient recycling methods. One example of chemical recycling is Aquafil (Italy), a recycling company that has developed a chemical-based method for the recycling of nylon nets coming from fishing nets, old carpets and pre-consumer nylon 6 waste.

Waste management of recreational fishing gear

Besides fishing and aquaculture gear, recreational fishing is also considered a complex waste fraction, not so much from a size and weight perspective, but rather because of the design of the products. The presence of smaller products containing both plastic and metal (e.g. fishing lures/bait), products made of materials that cannot be recycled with current methods and infrastructure (e.g. composite rods) and products that easily cause entanglement, both individually and together with other products (e.g., net-based fishing gear and lures with their hooks and barbs), make their collection and recycling difficult to manage. Further research is needed to facilitate the recycling and reuse of recreational fishing gear and to avoid entanglement of collected materials, which could happen if the same containers are used for the collection of all types of fishing gear. Nowadays, recreational fishing waste is not managed in any of the partner countries, resulting in this waste fraction being sent to landfill. Implementing measures like the ANLRS system (United Kingdom), could facilitate the management of recreational fishing waste and avoid landfilling.

Economic potential of fishing/aquaculture gear recycling

Challenges also exist concerning the economic potential of implementing collection and recycling schemes, as well as finding profitable recycling solutions. As can be seen from the SMRC example, sorting activities and transportation of materials are the main costs to cover in a collection and recycling scheme. If funding is lacking to set up and manage the systems, collection and recycling fees may be applied to cover the high costs of waste treatment and transportation. According to the EPR directive, the responsibility lies with the producers, i.e., net and fishing gear manufacturers. This could, therefore, result in higher fishing/aquaculture gear prices. On the other hand, manufacturing products made from recycled plastics instead of virgin plastics is more expensive, which is reflected in higher end-product prices. These economic constraints have consequences for consumers of fishing/aquaculture gear and buyers of products made from recycled marine debris, as they will have to pay higher prices to cover the costs of collection and recycling.

6

CONCLUSIONS

6. Conclusions

Through the exhaustive analysis of the collection and recycling systems of fishing and aquaculture gear present in the partner countries, and by investigating best practices and BATs that could be applied, the following conclusions were drawn:

- Differences in EOL fishing and aquaculture gear waste management practices among the partner countries are mainly related to the volumes of waste material collected, size and structure of the fishing industry, the presence of sorting and recycling infrastructure and funding opportunities.

- The Icelandic collection and recycling scheme between the Icelandic Recycling fund and the Association of Fisheries Companies (SFS) serves as a reference model for the other partner countries.

- In Sweden, improvements are needed in the collection and recycling practices for EOL fishing gear under the Fiskereturen project. The collection and recycling system could be more efficient by implementing pre-sorting procedures, pre- treatment activities and establishing adequate collection and transportation methods. In addition, further research is needed to balance out the collection and sorting costs to achieve economic viability and continuity of the collection and recycling system under the Fiskereturen project.

- There is great potential for the implementation of national schemes in Norway and Ireland. These schemes could be implemented by increasing investment in sorting and recycling facilities and designing efficient systems considering national peculiarities and the volumes of EOL fishing gear waste generated annually.

- Countries with low fishing and aquaculture industry (e.g., Finland and Sweden) and, therefore, low volumes of fishing/aquaculture gear waste generated annually, could collaborate in establishing a joint and more efficient collection and recycling scheme.

- Historical fishing/aquaculture gear waste should be included in national collection and recycling schemes and can be used as a starting point.

- Design and implementation of specific measures for the collecting and recycling of recreational fishing gear are needed to avoid landfilling.

- For the remediation of fishing and aquaculture gear waste, investment in and design of pre-sorting techniques are essential, as well as further research on recycling methods that allow efficient, cost-effective and sustainable recycling of materials.

- Finding economic potential in recycling end-of-life fishing and aquaculture gear is a challenge. Measures such as recycling fees and premium prices on recycled-end products can be applied to cover the collection and recycling costs.

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Annexes

Table 1: Review of Best practices and best available technologies (BATs) for the collection and recycling of discarded, abandoned or lost fishing gear.

