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RWS INFORMATION

How to come to a more circular (management) system of fishing gear in the OSPAR-region.

Which knowledge building blocks contribute to the development of a more circular and sustainable system of fishing gear, including the introduction of the extended producer responsibility, in the OSPAR-region, in the context of the EU SUP-Directive.

Colophon

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Executive summary

According to Neufeld et al., (2016) by 2050, for every kilogram of living species in the ocean there will be one kilogram of plastic litter. Yet, plastics are an important material in our economy and modern daily life is unthinkable without them. At the same time however, plastics have serious downsides on the environment and human health. Action on plastics was identified as a priority in the circular economy action plan (launched in 2015) to help European businesses and consumers to use resources in a more sustainable manner.
The first-ever European Strategy for Plastics in a circular economy, adopted on January 2018, will transform the way plastic products are designed, used, produced and recycled in the European Union (EU). Better design of plastic products, higher plastic waste recycling rates and more and better quality recyclates will help promote the market for recycled plastics. It will deliver greater added value for a more competitive and resilient plastic industry. The strategy is part of Europe's transition towards a circular economy and will also contribute to reaching the Sustainable Development Goals, the global climate commitments and the EU's industrial policy objectives. This strategy will help protect the environment, reduce marine litter, greenhouse gas emissions and the dependence on imported fossil fuels. Moreover, it supports more sustainable and saver consumption and production patterns for plastics (European Commission, 2020).
Part of the European Strategy for Plastics in a circular economy is the Singe Use Plastics (SUP) directive (EU/2019/904). With the SUP Directive, a set of ambitious measures to reduce plastic litter and increase collection and recycling is introduced. The SUP entails a focus on preventing and reducing the impact of certain plastic products on the environment. The SUP addresses the ten most found Single Use Plastic items on European beaches. The directive aims to prevent and tackle marine litter by, among other things, phasing out unnecessary single-use plastics and ensuring more circular and sustainable management of fishing gear. Via introducing economic incentives to reduce consumption and transition to reusable systems and establishing high collection rates and extended producer responsibility schemes (EPR).
Fishing gear represents 27% of all marine litter found in the European waters and is therefore also addressed by the SUP-directive. In fact, one of the most problematic form of marine litter is derelict or discarded (plastic) fishing gear e.g., (parts of) nets, traps and pots. Fishing gear may be accidently lost or deliberately discarded at sea, in harbors and on beaches. The annual loss of aquaculture and fishing gear in Europe is estimated to be around 4,000 – 10,000 tonnes (Viool et al. 2018). Because fishing nets and ropes are made of synthetic fibres since the mid-1960s, it is estimated that as much as 130,000 to 550,000 tonnes of fishing gear has accumulated in the European Economic Area until 2016 (Eunomia, 2016; European Commission, 2018; European Commission, 2020; Pham et al., 2014).

This report explores the concept of EPR for fishing gear. Included within the SUP Directive is the requirement for Member States to implement EPR scheme for fishing gear and components of fishing gear containing plastic. Under the EPR schemes, producers of fishing gear containing plastic should cover the cost for the separate collection of its waste and subsequent transport and treatment. The producers shall also cover the costs of awareness raising measures regarding fishing gear containing plastic. EU Member States are required to set up the EPR Schemes for fishing gear by ultimately December 31, 2024. Also, under the new Port Facilities Directive, Member States are required to ensure that in 2021 the facilities for end-of-life fishing gear are present in harbors and covered by indirect financing schemes. The involved Governments question what measurements are required for an EPR scheme to be the right policy option to stimulate the stakeholders of fishing gear system to move towards more circularity and sustainability. Recommendations from this study are primarily oriented towards the OSPAR-region (See chapter 1.3.). Nevertheless, lessons learned may also be of relevance and generalizable to countries across the globe.
The aim of this report is to analyse the various phases of the life cycle of fishing gear in the OSPAR-region. Moreover, which knowledge building-blocks can contribute to the development of a more circular and sustainable fishing gear system, including the introduction of the EPR, in the OSPAR-region in the context of the EU SUP directive?
The methodology used in this report consists of a literature review, explorative interviews, a survey about the EPR scheme for fishing gear, resulting in a SWOT analyses. A snowballing technique was used to collect more interesting contact-persons as well as relevant sources of literature.

Below, the dynamics and the problems of the fishing gear system in the OSPAR-region are described per phase in the life cycle of fishing gear. Three different phases have been distinguished in the fishing gear system being (1.) the design and production stage, (2.) the use stage and (3.) the end-of-life stage.

1. Design and production stage

Fishing gear is traditionally designed with the main driving forces being functionality, durability and costs. This created a situation where the reduction of environmental impacts, via designing with sustainability and circularity in mind, receives little attention. Creating a more sustainable and circular system for fishing gear is complicated, because a wide variety of types of equipment are used. Furthermore, it is complicated by the diversity of fishing-cultures involved, the international character of the fishing industry and tailored production to fit the site-specific circumstances. Fishing gear is considered a relatively small and diverse waste-stream. Therefore, being a challenge for recycling, as well as marine policy and marine law enforcement by governments being a 'grey' area at this moment.
One of the most important steps to move to a more circular system is making changes in the design (upstream). Fishing gear is comprised of various materials, from different types of synthetics to metals. The heterogonous materials used in fishing gear create a challenge for good reuse, repair and recycling of the fishing gear. An extra obstacle is the lack of transparency about the composition of the gear, and the different types of fishing gear. Purity of materials is a crucial factor for recycling, mixed material nets pose a challenge to the recycling phase. Currently, fishing gear is predominantly designed with a focus on efficiency and selectivity. This also counts for the depicted materials, the high-quality plastics used have potential for recycling. When the gear is designed as simple as possible, recycling also becomes a 'simpler' act. For increased recyclability of the gear a reduction in the number of materials used is required, while not compromising its functionality. By designing the gear in such a manner, making use of valuable materials and design as simple as possible for repair and recycling, good upstream changes can be made in the fishing gear system. Furthermore, within this phase the right moment needs to be stated at which moment the gear should be captured for repair, reuse and recycling. Yet, until now it is not rewarding for fishing gear manufacturers to produce less environmental harmful products, as this would lead to less consumption of fishing gear over time. This disincentive to produce more circular and sustainable gear can be changed when an EPR scheme is designed in such a manner that it creates an incentive for producers to produce more circular and sustainable gear. However, it is important to keep in mind that gear manufacturers, assemblers and suppliers suggest that a mixture of plastics is necessary for the functionality. This shows that more research and innovation in this stage is required.

Important is that fishing gear is captured at the right stage in its lifecycle in order to promote repair, reuse or the last-resort recycling. This is important to consider in the earliest phase of the system, because when materials are used too long the possibility to repair, reuse or recycle properly decreases. As earlier stated, an important step in creating changes in the design of the fishing gear are more insights via developing a monitoring system. This forms a fundamental knowledge basis that is required to make the right decisions regarding the design of an EPR scheme. A monitoring system should be developed with the international dynamics of the fishing industry in mind. Gear marking and gear tagging are interesting options to integrate in the design of the fishing gear. With gear marking-tagging, increased monitoring can be (financially) incentivized. It can also become a relatively easy control-mechanism for whom the owners/responsible parties for the fishing gear are. With that becoming easier to narrow down the right financial incentives to specific parties in the value chain to create a more circular and sustainable system for fishing gear.

2. Use stage

The use stage is an important stage in the fishing gear system to move towards more circularity and sustainability. Since the major problem of fishing gear as marine litter in the OSPAR-region is created because of parts of the fishing gear/net cuttings that end up in the sea. Therefore, the use stage is an important stage to intervene in order to prevent this. Because of this sustainable behaviour and good management of the net cuttings by the fishers must be supported and incentivised, to prevent that fishing gear makes its way into the ocean. Furthermore, the right circumstances need to be created to behave in a sustainable manner. Yet, also for this stage counts that there is a lack of relevant data. This is a major obstacle to understand how much gear is being used, lost and for the future what the effect of new measures are. Therefore, there is a need for good monitoring, to create better understanding about how much fishing gear is being used and what type of gear. Since lost gear is not restricted to borders, authorities must cooperate to effectively target and retrieve lost gear. By creating strong local clusters, collection repair and recycling of the fishing gear becomes embedded in the local structure. This creates an (financial) incentive for proper local management of the waste-stream since the value of the materials are captured. Properly managed logistics around waste and end-of-use gear collection should be ensured to assist the fishers. This includes unified collection of the gear onboard vessels in bags or containers, and provision of adequate facilities in the ports. The ports should support this as part of their service and ensure that there is sufficient storage and capacity available for handling

of any materials brought to shore. Repair is advised to be incentivized for example via repair vouchers funded by the EPR scheme or Governments.

One of the opportunities in this phase of the system is to create proper options for repair of the gear. This can be developed via good repair options in ports, as gear that is designed with easy repair in mind. Especially, since one of the reasons for fishing gear being a huge part of the marine litter problem in the OSPAR-region are the net cuttings and parts of the fishing gear that are not collected properly and got into the sea due to weather circumstances. Therefore, awareness raising measures are important to further educate the involved parties is required. Furthermore, any loss of fishing gear for fishers results in a financial loss, directly via losing nets or indirectly via a decreased quality of the marine ecosystem. This is extra incentive for the fishing sector to prevent this. Along with the development of good practice guidelines for use, repair and storage of fishing gear.

Good port reception facilities are an issue, for a good collection infrastructure the set-up of a more circular system for fishing gear is needed. Port waste facilities require frequently a long and inefficient walk with heavy fishing gear for fishers., creating a perverse incentive to leave gear at sea. With the revised port reception facilities directive being in place in all EU ports, good collection logistics are there for the fishing gear to be collected once it reaches it end-of-life. Furthermore, it brings important improvements as it removes financial disincentives to bring the gear to land. With the revised Port Reception Facilities directive, the idea is that this is taken care of. Interesting is it to monitor what the effects of this revised Port Reception Facilities are. The running fishing for litter scheme contributes to getting the abandoned, lost, discarded fishing gear (ALDFG) out of the ocean, being important for making the North-East Atlantic cleaner. An issue is that a lot of ALDFG that is in the marine ecosystem, is not accepted by recycling companies (not clean enough), due to the high costs of the related recycling processes. Along with the issue that there is only interest in valuable materials, this means that there is not a good solution available when non-valuable materials are still used in the design. Currently, one must pay a fee to deliver the plastic waste at recyclers, being a disincentive to sustainably manage plastic waste.

3. End-of-life stage

At this moment in time, disposal and end-of-life treatment of fishing gear is very low and the level of recycling of fishing gear in the EU is 1 to 5%. To run an efficient waste management system within a lot of small ports divided over a large area is cost-ineffective, although this should become better for all the EU ports with the revised port reception facilities directive. A weakness is that recycling is often a more costly process than landfilling or incineration. Therefore, only worthwhile when there exists a good functioning market for recycled goods or materials. Furthermore, there are only two main operators handling fishing gear at scale so capacity-building to better recycle fishing gear throughout the OSPAR-region is needed. The high organic contamination of materials reduces the ability to recycle the fishing gear, because clear plastics are required. Furthermore, differences in the materials and make up of nets imply the need for customised handling. This may include a separate storage for different gear types. Currently the assignment of responsibilities regarding handling, processing and disposal remains unclear. The main responsibility should lie with the net producers and assemblers when it comes to separation, disposing and recycling of end-of-life gear.

The process of identifying the material types and ascertaining the best method to undertake the labor-intensive task of separating and cleaning fishing nets before disposal is a critical component of the collection process prior to recycling. Development of facilities to enhance the capacity to recycle fishing gear within Europe need attention, in which the emissions related to the recyling should be taken into consideration. One of the threats are the low profit margins involved in plastic recycling, nowadays virgin plastics are cheaper than recycled plastics. Recycling can come with a high environmental and economic cost (i.e., chemical recycling), at the same time resulting in recycled plastic that is more expensive than virgin plastic. Combine this with the bad image recycled materials have with respect to virgin materials, and it is clear that this are not directly inviting business circumstances to start recycling.

Conclusively, an enumeration of the advised building blocks to the create a transition to a more circular and sustainable fishing gear system is presented below. The following steps are advised to be embedded in the EPR scheme for fishing gear to move to a more circular and sustainable fishing gear system. The points are ranked where number one is the most strongly advised based on necessity, impact and feasibility. Furthermore, what is strongly advised is to promote and incentivise upstream changes in the system as much as possible. Via upstream changes complex issues later in the value chain can be prevented as much as possible.

1. Develop a monitoring system throughout the value chain of the fishing gear system. More data results in more insight, now and in the future.

Better monitoring systems are needed throughout the value-chain of the fishing gear system. More data results in more insight now and in the future. More insight is needed about the amounts of gear that are in the fishing gear system (produced, bought, used, repaired, lost and collected in the end-of-life stage). Via these insights it becomes easier to target more precisely the weakness-points of the system, create here the right incentives to change and understand what the effects of the implemented measures are.

2. Develop a standard for sustainable and circular fishing gear.

By developing a standard for circular and sustainable fishing gear, it can be ensured that fishing gear is designed with a focus on gear that increases durability, strength and repairability. CEN (2020) is currently developing a European standard for circular design of fishing gear. Ensure that the gear is designed with valuable materials to increase the incentive to recycle. Provide a clear overview of the material-composition of the gear, if and how it can be repaired and the expected lifetime. Furthermore, a better understanding of the impact of different types of materials on the marine environment is needed, to be able to decide which materials must be used to create the most functional and sustainable composition of fishing gear. Embedding the principle of a pre-market producer responsibility in the extended producer responsibility for fishing gear is a way to stimulate that this circular standard of fishing gear is complied with.

3. Stimulating cooperation throughout the value-chain of the fishing gear system (producers/manufactures, fishing industry and the recyclers).

Strong cooperation with the fishing industry is fundamental, so that the fishers work together to create a more circular and sustainable fishing industry. A bottom-up and tailor-made approach is advised to ensure that the legislations and incentives to create a more circular and sustainable fishing gear system make sense to the stakeholders in the system. Ensure that strong cooperation throughout the fishing gear system is incentivized in the extended producer responsibility. The contribution of all the stakeholders is necessary to come to a more circular and sustainable (managed) fishing gear system. This can be done via financially incentivizing the parties to cooperate and take responsibility for their part. So, the different parties in the fishing gear system work together to solve the problem of fishing gear/net cuttings becoming marine litter. To ensure a resilient fishing industry, that moves forward to a sustainable future.

4. Develop simple and transparent rules for all the stakeholders in the value-chain, especially for the producers and fishers with the upcoming obligation of the extended producer responsibility (2024).

When developing the rules of the route to a more circular and sustainable fishing gear system it is important that these rules are simple and transparent. This makes it clear for all different stakeholders why the rules are there, what the (positive) consequences are and how and why to follow these rules. Via this a transparent system for fishing gear is created, ensure that information about sustainable gear, repair options and points, collection and recycling logistics are easily accessible for all the stakeholders. Also, transparency about the expected lifetime of fishing gear, composition of the fishing gear and options for repair is advised.

5. Guarantee a level playing field for the producers of fishing-gear on world-level, so European producers of fishing gear do not experience a competitive disadvantage due to obligations of the extended producer responsibility.

One of the challenges of extended producer responsibility for fishing gear is that the price of fishing gear increased due to the obligations for the producers. Result of this is that fishing gear, produced on other continents that are not involved in these measures (less circular and sustainable) becomes relatively extra-cheap and with that more attractive to buy. This must be taken into careful consideration so that European fishing gear producers are not pushed out of the market, resulting in a loss of control. With a level playing field, financial fairness is there for the sustainably behaving parties in the fishing gear system.

6. Set-up repair and storage facilities for fishing gear, technical and financial.

Set-up of repair and storage facilities for fishing gear is important. When repair is properly embedded in the design stage of fishing the development of good repair-points and storage facilities for the fishing gear is essential. Via this repairing gear becomes an easier and more attractive activity, the availability of spare parts for 'easy' repair is essential and must be financially incentivized. For example, via repair voucher funded by the extended producer responsibility for fishing gear.

7. Develop a good functioning waste collection and recycling infrastructures, technical and financial.

With the set-up of a good waste collection infrastructure, sustainably managing end-of-life fishing gear becomes an easier task for the fishers. Develop good functioning local-recycling clusters where the end-of-life fishing gear can be recycled, so end-of-life fishing gear does not need to travel long distances. The value of recycling remains locals resulting in reduced emissions related to recycling. Furthermore, develop good recycling equipment and ensure that there is a market for recycled materials.

8. Make the producers of the fishing gear responsible for both valuable and non-valuable materials.

Ensure that the producers in the fishing gear system also take responsibility for the non-valuable materials, via fees for example on these non-valuable fishing gear (parts). Sustainably managing the non-valuable net cuttings is needed, good behaviour can be promoted via financial incentives (e.g., vouchers) on good collection and collecting the net cuttings on board as in the harbours. This must address the net-cuttings, that are one the dominant problem for the fishing gear becoming marine litter in the OSPAR-region.

9. Development of control and evaluation of the extended producer responsibility for the fishing gear system via a strong 'market-master'.

The market-master needs to ensure that the rules are followed, that a fair and transparent system is ensured and that a level playing field is guaranteed for the sustainably acting producers of the fishing gear and the fishers. This role can be suited by a stronger involvement of Governments on the local, regional, national and international level.

10. Investigate the environmental benefits of a 'product as a service' as a potential part of the extended producer responsibility for fishing gear.

An option that is interesting to investigate in the future, but requires a radical change in fishing gear system is the set-up of a system of product as a service as part of the extended producer responsibility. More research is needed to find out the actual environmental benefits of such a system and the legitimacy with the stakeholders of the fishing gear system. Potential benefits are (if correctly developed) that is becomes clear who is the owner of the fishing-gear, therewith responsible for sustainable and circular managing the whole life cycle of fishing gear: the deliverer of the service.

Fig 1. Waves on the ocean (Rare, 2020)

Reading guide

The first chapter provides an introduction on the rationale behind this report being the issue of marine litter, circular-economy, extended producer responsibility. Furthermore, the ambition of the study, the study-area and the depicted research methods are described.
This second chapter provides an introduction about the fishing industry in the OSPAR-region, a description of a circular economy and a circular fishing gear system. Different (economic) instruments that can be implemented to support the transition to a more circular and sustainable system for fishing gear and the current legal landscape in which the fishing industry operates are described.
Chapter three discusses the lifecycle of fishing gear. The lifecycle has been divided into three phases, being design and production, the use phase and the end-of-life phase. The various lifecycle phases will be introduced and described. The description of each step concludes with a SWOT analysis in which the strengths, weaknesses, opportunities and threats faced by the fishing gear system to move to more circular and sustainable practices are summarized per lifecycle stage.
Chapter four describes the dynamic in the different contracting OSPAR parties about the fishing gear system and measures that are applied to create a more sustainable and circular fishing gear system and fishing industry.
Chapter five elaborates on extended producer responsibility schemes in general and specific for the fishing gear system. It is discussed what extended producer responsibilities are, what the different roles are for the general stakeholders in product-systems to integrate the extended producer responsibility scheme and specific for the fishing gear system and examples of extended producer responsibility schemes for fishing gear system are presented.
Chapter six present the outcomes of the survey conducted about an extended producer responsibility for fishing gear.
This report concludes with chapter seven and eight. In chapter seven a discussion and a conclusion are given about the results found in the survey on the extended producer responsibility scheme as the assessed literature. Chapter eight concludes with recommended building blocks for the way forward to a more sustainable and circular fishing gear system.

Fig 2. Sea lion, with nylon strings and piece of fishing net wrapped around his neck (Greenpeace, 2020)

1. Introduction

1.1. Setting the scene

Fishing gear as the main cause of plastic pollution in the sea

The profound consequences plastics have on our globe are staggering. Geologists consider, the developed plastic horizon in the world's soils and sediments as one of the key indicators marking the current geological era, the Anthropocene, this shows the profoundness of the plastic problem (Waters, Zalasiewics, Summerhaes, Barnosky, Poirier et al., 2016).
The ocean is of great importance for mankind, but it is being heavily polluted. Annually, eleven million tonnes of plastic is wasted in the ocean despite growing awareness and this problem continues to increase (Boucher & Friot, 2017; Eunomia, 2016; Jambeck et al., 2015; PEW & SYSTEMIQ, 2020; UNEP 2018).

Yet, plastics are an important material in our economy, and modern daily life is unthinkable without them. At the same time however, they have serious downsides on the environment and health.
It is well evidenced that plastic debris negatively impacts coastal and marine ecosystems (Galloway, Cole & Lewis, 2017). Plastic debris forms a big threat to the supply of marine ecosystem services and increasingly affecting the wellbeing of humans negatively in various domains, such as a loss of food security, decreased livelihoods, income and health (Beaumont et al., 2019; Macfadyen, Huntington & Capell, 2009; Naeem, Chazdon, Duffy, Prager & Worm, 2016). According to Neufeld et al., (2016) by 2050, for every kilogram of living species in the ocean there will be one kilogram of plastic litter.

The most problematic form of marine litter is derelict or discarded (plastic) fishing gear e.g., nets, traps and pots. Fishing gear may be accidently lost or deliberately discarded at sea, in harbors and on beaches. Fishing gear as marine litter is problematic since it continues to catch various animals unintentionally for years and is with that a major threat to ecosystems. This process has been termed "ghost fishing" by so-called ghost gear and is worldwide a huge problem, causing a numerous species to go extinct like sharks for example. Estimations are that 10% of all litter entering the oceans annually consists of so-called ghost gear (Macfadyen et al., 2009). Ghost gear can continue to catch target and non-target species unselectively for years, potentially decimating important food resources as well as endangered species, such as marine mammals, seabirds, and turtles. It is the deadliest form of marine plastic debris which damages vital ocean habitats, and poses dangers to navigation and livelihoods (WWF, 2020). The report on Ghost Gear from WWF (2020), suggest that on average each year between 500 million and a one billion kilo of fishing gear gets lost in the ocean. The wide bandwidth is caused because there is no widely accepted estimate for lost and discarded fishing gear out there and there is a lack of data related to this topic (European Commission, Deloitte & Wageningen Research, 2018; WWF, 2020). Comments vary from 5,500-10,000 net fragments lost per year (BaltSea, 2020) to 640,000 tons lost annually worldwide.
Yet, ghost-gear is worldwide a tremendous problem it isn't the largest problem in the North-East Atlantic. The issue in the North-East Atlantic is predominantly caused by net cuttings and other parts of fishing gear that are not properly managed and make their way into the sea. The annual loss of aquaculture and fishing gear in Europe is estimated to be around 4,000 – 10,000 tonnes (Viool et al., 2018). Since fishing nets and ropes are made of synthetic fibres since the mid-1960s, it is estimated that as much as 130, 000 to 550, 000 tonnes of fishing gear might have accumulated in the European Economic Area until 2016 (Eunomia, 2016). Plastic waste from fishing nets makes up a third of all the marine litter that is found in the North-East Atlantic. With the biggest issue in the North-East Atlantic, net-cuttings that end up in the ocean (KIMO, 2020). Only one to five percent of the fishing gear waste is being captured for treatment and recycling (Pham et al., 2014).

EU-policy: Single Use Plastics (SUP) directive

There is a clear need to address the environmental and socio-economic challenges related to fishing gear (European Commission, 2018). According to Deshpande, Philis, Brattebø & Fet (2020) the fishers perception of managing fishing gear is essential to understand the range of repair and reuse patterns and options for the different types of fishing gear.
The issues around plastics and fishing have also been identified by the European Union. According to studies carried out by the EU, plastics account for 85% of marine litter therefore action on plastics was identified as a priority in the circular economy action plan, to help European businesses and consumers to use resources in a more sustainable way (Eunomia, 2020; European Commission, 2018). The first-ever European Strategy for Plastics in a circular economy adopted on January 2018 will transform the way plastic products are designed, used, produced and recycled in the EU. Better design of plastic products, higher plastic waste recycling rates, more and better quality recyclates will help boost the market for recycled plastics. It will deliver greater added value for a more competitive, resilient plastic industry. The strategy is part of Europe's transition towards a circular economy and will also contribute to reaching the sustainable development goals, the global

climate commitments and the EU's industrial policy objectives. This strategy will help protect our environment, reduce marine litter, greenhouse gas emissions and our dependence on imported fossil fuels. It will support more sustainable and safer consumption and production patterns for plastics (European Commission, 2020). Part of the European Strategy for Plastics in a Circular Economy is the Single Use Plastics (SUP) directive (EU/2019/904) that has been introduced by the EU.

With the SUP Directive a set of ambitious measures to reduce plastic litter and increase collection and recycling is introduced. The SUP entails a focus on preventing and reducing the impact of certain plastic products on the environment. The ten most found Single Use Plastic items on European beaches account for 43% of total marine litter. Yet, fishing gear represents 27% of all marine litter found and is strongly contributing the issue of marine litter in the European marine waters. The European Commission is taking action in these two areas, which represent 70% of all marine litter found on Europe's beaches. Producers of fishing gear containing plastics will be required to cover the costs of waste collection from port reception facilities and its transport and treatment. They will also cover the costs of awareness-raising measures (European Commission, 2018; European Commission, 2020; Pham et al., 2014).

To conclude, the SUP is the world's first comprehensive Plastics Strategy and is introduced by the EU in January 2018. In May 2018 new laws are proposed to tackle the ten most found plastic waste items on Europe's beaches as well as fishing gear. The directive aims to prevent and tackle marine litter by, among other things, phasing out unnecessary single-use plastics, introducing economic incentives to reduce consumption and transition to reusable systems, and establishing high collection rates and extended producer responsibility schemes (EPR). Along with the production and use of plastic has come plastic pollution. In Europe, around 25.8 million tonnes of plastic waste are generated every year and less than 30% of such waste is collected or recycled. The impacts of plastic litter, especially of single-use and disposable items (such as bags, straws, coffee cups, beverage bottles and most food packaging) are growing as each year more plastic waste accumulates in our environment and oceans (Eunomia, 2020; European Commission, 2018).

1.2. Ambition of the report

The aim of this report is to analyse the fishing gear system in the OSPAR-region. Moreover, understand which knowledge building-blocks can contribute to the development of a more circular and sustainable fishing gear system, including the introduction of the EPR, in the OSPAR-region in the context of the EU SUP directive.

This report will explore the concept of extended producer responsibility (EPR) for fishing gear to create a more circular and sustainable system for fishing gear. Under the EPR schemes, producers of fishing gear which contains plastic should cover the cost for the separate collection of fishing gear waste that contains plastic and its subsequent transport and treatment. EU Member States are required to set up the EPR scheme for fishing gear by 31st December 2024.

The current report builds upon earlier work conducted by OSPAR such as the scoping study about positive practices for the design and recycling of fishing gear (OSPAR, 2020). Recommendations from this study are primarily oriented towards the contracting OSPAR parties. Nevertheless, the lessons learned may also be of relevance and generalizable to countries across the globe.

1.3. Study-area

The North-East Atlantic is covered by the OSPAR convention and forms in combination with the fishing gear the system boundaries of this report. The system boundaries are set to include the entire life cycle of fishing gear, from design to waste. The OSPAR Convention is dedicated to identifying potential threats in the North-East Atlantic Ocean and to organizing projects and measures to combat these threats on a national account. It assesses the status of the marine environment based on internationally set goals and commitments by the participating governments. The OSPAR Commission is a key-actor in helping governments to cooperate on a regional level. The North-East Atlantic can be subdivided in six regional seas, see Figure 2:

In the OSPAR maritime area, marine litter and in particular plastic marine litter is abundant. The OSPAR Ministers declared in 2010: “We note that quantities of litter in many areas of the North-East Atlantic are unacceptable, and therefore we continue to develop reduction measures and targets, taking into consideration an ambitious target resulting in a reduction in 2020” (Bergen Statement). The most recent assessment of beach litter monitoring was undertaken in 2019 and showed that litter is abundant on beaches in the OSPAR Maritime Area. About 90% of recorded items are plastic. In addition, OSPAR’s first assessment of seabed litter has shown that litter is widespread on the seafloor across the area, with plastic being the predominant material encountered (OSPAR, 2010). Plastics are extremely durable and persist in the marine environment for long periods, often up to hundreds of years. What happens during these periods, is the deterioration and fragmentation of the plastics in the environment. Marine litter is not only an aesthetic problem but creates socio-economic costs to the fishing industry via gear loss resulting in the need to replace the gear and on the long-term reduction is fish in the oceans via a worsened quality of the marine environment resulting in less catch for the fishermen. Furthermore, it threatens human health. Replacing lost fishing gear requires the use of scarce resources, since new fishing gear needs to be made which is paired with extra emissions.

- Region I: Arctic Waters
- Region II: Greater North Sea
- Region III: Celtic Seas
- Region IV: Bay of Biscay and Iberian Coast
- Region V: Wider Atlantic

Fig 3. The OSPAR-region/ North-East Atlantic (OSPAR, 2020)

1.4 Methodology

The methodology used in this report consist of a literature review, explorative interviews, a survey and a SWOT analysis. First a literature review and explorative interviews with experts were carried out.

Interviews and literature review

A snowballing technique was used during both the interviews as the literature to gather both more experts and knowledgeable persons as sources of literature e.g., reports and scientific articles.

SWOT analysis

Based on the collected literature, a SWOT-analysis is conducted to better understand the strengths, weaknesses, opportunities and threats in each lifecycle phase to move to a more circular system for fishing gear. The SWOT-analysis of each stage in the lifecycle has been summarized with a 2x2 matrix (internal factors: strengths and weaknesses; vs external factors: opportunities and threats) (Falcone et al., 2020; Sammut-Bonnici & Galea, 2015). SWOT-analysis showed to be an effective tool and has constituted a suitable baseline to diagnose current problems and sketch future action lines of systems (Terrados, Almonacid & Hontoria, 2007). A SWOT-analysis is often employed instrument. In the set of scientific techniques that are potentially able to evaluate all possible factors the SWOT-analysis is a proper instrument. It acts as bottlenecks or opportunities for prioritizing developmental strategies within a system. The primary aim of a SWOT-analysis is to examine the internal and external system characteristics simultaneously, by that supporting operational decisions (Miller, 2007). The SWOT analysis involves two main categories of factors of influence. Internal factors (i.e., strengths and weaknesses) and external factors i.e., opportunities and threats. The SWOT will be summarized by way of a 2x2 matrix).

The first part of the report focusses on the lifecycle of fishing gear, and where the right momentum is in the system to intervene with measures to create a more circular system. The three different phases are design and production, use and the end-of-life phase. The second part of the report focusses more on the development of an EPR scheme for fishing gear. In cooperation with experts a survey has been developed that aims to provide insights in how an EPR for fishing gear should be designed, (what the requirement are) and potentially interesting financing schemes. The survey was made in Google Forms and shared among the OSPAR-network via the OSPAR-basecamp and shared via email with different experts of the fishing gear system. Eleven different parties have filled in the survey. Moreover, the outcomes of the survey have been assessed with a SWOT-analysis to provide a clear overview of the strengths, weaknesses, opportunities and threats for an EPR scheme for fishing gear.

2. Status quo of the (circular) Fishing Gear system

2.1. A Circular Economy

A circular economy has a lot of benefits for the environment compared with the currently dominant linear economy. In the Circular Economy, technical materials remain in the economy, thereby minimizing the need to extract virgin materials and generation of waste. The consumption of energy and other resources also diminishes thanks to the creation of loops promoting waste prevention (maintenance and re-use), material recovery (repair, remanufacturing, recycling), and waste recovery (energy recovery). The replacement of certain products by services is another feature of the circular economic systems that is meant to reduce a product's impact on the environment, although empirical studies show limited environmental benefits. There is no authoritative definition what a circular economy entails (Kirchher, Reike & Hekkert, 2017), but the one used in this research article is derived from the work of Sandavol, Jacca & Ormazzabal (2018). Based on the academic literature reviewed in their study they defined the concept of the circular economy as following:

'The circular economy, an economic system that represents a change of paradigm in the way that human society is interrelated with nature and aims to prevent the depletion of resources, close energy and materials loops, and facilitate sustainable development through its implementation at the micro (enterprises and consumers), meso (economic agents integrated in symbiosis) and macro (city, regions and governments) levels. Attaining this circular model requires cyclical and regenerative environmental innovations in the way society legislates, produces and consumes.'

Implementing a circular economy ensures that system become more sustainable since less greenhouse gases are emitted, that soil, air and water remain healthy via a more optimal use of resources. This is contributing to the existence healthy ecosystems on earth, since natural reserves are taken care of. Integrating circular economy principles will reduce greenhouse gasses on a global scale. Calculations suggest that 62% of global greenhouse gas emissions (excluding those from land use and forestry) come from the extraction, processing and production of goods to meet society's needs; only 38% are emitted in the supply and use of products and services (The circle Economy, 2019). Emissions in the EU from the industry would reduce by 56% in 2050 if the circular economy would become a reality (SITRA, 2018).
A transition in the fishing gear system suits the broader demand for a transition from a linear to a more circular economy (UNIDO, 2019). A well-established management system for fishing gear allows for prolonged product life, which reduces waste generation and thereby promotes circularity of the system (EU, 2014). A variety of measures e.g., taxes on activities, or subsidies on behaviour can be used to stimulate the circular economy, as is shown in Figure 3.

A circular economy will prioritise repairing and reusing nets to extend their operational life as long as possible. When they are no longer suitable for fishing, they are sometimes re-purposed in other industries, such as in agriculture, via 3D printing or artworks sophisticated recycling facilities are needed for this. There are two predominant approaches for large-scale treatment of waste fishing nets and ropes: chemical and mechanical recycling. Chemical recycling does not need a completely pure input (less effort upon manual dismantling and separation of the net) and can produce output of high plastic quality (suitable for multiple reoccurring material circulations). Mechanical recycling, on the other hand, requires purer input in order to obtain good quality output (e.g., down to the type of low- or high-density PE). If different types of plastic are mixed in the input, the mechanical recycling can only be on a downgrading slope, giving low quality plastic that will not itself be recyclable. Currently, disposal and end-of-life treatment of fishing gear is very low and the level of recycling of fishing gear in the EU is 1 to 5% (European Commission, 2018).

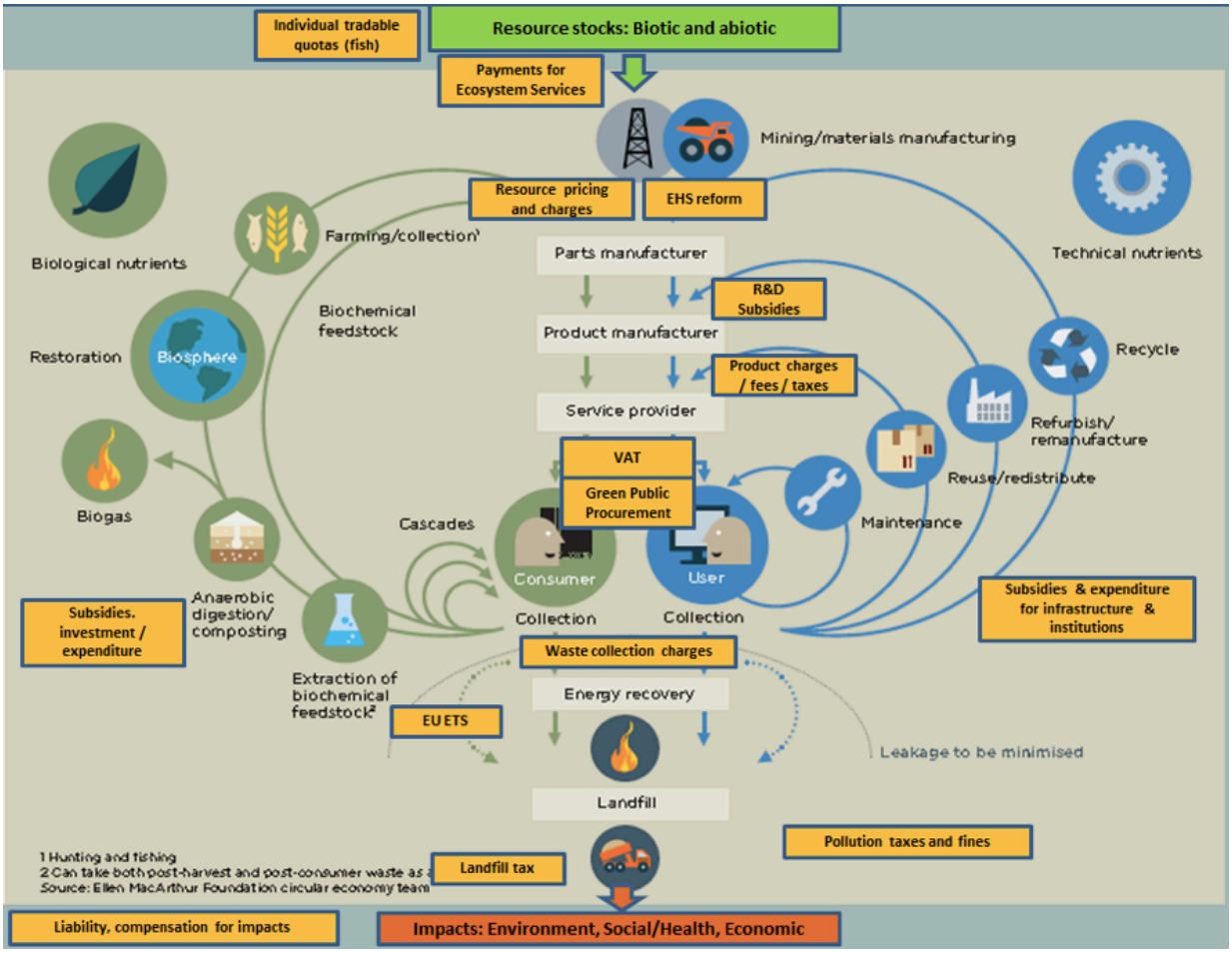


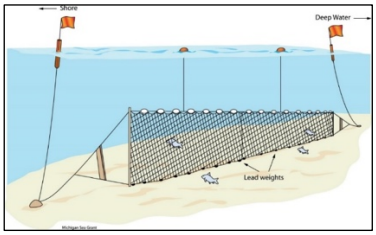
Fig 4. Fiscal policy measures that support the implementation of a circular economy system (Institute for European Environmental Policy, 2014)

In general, a circular economy for plastic is the only possibility to address plastic waste and pollution at the source. Therefore, this the vision of circular economy for plastic is briefly described below.
Already more than 850 organisations are united under the New Plastics Economy Global Commitment and the Plastics Pact network. Comparing a circular economy with business-as-usual, shows that a circular economy has the potential to reduce the annual volume of all plastics entering the oceans by 80% and reduce greenhouse gas emissions by 25%. This can generate savings of USD 200 billion per year (+-€170 billion), and create 700,000 additional jobs by 2040 (EllenMacArthurFoundation, 2020). National, regional and local governments have recently begun to present the concept of circular economy as a new pathway to sustainability and economic prosperity.The rationale of the circular economy addresses the increasing concerns over resource depletion, waste generation and overshoot of planetary limits induced by human activities on the biosphere (Korhonen, Honkasalo & Seppälä, 2018). The circular economy is broadly argued to meet these emerging challenges through slowing, closing and narrowing resource loops, maximising the functional utility of materials and energy (Geissdoerfer, Savaget, Bocken & Hultink, 2017). The circular economy theoretically builds upon and goes beyond earlier measures of waste valorisation and cleaner production initiatives to an integrated systems perspective addressing both production and consumption practices (MacArthur, 2013; Vermeulen, Reike & Witjes, 2018).The European Commission (EC) frames the circular economy aligned with economic opportunities stating that “will boost the EU’s competitiveness by protecting businesses against scarcity of resources and volatile prices, helping to create new business opportunities and innovative, more efficient ways of producing and consuming”(European Commission, 2015). National governments have similarly outlined specific strategies, including the Netherlands, France and Italy; with the Netherlands setting an initial target of 50% less primary material use by 2030 (Potting, Hanemaijer, Delahave, Ganzevles, Hoekstra & Lijzen, 2018).

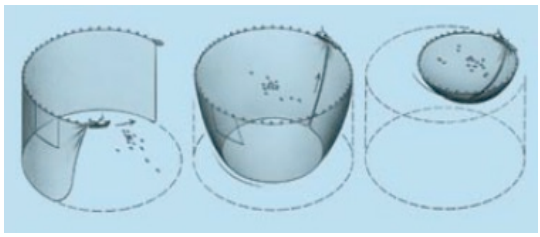
2.2. Fishing Industry in the OSPAR-region

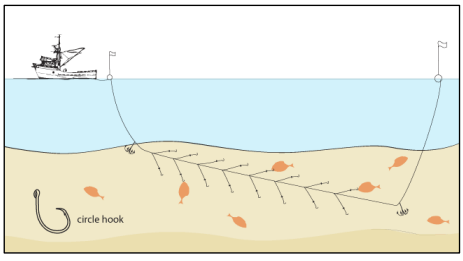
The FAO's 2020 report on the state of world fisheries and aquaculture projected that capture fisheries production in the EU and Norway would remain roughly unchanged between 2018 and 2030. The FOA report expects that globally, seafood prices will remain high over the period until 2030, despite some decline in real (rather than nominal) prices. This scenario is not a forecast, however, and could be affected by many factors such as macroeconomic conditions, trade rules, environmental conditions, fisheries management measures and market shocks (FAO, 2020).
The United Nations Food and Agriculture Organisation (FAO) reported that the total marine fisheries capture in the North-East Atlantic in 2018 was 9.32 million tonnes (mt), around 11% of the global figure of 84.4 mt. Norway was the biggest player in the fishing industry of the OSPAR nations the North-East Atlantic in 2018, with a catch of 2.28 mt. Iceland was the second largest, with a catch of 1.26 mt, followed by Denmark (0.79mt), the United Kingdom (0.69mt), the Faroe Islands (0.66mt), France (0.40mt), Netherlands (0.39m,) and Spain (0.31mt). A relevant division to make is the one between the large-scale fleet and the small-scale coastal fleet. Large-scale fleet covers vessels > 12 meters, making use of static gear and all the vessels use towed gear. Small-scale fleet includes vessels < 12 meters and they are making use of static gear. The large-scale fishing fleet is responsible for the most weight and value of catches. The European Union's Scientific, Technical and Economic Committee for Fisheries (STECF) stated that EU fleets in the North-East Atlantic and? the Eastern Arctic region, landed 98% of the total weight and 95% of the total value of catches

In most OSPAR countries, future developments in the fisheries sector are largely dependent on the European Common Fisheries Policies and associated future catch quota, as well as on the development of fuel prices. The most important environmental impacts of this economic sector are the removal of target species, by-catch of non-target species including water birds and marine mammals, as well as impacts on the seabed (European Commission, 2020).
A key consideration is the short lifecycle of fishing gear, which most often does not exceed one year. The turnover-rate of fishing nets is especially high, with 33% of nets being lost at sea every year, while the remaining 67% reach end-of-life within a year of use. To give a better understanding about the different types of fishing gear, the mostly used types are shown in Figure 4. The priority of the legislation is to prevent fishing gear ending up as waste in the marine environment and capture this resource back into the circular economy (Eunomia, 2016; Sherrington, Darrah, Hann, Cole & Corbin, 2016).

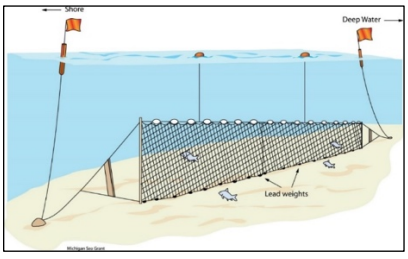


Gillnets

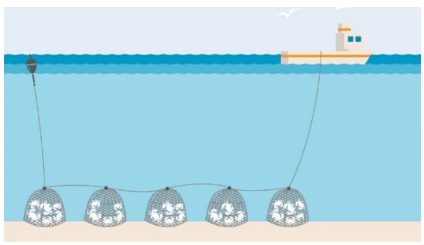

Purse seines

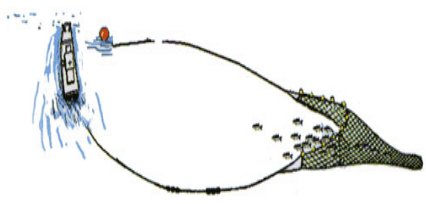


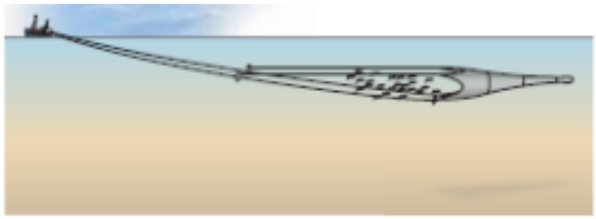
Longlines



Set Gillnets


Danish Seines


Traps/pots



Trawls

Fig 5. Visual examples of the popular types of fishing gear being used in the OSPAR-region (Deshpande, Philis, Brattebø & Fet, 2020)

2.2.1. Circular economy for Fishing Gear

A circular economy is 'restorative and regenerative by design, and it aims to keep products, components and materials at their biggest utility and value at all times, distinguishing between technical and biological cycles" (MacArthurFoundation, 2020). Considering the 'closed-loop, closed-source' concept of the circular economy, requires fishing gear component designers to plan and design for a product's entire lifetime, with the product repeatedly cycling through the circular economy. The European Commission aims with the SUP-directive to stimulate the set-up of a more circular and sustainable fishing gear system.
The challenge for the gear designers is to create fit for use, economically viable, and robust products with extensive adaptive possibilities that also can be repaired or remanufactured. In the open-loop, open-source concept product integrity is seen as a collective responsibility involving all stakeholders from producers to end users. Product designers have to prioritize reuse (reparability, remanufacturing), upgradeability (e.g., through modular designs) and recycling. Circular fishing gear design aims to reduce/ avoid virgin material input and generate less waste while maintaining and possibly improving gear components functionalities. Design for circularity eliminates waste as part of the design process and replaces the idea of a product's 'end-of-life' with 'the end of its period of primary use'. Along with that, design in the sense of the choice of materials is a key facilitating factor in the implementation of a circular economy. Further it has been recognized that for the fishing gear system the most beneficial changes need to be made in design stage to come to a more circular and suitable system. So upstream changes the product development process, at which point there exists the most potential for radical innovation before considerable time and resources have been committed to any particular design or direction. However, within the current industrial system, design for a circular economy faces a number of challenges, including those related to designer awareness and education, the availability and provision of product and material data, consumer expectations and technical and economic feasibility (Preston, 2012). Design for recyclability is an important principle to enable product disassembly and subsequent reuse and recycling of the product's inherent materials and components (MRAG, 2020).

The re-design of fishing gear within a circular economy must be associated with a high (or complete) use of recycled/reused materials, with the gradual elimination of virgin plastics within new gear. However, importantly there must also be continual research and development to assess and critique further development of materials that are partially (or wholly) manufactured with recyclates. The main reason for distrust discussed was a proposed reduction in the utility of the material comprising high recyclates, including reduced performance, durability and product lifetime in comparison to virgin materials. In this respect, to facilitate the uptake of newly re-designed fishing gear by the industry, there is a clear need to work closely within this industry in innovation and development of new technologies (European Commission, 2020). Three loops should be considered when it comes to product circularity, this also accounts for fishing gear (See Fig3). A short loop represents ‘reuse’, the medium loop being ‘repair’, and the long loop the ‘recycle’ process, the shorter the loop, the more circularity there is (NSAC, 2020).

For the establishment a circular system for fishing gear close cooperation with the fishing-industry is advised. Create for the fisher’s incentives to change their behaviour regarding fishing gear choice, use and collection. To facilitate the uptake of newly re-designed fishing gear by the industry, there is a clear need to work closely within this industry in innovation and development of new technologies. This will be important, as any new technology must not only be developed to enhance circularity in its lifecycle, but must also have a high utility, durability, performance and be economically feasible for the industry to use. Non-mixed materials must not reduce the utility of the material (e.g., durability, performance) and the

component they are used in (Feary et al., 2020). There has been a strong impetus throughout stakeholders for new innovation and development to enhance the likelihood of the use of recyclates in new fishing gear. However, an idea within the fishing industry (predominantly gear manufacturers) is that the quality (including performance, strength, durability) of materials that contain recyclates will be lower than those made completely of virgin plastics. However, to date (01/2021) there has not been any uptake of post-consumer fishing gear recyclates in the fibre industry (MRAG, 2020; OSPAR, 2020). Therefore, to use recyclates for newly designed fishing gear, there must be further testing of the performance of materials comprising certain levels of recyclates and further developments of innovative technologies to enhance the quality of such materials.

2.3. Instruments to stimulate circularity

If policy makers want to intervene to bring out a more circular situation in the fishing gear system, they have a choice of two main strategies, either regulation, by using regulatory instruments, or economic instruments, also known as market-based instruments. Economic instruments include measures as charges, levies and taxes or, alternatively incentives or subsidies where behaviour or an activity is judged to be beneficial. Each of these measures can be combined with targets for reductions in marine litter. Regulation is used to set standards which, if practical and well-designed, they can be used to achieve quantitative reductions in waste or marine litter.
Economic instruments can provide less initial confidence that targets can be reached, but can influence price and markets, to bring about a desirable change in behaviour of the stakeholders of product-systems (Optimize & Eftec, 2015; Van der Meulen et al., 2014).

2.3.1. Economic instruments

One way to promote the transition to a more circular fishing gear system are implementing instruments. Economic instruments are systems of economic incentives (positive or negative) that can be implemented with the purpose to change behaviour. Economic instruments can broadly be divided into market and nonmarket-based instruments.
Market based instruments rely on market price mechanisms in order to internalize the costs, for example the environmental costs of pollution on the system, and with that provide financial incentives to prevent pollution. Nonmarket-based instruments, 'voluntary' approaches are also increasingly being applied. For example, contracts on specific management of fishing gear, specifying compensations payments to fishermen. The Optimize & Eftec (2015) report elaborates on economic instruments, and how to implement them. Economic instruments can be implemented in the form of financial disincentives like penalties, taxes, and charges. These discourage 'wrong' behaviour, but generally do not end it entirely (and thereby provide a continuing stream of revenue). Financial incentives to change behaviour can be deposit-refund schemes, subsidies, direct payments, price differentiation, or preferential treatments. These can be applied to stimulate behaviour that encourages recycling and reuse of materials, and proper waste disposal. With reference to the marine litter problem, a number of incentive and disincentive instruments have been proposed. Examples of instruments that have the potential to address issues around marine litter are, a deposit-refund schemes to encourage post-use return of drinks containers and other food packaging, including the potential targeting of such schemes in tourism areas to encourage better disposal. Another economic instrument to apply is the ecotax used for single-use food packaging and service packaging to influence product design. Another instrument that can be applied is pay per weight/volume of rubbish disposed to influence consumption and disposal patterns. Also interesting is lower charging of port collection to encourage post-use disposal by ships. Incentive-based public-private partnerships to reduce waste in tourism areas. For policy makers it is important to consider several criteria when deciding on the suitability of an economic instrument in tackling marine litter. These criteria are briefly summed up:
- The effectiveness: the ability to produce a desired result.
-The magnitude of change in behaviour will depend on the price signal and other features of the instrument's design, and on various cultural, sociodemographic and economic influences.
- Cost of implementation and other transaction costs (cost-efficiency).
- Additional socio-economic side-effects both positive and negative, such as employment gains or losses in associated economic sectors, changes in competitiveness are important to consider.
Conclusively, economic instruments can be implemented to increase the efficiency of the use of natural resources and help to collect additional financial resources, make use of e.g., polluters pay principle and be of support to create more circular systems. (Deloitte, 2018, MRAG, 2020; Optimize & Eftec, 2015; OSPAR, 2020; Van der Meulen et al., 2014).

A tax-shift for a more circular and sustainable future

The recent rapport of the Ex'Tax project pleated that tax-shift is required to support the transition to more circular and sustainable economic system. A tax-shift is required from labour to products, to incentivise the circular economy and the creation of sustainable growth and jobs. Stated by the authors is that at this moment in time, perverse incentives are given making via taxes labour expensive and environmental polluting products cheap. The report shows that via a smart tax-system the labour market can be pushed into a direction of more repair, recycling and decrease the demand of polluting products via higher and smart taxes on these polluting products (Ex'Tax project et al., 2021). A shift in taxes could incentivize circular activities like repair and recycling, stimulating the circularity of product system. This is also of relevance for the transition in fishing gear system towards more circularity and sustainability.

Repair vouchers

Interesting to look into to stimulate the repair of products, also for fishing gear is the use of repair vouchers. Repair schemes at the national level are also progressing. Example is Austria, where the government halved the tax on certain repairs to 10% and a couple of states introduced a voucher system up to €100,- to promote and fund repair. The use of repair vouchers is in line with recent policy advances reflect support for what has been dubbed the "right to repair" for consumers. In December 2019, the EU adopted the first eco-design requirements in this case for white good like washing machines, lighting and fridges. Followed by the EU's Green Deal and the circular economy action plan with explicit commitment to exploring the "right to repair". Since then, the European Commission launched consultation processes looking at broader sets of products such as textiles, furniture and batteries. In November 2020 the European Parliament adopted a report about establishing stronger 'right to repair' rules (BBC, 2021; Köppl, Loretz, Meyer & Schratzenstaller, 2019; Stadt Wien – Umweltschutz, 2020). Interesting it is to further explore 'right-to-repair' for the fishing gear system. Example is that repair vouchers are used in the fishing gear system an economic instrument to push increase the circularity and sustainability of the fishing gear system. For example, net cuttings can be exchanged against repair vouchers for 'new' fishing gear parts.

2.3.2. Regulatory instruments

Regulatory instruments can be used to define the required standards, procedures or technology that authorities and private businesses must use in producing products or managing waste. These requirements relate to the targets and objectives set by legislation designed to encourage the choice of design, sustainable production processes and recovery of materials at different stages in the waste system. Regulation can be a good means of disseminating new technology and of stimulating technological innovation both with regard to manufacturing and product design. It requires the uptake of good environmental practices or useful available technologies. Regulation, sometimes called 'command-and-control', have the benefit of being unambiguous in that distinct standards or requirements are set. Another advantage is that is it easier to measure if the developed standards are being met. Nevertheless, how manufacturers and consumers respond to these standards is also of relevance as it can be experienced as too much top-down and in some cases as a punishment. The experience of a punishment might result in a disincentive to cooperate. There is also a need for legislators to be sure that other undesirable responses are avoided. For instance, that manufacturers are not encouraged to turn to other materials that could present an equal health or environmental risk or a new prospect of becoming marine litter. Producers might also choose to import rather than manufacture products if the regulation is directed at the manufacturing process rather than the output (Optimize & Eftec, 2015; Van der Meulen et al., 2014).
The upcoming standard for circular and sustainable design of fishing gear as a good example of regulatory instrument for the fishing gear system in the OSPAR-region. (CEN, 2020).

2.3.3. Relevant legislation

As fishing is an activity that exploits common natural resources, it needs to be regulated to safeguard fair access, sustainability and profitability for all. There are numerous important legislations and directives aimed to be implemented in the time period 2020-2040. In this paragraph all relevant legislation, international legislation as well as European legislation, of relevance to the fishing industry is described.

Relevant International legislation

Key international conventions that are relevant to marine litter are briefly pointed out.
• The United Nations Law of the Seas (1994) covers all aspects of ocean space. Entailing specific articles that are dedicated to the conservation of the marine environment. These can be used in the context of marine litter regulation (United Nations Convention on the Law of the Sea: http://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf)

• The International Convention for the Prevention of Pollution from Ships (1973) is 'the main international convention covering the prevention of pollution of the marine environment by ships from both operational and accidental causes'. MARPOL Annex V (1988), addresses the disposal of garbage at sea from ships. In 2013, Annex V was revised to forbid the discharge of all garbage into the sea except under specific circumstances. One of the main points of Annex V is the obligation for all ships of 100 gross tons and above, or ships certified to carry more than fifteen persons, to develop and follow a written garbage management plan (International Convention for the Prevention of Pollution from Ships (MARPOL): http://www.imo.org/en/about/conventions/listofconventions/pages/international-convention-for-theprevention-of-pollution-from-ships-(marpol).aspx)

• The London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter signed in 1972 and the 1996 Protocol to the Convention (London Protocol) cover the control of dumping of wastes at sea. Difference between the Convention and the Protocol is that the protocol is more restrictive in regulating the dumping of waste, with that relevant for fishing gear (London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter,http://www.imo.org/en/OurWork/Environment/LCLP/Documents/LC1972.pdf)

• The Food and Agricultural Organization of the United Nations (FAO) Code of Conduct for Responsible Fisheries was applied in 1995. The management measures covering pollution and lost or abandoned gear are addressed as well as disposal systems in ports and harbours (FAO Code of Conduct for Responsible Fisheries http://www.fao.org/docrep/005/v9878e/v9878e00.htm)

Relevant European Legislation

Important legislation for the fishing industry in the EU is the common fisheries policies (CFP). It is a policy that aims for good management of the European fishing fleets and conserving healthy fish stocks. The purpose is good management of a common resource, and equal competition by giving all the European fishing fleets equal access to the waters of the EU. In this policy a wide variety of measures with relevance to the fishing industry are discussed, only the once relevant for fishing gear will be elaborated upon.
CFP entails technical measures that represent a broad set of governmental rules about how, where and when fishermen are allowed to fish. They are established for all European sea basins, but they differ considerably from one basin to another, in line with the regional conditions. The measures include:
- specifications for design and use of gear
- minimum mesh sizes for nets
- requirement of selective gear to reduce unwanted catches
- closed areas and seasons
- limitations on by-catches (catches of unwanted or non-target species
- measures to minimize the impact of fishing on the marine ecosystem and environment.

Following the EU Fisheries Control Regulation (Council Regulation (EC) No 1224/2009), there is an obligation for fishers to make retrieval attempts for lost fishing gear and report losses. At this moment, this is rather poorly implemented and additional measures are deemed necessary (European Commission, 2018). Both the Single Use Plastic (SUP) and the revised

Port Reception Facilities (PRF), two directives accepted in 2019, aim with a set of measures to harmonise and incentivise a range of approaches that address the full lifecycle of plastics in fishing gear. The ambition is to promote circularity by preventing loss and promote end-of-life collection, reuse and recycling. With this capture it back into a circular economy (Plastic Solutions Fund, 2019). This is explained in more detail in the upcoming section.

Extended producer responsibility

The SUP Directive aims to implement the Extended Producer Responsibility (EPR) scheme for gear containing plastic by December 2024. EPR schemes are defined in the Directive 2008/98/EC (Waste Framework Directive) as "a set of measures taken by Member States to ensure that producers of products bear financial responsibility or financial and organisational responsibility for the management of the waste stage of a product's lifecycle."
EPR is an environmental policy approach in which the producer's responsibility for reducing environmental impact and managing the product is extended across the whole lifecycle of the product. From selection of materials and design through to its end-of-life stage, particularly for take-back, recycling and disposal. The costs of its subsequent transport and treatment and the cost of the awareness raising measures referred to in Article 10 regarding fishing gear containing plastic. The goal is to make sure that the cost of managing discarded plastic fishing gear, once it has arrived on shore, is borne by the producers and importers of plastic fishing gear parts and not by the ports (European Commission, 2018; Deloitte, 2018; OSPAR, 2020). Requiring producers to pay the full costs of the end-of-life of their products is not only fair but a crucial incentive to redesign their products with circularity and easy tracking in mind. It also prompts them to develop more sustainable business models, such as gear-leasing and buy-back schemes. The contribution should reflect the actual cost, which should be revised every year, both to adjust the costs and to measure progress on the reduction of litter.
A number of relevant provisions regarding the extended producer responsibility for the fishing gear system are briefly described.

Provision 3: Monitoring

Member States are required to monitor the volume of fishing gear containing plastic placed on their national market, as well as the volume of waste fishing gear collected nationally. This will enter into force in 2022, Member States shall also report to the European Commission, each year, the amount of fishing gear placed on the market and waste fishing gear separately collected. Only with harmonised and consistent monitoring across the EU it is possible to follow the trends of collection, reuse and recycling of waste fishing gear, adopt or alternate measures, and facilitate objective setting throughout the EU. Monitoring the share of waste fishing gear collected will be greatly eased by improved availability of gear tracking and marking. Tracking should specify the quantities of fishing gear entering the EU market from overseas for use in European waters. To make sure it supports concurrent efforts to ensure that sustainable fishing gear enters the market (Article 8(8)), reporting requirements (Article 13) at the national level (European Commission, 2018; Deloitte, 2018; TAUW, 2018).