Name of Best practice/BAT	Type of Best practice/BAT	Country	General description	Website link
Europe				
Antex	Textile producer	Spain	The Spanish yarn manufacturer uses different raw materials, including PET bottles, textile industry waste and PET from fishing nets. The yarn generated is used by Ecoalf for the manufacture of clothing.	https://antex.net/
"Net Viva" initiative	Programme	Spain	"Net viva" is a programme of the start-up POPSICASE focused on reusing and recycling the fishing nets that are discarded every year in the ports of Barcelona (Catalonia, Spain). The collection and cleaning of the nets is carried out in small work centres. The collected and processed materials are recycled into new products, such as plastic i-phone cases.	https://www.popsicase.com/?s=net+viva
BLUENET project	Project	Spain	BLUENET project aims to contribute to the sustainable blue economy by recycling abandoned, lost or discarded fishing and aquaculture gear from the Bay of Biscay. Through the project, a self-sustaining program for the recycling of abandoned, lost or discarded fishing and aquaculture gear was established in the Basque region (SE Bay of Biscay, Spain). Fishing vessels and fishing ports are equipped with fishing gear collection bins. In addition, the project promoted the design of alternative and sustainable fishing and aquaculture gear.	https://www.bluenetproject.eu/news/
Cosmos Trawl return system	Net manufacturer	Denmark	Manufacturer Cosmos Trawl collects EOL nets for dismantling and processing at its facility in Denmark. Recyclable parts are distributed to available recyclers. In addition, they offer a repair	https://www.cosmostrawl.dk/services/repair

			service for trawls, seines and other fishing equipment, which helps to ensure that repairs are carried out in port rather than at sea and prolongs the life of the trawls.	
Cux Trawl manufacturer and repair	Net manufacturer	Denmark	Cux Trawl manufactures trawls and other nets from PP and PE base materials, mainly, but not exclusively, for the fishing industry. They offer a trawl repair service and collect end-of-life PE and PP nets for recycling at Plastix (Denmark).	https://www.cuxtrawl.de/
Plastix	Recycling plant	Denmark	Plastix, a Danish firm, mechanically converts EOL fishing nets into recyclates in the form of a product called OceanIX®, which may then be utilised to make a variety of plastic goods.	https://plastixglobal.com/
Waterhaul	SME	UK	A social-enterprise that tackle ghost gear in oceans by transforming waste to valued resource. They utilise the strongest form of plastic in the oceans to produce exceptionally sustainable, recycled eyewear.	https://waterhaul.co/
Ocean recovery project (keep Britain tidy)	UK system for processing fishing trawl nets	UK	The UK's first system for processing fishing trawl nets. From the fishing port, the beach or even the seabed, giant nets are recovered and recycled at Milspeed to provide recycled plastic granulate to UK industry.	https://www.keepbritaintidy.org/uk-fishing-net-recycling
Fishy Filaments	SME	UK	Fishy Filaments aims to improve the sustainability of local fisheries in the UK by reducing waste and recycling nets more efficiently. Fishy Filaments is turning collected nets into filaments for 3D printers with the help of a crowdfunding campaign. To collect the old nets and ropes, Fishy Filaments works closely with the Port of Newlyn and the UK's Southwest Fishing for Litter initiative. After sorting, shredding and washing, Fishy Filaments converts the recovered nets into clean, high-quality nylon filaments that can be used in fused deposition modelling.	https://fishyfilaments.com/
Odyssey Innovation	SME	UK	Odyssey Innovation works with local fishing ports in the UK to provide centralised drop-off points around ports for unwanted fishing gear. This gear is collected from the ports and sent to facilities where it is prepared for recycling. Once the pre-recycling treatment has been completed, the material is handed	https://odysseyinnovation.com/pages/about-us-odyssey-innovation-our-odyssey