Provision 5: Awareness-raising measures

Member States are required to take the appropriate measures to inform users of fishing gear about their responsibility, for responsible use and disposal of fishing gear. These awareness-raising measures enter into force from the mid of July 2020 under article 10. The following-points need to be communicated:
- Availability of reusable alternatives, reuse systems, and waste management options for those products
- Impact of inappropriate waste disposal of those products on the environment, in particular on the marine environment
- Best practices in sound waste management, carried out in accordance with Article 13 of Directive 2008/98/EC. The costs of these awareness-raising measures will be covered by the producers of fishing gear containing plastic under an EPR scheme (Article 8 (9) of the SUP Directive) (European Commission, 2018; Deloitte, 2018, TAUW, 2018).

Port reception facilities directive

The European Parliament and Council adopted the Directive (EU) 2019/883 on Port Reception Facilities for the delivery of waste. This is referred to as the Port Reception Facilities (PRF) Directive. One of the principal requirements in the PRF Directive is the mandatory restructuring of cost frameworks (also called cost recovery systems) at EU ports for the collection of waste. Important is that litter mostly is comprised of plastic (90%), including fishing gear. The restructuring of fees at EU ports is intended to promote the maximum delivery of fishing gear and other litter to EU ports and will require several new measures at the ports (Article 8 PRF Directive). Member States are obliged to transpose the new requirements into national law by 28 June 2021 (13 Article 24(1) PRF Directive).
Relevant provision for the port reception facilities directive is described.

Provision 1 -100% Indirect Fee

The 100% indirect fee counts and allows for the delivery of all litter, up to the maximum dedicated storage capacity of the ship (Recital 30 and Article 8(2)(c) PRF Directive). Currently, it is a common practice at many EU ports for fishing vessels and other ships to be charged based on volumes of litter delivered. This creates incentives to discharge fishing gear and other waste at sea. This is no longer allowed under the PRF Directive, with the Directive going so far as to impose a corresponding obligation that requires ships to deliver all of their litter while in port, subject to limited exceptions (Article 9 PRF Directive). The 100% indirect fee also covers passively fished waste, litter including fishing gear caught in the nets during normal fishing operations. This is designed to encourage the recovery of fishing gear and other litter at sea, and to facilitate the establishment of fishing for-litter (FFL) initiatives.

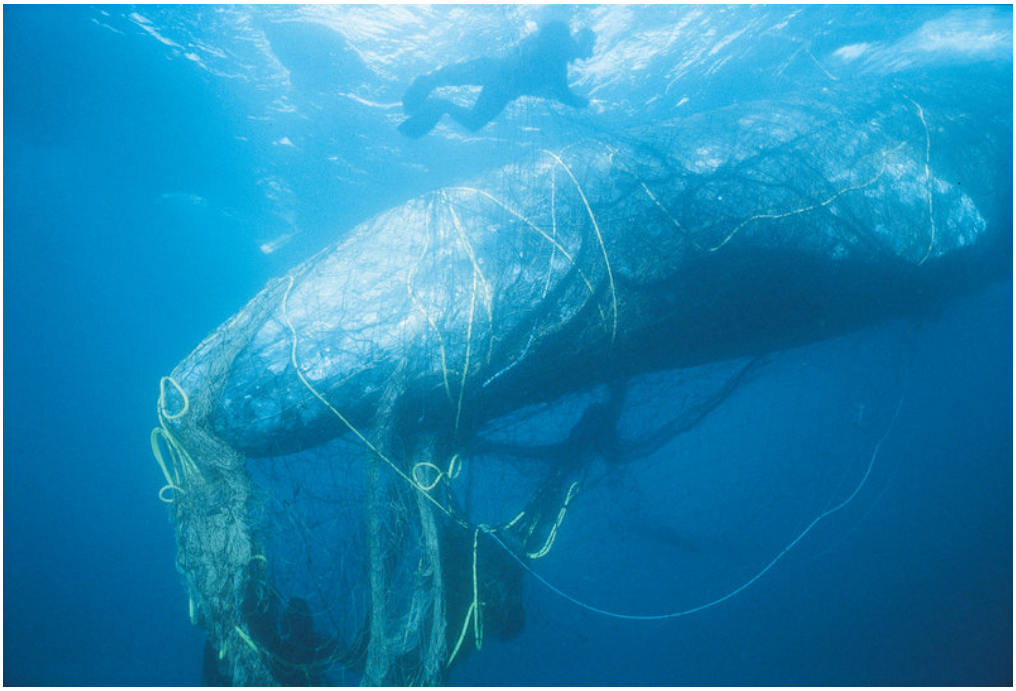


Fig 6. Entangled gray whale from ghost net (NPR, 2016, Bob Talbot/Marine Photobank/Courtesy of World Animal Protection)

3. Lifecycle of fishing gear

Fishing gear is defined in this report as “any physical device or part thereof or combination of items that may be placed on or in the water or on the seabed with the intended purpose of catching marine species. When the word “plastics” is used, it dominantly entails the polymers polyethylene (PE), polypropylene (PP) and nylon. These are the main building blocks in the production of modern synthetic fishing gear (Baeta, Costa & Cabral, 2007; Brown & Macfadyen, 2007).

Every year, fishing companies purchase fishing gear mainly to equalize the stock after annual losses from deployment or disposal after end-of-life. In the use phase, fishers deploy fishing gear in the ocean to catch target species. Deployed fishing gear, or parts of the gear, can get lost during operation due to various reasons like rough wetter, wear and tear of the gear, loosing parts during repair processes and dumping (parts) fishing gear on purpose (Macdafyen et al., 2019; Richardson et al., 2018). In the scientific literature there is a limited understanding on gear loss rates from fishing activities (Humborstad et al., 2003; Richardson et al., 2018). This demands for better monitoring, about the quantities of gear that are being produced, used and have turned into (collected) waste.

Fishing gear can broadly be divided into two categories, being active and passive gear. Active gear (seines and trawls) dynamically hunts the targeted species. Passive gear (lines, gillnets and traps/pots) are fixed and aimed to catch active fish. Passive gear is economically cheap making it popular among small-scale fishers (Muus & Nielsen, 1999).
When fishing gear reaches its end-of-life stage, it cannot be used any longer for fishing. Therefore, the optimal situation is that it is properly collected by the fishers and brought to waste management facilities. Continuing, when the fishing gear is collected at the waste management facilities there are various pathways that can be considered. The pathways for the end-of-life fishing are segregation for (mechanical or chemical) recycling, landfill or burning at an incineration site. The lifecycle of the most popular types of commercial fishing gear can be seen in Fig 6.

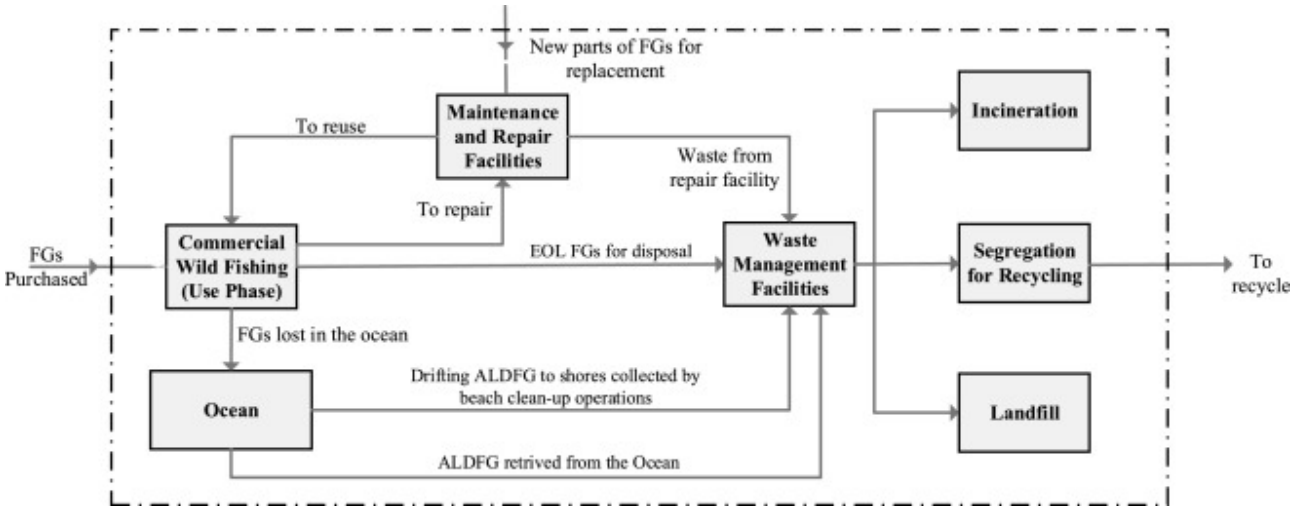


Fig 7. Life-cycle Fishing Gear retrieved from Deshpande et al., (2020)

3.1. Design and production of fishing gear

3.1.1. Description of the design of fishing gear

Fishing gear is largely composed of high-quality plastics, like nylon (6), polyethylene and polypropylene. These plastics have a potential for repair, reuse and recycling if captured at the right stage in its lifecycle. With the SUP and PRF directives, the European Commission encourages all stakeholders in the fishing gear operational chain to implement systems to responsibly manage, dispose of and recycle fishing gear, including at the design stage, to facilitate easier disassembly and treatment at the end-of-life stage. Fishing nets are made from a variety of materials, which impacts their suitability for recycling. For example, nets made from nylon 6 (PA6), like monofilament gillnets, have high value as a waste resource and are appealing for recyclers to work with because of the qualities of PA6 to recycle it into valuable products. Nets made from polyethylene (PE), polypropylene (PP) and other similar plastics have a lower value as a recycled material and incur prohibitive costs in shipping,

generating lower profit margins. The mix of polymers in the manufacturing of fishing gear along with metal components creates a challenge for recycling. Optimal situation for recycling is that fishing gear s designed with homogeneous materials to ensure efficient recycling (Deshpande et al., 2020). When considering the design of fishing gear for recycling, there are several important considerations applicable to many types of gear. The question arises, how can fishing gear be designed for the extension of its product life, enabling repair and perhaps remanufacturing and refurbishment of parts of the gear? Furthermore, spreading awareness and educating fishers to better repair nets in a way that facilitates recycling. Easy disassembly into constituent parts is required to minimise the manual labour time and cost to prepare gear for recycling. Like reducing the number of materials used. Since fewer materials (i.e. ideally large sections of gear made with a single polymer) would make disassembly and recycling more feasible. Materials also need to be easy to identify and of high purity. Create as much transparency as possible throughout the chain regarding the composition of the fishing gear. Since recyclers require accurate information on what materials have been used in the production of gear is very important. Including chemicals used in coatings), good value of materials will be an incentive for proper recycling of fishing gear. An example of this is making more use of materials like Nylon 6 that have a higher value on the secondary market, forming an economic incentive for recycling. Examples of good practices in the design and production stage are described below.

For an overview of the strengths, weaknesses, opportunities and threats in the end-of-life stage of fishing gear see the SWOT analysis in 3.1.5.
Fishing gear is composed of different types of plastics depending on the desired function. These different plastics and its characteristics pose a challenge when it comes to dismantling and recycling. In order to facilitate waste management, it is important to identify the types of plastics fishing gear is made of. Fishing gear producers in the European Union specialise in high molecular polyethylene (characterised by stability, elongation, tenacity) and Polyamide-6 (Nylon) (ensuring flexibility, strength, durability) to meet market demands. However, lots of materials are still being imported from outside the EU (especially cheaper grades of PE, PP, PET, PA). Eurocord stated that approximately half of ropes and nets come from outside Europe. A result of this is less control on the supply chain to regulate the quality of the fishing material and the likely recyclability of it (Deshpande et al., 2020; European Commission, 2020; NSAC, 2020). There is in general a lack of data about this stage, how much gear is exactly being produced, bought, used and reached its end-of-life stage.

Although, there are many different types and grades of materials available, a general consensus is that only around ten different grades of the main four polymer types are being used in net making and that the rest are simply variations of colour or additives. Synthetic fibres are defined by the type of polymer:
• Polyamide (PA) fibres are manufactured in two different types, PA 66 and PA 6. PA 6 is produced for fishing net purposes in the trade name Nylon.
• Polyester fibres (PES) are manufactures from polycondensation of terephthalic acid and the alcohol, ethylene glycol. Chemical compounds of an acid and alcohol are known as esters. The trade name is Terylene.
• Polyethylene (PE) is the polymer of the monomer ethylene, which is normally obtained by cracking petroleum.
• Polypropylene (PP) is the polymer of propylene obtained in the same way (Deshpande et al., 2020; NSAC, 2020; MRAG, 2020).

The continuous thread composed of fibres is called ‘yarn’, which entails all linear textile products. All synthetic polymers can be made into four different types of yarn. Following yarn types are characteristically used in the fishing industry.
- PA: Multifilaments, staple, monofilaments as singles; no split fibres.
- PES: Multifilaments; no split fibres.
- PE: Monofilaments (twisted); no staple fibres; no multifilaments. Split fibres are available but not common.
- PP: Multifilaments, split fibres and monofilaments for ropes.
If the material is recycled, two options of recycling methods are currently the dominant pathways, being mechanical recycling and chemical recycling. During mechanical recycling, the material is cleaned and sorted to achieve a quality close to virgin polymer fibres, which can be molten into high-quality recyclates.
During chemical recycling, the fibres are dissolved in chemical solvents. Sorting into polymer types is also required, but the procedure is not as sensitive to residual disturbances such as sediments (NSAC, 2020; Thomas & Sandhya, 2019).

3.1.2. Problem drivers in the design of fishing gear

The main problem drivers in the design for circularity of fishing gear are associated with, a low utility of current materials and the use of different material reducing the properties for effective reuse and recycling. Furthermore, there is a lack of support for the development of alternatives because of the high costs related to the alternatives. There is also a low use of (or lack of suitable) collection points in ports. Also, there is still little knowledge of the total volume of gear made and utilized throughout Europe. A better understanding of this would be of great support to address the problem and contributes to where innovation should focus on (i.e., which gear to redesign first and how). In addition, there is still little knowledge transfer of gear development across the Member State and this is a problem driver. The high organic contamination of materials reducing the ability to recycle. Regarding the logistics, issues that arise are associated with the sustaining value of the materials throughout the full product-chain within Europe.
Stakeholders stated a couple of obstacles that need to be considered, like the lack of regulations and legal structure to enforce design for recycling, lack of financial incentives and high cost of different design and recycling. Furthermore, it is clear that the design of fishing gear does not facilitate complete reuse or recycling of fishing gear at this moment in time. There is not a lot of interest within the fishing gear industry to design and produce develop materials that are repairable or recyclable. The request from the market is for high performance and low price of fishing gear. Therefore, there is a low demand for recycled products (due to the perceived lack of quality), resulting in recycled products having a lower value on the market compared to virgin products (MRAG, 2020; OSPAR, 2020).

Eco-design principles

Eco-design principles consists of integrating environmental protection criteria of a service or a products lifecycle. Main rationale behind eco-design principles is to anticipate and minimize negative environmental impacts (of manufacturing, using and disposing of products). Simultaneously, eco design keeps a product's quality level according to its ideal usage.
Recently, there has been a growing interest in plastics that are biodegradable in seawater. However, biodegradable materials are not yet of the same quality as e.g., high tenacity PA, and therefore are likely to not provide suitable materials for new fishing gear. Further economic incentives are needed to allow it to be competitive on cost. In addition, the rate of biodegradability depends on the 'aggressiveness' of the environment, with seawater considered less 'aggressive' than freshwater, soil or composting facilities. Therefore, materials will be relatively slower to degrade, with recent estimates of months to years for biodegradable fishing gear to degrade (Grimaldo, Herrmann, Tveit, Vollstad & Schei, 2018). In addition, the use of biodegradable fishing gear may increase microplastic pollution, as the biodegradable gear break down. At present biodegradability is not a solution as it interferes with recycling, is environmentally dependent (i.e., what bacteria are in the water) and may add to microplastics. Biodegradable fishing gear can increase risk of perverse incentive, as fishers feel they can throw away materials as it will naturally degrade in the environment, and this may lead to more waste being produced and less recycling (MRAG, 2020; OSPAR, 2020; WWF, 2020).

Contemporary fishing gear is designed for efficiency and selectivity, with the design also being substantially impacted by legislation. The range of materials used within fishing gear will differ depending on the type of fishing, (i.e., pelagic fishing, demersal fishing, aquaculture), where the fishing occurs (i.e., fishing grounds), and the fishing methods used (e.g., mechanical vs non-mechanical methods for hauling). This determines the types of material used within fishing gear, and therefore the range of materials that need to be examined in the circular design of fishing gear. Increasing ability to easily dismantle fishing gear may reduce the durability of the product, and therefore such materials may be more prone to wear and tear. Also, any design that has separability as a specific constraint may be impacted by post-use reconstruction of the fishing gear associated with fixing by the fisherman.
Specifically, fishing gear is comprised of a range of different materials (e.g., trawl nets contain nylon, polypropylene, polyethylene, steel, rubber amongst others), which is exceptionally labour intensive to disassemble, and can be impractical with current technology to separate into individual recyclable streams.
On the study question in the report about circular design by MRAG (2020): 'Do you consider a mixture of polymers within a product necessary if a single polymer provides the same functionality and performance?' The majority of stakeholders stated that fishing gear comprised of a single polymer was much more preferred over one comprised of multiple polymers, as long as functionality and performance is maintained. However, gear manufacturers, assemblers or suppliers stated that a mixture is always necessary and with that required, while stakeholders within government or international organisations and gear recycler or waste handler, stated that a single polymer should always be used. In the Eunomia (2020) report was stated by fishing gear designers and manufactures that they needed a mixture of materials.

Current legislation

There is a lack of EU legislation (and internationally) to support the use of (and therefore development of) fishing gear that is more likely to be recycled and reused. Important driver at present is the costs associated with the recycling of gear. In addition, where policy exists there is no matching of engagement between different stakeholders across the Member States. A positive example can be found Denmark's statutory order, entered force on the first of December 2000. This order prohibits the import and marketing of products containing lead. Despite this, there has been no mirroring of such a ban in other EU countries. Any redesign of fishing gear will need to comply with current fisheries legislation, which has not been developed to enhance eco-design. In addition, any development of legislation will be slow, reducing the likelihood of eco-design being incorporated. There is a high use of fishing gear that is imported from overseas (for example: 100% of pots and traps are from Asia). With this, it depends on the country of origin and the legislation that apply there, whether fishing gear needs to meet eco-conscious design standards. What is likely is that most of the fishing gear coming from other continents are not designed to conform to the upcoming EU standards for fishing materials (MRAG, 2020). This could enhance in the optimal situation the demand for circular and sustainable fishing gear coming from Europe.

Knowledge and willingness

The existing lack of knowledge about how to develop and design circular and sustainable fishing gear is an issue. Currently there is limited research done and limited development facilities are working on the redesign of fishing gear, this forms a challenge. Importantly, further innovation of fishing gear requires extra financial input. There is still little understanding of who should bear the costs for innovations, including the design of new materials, different gear structure, development, better end-of-life properties. Additionally, a big challenge to any further development of the design of fishing gear is the potential low price of contemporary gear. Understanding the cost to reward in the design of new fishing gear is needed. Within the fishing industry there is still an attitude that economic development is more important than environmental impact in fishing gear design. Regional and cultural differences in the behaviour of fishers and fisheries will impact the uptake of new designs of fishing gear (Deloitte, 2018; MRAG, 2020; OSPAR, 2020). Mitigation measures to reduce the impact of ALDFG to the environment are limited in their extent. Applying mitigation measures may increase costs for fishers through reduced effectiveness of gear or higher gear prices (CEFAS, 2017; Macfadyen et al., 2009). Conclusively, there is a disincentive for fishing gear manufacturers to produce less environmental harm products, as this would lead to less consumption of fishing gear over time.

3.1.3. Positive practices in the design and production of fishing gear

Below positive practices in the design and productions stage of the fishing gear system in the OSPAR-region are described.

Optimizing design of fishing nets for recycling, Fil & Fab (France)
The company Fil & Fab is having a guidance role in the development of fishing-gear. At the design stage, the recollection, repair and recycling are being considered. Clients are net-manufacterers and other companies from the fishing industry. For more information: http://fil-et-fab.fr/evenements http://www.pechpropre.fr/index.php/partenaires/

Pechepropre, La Cooperation Maritime (France)
Goal of the project (2016-2018) was to create a clear overview of the different plastics used in the fishing industry. With this being able to present the ecological effects the waste from the fishing industry, and how it legally should be treated. More information is available on: http://www.pechpropre.fr/

3.1.4. SWOT analysis

Below a SWOT matrix is presented, this SWOT matrix aims to give a good overview of the strengths, weaknesses, opportunities and threats of the design and production stage of the fishing gear system in the OSPAR-region to become more circular and sustainable

Table 1. SWOT analysis design & production stage fishing gear (source: literature & author).

Strengths (Internal)	Weaknesses (Internal)
1.Single Use Plastics - Directive and extended producer responsibility scheme for fishing gear. With this the European Commission encourages all stakeholders in the fishing gear operational chain to implement systems to responsibly design, manage, dispose of and recycle fishing gear. **2.**Fishing gear is largely composed of high-quality plastics, like nylon, polyethylene and polypropylene. Incentive for recycling. **3**.Plastics have a great potential for repair, reuse and recycling if captured at the right stage in its lifecycle. Making use of valuable materials as Nylon. So, there is an increased financial incentive for recycling. **4.**Willingness within fishing industry to contribute to more sustainable and circular practices throughout fishing industry.	**1**.Contemporary fishing gear is designed for efficiency and selectivity. No focus/incentive on design for sustainability and circularity. **2**.Data gap and lack of transparency, there is still little knowledge of the total volume of gear made and utilized throughout Europe. **3**.Mix of polymers in the manufacturing of fishing gear along with metal components creates a challenge for recycling. **4.**There is still little understanding of who should bear the costs for innovations. There is limited research and development facilities are currently working on redesign of fishing gear. Along with a lack of transparency about the composition of fishing. **5**.A disincentive for fishing gear manufacturers is there to produce less environmental polluting and more circular products.
Opportunities (External)	**Threats (External)**
1.Create as much transparency as possible about the composition of fishing gear. Enhancing repair, reuse and recycling. **2**.Develop a good monitoring system. **3**.Design with materials of good value, this is an incentive for sustainable management of fishing gear (parts), for the different parties involved. **4.**Modular design of the gear, easy disassembly into constituent parts is required to minimise the manual labour time and cost to prepare gear for recycling. **5**.Design as simple as possible. Don't melt and mix materials and keep it with that easy for dismantling.	**1.**Regional, geographical and cultural differences in the behaviour of fishers and fisheries will impact the uptake of new designs of fishing gear. Difficult, but crucial to take these behavioral differences into account. **2.**A lack of EU legislation. **3.**High use of imported fishing gear. Strongly globalized and (online)-market fishing gear coming from Asia, hard to control. **4**.Big challenge to further develop the design of fishing gear, investments are needed. **5.**Biodegradable materials are not of good quality (yet). Therefore, not likely to provide suitable materials for new fishing gear.

3.2. Use stage of fishing gear

3.2.1. Description of the use of fishing gear

The fishing industry, especially within large industrial fishing operations, makes use of a reuse, recycling, modification and repair system to allow the continual use of their fishing gear (until they reach end-of-life and disposal is necessary). Therefore, the development of a circular system of fishing gear needs to support this model, but also facilitate guidance in good practice for such a system and also engage with smaller fishing operations. These developments will be vital in fishing operations where fishing gear are replaced on a regular basis (i.e., gill netting, hand lines) and the use stage of fishing gear are potentially discarded or abandoned. Especially because the biggest issue of fishing gear becoming marine litter are the net cuttings and part of fishing gear that end up in the ocean after for example repair.
Therefore, in development of a guidance standard for circular design of fishing gear, there is a need to work directly with the industry to utilise such information and practices to prevent this from happening (CEFAS, 2017; Deshpande et al., 2020; MRAG, 2020; OSPAR, 2020). For an overview of the strengths, weaknesses, opportunities and threats in the use stage of fishing gear see SWOT analysis in 3.2.5.

3.2.2. Problem drivers use stage of fishing gear

Intentional dumping of fishing gear

Intentional dumping of fishing gear is a reason that fishing gear becomes marine litter. Reasons behind intentional dumpings are the low efficiency and effectiveness of schemes to prevent retrieved gear and end-of-life gear to re-enter the water. The required revision of the PRF will bring significant improvements as it removes financial disincentives to bring the waste from fishing gear ashore by means of the implementation of an indirect fee (fee is not dependent on the level of waste returned to ports). This revised PRF needs to be applied in all the European ports. However, insufficient reception facilities in ports are currently not the only problem of low efficiency and effectiveness of retrieval schemes. Laborious onshore processes may still exist, also under the revised PRF, as waste facilities may still require a long and inefficient walk with heavy fishing gear for fishers**.** If bringing fishing gear to collection points for formal waste management is too over-laborious, fishers have an incentive to leave gear at sea. This holds for both retrieved gear and end-of-life gear, since it does not make sense to dump functioning gear. Yet, it is interesting and relevant to understand what the effects of the revised PRF are via getting data about the amounts of fishing gear that have been collected so far.

Lack of storage space on board of ships and insufficient storage facilities at ports are factors that can contribute to intentional dumping of fishing gear waste. Gilman et al., (2016) state that setting excessive gear can also result in discarding gear. For example, there may be insufficient room on board for all of the gear, such as when the space used to store nets when starting a trip is subsequently used as fish-hold (CEFAS, 2017; Deshpande et al., 2020; Deloitte & Wageningen Research (2018).

Fuel costs

Fishing gear usually is heavy and carries a lot of weight. Bringing ashore fishing gear on a fishing vessel increases the weight of the vessel and hence the fuel used during the trip, which provides an economic incentive to not bring ashore waste from fishing gear (Deshpande et al., 2020; Deloitte, 2018).

Accidental loss of fishing gear

Fishing gear can also be lost unintentionally, are described drivers of accidental fishing and aquaculture gear losses are derived. Stated is that events like gear conflict, bad weather, vandalism and theft. Gear conflict is the contact of passing vessels with active gear, or even passive gear, which leads to a collision resulting in gear losses (FAO, 2009; Gilman et al., 2016).
When gear is lost, there might be little to no incentive for fishers to find or pick up abandoned lost or otherwise discarded fishing gear (ALDFG) themselves. The fishers might decide not to look for lost gear, as it is too costly to find it or too much of a hassle to pick it up. It should be taken into consideration that any loss of fishing gear for fishers results in a financial loss (WWF, 2015).
Also, fishers might not be able to locate lost gear. This can have multiple reasons, e.g., damage by marine organisms, gear becoming snagged, removal of marker buoys and entanglement with passive gear. All of these reasons lead to the fisheries not being able to locate their gear, and therefore having to see it as lost.
A very relevant role in the marine litter issue in the European marine waters is caused by net-cuttings (KIMO, 2020). Fishing nets and ropes account for 28% of all beach litter around the North East Atlantic. That means that almost one in three pieces of rubbish found on northern European beaches comes from the fishing industry, much of it from net cuttings. The primary source of this kind of waste in the North Sea is from trawl net repairs. Fishermen fix nets at sea or on the quayside in port by cutting away damaged sections. This creates net cuttings, which can find their way into the sea through lack of awareness, habit or carelessness. If not quickly removed from deck, storms, high winds, waves, rainwater, or crew cleaning can sweep cuttings into the sea. Cuttings can also fall onto the fishing nets on board and get trapped, dropping into the sea when the net is rolled up on the boat or rolled out during regular fishing activities. They can also fall into the water when nets are transferred from the quay to the boat, or when new nets are taken in use, as waste pieces from manufacturing can become trapped in the netting. After consulting with fishermen in four countries, KIMO has developed best practice recommendations. Examples come primarily from the results of a survey undertaken by KIMO at harbours, and from feedback from face-to-face dialogue with harbour staff and fishers. The recommendations demonstrate some of the most simple, practical and inexpensive ways in which fishers and harbour authorities can cut pollution. Implementing these practices will reduce the negative impacts caused by this waste to the marine environment and economy (KIMO, 2020).

Fig 8. Collected fishing gear (Recycling today, 2018)

Lacking efficient lost gear recovery scheme

When fishing gear is lost, efforts can be undertaken to retrieve fishing gear from the seas. An efficient lost gear recovery scheme would be an effective way to address the effects of ALDFG. The opposite, lacking an efficient lost gear recovery scheme, would however contribute to the detrimental impact of fishing gear in the sea. Problems that are related to recovery schemes are the sporadic reporting and recording of lost gear (and no standardized monitoring method), resulting in the authorities having an incomplete overview of the amount of lost fishing gear in Europe. In the proposal for a revision of the Control Regulation, new rules are proposed on gear retrieval that can also contribute to reducing ALDFG. Another obstacle to improve is the reporting of lost fishing gear. Via allowing fishers to use the (electronic) logbook for such reporting and at the same time removing current unnecessary and ineffective reporting obligations.

There is no standardized monitoring method resulting in differences between the authorities that monitor lost gear. Since lost gear is not restricted to borders, authorities could cooperate to effectively target and retrieve lost gear. Ineffective information exchange due to differences in monitoring methods could hinder this cooperation.
There where operations are ongoing to try and recover ALDFG, the limited efficiency of operations to recover lost gear hampers the ease at which lost gear gets retrieved, or that some gear cannot be retrieved at all, for example if the right retrieval or ALDFG locating instruments are not present.
Due to a lack of reporting about ALDFG it is not known which sea areas contain a lot of ALDFG, which hinder the effectiveness of retrieval operations. Also, the inappropriate retrieval equipment, fishers often not specialized equipment on board to retrieve lost gear (CEFAS, 2017; MRAG, 2020; OSPAR, 2020).

3.2.3. Positive practices in the use stage of fishing gear

Below an overview of some positive practices with regard to use stage of fishing gear system are described.

Frydendahl return system

The internationally operating Danish net manufacturer Frydendahl offers a return system for torn gillnets. Nets are collected in the fishing harbours together with the fish transport and shipped back to Frydendahl for repair. When repair is possible, repaired nets are returned to the owner. This system allows to keep otherwise short-lived monofilament netting as well as the re-used float and sink lines in the lifecycle substantially longer than without a repair scheme.

Cosmos Trawl return system in Denmark

The manufacturer Cosmos Trawl, part of the Icelandic Hampidjan Group, collects end-of-life nets for dismantling and processing on their facilities in Denmark. Recyclable parts are then distributed to the available recyclers. In addition, they offer a repair service for trawls, seines and other fishing equipment, which helps repairs to be carried out at the harbour instead of at sea and extends the useable lifetime of trawls. Cosmos Trawl also offers a "Trawl Hotel" service, where fishers can store unused nets indoor or outdoor, protecting netting from sunlight and weather wearing and diverting unused nets from the quayside.

Cux Trawl manufacturer and repair in Germany

Cux Trawl makes trawls and other netting from PP and PE base materials mainly, but not exclusively, for the fishing sector. They offer a repair service for trawls and collect end-of-life life PE and PP netting for recycling at Plastix in Denmark (Plastix aims to make raw materials of old fishing nets). Press here for a video about Plastix.

The Green-ship refund – Provision 3

The PRF Directive introduces the green-ship concept, requiring ports to reduce fees for "green ships" engaging in waste prevention and on-board waste management. Fees must be reduced for those ships that design equipment and operation in a sustainable manner and produce reduced quantities of waste or otherwise ensure waste is managed on-board in a sustainable and environmentally sound manner. The European Commission is considering whether to outline specific criteria applicable to the type of ship (fishing vessels versus cargo ships, for example) or more general criteria applicable to all ships. The level of the green-ship rebate however remains at the discretion of EU ports, but the rebate should be substantial enough to be able to provide the right incentives to encourage green behaviour (Plastic Fund Solutions, 2019).

"Net Viva" Initiative, Popsicase (Spain)

The start-up Poscicase from Barcelona collects and process Nylon6 Fishing-gear from Catalonian harbors.
The collection, cleaning etc. from the fishing nets happens in small working-places and the recycling techniques are developed in cooperation with a Basque University. More information can be found: https://www.popsicase.com/net-viva-mediterranea-recycled-fishing-nets-program/

"Buyback-Program" (South-Korea)

The program must motivate fishers to manage their waste collection. This also entails ghost-nets, and end-of-life fishing nets. The filled bags are coded, so that the bags belong to the skippers and can be given to the waste-collectors in the harbors. The fishing-cooperatives take further control over the bags filled with the gear. When one delivers a bag, a fee is being paid to the deliverer. Since the beginning of 2003 until 2009 the program is applied in 51 areas in South-Korea. Between 2004 and 2008 29.472 tonnes of waste from the fishing industry is collected. The program is sponsored by the Korean ministry of fisheries and carried out with local companies. More information can be found at: https://marinedebris.noaa.gov/marine-debris-prevention-projects-and-activities-republic-korea-and-united-states

3.2.4. SWOT analysis

Below a SWOT matrix is presented, this SWOT matrix aims to give a good overview of the strengths, weaknesses, opportunities and threats of the use stage of the fishing gear system in the OSPAR-region to become more circular and sustainable.

Table 2. SWOT analysis use stage of the fishing gear system (source: literature & author).

Strengths (Internal)	Weaknesses (Internal)
1.The proposed revision of the PRF, brings significant improvements as it removes financial disincentives to bring the waste from fishing gear ashore. Revised PRF applies to all EU ports. **2.**The common Fisheries Policy, and the SUP-directive. **3.**The level of the green-ship payback however remains at the discretion of EU ports, empower and promote sustainable labels like this for the fishing industry. **4.**Fishing for litter schemes. **5.**Interest in and development of new and functional recycling techniques for fishing gear.	**1.**Lack of data and transparency. Sporadic reporting and recording of lost gear (no standardized monitoring method), resulting in an incomplete overview of the amount of fishing gear lost in Europe. **2.** Net cuttings, and parts of fishing gear that make their way into the ocean. **3**.Insufficient waste-reception facilities in ports. And the port waste facilities require frequently a long and inefficient walk with heavy fishing gear for fishers**.** **4.**When gear is lost, little to no incentive for fishers to find or pick up abandoned, lost or otherwise discarded fishing gear. **5**.Inappropriate retrieval equipment, fishers often not have specialized equipment on board to retrieve lost gear.
Opportunities (External)	**Threats (External)**
1.Making use of a reuse, recycling, modification and repair system to allow the maximal use of fishing gear (until they reach end-of-life and disposal is necessary). **2.**Develop good practice guidelines for use, repair and storage of fishing gear and good management of net cuttings. More awareness raising measures. **3.**Development of a guidance standard for circular design of fishing gear, there is a need to work directly with the industry to use such information and practices. Use modular design, enhancing repair. **4.**Since lost gear is not restricted to borders, national authorities must cooperate to effectively target and retrieve lost gear. **5.**Stop bringing waste to other continents and create strong local waste systems via local clusters.	**1.**Lots of subsidies for the fishing industry world-wide. Without support from national governments, half of the current fishing industry would not be viable anymore, creating an unbalanced level playing field on the globalized market. **2.**Unfair competition within the international fishing industry, e.g., 'cheaper and fishing nets coming from Asia. And the swapping with pollution, waste is 'dumped' in continents (E.g., Turkey, Indonesia & Nigeria). **3**.Lack of EU Legislation.

3.3. End-of-life stage of fishing gear

3.3.1. Description of the end-of-life of fishing gear

The pathways in the end-of-life stage for fishing gear are numerous (See the right-part of Fig 6). First, fishing companies dispose fishing gear waste to the nearest waste handling facilities. When fishing gear is being lost, a really small part of those lost gear is retrieved through ocean clean-up actions. This results in the risk of ghost fishing and other associated damages to the marine environment.
When the gear is collected, waste managers segregate waste fishing gear into different fractions, which include the recyclable fraction, the fraction for landfill and the incinerable fraction for energy recovery. Some of those fishing gear and gear residue are further collected during annual beach clean-up operations conducted across coasts of the different OSPAR

countries. ALDFG collected from land and ocean ultimately end up at waste management facilities. Waste generated during fishing gear repairs also tends to end up in waste management facilities. The segregated fractions are then in the optimal scenario transported to their respective facilities (Deshpande et al., 2020; OSPAR, 2020). Currently, disposal and end-of-life treatment of fishing gear is very low and the level of recycling of fishing gear in the EU is 1 to 5% (European Commission, 2018). For an overview of the strengths, weaknesses, opportunities and threats in the end-of-life stage of fishing gear see SWOT analysis in 3.3.5.

Lost nets recovered in clean-ups are often in a greater state of degradation and may be heavily fouled, which adds another layer of complexity in the recycling process. Recycling fouled nets is still possible, although they must be 85% clean in order to be considered economically viable

3.3.2. Problem drivers in the end-of-life stage for fishing gear

Problem drivers in proper end-of-life management of fishing gear are described here. Manufacturers currently do not focus on using recyclable products (material is hard to recycle), as this would often mean using durable products, which are (more) expensive than the products currently used in fishing gear. This would mean that the prices of the fishing gear increase. Another problem is that ALDFG is not accepted by recycling companies (not cleaned/sorted), due to the high costs of the recycling process. In general, recycling companies have high demands regarding the state of the materials. Gear that is handed in is dirty (containing organic sediments etc.) or unsorted (mixed with other 'waste') might not be accepted by recycling companies, as it takes too much time, effort and costs to get the material in a state that enables the company to recycle it. Before fishing gear can be recycled, it should be sorted, cleaned and transported to the recycling facility.

Lack of end markets for recycled fish gear creates not enough demand for waste management companies to recycle fishing waste. Recycling is often a more costly process than landfilling or incineration, and therefore only worthwhile when there exists a market for recycled goods or materials. This can either be the fishing and aquacultural market itself (manufacturers using the materials again), or another raw material market, which is often not the case. Currently recycling technology exists for the four main polymers, which means that, in principle, up to 80% of gear could currently be recycled. As with all plastics, the prerequisite for recycling would be that different polymer types are separated, implying that fishing gear made of different components needs to be dismantled to facilitate recycling.

When buying their materials from chemical companies, net makers are aware of the type of plastic they acquire. Chemical recycling does not need a completely pure input (less effort upon manual dismantling and separation of the net) and can produce output of high plastic quality (suitable for multiple reoccurring material circulations). Mechanical recycling, on the other hand, requires purer input in order to obtain good quality output (e.g., down to the type of low- or high-density PE). If different types of plastic are mixed in the input, the mechanical recycling can only be on a downgrading slope, giving low quality plastic that will not itself be recyclable. Considering this, it is important to have information on the composition of the material marked on the gear. Affordable technology already exists to scan plastic and determine which kind of plastic a material is made of. E.g., Dyneema is frequently used in ropes to replace typhoon wire ropes, but Dyneema is not suitable for mechanical recycling as it burns in the process, rather than melts. Theoretically, it would be possible to make oil from this via chemical recycling and reuse this feedstock for production of new materials.

A good example are the measures in Iceland for the fishing gear system. For valuable materials in fishing gear (polyamide) a fee is received from recyclers, which covers transportation costs of waste from fishing gear. Recyclers stated that they are not able to pay for waste from fishing gear (anymore). It has no economic value on the market anymore, as China is not accepting plastic waste anymore. A result of this is that waste management companies in Europe general have to pay a fee to deliver the plastic waste at recyclers, this forms an obstacle for the collection of plastics (European Commission, Deloitte & Wageningen Research, 2018).

<u>No appropriate formal waste management</u>

Gilman et al., (2016) state that preventative measures are identified as the most effective way to tackle ALDFG, with the provision of adequate, affordable and accessible onshore port reception and collection facilities being one of these preventative measures to limit the influx of ALDFG. The following drivers have been identified related to no appropriate formal waste management:

High cost of port waste management. This can be related to relatively high costs of waste management for management companies to treat port waste management and earn money out of the waste. For example, smaller ports with a limited number of fisheries, produce a small amount of fishing gear waste. To run an efficient waste management system within a lot of small ports divided over a large area is cost-ineffective, although this should be in place for all port in Europe under the revised PRF. Inefficient waste management systems at ports make it hard for fishers to dispose of their fishing gear waste, which makes it more likely that fishers will dump their fishing waste into the sea. For example, waste disposal point that are located relatively far from the port-docks can create a burden for fishers to get rid of their, often heavy, fishing gear waste.

Limited handling capacity

Within Europe there are only a few operators willing to handle end-of-life fishing gear due to the low financial return and high logistical challenges, including the potential for contamination of loads and damage to machinery. The two main operators (Plastix and Aquafil) handling fishing gear at scale do not handle all of the materials of which fishing gear is comprised and need further capacity-building to scale-up their efforts to handle major volumes of fishing gear. Such capacity building would include appropriate training in coordinating portside logistics for handling these materials and raising awareness of processes for cleaning, disassembly and responsible disposal.

Logistics associated with the full value chain of recycling

Organising the collection, cleaning, segregation and transportation of large volumes of nets presents unique challenges in each region and will influence the success of any recycling project. The process of identifying the material types and ascertaining the best method to undertake the labour-intensive task of separating and cleaning fishing nets before disposal is a critical component of the collection process prior to recycling. Installation of portside reception facilities, establishing partnerships with surrounding fishing syndicates, ensuring nets are appropriately cleaned and separated by material type, high transportation costs and the high volumes of nets required to make the numbers work are common themes across regions. Most of the current successful models focus on collecting the nets directly from the fishers as soon as they meet their end-of-life, as opposed to seeking them for collection on beaches and waterways, as recovered ghost nets are usually heavily fouled and thus require an extra layer of labour (cleaning) before they can be reliably recycled. In addition, recycling can also come with a high environmental and economic cost (i.e., chemical recycling), at the same time resulting in recycled plastic that is more expensive than virgin plastic (European Commission, 2020)

Low level of capability to recycle in Europe

In Europe, there are only two companies working with the fishing industry and aquaculture to collect, dismantle and recycle fishing nets and other related products made from a range of source materials. Nofir AS is a Norwegian company that collects and recycles or repurposes discarded equipment from commercial fishing and fish farming around Europe and Turkey. Collected material is transported to the factory in Lithuania or Turkey, where it is dismantled and prepared for recycling. Nofir work in partnership with Aquafil in Slovenia to turn the recycled nets into regenerated polymers which are then used in products such as socks, swimwear, and carpet tile. Plastix Global has created a recyclate called OceanIX HDPE made from discarded fishing nets. They work with partners around the world to collect and recycle a range of fishing gear to create their OceanIX pellets. At their facility, they are able to handle the cleaning, separation, cutting and recycling of a variety of different net materials.

The economics of recycling fishing gear

Today, Europe has around 1,200 active plastic recycling and sorting plants, only two of these recycle fishing gear being Aquafil and Plastix. It is not a secret that there's at this moment in time not a lot of profit to be made in the recycling of fishing gear. Main reasons for this are:
- Supply and Demand: In this market, domestic and industrial demand for recycled products is not that high. At least not high enough to create and generate consistent production of recycled goods; making that investing in this sector is seen as high risk. For this purpose, governments worldwide are seeking to strengthen and nourish this industry until it can become self-sufficient and consistent through various incentives, legislation and funding programs.

- Low profit margins: currently, virgin plastics are cheaper than recycled plastic. This is due to several processes' virgin plastic does not need to go through, such as cleaning, shredding, recovery, logistics etc. All these processes require manual labour and value-adding activities that are far more costly than the actual value of the material, meaning, most of the times money is actually lost through processing fishing waste (ODYSSEY, 2020).

3.3.3. Economic numbers about the end-of-life stage of fishing gear

There is in general a lack of data about this stage, how much gear is exactly being produced, bought, used and reached its end-of-life stage. Nevertheless, estimations about the costs involved in collecting, dismantling and recycling fishing gear are presented. The estimations about the costs of proper end-of-life management of fishing gear, strongly based on numbers coming from Iceland.
One of the good examples is the 'Icelandic situation' can be achieved, where currently 90% of gear is retrieved in ports (Deloitte, 2018; MRAG, 2020; OSPAR, 2020). The cost per ton of recycled plastic waste from fishing gear in Iceland are 68€ (Eunomia, 2017). However, to get waste prepared for recycling, the port reception facilities need to handle the waste by cleaning, sorting and transporting it, these costs are set at 380€ per tonne. This number is derived from the handling costs per drink container as stated in Hogg, Lester and Ball (2010), which consists of capital costs for the reception system, space infringement re-imbursement and labour costs associated with the take back of container collection. Costs invovled for recycling a ton of derelict fishing gear equate to 448€ per tonne. Landfill costs are 350€ per ton delivered (which includes transportation and do not need handling (sorting and cleaning) at ports or by fishers).
Finally, to express the ARF as a percentage of costs, the average costs of fishing nets (to fishers) is taken into account. Fishing nets mainly consist of Polyethylene (60 – 70%) or Polyamide (20% - 30%), where Polaymide is a more durable source. Costs of these nets are €5,50 – 6,00 for every kilo of Polyethylene and €6,50 - 8,50 for every kilo of Polyamide depending on the thickness of the nets. These net costs per kilogram are used for the calculation of ARF as a percentage of net costs. Applying the costs for recycling and landfill for additional waste landed ashore compared to the baseline leads to total additional costs for recycling between €0.9m and €2.9m and for landfill and incineration between €1.6m and €5.3m. In total, the additional amount of plastic fishing gear delivered costs between €2.5m and €8.2m. For the 90% retrieval rate of Iceland, 50% more fishing gear waste is delivered to Ports compared to the baseline, which is between 33,000 and 109,000 tons annually. Applying the same factors as above, the additional costs for recycling are estimated between €4.4m and €14.6m and for landfill and incineration between €8.1m and €26.7m (Deloitte, 2018).

3.3.4. Positive practices in the end-of-life stage of fishing gear

Below an overview of some positive practices with regard to end-of-life of fishing gear are described.

Green Deal Fisheries for a Clean Sea in The Netherlands

In the Green Deal 'Visserij voor een schone Zee', the whole Dutch fishing chain (fishers, harbours, waste company) is involved in several activities, including fishing for litter and the collection of end-of-life fishing. The Dutch fishing industry is with this Green Deal one of the frontrunners in achieving a more sustainable fishing industry. For each harbour, a 'manual' is provided about the facilities for disposal of waste from fishing ships. Separate big bags are provided for the collection of dolly ropes and for fishing for litter waste. There will be per harbour, one container in which big bags can be disposed, together with household waste from ships and discarded nets. At the regional waste management facility of Bek & Verburg, this waste is sorted and forwarded to recyclers. A direct collaboration with Healthy Seas (press here for more information about Healthy Seas) is there for recycling nylon nets into socks, and the dolly ropes are converted into fish boxes (TAUW, 2018)

BLUENET

BLUENET is a program that aims to contribute to the sustainable blue economy. BLUENET is about recycling of abandoned, lost or discarded fishing and aquaculture gear. Recovering gear from the sea and using it as raw material to manufacture new gear. The aim of BLUENET is reducing, by the end of 2020, the marine litter from sea-based sources and from the Bay of Biscay by 20-40 %. The sources to be investigated are aquaculture and fishing, and the amount and harmfulness of marine litter produced by their ALDFG. This will be achieved by promoting the proactivity of the sectors in combating marine litter. Done through ocean literacy, preventing the intentional and unintentional disposal of nets and ropes at the sea. With facilitating the recovery of nets and ropes to fishers and operators with the aim of upcycling of these nets and ropes by recycling and using them as raw recycled materials for manufacturing new fishing and aquaculture gear. This forms a contribution to closing the loop of the circular economy. Fishing nets and aquaculture long-line ropes will be recovered and recycled, under the motto “locally wasted, locally recovered”. A self -sustaining program for recycling abandoned, lost and discarded fishing and aquaculture gear will be established in the Basque region (SE Bay of Biscay, Spain). Fishing vessels and fishing ports will be equipped with fishing gear collection bins, alternative and sustainable designs for fishing and aquaculture gear, and design for sustainability of gear will be promoted (i.e., designs with less materials, use of more environmentally friendly materials, inclusion of recycled materials, facilitating the recycling at the end of their use stage). The removal and recycling of fishing and aquaculture gear made of Polyethylene, Polyamide and Polypropylene are the focus to boosting the local circular economy from and for these sectors (BLUENET, 2020) (For more information about the bluenetproject: https://www.bluenetproject.eu/)

Fisheries Association Norden, Smögen Municipality, Sweden

The FF Norden collects both end-of-life and retrieved fishing gear from surrounding fishing harbours along the Swedish west coast. The Sotenäs Marine Recycling Center serves as a common collection and semi centralised sorting point. The fishing gear is partially dismantled and pre-sorted in the harbour by the fishers of FF Norden to extract parts for re-use. After that it is further sorted into metal and polymer fractions by trained personnel as part of a social employment project at Sotenäs sorting facility. Metals are recycled by a local scrap metal dealer, plastic materials are sent to Plastix, who recycle the PP or PE lines and netting, and forward any polyamide to Aquafil. The system relies on funding from various projects and is hoped to become self-sufficient in the future. Although the economic value of the materials forwarded to Plastix is not high, it is usable and recyclable, most end-of-life fishing gear is clean, pre-sorted, and ready for recycling. The environmental and economic cost of transportation to Denmark are low, and almost covered by the revenue from the plastic fractions. The Swedish west coast fisheries predominantly use trawls and pots/traps (no gillnets). This is similar to the situation in the Icelandic fisheries, which in both cases facilitates recycling of end-of-life fishing gear. Sweden is also currently in the process of setting up a national collection system for discarded fishing gear, called Fiskereturen. (https://www.fiskereturen.se/)

Recycling system (Japan)

Since 1988 is fishing gear in Hokkaido (Japan) being recycled from a company consortium collected, and the materials is mechanically being recycled and pellets are produced. Netrecycling happens cost-free, delivering the old nets is free in Japan and this is already happening for a long time. For more information: http://swfsc. Noaa.gov/publications/TM/SWFSC/NOAA-TM-NMFS-SWFSC-154_P935.pdf

Icelandic return scheme

Fisheries Iceland Fisheries Iceland cooperates with the local net manufacturer Hampidjan and the Icelandic Recycling Fund in a return scheme. End-of-life net fragments are returned to port and to the manufacturer for reuse or refurbishing, if possible and against a fee. The return system works because fisheries in place use trawls and purse seines, hence net fragments even from repairs are usually large and sturdy. If net segments cannot be refurbished or reused for the production of new gear, the fragments are shipped to Aquafil or Plastix (recycling companies) for recycling. Fisheries Iceland report that 80% of trawl and purse seine materials are currently re-used or recycled. The local approach in Iceland ensures that all members of the fishing community are aware of the collection system and cooperate in enabling the recycling scheme.

Antex, fishing gear recycler in Spain

The Spanish Garn-manufacter uses different raw materials, among others also PET bottles, leftover from the textile industry, like PET from fishing nets. The generated garn is used by Ecoalf for clothes. More information can be found on: https://www.antex.net/ https://ecoalf.com/ and https://ecoalf.com/en/p/upcycling-the-oceans-spain-16

Pilot-project: Local mechanical net-recycling BOSS-1D

Groningen Seaports, Bek & Verburg and Impact recycling are cooperating to recycle fish-nets material via the innovative BOSS-technique (See text below what this technique entails). With this Green Deal Pilotproject will be tested if plastic nets from the Netherlands at the Eemshaven (Groningen Seaport) can be transformed into high quality raw materials as PP and PE. 'The charming character of this project is that it tries to find a solution where the supplied fishing-nets can locally be processed and recycled to useful resources.' Furthermore, the BOSS-1D machine will have enough capacity for processing the fishing net from other Dutch harbors.
Impact recycling developed 'a revolutionary plastic recycling technology', which separates hard plastics into PE and PP, both with a purity of 98%. The BOSS-1D is a patented, density separation process with water. BOSS stands for Baffled Oscillation Separation System). The BOSS-1D makes use of the density differences between the plastics. By letting a stack of baffles vibrate in the water (oscillation), vortexes arise in the separation tank. In the eddies the less dense materials as PP turn slower than the denser PE. The most rapid rotating plastics stream to an outer tank, where it is collected. The heavier plastics fraction being nylon and styrene sink to the bottom of the tank and can be separated due to this.
The plastic recycling-installations at Groningen-Seaports is a test-setup. Its precursor stands in New Castle and has there been used with success. The BOSS-1D will be tested and production will slowly be increased, with potentially recycling two tons of fishing-net fibers per hour. 'Until now' there was not a process that could produce high quality fibers. With this new fishing nets can be made from old materials, and this forms a strong support to creating a circular economy of fishing gear plastics. Old fishing nets are with this valuable and become an incentive for fishers to collect them and bring them ashore. Promising as well of this outcome is that for all the old fishing a national and local solution is found.' (KIMO, 2020).

BOSS-1D technique
The vast majority of waste fishing nets end up in landfills or remain in the ocean where they account for up to 46% of all ocean plastic. The United Nations Environment Program (UNEP) estimates that discarded fishing gear in our oceans make up approximately 10% of the annual marine litter (640,000 tons each year). The chronically low recycling rates in the plastic fibre industry reflects the dearth of automated technology capable of separating 1D waste plastic material. Focus in the R&D was on developing fibre with laboratory scale trials revealing positive results with high purity outputs. We are in the process of developing a commercial scale 'BOSS-1D' technology that will separate fibres from waste fishing net and waste carpet into very pure recycled materials.
Scalability Global brands, supported by consumers, are committed to recycling product through campaigns like the Ellen McArthur "Plastic Pact". This has led to an increased demand for high quality recycled product. Ergo, technologies that can deliver high purity recycled material at scale. Chemical recycling is capable of producing near virgin like recycled resin. However, the process requires very pure feedstock; BOSS mechanical recycling technology unlocks the economics of chemical recycling technology by supplying pure post-consumer feedstock with no production losses to black or dark plastics because BOSS is a water-based density separation technology. BOSS technology compliments and enhances the economics of both the mechanical and chemical recycling technology industries (Impact-recycling, 2020).
With the BOSS-1D it is possible to both recycle the fishing gear locally and create high value recycled materials. Companies as Philips have shown their interest in these recycled plastics due to its high quality, and therefore the possibility to use it in products. (https://impact-recycling.com/boss/.

OCEANETS

Oceanets Is a project in Spain that focusses on technological approaches for circular economy solutions in terms of prevention, recover, re-use and recycle of fishing gear to obtain added-value products in the textile industry (http://oceanets.eu/).

Nofir AS

Nofir AS is a big player in the world of recycling fishing gear, The Norwegian company Nofir AS was set up in 2008 with the purpose of establishing a nationwide system for discarded plastic equipment from the fishing and fish farming sectors. The company was a result of a joint venture between a fish net producer and a waste management company based upon a joint problem: there existed few environmentally friendly methods of disposal for discarded plastic equipment from the fishing and fish farming industry. This problem has been well known and the organizations of Norwegian fishing vessel owners and Norwegian fish farmers have addressed the issue through several projects. Nevertheless, a solution was not found until Nofir was established.
In 2012 Nofir was as first Norwegian company granted support from the European Union through the Eco Innovation Project. The goal of this initiative is to help good, innovative ideas that protect the environment become fully-fledged commercial prospects, ready for use by business and industry. In doing so the initiative not only helps the EU meet its environmental objectives but also boosts economic growth. With this support Nofir was able to map and execute an expansion from Norway to Europe. From 2011-2015 Nofir collected equipment from 4 continents: Europe, Turkey, Asia and America (NOFIR, 2020).
For more information: https://nofir.no/about-us/

From waste to wear - programs

Various companies like Bureo, Healthy Seas and Interface has shown the opportunity to create goods out of recycled fishing nets. Goods like in the case of Bureo skateboards, sunglasses for example, or socks like Healthy Seas is doing. Also wear for the interior of your house such as carpets are made out of recycled fishing nets.

- **BUREO** (Making sunglasses, skateboard, surfboards from amongst other things recycled fishing nets) more information: www.bureo.co
- **Healthy Seas (**Making socks out of derelict fishing gear) more information: https://www.healthyseas.org/
- **Interface** (Make carpet from derelict fishing gear) more information: www.interface.com

Plastics2Fuel

What if plastics can't be recycled into a usable material? IGES and FinCo Fuel Netherlands agreed half July 2019 on a purchase-agreement under the name Plastics2Fuel. This agreement is for the extent of 5 years for a new transportation-fuel that IGES started to produce from non-recyclable plastics. IGES got this installation from Australia, customers are fishers, marine sector and the transportation-sector (KIMO, 2019).

AQUAFIL (Worldwide)

For the production of plastic-fibers, from 'Econyl', old fishing gear and carpet is being used. The fibers are chemically recycled (depolymerized), and is new garn created and used in among other clothes. The firm only accepts clean nets designed with Polyamid (PA6, Nylon) and a steady influence of new nets needs to be there.
For more information: www.aquafil.com/ und https://ensia.com/features/fishing-gear-recycling/www.econyl.com

3.3.5. SWOT-analysis

Below a SWOT matrix is presented, this SWOT matrix aims to give a good overview of the strengths, weaknesses, opportunities and threats of the end-of-life stage of the fishing gear system in the OSPAR-region to become more circular and sustainable

Table 3. SWOT analysis end-of-life stage fishing gear system (source: literature & author)

Strengths (Internal)	Weaknesses (Internal)
1.Fishing for litter programs and the Revised Port-Reception facilities- Directive. **2**.Most successful models focus on collecting the nets directly from the fishers as soon as they meet their end-of-life. No collection on beaches and waterways, as recovered ghost nets are usually heavily fouled and thus require an extra layer of labour (cleaning) before they can be reliably recycled. **3.**Create regional waste clusters, for effective regional-waste-management. Local approach ensures that all members of the fishing community are aware of the collection system and cooperate in enabling the recycling scheme. **4.**Cooperation throughout the whole chain. Involvement of the whole fishing chain (fishers, harbours and waste company) in managing end-of-life gear. **5.** Making use of the new development of new techniques, fishing nets become valuable due to improved recycling (incentive) for fishers to collect them and bring them ashore).	**1.**Currently, disposal and end-of-life treatment of fishing gear is very low and the level of recycling of fishing gear in the EU is 1 to 5%. Inefficient waste management systems at ports make it hard for fishers to dispose of their fishing gear waste. **2**.Fishing gear is a small waste stream. Recycling is often more costly process than landfilling or incineration, and therefore only worthwhile when there exists a market for recycled goods or materials. To run an efficient waste management system within a lot of small ports divided over a large area is cost-ineffective. **3.**If different types of plastic are mixed in the input, output likely low-quality plastic. Along with the high organic contamination of materials reducing the ability to recycle. **4.**Only two main operators handling fishing gear at scale. Complicated recycling logistics. Travelling long-distances with waste results in high emissions. **5.**Recycling can come with a high environmental and economic cost (i.e., chemical recycling), at the same time resulting in recycled plastic that is more expensive than virgin plastic.
Opportunities (External)	**Threats (External)**
1.Capacity building for recycling. Development of facilities to enhance the capacity to recycle fishing gear within Europe. Setting up national collection systems. Ensure a good functioning market for recycled materials. **2**.Determine the economic utility in developing potential market for return, repair and renting nets. **3**.Affordable technology already exists to scan plastic and determine what the composition of material is. Currently recycling technology exists for the four main polymers, which means that, in principle, up to 80% of gear could currently be recycled. **4.**Use of valuable materials in fishing gear (polyamide) like nylon. **5**.Take the emissions related to the recycling and the production of virgin materials into account.	**1**.Low profit margins, currently virgin plastics are cheaper than recycled plastic. Lack of end markets for recycled materials creates not enough demand for waste management companies to ensure a healthy business situation. **2.**Different polymer types mixed, makes it a challenge for recycling. **3.**Lack of EU legislation to incentivize the use of recycled materials. **4**.High cost of port waste management. Having to pay a fee to deliver the plastic waste at recyclers, is a barrier to actually perform the behaviour. **5.**Recycling is a business model, companies will not specialize in extracting resources from materials where the effort outweighs the profit. Investing in this sector is seen as high risk, because of the low supply and demand for recycled materials.

4. Overview measures in the different OSPAR countries.

An overview is given about what is already going on in the different OSPAR-countries with regard to a more circular and sustainable fishing gear system. With this a better understanding about different measures in the contracting OSPAR-countries is given. This gives an overview for the different parties about what works, what doesn't work and most importantly give clarification why certain measures work and maybe don't work in particular location and culture (CEFAS, 2017).