			over to Plastix. Unwanted fishing gear recyclates are converted into kayaks, bodyboards, surfing hand planes/hand boards and a diversity of other products	
America				
Redes de America	Fishing net and recycling programme	America	Redes de América is the fishing net and gear recycling programme of the Latin American Alliance for Sustainable Fishing and Food Security (ALPESCAS), which brings together 11 countries in the region.	https://alpescas.com/
Reel In and Recycle Programme (BoatUs Foundation)	Recreational fishing gear collection and recycling initiative	USA	The programme's goal is to establish a state-wide network of fishing line recycling bins to assist mostly recreational fishers to properly dispose of used fishing lines.	https://partnersforcleanstreams.org/programs/reel-in-and-recycle/#:~:text=Our%20fishing%20line%20recycling%20bins,for%20wildlife%20and%20humans%20alike.
Fishing for energy	Programme	USA	Fishing for energy was a programme launched by Covanta Energy Corporation, the National Fish and Wildlife Foundation (NFWF), the National Oceanic and Atmospheric Administration (NOAA), and Schnitzer Steel Industries, Inc. in 2008 on the east coast of the United States of America. The aim of this initiative was to provide a no-cost solution for fishers to dispose of old, derelict, or unusable fishing gear and to reduce the amount of ALDFG. Gear collected at ports are sorted at the Schnitzer Steel facility where metals are recycled. The non-recyclable materials that remain are sent to various Covanta Energy locations for energy recovery.	https://www.nfwf.org/programs/fishing-energy
Rest of the world				
Tangaroa blue Foundation	Australian marine debris initiative	Australia	Tangaroa Blue Foundation is an Australia-wide not-for-profit organisation dedicated to the removal and prevention of marine debris. They created the Australian Marine Debris Initiative (AMDI), an on-ground network of volunteers, communities and	https://www.tangaroablue.org/

			organisations that contribute data to the AMDI Database, and work on solutions to stop the flow of litter at the source.	
Rig Recycle	Tangaroa blue initiative to reduce recreational fishing littering	Australia	The aim of Rig Recycle is to divert specified recreational fishing items and packaging accessories from becoming litter in the environment or being disposed of in landfill by changing the recycling behaviours of consumers and retailers.	https://www.tangaroablue.org/amdi-network/reefclean/rig-recycle/
The Oliver Ridley Project (ORP)	Non-profit organisation	Pakistan	The non-profit organisation ORP produces a "Ghost Leash", which is a dog leash made from 100 % recovered and repurposed unwanted fishing net and waste fabric.	https://www.oliveridleyproject.org/ghost-leash
Ko win yang industrial co. Ltd	Recycling plant	Taiwan Province (China)	Ko Win Yang Industrial Co. Ltd. produces equipment specially designed to mechanically recycle unwanted fishing nets. They have developed a practical plastic shredder and integrated turnkey lines for washing and recycling fishing net scraps (PA, PP, PE and other plastic materials). Using their equipment, it is possible to produce plastic flakes from recycled fishing nets, which are directly available for extrusion-palletisation, plastic fibres or other recycled plastic products.	https://kowinrecycle.com/
"Good net" volleyball nets	Example of repurposing recovered ALDFG	International	The International Volleyball Federation (FIVB) and the Ghost Fishing Foundation, a marine conservation organisation came together to repurpose recovered ALDFG into volleyball nets for use by local coastal communities around the world.	www.fivb.com
OCEANETS project	Project	International	The OCEANETS project, "Technological approaches for circular economy solutions in terms of prevention, recover, reuse and recycle of fishing gears to obtain added-value products in the textile industry" is funded by the European Maritime and Fisheries Fund (EMFF). The aim of the project is to develop technology solutions, in line with the circular economy model, for EOL fishing nets.	http://oceanets.eu
Upcycling the Oceans	Initiative	International	The EcoALF Foundation's Upcycling the Oceans initiative works with local fishermen, divers, volunteers and other partners in Greece, Italy, Spain and Thailand to recover and collect	https://ecoalf.com/pages/upcycling-the-oceans?gad_source=1&g

	unwanted fishing gears and recycle it into their fashion clothing designs.	clid=CjwKCAjwkJm0BhBxEiwAwT1AXB9pcwfrE10GKegQbRY7hV5HOg7gRniZ6t7E-Du0G6gcet4eS6iBLxoCZP4QAvD_BwE

Best practices and BATs gathered through website search and literature research from Sala and Richardson, (2023) and van Nijen ,(2021).

circnets

Improving the management of end-of-life fishing gear

Blue Circular Nets (CIRCNETS) supports collection, treatment and recycling of fishing gear, so that these end-of-life nets are disposed appropriately, and they will not end up in seas and degrade the marine environment.

interreg-npa.eu/projects/circnets/

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