Fishing for litter projects

There are many projects where fishers remove litter from the sea by retaining and landing litter caught during normal fishing operations. Fishing for litter projects aim to remove litter whatever its origin is (e.g., from other sea-based and land-based sources) as well as litter which may have been generated by the fishing industry itself. The main initiative is called Fishing for Litter (FFL) which is coordinated by KIMO. For this initiative, the fishers are given bags to put the marine litter into, which they land at participating harbours when full and the project pays for the removal of the bags and the recycling or disposal of the waste. While these schemes primarily recover litter rather than preventing its loss to the marine environment, they also help to raise awareness among the fishers in order to reduce waste from the fishing industry entering the marine environment. Belgium, Denmark, Germany, Ireland, the Netherlands, Norway, Sweden, and the UK take part in the KIMO Fishing for Litter scheme. Spain also has projects that involve fishing for litter, but these are not covered under the KIMO scheme. Click here for more information: https://fishingforlitter.org/.

- Belgium participates in FFL and has put structural financing in place for this project.
- Germany currently has six harbours that participate in the scheme with approximately 60 fishers that are involved in FFL.
- Ireland has 24 vessels in three ports that are currently participating in FFL, with a target of seven ports in 2016.
- Iceland and Portugal do not take part in the FFL schemes. However, Portugal stated that many fishers collect litter during fishing activities (BIM, 2020; CEFAS, 2017; Deshpande et al., 2020; Deloitte, 2018; NSAC, 2020; MRAG;2020; OSPAR; 2020; Plastic Fund Solution, 2019, WWF, 2020).

Revised Port Reception Facilities - Directive

Under the new EU Port Reception Facilities (PRF) Directive (EU/2019/883), there is an obligation for ports to provide adequate facilities for the reception of waste from ships with a cost recovery system which requires the application of a 100% Indirect Fee (i.e., independent of how much waste a ship delivers to port). Ports must ensure separate collection, waste reception and handling plans, also with respect to fishing gear and passively fished waste. The barriers, best practices and solutions identified in this section may be of use for setting up effective waste reception facilities for fishing gear during implementation of the revised PRF Directive (OSPAR, 2020). Moreover, it is interesting to know what the effects of the revised PRF are on the amounts of gear that are being collected, at this moment in time this is not known what the improvements are. A good monitoring is fundamental for this understanding.

ICELAND

In Iceland, there is an interesting system for fishing gear in place. In many cases the manufacturing is done abroad. Lines, ropes, and netting are shipped in bulk. So, in any situation, the material has to pass through customs. Fishing gear is among the materials covered by a law aimed at encouraging reuse and recycling in order to remove those substances from the natural environment. Assumed is that since every part of fishing gear is taken through the customs number placed on each material, a fee can be easily placed on the materials.

General ambition of the law is to place a recycling fee on a specific material when manufactured or imported which in turn can be used to facilitate recycling at the end of the materials life cycle.
The system in Iceland is majorly based on a voluntary agreement where fishers can deliver nets and dolly ropes to waste receptions facilities free of charge. The voluntary agreement between the fishers and the Icelandic Recycling Fund (a state-owned agency) aims to recover and recycle fishing nets made from plastic. Fisheries Iceland Fisheries Iceland cooperates with the local net manufacturer Hampidjan and the Icelandic Recycling Fund, forming together a successful return scheme for fishing gear. End-of-life net fragments are returned to port and to the manufacturer for reuse or refurbishing, where possible, against a fee. Fisheries Iceland report that 80% of trawl and purse seine materials are currently re-used or recycled.

The local approach in Iceland ensures that all members of the fishing community are aware of the collection system and cooperate in enabling the recycling scheme. The system works well because the fishery uses trawls and purse seines, hence net fragments even from repairs are usually large and sturdy. If net segments cannot be refurbished or reused for the production of new gear, the fragments are shipped to Aquafil or Plastix for recycling (Clean Nordic Oceans, 2019; OSPAR, 2020).

Despite, the high recycling rates for recycling fishing gear, the recycling fishing gear system in Iceland also faces several challenges. Since recycling is a business model (recycling-companies sell the recycled-products), companies do not easily focus on extracting resources from materials where the effort outweighs the profit. This is the case with recycling fishing gear.
Therefore, the Icelandic system is based on and functions largely through a system that utilizes the small size of the country and the interconnectedness of people and organizations. It enables self-reporting and discourages free-riders through self-control. Still, the system should be constantly revisited to find areas for improvement and educate its users, to promote their involvement. If the current voluntary waste management system would fail, then there is the possibility to let the originally intended recycling fee to facilitate recycling of fishing gear enter force in the he future (Clean Nordic Oceans, 2018).

NETHERLANDS

In the Netherlands, a voluntary agreement the so called 'Green Deal Fishery for a Clean Sea' is applied. In this green deal the fishing sector, fishing harbours, waste organisations, NGO's and the ministry, cooperate to decrease the amount of marine litter from the fishing sector and to increase the recycling of the fishing waste collected. In this agreement there are various projects created in harbours including:
- Integrating waste facilities for the different waste streams (domestic waste, operational waste, Fishing for Litter waste and dolly ropes) to make it easierto collect the waste.
- Cooperation of the Dutch Wadden Sea harbours to improve their waste management linked to the 'ecoports' scheme.
- The study 'Waste-management in small Dutch harbours' which will give an overview of how waste management is organized in the different small fishing harbours in the Netherlands. This will include the views of the users on the present facilities and provides proposals of how facilities can be improved and what the positive practices are.
- A mobile phone application has been developed to help to reduce damaged and lost fishing gear. Dutch gill netters and trawlers fish the same grounds off the coast of the Netherlands and there have been problems with trawlers towing their gear through gill nets, resulting in damaged and lost nets. The phone application gives the location of the gill nets so that the trawler fishers can avoid them.
- Gill-net fishers have also started to set their nets with enough space for trawlers to fish between them. Since the app has been introduced, the number of gill nets that have been damaged or lost has declined substantially.
- In the Netherlands, the Green Deal for fisheries aims to create a sustainable fishing industry. The Netherlands, and Dutch fishing industry are one of the frontrunners to achieve a more sutainable fishing industry. For more information: https://www.greendeals.nl/green-deals/visserij-voor-een-schone-zee
- ProSea provided training on sustainability in the marine environment (including marine litter issues) at fishing schools.

NORWAY

In Norway the Climate and Environment Department has stated that a voluntary agreement, introducing extended producer responsibility for fishing gear, should be initiated. As part of Norway's 2013 waste strategy, marine litter caught in fishing gear can be handed in with no fee (an Indirect Fee System, where the fee for landing waste from a vessel is incorporated in an overall port charge and is not dependent on the quantity of waste landed), the waste generated on board a fishing vessel can be handed in at a port and the fishing gear can be recycled. In Norway, annual retrieval operations are conducted by the Directorate of Fisheries to recover lost gill nets. A system in place to report the location of set static fishing gear, which reduces the likelihood of damage or loss of the gear and improves the chances of recovery if it is lost. Norway has developed educational material for fishers to improve handling waste on board vessels, which has been trailed and has been successful.

PORTUGAL

In Portugal, waste generated by fishing vessels or litter caught in fishing gear can be placed in recycling containers or waste containers located at a port. For the project 'Fishing for Sea No Trash', containers were distributed to collect mixed waste and packaged waste on board vessels.
Portugal has awareness raising actions from the MARLISCO [roject, from the Portuguese Association for Marine Litter (APLM), and from the Interdisciplinary Centre of Marine and Environmental Research (CIIMAR).
Projects include 'Networks Ghost: abandoned fishing gear, lost and discarded: contributions to the prevention, mitigation, remediation and awareness of impacts on the North Coast', and 'Fishing for Sea No Trash'. They also participate in international projects such as 'Coastwatch', 'Clean Up the Atlantic' and 'Clean Up the Med'. There is voluntary co-operation from fishers resulting from the Docapesca project 'Fishing for Sea No Trash'. For more information: https://www.egf.pt/en/media/news/algar-in-partnership-with-docapesca/

Fig 9. North-East Atlantic, West-Algarve (Portugal)

ENGLAND

The Responsible Fishing Scheme (RFS) is a voluntary scheme which supports a responsible fishing industry by ensuring positive practice and is applied in the United Kingdom. One of the five key areas in this RFS is *'care for the environment'* which includes management of waste that may become litter and the recovery of fishing gear. Responsible Fishing Schemes have been included in the fishing industry. This has been done via educational modules for members of the fishing industry about the topic of waste and litter management.

IRELAND

In Ireland, the Bord Iascaigh Mhara (BIM) provides a Responsibly Sourced Standard by issuing a 'Certification of Best Practice' for wild caught Irish seafood. This certification involves a commitment to environmental responsibility, which includes waste management. Twenty-seven vessel are currently certified, and twenty-five vessels are ready to be audited. BIM also supports fishers with implementing Environment Management Systems on vessels. Responsible Irish Fish (RIF) has a code of practice and has 130 vessel members. BIM helps fishers to put in place Environment Management Systems on vessels, which includes waste management systems, to ensure that unwanted fishing gear is dealt with in a responsible manner (BIM, 2020).

BELGIUM

In Belgium, the fishing sector has its own waste reception facilities in harbours that are adapted to their situation and needs. Belgium had multiple measures for the fishing industry in preparation in 2016 as part of the Programme of Measures under the MSFD, such as the improvement of a waste deposit system for fishing vessels. Belgium is preparing an educational programme covering marine litter from the fishing industry as part of the MSFD Programme of Measures. In the Belgian fishing sector, the Flemish Fisheries Cooperative (VVC Equipment) examines how gear can be recycled. The Public Flemish Waste Agency (OVAM) is responsible to implement the SUP- and PRF-directive into law.
The recycling of nets, ropes and dolly rope is challenging because there are several aspects to take into account such as the type of gear, different materials etc. VVC has invested in metal cages in which the fishing nets can be stored until sufficient amount has been collected for transport to a processor.
Corajec, a Belgium recycling plant, started to collect the fishing nets since the end of 2019. There are also contacts with other Belgian recycling companies for possible collaboration (NSAC, 2020).

SWEDEN

In Sweden, fishing ports are responsible for receiving ship-generated waste including marine litter collected in fishing gear. As part of the 'No-Special-Fee' system, commercial fishers pay a port fee and can hand in any amount of waste (including marine litter) at the port. The project 'Keep the Sea Clean' facilitates fishers in Bohuslän (west coast of Sweden) to collect and recycle plastic marine litter caught while fishing, as well as recycling fishing gear, such as trawls, nets and ropes. The project is carried out by Smögens Fish Auction with support from the Swedish Agency for Marine and Water Management (SwAM). The Swedish Programme of Measures under Marine Strategy Framework Directive (MSFD) is aimed at improvements in implementation of already existing regulations for waste management in fishing ports and 'Promoting an effective and sustainable collection and reception of lost fishing gear and preventing the losses of new ones' (CEFAS, 2017).
Sweden has acted as a lead partner for a MARELITT project (2016 - 2018) investigated the problem of Derelict Fishing Gear (DFG) in the Baltic Sea. The project comprises a series of activities including professional fishers undertaking trips specifically for the purpose of retrieving derelict gear and the retrieval of gear from wrecks by divers. The awareness of the problem of litter and plastics in particular among the demersal fishers is generally high. It is common for fishers in Sweden to collect marine litter during fishing activities and bring it ashore. Thereafter, the litter is either sent for professional recycling or left at a recycling station. The individual fishers take over the costs of collection themselves. This work is done in an unorganised way during everyday fishing activities. Projects have been completed on identification of areas where gear was lost and possible removal of lost gear from hotspots where lost gear accumulate. Fishers have since long been taking active part in organized projects aimed at collecting ALDFG around the Swedish coastline. These projects have been successful over the years. In Sweden, recently a new project is launched. The project is the result of active work from the fishery and will be conducted by the fishery against financial compensation. SFPO, has a well-functioning unformalized co-operation with the leading recycler of fishing gear in Sweden. SFPO also has been actively promoting fishers to leave used old gear to the recycler (Fiskareföreningen Norden, 2020).

Sweden has made a proposal for a producer responsibility regulation for fishing gear to be decided in January 2021. The Regulation proposes differentiated fees, taking into account the circular design of fishing gear and eco-design when determining the producer levy for the collection schemes. This is in line with what is proposed to the Commission standardisation process for the development of circular fishing gear. The Single-Use Plastics Directive, in contrast to, for example, the WEEE Directive or the Battery Directive, does not regulate how historical waste is to be handled. There is therefore no explicit support in the Single-Uses Plastic Directive to cover the costs of historical waste relating to fishing gear containing plastic by producers. Therefore, Swam has made a proposal, but no decision yet, to have a holistic perspective in order to clean up Swedish seas from historically lost fishing gear with state resources. Depending on how high the collection schemes. This is in line with what is proposed to the commission standardisation process for the development of circular fishing gear. SWAM has made a proposal, but no decision, to have a holistic perspective in order to clean up Swedish seas from historically lost fishing gear with state resources. Depending on how high the collection targets for end-of-life fishing gear are set, the state funding will be phased out after 2025. Swam has also proposed to encourage voluntary producer responsibility until 31 December 2024 in order to jointly prepare producers, relevant authorities and stakeholders. In 2019, Sweden has created a government-funded collection system for end-of-life fishing gear on land called Fiskereturen.se, which collected 120 tonnes of fishing gear in 2019. Sweden has previously financed a collection system for marine factions where all types of fishing gear and beach litter are taken care of and the idea is that these systems will be financed by the producers after 31 December 2024, but that the state is involved in supporting and helping in the construction.

DENMARK

In Denmark marine litter and lost fishing gear is considered to be an issue of relevance. In Denmark it is common for fishers to bring marine waste and any lost or end-of-life gear to the port for proper disposal. Various campaigns on positive practices on handling waste at sea for Danish fishers to reduce loss to the marine environment have been conducted.There is an ongoing cooperation between Danish fishers and ports to ensure better information on the marine litter landed in ports by Danish fishers i.e., get a better overview of the amounts of different kinds of waste and their recyclability. Plastix is a clean-tech manufacturer based in Denmark, that is working on developing good recycling options for fishing gear. Press here for a video about Plastix. Ports are expected to report on the amount in tonnage and possibly their likely source. Derelict fishing gear are being delivered in port and sent to recycling facilities, where possible. Ports are key collaborative partners responsible for handling of waste and ensuring possible reuse. On-going projects in Denmark are mapping areas with lost gear and how to possibly remove of these, and a project on biodegradable nets (CEFAS, 2017; NSAC, 2020).

Fig 10. Seal entangled in fishing gear (PI FROM ©Colin Edwards / Caters News)

FRANCE

In France, a study will be undertaken to make an inventory of waste management practices in all French ports. This project aims to identify good practices (such as, a 'clean port' approach, environmental management certification in ports, or awareness raising actions) or deficient waste management facilities, and to make recommendations. Furthermore, pilot operations will be conducted to test the implementation of waste management or recovery.
Local initiatives have already been identified, such as recovering and repairing nets from the Basque coast to be sent to Africa and elsewhere (in co-operation with countries including Senegal, Gabon and Haiti) or used for other applications (for example, to protect hives or vegetable gardens, or for use in manufacturing clothing or street furniture).
In France, a project called 'Pechpropre', is being undertaken to assess the feasibility and acceptability of implementing a voluntary agreement with the fishing sector. This 20-month project is being conducted by a national professional federation of artisanal fisheries (who represents about 80% of the French fishing sector), with the support of the French Ministry of Environment. Part of the Pechpropre project, is a survey about the knowledge of fishers regarding marine litter arising from the fishing industry and to increase awareness. Awareness kits will be also developed, including a best practice guide and flyers.
France is also investigating the barriers to implementing the FFL scheme as part of the Pechpropre project.
Project PECHPROPRE (Coopération Maritime), which ran from 2016 to 2018, and dealt with assessing, at a national scale, the quantity of used fishing gear (trawls and nets) thrown away annually. This project also identified local and national

recommendations to be implemented in a near future in order to establish a voluntary ERP aiming to improve collecting of used fishing gear, recycling and valorisation. Another project is TEFIBIO (Parc naturel marin des estuaires picards et de la mer d'Opale & FROM Nord), which started in 2020 and dealt with defining and prototyping a biodegradable, bio-sourced, recyclable and microplastic free fishing net (gillnet). Work has been ongoing with the fishing gear retailers in France to set up a voluntary ERP with an eco-organism piloting all the collection, transport, treatment, recycling and valorisation of used fishing gear (NSAC, 2020).

SPAIN

According to the Spanish Programme of Measures as part of the MSFD, the following measures will be implemented:
- Separating and sorting of waste on board vessels,
- Raising awareness with fishers,
- Promoting the installation of recycling points in harbours and providing harbours with facilities for selective collection of marine litter removed from the sea by the fishing fleet.
- Improvement of waste management in ports at a national level (development of a guide on waste management in state ports) and regional level (Waste Reception and Handling Plans for sound waste management in regional ports).
- Promoting projects to recycle fishing materials such as polystyrene boxes or fishing nets.

Spain has undertaken two projects where fishers have collected marine litter: One project is named 'Nothing thrown overboard' ambition is protecting and cleaning the seabed' from 2009 to 2010 and Sustainable fisheries in clean fishing grounds from 2012 to 2014. Under the MSFD, Spain is also expecting to develop a framework document to implement a coherent scheme of fishing for litter, to promote and finance fishing for litter activities, and to design and maintain a national database recording items collected from fishing for litter activities. Spain has produced an environmental awareness module to raise awareness and promote good practices in the fishing industry as well as providing a manual of good environmental practices for training people in the fishing industry.

- Installing waste containers in participating fishing vessels to collect waste generated on board.
- Installing recycling points in fishing and recreational navigation docks (for glass, paper, cardboard, batteries and domestic waste), which is now incorporated in Waste Reception and Handling Plans
- Research on potential markets for plastic waste from the fishing industry, which has considered the recovery of fishing nets and polystyrene boxes from the fishing sector (CEFAS, 2017; NSAC, 2020; MRAG, 2020; OSPAR, 2020).

Best practice in the end-of-life stage of fishing gear with two projects led by Spanish teams:
- OCEANETS: Technological approaches for circular economy solutions in terms of prevention, recover, re-use and recycle of fishing gear to obtain added-value products in the textile industry (http://oceanets.eu/).
- BLUENET PROJECT, creating new life for abandoned, lost or discarded fishing and aquaculture gear to prevent marine litter generation (https://www.bluenetproject.eu/).

GERMANY

The German Environmental Agency is supporting measures to contribute to the good environmental status. Thünen Institute for fisheries research develops together with the North Sea shrimp fisheries alternative designs that allow shrimp trawling without dolly ropes in the DRopS (Dolly Rope Suspension) project. The aim of the project is not to replace dolly ropes by other materials, but to add buoyancy through floats and alternative gear designs which lead to less seafloor contact, abrasion, collection of heavy sediment and rocky material, such that degradation of the netting is reduced without the need for cod end protection through dolly ropes.
WWF Germany developed an ecologically viable methodology for lost fishing net searches. Searching activities are conducted with sonar technology and retrieval is done with fishing and working vessels, to improve waste management for fishing gear retrieved from the Baltic Sea. WWF Germany is currently (2020) working on the political implementation in collaboration with the area of Mecklenburg-Vorpommern and with additional support from the Federal Environmental Agency (UBA) and the German Ministry for the Environment (BMU). In Germany, where a deposit refund scheme was applied for EPS fish box. The user (fishers, fish processor, retailer) had to pay a certain deposit for each EPS fish box (i.e., 0.5- 2 EUR). When returning the fish box to the fish box collecting point (i.e., in ports, at local fish markets, in retail) the deposit is paid back (Interwies et al., 2013). NABU coordinates the Fishing for Litter project in Germany, including ALDFG collected during regular fishing activities (usually small fragments) and all types of marine plastic litter. In a similar approach to the WWF project in order to enable end-of-life gear recycling, NABU has also started collection of end-of-life fishing gear, yet both organisations have not found a good solution for transport and regular recycling of the net materials characteristically used in the German coastal fishery. CuxTrawl is a net manufacturer producing PE netting for offshore trawlers. The company collaborates with Plastix in Denmark for PE and PP net and rope recycling (NSAC, 2020; OSPAR, 2020; WWF, 2020).

Fig 11. German fishing vessel (The Guardian, 2020)

5. Extended Producer Responsibility

5.1. Introduction extended producer responsibility scheme

This chapter focusses on if and what kind of Extended Producer Responsibility (EPR) scheme is interesting to apply for the fishing gear system. EPR is an environmental policy approach which aims to impact businesses and the markets to function more sustainably. The EPR scheme for fishing gear is of relevance, because of the Single Use Plastics (SUP) Directive (EU/2019/904) that is introduced by the EU. This so-called SUP introduces a set of ambitious measures to reduce plastic litter and increase collection and recycling, with a focus on preventing and reducing the impact of certain plastic products on the environment. Included within the Directive is the requirement for Member States to implement an EPR scheme for fishing gear and components of fishing gear containing plastic. Idea behind the EPR scheme for fishing gear is that the producers of the fishing gear containing plastic cover the cost for separate collection of waste fishing gear containing plastic and its subsequent transport and treatment. The producers shall also cover the costs of the awareness raising measures regarding fishing gear containing plastic. EU Member States are required to set up the EPR scheme for fishing gear by 31st December 2024.
Yet, there is a lot not known what an EPR scheme for fishing gear must look like to create the right incentives for the different parties in the fishing gear system to create a more circular system.

An EPR scheme is defined by the OECD as the producer's responsibility for reducing environmental impact and managing ‘their’ product across the whole lifecycle. Produces have responsibility for their products after the point of sale. From selection of materials and design through to its end-of-life stage, particularly for take-back, recycling and disposal. Producers have to accept more the total responsibility for the products they place on the market. Therefore, the idea is that EPR schemes form an incentive to design their products in such a manner that it minimalizes the environmental impacts throughout the product’s lifecycle. EPR like schemes has been applied for the first time been implemented in Europe in the early 90’s (Kunz, Mayers & Wassenhove, 2018), with the focus on packaging waste. EPR is considered as one of the important instruments to stimulate the implementation of policies to create more circular economies. Aim is to it create incentives for the important stakeholders of a product-system to change their behavior. Relevant stakeholders are generally: policymakers, retailers, users, local governments, waste-managers and recyclers. Furthermore, the idea is that the producer accepts the legal, physical and socio-economical responsibility for the environmental impact of the product that cannot be eliminated by a different design. Responsibility is extended to the post-user-phase of the product, this means in reality that the producer also has the responsibility about the collection of the products, sorting, treating and recycling. The ambition is that the producers experience and take responsibility and control over the full life of the products they put on the market. Producers have to design in such a manner that waste collection can be properly monitored, managed, collected, repaired or recycled (DG Mare, 2020, TAUW, 2018; OECD, 2020).

This raises a number of questions, such like is EPR-scheme suited to create a more circular system for fishing gear in the OSPAR-region? And how must the EPR scheme be designed so it creates the right incentives for the stakeholders to support the transition towards more circularity? In table 4 an overview is given of the different policy instruments that can be applied in an EPR scheme.

Table 4. Typologies of EPR policy instruments (Saki, 2011)

Typologies of instruments	Policy instruments
Administrative/ legal	- Landfill and incineration bans - Material restrictions - Eco-design requirements related to reuse/recycling, minimum recycled material content standards - Source separation/collection requirements - Waste prevention requirements Waste prevention targets Collection targets - Landfill/incineration diversion targets - Reuse targets - Recycling targets - Recovery targets
Administrative/economic	- Producer take back requirements
Economic/Market Based	- Deposit-refund systems - Producer responsibility - Taxes on virgin materials - Taxes on hazardous substances - Landfill and incineration taxes/charges - Waste disposal taxes/fees/charges - Recycling fees/charges - Product taxes/charges - Tradable recycling credits
Informative	- Information provision requirements, eco-labels

5.2. Characteristics of EPR-systems in general

The theoretical rationale behind an EPR scheme is that economic instruments, as an EPR scheme can stimulate gradual changes in the behaviour of users by allowing environmental costs (externalities), including costs of lost gear recovery and recycling, to be internalised by "polluters" through including costs of retrieval into the price of products or activities. This is an approach in line with the 'Polluter Pays principle', being an essential part of modern marine environmental laws (liability and compensation) and furthermore a legally binding principle of a law of the EU (Maitre-Ekern, 2018; Oosterhuis et al., 2014).
Based on the relevant price elasticity and taking into account the minimal EU requirements of EPR schemes, the costs will be distributed over the different segments in the production and value chain (Kunz et al., 2018). One of the aims when introducing an EPR scheme has often been to give producers an incentive to change product design in environmentally benign ways, for example by making it easier to reuse or recycle the products (Deloitte, 2018; OECD, 2020; TAUW, 2018).
As earlier stated, the policy-instrument EPR tries to internalize the external effects of a problem in the whole value-chain. This allows with a good design of the EPR scheme to share the responsibilities for the externalities of a product over the whole value-chain. General aims of an EPR scheme are:

- Eco-design:

Because producers become responsible for the waste-management of their product, it is suggested that they at the design stage integrate the recyclability and repairability of the product to a larger extent. Producers are made responsible for the reaching recycling and waste prevention targets.

- Polluter pays principle:

Because producers need to bear the costs for collection and further waste management. By integrating the costs for proper waste-management on the price of a product, it is made ensured that the polluter pays.

- Producer Responsibility Organisation:

A vital role in most EPR is there for Producer Responsibility Organisation (PRO). PRO's are collective entities set up by producers or through legislation. The PRO becomes responsible for meeting the recovery and recycling obligations of the individual producers. Even though EPR is in theory, an individual obligation, in practice producers and manufacturers often exert this responsibility collectively. A Producer Responsibility Organisation (PRO) is set up to implement the EPR principle on behalf of all the adhering companies (the obligated industry). PROs exert predominantly three main functions:

1. Financing the collection and treatment of the product at the end of its life (targeted waste stream) by collecting fees and redistributing the corresponding financial amounts.

2. Managing the corresponding data.

3. Organising and/or supervising these activities.

Fig 12. Collected end-of-life fishing gear (NOFIR, 2017)

5.3. EPR and the fishing gear system

For the fishing gear system, the idea is that an EPR scheme can create the right incentive for the producers to start a transition towards a more circular (management) system. Via internalising the externalities of fishing gear like the gear becoming marine litter, proper collection and recycling in the system of fishing gear/fishing industry system. It can notably contribute to easing cost burdens for small scale ports and/or fishing operators by ensuring that some or all of the costs linked to increased collection and treatment of litter from fishing gear in ports, and treatment beyond the framework of the PRF Directive, is taken over by the producers of fishing gear. One of the benefits of this policy option is also shown in the fact that it "shifts consumption away from harmful products". In the case of fishing gear, it therefore can reduce the use and abandonment of plastic components of fishing gear that are designed in such a way that they might break apart during their use, e.g., plastic dolly rope, and polystyrene floats and buoys not sealed in a protective cover. This could be achieved, with an outright ban on sale and use of such items, or through an environmental tax (or fee) that will make alternative products, therefore products with less environmental impact, cost competitive. In the case of EPR scheme, an additional fee could potentially be used to pay for, for example, improved waste management services, sorting and cleaning, recycling, education and awareness, R&D and collection or retrieval operations. In this way, it could also act as an (in)direct incentive to prevent the discarding of used fishing gear (Eunomia, 2016; Eunomia, 2020; Sherrington, Darrah, Hann, Cole & Corbin, 2016). See table 5 for an overview of the different problem-drivers in the fishing gear system, and the suggested policy options to address these problem drivers.

What should be noted is that recycling is both in the circular economy approach as for an EPR is considered as one of the last resorts, to stimulate the circularity of the system. Focus must be on repair and re-use before moving towards recycling as the option.
The aim is that the right incentives are created throughout the value-chain. The idea is that the producers want to make the financial consequences of their products like collection, waste-management and recycling as small as possible. So that the costs of managing discarded plastic fishing gear, once it has arrived on shore, is borne by the producers and importers of plastic fishing gear parts and not by other parties e.g., ports.

Various instruments can be applied in an EPR scheme to reach more circularity of the system, these are interesting to discover. For example, different ownership systems like a product as a service. So, fishers are buying the opportunity to fish and not the gear itself. In EPR schemes a duty can be imposed on the producers to recycle a minimum percentage of the plastic fishing gear and with this improve the circularity of the system. In the end the ambition of a good functioning EPR scheme is that all the parties in the system have their own responsibility and have the right incentive to act upon this. Therefore, it is of importance that all the different partners in the life-chain of fishing gear are represented in the design of an EPR scheme for fishing gear. Deposit return schemes (DRS) are mentioned in the table. DRS provide a small refund to consumers when a plastic item is returned to an authorized collection point (Deloitte, 2018; TAUW, 2018)

Table 5. Policy options to tackle problem drivers in fishing gear system (Retrieved and adjusted from: Deloitte, 2018)

Problem drivers	Policy option
Low efficiency and effectiveness of schemes to prevent retrieved gear and end-of-life gear to re-enter the water	• EPR without/with DRS • Collection target setting
Lack of storage space on ship	• EPR without/with deposit scheme • Waste-collection target setting
Gear conflict, adverse weather, vandalism/theft etc.	• Alternative product design
No incentive for fishers to find/pick up ALDFG themselves.	• EPR with deposit scheme • Alternative product design
Fishers are not able to identify location where they lost gear.	• Alternative product design
Disincentive for fishing gear manufacturers to produce less environmental harm material.	• Collection target setting • Alternative product design
Sporadic reporting and recording of lost gear (and no standardized monitoring method).	• EPR with DRS • Waste-collection target setting
Limited efficiency of operations to recover lost gear.	• EPR without/with DRS
Widespread distribution and long lifetime in water of the fishing-gear.	• Alternative product design
Lack of knowledge of hotspots and snagging sites, sustainable handling of gear, retrieval.	• EPR without/with DRS
High cost of port waste management.	• EPR with DRS • Waste-collection target setting
Inefficient waste management systems at ports.	• EPR without/with DRS • Waste-collection target setting
Manufacturers do not focus on using recyclable products (material is hard to recycle).	• Alternative product design • Waste-collection target setting
ALDFG is not accepted by recycling company (not cleaned/sorted).	• Alternative product design • Waste-collection target setting

What needs to be considered is the effectivity, and especially the costs-effectivity of an EPR scheme for fishing gear are questionable. In comparison with already existing EPR schemes, the EPR scheme for fishing gear addresses a relatively small amounts of materials. The costs of organizing the EPR scheme, having a good repair and collection system and recycling need to be financed then with a disproportional low amount of material. This is a challenging issue for the EPR fishing-gear and is something that needs further research. Maybe, this issue also appears for other products that are addressed with the SUP-guideline. Further research about this can create new insights about how to do this effectively for the addressed products.

The roles and responsibility of the different parties in the value-chain

It can be only be made sure what the different roles and responsibilities are for the different stakeholders in the fishing gear at the moment a choice has been made what the exact design will be for the EPR for fishing gear. Yet, a general overview is presented based and adjusted on a report by TAUW (2018) about a potential EPR for fishing gear in the Netherlands.
The 'general' roles for the different stakeholders within an EPR scheme for fishing gear are shown in table 6.
Important is the need for harmonization, or standards that contribute to a level-playing field in the fishing gear system in the OSPAR-region. A level playing field promotes the long-term involvement of important stakeholders. The Longman Dictionary of Contemporary English (1995 edition) provides the following definition of a 'level playing field':

"A situation in which different companies, countries etc. can all compete fairly with each other because no one has special advantages."

Table 6. Different roles and responsibilities for EPR within the OSPAR fishing gear system (Adjusted from TAUW, 2018)

Actor	Role/Responsibility
International governments	- Develop International/European Guidelines - Contribute to a level playing field - Design international monitoring schemes - Provide capacity to control the system - Develop standards for the design of the gear as well as the monitoring
National government	- Translating International/ European Guidelines to national legislation. - Designing supportive policies. - Preventing an unequal level playing field. - Coordinating the design and developing-stage of the EPR-system, by bringing different parties together, potentially subsidies. - Negotiating when there are conflicting interests. - Developing standards and making appointments about monitoring. - Providing the capacity to control the system.
Producers and importers	- Creating sustainability plans and appointments about the design stage for fishing gear (Repairability, recyclability, and the use alternative materials). - Selecting the right model and economic instruments for design of an EPR scheme - Creating the right monitoring systems, to provide data about the targets that are being reached and the flow within the fishing gear system.
Producer organisation Fisheries	- Taking care of the practicability for the fishing industry, enhancing the legitimacy of the system in the sector. - Enhancing the consciousness throughout the fishing industry to support the circularity and sustainability of the system.
Fisheries harbours & Municipalities	- Design of suited collection system, creating the appropriates facilities that promote the collection of fishing gear.
Collectors & Recyclers	- Design of a collection-system and a suited logistics model. - Taking care of enough and high-quality recycling capacity. - Selecting the suited recycling method.

5.4. Optional EPR-schemes for the fishing gear system

In the Deloitte (2018) report about fishing gear the following options for an EPR scheme were addressed and assessed as possibilities.
-) EPR scheme without Deposit return scheme (DRS) funding by manufacturers
-) EPR scheme without DRS, with retrieval options
-) EPR scheme without DRS (situation with retrieval – funding by manufacturers)
-) Target setting

Options for EPR scheme

- Extended producer responsibility scheme without a deposit scheme.

In this option, a fee will be added to the fishing gear meaning that the price of the fishing gear increases, which could be used for improved services to collect fishing gear at fishing ports. The rationale behind this option is that providing better services (minimising the threshold to deliver used gear into ports) could provide an additional incentive to fishers to deliver more

waste from fishing gear back into ports. Other examples of activities paid for by such a fee could be awareness courses and education (see also the requirements mentioned in the proposed amendments for the Waste Management Directive 2008/98/EC described below) or harmonised reporting with a central database to facilitate identification of hotspots and snagging sites. The fee could be added to the price of fishing gear by manufacturers. An alternative or additional option could be a fee paid for by fishers that could be levied as a certain percentage of the auction price of fish. The principle is the same: fishers pay an additional fee on their gear. In this policy option, we take into account the minimum requirements of MARPOL Annex V, the Port Reception Facilities (PRF) Directive, and the Control Regulation for the Common Fisheries Policy (CFP), which are all part of the baseline for this study. The proposal for the new amendments to the Waste Management Directive 2008/98/EC (which are adopted during the spring of 2018) specifically describes minimum requirements for EPR scheme and is relevant to this policy option (European Commission, 2018; Sherrington et al., 2016):
With regard to the costs, these are clearly defined to cover the costs of separate collection and all subsequent treatment of waste. The minimum requirements do not specifically include costs of clean-up of litter or costs of the management of residual waste in the mixed bag (i.e., not collected separately), but can ask the EPR scheme to cover these costs. Minimum requirements do however ask the EPR scheme to cover the costs linked to providing information to consumers on waste prevention and better waste management.
Important requirement to modulate EPR fees is linked to different criteria: durability, reparability, reusability and recyclability and the presence of hazardous substances. There is no direct link to considering the aspects that the products are prone to littering. Another minimum requirement that could have an impact is that EPR schemes have to have a clearly defined geographical, product and material coverage without limiting those areas to those where the collection and management of waste are the most profitable. And a requirement that EPR schemes provide an appropriate availability of waste collection systems.

- Extended producer responsibility scheme without deposit scheme, with retrieval options ghost gear.

This policy option is the same as the one described above but now includes retrieval operations as part of the ERP (i.e., beach clean-ups, Fishing for Litter). The rationale behind this policy instrument is that paying for retrieval operations would also make fishers more aware of the effect of not delivering used fishing gear back to ports and the importance of doing so. A consideration to take into account when implementing such a scheme is that not all litter collected during retrieval operations is related to (current) fisheries operations or of fisheries occurring near the location of retrieval (fishing net lost in Belgian waters may end up on a Dutch beach). As not all litter collected during clean-ups is related to fisheries, only the percentage related to fisheries should potentially be paid for by the fisheries sector. As fisheries related litter collected at beaches or retrieved at sea may not originate from that particular area, a European wide fee system (including a governing body) and fund should distribute money to pay for the collective costs of clean-up and retrieval operations.

- Extended producer responsibility scheme with a deposit scheme.

This policy is almost similar to the one described before, but this option includes a deposit scheme. The rationale behind a deposit scheme is that it intends to provide an incentive for fishers and fishing companies to return used fishing gear in order to receive back the deposit. This will form an incentive to return more gear then is happening currently.
Obviously, the deposit-refund scheme could be applied also to whole nets, not just its components, particularly if the objective of the return system is to discourage illegal or improper disposal of fishing gear. Reference should be made to the fact that the deposit refund system is in fact best suited for products whose disposal is difficult to monitor and potentially harmful to the environment.
The rationale behind this approach is as follows: If used nets are lost (or discarded) at sea, a new fishing-net would be more expensive to buy as there is a deposit in place. Fishers will then pay for the ecological damage to the ecosystem services of the sea caused by losing their nets. Nets are generally speaking, already an expensive item for fishers to purchase, hence they already pay attention not to lose, or even less, voluntarily discard their nets. In line with this Gilman et al., (2016) stated, that the best economic instrument to reduce cases of abandoned, lost or otherwise discarded gear is to create a mandatory deposit on new gear, which is returned when unwanted gear is delivered to an appropriate port facility reception, and not, for example, the granting of subsidies to fishers regarding the replacement of their nets (Deloitte, 2018; Eunomia, 2020).

A deposit scheme in place on top of an EPR scheme, there will be extra costs for the individual fisher or fishing company to buy fishing gear. However, the deposit is regained when the used gear is returned. This may well provide an incentive to fishers to return to port all of their own gear but also any gear found and retrieved out at sea. Nevertheless, operating a deposit-refund scheme will also bring extra costs of managing the system. Port facilities have to be adequately equipped to

receive returned fishing gear and administratively manage such a scheme. For such a scheme to be implemented, a governing body should be in place to organise retrieval and transport and pay the fishers the deposit on returning the gear, either directly or through a port facility where fishers can deliver their used fishing gear and receive the deposit on the gear back.
Difficulty is that fishing gear usually consists of several or many different parts (i.e., bottom trawling or pelagic gear, ropes attached to lobster cages, etc.). Fishing nets can also be bought, subsequently sold, combined with different gear and updated/repaired extensively throughout the product life. Therefore, fishing gear may consist of parts with and without a deposit. As a result, it would be almost impossible to return exactly the same product for a deposit refund or extended producer responsibility scheme. An addressed solution to this could be to set the refund amount somewhat lower than the deposit amount. Another solution could be a requirement to return an equal volume or weight of fishing nets instead in order to achieve the intended effect (Sherrington et al., 2016).
Another issue to consider, fishing gear is subject to substantial wear and tear plus often parts of the gear are lost at sea. This raises the question if parts of the fishing gear are still eligible for a deposit?
Therefore, it is essential to decide in an EPR scheme with a deposit scheme how to deal with this. In the study of Deloitte (2018) another issue was addressed about an optimum deposit level being a challenge. First, different sectors display a large variety of refund levels. Secondly, scientific articles on deposit schemes do not provide a method for an optimal level which can be applied in relation to fishing gear. Thirdly, the practicalities mentioned earlier, in combination with the chance that used fishing gear may only be brought back to port in the case that the deposit is higher than the costs saved by abandoning fishing gear at sea, may make it a challenge to decide on an optimal refund level.

Fig 13. Collected end-of-life fishing gear (Recycling today, 2019)

- Target setting

Recycling of fishing nets contributes to the concept of circular economy. Another option for the EPR scheme for fishing gear is a recycling target. However, making more fishers aware and dedicated to bringing end-of-life fishing gear back to port is required.
When setting a recycling target for fishing gear, the following considerations should be taken into account:
The incentive by recyclers to pay (a higher value) for the (sorted and cleaned) waste from fishing gear may in some cases be minimal. Waste from fishing gear is usually a small portion of the total waste that is offered to recyclers. It is not expected that specialised facilities for the recycling of fishing gear waste will start operations in the near future, as fishing gear waste consists of many different and unsorted materials which make it difficult to recycle and the economic value of most fishing

gear waste is zero or negative. The consequence is that waste will need to be transported to recycling facilities which are not located closely to most ports and hence considerable transportation costs could be in place.
Using target setting as a single option, one must be aware that it entails no (financial) incentive for fishers to bring ashore more used fishing gear. Furthermore, in order to make a recycling rate target work for fishers, ports should offer a very practical and low threshold system of waste collection to fishers. This allows easy collection of waste with a minimum effort for the fishers.
Furthermore, next to a recycling target, a collection target could also be a policy option to consider with the aim of reducing ALDFG. A target would be set for fishing vessels or fishing harbours for the amount of used fishing gear to be delivered to ports based on an assumption on what could be expected to be delivered to ports on an annual basis. Such a target could then act as a benchmark to compare the actual amount of used fishing gear brought back to port on an annual basis and to create action plans to improve the situation. The study of Deloitte (2018) looked into the potential of implementing such a policy option. What became clear is that in practice it is quite a challenge to implement this option effectively and with the support of involved stakeholders. Reasons mentioned were that the practicalities involved with keeping detailed track of new and used fishing gear for each vessel is (too) complicated. Secondly, it would be very hard to prove what has happened to fishing gear at sea based on the amount of used fishing gear taken back to ports. Thirdly, there is other European legislation in place which targets and monitors fishing gear waste under the revised PRF (Deloitte, 2018; TAUW, 2018).

5.5 Extended producer responsibility scheme for fishing gear examples Norway and Iceland

Two kind of EPR schemes already exist in Europe for the collection and recycling of fishing gear. One is running in Iceland and one originated in Norway and now covers various European countries. These schemes are similar to extended producer responsibility but have not been developed in a way most EPR schemes did (Eunomia, 2020).
Given the value of secondary materials obtained from end-of-life fishing gear, these schemes do not charge producer contributions for quantities placed on the market like applied EPR schemes in other sectors. Primarily, schemes for fishing gear operate in the countries with the largest fisheries production. This is the case, because these countries produce the highest amount of gear which makes the set-up of management for the product financially the most interesting (European Commission, 2016). The scheme in Iceland is managed by the Federation of Icelandic Fishing Vessel Owners and Fish Processing Plants (SFS). Norsk Fiskeriretur AS (Nofir AS) was established in Norway in 2008 and has since expanded to collect fishing gear from other countries in Europe – including the Netherlands, Scotland and Greece (Eunomia, 2020).

Due to the value of fishing gear at end-of-life, the schemes do not charge producers a fee for gear placed on the market. The schemes are generally being financed by the revenue generated from recycling. The cost of logistics in Iceland and Norway is covered by the fishing vessel owners with vessel staff responsible for cleaning and sorting gear and vessel owners covering the cost of transport to a preprocessor – although in some instance's reception facilities are provided in ports. As such, there is no fee modulation in the schemes as presently run. In the case of Iceland, if the recycling targets are not met the scheme may be legislated under an advanced disposal fee in the future. At this point, the scheme looks at modulating fees for gear. It is possible that design for recycling, and inclusion of recycled content is embedded in future of modular design. Polyamide (nylon) is well recycled and makes up much of the fishing gear. This creates an inherent incentive to the material for good management, so little fee modulation is required (Eunomia, 2020).

Norway

In Norway, NoFir (Norwegian fishery recycling) established a project in 2008 to collect and recycle discarded fishing gear in Norway. The project has tremendously expanded since the establishment (Jakobsen & Nystad, 2010), starting from Norway, the scheme now collects and recycles discarded equipment from fishing and aquaculture around Europe and in Turkey. Collected material is transported to facilities in Lithuania or Turkey where it undergoes dismantling and preparation for recycling. The prepared materials are then recycled in European or Asian facilities, depending on the material type. E.g., Aquafil facilities in Slovenia process nylon collected from fishing nets (Eunomia, 2020). The secondary material, Econyl, is incorporated into new products such as clothes, furniture and carpets. Nets must be washed and disinfected before collection and other types of gear can be collected as they are. The fractions containing nylon or metals have a positive market value, with nylon making up the majority of gear collected. NoFir have regional collection facilities established in Norway and fishermen or ports can also request collections of gear via the NoFir website once they have amassed a certain quantity.
Following initial operations in Norway, NoFir received EU funding (€680k) under the Ecolinovation Programme to expand its operations into other Member States, this expansion has been done as part of the project EUfir (Eunomia, 2020). Expanding the project was challenging due to the lower tonnages of waste fishing gear generated in other countries and the greater transport costs involved. Norway's large fishing industry had meant that a large quantity of waste was being generated in a relatively small area, resulting in low transport and collection costs relative to yields. The fishing and aquaculture industry is more widely distributed elsewhere in the EU, making the costs higher per tonne of fishing gear collected. Net dismantling facilities were established in Turkey to manage Mediterranean nets and save transportation costs both financially as environmental costs in the form of emissions. Additionally, NoFir improved collection efficiency by pooling small quantities of nets from different customers in the same country. However, it is worth recognising that the scale of the fishing industry in Norway (where the scheme started), and Iceland (where another collection/recycling system run) is considerably greater than in other EU countries. As such, efficient set up in terms of logistics is required for the scheme in other countries to obtain the value inherent in the material.
Second challenge with the scheme's expansion was increased competition from alternative disposal routes in other countries. In some countries, the alternative disposal route (i.e., landfill) was cheaper than in Norway where landfill costs (for fishing gear) are in the region of 280 €/t, and hence there is a strong economic incentive for fisheries in Norway to dispose of their waste gear through the programme as it presents a saving relative to the status quo (Deloitte, 2018). Elsewhere, if landfill is a similar cost and as convenient or more convenient as disposal through NoFir then there may be less of an incentive for fishing vessels to use the scheme for disposal (Eunomia, 2020).

Structure Fee-system

In contrast to EPR schemes in other sectors, NoFir is not funded by producer fees. Instead, it operates more as a collection and recycling system – obtaining funding from the material revenue of recycling fishing gear and having received EU funding to invest in expansion. All fishing gear, whether profitable or not profitable to recycle, is accepted by NoFir and the organisation reports receiving increasing quantities of material from small suppliers who would otherwise have difficulty of disposing the waste correctly. NoFir can offer considerable savings to such operators as a large 20 tonnes net would usually cost around €5,600 to landfill and another €1,400 to transport. By contrast, these materials are collected for free by NoFir. As such, no fee is paid by fishermen at the point of collection, this creates an incentive to deliver to the scheme as the alternative disposal routes generally charge a fee for disposal. In some cases, NoFir may pay to collect material depending on both the quality and the transport distance required. Nylon is the most valuable material and hence fishermen may receive a payment for this.
The project was operating as a profit (€430,000 before tax in 2014), it is reliant on access to cheaper labour in the countries of Lithuania and Turkey for reprocessing the collected materials. What likely happened is that the profits have reduced slightly since 2014. Reasoning behind this are the financial investments following expansion to cover a greater number of countries, largely subsidised by revenue from the Norwegian scheme (Eunomia, 2020). Scheme performance EuFir collected 910 tonnes of fishing gear over the three years of the eco-innovation project. The material was collected from Iceland, Scotland, Ireland, Denmark and the Netherlands (collections of material from Norway partly subsidies Nofir's activities in these countries). During the project, Nofir collected 501 tonnes from Iceland, 340 tonnes from Scotland, fourteen tonnes from Ireland, twenty-two tonnes from Denmark and 33 tonnes from the Netherlands.

A life-cycle-analysis report of Nofir about fishing gear collection looked at the impacts of the EuFir programme, based on the average output composition of 76% PA6 (nylon), 13% PP, 9% HDPE, 2% lead and 1% steel. The report found that per kilogram output material the scheme resulted in an average 0.8kg decrease in waste material compared to landfill, to incineration, or discarded at sea. There was a 3.6kg emission of CO2 (per output kilogram) decrease in overall carbon footprint based on virgin production of gear compared to the total EuFir system (Eunomia, 2020; NoFir, 2015).

Fig 14. Fishing vessel in the area of Norway (MyNewsdesk, 2020)

NoFir continues to expand beyond Norway. In 2017 a partnership with DIOPAS AS in Greece was developed (Nofir, 2017). The collections starting in Malta in 2016. In Malta, fishermen were having difficulties with disposing end-of-life nets with limited options for storage of the nets and with landfills often refusing to take this kind of waste due to difficulties of entanglement with their machinery (Independent, 2016). Establishment of a collection system through NoFir may have prevented disposal of these nets at sea. In upcoming times, NoFir looks to continue expansion of geographical scope with the organisation looking at expansion to other countries with strong fishing industries like Vietnam, Canada and the Seychelles. Nevertheless, quantities collected by NoFir are however still hugely made up of material from the Norwegian fishing fleet (Eunomia, 2020; Olsen, 2018).

Iceland

In Iceland, the fishing industry is economically an a really important sector to the country. With the fishing industry representing 30-35% of the GDP and with Iceland's catch making up a significant proportion of the total for the European Economic Area being 17% (Sverrisson, 2015). In Iceland, fishing gear is included in the legislation for an advanced disposal fee under the Icelandic Recycling Fund. An advanced disposal fee is a charge applied at the point of import of material, based on tariff codes, to cover the cost of end-of-life treatment. Whilst legislated, this system is not currently employed as the Federation of Icelandic Fishing Vessel Owners and Fish Processing Plants (SFS) manages fishing gear waste instead of an advanced disposal fee. SFS have been responsible for the operation of collection stations for fishing gear since an agreement in 2006, with fishing nets exempted from the recycling fee and a collection scheme starting in 2007 (Fisheries Iceland, 2017). The government is satisfied with this system but could require fishing gear to be covered by the advanced disposal fee in future if the scheme's performance declines. SFS gains from taking responsibility for this waste management as they can

operate the system at a lower cost than via the government's advanced disposal fee when fishing gear reaches end-of-life and needs to be recycled, vessel crews undertake the process of cleaning and separating the materials.
Once prepared, the material is transported to a collection center in Iceland with the transport cost paid for by the vessel owner. Alternatively, for small vessel owners using major harbours some collection containers are provided where material can be deposited free of charge. The average cost to vessel owners is around 85-110 €/t of fishing gear which is similar to the price of disposal through landfill but with the benefit of an organised waste management system, environmental credentials for the fishing and aquaculture industry and recycling. The cost to vessel owners varies based on transport distance required. In addition, there is a time cost for the cleaning and sorting required from vessel crews. However, it is worth remembering that it is in the interests of the fishing industry to recycle gear and meet the targets set as the operation of the scheme is currently cheaper than it would be under an advanced disposal fee. Most of the waste collected is transported to Denmark to be processed. There is an open market for recycling companies to compete for the material. However, at the moment the Danish firm Plastix receives most of the material exported (Eunomia, 2020). This is then recycled or transported onwards to other recyclers. Estimation of the cost of shipping the gear from Iceland to Denmark (+-95€/t) is paid by the receiving recycler and no gate fee is charged.

The functioning of the Icelandic system for fishing gear does not use producer fees for quantities of gear placed on the market. The industry association is responsible for providing the collection and recycling of fishing gear, the cost of which is covered from the recycling revenue and from transport charges to fishing vessels. In addition, fees are not charged to fishing vessel owners beyond the cost of transport of material which tends to be cheaper than disposal through landfill. In the instance that the industry fails to achieve recycling targets in future, advanced disposal fees would be applied to fishing gear in Iceland. However, at present there is no producer fee and hence no fee modulation within the Icelandic system.
Scheme Performance Targets have been in place for recycling of nets. These were set at 45% for 2006, 50% for 2007 and 60% for 2008. SFS reports back annually to the IRF on the results of the recycling programme. Performance of the scheme is based on estimated quantity of material placed on the market combined with an understanding of the lifespan of different types of fishing gear. This understanding has been developed through undertaking research on the Icelandic fishing industry, and the lifespan of gear types used. As a general rule, it is estimated that one kilogram of fishing gear is used per tonne of fish caught and as such the amount used per year is around 1300 tonnes in Iceland (Sverisson, 2015) In comparison with export figures of +- 1000 tonnes per year to Denmark for recycling this yields an approximate recycling rate of +-74% - exceeding the targets set for the scheme. A small amount of material is collected which cannot be recycled, which includes tyres used for bottom trawling nets. These are instead landfilled within Iceland. Fisheries Iceland state that during the period 2006-2016, 96% of collected material was recycled, as such, the vast majority of material collected is recyclable (Fisheries Iceland, 2017).
Combined materials such as PE or PP with steel can cause a problem for recycling as these are difficult to separate. In addition, new stronger polymers used in fishing ropes such as Dyneema® can be a challenge at the end-of-life stage. However not much is known about this at the moment, and more research about this is needed. Dyneema® is an ultra-high molecular weight polyethylene which cannot easily be cut, enhancing durability of the gear and limits its recyclability.
One of the factors in ensuring the success of the scheme is the potential for Iceland to legislate fishing gear under the advanced disposal fee if the scheme performance is unsatisfactory. As this would be more expensive for the industry, it is in their interest to ensure that the recycling targets are met and that fishermen deliver material to the scheme. Further, participation in the scheme is being used by some producers as a marketing point, highlighting their sustainable use of fishing gear (Eunomia, 2020).

Fig 15. Fishing vessels in an Icelandic harbour (IcelandMag, 2017)

6. Survey, Extended Producer Responsibility scheme for fishing gear

Set-up of the survey

In this section the outcomes of the conducted survey about the EPR scheme for fishing gear are being described and discussed. The survey has been filled in by eleven respondents from eight different countries. The majority of the respondents work for governments (8 from the 11). Other respondents include representatives from a consultancy company, shellfish farming representative and the fishing industry. On request of some of the respondent's outcomes of the survey are shown in an anonymized manner. Due to the number of respondents being eleven, the outcomes are not suited for statistical interpretations. Therefore, all outcomes are interpreted qualitatively (Kumar, 2018). Quotes from the open answers in the survey have been used to integrate and illustrate the visions of the respondents in the upcoming chapter.

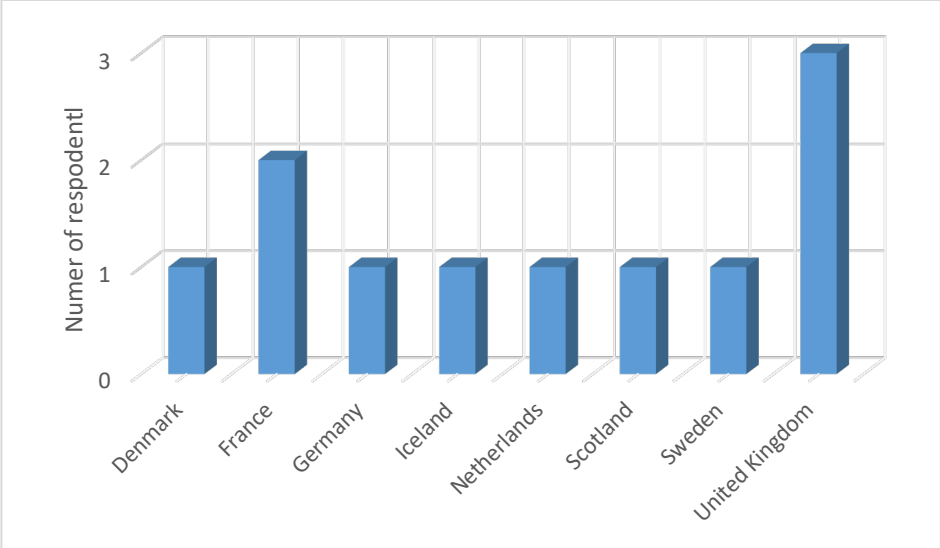


Fig 16. Country of origin of the respondents

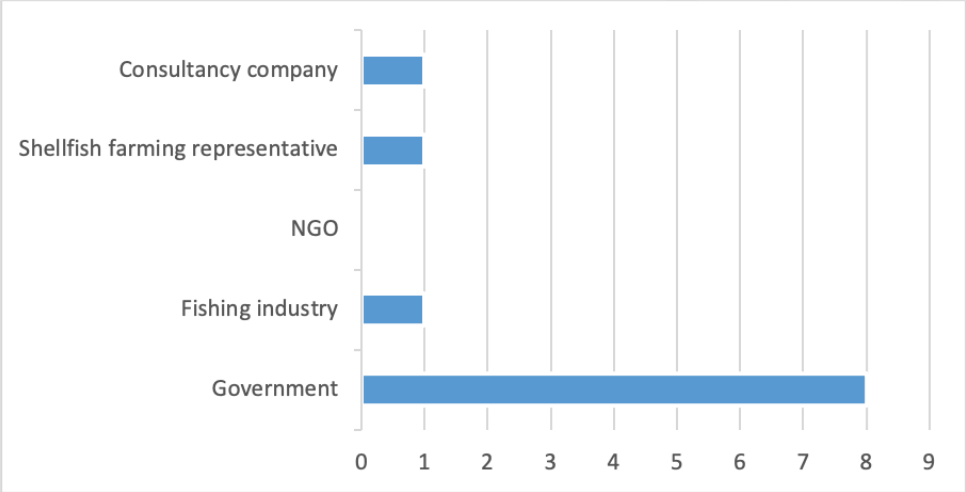
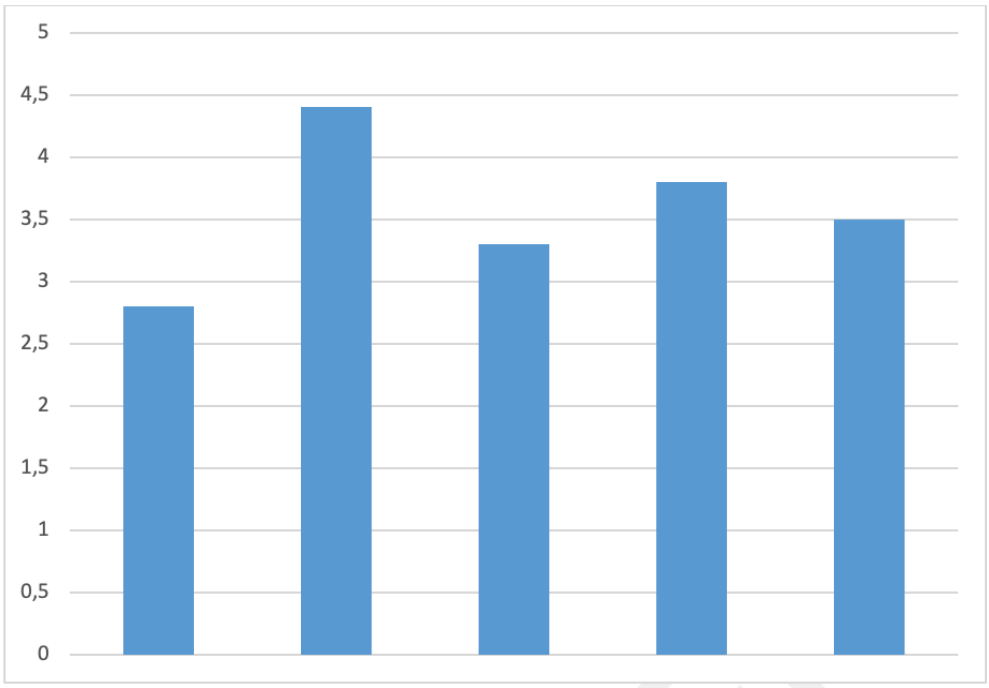


Fig 17. Professional background of the respondents

General questions about the extended producer responsibility scheme for fishing gear

-Which requirements for a good EPR scheme do you deem most important?
(Rank them: 5 most important)

1. Low administrative burdens
2. The right financial incentives
3. Ambitious collection target
4. Accurate monitoring and reporting scheme
5. Voluntary actions by producers / fisheries sector / other parties involved



Average score: **1:** 2.8. **2:** 4.4. **3:** 3.3 **4:** 3.8 **5:** 3.5

Fig 18. Requirements for a good EPR for fishing gear

The responses on the question: which requirements for a good EPR scheme do you deem most important? Showed that the option of the right financial incentives is considered the most important by the respondents with an average score of 4.4. The option accurate monitoring is considered the second most important option out of the five choices with an average score of 3.8. Ambitious collection target, accurate monitoring and reporting scheme and voluntary actions by producers/ fisheries sector/ other parties involved are in a relatively close range from on and other being 0.5. The most depicted option is the right financial incentives and the least preferred is the option of low administrative burdens to move to a more circular system for fishing gear.
All in all, the option of right financial incentives scored the highest and is therefore considered as the most preferred requirement to stimulate more circular and sustainable behaviour in the value chain of fishing gear. Taking these two into consideration in the development of the EPR scheme is therefore relevant. How to develop the intelligent financial incentives to come to a more circular fishing gear system needs more research.

-Which financial instruments are interesting to apply in the EPR scheme for fishing gear, to stimulate the enthusiasm and responsibility for all the parties in the fishing gear system to contribute?

1. Extra deposit-fee
2. Fee differentiation between types of fishing gear (e.g., different fee for types of fishing gear with a lower environmental impact)
3. No financial instruments, a voluntary basis (Iceland model)
4. Different system of ownership (product as a service)

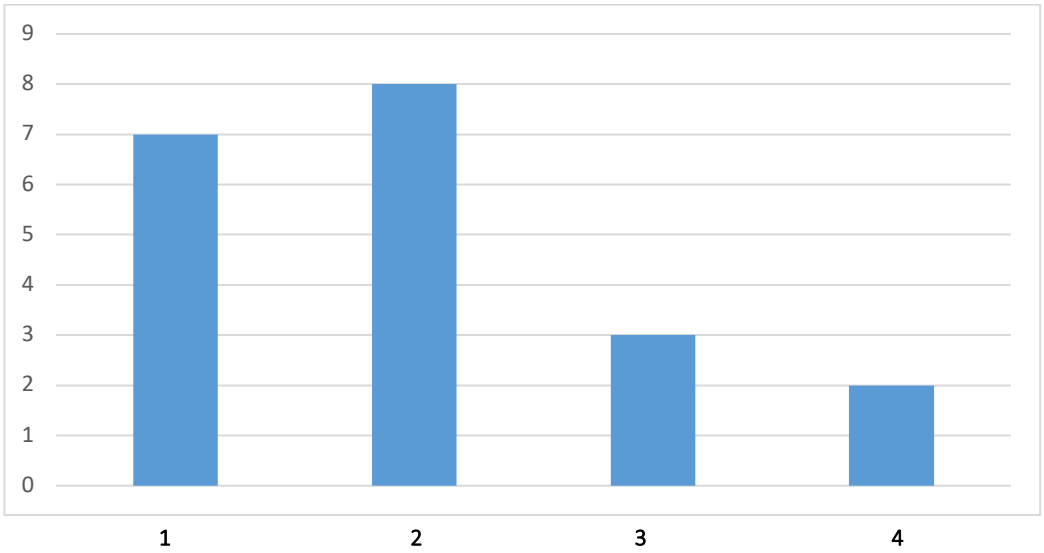


Fig 19. Interesting financial instruments to apply for an EPR scheme for fishing gear

On the question: which financial instruments are interesting to apply in the EPR scheme for fishing gear, to stimulate the enthusiasm and responsibility for all the parties in the fishing gear system to contribute?
The two financial instruments that are the most depicted by the respondents for the EPR scheme for fishing gear are the extra-deposit fee (depicted seven times) and a fee differentiation between the different types of gear (depicted eight times). There is a favour of creating an EPR scheme that works with deposit fees. Differentiation between different types of fishing gear is considered by eight respondents to be an interesting option. The option of going for a more voluntary based model is depicted three times and a different system of ownership is depicted two times.
To sum up, working with financial fees is the most preferred of the respondents. The two options that are about a different set-up of the system being the option of no financial instrument and an EPR scheme on a voluntary basis or a different system of ownership are least preferred by the respondents.

6.1. Analysis for the design of an EPR scheme for fishing gear (per phase)

In this part the outcomes of the survey are categorized per stage in the life cycle of fishing gear. Each stage of the lifecycle has different opportunities and challenges, and therefore requires different measures to improve the circularity of the system via an EPR scheme. On the basis of the themes that have been frequently mentioned by the respondents on the open questions in survey the different phases of the fishing gear system are described. Behind each theme can be seen how often it has been mentioned in the answers of the respondents. Briefly explain how the themes are counted, when in one answer a theme is used a couple of times it is counted as one. Quotes from the open answers are shown to illustrate vision of the experts on the different themes.

6.1.1. Design & Production stage

In this section, the outcomes of the survey that are relevant for the production and design stage of the fishing gear system are summed up. The design and production stage of the fishing gear system is an important stage to create a more circular and sustainable fishing gear system. Because in this stage upstream-adaptation can be made to prevent complex problem solving later on in the value-chain as much as possible. This is in line with the responses of the experts on the open questions

of the survey who mentioned frequently that design is an important stage to intervene in the fishing gear system to come to a more circular and sustainable system for fishing gear. The most frequently mentioned themes by the respondents are illustrated with quotes that the respondents provided on the open questions in the survey. A SWOT analysis for the set-up of the EPR scheme for the design and production stage is presented (table 7).

> *'The design is essential for a circular system whether it is reuse or recycling. This is not special for fishing gear....'*

Theme: monitoring and transparency (mentioned 9 times)

One of the most frequent responses in the survey was that the need for a better understanding of the fishing industry, and the fishing gear system. Moreover, the lack of monitoring at this moment in time creates a lack of understanding for the involved parties about how much gear is being produced, used, lost and is collected in the end-of-life stage.

> *'First step instigates a transboundary monitoring system of fishing equipment. Via mandatory marking at the production stage, a reporting system when a piece of equipment is lost.'*

More information about the amounts of fishing gear that are being produced, used and disposed is fundamental in order to create the appropriate design for an EPR scheme for fishing gear. This is in line with the request that has recurrently been made about more transparency in the fishing industry and the fishing gear system.

> *'Transparency on the manufacturing processes'*

> *'We are undertaking a value chain study at the moment to better understand our fishing and aquaculture gear markets. In addition, we are doing inventory work for this gear and collecting information on current disposal routes. We cannot clearly identify which is the best route for intervention without that information first.'*

For the monitoring a good function system where the amounts of gear that are produced, bought, used, lost, collected in the end-of-life stage and recycled is important. In such a system cooperation of the stakeholders cooperate needs to be ensured. Cooperation throughout the fishing gear system is frequently mentioned as one of the key aspects for right incentives via an EPR scheme for fishing gear. Moreover, maritime policy and enforcement is a grey area, due to the transnationality of the industry and therefore it is especially important that it becomes attractive for the different parties to become involved.

> *'Perhaps the biggest obstacle will be the logistics of monitoring, this will require significant support from the users of fishing equipment. Maritime policing is a grey area, especially within transnational borders, so incentivizing fisherman to engage with the EPR will be especially important.'*

> *'We are aware from other research that strong governance and accurate monitoring and reporting schemes will be critical in ensuring that any free-riding or non-compliance can be addressed quickly through enforcement. Ambitious targets will feed into this accurate monitoring, but the targets will also need review and adjustment. The right incentives have been shown to stimulate changes in the design phase in other EPRs.'*

One of the addressed options to do better monitor the amounts of gear is the implementation of gear marking and gear tagging. Via gear marking incentives are given to the owners of the gear to take good care of the gear, since there is the option to relate the gear to a certain producer or user. Additionally, more data can be generated since the gear is better traceable.

> *'Via mandatory marking at the production stage, and a reporting system when a piece equipment is lost. Therefore, the equipment is both traceable and the value can be quantified at the point of recycling as a basis for EPR. This can in turn be used in setting the correct producer fee level, ensuring the levy covers the recycling costs. Moreover, if one of the costs incurred by producers was directed specifically toward clean-up activities, this would further incentivize investment into sustainable material design.'*

> *'How to prevent gear being lost in the aquatic environment and becoming waste - by creating technical readings to recover the gear in case of losses and make it possible to include this in national legislation so that it is the requirement that the fishing gear equips with this.'*

Yet, more information and a better understanding serves as the foundation for how an EPR scheme can incentive changes in the design of the fishing gear. There was a strong overlap in the suggestions made about what a different design for fishing gear needs to entail.

Theme: changes in the design of fishing gear (mentioned 16 times)

> *'Using recyclable, solid and long-life materials to promote durability of the gear.'*
>
> *'Simple design of fishing gear with easily dissociable plastic components for easier recycling.'*
>
> *'Using recyclable, solid and long-life materials to promote durability of the gear.'*
>
> *'Design for easy maintenance.'*

Moreover, use valuable materials to uplift the value of fishing gear and therefore the incentive to properly manage the gear and collect it since recycling with valuable materials is financially interesting for the stakeholders.

> *"Focus on design that increases the durability and strength of the fishing gear, to reduce abrasion and breakage of material, and therefore extend the lifetime of the fishing gear. In this respect, increase the quality of the materials utilised within the fishing gear (i.e., replace PP/PE with nylon/PE), which will increase the value, lifetime of the product and consequently will increase the incentive to recycle the product. Moreover, use environmentally friendly coatings to extend the lifecycle of products" and "Increase the value of the fishing gear by using materials (e.g., Nylon 6), that have a higher value on the secondary market, and will therefore incentivise reuse and recycling".*

In addition, there is a need to perform more research. For example, to develop bio-sourced and biodegradable fishing gear as an option to create a more sustainable composition of the fishing gear.

> *'Research/development of bio-sourced and biodegradable fishing gear'*
>
> *'Involving fishing gear manufacturers and fisheries in being responsible for the end-of-life stage or recycling stage. When manufacturers are involved in the recycling stage, they are more aware of the impacts of designing decisions.'*

Theme: incentivise cooperation (mentioned 8 times)

As mentioned before, the cooperation and involvement of the parties in the fishing gear system is very important for an EPR scheme to be successful.

> *'A key risk is the financial burden that might be placed on fishers as a result of gear manufacturers not being able to fully absorb the cost of the proposed EPR schemes. This may result in gear manufacturers having to increase the pricing of gear, making them less competitive in the global market. Ensuring a level playing field is therefore important, globally, but especially within the OSPAR area. We think that EPR scheme have to be developed in very close collaboration with the fishing industry to ensure that the reception is as positive as possible, and that fishers "buy-in" to the scheme and the changes it brings. This stakeholder engagement is something we are looking at closely, even at the very early stages of the project.'*

Theme: level playing field (mentioned 7 times)

This quote leads us to one of the frequently called challenges of an EPR scheme being the creation of an unequal level playing field. When an EPR scheme is applied on fishing gear that is manufactured in the OSPAR-region and not on fishing gear that is coming from Asia and South America - strong price-differences are created.

A result of the strong price-differences is an unequal level playing field, challenging the fishing industry to import cheaper gear from other continents and with that not contributing to the creation of a more circular system. Moreover, when more gear is imported – one of the results is a loss in control, undermining the first step that has been suggested a proper monitoring structure.

> *'Loss of control when EPR causes price to increase and this doesn't count for fishing gear coming from Asian and South American market.'*

> *'Foreign manufacturers should participate financially in the disposal in the EU states where their waste is generated.'*

Theme: fee-system (mentioned 10 times)

Additionally, how to create the right incentive? The use of financial incentives or fees to change behaviour is proposed as an option to make the producer responsible the management and reporting for the products they place on the market.

> *'We don't want an EPR to be voluntary, we want it to be fair and functional.'*

> *'Producers of fishing gear should be obliged to fund the full net cost recovery of their placed-on market equipment, and be subject to monitoring and reporting, with the possibility of a modulated fee system.'*

> *'Ensuring a level playing field seems to be difficult, as there is a lot of international exchange between countries (buying in country A, hand in was waste in country B) This also complicates having national collection targets. Also, different countries could put different tariffs on different kinds of fishing gear, leading to price differences.'*

> *'Producers of fishing gear should be obliged to fund the full net cost recovery of their placed-on market equipment, and be subject to monitoring and reporting, with the possibility of a modulated fee system.'*

Additionally, what needs to be explored are the legal powers that can be applied to create the right legal circumstances to promote changes in the fishing gear system.
Below, a summary is given in the form of a SWOT-matrix about what the strengths, weaknesses, opportunities and threats are for the EPR scheme for fishing gear regarding the Production and Design stage.

Table 7. SWOT – EPR scheme Design & Production (Source: Survey & author)

Strengths (Internal)	Weaknesses (Internal)
1. Create financial incentives to cooperate: 'work together on sustainable and circular design, use and collection/recycling'. **2.**Stimulate focus on design that increases the durability and strength of fishing gear. Increase the quality of the materials utilised within the fishing gear (i.e., replace PP/PE with nylon/PE), increases the value, lifetime of the product and consequently increases the incentive to recycle the product. **3.**Create a fee differentiation between the measures for the different types of equipment (big professional, small semi-professional and angling etc. **4.**Mandatory marking, creating technical readings to recover the gear in case of losses. Include this in national legislation (required that fishing gear is equipped with this). **5.**Simple design of fishing gear with easily dissociable plastic components for easier recycling. Design with uniform materials and easy maintenance. More research/development of bio-sourced and biodegradable fishing gear.	**1.**Lack of transparency on the manufacturing processes, Lack of detailed data on the types, amounts, locations of fishing gear. Making the Fishing gear system a complicated value-chain to understand. **2**.Lot of work on sustainable/circular fishing gear is in its early stages. **3.**Different countries could put different tariffs on different kinds of fishing gear, leading to price differences. **4.**An industry who will not wish to see any additional costs to their gear. **5.**Small businesses are likely disproportionately affected if costs rise. Extra costs of an EPR scheme levied on manufacturers, would most likely be in turn levied onto the fishermen, unlikely they could pass that cost onto their customer base.

Opportunities (External)	Threats (External)
1. Creating a simple and transparent system, with clear rules with the least burden to producers, fishers and recyclers fishermen for sustainable managing the fishing gear. **2.**Create transparency on the manufacturing processes, guarantees on non-toxicity and robustness of recycled materials. Develop a transboundary monitoring system of fishing equipment. Via mandatory marking at the production stage, a reporting system when a piece of equipment is lost. Via this a better understanding about the fishing gear market. **3**. Design for durability and repairability (easy maintenance) with the recycle stage in mind. Use of recyclable, solid and long-life materials, use of non-toxic materials for the ecosystems. Incentivizing producers to create fishing gear that is too valuable to discard. **4**. Fees based on weight or value, create small incentives to further develop the gear in the direction of sustainability and circularity. If the costs incurred by producers was directed specifically toward clean-up activities, this would further incentivize investment into sustainable material design. **5**.Ensure via taxes that recycled materials for fishing comes with competitive cost compared to new fishing gear.	**1.**Globalized market for fishing gear. Currently producers outside the EU can hardly be held responsible for fishing gear that they put on the market. **2.**Limited devolved legal powers to implement EPR schemes. Maritime policy and enforcement are a grey area, especially within transnational borders, so incentivizing all the parties' value-chain to engage with the EPR scheme is very important. **3**.Financial burden that might be placed on fishers as a result of gear manufacturers not being able to fully absorb the cost of the proposed EPR schemes. This may result in gear manufacturers having to increase the pricing of gear, making them less competitive in the global market, resulting in an unequal level-playing field. **4**.Loss of control via unequal level playing field, when the EPR scheme causes the price of fishing gear to increase and this doesn't count for fishing gear coming from other continents. **5**.When the EPR scheme is not properly designed, risk that EU-based manufactures are forced out of the market due to an unequal level playing field.

6.1.2. Use stage

In this section, the outcomes of the survey that are relevant for the use stage of the fishing gear system are summed up. The use stage is important place in the fishing gear system, because here the fishing gear is used. Sustainable behavior in this stage of the system can have an important contribution to prevent that parts of the fishing gear make their way into the sea. What has been addressed here is that good collection infrastructure is essential. A good collection infrastructure is essential since it provides an easy route for the fishermen to dispose their fishing gear when it has reached the end-of-life stage, or to be collected when it can be repaired. The set-up of improved storage points and repair facilities has been addressed as options in the use stage of the fishing gear system to create a more circular system. The most frequently mentioned themes by the respondents are illustrated with quotes that the respondents provided on the open questions in the survey. A SWOT analysis for the set-up of the EPR scheme for the use stage is presented (table 8).

Theme: monitoring and transparency (mentioned 9 times)

Also, in the use-stage of the fishing-gear system has the need been addressed that there is a lack of data. Enhanced data provide a deepened understanding to all the involved parties about the amounts of fishing gear that are being use. As stated earlier a good understanding about the amounts of gear that are in place is fundamental for the design of an EPR scheme. For good monitoring cooperation of the fishing industry is important.

> *'Biggest obstacle will be the logistics of monitoring, this will require significant support from the users of fishing equipment.'*

What has been addressed as a critical point, in line with the set-up of good collection points are the development easy and common rules for the system. These common and simple rules are thought to enhance the legitimacy of the changes made in the fishing gear system for the different parties in the fishing-gear system.

> *'The development of common and simple rules of the game'*

Theme: incentivise cooperation (mentioned 8 times)

Moreover, also for the use-stage counts that cooperation throughout the whole value-chain is considered to be helpful. It is considered to be helpful, because via this it can be better understood what the different parties in the fishing gear need from the other parties to move to a more circular and sustainable system for fishing gear.

> *'I have found it to be helpful to incentivise the fisheries and the fishing gear manufacturers to work together on the matter. Incentive can vary between countries but in the case of Iceland it is that the industry is exempted from paying a deposit fee into the Icelandic Recycling fund and instead handle the matter within the industry.'*

Furthermore, cooperation with the fishing industry has been addressed as an essential point because it promotes legitimacy with the industry.

> *'Close collaboration with the fishing industry to create as much legitimacy as possible. Promoting a positive reception, so fishers "buy-in" to the scheme and the entailed changes.'*

> *'Maritime policing is a grey area, especially within transnational borders, so incentivizing fisherman to engage with the EPR will be especially important.'*

Theme: awareness raising (mentioned 5 times)

Moreover, the creation of more awareness among fishers to manage their fishing-gear more sustainably has also been pointed out as an important step in the use stage. Especially relevant for sustainable management of the net-cuttings and part of the fishing gear that make their way into the ocean.

> '*Port reception facilities or other collection containers must be available at the point of origin. Fishermen should hand in the nets for recycling at the ports or at the manufacturers.'*

> *'If fishermen replace individual net parts during the utilization phase, care should also be taken to ensure the purity of the individual types. Efforts should be made to collect the recyclable nets and to collect them in containers provided for this purpose.'*

> *'Raise awareness among fishermen of separate waste facilities in different harbours for fishing gear.'*

Fig 20. Lobster/crab trap in harbour in the United Kingdom

Below, a summary is given in the form of a SWOT-matrix about what the strengths, weaknesses, opportunities and threats are for the EPR scheme for fishing gear regarding the Use-stage.

Table 8. SWOT – EPR scheme Use stage. (Source: Survey & author)

Strengths (Internal)	Weaknesses (Internal)
1.Strong cooperation within the value chain (Producers, fishing industry and recycles) is a key-aspect and should be incentivized. **2.**Lots of collection points close to fishers. **3.**Incentivise the fisheries and the fishing gear manufacturers to work together on the matter. **4**.Mandatory recycling targets. When fisherman return their used or broken equipment to specialist recyclers they are compensated, as when the materials are sorted and cleaned. The recycled material has value on the end market. **5.**Development of good practice guides for the use of fishing gear containing plastic. More awareness raising activities among fishermen to sustainably manage the fishing gear.	**1.** Lack of detailed data on the types, amounts, locations of fishing gear. Lack of transparency. **2.** Lack of appropriate storage and recycling facilities. **3.**Relatively few fishing equipment recycling operators, which would make material monitoring more easily traceable at this stage. **4.** The risk of free-riders.
Opportunities (External)	**Threats (External)**
1. Creating a simple and transparent system, with clear rules with the least burden to producers, fishers and recyclers fishermen for sustainable managing the fishing gear. **2.** Incentivize investment into sustainable and circular material design (Durability, repairability and recyclability). **3.**Instigate a transboundary monitoring system of fishing equipment. Requires significant support from the users of fishing equipment. Incentivize all the parties in the value-chain to engage with the EPR scheme. **4.** Producers have to be directly involved in the handling of the (waste) equipment as soon as possible. Close collaboration with the fishing industry to create as much legitimacy and awareness as possible. **5.**Development of good practice guides for sustainable use and management of fishing gear containing plastic. Set-up/improvements of storage and repair facilities.	**1.** Globalized market of fishing gear, therefore difficult to ensure a level playing field. **2**.Governmental decision and laws are 'slow' processes. While marine pollution keeps on accumulating. **3**.Marine legislation and law enforcement is a grey area. So hard to control what happens on sea.

6.1.3. End-of-life stage

In this section, the responses of the survey that are relevant for the end-of-life stage are summed up and categorized. Also, for the end-of-life stage it is frequently suggested that a lack of data about the amounts of fishing gear that reach the end-of-life stage forms an obstacle in the set-up of a good functioning EPR scheme. Moreover, also for this stage of the fishing gear system counts that creating a simple and transparent system, with clear rules with the least burden to producers, fishers and recyclers fishermen for sustainable managing the fishing gear. The most frequently mentioned themes by the respondents are illustrated with quotes that the respondents provided on the open questions in the survey. A SWOT analysis for the set-up of the EPR scheme for the end-of-life stage is presented (table 9).

Theme: monitoring and transparency (mentioned 9 times)

What also counts for the earlier stages of the fishing gear system is that a good monitoring-system is required. It is required to better understand what is going on right now in the stage of the fishing gear system. What are the amounts of fishing gear that are being collected, recycled and also lost, but a good monitoring system is also required to understand what the effects of measures taken to improve the circularity of the fishing gear system.

> *'Obstacles that have been defined for the implementation of a well-functioning EPR are the lack of knowledge about the amounts of fishing gear that is on the market.'*

> *'Logically, the first step would be to instigate a transboundary monitoring system of fishing equipment- via mandatory marking at the production stage, and a reporting system when a piece equipment is lost. Therefore, the equipment is both traceable and the value can be quantified at the point of recycling as a basis for EPR.'*

Theme: incentivise cooperation (mentioned 8 times)

Addressed for all three stages of the fishing gear system is to incentivise cooperation, this also counts for the end-of-life stage. By making the producers aware of what needs to happen in the end-of-life stage, changes can be made at the design stage to make quality of the recycling process as good as possible. Furthermore, when the recyclers are in touch with the fishers it can be communicated to the fishers what the right moment is to deliver the fishing gear resulting in an easier recycling process with high quality output of the recycled materials.

> **'***If one of the costs incurred by producers was directed specifically toward clean-up activities, this would further incentivize investment into sustainable material design.'*

> *'Fishermen should hand in the nets for recycling at the ports or at the manufacturers. Passively fished nets are no longer suitable for recycling due to their quality. Therefore, these two waste fractions should be strictly separated.'*

Theme: level playing field (mentioned 7 times)

Ensuring a level playing field between the (involved) countries is an obstacle that requires attention in the set-up a more circular fishing gear system.

> *'Ensuring a level playing field seems to be difficult, as there is a lot of international exchange between countries (buying in country A, hand in was waste in country B) This also complicates having national collection targets. Also, different countries could put different tariffs on different kinds of fishing gear, leading to price differences.'*

Furthermore, suggested option to contribute to an equal level playing field is that foreign manufactures must participate financially in the end-of-life management of fishing gear in the EU/OSPAR-region. Suggested is that a concrete European guideline are required so that participation is ensured of foreign manufactures in the end-of-life.

> *'Ways must be found to what extent foreign manufacturers should participate financially in the disposal in the EU states where their waste is generated. A concrete European guideline for cost sharing based on the quantity of waste put into circulation would be helpful.*

> *'It is important that EPR systems are harmonized as long as possible so as not to create barriers to trade. But then the EU needs to review the e-Handeol directives so that producers outside the EU can also be held responsible for fishing gear that they put on the market.'*

> *'Foreign manufacturers should participate financially in the disposal in the EU states where their waste is generated.'*

Theme: collection and recycling infrastructure and collection targets (mentioned 12 times)

One of the main themes according to answers of the respondents is the absence of a good infrastructure for the collection of the end-of-life fishing gear at this moment in time.

> *'Currently the greatest obstacle in place is the absence of infrastructure. Notably an infrastructure that allows for end-of-life fishing gear to be stored or disposed of, transported to a recycling facility and then subsequently recycled or made fit for reuse.'*

This quote relates to multiple answers given by the respondents about the relation between the choice of applying collection targets and having an appropriate end-of-life infrastructure for fishing. Respondents mentioned frequently that setting collection targets requires good collection and recycling logistics.

> *'A high collection target is only important when there is a proper way to recycle nets. Also, temporal storage of fishing gear is common, and should not be discouraged.'*

Options to set up a system to promote a good functioning end-of-life structure for fishing gear are making the producers responsible to organize take-back schemes. A simple system is suggested, so that it becomes as easy as possible for the fishermen to dispose the gear. Moreover, it is suggested that a division has to be made between different types of fishing nets: being actively and passively fished nets. Passively fishing nets are no longer suitable for recycling are due to heavy wear and tear.

> *'Creating a simple system with the least burden to fishermen when disposing of the equipment, to ensure the buy-in.'*

> *'Take-back schemes handled by producers can be very effective; producers have to be directly involved in the handling of the (waste) equipment as soon as possible.'*

> *'Port reception facilities or other collection containers must be available at the point of origin. Fishermen should hand in the nets for recycling at the ports or at the manufacturers. Passively fished nets are no longer suitable for recycling due to their quality. Therefore, these two waste fractions should be strictly separated.'*

Yet, when the fishing gear is collected at the ports it needs to be brought to a facility where the gear can be recycled. In this stage a new obstacle for good end-of-life management of the gear arises, various respondents stated that the absence of recycling facilities is currently an obstacle for a more circular system for fishing gear.

> *'Few fishing gear recycling plants, therefore required to travel long distances with the recycled gear.'*

> *'Limited recycling facilities that specialise in recycling fishing gear. Recycling processes will of course be aided by changes in the design of fishing gear, making gear more recyclable.'*

Theme: recycling infrastructure (mentioned 7 times)

With the fishing gear being collected, the next phase enters. In this phase the gear needs to be cleaned and prepared for the actual recycling. For good recycling various obstacles and requirements have been formulated by the respondents, cleaning the materials that is often covered with biological materials is challenging, because a lot of labour is required for this.

> *'Enhance cleaning techniques of fishing gear containing plastic, often covered with biological materials.'*

> *'A mass flow suitable for recycling must be collected. Ways must be found to separate the individual types of plastic from each other in a cost-effective and efficient manner. Buyers must be found for the product so that the recycling of fishing gear becomes lucrative.'*

When one wants to recycle the gear, a good market has to be found or created. When this is done recycling becomes a financially lucrative activity and therefore an incentive is created to properly manage the fishing gear. It is suggested to design fishing gear with valuable materials like Nylon 6. Recycled materials have to be of good quality. When this is the case a strong connection and cooperation with buyers is required so that recycling indeed becomes lucrative.

'Increase the value of the fishing gear by using materials (e.g., Nylon 6), that have a higher value on the secondary market, and will therefore incentivise reuse and recycling'

'Buyers must be found for the product so that the recycling of fishing gear becomes lucrative'

Fig 21. Collected fishing-gear at recycling facility (Plastix, 2020)

Below, a summary is given in the form of a SWOT-matrix about what the strengths, weaknesses, opportunities and threats are for the EPR scheme for fishing gear regarding the end-of-life stage.

Table 9. SWOT – EPR scheme End-of-life stage. (Source: survey & author)

Strengths (Internal)	Weaknesses (Internal)
1.The upcoming EPR for fishing gear. **2.**Guarantees on the quality, non-toxicity and robustness of the recycled materials. **3.**Europe-wide coordination as littered gear may be found in a different country to its origin. **4.**Collection of fishing gear, whether this is of disposed of fishing gear at sea or on land, is the most likely policy to reduce ALDFG and therefore reduce its harm. **5**.Take-back schemes handled by producers can be very effective; producers have to be directly involved in the handling of the (waste) equipment as soon as possible.	**1.** Lack of data and monitoring of gear placed on the market, and waste left on the harbours. Lack of transparency Lack of detailed data on the types, amounts, locations of fishing gear. **2.**Absence of a good collection infrastructure. **3.** Use of non-valuable materials to make fishing equipment, EPR system need to accept responsibility for the valuable and non-valuable materials used. **4.**Few fishing gear recycling plants, it is therefore required to travel long distances with the recycled gear. **5**.Handled in municipal waste system, difficult to sort it out from other plastic waste, lot of work and with that money involved for recycling small amounts in each batch.
Opportunities (External)	**Threats (External)**
1. Creating a simple and transparent system, with clear rules with the least burden to producers, fishers and recyclers fishermen for sustainable managing the fishing gear. **2.**The costs incurred by producers was directed specifically toward clean-up activities, this would further incentivize investment into sustainable material design. **3**. Improved cleaning techniques. Improve, cleaning techniques of fishing gear containing plastic, often covered with biological materials. Guarantees on non-toxicity and robustness of recycled materials. **4**. Good market must be created for the recycled fishing gear, so that the recycling of fishing gear becomes lucrative. Ensure Competitive cost compared recycled vs virgin materials. **5.**Important that EPR systems are harmonized as much as possible, to not create barriers to trade within the EU.	**1.**Equipment that is easy to dismantle, thereby easy to sustainably manage on board, in the harbours and collection points. **2.**Limited recycling facilities that specialise in recycling fishing gear. There is not a large scale, uniform application for the recycling of fishing gear. Dominantly small-scale projects at this moment. **3.**Risk of free riders. **4.**Limited devolved legal powers. **5**.The image recycled materials has compared to virgin materials (quality of virgin materials better), plus the price of virgin materials is lower.

7. Discussion and Conclusion

7.1. Discussion

A discussion is given about the main themes in the transition to a more circular and sustainable fishing gear system in the context of the upcoming EPR scheme for fishing gear.

To ensure proper implementation of any measures to create a more circular fishing gear system, step one is the set-up of a good monitoring system. Via this monitoring system more knowledge about the fishing gear system is given to all the stakeholders. This is necessary since at this moment in time there is not a good understanding about the amounts of gear that are being produced, used, lost, disposed and recycled. From an economic point of view, it is important to understand the scale of the issue as well as to outline the complexity of the topic. Additionally, when more data is collected a better understanding is given to all the involved parties about what the costs and benefits are of creating a more circular fishing gear system.
When products value-chains open up, they provide more insights in the sustainability performances of the product-system. Without these insights, there is much unknown about the functioning of the system making it hard to understand what exactly is required to create transitions to more circular and sustainable product/business systems (Eunomia, 2020; Maitre-Ekern, 2020; MRAG, 2020; Mol, 2015; OSPAR, 2020). It would be beneficial for fishers to be involved in identifying new materials and designing new gear. While this is a long-term approach, short-term goals can be achieved through awareness raising and knowledge sharing through information and communication. Cooperation with the stakeholders of the fishing gear system is required and must be ensured within the EPR scheme (important players being manufactures and the fishing industry). Greater transparency and collection of global data is required. Mapping out and opening the supply chain up and monitoring the products is essential in order to identify the sources of materials and their disposal (Eunomia, 2020; Maitre-Ekern, 2020; Mol, 2015).

It is essential to be transparent and have a clear picture about who the different parties are that involved in the system in order to create a sustainable system where all the involved parties take their responsibility. Therefore, identify the producers and importers of the fishing gear, users, transporters collectors and recyclers. Additionally, it is of relevance for a well-functioning circular and sustainable system to be transparent (Mol, 2015). Openness about the amounts of gear that are produced, under which circumstances, composition of the materials, amounts of materials that are being used, collected for repair and at the end-of-life stage disposed and collected, the amounts of material that are being recycled and after that what types of products they are used for. Without a good understanding about the fishing gear system, there is no fundament of the system to build upon to create a more circular system. This is the first step, and with that creating the basis of the transition towards a more circular system for fishing gear in the OSPAR-region. Via this more awareness to all the involved parties in the value chain can be created based upon actual numbers.

What can be questioned is whether the rationale behind an EPR scheme is actually suited to create a more circular and sustainable system for fishing gear. Moreover, various authors stated that most of the applied EPR scheme focus predominantly on waste management (Eunomia, 2020; Kunz et al., 2014; Kunz et al., 2018; Maitre-Ekern, 2020). A focus on who is financing the waste management, can be limiting to intervene with structural changes in the design of the gear. This can be limiting because focusing on what to do with the waste, means accepting that waste is created in the first place. Making changes in the design stage of the fishing gear has frequently been suggested, both in the literature as the performed survey to be the most important stage to create changes to move to a more circular system for fishing gear. Therefore, a strict standard and guidelines for the design of the gear that is correctly incentivized in the EPR scheme for fishing gear is an interesting option. A different design can enhance the durability of the gear with that increasing the circularity and sustainability of the material. Furthermore, the option for improved repair must be taken into consideration to embed in the EPR scheme via e.g., repair vouchers. When fishing gear is designed with both durability and repairability in mind, this will be a huge push for the fishing gear system to become more circular.
Along with a strong focus on the design of products is the idea of a pre-market producer responsibility (PPR). A PPR places the focus on the early stages of the products value-chain, before a product enters the market. PPR aims to ensure that producers held responsible for placing products on the market and thus for the impacts they cause on the environment, human health and social justice. Rather than focusing on requirements about the end-of-life of products, a PPR would establish the basis for imposing environment-oriented measures upon placing products on the market (Maitre-Ekern, 2020). The rationale behind a PPR is, requiring that products meet certain standards for sustainability and circularity prior to entering the market. This is meant to open the door to new ways of regulating products in setting up sustainable circular

product systems. But embraces the precautionary principle via taking care for products before they are placed on the market (Maitre-Ekern, 2020; Sand, 2000). Moreover, a PPR makes producers responsible for taking measures to limit the environmental impact of the products prior to placing them on the in this case OSPAR fishing gear-market. Taking measures before products are placed on the market is an important stimulant to create a more circular fishing gear system. Figure 21 shows the main difference between an EPR and a PPR for product-systems. A PPR is in line with the responses of the experts on the questions asked in the survey. Experts stated that making changes in the design stage via designing with repairability, reusability and the end-of-life phase in mind is the biggest support to come to a more circular and sustainable system for fishing gear. Preventing the gear becoming waste is the most important step to move to a more circular system and follows the precautionary principle and is one of the mantras of EU environmental thinking (European Commision, 2014; Maitre-Ekern, 2020).

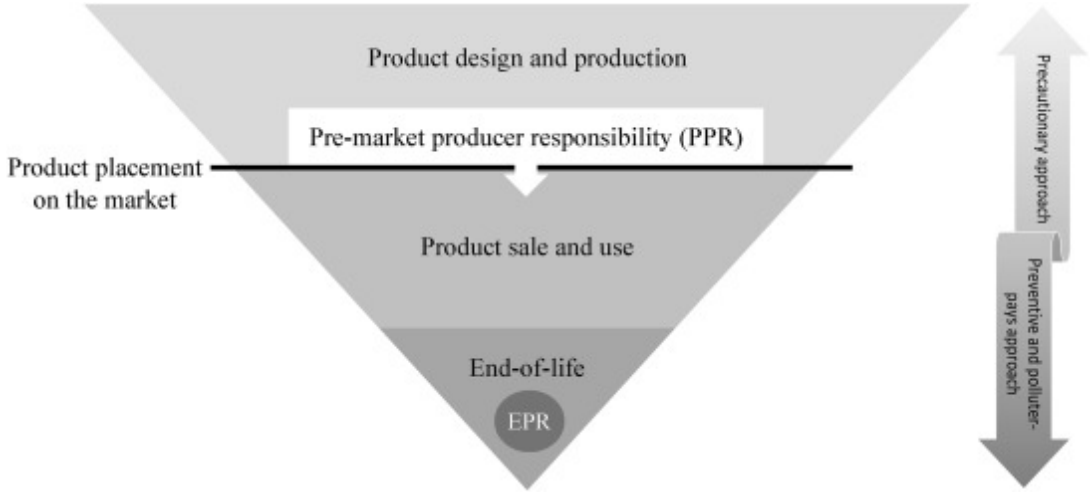


Fig 22. Pre-market producer responsibility (Maitre-Ekern, 2020)

Supporting the PPR is the standardization request to CEN (European standardization committee) at the end of 2020 about fishing gear. This request was made to prepare for the SUP-Directive. The standard(s) for circular design of fishing gear should provide a level playing field for the industry to develop a higher quality and environmentally friendly fishing gear that is easily reused or recycled at the end-of-life and will provide the industry the opportunity to act sustainably for a healthier planet (CEN, 2020). Objective of the development of a standard for circular design of fishing gear is to achieve that fishing gear never becomes a waste-stream. A standard for circular fishing gear must describe the technical specifications for fishing gear containing plastic to facilitate its reuse and recycling at the end-of-life, but also good management of the net-cuttings (Deshpande et al., 2020; Eunomia, 2020; KIMO, 2020; MRAG, 2020). This can be embedded in an EPR scheme via promoting research and development about a circular design for circular fishing gear. Because there is currently no sustainable circular economy or full life cycle thinking used for fishing gear design and manufacturing. End-of-life fishing gear has relatively limited value, resulting in substantial environmental impacts including development of ALDFG and high disposal of gear in landfill. Upstream changes have major influence on the total environmental impact of fishing ger, via this the creation of waste can be minimized, being in line with the sustainability visions of the European Union (European Commission, 2014).
The development of a standard for circular design of fishing gear must acknowledge the need for continual research and development. Research and development must not be born entirely by the industry, but also be supported by substantial and long-term external funding support. Funding can (partially) be organized via the EPR schemes and must be made available across the entire market chain and encompass the broadest array of stakeholders, to ensure consensus in development goals and continual collaboration between the different parties in the fishing gear system.
All in all, developing a good standard, that is implemented correctly will ensure that the required upstream changes of the fishing gear system are ensured (Deloitte, 2018; Deshpande, 2020; Eunomia, 2020, European Commission, 2020; MRAG; 2020).
Designing and producing environmentally conscious and circular fishing gear is a strong contribution to move to a more circular fishing gear system in the OSPAR-region. When the circular fishing gear contains a maximum amount of plastic that is suited for subsequent reuse and high recyclability at end-of-life while maintaining and possibly improving the gear components full functionalities, durability and catchability. By this the overall ecological footprint of the fishing industry in the OSPAR-region is reduced.

Cooperation with all the stakeholders in the fishing gear system to work on the development of a standardisation for circular fishing gear is very important. Making use of a bottom-up approach, granting all the stakeholders a sense of contribution to the solution as much as possible. Rather than them being a target of imposed top-down legislation. Involvement of fishers in the process of standardisation is deemed useful in terms of feeding in important user information, as well as ensuring greater compliance with the voluntary standard. A standard for circular design of fishing gear can be regulated and incentived via the EPR scheme for fishing gear via embracing a more PPR approach (Deshpande, 2020; Maitre-Ekern, 2020; MRAG, 2020; OSPAR, 2020).

One of the most important aspects for a good functioning EPR scheme for product systems is that a level playing field is ensured. This equal level playing field also counts as one of the important aspects for the EPR scheme fishing gear, addressed by both the literature as the expert reaction in the survey (EUNOMIA, 2020; MRAG, 2020; TAUW, 2018). An EPR scheme for fishing gear can result in higher prices for the fishing equipment. Likely result of this is that fishing gear coming from continents as Asia and South America becomes financially even more attractive for the fishers to buy than it already is. When this is not correctly taken into consideration a result might be that more gear from the international market is entering the OSPAR-region. Resulting in a loss of control, OSPAR-based producers and manufactures are forced out of the market and this can also result in decreased chances of sustainability and circularity (European Commission, 2020; MRAG, 2020; OSPAR, 2020). This is one of the aspects that needs special attention for the implementation of an EPR scheme. In this strongly globalized world, the question arises if you as a nation or a group of nations are able to set boundaries the set-up of a more sustainable system, in the form of sustainability protectionism. This could be done when it is ensured that products from other continents face the same taxes and rules regarding transparency as those produced and used in the EU and OSPAR-region, and extra emissions are charged like is done with the proposed Emission Trading System in the EU and the Carbon Border Adjustment Mechanism (European Commission, 2017; European Commission, 2019).

Ensuring that the externalities of the fishing gear system via strict rules are integrated in the product system and taking the environment of global economic competition into account via ensuring a level playing field is the essence of what is required to move forward to more sustainable and circular systems. On a legal level the European Union should ensure that products that are entering the European market are facing the same requirements of circular and sustainable fishing gear.
A strong market master is likely required to ensure the transition to a more circular system is controlled and protected, and freeriding is punished. The role of strong market-master can be reserved for concise acting national governments and the European Union, who have a mandate that the OSPAR-commission does not have. A stronger involvement to deal with market-failures to ensure that the negative externalities are embedded in the value-chain of the business systems in general and also the fishing gear system seems needed. This requires a stronger role of governments to deal with the externalities of economic (product) systems, and function as a strong and sustainable market-master (Dasgupta, 2021; Hanemaaijer et al., 2021; Mazzucato, 2018).

Fig 23. The Wadden Sea part of the North-East Atlantic (Netherlands) (Hetty Melink, 2015 ©)

7.2. Conclusion

On the whole, improving the circularity and sustainability of the fishing gear systems is in general at two territories. The first, optimising sustainable ad circular management of net-cutting and smaller parts of the fishing gear. The second, extending the product lifetime, reusability, upgradability, reparability, recycled content and recyclability. Therefore, regulatory measures like the standard for circular fishing gear to ensure upstream changes in the fishing gear system, with that prevent downstream problems as much as possible. The biggest problems in the fishing gear system in the OSPAR-region, are not the complete fishing nets that end up in the ocean, but bigger and smaller pieces of the gear and net-cuttings that make their way into the sea.
In general, ensure via the upcoming EPR scheme for fishing gear that upstream changes in the fishing gear system are made as much as possible. Via this complex issues later in the fishing gear system can be prevented as much as possible.
Below conclusions are given per stage of the fishing-gear system in the OSPAR-region.

Design and production stage

Currently, fishing gear is predominantly designed with a focus on functionality and economic efficiency. This created a situation where the reduction of environmental impacts, via designing with sustainability and circularity in mind, received little attention. To put it differently, there is at this moment in time a disincentive for fishing gear manufacturers to produce less environmental harm products, as this would lead to less consumption of fishing gear over time. Fishing gear is considered a relatively small and diverse waste-stream with that a challenge for recycling. Important is that fishing gear is captured at the right stage in its lifecycle in order to promote repair, reuse or the last-resort recycling. This is important to consider in the earliest phase of the system, because when materials are used too long the possibility to repair, reuse or recycle properly decreases. By designing the gear in such a manner, making use valuable materials, design as simple as possible for repair and recycling and define the right moment when the gear must be captured for repair, reuse and recycling there is an increased (financial) incentive for recycling throughout the value chain and good management of the net-cuttings. Use materials that have been identified as reusable, recyclable or repairable to ensure the following circularity requirements: modification, reusability, end-of-life recycling and efficient dismantling of fishing gear. The decoupling of the range of materials used in fishing gear from the use of finite virgin plastic resources (i.e., through a virgin plastic reduction target) is important. This decoupling involves a gradual elimination of the virgin plastic (as long as this does not reduce performance), increased use of recycled content, increased use of renewable materials and substitution by other materials. Any reduction target for virgin plastics should focus as its underlying delivery mechanisms on both eliminating the plastics that are not needed, through innovation and reuse, and increasing recycled content for those plastics that are required, which should also be fit for use and maintain utility. Avoid the use of mixed materials, the use of less diverse parts within a gear or its components, and an increase in the use of internally recovered or recycled materials from process waste. The willingness increases to contribute throughout to sustainable and circular manage fishing gear on the long run. As earlier stated, an important step in creating changes in the design of the fishing gear are more insights via developing a monitoring system. This forms a fundamental knowledge basis that is required to make the right decisions regarding the design of an EPR scheme. A monitoring system should be developed with the international dynamics of the fishing industry in mind. Gear marking and gear tagging are interesting options to integrate in the design of the fishing gear. With gear marking-tagging, increased monitoring can be (financially) incentivized. It can also become a relatively easy control-mechanism for whom the owners/responsible parties for the fishing gear are. With that becoming easier to narrow down the right financial incentives to specific parties in the value chain to create a more circular and sustainable system for fishing gear. The high amounts of imported fishing gear make it harder to control and monitor the gear and the composition of the gear also with (upcoming) legislation. A threat in strongly globalized and online world is fishing gear coming from Asia, being hard to control.

When the gear is designed as simple as possible, recycling also becomes a ‘simpler’ act. One of the most important steps to move to a more circular system is making changes in the design (upstream). Fishing gear is comprised of various materials, from different types of synthetics to metals. The heterogonous materials used in fishing gear create a challenge for good reuse, repair and recycling of the fishing gear. An extra obstacle is the lack of transparency about the composition of the gear. To create a more circular system for fishing gear, it is of importance to create as much transparency as possible about the composition of the materials. This promotes repair, reuse and recycling and gives further insight in the sustainability of the manufacturing process. Modular design of fishing gear could promote easy disassembling the gear into constituent parts. Modular design if done correctly and in cooperation with the stakeholders supports easier and sustainable repair. Further economic incentives as a tax shift from labour to products is needed to promote the use of recycled materials over virgin plastics.

Use stage

What also applies to the use stage of the fishing gear system is that there is a clear need for good monitoring. With a good functioning monitoring system, it can be understood how much gear is being lost, how much is being used and what the effects are of measures taken. Since lost gear is not restricted to borders, national authorities must cooperate to effectively target and retrieve lost gear. In the OSPAR region the biggest issue for fishing gear becoming marine litter are the net cuttings, parts of fishing gear that make their way into the ocean, the use stage is an important stage to intervene. Sustainable behaviour of the fishers on board and in the harbour is therefore very important to incentivise with the EPR scheme. Having the right incentives to properly manage the part of the fishing gear, contributes to prevent parts of the fishing gear ending up in the ocean. Because of this organizing easier access to product information (product and material type, composition, reuse/recyclability options etc.) for all components utilised in fishing gear is important. With this it becomes easier to understand where the gear is composited of, and extra tools can be added so the industry can register new-bought products, as materials loss and derelict fishing gear.
Gear durability enhances the performance as well as the likelihood of being reused, repaired and/or recycled, that all the materials utilised are reusable, recyclable or repairable. What furthermore is of great importance is that future materials and products not merely take into account recyclability, reusability or composability, but should also be fit for use and maintain utility. Design should encompass innovation in preventative maintenance, repair, remanufacturing, ability to refurbish, and not merely focus on recycling at 'end-of-life' and upcycling. Being supportive to stimulate sustainable behaviour in the use-stage of the fishing gear system. Properly managed logistics around waste and end-of-use gear collection should be ensured to assist the fishers. This includes unified collection of the gear onboard vessels in bags or containers, and provision of adequate facilities in the ports. The ports should support this as part of their service and ensure that there is sufficient storage capacity available for handling of any materials brought to land. Repair is advised to be incentivized via for example repair vouchers funded by the EPR scheme or Governments. For example, exchanging old net-cuttings for repair parts, as a financial incentive to promote good management of waste coming from the fishing gear and increase repair activities. For good repair activities it is advised to create strong local repair clusters. This creates a social and financial incentive for proper local management of the waste-stream along with the development of good practice guidelines for use, repair and storage of fishing gear.

Awareness raising measures are important to further educate all the involved parties about sustainable management of fishing gear, and the effects of not doing this. Furthermore, any loss of fishing gear for fishers results in a financial loss, directly via losing nets or indirectly via a decreased quality of the marine ecosystem. This is extra incentive for the fishing sector to prevent this. Involvement of the fishers to collect more data (gear used, repaired, lost, collected) is important this can be done via for example an electronic logbook for gear monitoring.
A weakness in the fishing gear system to become more sustainable and circular was insufficient waste-reception facilities. Port waste facilities require frequently a long and inefficient walk with heavy fishing gear for fishers**.** Important reasons why fishers have a perverse incentive to leave gear at sea, and not properly clean the fishing vessel or their spot in the harbour. With the revised PRF being in place in all ports, good waste collection logistics are there for the fishing gear to be collected once it reaches it end-of-life. Interesting is to see in the upcoming years what the effects of this revised PRF are on fishing gear becoming marine litter.

End-of-life stage

At this moment in time, disposal and end-of-life treatment of fishing gear is very low and the recycling-level for fishing gear in the EU is 1 to 5%. A weakness is that recycling is often a more costly process than landfilling or incineration. The low profit margins involved in plastic recycling combined with the fact that recycled plastic is currently more expensive than virgin plastic. Combine this with the bad image recycled materials have with respect to virgin materials, and it is clear that this are not directly inviting business circumstances to start recycling. Therefore, it is important to create a more circular fishing gear system to have a good functioning market for recycled goods or materials. Option is to stimulate this via a broader tax shift from labour to products, creating a financial incentive to repair and recycle products over using virgin materials.
Furthermore, there are only two main operators handling fishing gear at scale so capacity-building to better recycle fishing gear throughout the OSPAR-region is needed. The high organic contamination of materials reduces the ability to recycle the fishing gear, because clear plastics are required. Differences in the materials and make up of nets imply the need for customised handling. This may include a separate storage for different gear types. Currently the assignment of responsibilities regarding handling, processing and disposal remains unclear. The main responsibility should lie with the net producers and assemblers when it comes to separation, disposing and recycling of end-of-life gear.

The process of identifying the material types and ascertaining the best method to undertake the labor-intensive task of separating and cleaning fishing nets before disposal is a critical component of the collection process prior to recycling. Development of facilities to enhance the capacity to recycle fishing gear within Europe need attention, in which the emissions related to the recyling should be taken into consideration.
To run an efficient waste management system within a lot of small ports divided over a large area is cost-ineffective, although this should be in place for all port in Europe under the revised PRF. Currently, the assignment of responsibilities regarding handling, processing and disposal remains unclear. The main responsibility should lie with the net producers and assemblers when it comes to separation, disposing and recycling of end-of-life gear. Logistics around collection and dismantling must be considered, such as the costs involved in dismantling nets for recycling or removal of lead lines for incineration in the case of gillnets. Marking and tagging of fishing gear components would then facilitate dismantling at the recycling stage, and therefore have positive economic impacts on the costs of recycling of materials.

The most successful collection and recycling models focus on collecting the nets directly from the fishers as soon as they meet their end-of-life. Furthermore, the development of new techniques is important to increase the recycling value of fishing gear become valuable due to improved recycling. Purity of materials is a crucial factor for recycling, mixed material nets pose a challenge to the recycling phase. For increased recyclability of the gear a reduction in the number of materials used is required, while not compromising its functionality. By designing the gear in such a manner, making use of valuable materials and design as simple as possible for repair and recycling, good upstream changes can be made in the fishing gear system resulting in easier recycling at the end-of-life stage. At this moment recycling technology exists for the four main polymers, which means that, in principle, up to 80% of gear could currently be recycled. Affordable technology already exists to scan plastic and determine what the composition of material is. The process of identifying the material types and ascertaining the best method to undertake the labor-intensive task of separating and cleaning fishing nets before disposal is a critical component of the collection process prior to recycling. Develop facilities to enhance the capacity to recycle fishing gear within Europe is important to create a good collection and recycling infrastructure. Properly, managed logistics around waste and end-of-use gear collection must ensure to assist the fishers in their largely voluntary actions. This includes unified collection of the gear onboard vessels in bags or containers, and provision of adequate facilities in the ports. The ports should support this as part of their service and ensure that there is sufficient storage and capacity available for handling of any materials brought to shore.

Fig 24. Fishing vessel in Spanish Harbour (Republic World, 2020)

8. Recommendations

An enumeration of the advised building blocks to the create a transition to a more circular and sustainable fishing gear system, in the context of the upcoming EPR scheme for fishing gear are presented below. The following steps are advised to be embedded in the EPR scheme for fishing gear to move to a more circular and sustainable fishing gear system, and a resilient fishing industry. The points are ranked where number one is the most strongly advised based on necessity, impact and feasibility. Furthermore, what is strongly advised is to promote and incentivise upstream product-design changes in the system as much as possible. Via upstream changes complex issues later in the value chain can be prevented as much as possible.

1. **Develop a monitoring system throughout the value chain of the fishing gear system. More data results in more insight, now and in the future.**

Better monitoring systems are needed throughout the value-chain of the fishing gear system. More data results in more insight now and in the future. More insight is needed about the amounts of gear that are in the fishing gear system (produced, bought, used, repaired, lost and collected in the end-of-life stage). Via these insights it becomes easier to target more precisely the weakness-points of the system, create here the right incentives to change and understand what the effects of the implemented measures are.

2. **Develop a standard for sustainable and circular fishing gear.**

By developing a standard for circular and sustainable fishing gear, it can be ensured that fishing gear is designed with a focus on gear that increases durability, strength and repairability. CEN (2020) is currently developing a European standard for circular design of fishing gear. Ensure that the gear is designed with valuable materials to increase the incentive to recycle. Provide a clear overview of the material-composition of the gear, if and how it can be repaired and the expected lifetime. Furthermore, a better understanding of the impact of different types of materials on the marine environment is needed, to be able to decide which materials must be used to create the most functional and sustainable composition of fishing gear. Embedding the principle of a pre-market producer responsibility in the extended producer responsibility of fishing gear is a way to stimulate that this circular standard of fishing gear is complied with.

3. **Stimulating cooperation throughout the value-chain of the fishing gear system (producers/manufactures, fishing industry and the recyclers).**

Strong cooperation with the fishing industry is fundamental, so that the fishers work together to create a more circular and sustainable fishing industry. A bottom-up and tailor-made approach is advised to ensure that the legislations and incentives to create a more circular and sustainable fishing gear system make sense to the stakeholders in the system. Ensure that strong cooperation throughout the fishing gear system is incentivized in the extended producer responsibility. The contribution of all the stakeholders is necessary to come to a more circular and sustainable (managed) fishing gear system. This can be done via financially incentivizing the parties to cooperate and take responsibility for their part. So, the different parties in the fishing gear system work together to solve the problem of fishing gear/net cuttings becoming marine litter. To ensure a resilient fishing industry, that moves forward to a sustainable future.

4. **Develop simple and transparent rules for all the stakeholders in the value-chain, especially for the producers and fishers with the upcoming obligation of the extended producer responsibility (2024).**

When developing the rules of the route to a more circular and sustainable fishing gear system it is important that these rules are simple and transparent. This makes it clear for all different stakeholders why the rules are there, what the (positive) consequences are and how and why to follow these rules. Via this a transparent system for fishing gear is created, ensure that information about sustainable gear, repair options and points, collection and recycling logistics are easily accessible for all the stakeholders. Also, transparency about the expected lifetime of fishing gear, composition of the fishing gear and options for repair is advised.

5. Guarantee a level playing field for the producers of fishing-gear on world-level, so European producers of fishing gear do not experience a competitive disadvantage due to obligations of the extended producer responsibility.

One of the challenges of extended producer responsibility for fishing gear is that the price of fishing gear increased due to the obligations for the producers. Result of this is that fishing gear, produced on other continents that are not involved in these measures (less circular and sustainable) becomes relatively extra-cheap and with that more attractive to buy. This must be taken into careful consideration so that European fishing gear producers are not pushed out of the market, resulting in a loss of control. With a level playing field, financial fairness is there for the sustainably behaving parties in the fishing gear system.

6. Set-up repair and storage facilities for fishing gear, technical and financial.

Set-up of repair and storage facilities for fishing gear is important. When repair is properly embedded in the design stage of fishing the development of good repair-points and storage facilities for the fishing gear is essential. Via this repairing gear becomes an easier and more attractive activity, the availability of spare parts for 'easy' repair is essential and must be financially incentivized. For example, via repair voucher funded by the extended producer responsibility for fishing gear.

7. Develop a good functioning waste collection and recycling infrastructures, technical and financial.

With the set-up of a good waste collection infrastructure, sustainably managing end-of-life fishing gear becomes an easier task for the fishers. Develop good functioning local-recycling clusters where the end-of-life fishing gear can be recycled, so end-of-life fishing gear does not need to travel long distances. The value of recycling remains locals resulting in reduced emissions related to recycling. Furthermore, develop good recycling equipment and ensure that there is a market for recycled materials.

8. Make the producers of the fishing gear responsible for both valuable and non-valuable materials.

Ensure that the producers in the fishing gear system also take responsibility for the non-valuable materials, via fees for example on these non-valuable fishing gear (parts). Sustainably managing the non-valuable net cuttings is needed, good behaviour can be promoted via financial incentives (e.g., vouchers) on good collection and collecting the net cuttings on board as in the harbours. This must address the net-cuttings, that are one the dominant problem for the fishing gear becoming marine litter in the OSPAR-region.

9. Development of control and evaluation of the extended producer responsibility for the fishing gear system via a strong 'market-master'.

The market-master needs to ensure that the rules are followed, that a fair and transparent system is ensured and that a level playing field is guaranteed for the sustainably acting producers of the fishing gear and the fishers. This role can be suited by a stronger involvement of Governments on the local, regional, national and international level.

10. Investigate the environmental benefits of a 'product as a service' as a potential part of the extended producer responsibility for fishing gear.

An option that is interesting to investigate in the future, but requires a radical change in fishing gear system is the set-up of a system of product as a service as part of the extended producer responsibility. More research is needed to find out the actual environmental benefits of such a system and the legitimacy with the stakeholders of the fishing gear system. Potential benefits are (if correctly developed) that is becomes clear who is the owner of the fishing-gear, therewith responsible for sustainable and circular managing the whole life cycle of fishing gear: the deliverer of the service.

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10. Appendices

10.1. Personal communications

I would like to say thanks to all the persons that were willing to have a chat with me. During these enjoyable conversations they shared their insights. This has been a great contribution to the work that has been done and made it an interesting and enjoyable experience, especially when taking the covid-19 situation into account.

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- Eileen Blackmore (House of Design)
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- David Walsh (CEO, Impact Recycling)
- Andrea Stolte, WNF Germany, Fishing Gear expert
- Louisa Goodfellow, Ecosurety
- Robbie Stainforth, Ecosurety

10.2. Survey - Extended Producer Responsibility scheme Fishing-Gear

Dear Sir/Madam,

This study looks into how to create a more circular system for fishing gear in the OSPAR-region by exploring the financial aspects of implementing Extended Producer Responsibility (EPR) for fishing gear. The aim of the study is to establish recommendations for the EPR for fishing gear in such a manner that it gives the right incentives for all the involved parties in the system to support the transition to a more circular system including by increasing the value of fishing gear.

Thank you for your time and participation!

Regards,

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Introduction

Fishing Gear is an important source of marine litter within the North East Atlantic. The harm that is caused by fishing gear as a source of marine litter is well documented, with recognition that entanglement in, or ingestion of, abandoned, lost or otherwise discarded fishing gear (ALDFG) can have negative consequences on the physical condition of marine animals and even lead to death (TG-ML report on Harm, 2016).However, it is also important to recognize that losing fishing gear (assuming it is lost unintentionally) is also costly to fishers, as they will be required to replace it to continue operating.
The Single Use Plastics Directive (EU/2019/904) introduces a set of ambitious measures to reduce plastic litter and increase collection and recycling, with a focus on preventing and reducing the impact of certain plastic products on the environment. Included within the Directive is the requirement for Member States to implement Extended Producer Responsibility (EPR) for fishing gear and components of fishing gear containing plastic. Under the EPR schemes, producers of fishing gear containing plastic should cover the cost for the separate collection of waste fishing gear containing plastic and its subsequent transport and treatment. The producers shall also cover the costs of the awareness raising measures regarding fishing gear containing plastic. EU Member States are required to set up the EPR Schemes for fishing gear by 31st December 2024. Also, under the new Port Facilities Directive, Member States are required to ensure (2021) that facilities for end-of-life fishing gear are present in harbors and covered by indirect financing schemes.

1. How could effectively be intervened in the value-chain of fishing gear in order to create a more circular system for fishing gear? Please consider the different phases of the fishing gear chain in your answer. Concrete best-practice examples and any additional details are appreciated.

Phases:

- The design and production phase
- The use phase
- The collection phase
- The recycling and re-use phase

2. Which requirements for a good EPR scheme do you deem most important? (Rank them 5 = most important)

- *Low administrative burdens*
- *The right financial incentives*
- *Ambitious collection target*
- *Accurate monitoring and reporting scheme*
- *Voluntary actions by producers / fisheries sector / other parties involved*

Optional: Please elaborate on your response and provide any additional details you feel are relevant, like best practices and ideas:

3. Which financial instruments are interesting to apply in the EPR for fishing gear, to stimulate the enthusiasm and responsibility for all the parties in the fishing gear system to contribute? (multiple-choice)

- Extra deposit-fee
- Fee differentiation between types of fishing gear (e.g. a higher fee for types of fishing gear with more environmental impact)
- No financial instruments, a voluntary basis (Iceland model)
- Different system of ownership (product as a service)

Optional: Please elaborate on your response and provide any additional details you feel are relevant, like best practices and ideas:

4. Do you have any innovative ideas how to improve the value of fishing gear? (open question)

Concrete best-practice examples and any additional details are appreciated.

5. What do you consider to be the obstacles for the implementation of an EPR within the OSPAR-region? (For example: How to take the globalized market into account for fishing gear, Administrative burdens, ensuring a level playing field within the OSPAR area, identifying the right producers and parties)

Your answer: