OSPAR COMMISSION

OSPAR scoping study on best practices for the design and recycling of fishing gear as a means to reduce quantities of fishing gear found as marine litter in the North-East Atlantic

Environmental Impacts of Human Activites

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OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the "OSPAR Convention") was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. The Contracting Parties are Belgium, Denmark, the European Union, Finland, France, Germany, Iceland, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Convention OSPAR

La Convention pour la protection du milieu marin de l'Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d'Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998. Les Parties contractantes sont l'Allemagne, la Belgique, le Danemark, l'Espagne, la Finlande, la France, l'Irlande, l'Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume-Uni de Grande Bretagne et d'Irlande du Nord, la Suède, la Suisse et l'Union européenne.

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This scoping document has been prepared by the task leads for Action 36 of the OSPAR Marine Litter Regional Action Plan (The Netherlands and The United Kingdom), with contributions from Andrea Stolte, Wouter Jan Strietman, Roos Bol, Jennifer Godwin, Emma Day, Mareike Erfeling and Mark Intven.

Cover Photo: New fishing nets, photo provided by WJ Strietman

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List of abbreviations

ALDFG	Abandoned, Lost or Discarded Fishing Gear
ASC	Aquaculture Stewardship Council
CPs	Contracting Parties
EPR	Extended Producer Responsibility
EOL	End of Life
FAD	Fish Aggregating Device
FAO	Food and Agriculture Organization of the United Nations
FFL	Fishing for Litter
GES	Good Environmental Status
MSC	Marine Stewardship Council
ICG-ML	OSPAR International Correspondence Group on Marine Litter
MARPOL	International Convention for the Prevention of Pollution from Ships
MSFD	Marine Strategy Framework Directive
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PRF	Port Reception Facilities
RAP ML	Regional Action Plan for the Prevention and Management of Marine Litter
SUP	Single Use Plastics

Plastic materials:

ABS	Acrylonitrile butadiene styrene	PP	Polypropylene
GRFD	Glass fibre reinforced plastic	PS	Polystyrene
HDPE	High Density Polyethylene	PU	Polyurethane
HMPE	short for UHMWPE	PVC	Polyvinylchloride
PA/PA6	Polyamide (nylon)	PVDF	Polyvinylidene fluoride
PE	Polyethylene	UHMWPE	Ultra High Molecular Weight Polyethylene (e.g. Dyneema®)
PET	Polyethylene terephthalate (Dacron/Polyester)		

OSPAR Contracting Parties:

BE	Belgium	GE	Germany	PT	Portugal
CH	Switzerland	LU	Luxemburg	SP	Spain
DK	Denmark	IC	Iceland	SW	Sweden
EU	European Union	IR	Ireland	UK	United Kingdom
FI	Finland	NL	The Netherlands		
FR	France	NO	Norway		

Executive Summary

The OSPAR Convention is the mechanism by which 15 Governments and the EU cooperate to protect the marine environment of the North-East Atlantic. In 2014, OSPAR adopted a Regional Action Plan for Marine Litter (RAP ML), which sets out the policy context for OSPAR's work to prevent and reduce the occurrence of marine litter in the North-East Atlantic. In the latest OSPAR assessment of beach litter (2019), fishing[1] related items was one of the top three most common litter types recorded on OSPAR beaches. To begin to address this important issue and to fulfil the objectives of the RAP ML, OSPAR is considering the design and recycling of fishing gear, and how this could play a part in reducing the amount of fishing gear found as marine litter in the OSPAR Maritime Area.

This scoping document sets out current understanding of the provisions, challenges, barriers, solutions and best practice examples for design and recycling of fishing gear, while also providing suggestions for next steps. The information collated in this document may aid Contracting Parties in implementing Extended Producer Responsibility schemes for fishing gear containing plastics, as foreseen under the EU Directive (EU) 2019/904. The study was based on a detailed questionnaire, sent out in July 2019 to stakeholders across the fishing sector, and additional expert interviews. Preliminary conclusions were discussed and verified in an expert workshop in February 2020, organised in collaboration with the European Commission in the context of the implementation of the EU Directive on the reduction of the impact of certain plastic products on the environment (EU/2019/904).

Marine litter from fishing gear (Section 2)

Both unintentional and intentional loss of fishing gear at sea result in marine litter and negative environmental impacts. Inadequate waste management on-board vessels during repairs, snagging of fishing gear beneath the surface and severe weather were reported as the most substantial reasons for loss of fishing gear. Conflicts with other gear or vessels were also commonly reported as a reason for loss, especially for gillnets. Discarded or lost fishing gear containing plastic materials will degrade very slowly, remaining in the marine environment for decades if uncollected. Gradual shedding of microplastic fibres leads to ingestion by filter feeding organisms and fish. Netting made from low-density plastics continues to float on the surface and remains hazardous for marine animals (ghost fishing) as well as posing security risks to vessels. Furthermore, loss of fibres or materials through abrasion during normal use (e.g. dolly rope) contributes to the presence of plastics in the ocean.

Fishing gear usage and supply chain (Section 3)

A varied array of fishing gears and materials are used in the OSPAR Maritime Area, with gear usage depending both on target species and area of fishing. Bottom trawls, pelagic trawls and nets (including gillnets) are the main types of gear used, followed by seines and traps. Independent of gear type, the main plastic materials used are polypropylene (PP), polyethylene (PE) and polyamide (nylon/PA6). However, fishing gear can also include single and mixed materials containing metals, PVC, polystyrene, PVDF, Dacron (PET, Polyester), HMPE (e.g. Dyneema®), rubber, foams and various hazardous materials (e.g., lead weights, copper coatings).

Raw materials for fishing gear production, as well as final fishing gear products (i.e., ropes or nets) are predominantly sourced from overseas, with final assembly undertaken locally. Such assembly is often tailor-made and performed by specialized facilities (e.g. fisheries cooperative). Sometimes, fishers carry out assembly or repairs themselves. Overall, the supply chain for fishing gear is complex and country-specific, with many different parties involved at various stages. There is currently little information known about this supply chain.

Recycling of fishing gear (Section 4)

Currently in the OSPAR Maritime Area, a small proportion of fishing gear is recycled at end-of-life and various barriers were identified. In Europe, dedicated fishing gear plastic recycling is predominantly done by two companies, both being highly specialised in the material they can process and with high standards and requirements on accepted end-of-life fishing gear. Facilities available for collection and recycling are limited, requiring high effort and costs to pre-process and transport material to the recyclers, which results in a high

[1] Recordings of fishing gear within the OSPAR beach litter monitoring should be understood as being either complete gear items (e.g. a lobster cage or gillnet) or, most often, parts of gear (e.g. net clippings or larger sections of fishing nets).

ecological footprint for recycling. Some regions still lack facilities for fishing gear collection in ports, including lack of available space to store old gear for collection, contamination of disposal facilities by fly-tippers, and poor portside coordination on the cleaning and separation process. Lastly, recyclates originating from fishing gear generally have a lower quality and / or a perception of lower quality, therefore lower market value than comparable virgin polymers.

Fishing gear can contain multiple types of (mixed) polymers, which require a high level of pre-processing (sorting & dismantling) in order to be recycled, with high costs and time involved. This is because fishing gear needs to be sorted into individual polymer type components before shipping to the recycling facility, and all contaminants such as lead from sink lines need to be removed. Fishing gear must also be relatively clean, without sediment, sand or organic materials. However, gear experts say that the technology to recycle fishing gear is available, that contaminated fishing gear can be recycled, and that the market for such products is growing. Further understanding is needed of feasible solutions to pre-processing materials at scale and the available technology to undertake this.

Design of fishing gear (Section 5)

Design of fishing gear is predominately driven by functionality and cost. It is accepted that these two factors will always be key considerations for fishermen, however it is also hoped that environmental impact and waste management will increasingly become drivers in their own right for the design of fishing gear. Three options for design modifications to reduce marine litter from fishing gear were investigated in this study: design to reduce impact on the marine environment when fishing gear is lost; design for better recyclability; and design for better traceability.

Regarding environmental impacts, hazardous materials are still used in fishing gear (i.e., copper coating, lead), which may negatively impact marine life. For these, alternative materials might be viable, subject to the appropriate analysis of erosion rates and biota interaction. Secondly, there is increasing discussion and research on marine biodegradable fishing gear or its components, but little evidence is available to demonstrate the feasibility of these materials for use in fishing gear on a large-scale. Concerns remain about how long these materials take to degrade, what they degrade to, and whether they create perverse incentives to dispose of gear irresponsibly. Therefore, with this in mind, first and foremost, we should aim at preventing loss of gear (or parts thereof) in the first place. In situations where this is not deemed possible, then design solutions to reduce environmental impact should be implemented.

With respect to design for recyclability, there is still a range of materials and mixtures of materials used in fishing gear design that reduces or negates its ability to be recycled. End-of-life materials are often difficult to dismantle into individual material fractions. Little research has been done into the potential for reducing the number of materials used in fishing gear, design for better disassemble, or marking materials for identification purposes to aid dismantling at end-of-life. There is also a lack of technology to extract hazardous materials from fishing gear, e.g. for nets that have been treated with copper or other antifouling agents.

Lastly, various new technologies have been developed to mark fishing gear, which could disincentivise the intentional loss of fishing gear, incentivise lost fishing gear to be reported, and aid the retrieval of lost fishing gear (e.g. through location and identification). However, there is still a lack of standardised approaches, and gear marking may only be effective to trace larger parts / sections of gear, or specific gear items such as traps and pots.

Conclusions and potential next steps (Section 6)

Several options were identified for next steps to reduce the amount of fishing gear that ends up as marine litter within the OSPAR Maritime Area (in terms of design and recycling of fishing gear). Firstly, knowledge gaps need to be addressed and further research is needed to understand the fishing gear supply chain and life cycle. OSPAR Contracting Parties could undertake national mapping exercises for the 'life cycle of fishing gear'. Secondly, analysis of existing national legal frameworks, related to end-of-life fishing gear as waste, is needed. The establishment of a harmonised waste categorisation scheme throughout Europe would remove barriers for recycling.

To increase efficiency of recycling schemes, Contracting Parties could develop measures to better organise end-of-life management of fishing gear (through separate collection), including straightforward return logistics, centralised sorting and dismantling facilities, harmonised waste reception facilities (tailored to specific harbour requirements), monitoring of fishing gear placed on the market and collected at end-of-life, and providing both market and non-market incentives (i.e., financial or positive branding benefits) to encourage recycling. Awareness raising is also needed, both on the issues of fishing gear as a source of marine litter, and on the practical considerations when preparing gear to be recycled.

Recyclability of fishing gear could be improved at the design stage by reducing the number of materials in gear, making materials easier to identify, ensuring higher purity of materials and making gear easier to dismantle. Any adaptations should follow the waste hierarchy, favouring re-use and repair, over recycling. OSPAR could play a role in further awareness raising on this topic, and further steps for Contracting Parties could be to explore the role of legislative or voluntary measures to improve fishing gear design or recycling. OSPAR and / or Contracting Parties could share their experiences on how to apply EPR-schemes along the production chain and support pilot studies that consider alternative, more environmentally friendly materials or aiming at better gear protection. Design to reduce environmental impact should include considerations to make gear less prone to wear and tear and less prone to getting lost, as well as reducing environmental impact in the event that gear is lost at sea.

Beach Litter in Iceland, photo provided by WJ Strietman

Récapitulatif

La Convention OSPAR est le mécanisme par lequel quinze gouvernements et l'Union européenne, coopèrent pour protéger l'environnement marin de l'Atlantique du Nord-Est. En 2014, OSPAR a adopté un plan d'action régional pour les déchets marins (RAP ML), qui définit le contexte politique des travaux d'OSPAR pour prévenir et réduire l'occurrence des déchets marins dans l'Atlantique du Nord-Est. La dernière évaluation OSPAR des déchets sur les plages (2019) montre que les articles liés à la pêche[2] étaient l'un des trois types de déchets les plus courants enregistrés sur les plages OSPAR. Pour commencer à traiter cette question importante et pour atteindre les objectifs du RAP ML, OSPAR étudie la conception et le recyclage des engins de pêche, et comment cela pourrait jouer un rôle dans la réduction de la quantité d'engins de pêche trouvés comme déchets marins dans la zone maritime OSPAR.

Cette étude exploratoire présente la perception actuelle des dispositions, défis, obstacles, solutions et exemples de meilleure pratique portant sur la conception et le recyclage des engins de pêche ainsi que les prochaines étapes suggérées. Les informations figurant dans ce document pourraient aider les Parties contractantes à mettre en œuvre les régimes de Responsabilité étendue des producteurs (REP) relative à l'incidence de produits plastiques dans les engins de pêche, selon les prévisions de la Directive (UE) 2019/904. Cette étude s'est fondée sur un questionnaire détaillé, communiqué en juillet 2019 aux parties prenantes dans l'ensemble du secteur de la pêche, ainsi que sur des entrevues d'experts supplémentaires. Un atelier d'experts qui s'est tenu en février 2020 s'est entretenu des conclusions préliminaires et les a vérifiées, atelier organisé en collaboration avec la Commission européenne dans le cadre de la mise en œuvre de la Directive (UE) 2019/904) relative à la réduction de l'incidence de certains produits en plastique sur l'environnement.

Déchets marins provenant d'engins de pêche (Section 2)

La perte accidentelle ou délibérée d'engins de pêche en mer cause des déchets marins et a des impacts environnementaux négatifs. La gestion inadéquate des déchets à bord des navires au cours de réparations, d'accrochages des engins de pêche sous la surface et de graves intempéries sont les causes majeures de pertes d'engins de pêche notifiées. Les collisions avec d'autres engins ou navires sont d'autres causes de pertes souvent notifiées, en particulier en ce qui concerne les filets maillants. Les engins de pêches abandonnés ou perdus contiennent des déchets plastiques qui se dégradent très lentement, pouvant subsister dans le milieu marin des décennies s'ils ne sont pas recueillis. Les fibres microplastiques perdues progressivement sont ingérées par les organismes filtreurs et le poisson. Les filets en plastique basse densité flottent encore à la surface et présentent un danger pour la faune marine (pêche fantôme) et également des risquent pour les navires sur le plan de la sécurité. De plus, la perte de fibres ou de matières par abrasion lors de l'utilisation routinière (par exemple « dolly rope » (Tresses de fils polyéthylène utilisées pour protéger le cul des chaluts contre les abrasions)) contribue à la présence de plastiques dans l'océan.

Utilisation et chaîne d'approvisionnement des engins de pêche (Section 3)

Une gamme étendue d'engins et de matériel de pêche sont utilisés dans la Zone maritime OSPAR, dépendant aussi bien des espèces ciblées que de la zone de pêche. Les chaluts de fond, les chaluts pélagiques et les filets (notamment les filets maillants) sont les principaux types d'engins utilisés, suivis par les sennes et les trappes. Quelque soit le type d'engin, polypropylène (PP), polyéthylène (PE) et polyamide (nylon/PA6) sont les principales matières plastiques utilisées. Les engins de pêche peuvent cependant comprendre également des matières simples ou mixtes contenant métaux, PVC, polystyrène, PVDF, Dacron (PET, Polyester), HMPE (par exemple Dyneema®), caoutchouc, mousses et diverses matières dangereuses (par exemple, poids en plomb ou revêtement de cuivre).

La matière première utilisée dans la fabrication d'engins de pêche, de même que le produit fini (c'est-à-dire cordage ou filets) proviennent essentiellement d'outremer, le montage final étant effectué à l'échelle locale. Ce montage est souvent sur mesure et effectué par des entreprises spécialisées (par exemple coopérative de pêche). Les pêcheurs effectuent quelquefois eux-mêmes le montage ou les réparations. Dans l'ensemble, la

[2] On entend par enregistrements d'engins de pêche dans le cadre de la surveillance des déchet sur les plages OSPAR soit des éléments complets d'engin (par exemple cage à homard ou filet maillant) soit, plus fréquemment, des parties d'engin (par exemple petites coupures ou parties plus grandes de filets de pêche).

chaîne d'approvisionnement en engins de pêche est complexe et propre à un pays, des parties différentes y prenant part à diverses étapes. On ne possède actuellement que peu d'informations sur cette chaîne d'approvisionnement.

Recyclage des engins de pêche (Section 4)

Une petite proportion des engins de pêche en fin de vie sont actuellement recyclés dans la Zone maritime OSPAR et divers obstacles ont été déterminés. En Europe, essentiellement deux entreprises se concentrent au recyclage des plastiques des engins de pêche, elles sont toutes deux très spécialisées et leurs critères d'acceptation d'engins de pêche en fin de vie sont élevés. Les installations de recueil et de recyclage disponibles sont limitées, le prétraitement et le transport du matériel aux centres de recyclage exigent des efforts et des ressources importants, et ont donc une empreinte écologique élevée. Certaines régions ne possèdent pas encore d'installations portuaires de recueil des engins de pêche, notamment elles ne disposent pas d'espace disponible pour le stockage de vieux engins en attente de recueil, les installations d'élimination sont contaminées par les décharges sauvages et les processus portuaires de nettoyage et de séparation sont mal coordonnés. Enfin, les produits recyclés provenant d'engins de pêche sont, ou sont perçus, dans l'ensemble de qualité inférieure et leur valeur est donc inférieure à celle de polymères vierges.

Les engins de pêche peuvent contenir plusieurs types de polymères (mixtes) exigeant un prétraitement (tri et démantèlement) de haut niveau, tâche longue et onéreuse, avant de pouvoir être recyclé. En effet, les engins de pêche doivent être triés selon le type individuel de composants de polymère avant d'être expédiés à l'installation de recyclage et il est nécessaire de retirer tous les contaminants, tels que le plomb. Les engins de pêche doivent également être relativement propres, dénués de sédiment, sable ou matière organique. Des experts pensent cependant qu'une technologie permettant de recycler les engins de pêche existe, qu'il est possible de recycler les engins de pêche contaminés et que la demande pour de tels produits est en hausse. Une meilleure compréhension est nécessaire afin de trouver des solutions réalisables pour le prétraitement des matières à l'échelle et la technologie disponible correspondante.

Conception des engins de pêche (Section 5)

La conception des engins de pêche dépend essentiellement de la fonctionnalité et du coût. On reconnaît que les pêcheurs considèreront toujours que ces deux facteurs sont essentiels mais on espère également que l'impact environnemental et la gestion des déchets seront de plus en plus motivants dans ce contexte. Cette étude s'est penchée sur trois options de modification de la conception afin de réduire les déchets marins provenant des engins de pêche, il s'agit de la réduction de l'impact sur le milieu marin d'engins de pêche perdus, d'une meilleure recyclabilité et d'une meilleure traçabilité.

On continue à utiliser des matières dangereuses dans les engins de pêche (c'est-à-dire revêtement de cuivre, plomb) ce qui risque d'avoir un impact négatif sur le milieu vivant marin. D'autres matières pourraient être viables, sous réserve de les analyser afin de déterminer la vitesse d'érosion et les interactions avec le milieu vivant. Ensuite, des engins de pêche biodégradables en mer et leurs composants font de plus en plus l'objet d'entretiens et de recherches mais on ne dispose que de peu de preuves démontrant la possibilité d'utiliser ces matières dans la fabrication d'engins de pêche à grande échelle. Des préoccupations subsistent quant au temps de dégradation de ces matières, aux résultats de cette dégradation et aux incitations perverses éventuelles à une élimination irresponsable. Nous devrons donc avant tout avoir pour objectif d'empêcher la perte d'engins (ou de leurs parties) en premier lieu. Lorsque cette démarche s'avère impossible, on devra envisager des conceptions permettant de réduire les impacts environnementaux.

Il existe toute une gamme de matières et de mélanges de matières utilisés dans la conception d'engins de pêche susceptibles de réduire ou d'empêcher les possibilités de recyclage. Il est souvent difficile de désassembler des matières en fin de vie en plusieurs éléments individuels. La possibilité de réduire le nombre de matières utilisées dans les engins de pêche, des conceptions permettant un meilleur désassemblage ou un marquage permettant d'identifier les matières pour faciliter le démantèlement en fin de vie ont fait l'objet de peu de recherches. Aucune technologie permettant d'extraire des matières dangereuses des engins de pêche, par exemple les filets traités au cuivre ou autre agent antisalissure, n'est disponible.

Enfin, diverses technologies nouvelles ont été développées pour le marquage des engins de pêche qui pourraient décourager les pertes délibérées d'engins de pêche, motiver la notification d'engins de pêche perdus et permettre de récupérer les engins de pêche perdus (par exemple en les localisant et les identifiant). Des approches normalisées sont cependant inexistantes et le marquage des engins risque de ne permettre le traçage que des grosses pièces/sections de l'engin ou de parties spécifiques telles que trappes et casiers.

Conclusions et prochaines étapes potentielles (Section 6)

Plusieurs prochaines étapes possibles ont été déterminées, permettant de réduire la quantité des engins de pêche constituant des déchets dans la Zone maritime OSPAR (du point de vue de la conception et du recyclage des engins de pêche). Il faudrait tout d'abord aborder les lacunes des connaissances, des recherches supplémentaires sont nécessaires pour pouvoir comprendre la chaîne d'approvisionnement et le cycle de vie des engins de pêche. Les Parties contractantes OSPAR pourraient entreprendre des exercices cartographiques au niveau national portant sur le « cycle de vie des engins de pêche ». Il est ensuite nécessaire d'analyser les cadres de travail juridiques nationaux existants portant sur la fin de vie des engins de pêche à titre de déchets. La création d'un programme harmonisé de catégorisation des déchets dans l'ensemble de l'Europe réduirait les obstacles au recyclage.

Dans le but d'améliorer l'efficacité des programmes de recyclage, les Parties contractantes pourraient développer des mesures permettant de mieux organiser la gestion de fin de vie des engins de pêche (grâce à un recueil distinct). Il s'agit notamment de logistiques simples de retour, d'installations de tri et de démantèlement centralisées, d'installations de réception des déchets harmonisées (adaptées aux besoins spécifiques d'un port), d'une surveillance des engins de pêche en vente et de leur recueil en fin de vie et de fournir aussi bien des incitations commerciales que non commerciales (c'est-à-dire les avantages financiers ou d'image de marque positive) afin d'encourager le recyclage. Une sensibilisation est également nécessaire aussi bien à la question des engins de pêche en tant que source de déchets marins et aux aspects pratiques de la préparation des engins au recyclage.

On pourrait améliorer les possibilités de recyclage des engins de pêche au cours de l'étape de conception en réduisant le nombre de matières dans les engins, en facilitant leur identification, en garantissant une meilleure pureté et en facilitant le démantèlement des engins. Toute adaptation devra suivre la hiérarchie des déchets, favorisant la réutilisation et la réparation plutôt que le recyclage. OSPAR pourrait jouer un rôle dans la sensibilisation à cette question et les Parties contractantes pourraient envisager le rôle de mesures législatives ou facultatives permettant d'améliorer la conception ou le recyclage d'engins de pêche, à titre d'étapes supplémentaires. OSPAR et / ou les Parties contractantes pourraient échanger leurs expériences sur la manière de mettre en œuvre des régimes REP parallèlement à la chaîne de production et soutenir des études pilotes envisageant des matières alternatives plus respectueuses de l'environnement ou ayant pour objectif une meilleure protection des engins. Une conception permettant de réduire les impacts environnementaux devrait envisager des engins moins susceptibles de se détériorer et de se perdre ainsi que de réduire l'impact environnemental en cas de perte en mer.

1. Introduction and setting the scene

1.1. Marine litter and the environment

Marine litter is one of the most pervasive pollution problems affecting the marine environment. It is not only an aesthetic problem but incurs socioeconomic costs, threatens human health and safety and impacts marine organisms and habitats. It is broadly documented that entanglement in, or ingestion of, marine litter can have negative consequences on the physical condition of marine animals and even lead to death. Ingestion of litter items is also of concern as it causes blockages and injuries of the digestive system. Furthermore plastic litter in the micro size and smaller may provide a pathway for transport of harmful chemicals into the food web. Additionally, marine litter is known to damage and degrade habitats (e.g. in terms of smothering) and to be a possible vector for the transfer of alien species.

1.2. OSPAR's marine litter objectives

OSPAR is the mechanism by which 15 Governments and the EU cooperate to protect the marine environment of the North-East Atlantic (**Figure 1.1**). The OSPAR objective with regard to marine litter is "to substantially reduce marine litter in the OSPAR maritime area to levels where properties and quantities do not cause harm to the marine environment" by 2020 (The North-East Atlantic Environment Strategy 2010-2020). In order to achieve this objective, the current North-East Atlantic Environment Strategy commits to "develop appropriate programmes and measures to reduce amounts of litter in the marine environment and to stop litter entering the marine environment, both from sea-based and land-based sources".

To fulfil this objective, OSPAR agreed a Regional Action Plan on Marine Litter (OSPAR Agreement 2014/01) to be implemented in the period 2014-2021. The Regional Action Plan for the Prevention and Management of Marine Litter in the North-East Atlantic (RAP ML) sets out the policy context for OSPAR's work on marine litter. The RAP ML describes the various actions that OSPAR is working on, considering both land-based and sea-based sources of marine litter, including fisheries-related marine litter as well as actions for removal and awareness raising.

Figure 1.1

The OSPAR Maritime Area, including the five OSPAR Regions.

This scoping study aims to address two actions of the OSPAR Regional Action plan for Marine Litter:

Action 36

Through a multinational project, together with the fishing industry and competent authorities develop and promote best practice in relation to marine litter. All relevant aspects (including e.g. dolly rope[3], waste management on board, waste management at harbours and operational losses/net cuttings) should be included.

Action 37

Investigate the prevalence and impact of dolly rope (synthetic fibre). Engage with competent authorities (such as National Authorities, EU, NEAFC etc.) and the fishing industry in order to work together to reduce the waste generated by dolly rope on a (sub) regional basis.

Further to Action 36 and 37, the OSPAR RAP ML also has a related action to 'Identify the options to address key waste items from the fishing industry and aquaculture, which could contribute to marine litter, including deposit schemes, voluntary agreements and extended producer responsibility' (Action 35).

1.2.1. Published OSPAR reports

There are a number of published OSPAR documents on the topic of fisheries related marine litter. These include:

- A scoping study to identify key waste items from the fishing industry and aquaculture to support work under Action 35 (2019);
- A Review of Marine Litter Management Practices for the Fishing Industry in the North-East Atlantic Area to support work under Action 36 (2017);
- A workshop and report on 'Handling (plastic) garbage in the fishing industry' to further inform work under action 36 (2017);
- An OSPAR Recommendation 2016/01 and supporting guidelines (2017) on the reduction of marine litter through the implementation of fishing for litter initiatives; and
- An OSPAR Recommendation 2019/01 and supporting Background Document on the reduction of marine litter through the Implementation of Sustainability Education Programmes for Fishers.

This scoping study builds on the information within these documents, and any possible next steps will further make use of this past work.

1.3. Fishing gear as a key source of marine litter

For the purposes of this report, fishing gear means 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 capturing or controlling for subsequent capture or harvesting marine organisms (FAO, 2019). Fishing gear can be made from a range of metal and plastic materials and often has different types of material combined in one piece of gear.

OSPAR currently assesses common indicators on beach litter, seabed litter and plastic particles in fulmar and turtle stomachs, based on standardised monitoring and assessment programmes carried out by Contracting Parties. OSPAR publishes assessment results for abundance, trends and

[3] *Bunches of polyethylene threads used to protect the codend of demersal trawlnet from abrasions*

composition of marine litter in the North-East Atlantic for the different marine compartments (i.e. floating, seafloor and coastal).

The longest and most comprehensive dataset is available for beach litter. Fishing gear (and parts thereof) is commonly found on beaches in the OSPAR Maritime Area (see **Section 2.1**). In the latest OSPAR assessment of beach litter (2019), fishing gear was one of the top three most common litter types recorded[4] on OSPAR beaches and fishing activities are still one of the main sources of litter in the OSPAR Maritime Area accounting for up to 40 percent of the findings in different sub-regions (see **Section 2.1.2** for more detail).

Fishing gear as a source of marine litter ending up in the North-East Atlantic can be understood as an accumulation of (1) loss due to wear and tear during operational use, (2) accidental loss of gear and gear parts which cannot be retrieved or are too risky to retrieve, and (3) intentional dumping of unwanted gear or parts thereof / loss due to poor handling practice (e.g. clippings from net mending).

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. However, this also depends on the type of gear, for example trawl nets are expensive, but gill nets are rather cheap, therefore the time and costs required to relocate them might seem disproportionate to their value. The secondary effects of lost fishing gear will also have an impact on fishers through reduced fish stocks as a result of 'ghost fishing'. Furthermore, lost gear presents additional navigation hazard in general, as well as a risk of snagging to bottom contact gear types and could potentially lead to further gear loss still (TG-ML report on Harm, 2016).

Section 2 of this report discusses 'fishing gear as a source of marine litter' in more detail.

1.4. Scope and purpose of this study

To begin to address the issue of fishing gear as a source of marine litter and to fulfil the objectives of the RAP ML, the task leads for Action 36 (The Netherlands and The United Kingdom) have developed the Design and Recyclability of Fishing Gear Project. The project aims to assess the challenges and barriers (both legal and practical) to the collection of and logistics for recycling of end of life fishing gear and ALDFG. The project also considers how the design of fishing gear can be modified for increased recyclability and re-use, as well as the potential for design modification to reduce the impact on the marine environment in the event that gear is lost. The overall ambitions of the project is to feed into the identification of next steps for OSPAR to ultimately reduce the amount of fishing gear found as marine litter in the OSPAR Maritime Area.

There are many options for achieving this goal. Crucial in combating marine litter from fisheries is the provision of adequate port reception facilities in line with the implementation of all provisions of the revised PRF Directive in fishing harbours (e.g. the 100 % indirect fee system), and effective waste management on board fishing vessels (where space is a major concern). High levels of awareness and education are needed to achieve this. As an additional way to reduce the amount of fishing gear in the North-East Atlantic, this project focuses specifically on making available information and providing recommendations on environmentally friendly design of fishing gear and opportunities and challenges with recycling fishing gear.

This scoping study considers recycling of fishing gear with the idea that, with increased collection of fishing gear, there will be an increased demand for recycling, and with higher demand, the efficiency

[4] When looking at the most frequently recorded items across all OSPAR beach survey sites, see Section 2.1.2 for more detail.

of the system could also increase, making it more financially attractive to bring fishing gear to be recycled. Consequently, there should be less fishing gear found as a marine litter.

The results of this work will support those OSPAR Contracting Parties who are also EU Member States in implementing Extended Producer Responsibility (EPR) for fishing gear containing plastics and the further development of harmonized standards for circular design of fishing gear, as required by the EU Directive on the reduction of the impact of certain plastic products on the environment (referred to as the Single Use Plastics (SUP) Directive) (EU 2019/904). However, this study will also support any Contracting Parties who are not EU Member States intending to take action on fishing gear as a source of marine litter.

This study focusses on recycling end-of-life commercial fishing gear, but the recycling of ALDFG, recreational gear and aquaculture equipment will also be considered, based on the information available. The main outputs of this scoping study will be the identification of best practice examples and a summary of potential future work for consideration by OSPAR or individual Contracting Parties.

1.5. Relevant European Union legislation

The Marine Strategy Framework Directive (MSFD) (2008/56/EC) aims to achieve Good Environmental Status (GES) of the EU's marine waters by 2020 and to protect the resource base upon which marine-related economic and social activities depend. With respect to marine litter, the MSFD requires EU Member States to ensure that, by 2020, "properties and quantities of marine litter do not cause harm to the coastal and marine environment".

The Waste Framework Directive (2008/98/EC) was adopted in 2008 and provides a general framework for waste management requirements in the EU, setting out definitions related to waste, recycling and recovery. The governing principle of the Directive is the waste management hierarchy; prevention, preparing for re-use, recycling, recovery, and finally disposal. Amongst other things, the directive works on the basis of the ‘polluter pays principle’ and ‘extended producer responsibility’.

The revised Port Reception Facilities Directive (EU/2019/883, revision of EC/2000/59) was adopted in 2019 and aims to reduce pollution from the waste produced by ships. The EU directive aligns with the International Maritime Organization’s MARPOL Convention 73/78 and obliges Member States 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 European Strategy for Plastics in a Circular Economy was adopted in January 2018 as an official communication by the European Commission. The Strategy is linked to the EU’s wider plan to develop a circular economy and originated from the 2015 Circular Economy Action Plan, which identified plastics as a priority area.

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. The Directive also envisages the European Commission to request European standardization organization to develop harmonized standards for circular design of fishing gear.

1.6. Collaboration with European Commission funded study on the circular design of fishing gear

In order to implement the measures foreseen under the EU's Single Use Plastics Directive, the EC launched a study on the Circular Design of fishing gear for a reduction of environmental impacts, which is led by MRAG. The objective of the study is to provide the background and information necessary to support the EC in requesting the European standardisation organisation to develop harmonised standards relating to the circular design of fishing gear to encourage preparation for re-use and facilitate recyclability at end-of-life.

Due to the similarities between the EC funded MRAG study and the OSPAR Design and Recyclability of fishing gear project, the two project teams joined up to collaborate on the organization of a stakeholder workshop. A summary of the workshop is presented in **Annex E**.

1.7. Methodology

OSPAR circulated a detailed questionnaire in July 2019 designed to collect and assess responses from all relevant sectors on challenges, barriers (legal and practical), solutions and best practices in the collection and logistics for recycling, practical recycling (End of Life (EOL) & ALDFG), design for recyclability and re-use, and design to reduce the impact on the marine environment. The questionnaire reached out to the fishing industry, recycling industry, ports and harbours, fishing gear manufacturers and designers, policy makers, NGOs and research institutes (see **Figure 1.2**). In addition, interviews were conducted with various experts on the topic of design and recycling of fishing gear. The questionnaire is included in **Annex A**.

Over 70 responses were received, representing views from 12 Contracting Parties[5] (Belgium, Denmark, France, Germany, Iceland, Ireland, The Netherlands, Norway, Portugal, Spain, Sweden, and The United Kingdom). The number of responses received per Contracting Party is shown in **Figure 1.3**.

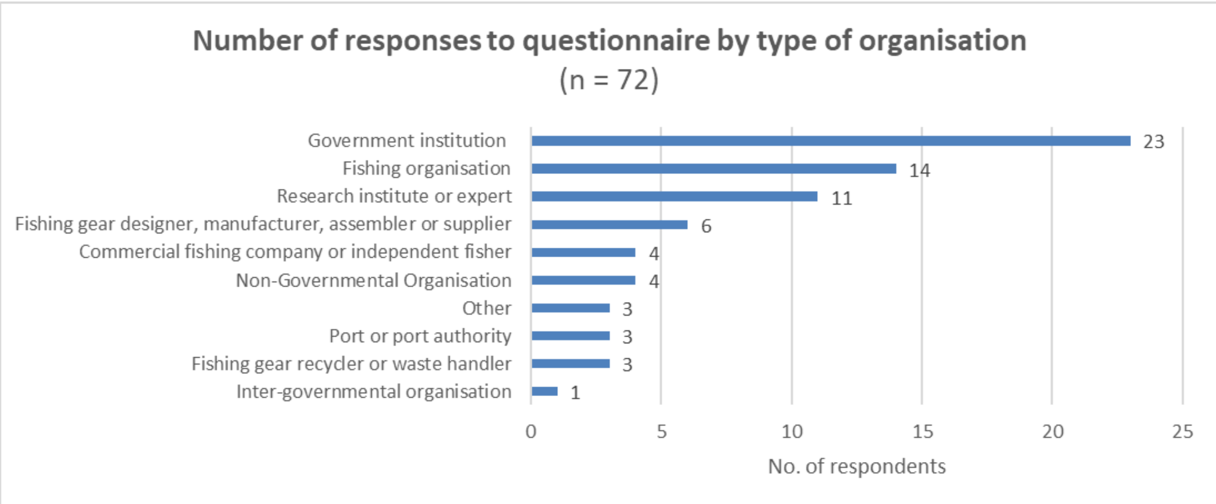

Figure 1.2 Responses received per type of organisation

[5] The four Contracting Parties that did not respond were Finland, Switzerland, Luxembourg and The European Union. Finland is not on the western coasts of Europe, but some of its rivers flow to the Barents Sea and historically it was involved in efforts to control the dumping of hazardous waste in the Atlantic and the North Sea. Luxembourg and Switzerland are Contracting Parties due to their location within the catchments of the River Rhine.

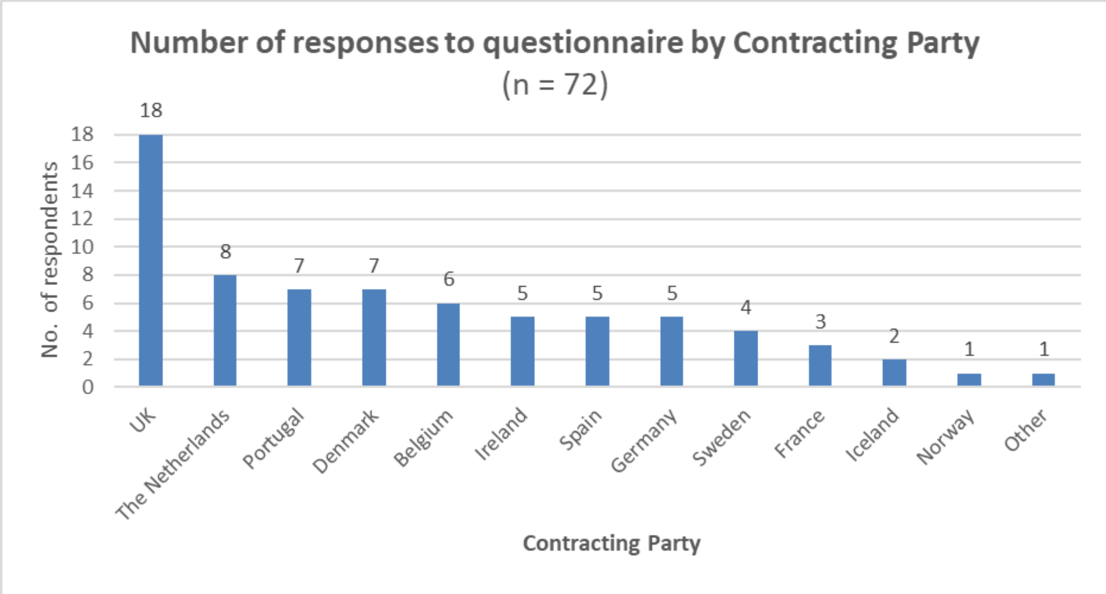

Figure 1.3 **Responses received per Contracting Party. Note that 'other' is a response from a fishing gear recycler / waste handler based in UK but operating across Europe, and that for responses from international NGO's the location of the NGO representative who filled out the questionnaire was used, although the views provided represent the views from across the countries the NGO operates in.**

Using the information gathered through the questionnaire and interview process, in combination with an extensive literature review the OSPAR project team developed some initial conclusions and potential recommendations for further work on the topic of design and recyclability of fishing gear. The preliminary conclusions were shared and developed further at the joint OSPAR / EC stakeholder workshop on 19 / 20 February 2020 (see workshop summary in **Annex E**).

This scoping study combines and presents the findings of the questionnaire, expert interviews, literature review and conclusions reached by the stakeholder workshop. The identified best practice examples (**Section 4** and **5**) and options considered for next steps (**Section 6)** will be discussed at OSPAR's Intersessional Correspondence Group on Marine Litter and at OSPAR's Environmental Impacts of Human Activities Committee, where a decision will be made on next steps.

2. Fishing gear as a source of marine litter in the OSPAR Maritime Area

2.1. Prevalence and quantities of fishing gear as a source of marine litter

2.1.1. OSPAR litter monitoring

OSPAR has a standardised monitoring and assessment programme for marine litter which is undertaken by Contracting Parties within the OSPAR Maritime Area. Three indicators are currently monitored and assessed:

- beach litter (abundance, composition and trends of litter at the coast);
- seafloor litter (composition and spatial distribution of litter on the seafloor);
- plastic particles in fulmar stomachs (floating litter); and
- Plastic particles in turtle stomachs.

These indicators are assessed on a periodic basis, and the latest versions are published in the OSPAR Assessment Portal.

The most extensive OSPAR marine litter monitoring programme is for beach litter. The amount of litter (numbers of items) on beaches is one of the key indicators of abundance, composition and trends of litter in the marine environment. Therefore, for the purposes of this scoping study, the most recent results of the OSPAR beach litter indicator assessment are used to give an understanding of the quantity and types of fishing gear found as marine litter on beaches within the OSPAR Maritime Area.

OSPAR monitors litter on 100m stretches at over 70 beaches in the North-East Atlantic following common monitoring guidelines (OSPAR Agreement 2010-02). The same 100m stretches of beach are surveyed four times per year, with monitoring taking place for over 10 years. Data on the amount of litter on a given stretch of coastline is recorded at item level[6]. Items comprise identifiable pieces of litter, including items such as plastic bottles, metal drinks cans, rubber gloves, fishing line (angling), nets and pieces of nets, crab / lobster pots and fishing weights (see **Figure 2.1** and **Table 2.1**).

The items recorded are assigned to specific categories according to the material from which they are made (e.g. plastic, wood, metal) or their use (e.g. medical, sanitary). These categories are referred to as ‘types’. In total, there are 112 defined litter types: plastic / polystyrene (54 items), metal (15 items), paper and cardboard (9 items), wood (9 items), sanitary waste (6 items), cloth (5 items), rubber (4 items), glass (3 items), pottery/ceramics (3 items), medical waste (3 items) and faeces (1 item).

Recordings of fishing gear within the OSPAR beach litter monitoring should be understood as being either complete gear (e.g. a lobster cage or gillnet) or, most often, parts of gear (e.g. net clippings or larger sections of fishing nets). For example, a section of a fishing net on a monitoring beach would be registered as a single item in either the category ‘nets and pieces of net <50 cm’ or the category ‘nets and pieces of net >50 cm’ (see **Figure 2.1** and **Table 2.1**). Whereas, smaller off-cuts / clippings from nets will most likely be registered as ‘string and cord (diameter less than 1 cm)’.

[6] OSPAR Beach litter monitoring uses counts of items for two reasons; firstly because counts better reflect the potential impact of marine litter as marine species and activities are more affected by the number of items found than by weight, and secondly for practical reasons, as should litter be monitored by weight, it would need to be first dried and cleaned of sand in order to get an accurate reading.

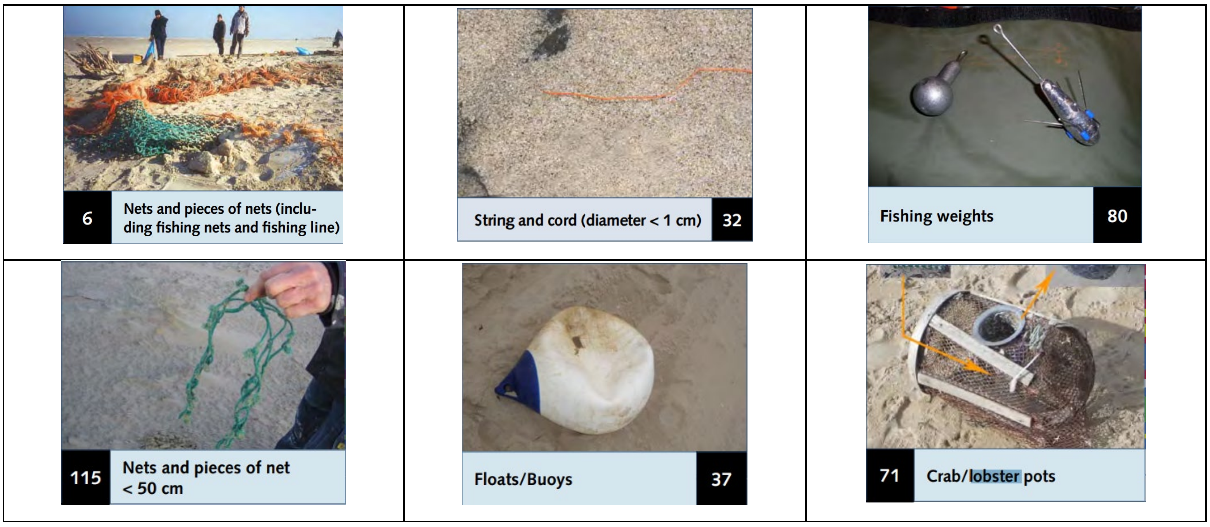

Figure 2.1 **Examples of items recorded in the OSPAR Beach litter monitoring programme (taken form the OSPAR Guidelines for monitoring beach litter)**

Table 2.1 **A selection of fisheries-related litter items within the 'plastic / polystyrene' categories in the OSPAR Guidelines for monitoring beach litter**

OSPAR ID	Unep ID	Items	Total
29		Oyster trays (round from oyster cultures)	
30		Plastic sheeting from mussel culture (Tahitians)	
31		Rope (diameter more than 1 cm)	
32		String and cord (diameter less than 1 cm)	
115		Nets and pieces of net < 50 cm	
116		Nets and pieces of net > 50 cm	
33		Tangled nets/cord/rope and string	
34		Fish boxes	
35		Fishing line (angling)	
36		Light sticks (tubes with fluid)	
37		Floats/Buoys	

2.1.2. OSPAR beach litter assessment 2019

The most recent beach litter assessment was undertaken in 2019 (and can be accessed at https://oap.ospar.org/en/ospar-assessments/committee-assessments/eiha-thematic-assessments/marine-litter/beach-litter-monitoring/). Between December 2009 and January 2018, of the 128 designated OSPAR beaches, 18% show a significant reduction in fishing gear and 4% show a significant increase in fishing gear found as marine litter. There is some evidence that fishing gear concentrations are higher in areas with relatively high fishing intensity, such as in the Arctic Seas and Northern North Sea (Falk-Andersson & Strietman, 2019).

The results of OSPAR beach litter monitoring in the 2012- 2018 period for the entire OSPAR Maritime Area show that, of the total amount of items found on beaches, 13% are attributable to the fishing sector (Fleet, D., 2019, pers. comm.). Of these fishing related items, approximately 67% are 'plastic string and cord' (mostly dolly rope), and about 15% are smaller or larger fishing nets. 'Plastic string and cord' is third on the list of most widespread and therefore top litter items (i.e. number of survey sites with a given litter type as one of the most frequent items); on 77% of survey sites, it is the most common litter category. On 26% of survey sites, the most frequently found litter is the category 'nets and pieces of net < 50 cm'. 'Tangled nets/cord' are the most common litter item on 19% of survey sites, and 'fishing line (angling)' on 14%.

When interpreting beach litter monitoring data, it is important to note that most litter that ends up on beaches has high buoyancy, which causes items to be washed ashore by waves and currents. For fishing gear, OSPAR beach litter monitoring data will be biased towards fishing gear that floats so it is not representative of all fishing gear that ends up in the sea. Due to polyethylene's tendency to float, the most commonly recorded items on OSPAR beaches are small clippings and sometimes larger sections of trawl nets, dolly rope and ropes. What is often not recorded is fishing gear that does not float, such as gillnets made from nylon or lobster cages.

The mean total abundance of litter items per survey site varies greatly between OSPAR sub-regions (**Figure 2.2**), especially between the northern North Sea (Greater North Sea – North) and all other regions. However, due to high variability in litter abundance between sites, the differences between regions are not always significant. With respect to the total litter abundance, mean abundance per survey is significantly lower on Arctic Sea sites than on sites in all other OSPAR sub-regions, except the Wider Atlantic. Mean total abundance is significantly higher on northern North Sea sites than on sites in the Celtic Seas.

The mean abundance of fishing gear litter items per survey site also varies between sub-regions, with the largest abundance found in the northern North Sea. In the Arctic Waters and northern North Sea, fisheries related litter makes up the largest fraction of the total litter abundance compared to the other regions (51% and 39%, respectively). However, for fishing related litter, the only significant difference between the sub-regions is that mean abundance on the northern North Sea sites is higher than on sites in the Celtic Seas.

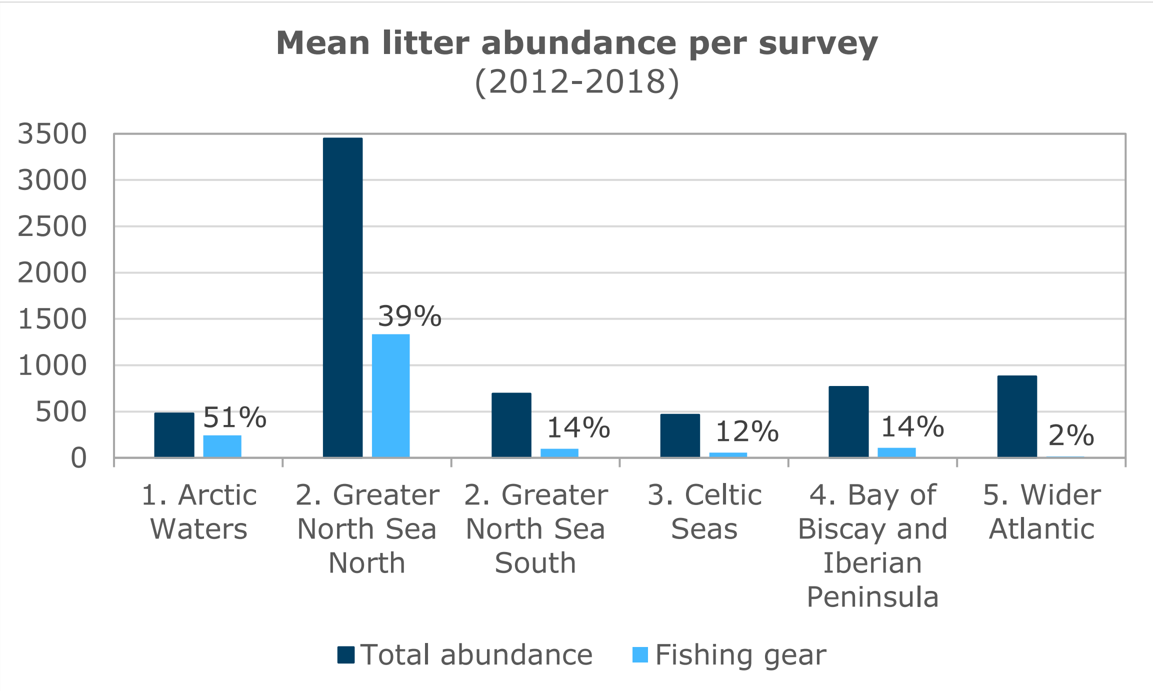

Figure 2.2 **Regional differences in mean total abundance of litter items (dark blue) and fishing related litter items (light blue) on OSPAR survey sites, in the period April 2012 – January 2018 (data from OSPAR Beach Litter Assessment 2019). Percentages indicate the fraction of the total litter abundance represented by fishing gear litter.**

2.1.3. European beach litter baselines

Baseline values for the abundance of litter items on European beaches, including the OSPAR beach litter survey sites, were set by the EU MSFD Technical Group on Marine Litter in 2019, and are elaborated in the EU Marine Beach Litter Baseline Report (Hanke et al. 2019). By combining various beach litter databases, including the OSPAR database, this report assesses and compares beach litter for the various European regional seas. **Figure 2.3** shows the baselines set specifically for the fishing gear category for the North-East Atlantic, at country (**Figure 2.3 a**.) and at EU sub-regional level (**Figure 2.3 b**.). These baselines are based on 2015 and 2016 monitoring data.

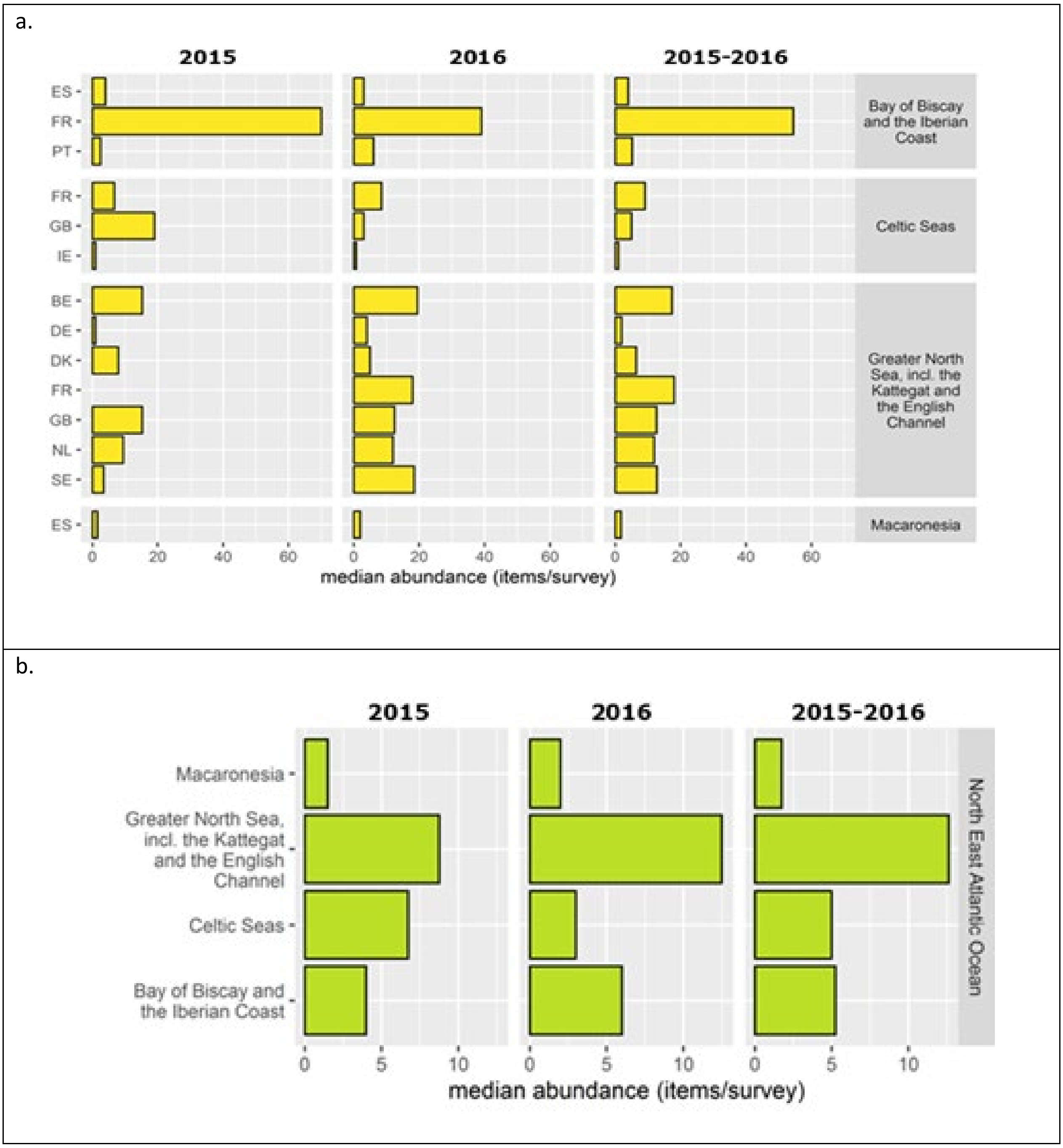

Figure 2.3 **Fishing gear beach litter category baseline levels as established by the EU, at country level (a.) and at subregional level (b.), for 2015, 2016 and 2015-2016 combined (the final baseline). Fishing gear here includes the categories nets and pieces of nets, fishing line/nets (tangled), and monofilament (angling) (B28). Source: Hanke et al. (2019)**

When comparing the OSPAR Maritime Area to other European regional seas, fisheries related litter makes up a larger fraction of total beach litter in the North-East Atlantic than in the other European regional seas (**Table 2.2**).

Table 2.2 Median abundance of total litter items per survey and median abundance of litter items from fishing gear per survey, at regional sea level across the EU (2015-2016 data, items per 100m beach). Adapted from Hanke et al. (2019)

	Baltic Sea	**Black Sea**	**Mediterranean Seas**	**North-East Atlantic**
Number of surveys (2015-2016)	498	41	346	585
Mean total litter abundance	40	106	274	233
Mean abundance of fishing gear litter	2	2	17	40
Fishing gear as % of total abundance	5%	2%	6%	17%

2.1.4. Marine litter from aquaculture

In the OSPAR Beach Litter Guidelines, four litter categories are specifically linked to the aquaculture sector: No. 114 'lobster and fish tags', No. 28 'oyster nets or mussel bags including plastic stoppers', No. 29 'Oyster trays (round from oyster cultures)' and No. 30 'plastic sheeting from mussel culture (Tahitians)'. Using data for these categories from the OSPAR database, the AQUA-LIT project (Sandra et al., 2019) found a geographic distribution of aquaculture related beach litter in the North Sea region. While debris from shellfish culture was mainly found in the English Channel and Southern North Sea, litter from finfish farming was mostly found in the areas of the Northern North Sea, Skagerrak and Kattegat. Furthermore, litter found on Belgian, Dutch and German beaches predominantly originated from mussel and oyster cultivations in Normandy, France. Other categories might also contain aquaculture related items but are not registered as such (e.g. 'string and cord', 'rubber gloves', 'plastic/ polystyrene pieces > 50 cm'). Therefore, the abundance of aquaculture related litter in OSPAR data might be an underestimate of the actual abundance.

2.1.5. Quantities of fishing gear as marine litter in the marine environment

In the North Sea and North-East Atlantic, waste from the fishing industry represents up to one third of marine litter by number of items on the seafloor and in the water column (Pham et al., 2014). To take one example from OSPAR countries, a German based Fishing for Litter project (see Box 4.2) found that net fragments, ropes and lines contributed to about 30% of the litter items returned to port in the North Sea by German trawlers (Dau et al., 2014). Whereas, for the Netherlands, it is estimated that fisheries related waste makes up around 20% of the items and around 50% of the weight collected through Fishing for Litter (Wenneker, B., pers. comm., 2020). A recent desktop study by EUNOMIA on the influx of plastic litter into the European seas, estimates that between 2 000 and 12 000 tonnes of fishing gear are lost each year from the active fishing fleet, with even higher levels expected in the coastal areas from aquaculture gear loss or abandonment (estimated at between 3 000 and 41 000 tonnes) (EUNOMIA, 2016). Since fishing nets and ropes are made of synthetic fibres since the mid-1960s, the study concludes that as much as 130 000 to 550 000 tonnes of fishing gear might have accumulated in the European Economic Area until today, given the development of the European fishing fleet over the past five decades. These numbers are the best ones available, but are also mostly based on expert judgement of estimates of fishing gear loss at sea rather than actual field monitoring data and should therefore be treated as best-guesses.

Dolly rope at sea (left) and dolly rope on a beach (right), photos provided by by WJ Strietman

2.1.6. ALDFG versus EOL

Abandoned, lost or otherwise discarded fishing gear (ALDFG) (also called waste or derelict fishing gear in EU legislation) has to be distinguished from end-of-life (EOL) fishing gear that is removed from operations by the fisheries because of wear and tear. End-of-life fishing gear is relatively clean and can be manually sorted into individual material types. For sorted end-of-life gear, recycling options are already available in Europe today (**Section 4**). ALDFG retrieved from the sea, on the other hand, is entangled and mixed with metal waste, organic matter and other marine debris. This mixed ALDFG is unlikely to be recycled and in some cases even difficult to manage in the existing waste systems (Stolte & Schneider, 2018).

2.2. Harm / impact of fishing gear as marine litter

The harm that is caused by fishing gear as marine litter is well documented, and a brief summary of the main environmental impacts is:

- potential for harm to wildlife through entanglement, ingestion and ghost fishing;
- potential for harm to habitats through smothering and / or abrasion;
- potential to support the spread of invasive alien species;
- potential to cause harm by the transportation of additives / absorption of persistent organic pollutants, which are transmitted within and between habitats, and throughout the food chain.

Furthermore, there is the potential for socio economic impacts, e.g. related to navigational hazards for marine traffic, eyesores on touristic beaches, costs related to clean-up operations and impacts on business activities.

One of the main concerns with fishing gear as marine litter and its impact on the marine ecosystem is that nets and ropes degrade very slowly under marine conditions, and are designed to catch fish / marine organisms, so are innately harmful to marine life. Netting and ropes made from polyamide (nylon, PA6) or polyester (PET) tend to sink to the seafloor where they remain unexposed to mechanical abrasion from waves, UV radiation and oxygen degradation. Netting and ropes made from polyethylene and other highly buoyant materials tend to float and usually end up on beaches and in Arctic sea ice, taken there by ocean currents. Over decades, fishing nets shed microplastic fibres into seawater and sediment, from which they can be ingested by filter feeding organisms and fish. Exact degradation rates under real marine conditions are unknown, yet, fibres have been found to be shedding off from the surface of the trawl fragments older than 30 years, while the netting itself remains sturdy and robust (Stolte, A., 2019, pers. comm.). The harm caused by fishing gear as marine litter, both short and long-term, is a major motivation for developing interventions to reduce the amount of fishing that becomes marine litter in the first place, and, in the event of loss, remove it. It is also a motivation to look for more environmentally friendly alternatives.

2.3. Pathways of fishing gear into the sea

Fishing gear becomes a source of marine litter for many reasons, both intentional and unintentional. In the North-East Atlantic, fishing gear (or parts thereof) that have become marine litter can be understood as an accumulation of:

- loss due to wear and tear during operational use;
- loss due to hydrographical conditions, weather and currents;
- accidental loss of gear and gear parts which cannot be retrieved or are too risky and / or too expensive to retrieve (including due to severe weather and snags beneath the surface);
- loss due to conflict with other gear e.g. in mixed fisheries;
- stretching the boundaries of what the gear can handle;
- intentional or accidental discard of gear (or parts thereof) due to poor handling practice (e.g. clippings from net mending) or lack of storage facilities; and
- to a lesser extent in the OSPAR Maritime Area, intentional loss due to illegal, unregulated and unreported fishing and from vandalism / theft.

In the questionnaire, respondents suggested that snags beneath the surface and severe weather conditions are the two most significant reasons for gear loss, although accidental loss during repairs, conflict with other gear and intentional discard were also commonly reported (see **Figure 2.4**).

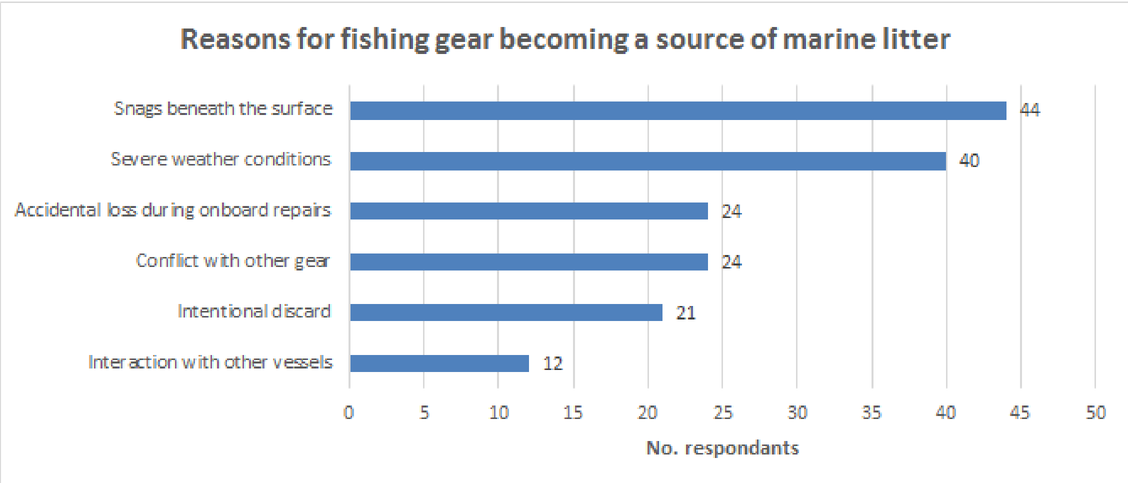

Figure 2.4 **Reasons for fishing gear to become marine litter within the OSPAR Maritime Area.**

2.3.1. Marine litter from aquaculture

Although there are similarities, pathways for marine litter from aquaculture are different than for wild catch fisheries, and should therefore be treated as separate issues. The main sources of marine litter from aquaculture gear are:

1. Extreme weather (e.g. loss of feedpipes or other pvc pipes used to build seapens);
2. Mismanagement and discarding (e.g. loss of gloves, glove packages, off-cuts of ropes, off-cuts of pipes, water bottles used by crews at seapens, etc.); and
3. More relevant to shellfish aquaculture – wear and tear (e.g. loss of ropes, floats and weights, rubbing or stripping of ropes which releases microfibers).

These pathways are reflected in the most common plastic aquaculture components found on beaches. A study by Strietman et al. (WJ Strietman, 2019, pers. comm.) identified these as:

- PVC pipes from salmon farming;
- Rope offcuts from securing cages;
- Floating buoys and drums;
- Tahitians or cones from mussel culture;
- Taquets or pins from mussel culture;
- Mussel socks;
- Oyster mesh bags/cages;
- Coupelle or oyster seed collectors;
- Rubber gloves & protective clothing; and
- Fish trays and feed bags.

2.4. Potential interventions to reduce fishing gear found as marine litter

It is important to understand the reasons why fishing gear becomes a source of marine litter in order to develop interventions to address this issue. However, currently information on the pathways is mostly anecdotal in nature, and reporting losses is not widely performed or accessible (even though there are obligations to report lost gear under the EU fisheries control regulation). A general suite of potential interventions to reduce the amount of fishing gear found as marine litter could include:

- best practice guidance and awareness raising to affect behavioral change and prevent intentional or thoughtless discard;
- providing appropriate waste management provisions onboard and at ports and harbours, including appropriate information on services offered in each port, and implement new provisions of revised PRF-Directive in fishing harbours such as the 100 indirect fee system;
- reducing the risk of accidental loss through (gear specific) design modifications;
- targeted removal activities, drawing on marking and reporting systems for lost gear;
- removal of legal, financial or practical barriers to, and providing incentives for, returning ALDFG and EOL gear to shore for appropriate disposal / recycling;
- altering design to reduce impact of gear in the event that it is lost in the marine environment;
- gear marking to dissuade intentional loss and incentivise reporting in the event of loss (noting the existing conditions set out in the EU fisheries control regulation); and
- control or restriction of fishing activity in high loss areas.

This scoping study focuses on the challenges and barriers to the collection of and logistics for recycling of EOL fishing gear and ALDFG (**Section 4**). The project also considers how the design of fishing gear can be modified for increased recyclability and re-use, as well as the potential for design modification to reduce the impact on the marine environment in the event that gear is lost (**Section 5**). However, most of the potential interventions listed above are considered at some point within this report.

2.5. Marine litter from recreational fishing gear

The focus of this study is marine litter from commercial fisheries and aquaculture facilities, however questionnaire respondents were also asked about their views on the importance of recreational fishing as a contributing factor to marine litter. Most respondents agreed that recreational gear contributed to some degree but there was a lot of variation in responses and many people did not know (**Figure 2.5**). This suggests that further investigation is needed in this area.

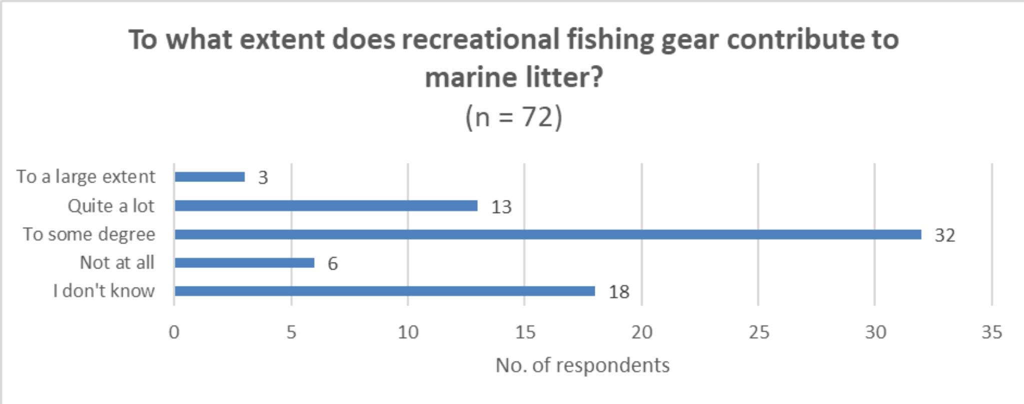

Figure 2.5 Extent to which respondents felt that recreational fishing gear contributed to marine litter in the OSPAR Maritime Area

3. Fishing Gear in the OSPAR Maritime Area

Fishing is an important economic activity in the OSPAR Maritime Area. A number of different fisheries operate throughout the regions, mostly deploying specific types of gear targeting specific species. Material use and therefore waste management options are highly specific to the type of gear. This section describes the different types of gear used in the OSPAR Maritime Area, the materials they consist of, the distribution of this gear throughout the regions and main fisheries involved, and the supply chain for fishing gear.

3.1. Types of commercial fishing gear

Various types of fishing gear are used throughout the OSPAR Maritime Area, depending on the target species and the specific area. A wide selection of plastic materials is used in these different types of gear, with the main materials including polypropylene (PP), polyethylene (PE), polyamide (PA6 or nylon) and polyester (PET). Information in this section was collected from the websites of Marine Stewardship Council (MSC) (2020), FAO (2020), questionnaire responses and additional expert interviews. **Table 3.1** gives a summary of the main plastics used in different types of commercial fishing and aquaculture gear.

Table 3.1 Overview of plastics used in fishing and aquaculture gear. Source: EUNOMIA (2018)

Material	Use
Polyamide/Nylon (PA)	Nets (mostly gillnet and seine), lobster and crab
Polypropylene (PP)	Nets (mostly gillnet and trawl net), rope, mesh
Polyethylene (PE)	Nets (mostly trawl net, purse seine net); longlines; Aquaculture: rope, cage, floats, tubes, disks
High-density Polyethylene (HDPE)	Trawl doors, dredges, small parts and cladding
Expanded Polystyrene (EPS, foam), Polyurethane (PU)	Insulation, floats and buoys, including in fish aggregation devices (FADs)
Polyvinylchloride (PVC)	Aquaculture: cages, tubing and piping
Acrylonitrile butadiene styrene (ABS), Polyvinyl difluoride (PVDF)	Aquaculture: valves
Aramids, Ultra High MW Polyethylene (UHMWPE, e.g. Dyneema®), Aromatic polyester	Rope, net (newer technology)
Glass fibre reinforced plastic (GFRD)	Aquaculture (newer technology)

3.1.1. Dredges

Dredges (**Figure 3.1**) are rigid frames that are towed along the seabed by a fishing boat to target bottom-dwelling species, typically bivalves such as scallops, oysters and clams. A dredge consists of a heavy steel frame with an attached collection bag, although the specific design depends on the target species and specific area. Two respondents from the UK indicated that UK dredges (targeting scallops) are typically made of a steel frame and chains, with PE netting on top.

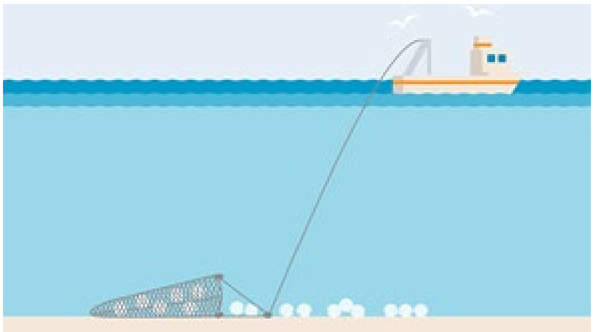

Figure 3.1 Typical design of a dredge. Image from MSC (2020)

3.1.2. Trawls

Trawls (**Figure 3.2**) can be deployed on the bottom or in midwater (pelagic). A bottom trawl is a cone-shaped net with a closed end, also called the cod-end, which is towed along the seabed by one or two boats. Bottom trawls target species living at depth or on the seabed. Contact with the seabed is necessary to capture the target species. Based on the design of the horizontal opening, a distinction is made into three different types of bottom trawls: beam trawls, bottom otter trawls, and bottom pair trawls. In the case of beam trawls, dollyrope may be attached to the codend, to protect it from wear and tear. Dollyrope consists of bundles of orange or blue plastic (polyethylene) threads. Bottom trawl nets are made of plastic composite/non-composite twines, typically PE, with parts also in PA and even PES. The nets can be strengthened with additional materials, such as dollyrope, volcanic rubber and metal chains. The headline and footrope may also contain metal strengthening, such as steel or lead. Rubber-layered discs (10cm-30cm in diameter) are also commonly threaded on the bottom rope of a bottom trawl, to provide rockhopper capabilities for the net on rougher bottoms. A commonly encountered type of rope in trawls (and flyshooting) is the combirope or typhoon wire, which consists of a metal core with plastic sheathing.

Pelagic trawls are similar to bottom trawls, but are deployed in midwater (no bottom contact). They are generally much larger than bottom trawls. Target species are fish in the mid- and surface water, such as herring and mackerel. Pelagic trawl nets are typically made of PA, but sometimes also of other plastics (e.g. PE or UHMWPE). Normally, nets for pelagic trawling do not contain chains, rubber discs or other additions for strengthening, as the nets are not in contact with the bottom.

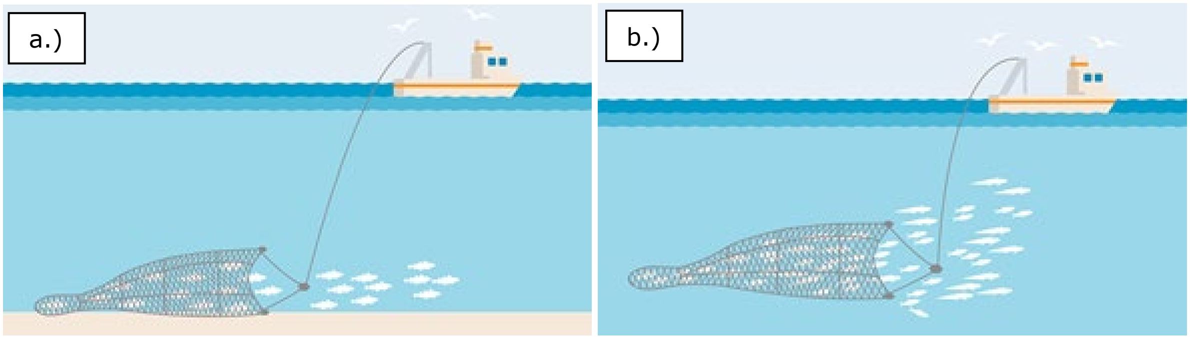

Figure 3.2 Bottom trawl (a.) & pelagic trawl (b.). Images from MSC (2020)

3.1.3. Line fishing

With rod and line, large pelagic species (such as tuna) are caught one at a time, using a rod and line deployed from a boat (**Figure 3.3**). In longline fisheries, a long line with baited hooks is trailed behind a boat, either targeting a pelagic or demersal fish species. Modern lines from fishing are made of a wide range of different plastics, including polyamide/nylon, polyvinylidene fluoride (PVDF), polyethylene, PET/Dacron and UHMWPE/HMPE. Hooks are typically made of steel, sometimes with a corrosion-resistant surface coating.

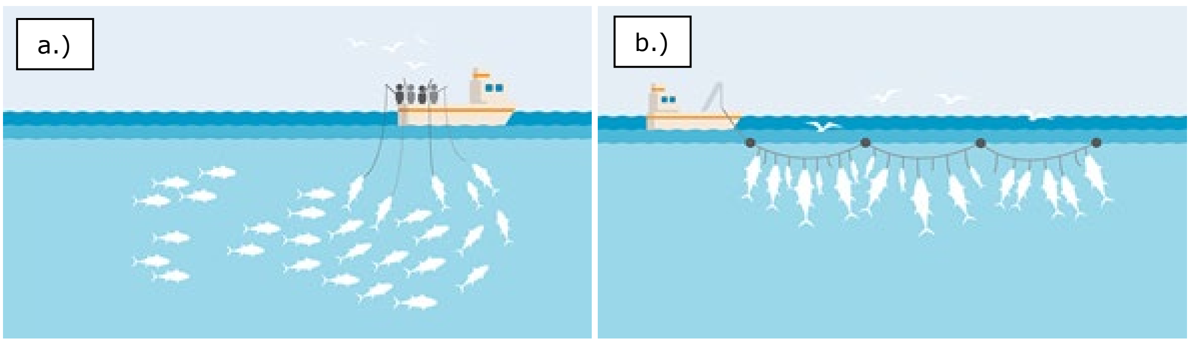

Figure 3.3 Rod and line fishing (a.) and longline fishing (b.). Images from MSC (2020)

3.1.4. Traps

Stationary traps, or pots (**Figure 3.4**), are deployed on the bottom, typically for around 24 hours, to catch crustaceans such as lobster and crabs. Traps are typically made of wood, wire netting or plastic. Respondents indicated that trap or creel fisheries in the UK and Sweden mainly use steel frames with PE covers and rubber bands, combined with PE or polysteel ropes. Surface markers are commonly polystyrene floats with a wooden or plastic pole and flag to make spotting them more obviously.

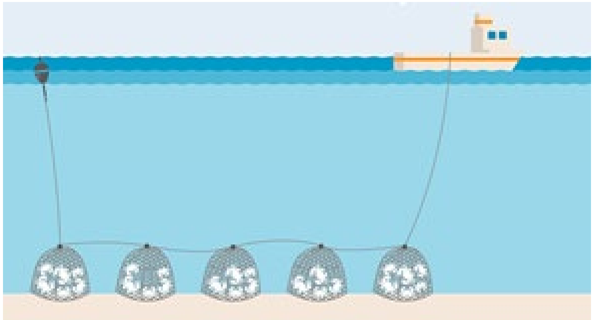

Figure 3.4 Typical design for stationary traps. Image from MSC (2020)

3.1.5. Stationary nets

Various types of stationary nets are used throughout the OSPAR Maritime Area, depending on the species targeted. A common type is the gillnet (**Figure 3.5**): this is a wall or curtain of netting that hangs in the water column vertically. Fish swim through with their head and get caught by the gills. Gillnets consist of single, double or triple netting (known as "trammel net") mounted together on a single frame of ropes. A stationary gillnet is kept in place by anchors or poles on the seabed, whereas a drift net is kept afloat at a target depth using a system of weights and buoys.

Gillnets are typically made of monofilament or multifilament polyamide (PA6, nylon). Along the footrope, weights are evenly distributed, and small solid floats (usually plastic, e.g. PE/PP) are attached to the headrope. The float lines are typically a mix of woven PE and PP, with floats made of PP or expanded polystyrene. Sink lines generally consist of a woven PET mantle or sheathing around small lead weights. Lead is commonly used in gillnet sink lines. As lead is a toxic heavy metal, retrieved gillnets strengthened with lead are considered hazardous waste. This leads to waste management issues in e.g. Germany (for further details, see **Section 4**).

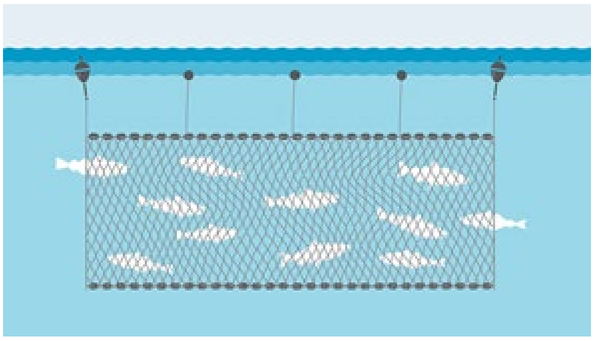

Figure 3.5: A gillnet, kept in place with floats. Image from MSC (2020)

3.1.6. Seine

A seine is a vertical net used to surround a school of single-species fish. It is deployed either from shore or from a boat, and is operated by two long ropes fixed to its ends. In a purse seine (**Figure 3.6**), targeting pelagic species, the bottom of the net is drawn together to enclose the fish (similar to tightening the cords of a purse). Like trawl nets, seine nets are often composed of single polymer materials, typically polyamide or polyethylene. Plastic floats are often attached to the top of the net, and can be made of e.g. PVC, PET, EVA (Ethylene Vinyl Acetate) or PE/HDPE.

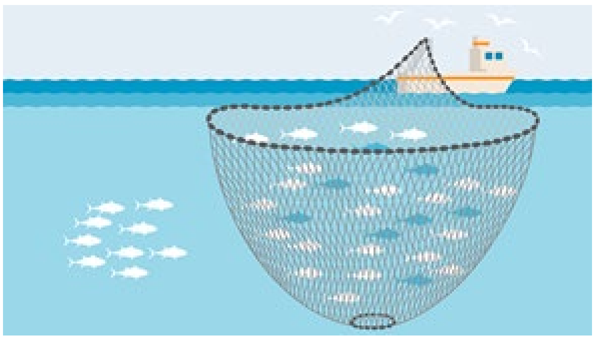

Figure 3.6: Example of a purse seine net Image from MSC (2020)

3.1.7. FADs

A FAD, or Fish Aggregating Device (**Figure 3.7**), is a permanent, semi-permanent or temporary structure or device used to attract fish. As certain pelagic fish species tend to aggregate under floating objects, the FAD is left in the water to allow fish to school under or around it. Tuna is an important target species. FADs exist in many different varieties and can be deployed either at the surface or in midwater. In general, a given FAD can be fished every 10-30 days, and a permanent FAD often has a life expectancy of 2 to 3 years (FAO, 2019). FADs can be made of many materials, but generally comprise of buoys and floats close to the surface. Midwater FADs only have a smaller surface buoy, with a larger buoy in midwater. Modern, deeper variants may be anchored to the bottom. FADs are always used in combination with other fishing gear, often purse seine nets. FADs used by commercial vessels are typically crafted from durable materials such as PVC pipe, synthetic rope, and nylon mesh net.

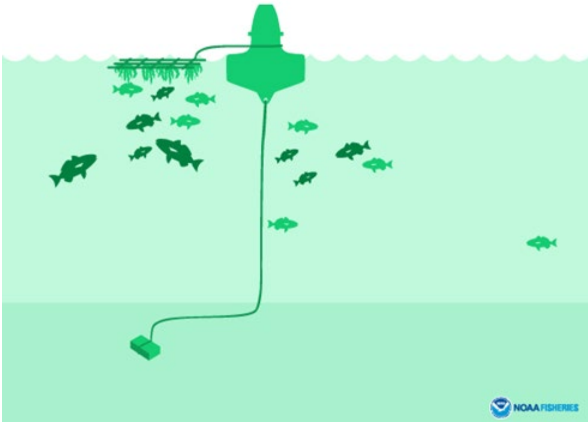

Figure 3.7 **Example of a Fish Aggregating Device. Image from NOAA (2020)**

FADs are not commonly used in the OSPAR Maritime Area and no respondents reported use of FADs in OSPAR Countries. However, FADs are used by EU vessels operating in tropical regions and international waters outside of the OSPAR Maritime Area (e.g. the Gulf of Guinea).

3.1.8. Aquaculture gear types

Aquaculture is also a common source of marine litter in the OSPAR Maritime Area (ASC, 2019). Aquaculture makes extensive use of plastic materials, both for equipment and packaging material. Reasons for using plastics include the resistance to abrasion, durability, resistance to rust, the light weight (to ease handling), and the possibility to easily mould the material into specific shapes. High density polyethylene (HDPE) is the most commonly found plastic type in aquaculture, but many more materials are used, including nylon/PA6, PE, PP and expanded polystyrene (EPS).

The major aquaculture gear types as classified by ASC (2019) include:

- Open-water cages and pens: floating collars with suspended net enclosures in the open environment, used for e.g. salmon and yellowtail;
- Suspended ropes and longlines: anchored to the seabed and suspended to the water surface with buoys or rafts, mainly used for shellfish farming (e.g. oysters or mussels) and also for seaweed cultivation;
- Coastal and inland ponds: open, on-land ponds fed with sea or river water, in the OSPAR Maritime Area mainly used for trout and other freshwater fish.
- Tanks: often high density in an enclosed area, for a wide range of species under a wide range of conditions.

Many different types of plastic are used for the different gear components, with the most common plastic components including:

- Different nets and ropes made of nylon, PE, PP and PET, and sometimes also UHMw-PE (e.g. Dyneema®);
- Various types of pipes made of PVC, HDPE or FRP;
- Buoys made of HDPE, LDPE or PE; and

- Other floatation components commonly made of EPS, HDPE or PVC.

A complete overview of the different plastic components of aquaculture gear is given by ASC in their White Paper on marine litter from aquaculture (Huntington, 2019).

3.2. Distribution of commercial fishing gear in the OSPAR Maritime Area

This section describes the most important fisheries and their type of gear in the OSPAR Maritime Area. Overall, fisheries in OSPAR waters account for over 60% of the landed weight in the EU: the North Sea & Eastern Arctic fishing areas account for 32% of the total landings by the EU fleet, and the North-East Atlantic (FAO area 27) for another 30% (STECF, 2018).

3.2.1. North Sea & Eastern Arctic commercial fisheries

Following the STECF (2018) report, this section describes the commercial fishing sector for the eastern part of OSPAR Region I (Arctic Waters) and OSPAR Region II (Great North Sea) combined. All data mentioned are from 2016 and were retrieved from STECF (2018).

Revenue generated by the North Sea and Eastern Arctic fleet in 2016 was estimated at almost EUR 2.1 billion. In terms of value, the most important species include Atlantic herring (12.5%), Atlantic mackerel (10%), Atlantic cod (10%), common shrimp (10%), common sole (8%) and European plaice (7.5%). Based on the 2016 income from landings, the most important large-scale segments of the fishing fleet were the UK pelagic trawlers over 40m (EUR 192 million); the Danish pelagic trawlers over 40m (EUR 145 million); the Dutch beam trawlers over 40m (EUR 133 million); and the UK demersal trawlers 24-40m (EUR 126 million). Concerning small-scale fisheries, the most important fleet segments were the UK pots and trap vessels under 10 metres (EUR 36.6 million) and the French drift netters of 10-12 meters (EUR 17.7 million). **Table 3.2** gives an overview of the main fisheries in the region of the North Sea & Eastern Arctic.

Table 3.2 Main fisheries in the North Sea and Eastern Arctic, including main countries operating in this fishery, main target species and main gear type deployed

Fishery	Main countries (in order of importance, in terms of landings in weight and value)	Main target species	Main gear
Pelagic fishery	Denmark, UK, the Netherlands, Germany, Sweden, France and Ireland	Mackerel, herring, horse mackerel, jack mackerel. Also sandeels and European sprat (Sweden, Denmark; for industrial purposes i.e. fishmeal/fish oil)	large pelagic trawls
Demersal roundfish and Nephrops (Norway lobster) fishery	UK, Spain, Denmark, France, Germany, the Netherlands, Sweden and Belgium	Cod, Norway lobster, haddock, saithe and hake	demersal (bottom) trawls
Flatfish fishery	Netherlands (dominant, also owning part of the fleet of other MS), Denmark, UK, Belgium, France	Mainly common sole and European plaice, but also brill and turbot	(large) beam trawls, NL in 2016 also pulse fishing (now forbidden),

	and Germany		otter trawls (DK)
Brown Shrimp Fishery	Netherlands, Germany, Denmark, and Belgium	Brown shrimp	Smaller beam trawls (<24m)

3.2.2. North-East Atlantic commercial fisheries

The North-East Atlantic, as defined by the STECF (2018) and as described in this section, covers OSPAR regions III (Celtic Seas), IV (Bay of Biscay and Iberian Coast) and V (Wider Atlantic) and the middle part (around Iceland) of region I (Arctic Waters). All data mentioned are from 2016 and were retrieved from STECF (2018). Revenue generated by the NE Atlantic fleet in 2016 was estimated at EUR 2.66 billion, of which 95% was produced by five Contracting Party fleets: France (EUR 799 million), Spain (EUR 691 million), UK (EUR 525 million), Ireland (EUR 265 million) and Portugal (EUR 254 million). France and Spain also operate the largest numbers of active vessels in the large scale fleet, with 2 881 vessels and 1 042 vessels, respectively. Other fleets operating in this region include Belgium, Denmark, Germany, Lithuania and the Netherlands. The countries operating in the small-scale coastal fleet are Ireland, Portugal, Spain, France and the United Kingdom.

In terms of landed value, the most important species are European hake and Atlantic mackerel (usually caught using pelagic trawls) and Norway lobster (targeted with traps). These are followed by the monkfishes and anglerfishes, and the Great Atlantic scallop, which are commonly caught using beam trawls and dredges, respectively. However in contrast, in Spain, European hake is caught by bottom trawl, gillnets and longliners, and Monkfishes and anglerfishes are caught using bottom trawls. Based on the 2016 data on income from landings, the most important fleet segments for the North-East Atlantic are the French demersal trawlers between 18 and 24m (EUR 128 million in 2016), the Spanish polyvalent passive gears between 24 and 40m (EUR 121 million), and the UK pelagic trawlers over 40m (EUR 118 million). These are followed by the Irish and Portuguese demersal trawlers of 24 to 40m, and the French drift nets.

3.2.3. Gear types for commercial fisheries by country

Figure 3.8 shows the questionnaire responses on the predominant gear types used in each country. Bottom trawls were most frequently mentioned by respondents as an important type of gear in the OSPAR Maritime Area, followed by pelagic trawls and various types of nets.

Many respondents indicated that for the North Sea, bottom trawls are the dominant type of gear, targeting mostly shrimp and flatfish. None of the respondents indicated that FADs are used in their country. Below are further specifications given by respondents from the various countries:

- Respondents from Belgium indicated that commercial fisheries in Belgium mainly use beam trawls targeting flatfish, such as sole and plaice, and shrimp, as well as gadoid and roundfish. There are also some vessels that use otter trawls. Static gear used consists mainly of trammel nets targeting sole. Dredges target scallops but are few, and seines are typically flyshooters.
- In the Kingdom of Denmark, all indicated types of gear are used, but the main categories used include pelagic trawls and seines, demersal bottom trawls and demersal seines, and set nets. The most dominant species include herring, sandeel spratt, plaice, mackerel, and Norway lobster. For Greenland, the most dominating species (in terms of income) are shrimp, Greenlandic halibut and cod.
- The main gear type in France is also the bottom trawl. Pelagic trawls, nets and long lines are also used frequently.

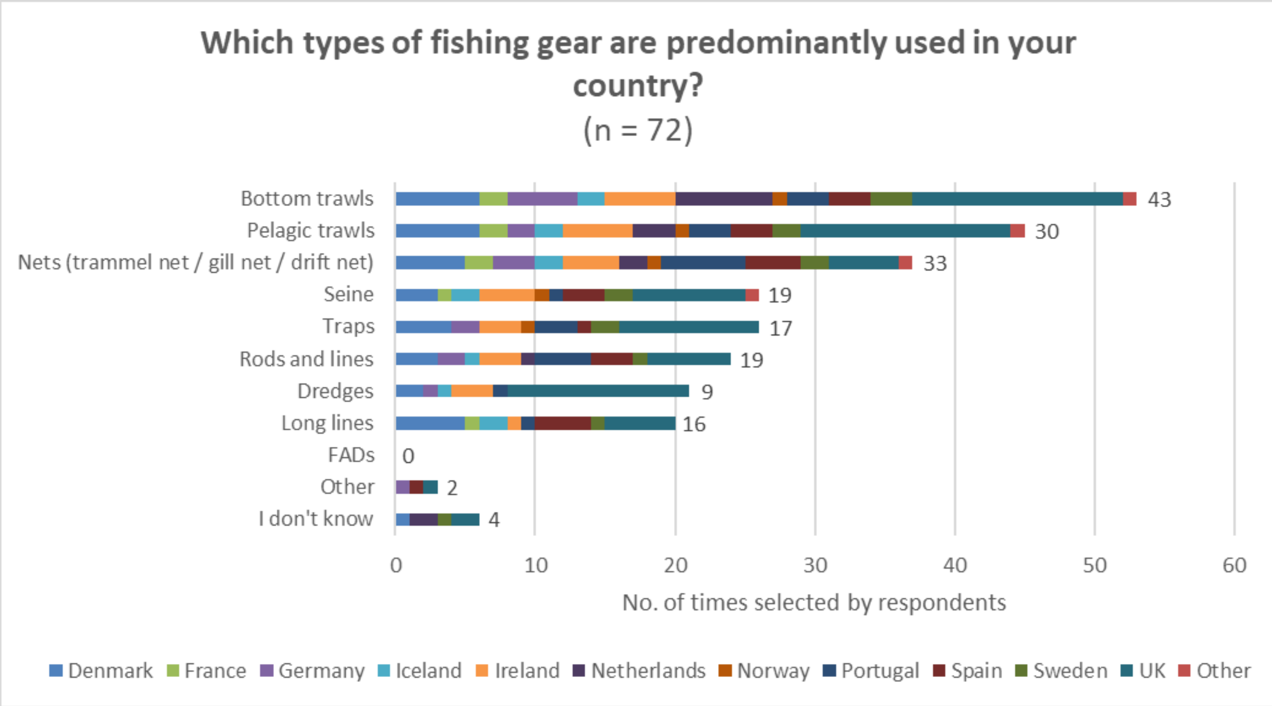

Figure 3.8 **Questionnaire responses on predominant types of fishing gear in each Contracting Party, colour coded by country**

- In Germany, the main fishing gear used in the North Sea are dredges used in Blue Mussel fisheries and bottom trawls (mainly beam trawl) used in shrimp and flatfish fisheries. To a lesser extent, traps are used in eel and lobster / brown crab fisheries, and stow nets are used in estuaries in smelt and mixed fisheries. Gill nets are used mainly in coastal fisheries in the Baltic.
- In Iceland, the most dominant gear types include bottom trawls, pelagic trawls, long lines, nets and seines.
- In Ireland, bottom trawls are used for demersal fisheries, pelagic trawls for midwater fisheries, traps for crab and lobster and seines for demersal fisheries. A small part of the fishing fleet uses dredges, mainly in the inshore razor fleet and scallop fisheries. Bottom trawls and seines are used throughout the year, while the other types of gear are mainly used seasonally.
- In Norway, many vessels combine various gear types due to seasonal fisheries. Nets and long lines are a common combination in the traditional coastal fleet. Trawls are mainly used in the offshore fleet, and Danish seine in bigger coastal vessels. Traps are mainly used in recreational fishery, but are also used in (limited) commercial fisheries for crab.
- Respondents from Portugal indicated that the most used gear include traps, nets and hooks (in number of vessels), with less bottom trawling and seining, and some dredges. Some respondents also indicated that rods and lines were also used. Pelagic trawling is forbidden in Portugal and so not used.
- In Spain, the most common commercial fishing gear include trawls (bottom only as Spanish regulation forbids use of pelagic trawls), rods and lines, long lines, traps, nets and seines. Aquaculture pen nets were also mentioned as an important gear type. Blue whiting and mackerel are caught using bottom trawls.
- For the commercial fisheries in Sweden, based on days at sea, gillnets, pots and traps and bottom trawls are the most used gears. A small part of the fisheries also uses set gillnets. However, on the Swedish west coast pelagic trawling is commonly used.

- In the Netherlands, bottom trawls represent the main type of gear, followed by pelagic trawls. Bottom trawls are used mainly within flatfish (sole and plaice) and shrimp fisheries. To a lesser extent, nets and rods and lines are also used.
- Respondents from the UK indicated that all types of gear are used in commercial operations around the country, depending on the target species. Bottom trawls form the largest sector, extensively used for whitefish and nephrops. Beam trawls are also used for flatfish & cuttlefish, and there is a small fishery for queen scallops. The next most important gear type are traps (creels), followed by pelagic trawls. Pelagic trawls and purse seine are used to target mackerel and herring. Nets are widely used in inshore and offshore waters, although gillnets are prohibited in inshore Scottish waters. Towed dredges target scallops & oysters, while hydraulic dredges are used to target burrowing bivalves in shallow water. Long lines form a minor fishery, just like rods and lines.

3.2.4. Aquaculture in the OSPAR Maritime Area

Aquaculture is of growing importance for food production around the world, and also in the EU. In terms of volume, worldwide aquaculture production overtook capture fisheries in 2013 (FAO, 2019). However, it should be noted that aquacultured fish are fed with wild fish, and so the two recorded amounts are not unrelated. The most important cultivated species in the OSPAR Maritime Area include salmon, mussels, oysters, sea bream & sea bass, and trout. In terms of produced weight from aquaculture, Norway is by far the main producer, producing over 1.3 million tonnes in 2017 (mostly from salmon cultivation). Spain, the UK and France follow at a distance, all producing around 200 to 300 thousand tonnes. **Table 3.3** gives an overview of the top 10 OSPAR Contracting Parties in terms of produced weight from aquaculture, and their main cultivated species.

Table 3.3 Total aquaculture production and main cultivated species of the top 10 OSPAR Contracting Parties in terms of weight produced (2017 data). Data from Eurostat (2019) and EC (2012)

Country	**Total production (tonnes of live weight)**	**Main cultivated species:**				
		Salmon	*Mussels*	*Oysters*	*Sea bream and seabass*	*Trout*
Norway	1 308 484	x				
Spain	314 958		x	x	x	
UK	222 249	x	x	x		
France	188 622		x	x		x
Netherlands	51 031		x	x		
Ireland	43 247	x	x	x		
Germany	36 142					x
Denmark	34 327					x
Iceland	21 685	x				

3.3. Recreational fisheries

Next to commercial fisheries, marine recreational fisheries (including angling) play an important role in terms of the removal of biomass from fish stocks. For example, recent research by Radford et al. (2018) estimated that for Europe, the annual contribution of marine recreational fisheries to the total removal (recreational + commercial) of fish stocks ranged between 2%, for Atlantic mackerel in the North Sea and Skagerrak, and 43%, for Atlantic pollock in the Celtic Seas and English Channel. Despite the clear importance, research on recreational fisheries is still lacking, especially with respect to marine litter. In Germany, diving campaigns are currently carried out in the context of a research and development project to survey lost angling gear and systematically collect lost fishing lures at sea (UBA, 2020). The results of the project will make it possible to assess to what extent pollution of a certain sea area takes place by fishing lures. Considering the scale of marine recreational fisheries, it is important to also include recreational fishing gear in measures aiming at marine litter reduction. In Ireland, some inshore vessels in areas with high shore angling activity report entanglement of traps and pots with angling gear, sometimes leading to impacts on bottom species such as lobster and crab.

Figure 3.9 shows questionnaire responses on the relevance of commercial and recreational fisheries in OSPAR Contracting Parties. For almost all countries, respondents indicated that both commercial and recreational fisheries are important, although in most cases, more respondents opted for 'Mainly commercial'. The exceptions are Iceland (only 'Mainly commercial') and Sweden (only 'Both commercial and recreational).

With respect to types of fishing gear, rods and lines were mentioned as being important recreational gear types. Respondents from Germany and the UK indicated the presence of a widespread recreational fishery sector. As for commercial fisheries, rods and lines typically consist of a plastic line with metal (steel) hook. Often, small plastic floats are used, as well as metal weights. There is still widespread use of lead for weights in recreational angling gear. In Norway, pots and traps and gillnets were also mentioned as important for recreational fisheries.

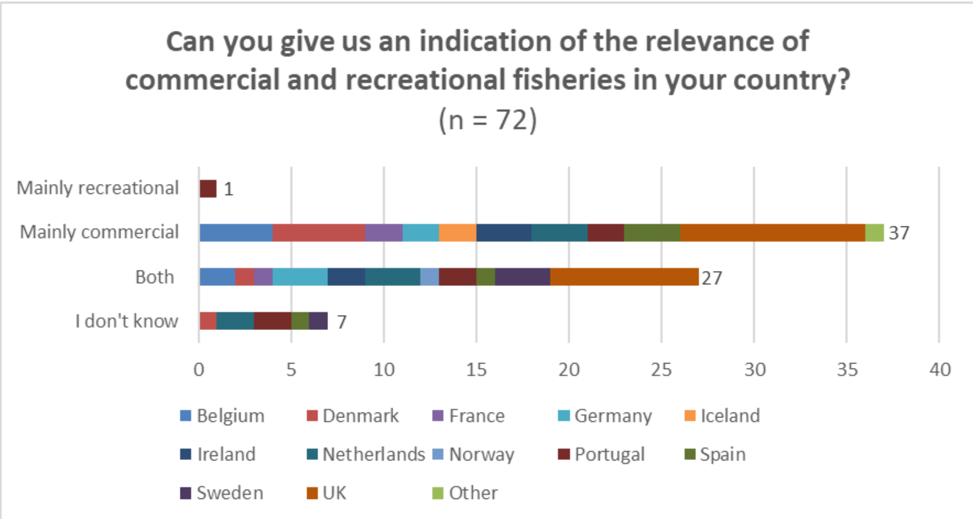

Figure 3.9: Questionnaire responses on the relevance of commercial versus recreational fisheries, colour coded by country

3.4. Fishing gear supply chain

To implement Extended Producer Responsibility (EPR) schemes on fishing gear, it is important to identify the producers of fishing gear in each Contracting Party. The SUP Directive states that the 'producer' of fishing gear is *'any natural or legal person established in a Member State that professionally manufactures, fills, sells or imports, irrespective of the selling technique used, including by means of distance contracts as defined in […], and places on the market of that Member State […]* ***fishing gear containing plastic****, other than persons carrying out fishing activities as defined in […]'*. This definition extends to manufacturers as well as assemblers and suppliers, both for complete fishing gear and for intermediate products such as netting or ropes. Therefore, it is important to investigate the fishing gear supply chain for EPR implementation. **Figure 3.10** gives a general overview of the supply chain for fishing gear. This section deals with the fishing gear supply chain in the OSPAR Contracting Parties, up until the point of sale to fishers & fish farmers; the chain for collection / processing is addressed in **Section 4**.

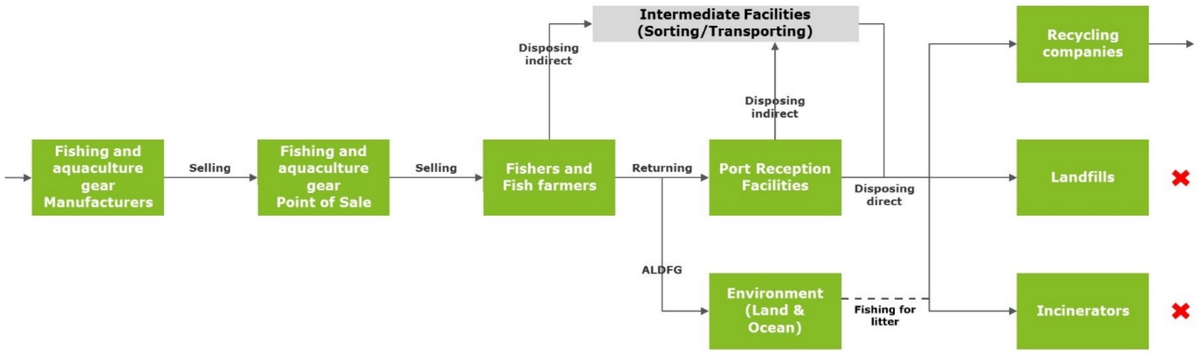

Figure 3.10 The fishing gear supply chain. Figure adapted from Viool et al. (2018). Note that the primary source of the supply chain, i.e. polymer manufacturers delivering raw materials to gear manufacturers, is not included in the figure.

Manufacturers and assemblers or netting companies were most often mentioned as the places where fishers buy their gear (**Figure 3.11**). Often, fishing gear is assembled locally from raw materials. Various respondents (Denmark, Germany, Ireland, Sweden, Netherlands, UK) indicated that part of the gear consists of tailor-made fishing equipment, made according to specific demands depending, for example, on the ship and the target species. Trawl gear especially was mentioned as often being custom-made, according to individual preferences of fishers. This results in a high diversity of especially trawling gear design. To some extent, fishers also self-assemble their gear, as fishers may build their own nets using raw material from netting companies or from older pieces of gear (mentioned e.g. for Germany, Ireland, Sweden). For the UK, pots and traps were also indicated as sometimes being self-assembled. A respondent from the UK indicated that in general, larger offshore operating vessels are less likely to assemble their own gear, while those that assemble their own gear are often smaller scale, inshore operations.

In some countries (especially the Netherlands and Belgium), fishers buy part of their gear through fisheries cooperatives. For example, In the Netherlands, several of the raw materials are bought via the Fisheries Cooperative Buyers (CIV). In Belgium, the main cooperative is called VVC Equipment.

Online ordering was not mentioned as an important source for most commercial gear. Respondents mentioned online ordering as a source for cheaper gill nets, static gear and rods & lines. During interviews, several producers of fishing gear expressed concerns that if the price of gear increases due to EPR, more gear might be ordered online to avoid the additional EPR fee imposed in the EU. Concerning recreational fishing, respondents often indicated that gear (angling gear, rods & lines) is bought in specialised shops or through online ordering. Since cheap gear such as gill nets are especially prone to be discarded or left behind it is of high importance to provide solutions on how to implement ERP for gear ordered online / overseas.

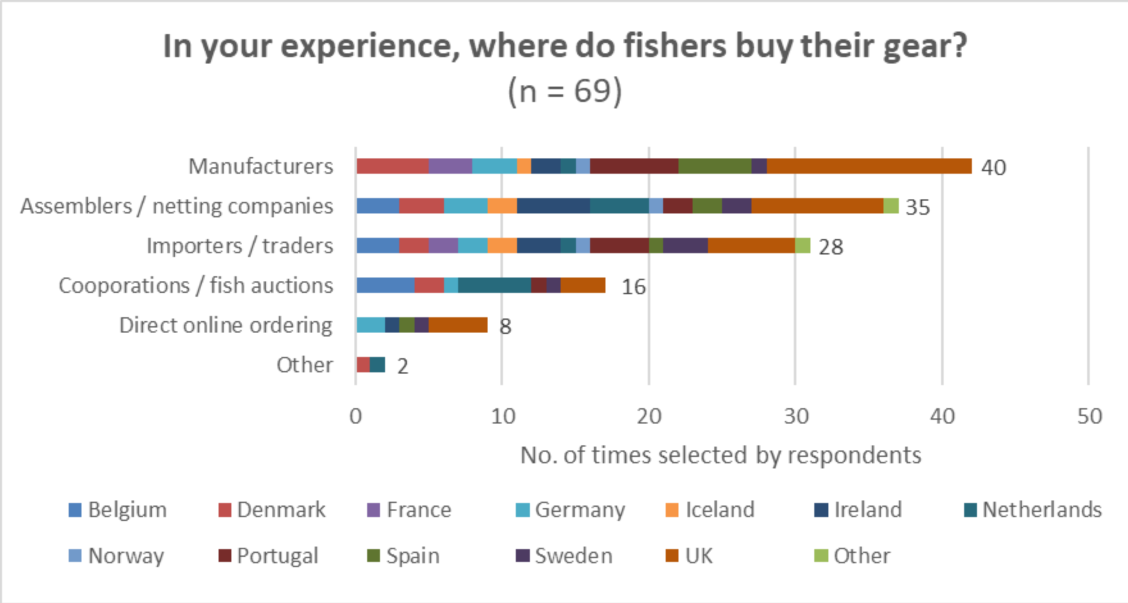

Figure 3.11 **Questionnaire responses on where fishers buy their gear, colour coded by country**

In many cases, respondents replied that local net manufacturers assemble gear, while the manufacturing of raw materials is typically done overseas. Companies in Spain (Redes Salinas) and Portugal (Euronete) are mentioned as important producers of fishing gear. For synthetic yarn, Eurocord was mentioned as an important distributor. Eurocord is the European Association of Rope, Twine and Netting manufacturers, their suppliers and their affiliate industries. Important international netting companies mentioned by respondents include Euronete and Hampiðjan.

Figure 3.12 shows the questionnaire response on types of fishing gear manufactured in respondents' respective countries. The distribution reflects the types of gear that are used in the region (**Figure 3.8**), with bottom trawls, pelagic trawls and nets most mentioned as manufactured in respondents' countries.

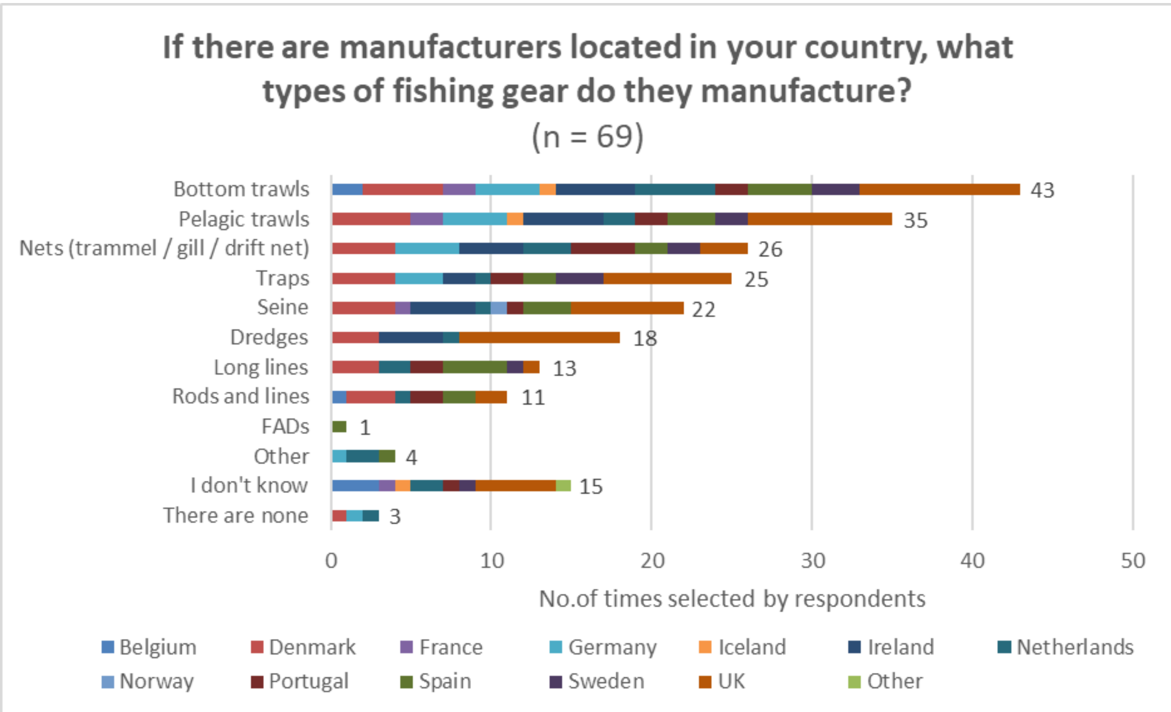

Figure 3.12 **Questionnaire responses on types of gear manufactured in the different countries, colour coded by country**

Next to the larger overseas suppliers of materials, there is a wide range of local suppliers in each Contracting Party. **Table 3.4** provides an overview of the main fishing gear suppliers (manufacturers and assemblers) per country, as mentioned by respondents.

Table 3.4 Questionnaire responses on main fishing gear suppliers per country and, where mentioned, type of gear supplied

Contracting Party	Type of gear	Manufacturers / assemblers
Belgium		Main companies in Portugal, Italy, Greece, Iceland, Norway and to a lesser extent Central European countries.
		VVC equipment https://www.vvcequipment.be (VVC Zeebrugge, VVC Oostende)
Denmark	trawls	Tor-Mo Trawl: http://www.tormotrawl.dk/dk/profil.html Cosmos Trawl: http://www.cosmostrawl.dk/ Comet Trawl: https://comet-trawl.dk/erhvervsfiskeri/
		Strandby Net: http://www.strandbynet.dk/forside.aspx
		Egersund Danmark: https://www.hmsn.dk/da/medlemmer/egersund-danmark
	aquaculture	Hvalpsund net
France		Fiskevegn, Norway
	trawls	Le Drezen (Finistère) / Nabera (Spain but an office in Finistère) and DEMK (Morbihan)
	nets	Mondiet (Gironde) / le Drezen (Finistère) / Alprech (Pas de Calais) / Kerfil (Finistère) / Atelier du Filet (Vendée)
Germany	trawled gear netting	Gruchow Norddeich, Cux-Trawl, Dutch auctions
	gill nets	Frydendahl/Haugesund in Denmark. Also online trade, presumably focus on Asian production sites
	angling equipment	Presumably from regular global market sources in the shops
	lines	Likely from the Asian line market
	bottom and pelagic trawls	Rostock-Warnemünde Kloska Group Net manufacturer Engel Netze https://engelnetze.com/
	gill nets for lake fisheries	Kremmin Netze https://www.kremmin.net Vogt Netze https://shop.vogtnetze.de/
	gill nets, small nets, traps, crab pots etc.	Herberle Netze https://www.heberle-netze.de/
	rod & line lines and others	a large number of monofilament-nylon producers
Iceland		Hampidjan, Ísfell, Egersund and Morenot
Ireland	all types of gear	Swan Net Gundrys, Castletownbere, Union Hall & Killybegs; Jackson Trawls, Peterhead, Scotland
	pelagic	KT nets Killybegs
	trawls and seine nets	Donegal, Stuart nets & Castletownbere
		Frankie Griffin, Schull; Ger Dougal, Greencastle; Cavanagh Nets, Greencastle (but nationwide); Mc Carry nets, Greencastle (but nationwide); Stuartnets, West Cork; Carrymccarry, Donegal, North West; Pepe Trawls and Marine Suppliers, Howth, East coast. Also producers in Scotland, Cornwall and Iceland.
Norway	seine	Only some manufacturers of purse seine and Danish seine
	other gear	Production of components abroad, mainly in Asia
Portugal		Spanish manufacturers
Spain		MoreNot; Spanish manufacturers

Sweden		FF Norden, Smögen; Hönö trawl, Hönö, (Gothenburg); Träslövsläge trawl, Träslövsläge
The Netherlands	pelagics	H. Maritiem BV and Nettenfabriek van Duijn
	bottom trawls	VCU Maritime BV, JV Visserijconsultant and Cooperatie Westvoorn
		IJmuiden stores Holland BV (Ijmuiden), Van Beelen Group (Ijmuiden)
		Euronete (Portugal), Redes Salinas (Spain)
		Alibaba/China
UK		Larger, Rep. of Ireland manufacturers such as Peep Trawls, Howthe and Swan Net Gunndry
	trawl gear	NE Scotland - Jackson trawls, Faithlie trawls, Strachan trawls. England - Boris nets, Fleetwood, Coastal nets Bridport, Caedmon Nets in Whitby. Shetland LHD Net store and Swan nets both in Lerwick. Also several smaller operators.
	pelagics	nylon gear produced in Ireland, Scotland, Iceland & Norway
	pots & static gear	Gaelforce in Inverness, Caithness creels & numerous small-scale
	nets	Some netting is supplied by overseas companies (e.g. Euronete and Hampiðjan)
		Bridport Net Gundry, Tyson's Ship Riggers

4. Recycling of fishing gear

4.1. Recycling of end-of-life fishing gear: current state of play

Fishing gear is a complex recycling material stream to work with. Fishing gears are composed of mixed types of plastics, metal pieces including lead weights, natural materials such as wood in otter boards, and are sometimes treated with copper-based antifouling coatings. Fishers across Europe customise their gear for the particular circumstances in which they operate, including adapting nets, ropes and floats to target species and for functionality at sea. All of these aspects are challenges for fishing gear recycling. In addition, the waste stream for each material type is - in comparison to, for example, plastic packaging waste - relatively small, such that dedicated facilities are few and operate near the cost-efficiency limit. In the following sections, information is compiled on the types of fishing gear currently recycled in the OSPAR Maritime Area, the logistical and other requirements needed to facilitate a wider implementation of recycling for fishing gears, barriers and challenges identified by stakeholders in the OSPAR Maritime Area, and how design and an extended producer responsibility scheme together with other measures might push recycling of fishing gear forward.

4.1.1. Current options for fishing gear recycling

Before any waste processing, collected fishing gear – either at end-of-life or recovered from the sea – must be sorted and cleaned (**Figure 4.1**). Currently, three different options exist for waste fishing gear processing: thermal processing (incineration/energy recovery), mechanical recycling and chemical recycling, where the last two can only be performed in dedicated fishing gear recycling facilities. Mechanical recycling consists of mechanically shredding the plastic fibres, and melting them to produce plastic pellets. Chemical recycling refers to a range of processing technologies where plastic waste is broken down to its chemical building blocks. In the case of polyamide used in fishing gear, depolymerization results in the production of monomers, which are then used to produce new plastic virtually identical to the virgin feedstock. Additionally, thermochemical recycling is a relatively new method that is still in development and might, in the future, be used for plastic in fishing gear.

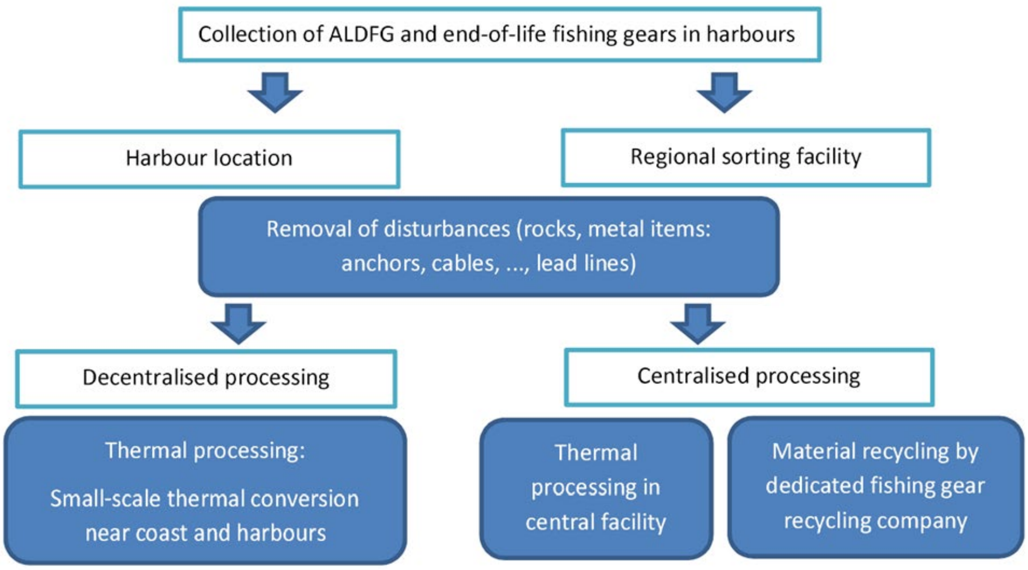

Figure 4.1 **Recycling pathways for ALDFG and end-of life fishing gear, including centralized and decentralized processing options. Note that ALDFG and end-of-life fishing gear are not the same in terms of degradation, gear contamination and waste management on-board and in ports, and therefore are often treated as two separate waste streams. However, the possible pathways are generally the same for both. Image source: Stolte et al. (2019)**

Table 4.1 gives an overview of the general recycling pathways available today for fishing gear. Only three companies recycle fishing gear on a larger scale in Europe:

- Plastix A/S in Denmark mechanically recycles end-of-life nets, ropes and fishboxes made from polyethylene (both high-density HDPE and low-density LDPE) and polypropylene into recyclates. Fishing gear is shredded into fibres, fishboxes into flakes, mechanically cleaned and extrusion-melted into granulates with 95% material purity. Recyclates are sold on the recycling material market and shaped into packaging and piping products including bottles for cleaning detergents. Delivered fishing gear has to be pre-cleaned and sorted into individual polymer fractions to allow for recycling. More information can be found in **Annex D** (**BP 4.1).**
- Aquafil Italy/Slovenia collects end-of-life polyamide netting, e.g. from gillnets or lobster pots, from fishing harbours worldwide, for chemical recycling. Nets have to be clean and pre-sorted into pure PA6 (nylon) materials. Fibres are chemically split into monomers and catalysed back into PA6 polymers for yarn spinning. Fishing gear fibres are combined with nylon carpet production residues and post-consumer carpet waste to generate Econyl yarn used for clothing in the outdoor textile industry and carpets. More information can be found in **Annex D** (**BP 4.2).**
- Antex Spain carried out a pilot project to generate specialised yarns for the textile industry, including a polyester yarn made from polyester (PET) fishing nets. The recycling process appears to be chemical disintegration into monomers and reintegration for spinning. The textile manufacturer Ecoalf in Northern Spain used the yarn for fashion clothing, but has moved to using Econyl instead. Ecoalf and Antex are supporting further pilot projects to recycle fishing gears from fisheries harbours in Spain locally, but products are not yet industrially available.

OSPAR doesn't currently hold information related to the available market capacities / waste volumes that are recycled or incinerated by the above mentioned companies, however this type of information would be useful for any future work on this issue (see Section 6).

Material	Recycling pathway	Where
Steel (and occasionally lead)	Regular metal recycling	All countries
PP and PE (both HDPE and LDPE)	Mechanical recycling into plastic granulates	Plastix, Denmark
PA6	Chemical recycling (solvolysis) and re-threading into yarns	Aquafil, Slovenia
PET	Chemical recycling and re-threading into yarns	Antex, Spain

Table 4.1 General recycling pathways currently available for fishing gear materials

For the dismantling of fishing gear collected from the sea and end-of-life fishing gear such as traps and pots, Nofir (see also **Annex D BP 4.3**) from Norway established dismantling plants in Lithuania and Turkey, where manual labour is considerably less costly. Dismantled plastic materials are forwarded to Plastix and Aquafil depending on their composition. Steel components are sold to local scrap-metal dealers. The management path of any other extracted materials (landfill or incineration or recycling) is not communicated. Other small-scale enterprises and worldwide efforts to recycle fishing gear can be found in the compilation "Products from Waste Fishing Nets" by Charter, Carruthers & Jensen (2018).

All efforts to recycle fishing gear and keep the plastic components in the circular economy material cycle have several challenges in common that impede fishing gear recycling becoming general practice:

- Fishing gear must be sorted into individual polymer types and cannot be mixed polymers or mixed with metal fragments. Contaminants, e.g. lead from sink lines, must be excluded.
- Fishing gear must be relatively clean, without sediment and organic disturbances, as sand causes excessive wear on shredding machinery and residual sediment might cause the recycling product to become brittle.
- The companies mentioned above are highly specialised on individual material types and have high standards and requirements on accepted end-of-life fishing gears. A general collection system for fishing gear is currently not in place, complicating action towards recycling by individual fisheries.

These complications hinder the general recycling of end-of-life fishing gear. In Germany, end-of-life fishing gear is separated by fishers into the net body, float lines and sink lines, the latter of which are reused for as long as possible when the net body needs replacement. End-of-life nets are cut to 1 metre fragments and are incinerated as no specific collection or waste stream exists for fishing gear. This implies that, today in the fishing sector, in most European countries end-of-life fishing gear is either incinerated or landfilled, where landfill is still available for commercial waste discarding. The recycling potential of fishing gear, even if it comprises a small-scale waste stream compared to packaging waste, is currently only exploited on a limited scale although facilities capable of treating these materials are in place in Europe.

4.1.2. Recycling pathways identified in each OSPAR country

The limitations on recycling options, but also the existing possibilities, become evident from the responses to Section 13 of the questionnaire: “Recycling of fishing gear”. Regarding types of gear that are recycled (**Figure 4.2**), twenty-six stakeholders from all countries are aware that bottom and/or pelagic trawls are recycled. Sixteen stakeholders mention that trammel-, drift- or gillnets are recycled, fourteen indicate purse seines are recycled, stakeholders from eight countries are aware of traps being recycled (Denmark, Germany, Ireland, Sweden, Norway, The Netherlands, UK), and six stakeholders (including Iceland but excluding Germany) suggest that rods, long lines or lines are recycled. Only one party from Spain included FADs in the recycling portfolio, while four parties indicated that other parts of fishing gear are recycled, but further details were not requested.

The answers provide a clear picture of where materials are shipped for recycling:

- In Belgium, ship owners bring end-of-life fishing gear to the net manufacturer and ship waste managers (e.g. VVC Equipment (a fisheries cooperative))
- In Denmark, fisheries send all types of gear to Plastix (PE/PP) and Nofir (nylon/PA6) (see **Annex D BP 4.1 and 4.3**)
- In Germany, Cux-Trawl (a net and mooring repairer / manufacturer, see **Box 4.4**) is part of the EU Retrawl project and collects trawl netting for recycling in collaboration with Plastix in Denmark
- In Iceland, Hampidjan (see **Annex D BP 4.5**) recycles end-of-life netting, and some gear is sent to Lithuania (presumably to Nofir) for dismantling, from where nylon is likely forwarded to Aquafil (**Annex D BP 4.2**), while some seine netting is repurposed locally to secure construction sites against falling rocks. Collected purse seine and trawl netting is mainly made from PE and sent to Plastix for recycling.

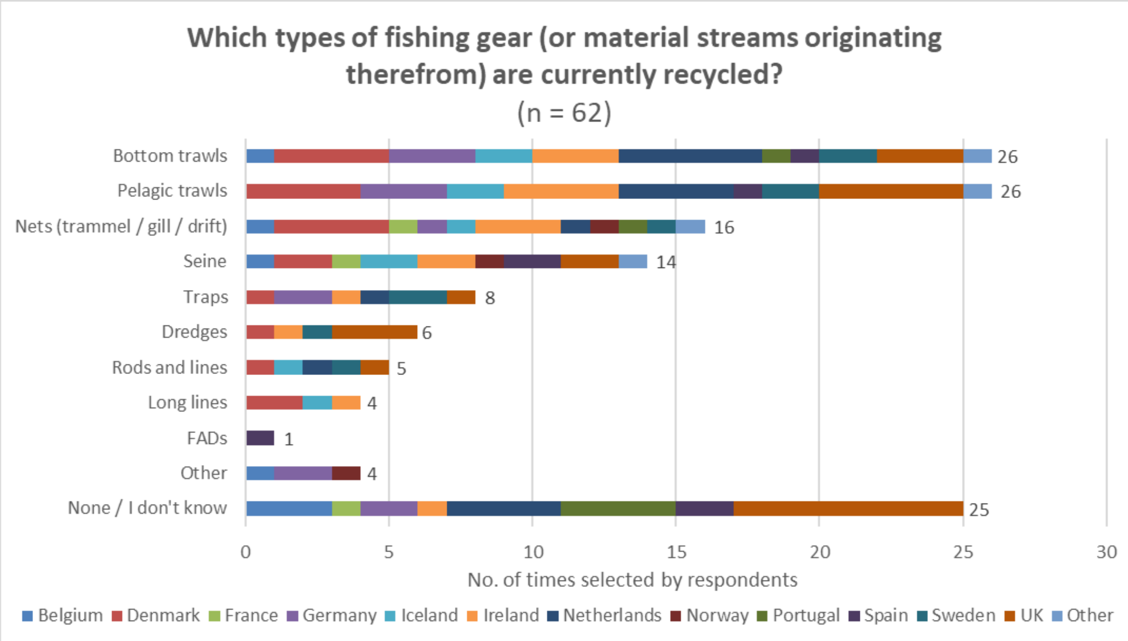

Figure 4.2 **Fishing gear types identified by questionnaire respondents as being currently recycled**

- In Ireland, metals from fishing gear are sent to recycling centres and netting is collected by Stuart Nets in Cork County.
- In Norway, Nofir collects discarded fishing gear which is sent to Lithuania and Turkey, where it is dismantled and prepared for recycling. From there, PA is sent to Aquafil. The waste collected through the Norwegian Fishing-for-Litter project is handled by Nofir.
- In Spain, trawls, seines, and FADs are send to Aquafil (accepting nylon only) and Seaqual (collaborating with Antex in the pilot project on polyester yarn recycling).
- In Sweden, Fisheries Association Norden in Smögen (FF Norden, see **Annex D BP 4.7**) collects end-of-life fishing gear of all types, predominantly trawls and traps, which are dismantled and pre-processed in Smögen and in the recently established Sotenäs Marine Recycling Centre, where fishing gear are sorted and all plastic nets and ropes are sent for recycling to Plastix in Denmark, where it is then forwarded on to Aquafil in Slovenia. Metal fractions are sold to a local metal recycler. Some items and parts of the fishing gear are reused by FF Norden (Fisheries Association Norden) or by others.
- In the Netherlands, all types of discarded fishing gear (mostly trawls) are collected by Bek & Verburg (see **Annex D BP 4.6**) in Rotterdam for sorting and dismantling. HDPE netting was, until recently, sent to China for recycling, which has stopped with the Chinese waste import ban; instead, they now forward this gear to a mechanical recycling plant in Vietnam. Nylon is sent to Slovenia (Aquafil). Dolly ropes typically made from PE are collected separately for PE recycling.
- In the UK, all fishing gear are also either sent to Nofir (Lithuania) for dismantling, from where nylon goes to Aquafil, PE/PP to Plastix, or Fraserburgh, where some gear materials are dismantled for recycling either at Aquafil or at Plastix; one stakeholder states that "most harbours will collect old dredges as, being predominantly made of steel, they are easily (and lucratively) recycled as scrap metal."

Figure 4.3 shows the material streams selected by respondents as fishing gear components currently recycled. The most commonly recycled materials include nylon/PA, PP and PE polymers and metals, as reported by 15, 12 and 11 respondents respectively. Plastix in Denmark suggests rigid components are currently recycled, in addition to the previously listed fish boxes and the different fibre polymer fractions. Metals are also mentioned by several stakeholders from multiple countries as an economically viable recycling stream. Here, apparently, lead from sink weights is not considered hazardous waste but counted into the metal recycling fraction, as some stakeholders mention lead as a recycling material in the following questions. Unexpectedly, rubber is also recycled in Iceland, The Netherlands, and Sweden, which provides a new aspect on recyclability of gear segments that are not commonly considered recyclable.

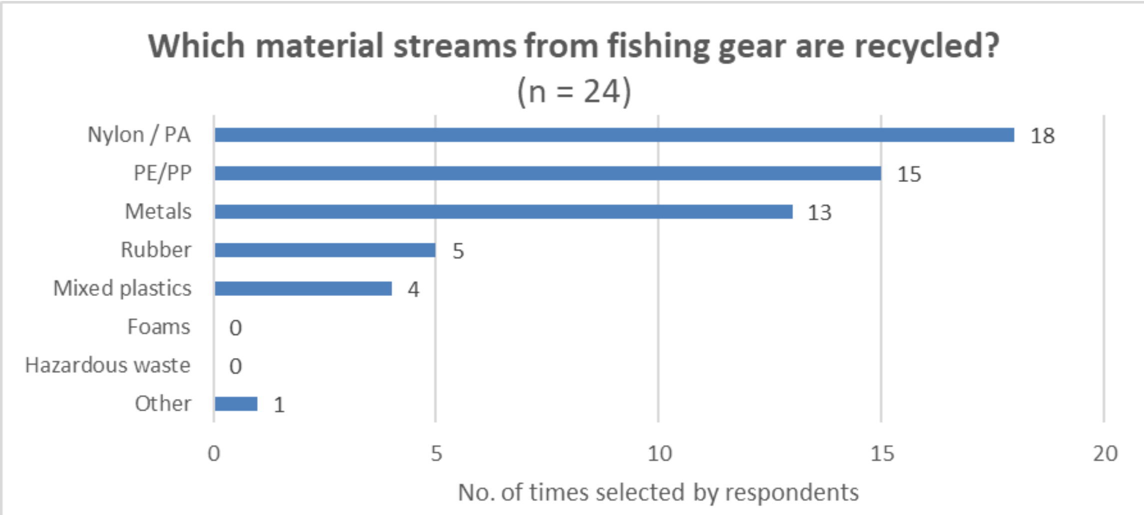

Figure 4.3 **Material streams from fishing gear identified by questionnaire respondents as currently being recycled**

Both mechanical and chemical recycling are known technologies applied to recycle fishing gear, although mechanical recycling is substantially better known than chemical recycling. Of the 72 respondents answering the questionnaire, thirteen are aware of mechanical recycling of fishing gear (with some references to Plastix), while only four stakeholders are aware of the chemical recycling option (with reference to Aquafil and Ambiberica, but according to their webpage, Ambiberica trades with pre-sorted fishnet scraps as a waste manager and does not recycle any of the materials themselves). Only one stakeholder from The Netherlands remarks that nets are sent to Asia for recycling, hence mechanical recycling is likely but cannot be properly monitored.

The following output streams from the different recycling technologies were identified by a variety of stakeholders in various countries:

- rPPC, rPP, and rHDPE + PA6 (Chemical) as granulates/pellets ("plastic feedstock")
- Yarns for clothing (Antex/Ecoalf in Spain, Aquafil for Econyl mixed with carpet fibres in Slovenia)
- Granulation/melting and direct marketing of final products (bureo Chile, see **Box 4.1**; marketed also through *patagonia*)
- In the UK and Iceland, nets are also repurposed for reuse or reassignment e.g. into garden features or as protective netting for construction sites (see above)

Most stakeholders could not provide information on the material quality or purity that can be achieved in these output streams, and most suspect that the output material quality is typically quite low. One UK-based NGO finds that the material quality is "acceptable but not sufficiently valuable to recover the recycling costs." Reference is made by a German NGO to the Chilean /USA based NGO Bureo (**Box 4.1**), who try to maximise the amount of fishing gear recyclates in their products with an additional focus on functionality, but not necessarily on purity. However, the general notion of low purity of recycled materials seems to be caused by misinformation, as fishing gear recyclers maintain that very high purity of recycled materials can be achieved. The Danish recycler Plastix finds that the purity can be very high if the input stream is sufficiently well-sorted and clean [>95% recycled polymers according to the factsheets for recycled fishing nets and ropes on their webpage]. For Econyl, produced by Aquafil from a mix of carpet fibres (dominant component) and discarded PA6 netting from fishing gear, the same purity can be achieved as for virgin PA6. The Econyl production process requires 95% purity for input materials (after pre-processing).

Box 4.1: best practice examples for economic viability and positive marketing

1. **Healthy Seas**

Healthy Seas is an initiative set up by the recycler Aquafil, producing textiles (socks, swimwear) from the recycled yarn (Econyl) produced by Aquafil's recycling plant in Slovenia (see **Annex D BP 4.2**). Part of the revenue of *Healthy Seas* is used for ALDFG clean-up activities.

2. **Fathoms Free from ghost gear to kayaks**

Fathoms Free is an organisation founded by a single dedicated kayaker and diver who was keen to clean up the marine environment from ghost gear and other litter. Now a small team, they organise awareness events and beach cleanups. Sorted plastics and ghost gear is recycled in cooperation with Plastix into kayaks available at Odyssey Innovations, their own market brand.

3. **Bureo end-of-life fishing gear to skateboards**

bureo in Chile collect end-of-life nets from both industrial vessels and artisanal fisheries and has its own transparent recycling scheme, feeding funds back into social community projects, focused on schools and education. The bureo process uses nylon/polyamide netting with the aim to maximise the amount of fishing gear included in their products (skateboards, frisbies, sun glasses). According to the founder, despite sourcing from 3 South American countries, the origin of their end-of-life fishing gear can transparently be followed to the originating harbour and vessel owner for each batch of recycled materials.

4. **Circular Ocean**

The Circular Ocean project aims to create an enabling environment for enterprises creating products from discarded fishing nets and ropes in the Northern Periphery & Arctic (NPA) region. The EU-funded initiative aims to develop, share and test new sustainable solutions to incentivise the collection and reprocessing of discarded fishing nets and assist the movement towards a more circular economy, through transnational collaboration and eco-innovation.

4.1.3. Economic viability of recycled fishing gear materials

Stakeholders from Iceland, Portugal, and the UK find that metals (iron/steel, lead) most easily generate a positive market value. The fisheries in Iceland have identified PA6 (nylon) and PE as fishing gear polymers with a positive market value through the well-established Icelandic collection and recycling scheme, while in the UK, PP is also considered marketable. A German NGO working with fishing gear finds that granulates, yarns and fibre fabric all have a positive market value if generated from single polymers, but might need mixing with virgin material fractions, while ALDFG recycling is not an option in most cases from an economic perspective, as disentangling is too costly and labour intensive. Along the same lines, the Danish recycler Plastix comments that all fishing gear plastics generate a positive market value if the maximum purity level is achieved.

Regarding fishing gear that can technically be recycled but currently costs are too high, stakeholders from Portugal, The Netherlands, UK commented that especially logistical and sorting costs are too high to compete with prices for new materials. Respondents from Belgium and Germany particularly mentioned lost fishing gear retrieved from the sea (ALDFG) as an obstacle for fishing gear recycling: the dismantling and cleaning costs are too high to render recycling economically viable for mixed ALDFG. Rubber is also mentioned as a high-cost challenge for recycling.

Used fishing nets, photo provided by WJ Strietman

4.1.4. Summary of state-of-play

In summary, for many of the materials employed in fishing gear today, recycling pathways exist in the European Economic Area and are known by stakeholders in most countries. However, the facilities available for collection and recycling are limited, requiring high transport effort, ecological footprint and costs, and all recyclate manufacturers are highly specialised. High demands and resulting costs on dismantling of gear for recycling are a major obstacle. There is also a general notion that recyclates originating from fishing gear have a lower market value and quality than virgin polymers, which might explain why recyclates are still not universally accepted and embraced by plastic producers today. Here, both availability and marketing of high-quality outputs are necessary to change attitudes. One example is the yarn Econyl chemically recycled by Aquafil from carpet rests and fishing nets. This yarn has achieved wide-spread acceptance because of its high quality (identical to virgin yarn) and because of the positive image generated through ‘cleaning up the oceans’, with a fraction of the revenue by their own organisation *Healthy Seas* being used for ALDFG clean-up activities. This market is growing, and more positive examples are required to ensure that recyclates are accepted and marketable.

4.2. Fishing gear retrieved from the sea

Lost fishing gear retrieved from the sea (ALDFG) was identified by several stakeholders in multiple countries as non-recyclable, however this view is not supported by all OSPAR countries. The reason lies in most ALDFG being heavily contaminated with salt, sediments and other disturbances, and potentially with hazardous substances. In addition, dismantling mixed ALDFG is substantially more labour-intensive than end-of-life fishing gear and might not even be manually feasible. Further material streams identified as non-suitable for recycling included rubber (although claimed to be recycled in some countries), rock hoppers, and contaminated gear, e.g. copper-coated netting or gillnets containing lead.

As ALDFG usually would be moved around on the seafloor for several years or even decades, the individual material segments such as lines, ropes and netting are heavily entangled. In gillnets, for example, it is almost always impossible to extract hazardous lead lines from the entangled ALDFG bulk. Trawls collect other types of marine litter, such as anchors, rocks, car tires, organic matter and all other items encountered on the seafloor. Netting that has been on the seafloor for extended periods of time is also prone to adsorbing fine-grained sediments in the twists and knots that cannot easily be washed out. As recycling requires clean, pure materials, ALDFG will only be recyclable in rare cases, e.g. when trawl repair segments are collected as isolated net fragments. At the same time, ALDFG retrieval is costly and currently only the Norwegian government collects and dismantles lost fishing gear on a regular basis in Europe, such that the amounts of ALDFG to be managed are comparably small (**Box 4.2**). Norway supports the company Nofir in the process of dismantling and recycling damaged lobster pots and, to a smaller extent, gillnets. Lost gear is reported immediately through a centralised system, which facilities rapid recovery and avoids long residence times on the seafloor. The solid rock bottom of Norwegian fjords facilitates cleaning of retrieved gear. In other European sea areas, such as the southern North Sea, the Baltic Sea and the Atlantic coast, ALDFG embedded in sediments and composed of a mix of materials is unlikely to re-enter the circular economy of fishing gear. Various NGOs organise ghost gear clean-up campaigns, such as the Fishing for Litter (F4L) scheme (**Box 4.2**).

4.3. Collection and pre-processing

Collection of fishing gear as a separate waste stream and some form of pre-processing to sort materials are prerequisites to establish a functioning recycling system for fishing gear. Beyond the requirements mentioned above, fishing gear is composed of sturdy fibres that require specialised machinery to process. Also, because other waste readily entangles into netting, a mix with residual commercial or household or even other plastic waste will lead to landfill or incineration as sorting in retrospect cannot be made cost-effective.

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.

Box 4.2: Best practice examples for ALDFG retrieval

1. **Norway retrieval of ALDFG & recycling of fishing gear by Nofir**

The Norwegian government started in the 1980s to support efforts, originally initiated by a Norwegian NGO, to retrieve lost fishing gear at the end of each fishing season. The fishing sector is heavily involved in the 2-3 week long gear retrieval campaign. Fishers have a strong interest in recovering expensive lobster pots, which can in most cases be reused. This motivation facilitates reporting of lost gear. Likewise, retrieval of gillnets in the fjord areas removes hazards from the fishing grounds for target species and as a source of gear conflicts. The Norwegian company Nofir collects and pre-sorts materials, which are then shipped to Nofir Lithuania for dismantling. All types of fishing gear, including trawls, traps and gillnets, are dismantled into polymer types and metal parts. Polymers are forwarded to Aquafil (nylon) and Plastix (PE/PP). Metals enter scrap metal recycling. Further details in **Annex D** (**BP 4.3**).

2. **Fishing for Litter and ALDFG collection in the Netherlands and the UK**

Fishing for Litter (F4L) in Scotland carried out a recycling trial with end-of-life gear. Furthermore in the UK, a scheme in Brixham operates gear collection with a charity (Torbay Cleaner Coast Initiative who also organise ghost gear retrievals) and Brixham trawl makers, and Excelsior Fishing in Fraserburgh dismantles gear and sends nylon to Nofir/Aquafil for recycling. F4L/KIMO Netherlands collects and separates waste free of charge, fishing nets feed into Aquafil to make socks from Econyl yarn, but in other projects key chains and playground equipment were made, though all recycling projects were short-term schemes. Ghostfishing.org, as part of Healthy Seas, an NGO established by Aquafil, is also based in NL and carries out retrievals of ALDFG in both the North Sea and the Baltic Sea, some fraction is send for dismantling to Nofir.

3. **MARELITT Baltic methodology development for ALDFG retrieval & waste management**

The EU Baltic Sea region INTERREG project MARELITT Baltic had the aim to mitigate the problem of lost fishing gear and its ecological impact on the Baltic Sea marine environment. During the 3-year project (2016-2019), best practice methodologies were developed for the search & retrieval, the processing & waste management, and preventive measures for ALDFG. The results are summarised in 11 in-depth reports and an overarching Blueprint with recommendations for all mitigation measures, including waste management, available via the above link.

4.3.1. Collection of end-of-life fishing gear

In practically all OSPAR countries, some stakeholders state that fishing gear is collected as a separate waste stream or as a combination of generic mixed waste and separated fishing gear (**Figure 4.4**). Stakeholders from Belgium, Denmark, Germany, Spain and the UK also state that fishing gear can be collected as mixed industrial/commercial waste. In Germany, larger fishing harbours collect end-of-life gear as commercial waste, while in smaller harbours, fishers discard gear in household waste. In the UK and in Germany, some respondents indicate that to their knowledge, no special collection scheme is in place. This shows the huge regional diversity, and some knowledge gaps and lack of communication. For example, in Germany two fishing associations based in small fisheries harbours collect end-of-life fishing gear twice per year separately from all other waste streams in a dedicated container. While this gear could, in principle, be shipped to recycling facilities, it is currently cut into segments for incineration. The diversity of the situation is particularly striking in the UK, where out of

17 individual responses, 3 report that fishing gear is collected as a combination of mixed generic waste and separate collection, 4 report that fishing gear is a separate waste stream, and 2 report it as part of the mixed industrial waste.

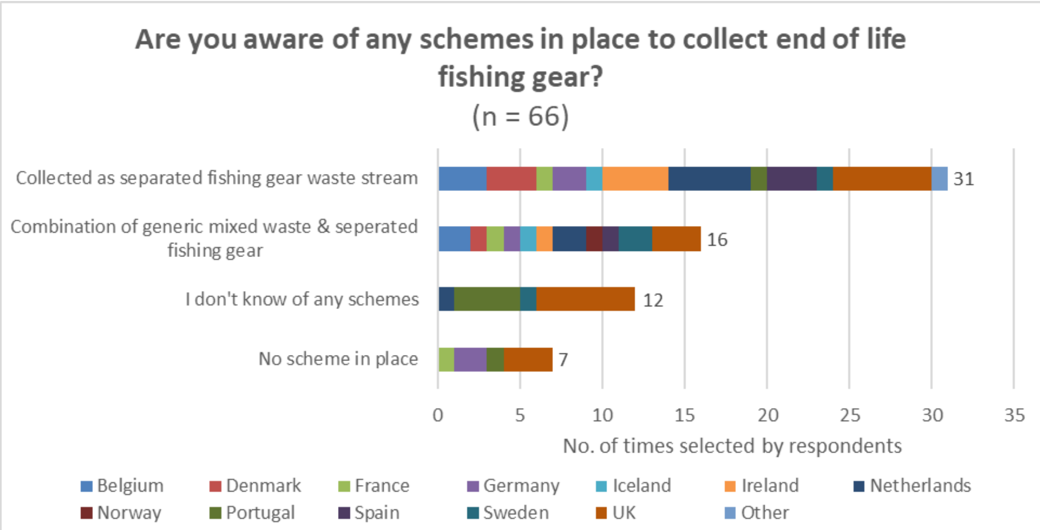

Figure 4.4 **Questionnaire response on awareness of schemes in place to collect end-of-life fishing gear**

Both in the UK and in Denmark, the costs – if allocated – of sorting, transport and collection are considered too high for such a system to be economically self-sustaining. Sorting and collection have to be carried out on a voluntary basis, as also found by a French study in the project PECHPROPRE 2 (**Box 4.3**). Apparently, in none of the participating countries a government-supported municipal waste collection system for end-of-life fishing gears is installed.

Box 4.3: best practice example for study of fishing gear collection & knowledge exchange

PECHPROPRE

The aim of the project PECHPROPRE was to make an inventory of all plastic products used by fisheries in France, and of all collection systems in place to collect those products at end of life. This was carried out through a nation-wide survey, involving 67 fisheries harbours all across France. A pilot study in several smaller fishing harbours in the Mediterranean was run, to test a harbour management regime with separate collection facilities for different waste streams. Important conclusions of the project are that local initiatives should be preserved, and that stakeholders across the entire value chain of the fishing sector must be involved. The project also concluded that for France, a voluntary EPR scheme on all fishing gear containing plastics would be an effective measure to improve collection. This is now being implemented, prior to the SUP Directive compulsory EPR coming into force. Further information is given in **Annex D** (**BP 4.4**).

Clean Nordic Oceans

The Clean Nordic Oceans (CNO) project was established in 2017 through the Nordic Council of Ministers. The primary function of CNO can be described as knowledge acquisition and knowledge sharing within a network of experts. Through CNO, the Nordic countries have obtained a relatively clear picture of the Nordic status in terms of both knowledge and measures regarding marine litter. In March 2020, CNO published a report focussing on fishing-related litter, building a knowledge base and suggesting potential measures to tackle the issue.

The driving forces behind the separate collection, dismantling and sorting are the fisheries associations, such as FF Norden in Sweden. Net manufacturers take back netting in Denmark and Germany (**Box 4.4**), in Iceland on a larger scale, and possibly in the UK locally. These initiatives can serve as templates for an EU-wide Extended Producer Responsibility scheme.

Box 4.4: best practice examples of gear return systems for repairs

1. **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.

2. **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 & weather wearing and diverting unused nets from the quayside.

3. **Cux Trawl manufacturer and repair in Germany**

Cux Trawl custom-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 PE and PP netting for recycling at Plastix in Denmark.

4.3.2. Logistics requirements

In addition to a regular collection of end-of-life fishing gear to incentivise recycling, a full logistics pathway for fishing gear waste into the waste stream needs to be established. Stakeholders from OSPAR countries were asked about the ideal logistics process for end-of-life fishing gears and which barriers, in their view, currently impede recycling.

The following requirements and barriers were identified:

- Easy, cheap and quick collection on the quayside by local/regional specialised companies to reduce transport costs;
- Collection should be organised uniformly in all major European fisheries ports, with uniform tariffs (if any) to incentivise that all broken gear is brought back to shore;
- Removal of lead lines and metal items is key for recycling;
- ALDFG has to be stored separately from end-of-life fishing gear to avoid contamination;
- A deposit return scheme could finance pre-cleaning and transport;
- Separate storage of different material types (PP, PE, PA6) is key to recycling, sorting is labour-intensive but required, a centralised sorting facility specialised on fishing gear dismantling as exemplified by Nofir in Lithuania can maximise chances of recycling;

- The diversity of harbours in size, number of vessels and man power is identified as a barrier to a uniform collection and pre-processing scheme, and collection of sufficient amounts of plastics attractive for recyclers is considered difficult in small fishing harbours; and
- A collection route along the coast of each country could connect smaller harbours and mitigate the logistics challenge, increase the waste stream, and uniformity could be achieved by a centralised sorting facility as exemplified by FF Norden / Sotenäs in Sweden.

Further obstacles are: the availability of dedicated containers, sorting areas in harbours, collection areas, and companies capable of processing the material further for recycling or incineration.

Box 4.5: Best practice example of organising fishing gear recycling

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, where possible, against a fee. The return 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. 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. More information is listed in **Annex D** (**BP 4.5**).

4.3.3. Pre-processing

Pre-processing was identified as a prerequisite to increase the amount of recycled fishing gear. However, pre-processing can involve several stages, all of which are labour intensive. Dedicated areas in each harbour are necessary to allow for pre-processing, unless end-of-life fishing gear is sent to a dedicated, centralised sorting facility. **Figure 4.5** gives an overview on the responses on the various pre-processing stages known by stakeholders in their country. Removal of parts for re-use is carried out by fishers in all participating countries. In almost all respondent countries, some form of cutting and material separation, sorting, and disentangling of end-of-life fishing gear takes place. Removal of parts to meet acceptance criteria for waste management is known in the UK, NL, IR, IC, DE, DK, BE, NO, SW but is not specifically stated in DK, FR, SP and PO, although some of these countries' fisheries are using gillnets with lead weights. Pre-cleaning is less commonly known by stakeholders, but is stated by at least one stakeholder in all countries except for Sweden and France.

In many countries, nylon/PA6 is specifically extracted from end-of-life fishing gear for recycling, presumably at Aquafil. In Spain, polyester netting is also extracted for yarn making in a similar chemical recycling pilot process at Antex. Spanish stakeholders also try to find pathways for re-use and recycling to divert end-of-life gear from landfills through EU-supported local initiatives such as BLUENET.

In most areas, fishers at the harbours are responsible for pre-processing, which implies removal of metal parts and lead lines for re-use and to meet acceptance criteria of the waste managers. Although recyclers in Denmark cooperate with fisheries so that end-of-life gear is delivered in recyclable form, a Danish manufacturer states that fishing gear should be delivered back to the manufacturer because they know best how to handle and dismantle the materials. Ireland and UK stakeholders point out that any pre-processing is entirely voluntary, fishers dismantle gear for their own re-use of parts, and in Ireland, further processing is dominated by "informal processes at small recycling centres" and that there is a "huge barrier to handling end-of-life gear".

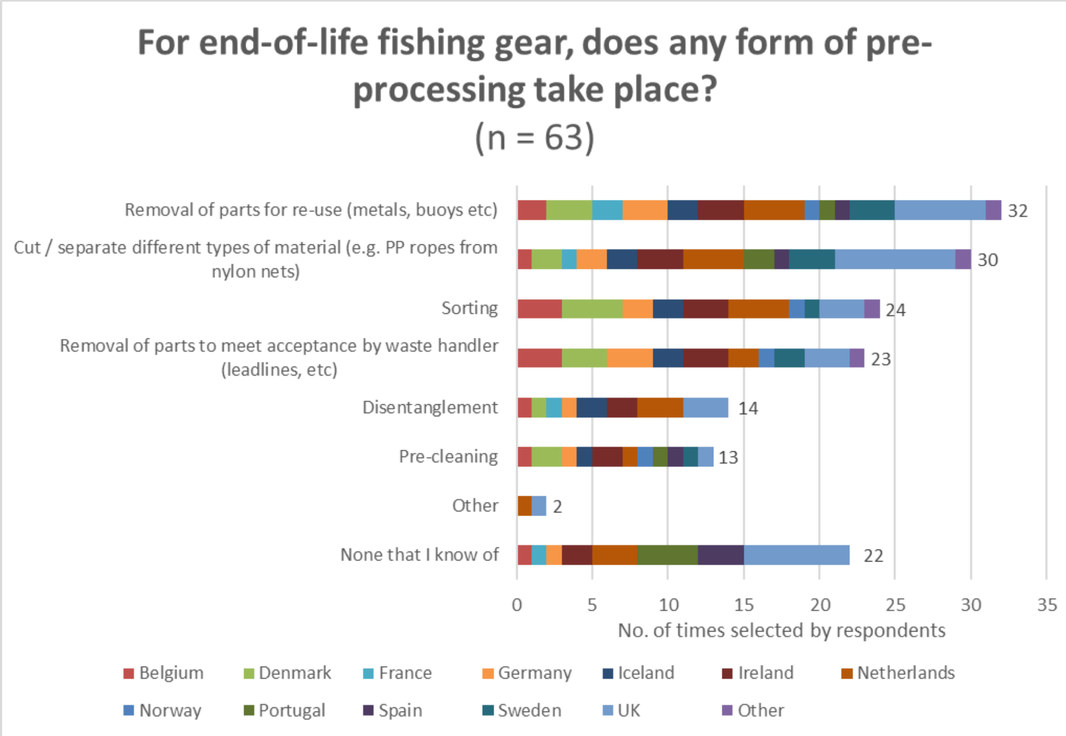

Figure 4.5 **Pre-processing steps for end-of life fishing gear identified by questionnaire respondents**

In other cases, pre-processing is organised more centrally in regional facilities, to increase efficiency and thus reduce cost (**Box 4.6**). In the Netherlands, one container is provided per harbour in which all waste streams can be accommodated (i.e. using different big bags), and the waste is sorted and cleaned in the sorting facility of the waste management company Bek & Verburg. Nets are dismantled and metals, rubber, buoys and dolly ropes are removed to facilitate recycling. One of the most advanced sorting facilities is the Sotenäs Marine Recycling Centre in Sweden, where pre-processing is partially carried out by fishers of FF Norden in Smögen harbour. Extended material sorting is professionally provided in the new municipality sorting facility, where fishing gears from harbours all across the Swedish West Coast arrive. The Norwegian Fisheries Directorate carries out regular gear collection and dismantling by Nofir in Lithuania, from where recyclable nylon is sent to Aquafil, PE/PP to Plastix, and metal to scrap metal recycling.

In Germany, two fishing harbours/fisheries associations organise collection in separate containers one to two times per year. For incineration, lead lines have to be removed (EU acceptance criteria); to avoid fire hazard in the waste storage bunker, nets have to be cut to 0.5-1m fragments to be acceptable (spark risk with long ropes or nets). This cutting and separation work is carried out by the fishers of the respective fishing association, prior to disposal into the dedicated container. In all other German fisheries harbours, end-of-life nets are either discarded as household waste or as mixed commercial waste. Both these streams are most likely mixed into the common incineration waste stream, which is not desirable and if lead lines are included, is illegal.

Box 4.6: best practice examples for regional organisation of collection / dismantling facilities

1. **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 gear. For each harbour, a dedicated 'manual' is provided detailing 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. Per harbour, one container is provided in which these big bags can be disposed of, 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. There is a direct collaboration with Healthy Seas to recycle nylon nets into socks, and dolly ropes are converted into fish boxes. Further details can be found in **Annex D** (**BP 4.6**).

2. **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. Gear is partially dismantled and pre-sorted in the harbour by the fishers of FF Norden to extract parts for re-use, and is then 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 (including EU/EMFF), 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, asmost end-of-life fishing gear is clean, pre-sorted, and ready for recycling. The cost of transportation to Denmark is 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 gears. Further information can be found in **Annex D** (**BP 4.7**). Sweden is also currently in the process of setting up a national collection system for discarded fishing gear, called Fiskereturen. Further information on this project can be found in **Annex D** (**BP 4.8**).

4.4. Challenges & barriers in fishing gear recycling

Stakeholders were asked what, in their opinion, are the most important barriers for (large scale) implementation of fishing gear recycling, and what steps are necessary to increase the recycling rate of fishing gear in the OSPAR Maritime Area (**Figure 4.6**). All countries except for Portugal and Denmark identified technological, organisational, logistical and cost challenges as the major barriers for a large-scale implementation of a recycling system for fishing gear. Respondents from Portugal identified organisational, logistical and cost challenges, but not technology as a barrier, while Denmark responses focused on logistical and cost challenges, but technology and organisation were not considered major barriers. This is likely due to the well-established recycling system of the fishing gear recycler Plastix located in Denmark (**see Annex D BP 4.1** for details). To a lesser extent, legislation and lack of information were also marked by at least one stakeholder in each country.

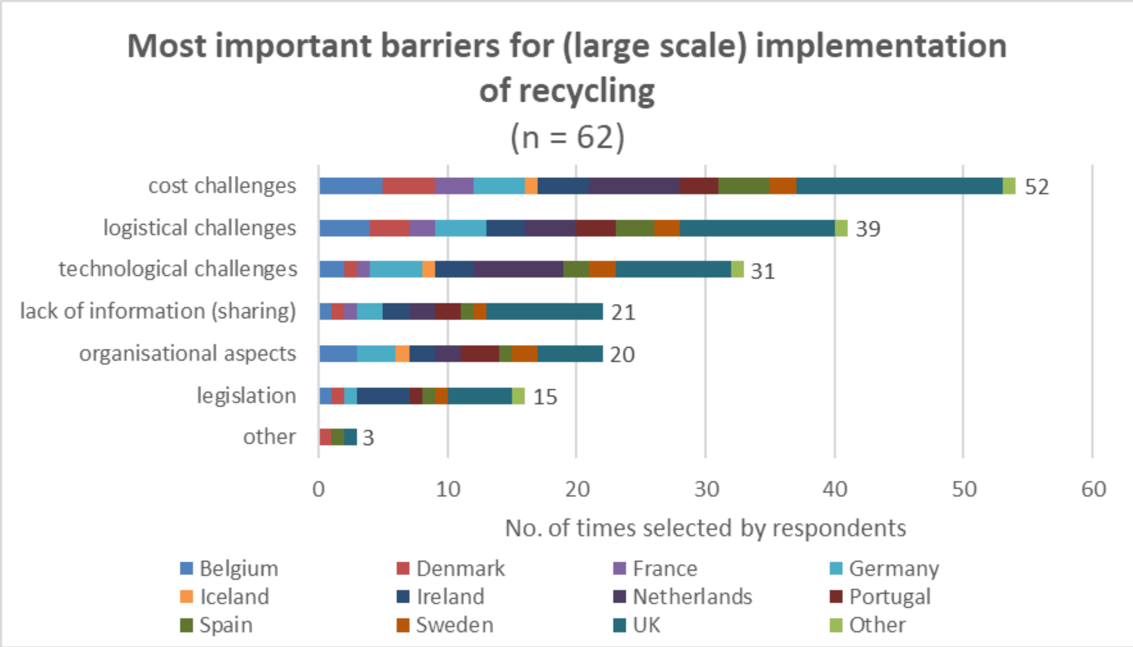

Figure 4.6 **Questionnaire responses on most important barriers for (large scale) implementation of fishing gear recycling**

Stakeholders from all countries identified several barriers impeding the recycling of fishing gear today:

Organisational, collection and cost barriers:

- A viable, EU-wide recycling system has to deal with thousands of larger and small-scale fisheries ports in Europe, while only a few recyclers currently accept highly pre-processed, sorted and cleaned very specific types of fishing gear materials.
- Fishing gear is contaminated with sand, organic matter and salt from long-term exposure in seawater. Recycling requires labour-intensive pre-processing which is expensive in Europe, and fishers cannot be expected to carry out extensive sorting and dismantling work for free in addition to the heavy-duty work involved in work at sea.
- There is no economic benefit from recycling of fishing gear today, but costs for regular collection, transport and sorting will be high. A collection system needs to account for smaller and larger harbours and long distances to a central facility, and needs to be supported by government or EU funding at least initially.
- Lack of coordination along the value chain, from the net manufacturer to the end user and poor cross-engagement of involved stakeholders with insufficient collaboration and cost sharing are identified as organisational barriers.
- Local recycling companies taking on the challenge of fishing gear would reduce transportation costs, making recycling of fishing gear cheaper and easier to manage (reduced customs challenges, waste transport within the EU, no longer-term storage and collection facilities required), but would need to find ways to combine fishing gear with other recycling materials to increase the revenue.

Technological barriers:

- Fibres are very hard to process, as machinery gets stuck and blades get blunt. Yet, development of functioning technologies is also beneficial for the much larger textile industry, which could open the door for textile recycling.

- Developing standardised technology specifically for fishing gear, such as chemical recycling plants, is expensive. The cost of recovery, sorting and transport is greater than the economic benefit, and fishing gears are not the most suited plastic materials for recovery, recycling and reuse.

Lack of information:

- Companies in neighbouring countries working with end-of-life fishing gear are not known to fisheries associations, proper handling for proper waste management might be unknown to local fishers, especially where infrastructure for collection and sorting does not exist.

Legislation and market barriers:

- Licensing and permits and legislative waste regulations are barriers to transporting fishing gear to the few recycling companies available across Europe.
- The large supply of cheap recyclates on the secondary polymer market from other sources, such as packaging and post-industrial waste, imply high market competition. The high costs involved with fishing gear recycling impede competitiveness on this market. Solving the technological challenges in pre-cleaning and material separation would allow for a cheaper fishing gear recycling chain.
- Even for domestic waste only few plastic items can be recycled today. There is a general need for improved sorting and processing technology that would not only benefit fishing gear circularity but the recycling system as a whole.
- The small amounts of materials are a challenge for developing dedicated technology and establishing a specific waste stream for the recycling of fishing gear. Improved industrial material sorting (technological development) would support the inclusion of fishing gear into the existing recycling system.
- Gear design needs to encompass recyclable materials still safe and durable for use at sea.

In addition to the challenges mentioned above, there are several aspects that impede recycling of fishing gear to be implemented in common waste management policies so far. One aspect particularly challenging for standardisation and recycling is the customisation of fishing gear. Each fisher or company will have their own preferred gear assembly, which increases the mix of different material types and complicates dismantling when the gear has reached the end of its life. Twelve stakeholders from all countries indicated that fishers customise gear after the point of purchase. Materials and parts added include:

- lead weights, chains, floats, additional netting
- dolly ropes/chafers, square mesh panels
- dredge teeth
- rubber from tyres to protect the base of creel pots
- protective old netting or plastic, wire against abrasion
- trawls: ropes added from different materials and wooden (otter) boards
- gillnets: float lines (PE, PP), sink lines with lead weights (PET sheathed lead)
- antifouling-coatings are added in Portugal

In addition, net segments are sewn together using nylon, because of its shrinking property in water which leads to knot tightening, while other materials such as PE or PP do not provide knots with long-term stability. For the same reason, nylon is also used as a preferred repair material, increasing the material mix when used on PE, PP or PET netting.

Extensive customisation increases the manual labour required to dismantle fishing gear for recycling and waste management in general. Today, fishing gear and add-ons are available on the international market, such that even the base gear is not always bought locally but imported. This is a challenge for market influx and gear loss monitoring, but also for standardisation. More details are provided on some of the critical aspects impeding recycling today in the following sections.

Another challenging aspect is the lack of a harmonized waste categorisation across Europe. In some countries, waste from fishing gear is automatically considered hazardous waste due to e.g. potential oil pollution. In Ireland, an old disease protection regulation (Diseases of Animal Act, S.I. No. 597/2001), prohibits the (re-)use of 'swill', waste that contains any carcass or waste of animal origin, including fish waste. As a result, discarded fishing gear generally has to be buried in deep-area landfills. A uniform waste classification scheme for fishing gear in Europe is a prerequisite to set up a well-functioning recycling system. In such a system, different types of gear could be categorised in dependence of their material composition, and whether or not hazardous materials or coatings are incorporated. Defined waste categories would facilitate sorting along the entire value chain, and would also facilitate cross-boundary transport as part of the recycling implementation. The OECD Basel codes for the control of transboundary movements of wastes destined for recovery operations could be a potential instrument to implement this, although currently most materials of fishing nets fall under the category B3010 solid plastics, which doesn't suit fishing gear and thus would benefit from having its own code.

Separate challenges exist for the collection of smaller off-cuts of nets and ropes, that are easily lost into the marine environment. KIMO International is currently running a project to identify best practices to reduce inputs of cuttings of nets and cord to the marine environment; for more information and a list of these best practices, see **Annex D** (**BP 4.10**).

4.4.1. Import of fishing gear

Especially with light-weight gear such as gillnets, pre-assembled nets including sink and float lines can be bought from catalogues and on the internet. Some of the cheaper products are Asian imports, and a return scheme needs to account for the fact that not all net manufacturers are regional. An example for a return system accounting for imports could be the packaging collection of the "green dot" in Germany, where producers or importers are required to pay a licence fee for packaging. Implementing such a system for fishing gear would, however, require control over the online market, because direct orders abroad can skip the importer and the licence fee.

Imports and online marketing can also be a challenge for Extended Producer Responsibility schemes for fishing gear, however it is expected that Member States will be required to identify the relevant enforcement body to ensure that producers and other actors fulfil their obligations. The basis for a functioning EPR system is that manufacturers pay the full net costs for the products they place on the market. When EPR schemes are combined with fee-return systems, the manufacturer is responsible for the re-collection of materials for recycling, however combined schemes with other systems are not required under the SUP Directive. In the case of fishing gear, online orders by fishers can circumvent the EPR system. For long-lifetime gear such as trawls or purse seines, the netting might be returned only after more than 10 years, hence the trader who paid the EPR fee might not receive any of the nets again for which a return fee was collected. How an EPR and/or return fee scheme might support higher recycling rates for fishing gear needs thorough consideration from a costs and benefits point of view.

4.4.2. Purity of materials

The largest challenge for recycling is the mix of materials and different polymer fibres used for ropes and netting. Partially, netting is composed of single polymers such as polyamide PA6, PET or PE. Ensuring high fractions of single-polymer materials and easy separation of different polymers at end-of-life supports recycling and the effort to keep the material in the value chain.

Hazardous substances pose an additional risk to material recycling. Of 72 responses to the questionnaire, 28 reported "dangerous substances" in fishing gear, 19 of which reported lead predominantly in sink lines in gillnets, but long lines and recreational gear are also mentioned. Individual answers also referred to coatings, especially copper in traps, gillnets, and trawls. In Belgium and the Netherlands, dolly ropes are mentioned as potential recycling obstacle, while one stakeholder from the UK referred to aquaculture nets as hazardous, presumably also because of coatings although this is not elaborated on.

4.4.3. Specialised companies for fishing gear recycling

Fibre recycling is still niche, especially as textile recycling is not very established in Europe. Fibres are difficult to shred and cut, as they cause rapid degradation of blades and cutting devices, and fibre fluff causes blockage in machinery. For these reasons and because the fishing gear waste stream is small by comparison to packaging and other types of wastes, there is no general waste management system for fishing gear. Recycling companies such as Plastix, Aquafil and Antex are highly specialised, having developed their own dedicated technology that is capable of dealing with fibre materials. Because of this specialisation, very few companies exist in Europe and worldwide which are capable of handling waste fishing gear. Transporting end-of-life fishing gear to these dedicated facilities needs to be economically and ecologically viable. Acceptance standards are high and need to be followed for the logistical effort to be worthwhile. Resulting products can only be marketed if the quality standard is ensured, which hampers acceptance even further.

More widely distributed dismantling facilities trained for the specialised task of sorting and pre-cleaning fishing gear for recycling would increase recycling amounts and acceptance rates. Research on recycling options and development of less restrictive recycling pathways would increase the amount of fishing gear that can be kept in the circular economy, and would foster the market for recycling products, which is currently driven by the few materials available.

4.4.4. Cost of recycling vs. virgin plastics

Given the effort required to dismantle and clean fishing gear for recycling, the low cost of virgin plastics is still a large hindrance to the extension of fishing gear recycling, but also for the recycling of textiles and other fibre products for a recyclate market. Incentives are urgently required to increase the value of recyclates on the market and promote the use of recycling materials above virgin polymers.

When asked about measures that can be taken to improve demand for secondary materials from recycling of fishing gear, stakeholders in the UK suggest that secondary materials from recycled fishing gear must have the same market value as new materials. A Danish stakeholder suggested compulsory recycled content in new nets would increase demand, however this would require legal measures. One German stakeholder suggests that more research and development in technologies is required to further fishing gear recycling to achieve adequate quality of recyclates.

Awareness campaigns for materials derived from recycled fishing gear could also promote secondary materials on the market. Fishing gear recyclates have market value, as shown by Bureo, Plastix and the very efficient marketing of Econyl as "ocean yarn" and the Adidas "ocean shoe". However, misleading marketing campaigns should be discouraged through clear definitions of secondary materials from fishing gear. For example, some brands achieve high market values for their "ocean" products despite marginal or no inclusion of ocean-derived plastics or fishing gear. Companies working with the challenging fishing gear materials could be promoted through a unique identification / labelling system of their products to gain positive branding and market benefits.

4.4.5. Cost of logistics and pre-processing

A major obstacle to fishing gear recycling is high costs, including for manual labour, transport to processing facilities, and the small waste streams when compared to packaging or post-industrial waste. Only a few stakeholders have taken a detailed look into the economic viability of fishing gear recycling. A detailed analysis of the economic cost of fishing gear management was carried out by Fraunhofer UMSICHT with a focus on Germany and the Baltic Sea region in the framework of the MARELITT Baltic project (available at https://marelittbaltic.eu). A stakeholder in the UK states that KIMO carried out a cost-benefit analysis in Scotland and the Scottish-based waste handler North 53 Ltd undertook a study on the recyclability of marine nets for the Scottish government. A Belgian representative states that the only company paying for the collection of end-of-life gear is Plastix. Along the same lines, responses from both Denmark and Iceland point out that sorting of used trawls is expensive and requires intensive manual labour, so that in Iceland there is no monetary benefit, but merely the "goodwill" conservation aspect that drives participation from the fishing sector (although tariffs are installed if end-of-life netting is not returned to the manufacturer), while in Denmark 50% of the costs are gained back through selling the sorted materials.

This implies that some costs need to be reduced to improve economic feasibility. The manual labour associated with pre-sorting, cleaning and handling at the harbour is a major contributor to the high cost involved in fishing gear recycling. The following recommendations for changes were made to lower the recycling costs:

- A joint regional sorting station (with funding sources to be agreed nationally), as exemplified by FF Norden and the Sotenäs Marine Recycling Centre in Sweden, would leverage transport, collection and sorting costs.
- Remote locations, such as Iceland but also small-scale fisheries harbours along the British, Swedish, German, Irish coasts face high transportation costs. A systematic, well-coordinated collection system would decrease logistics costs.
- Centralised (regional) sorting facilities lead to improved input material quality by standardised source sorting.
- Keeping the processing chain as technically simple and short as possible, as exemplified by Plastix in Denmark, also serves to reduce processing costs.
- Pure, single-polymer material types help to save sorting costs and reduce contamination. Reducing the number of polymer types within ropes, lines, netting and floats will facilitate separation, but functionality/material strength must be kept.
- Replacing shrunken PET sheathing around lead weights with non-hazardous sink line materials is essential for gillnet separation and recycling.
- Support from the fishing sector is essential to minimise additional sorting/handling after collection.
- Net manufacturers might be employed to assist in the sorting, as exemplified by Hampidjan in Iceland (**Box 4.5**), as they know best how gear was assembled and which materials were used in each specific type of gear.
- For an efficient recycling system, it is important to involve stakeholders along the entire value chain, from the net manufacturer to fishers to the waste management companies.

4.4.6. Conclusion of challenges and adaptations for fishing gear recycling

In summary, there are numerous challenges that need to be overcome before recycling of end-of-life fishing gears will be a standard procedure throughout the OSPAR Maritime Area and the EU. Some of these challenges are easier to address, such as regular collection containers in harbours, while others related to dismantling costs are more difficult to overcome. One way to support recycling is to rethink today's design of fishing gear to be more suited to handling, dismantling and sorting into individual material streams (see Section 5).

4.5. Moving towards more efficient recycling of fishing gear in the OSPAR Maritime Area

4.5.1. Necessary steps to increase recycling

When asked about necessary steps to increase recycling, stakeholders commonly responded with focus on reducing the cost and effort to recycle fishing gear. Awareness of recycling options and the simplicity of transferring end-of-life gear to recycling companies are mentioned as key points to implement recycling in the OSPAR Maritime Area. Collection or drop-off points need to be installed and in reach, including for fishers operating from small harbours with limited space for collection facilities. Free disposal of end-of-life and recovered fishing gear is a key incentive, as for example in the collection scheme organized by the waste management company Bek & Verburg in the Netherlands (**Annex D BP 4.6**). Currently, transport and handling/sorting costs were identified as major barriers to gear recycling. Increasing the recycling rate requires a fair cost-sharing system throughout the complete value chain from the manufacturers to the end user and waste manager, so that the burden is not exclusively on harbours and fishers. Installing such a system would require government and EU financial support. An EPR scheme could also facilitate sorting and collection. Specific recommendations provided by stakeholders were:

- Legislative mandatory monitoring and reporting of fishing gear amounts placed on the market and recycled at end-of-life stage;
- Easy and free options to safely dispose of end-of-life gear in or near every fishing harbour;
- Harmonised waste reception facilities in ports, at least between smaller ports/larger ports in different countries (an example is the system in the Netherlands facilitated by KIMO);
- Collection schemes for recycling and disassembly need adapted solutions for smaller and larger harbours;
- Uniform waste classification scheme for fishing gear in Europe to facilitate transport of EOL and ALDFG;
- Awareness raising among harbours and fishers of already existing recycling options;
- Sharing of transportation costs and funding schemes to support the effort and time needed to sort gear for recycling;
- Combine fishing gear waste with other waste streams from similar materials, to increase efficiency and thus reduce costs; preferably in sorting facilities, where different waste streams of identical materials are collected;
- Trawl/purse seine/trap suppliers/manufacturers could offer collection points or collect end-of-life repair material when delivering new trawl netting, as exemplified by e.g. Hampidjan, Cux-Trawl and Frydendahl (**Box 4.4 & 4.5**);
- Monitoring system to measure the amount of gear taken on-board and brought back to shore;
- Designated mending areas in ports to avoid leakage and facilitate small-part recycling; e.g. drivable "hoovers" and large leaf-blower can be used to concentrate & collect fibre strings;
- Labels or other forms of accreditation for fishing companies with active recycling efforts;
- Reduced EPR or licencing fees for companies actively collecting end-of-life gear, incorporating a significant percentage of recycling material in their netting, and for fishers returning end-of-life and repair nets to the collection points; and
- A fee system could be supported through a scoring matrix taking into account durability, longevity, recyclability and reduced environmental impact.

Regarding recycling technology and gear design, the following recommendations were provided:

- Design for recyclability and circularity: less different material types, easier to separate, use of recycling-friendly materials;
- More standardisation of fishing gear design across EU borders;
- Mandatory recycled content in new products, including in new fishing gears;
- Technological innovation needs to be supported by governments/the EU to improve recycling technology;
- The aim of research & development has to be that the cost for recycling becomes lower than the economic benefits achieved from fishing gear recycling;
- Initially, financial support is required to establish the logistics for a common collection, sorting and recycling system, and support for recycling companies willing to manage end-of-life fishing gears; and
- An Extended Producer Responsibility Scheme can assist financing a recycling system, but needs to account for online purchase, long product lifecycle, and the comparably small European fishing gear market; small gear-manufacturing enterprises have to remain profitable and competitive and EPR fees must support design for recycling rather than implying a mere increase in the gear price for fishers.

EU-wide standardisation was mentioned as necessary for equal market access especially for local manufacturers. At the same time, custom-made trawls will remain individually assembled, yet the base materials could be standardised (i.e. any potential EPR scheme could not apply only to fishing gear manufacturers but also to nets and ropes / base materials manufacturers). One stakeholder fears that standardisation, while helping to reduce recycling costs and increasing the likelihood and efficiency of fishing gear recycling, would be a costly and prolonged process which might impede a fast route to fishing gear recycling in the next few years.

An important aspect mentioned by many stakeholders is the lack of good data on the amount of gear that is sold, discarded, and collected for recycling. An EPR scheme for fishing gear will require monitoring schemes to be set up, monitoring the above mentioned streams. A three year project in Norway was run to collect these different data; stakeholders indicated that the experience from Norway could be used to develop a standardised methodology to collect market turnover data for fishing gear in all EU countries. In Ireland, a project called SMART Net is looking into the current tracking of fishing gear and potential opportunities for monitoring and reporting.

Positive examples that can serve as role models are the Sotenäs Marine Recycling Centre in Sweden (**Box 4.6**) and the Icelandic return system (**Box 4.5**). The Sotenäs facility receives all kinds of fishing gear from Smögen and other Swedish harbours, for dismantling, sorting and forwarding to Plastix for recycling, or the sending of parts to FF Norden for re-use. The involved fishers pre-sorting, cleaning and dismantling the material in Smögen receive a small financial return from selling end-of-life fishing gears, while the project is also supported by EU/EMFF public funding. The Icelandic return system for trawls and purse seines serves as an excellent model where cost equals but does not exceed benefit – the benefit is environmental and image improvement for the fishing sector, as fishers return repair fragments and end-of-life nets in exchange for a fee, and the cost of new gear is increased by a penalty if old gear is not returned. This system offers a mix of financial and environmental incentive and could be adapted in all OSPAR areas with trawling fleets.

4.5.2. The waste hierarchy

Following the European waste hierarchy (**Figure 4.7**), re-use surpasses recycling. Re-use can be facilitated if end-of-life fishing gear is not individually discarded, but collected at gear manufacturers who are best equipped to separate components and decide which parts can be reused[7]. Besides, repairs should be encouraged to extend the lifetime of fishing gear as much as possible. An efficient way to encourage repairs could be a return system offered by the manufacturer, such as the Frydendahl return system for gillnets or the Cosmos Trawl and Cux Trawl return systems for trawling gear (**Box 4.4**). If reuse is not feasible, recycling into high-quality goods is the next preferable option. Until now, fishing nets have been designed from some of the most durable yet inexpensive plastics such as nylon, which has a very long lifespan. The introduction of the EU Single-Use Plastics Directive and required EPR schemes for EU Member States is the first time that circularity considerations will be demanded of the gear industry.

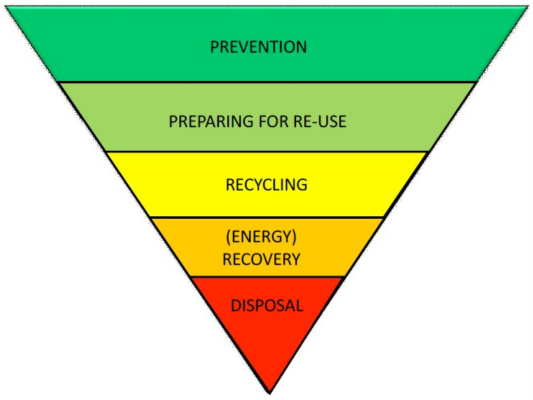

Figure 4.7 **The waste hierarchy as set out in the Waste Framework Directive (2008/98/EC). EU Member States should apply this as a priority order, with prevention of waste as priority, followed by re-use, recycling, (energy) recovery, and disposal as the final option.**

4.5.3. Conclusion

In summary, easy access to collection infrastructure and easier sorting of materials, with design focusing not only on functionality and durability at sea, but also on recyclability, are prerequisites for increasing the amount of recycled fishing gear. Design options to improve recyclability and achieve a more circular economy approach to fishing gear are considered in the next section.

[7] Re-use is one of the strategies to extend the lifespan of a product; other strategies include e.g. repair and refurbishment. The R-ladder further details different Circularity Strategies, in line with the EU Waste Hierarchy.

5. Design of fishing gear

5.1. Introduction

Depending on the type of fisheries involved, local circumstances, and individual preferences in design, fishing gear can be composed of anything between a few or many different materials, often with different designs and materials used for similar purposes. Choices over which design or material to use are based on many factors, including the costs, material characteristics and properties (e.g. strength, flexibility, durability, weight, buoyancy), as well as past experiences in using certain designs or materials and existing regulations (e.g. Technical Measures of the Common Fisheries Policy). As a result, fishing gear tends to consist of a heterogeneous range of materials and designs, each with different characteristics and properties. And, as cost-effectiveness is a major component driving fishing gear design, choices over which materials and design to use may not always have environmentally friendly design in mind, as this is often costlier. Significant repair and modification is practised to extend the lifespan of (components of) nets, but product life extension is not yet widely factored in from the design phase. Eco-design, and within it circular design, are not currently practiced in the fishing gear industry.

This chapter investigates possible ways to address marine litter from fishing gear through fishing gear design. Alternative fishing gear design is considered from three perspectives: (1) improving gear recyclability at end-of-life; (2) reducing environmental impact when gear is lost, and; (3) improving gear traceability. For each we will discuss best practice in the OSPAR Maritime Area, the feasibility of the options available, and current knowledge gaps and challenges.

5.2. Design for better recyclability and management of end-of-life fishing gear

Design of fishing gear needs to employ a circular economy approach, taking into account its management at end-of-life and potential for reuse and recycling. This could be approached from the Circular Economy hierarchy, including proactive design for better maintenance, repairability, remanufacturing, refurbishment and material recycling. **Annex F** gives an overview of different criteria that could be used to facilitate eco-design. Questionnaire respondents recognised the potential for design for better recyclability in many gear types, especially in gillnets and trawls. There is a potential in this respect to make step-wise changes, however there are also many challenges to overcome, and trade-offs to balance. When asked about the key barriers for large-scale implementation of design for recyclability of fishing gear, questionnaire respondents listed cost challenges and technological challenges as the most important barriers, followed by potential compromises to functionality and logistical challenges (**Figure 5.1**).

When considering the design of fishing gear for recycling at end-of-life, there are several important considerations that apply to many types of gear, including:

- lifecycle approach – how can gear be designed for product life extension, to enable repair and perhaps remanufacturing / refurbishment of parts of the gear, as well as educating fishers to better repair nets in a way that facilitates recycling at end-of-life;
- disassembly into constituent parts – easy disassembly is required to minimise the manual labour time and cost to prepare gear for recycling;
- number of materials – fewer materials (i.e. ideally large sections of gear made with a single polymer) would make disassembly and recycling more feasible. Materials should also be easy to identify and of high purity where possible;
- transparency – recyclers require accurate information on what materials have been used in the production of gear (including chemicals used in coatings); and

- value of materials – using materials such as Nylon 6 which have higher value on the secondary market will incentivise recycling.

Given the different functionality and other requirements for different types of gear, there may be more specific considerations. These are described below.

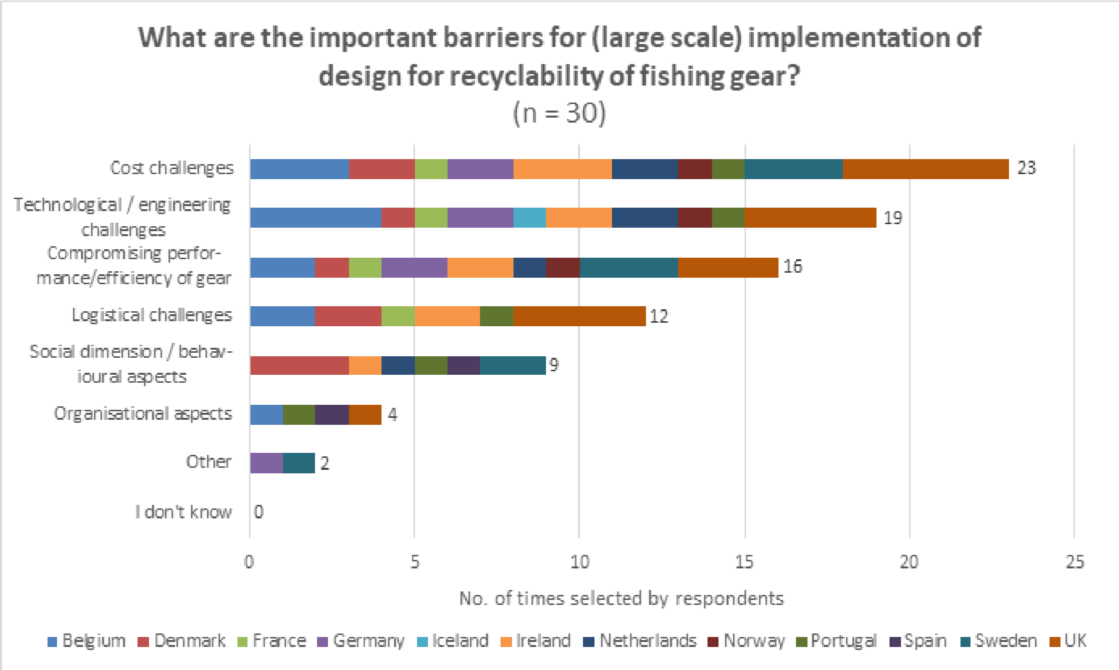

Figure 5.1 **Responses to the most important barriers to designing fishing gear for recyclability**

5.2.1. Gillnets

In European coastal fisheries, gillnets are one of the most common gear types employed in shallow waters. A single gillnet is typically composed of the four most common types of plastics produced, because nets were originally designed for functionality of their parts:

- polyamide (PA6, nylon) or polyester (PET) for the main net body for sturdiness;
- polyethylene and polypropylene with a lower density than water for float lines and floats, possibly with added expanded polystyrene floats for enhanced buoyancy; and
- PET sheathing around lead weights in sink lines as a sturdy, high-density fibrous material.

Currently, nylon (PA6) netting as well as PP/PE floats and lines can be recycled by Aquafil in Slovenia and Plastix A/S in Denmark (see **Table 4.1** in **Section 4**, and **BP 4.1** and **4.2** in **Annex D**). These must be separated into individual polymer components before shipping to the recycling facility; mixed materials cannot be accepted because of the extensive manual labour involved in separating material fractions once netting and lines are entangled. Therefore, reducing the number of different polymers used in gillnets and simplifying their dismantling after use could increase the amount of fishing gear entering the recycling process.

Sink lines with lead weights are particularly problematic because lead it is considered hazardous waste. The weight fraction of lead in gillnets is substantially higher than the 0.3% of contamination acceptable in European incineration facilities, according to the EU Waste Framework Directive. Although lead as a metal can be recycled easily, it is very difficult to isolate from its polyester sheathing when attached to gillnets. Therefore, lead weights in sink lines should be replaced by less hazardous materials and this should support recyclability of sink lines when reuse is not possible. Efforts to replace lead by other metal alloys and specific high-density volcanic rock are under investigation, but wide-scale replacements of lead sink lines may require financial incentives and close collaboration with the fishing sector to enable lead to be phased out since sink lines are reused for many years before the PET sheathing becomes fragile.

5.2.2. Pelagic trawl, bottom trawls (including flyshoot) and purse seine gear

Trawls and purse seine gear are, apart from sections containing metal and rubber, mainly composed of ropes and nets from mainly single polymer materials such as polyethylene, nylon and polyester. A recent trend has been to incorporate more HMPE (mainly Dyneema®) in these nets. Of these materials, polyethylene is mainly used in bottom trawling nets because of its buoyancy, which keeps the net in the right shape when fishing at a low towing speed. HMPE, nylon and polyester are stronger (more energy absorbing) materials than polyethylene and are mainly used in those sections of the net where there is more wear and tear. HMPE and regular polyethylene both float, while nylon and polyester do not float. The latter two therefore usually sink to the seabed when lost at sea; polyethylene and HMPE tend to float and may thus end up on beaches.

Since conventional trawl and purse seine nets mainly consist of single polymer materials, it makes these nets easier to recycle (except for HMPE, such as Dyneema®, which cannot be recycled). However, a recent trend has seen some sections of netting use material made from a mix of nylon and polyethylene (usually when a certain combination of strength, energy absorption and wear resistance is needed). These mixes of polyethylene and nylon are less easily recyclable due to their different melting temperatures and inherent material properties.

In the flyshoot fishery, a plastic fibre material called 'eurosteel' is used. Even though this is a mix between polyethylene and polypropylene, this mix can be recycled into mixed PE/PP recyclates with comparable material qualities as eurosteel.

Ropes are usually produced from a large variety of materials – including taifun wire ropes with steel cores. The fibres themselves might be composed of mixed polymer strands, optimised for durability and performance at sea. Bridle lines, sweep lines, head and foot ropes as well as towing warps might be forged from different polymer types, including or excluding metal fortification. In general, trawl fisheries adapt their gear extensively and so far, concern has only been given to functionality at sea, long-term durability, and availability of inexpensive materials, rather than to the recycling potential.

Trawl netting, as well as aquaculture nets, might also be copper-coated to decrease biofouling during extended periods in the water. Copper-coated netting cannot be recycled at present, because of potential toxicity in the recyclate. The current mix of materials especially in ropes and lines limit the ability to establish a circular economy around pelagic and bottom fishing gear.

Therefore, there is a need to incentivise the use of single polymer ropes and netting to facilitate recycling. Coating with antifouling and interwoven copper threads in ropes and lines should be avoided where possible.

5.3. Design to reduce environmental impact of lost gear

Given the harm that lost gear causes in the marine environment, alternative design has the potential to reduce this environmental impact. In line with the waste hierarchy and when taking a whole life-cycle approach to fishing gear, a core objective when trying to reduce harm is to reduce the amount of fishing gear that becomes marine litter in the first place. For example, there is potential to design fishing gear so it is more durable and less prone to wear and tear. Where reduction of materials is not an option, there is potential to use alternative materials (e.g. natural fibres, less hazardous materials, biodegradable polymers) to design fishing gear in a way that reduces harm in the marine environment if it is lost.

One of the strategies of designing for product life extension that is relevant for fishing gear, is design for durability. This applies specifically to designing set gear, including aquaculture, fit for different (natural) circumstances. For example, fish farms in a secluded bay where weather circumstances are milder, can require thinner ropes and smaller floating barrels than aquaculture at open sea. In the Netherlands, there have been several attempts to create a seaweed farm at open sea, of which the first few initiatives failed and contributed large amounts of marine litter. The "North Sea Innovation Lab", that is currently exploring the possibilities of different types of aquaculture at open sea, was required to carry out an independent technical study to prove the installation was storm proof, before it was being placed at sea. Such measures can help in the prevention of marine litter from pioneer initiatives, as well as contribute to shipping safety around new installations.

5.3.1. Biodegradable gear

There has been growing interest in plastics that are biodegradable in seawater, where polymers disintegrate in either industrial composting installations or the natural environment into smaller molecules and eventually minerals (CO2, H2O, CH4, etc.). The rate of biodegradability depends on the 'aggressiveness' of the environment; seawater is considered less 'aggressive' than freshwater, soil or composting facilities and therefore materials will be slower to degrade (CE Delft, 2017).

Currently, only a small number of plastics that are biodegradable in seawater are available on the market. These are available in low quantities and with different characteristics and properties than the current types of plastics used in fishing gear, and, as such, are not feasible to replace conventional plastics on a large scale. Since 2015, an official certificate has been available for plastics that are biodegradable in seawater called OK biodegradable MARINE issued by TÜV AUSTRIA. For this certification scheme, plastic is considered to be marine biodegradable if, under laboratory conditions, the disintegration of a slim film of the material being tested happens within 2.5 months and biodegradation (mineralisation) within six months. However, for the test, the water temperature is maintained at 30 ± 2°C and the test item is put in a shaking unit during the entire duration (TÜV AUSTRIA, 2019). In field conditions, however, the biodegradation of materials in the marine environment is difficult to predict and can vary depending on the properties of the material and the environmental conditions including nutrients, abundance of microorganisms, climatic variations (including temperature), and fouling by micro- and macro-organisms.

A research project in Norway, involving SINTEF Ocean, Arctic University of Norway and S-ENPOL, is currently trialing biodegradable gillnets made from polybutylene succinate co-adipate-co-terephthalate (PBSAT). After 25 months in the marine environment, PBSAT gillnets exhibited a 35% reduction of tensile strength due to degradation. While this is attractive from the perspective of reducing the lifespan of gear if it becomes lost, there is an important trade-off with functionality. Two studies by Grimaldo et al. (2018a, 2018b), comparing these biodegradable PBSAT gillnets with conventional gillnets, concluded that biodegradable nets have a lower fishing efficiency than conventional nets. The catch of Greenland halibut with biodegradable nets was 16% lower than with nylon nets; for Siathe this was 22-40% lower, and for Cod 21% lower. This is because marine biodegradable nets are both weaker (10-12% lower tensile strength) and more elastic (about 5%) than nylon nets.

Currently, there are serious constraints on marine biodegradable plastics being used for fishing gear on a large scale. In addition to trade-offs with design for functionality, durability and recyclability, there are concerns that marine biodegradable materials could create a perverse incentive to intentionally discard more gear into the marine environment, ultimately doing more harm. Besides, there are concerns about the degradation process leading to the emission of microplastics into the marine environment. Differences between gear types and related risk of (un)intentional discards should also be considered. For example, the best strategy for expensive trawl gear might be to improve durability and increase life span. However, for gill nets, that are less expensive and more likely to end up in the marine environment, biodegradable netting could be looked into further. When asked about the success of biodegradable materials for fishing gear, questionnaire respondents gave mixed responses. Some saw the trials as promising, while others raised concerns about the functionality of alternative materials and the time it takes to biodegrade in the marine environment. More research is clearly needed to understand the balance of benefits and risks of marine biodegradable materials in different circumstances, in order to define clear standards on marine biodegradability.

However, there are some specific instances where use of marine biodegradable materials seems promising. For example, studies have shown that the ghost fishing by lost pots causes significant economic losses (e.g. see Scheld et al., 2016). Simple design modifications have the potential to reduce this. In Norway, ResQunit has developed a floatation device that can be attached to lobster traps and pots with cotton twine that disintegrates in 90 days, revealing an escape hatch and releasing the floatation device. This enables wildlife to escape and alerts fishers to the location of the lost gear (see **Annex D BP 5.1**). Such small design modifications can easily be embedded in regulations. For example, in Puget Sound/Washington and Alaska, a biodegradable cord on shellfish trap escape hatches is compulsory. These cords are generally made of cotton. A similar regulation is in place in Canada, California and Oregon.

5.3.2. Alternatives to hazardous materials

Where hazardous materials are used in fishing gear, there is potential to develop and test alternative materials that cause less harm. For example, lead is a Persistent Bioaccumulative Toxin (PBT) and is included on the list of chemicals requiring priority action by several international and European bodies; however, it is still widely used in different types of fishing gear, including gillnets and recreational gear. Verleye & Devriese (2019) tested a number of alternatives for lead fishing weights in recreational angling in Belgium and indicated that these are feasible solutions, depending on the specific situation (e.g. target species, environmental conditions). The authors conclude that for a successful transition, innovation and development by manufacturers of angling equipment is needed, to produce affordable environmentally-friendly lead alternatives that match the use properties of lead. There is already some work happening in the OSPAR region to replace hazardous materials with less hazardous materials through voluntary (e.g. the Dutch Green Deal ‘Angling Lead Free’) or legal measures (e.g. Danish Statutory Order no. 856 of 5th September 2009, see **Box 5.1**).

5.3.3. Use of alternative materials or natural fibres

In addition to investigating the potential for non-hazardous and marine biodegradable materials, some projects are considering whether alternative materials (e.g. natural fibres or stronger materials) can replace plastics in whole or parts of fishing gear, reducing their environmental impact if they are lost or reducing the chances of losing gear due to wear and tear.

One such project is DollyropeFree based in the Netherlands (see **Annex D BP 5.2**) which aims for a significant reduction in the amount of dolly rope that ends up in the sea. Dollyrope (also referred to as ´chaffe´ in the UK or ‘vahiné rope’ in France) is the name given to orange or blue plastic threads often attached to the underside of flatfish and shrimp (and some whitefish) bottom-trawling nets to protect against wear and tear, mostly in the southern North Sea and English Channel, but also in other parts of the world. Due to abrasion and poor waste management, dollyrope threads end up in the sea during fishing operations, making it one of the most commonly encountered litter items on beaches in Belgium, the Netherlands, Germany, Denmark, south-west Sweden and south-west Norway.

Box 5.1: Case study on lead restrictions in Denmark

The Danish Statutory Order (no. 856 of 5th September 2009) prohibits the import and sale of products containing lead. In the case of metallic lead, there is a ban on the import and sale of the products listed in Annex 2 of the statutory order. This includes among others equipment for commercial fishing (sinkers, sinker lines and cables) and fishing equipment for sports fishing.

For sports fishing, lead free alternatives are in place and used in Denmark. For commercial fishing, the Danish Environmental Protection Agency holds the opinion that alternatives containing iron or zinc instead of lead are available, but have the disadvantage that they take up more space (1/3rd more) on a fishing vessel and are heavier. This has a big impact on vessel stability and the amount of fishing gear that can be carried per vessel. The amount of fishing equipment that can be carried per vessel has a direct impact on the vessel's economy, and thereby a negative impact additionally to the purchasing costs. Besides that, the working space is more limited, and thus having a negative impact on the working environment of fishermen.

Based on the availability of suitable lead free alternatives evaluated in 2014, lighter sinker lines have been illegal to import and sell after 2014, while the ban has been waivered for heavier sinker lines of more than 7kg/100m until 2017. In 2016 the waiver was re-evaluated based on a report of experiences by the Danish Fishermen PO (DFPO). The report stated that no fishermen have started using the lead free alternatives as a result of problems in the handling of the alternatives and probably because the national ban only restricts import and sale and not use and reuse of sinker lines already in use. As a result, a waiver was granted for a five year period this time including all sinker lines.

During the course of the project, alternative materials and designs to replace conventional dollyrope were tested, including natural fibres (i.e. sisal, manila), yak leather, rubber, biopolymers (both compostable and certified as marine biodegradable materials), and non-degradable polymers (but stronger and more durable and therefore less prone to wear and tear). Several options came through as being more sustainable alternatives to conventional dollyrope, notably yak leather, marine biodegradable polymer fibres and a protective layer of specially designed netting that is wrapped around the cod-end of a bottom-trawling net. Sea trials with these three options are currently ongoing as of March 2020 and the results will be published mid-2020 (WJ Strietman, pers. comm.).

A research project in Germany, called DRopS, is aiming to reduce the environmental impact of dollyrope by looking at design modifications in the net, rather than using natural or biodegradable alternatives. Within the project, four different approaches are considered and tested to minimize the ground contact of the trawl. Further details can be found in **Annex D** (**BP 5.3**).

Although not in the OSPAR Maritime Area, another project by the Spanish tuna fleet and Inter-American Tropical Tuna Commission is developing and testing 'BIOFAD' prototypes to replace traditional Fish Aggregating Devices (FADs), artificial floats deployed by fishers to attract and follow ocean going pelagic fish such as tuna (Zudaire et al., 2019). These BIOFADs must comply with the requirements of being non-entangled and will not use synthetic materials (except for their satellite buoy and markers) or chemicals toxic to the marine environment. The International Seafood Sustainability Foundation is likewise attempting to redesign FADs using natural materials including wood, cotton and cork (see **Figure 5.2**). While these projects are still in the trial phases in terms of assessing their functionality and environmental impact, they are interesting case studies of synthetic materials being replaced by natural fibres to reduce harm in the marine environment.

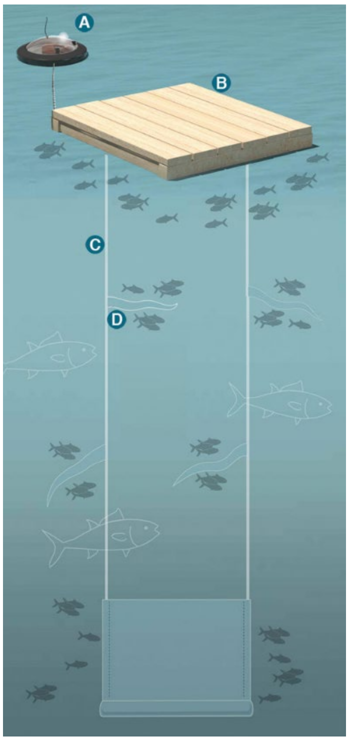

Figure 5.2 **Example of a more eco-friendly design for a Fish Aggregating Device (FAD) used to catch tuna. Components are: A) a satellite tracking device; B) a wooden fish aggregating device (FAD); C) cotton rope; and D) cotton canvas used to control drift, made of biodegradable ropes and flags. Picture from Richard Bornemann/WWF-US:** https://www.worldwildlife.org/magazine/issues/winter-2017/articles/finding-a-better-way-to-fish-for-dolphin-safe-tuna.

5.4. Design for better traceability

Fishing gear can be designed so that it is traceable through the supply chain by being marked in a number of different ways. In recent years, various new technologies have been developed to mark fishing gear including electronic tagging (i.e. RFID identifiers), coded wire tags, QR coding, colour-coded ropes, metal stamping, metal tags, chemical marking and radio beacons, and transponders. Gear marking has the potential to reduce the environmental impact of fishing gear by, for example: acting as a deterrent for the deliberate or inappropriate disposal of fishing gear, preventing the unauthorised setting or use of fishing gear which reduces the potential for gear conflict and loss, enabling the location of fishing gear to be tracked and subsequently retrieved, and assisting with the prevention of illegal, unreported and unregulated (IUU) fishing. An example of a gear marking project to reduce marine litter from fisheries is NetTag (**Box 5.2**). Besides, markings on gear could contain information about the type(s) of material of the gear component(s), which can contribute to easier recognition of materials for recycling.

Box 5.2: best practice example project for gear marking: NetTag

NetTag is a project promoting waste free fisheries through tagging fishing gears and enhancing on board best-practices in Portugal and Spain. The project is running from January 2019 to December 2020 and is aimed specifically at the regions of north-west Portugal and Galicia (Spain). Scientists, engineers and the fisheries industry are involved. The approach used combines two different types of preventive measures: (i) new technology to prevent lost gears; and (ii) awareness actions to promote best-practices for on-board waste management.

NetTag will develop new technologies to track fishing gears in case gears get lost, including low cost, miniature and environmental friendly acoustic tags and acoustic transceivers for localization (with fisher's personal ID) of lost gear, and an automated-short-range robotic recovery system. Participant fishers will evaluate the new technology in a dedicated demonstrative field action.

When asked about whether gear marking was an effective measure to prevent losses of fishing gear, around twice as many questionnaire respondents answered affirmatively than negatively. Reasons cited were deterring intentional loss, being able to trace lost gear back to specific vessels and aiding clean up. However, there was broad recognition that gear marking would be more effective for preventing intentional, rather than accidental loss, and is more suited in the event of larger sections of gear being lost. Some people said gear marking is not preferable precisely for these reasons – because, in their view, gear loss is mainly accidental and parts rather than whole sections of gear are most often lost.

Current best practice on gear marking is through the UN Food and Agriculture Organization (FAO) Voluntary Guidelines for the Marking of Fishing Gear, which were endorsed by the FAO Committee on Fisheries in 2018. These Guidelines are global in scope and apply to all fishing gear types. It recommends the system for the marking of fishing gear should:

- Build on an assessment of risks associated with ALDFG so that gear marking actions are prioritized and proportionate with the identified risks and designed to reduce, mitigate and eliminate these risks effectively;
- Provide a simple, pragmatic, affordable and verifiable means of identifying the ownership and position of fishing gear;
- To the extent possible, be compatible with related traceability and certification systems;
- Be supported by a monitoring process that ensures that the system is responsive to the changing conditions of all stakeholders; and
- Promote employment of methods that do not pose environmental risk (e.g. plastic pollution)

Most questionnaire respondents are aware about various gear marking requirements in their countries, either voluntary or compulsory (**Figure 5.3**). Since 2005, gear marking for passive gear and beam trawl gear has been compulsory in EU countries, and gear marking requirements were updated in the Commission Implementing regulation EU/404/2011. Building on existing regulations on gear marking in OSPAR Contracting Parties, there is scope for designers, net manufacturers and regulators to introduce further gear marking requirements in line with the FAO's Voluntary Guidelines, considering the costs and benefits of marking in specific circumstances. One promising project in the OSPAR Maritime Area is PingMe by Ocean Space Acoustics in Norway, which uses transponder technology, either integrated with a vessel's sonar or as a stand-alone system, to enable gear to be identified and located when lost. But, in some cases, only portions of the full gear is lost (e.g. due to wear and tear and during repairs) so this should be an important consideration when choosing the appropriate gear marking method. This is particularly relevant in the OSPAR Maritime Area, where the majority of fisheries related litter found on beaches is parts of fishing gear, rather than whole or large sections (see **Section 2**). Under what circumstances gear marking is feasible and a priority in the OSPAR Maritime Area could be a topic for further study.

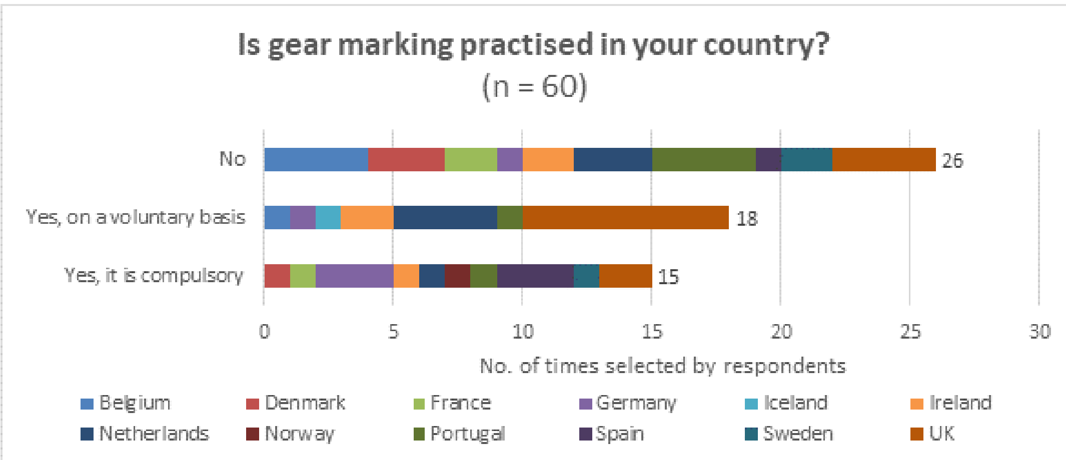

Figure 5.3 **Responses to whether gear marking is practiced in OSPAR Contracting Parties**

5.5. Discussion and conclusion

Fishing gear has traditionally been designed for functionality, durability and cost, with design to reduce environmental impact on the marine environment and promote a more circular economy being relatively recent developments. Questionnaire respondents said there is now scope for many stakeholders – including governments, gear producers, material manufacturers, and fishery organisations – to consider the benefits of alternative design (**Figure 5.4**).

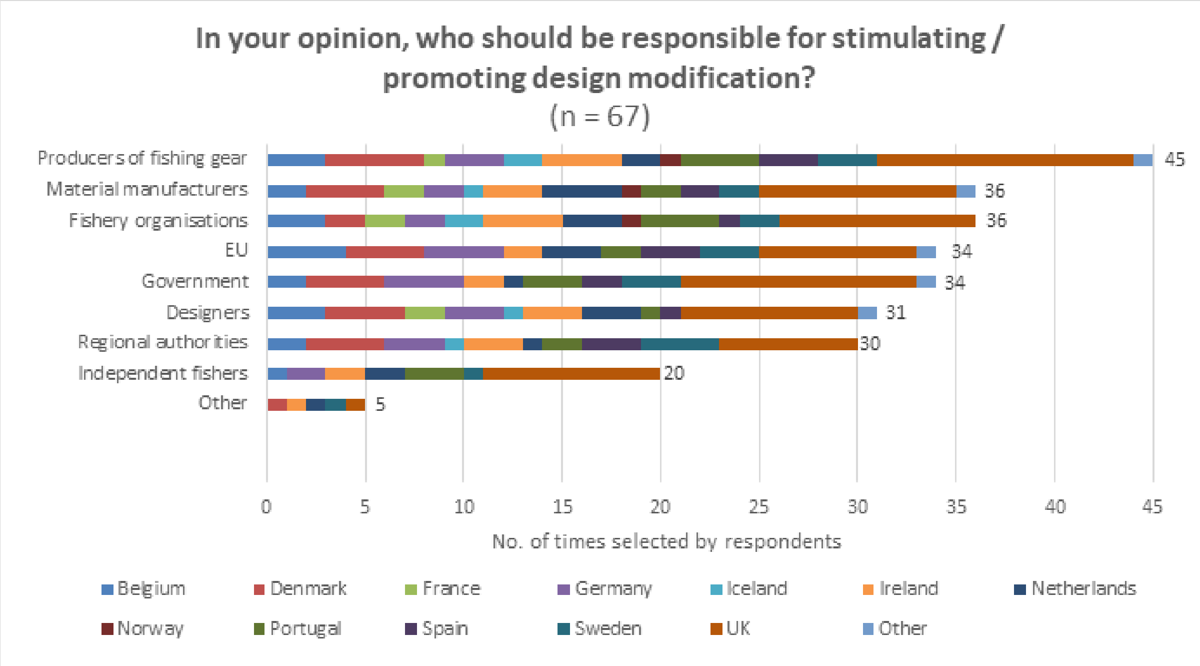

Figure 5.4 **Responses to which stakeholders should be responsible for promoting and stimulating design modifications**

However, in general, replacing current materials in fishing gear with more environmentally friendly substitutes poses many practical challenges. Firstly, there are legal considerations such as mesh size under the Technical Measures of the Common Fisheries Policy, which will render some alternatives unsuitable to replace currently used materials e.g. due to potential to shrink or expand. Further, for most materials, there are no off-the-shelf alternatives available which have the same characteristics and properties and are simultaneously more environmental friendly (e.g. marine biodegradable). Those that are available exist in relatively low quantities and only work as replacement in specific circumstances. Whilst we have highlighted some examples of best practice, there is no indication that large-scale change is feasible in the short-term.

There are also important risks to consider, especially in the context of marine biodegradable materials. These could also create a perverse incentive to intentionally discard more gear into the marine environment and could lead to leakage of microplastics. There are also concerns about the lifespan of these biodegradable materials, which could take several months or years to degrade in the marine environment. Another risk is low uptake by the fishing industry, due to the lower fishing power that biodegradable materials confer to certain fishing gear types. These factors combined could mean marine biodegradable fishing gear needs more research to ensure the status quo in terms of functionality and environmental impact.

There is another question about whether substituting materials with more sustainable materials addresses the most important causes of fishing gear ending up in the sea and is therefore the most effective policy option. For example, based on analysis of beached trawling gear throughout the North Sea and north-Atlantic (pers. comm. WJ Strietman), most trawling gear found on beaches is small off-cuts from meshes or slightly larger sections of net that have been cut out during repairs (see also **Section 2**). If intentionally discarding these off-cuts is addressed directly through behavioural change, this could significantly reduce most trawl gear related litter on beaches in Northern Europe. However, this is not necessarily the same for all gear types. For gillnets and lobster / crab cages and some aquaculture gear, this gear sinks and remains on the seabed when lost or discarded. Here, design for less environment impact, e.g. by replacing lead in sink lines with non-toxic alternatives, could be beneficial for the marine environment.

Evidence of the underlying causes of gear loss should be used to inform the most effective policy options for different gear types in different contexts. This would inform how to prioritise alternative gear design relative to other measures such as behavioural change, better waste management on board vessels, and strengthening and enforcement of gear reporting and gear marking requirements. A possible way to facilitate design improvements is through the EPR scheme on fishing gear as set out in Directive EU/2019/904. EPR fees can be modulated, where possible, for individual products or groups of similar products, by taking into account (by, for example, a scoring matrix) their durability, reparability, re-usability and recyclability and the presence of hazardous substances, thereby taking a life-cycle approach. This can be an efficient way to encourage improvements in gear design.

With regard to design for product life extension and recyclability at end-of-life, there are general considerations that apply to many types of gear. The first priority should be to keep gear products in circulation for as long as possible, facilitating reuse and remanufacturing. Next, it will be important, where possible, to reduce the number of materials used, to use materials with high value on the secondary market, to ensure materials are easily identifiable and of high purity, to ensure gear is easy to disassemble, and to ensure recyclers have accurate information on what materials are used in the production of gear. With these factors in mind, regulators, gear designers and manufacturers have an opportunity to integrate end-of-life considerations into fishing gear design to ensure more of it is recycled.

6. Options considered for next steps to reduce the amount of fishing gear that ends up as marine litter within the OSPAR Maritime Area

This section of the scoping study sets out a number of possible next steps that could be taken either nationally (by individual Contracting Parties), collectively (by OSPAR), or by supporting processes through other mechanisms (i.e. the European Union). Any possible next steps specifically relating to implementation for the SUP Directive should be progressed in close collaboration with the European Commission.

The identified best practice examples (in **Sections 4** and **5** and in **Annex D**) and possible next steps for further work presented below will be considered at OSPAR's Intersessional Correspondence Group on Marine Litter (ICG-ML) and at OSPAR's Environmental Impacts of Human Activities Committee (EIHA). The results of this work will also feed in to OSPAR's review and update of the Regional Action Plan for Marine Litter.

6.1. General considerations for Contracting Parties / OSPAR

Some common themes were identified during the drafting of these options considered for next steps to reduce the amount of fishing gear that ends up as marine litter within the OSPAR Maritime Area, these include:

- All processes should be cognisant of the waste hierarchy (prevention, repair / re-use, recycling, other recovery, followed by disposal as a last resort);
- All solutions should be subject to cost-benefit analysis, and be considered in terms of a full life cycle analysis, taking into account CO_2 emissions during operational phase as well as during transport of gear for recycling at end of life. Life cycle analysis should also consider the environmental costs / consequences of fishing gear ending up in the marine environment. Life cycle analysis could also serve as an incentive, should it be possible to show that increased durability of gear (for reduced environmental impact), will result in financial savings;
- In the development of any solution, all relevant experts (especially fishers, net manufacturers, material experts and designers from outside the sector) should be consulted. This could be in the form of a cross sectoral network of international experts, set up with the purpose of exchanging best practice, with the ability to act as a brokerage platform to solve relevant research needs / challenges; and
- Any solutions should be tailored to the specific location in which they will be implemented (e.g. accounting for different port / harbour locales and / or different sea basin characteristics / fishing areas).

6.2. Knowledge gaps and further research needed to understand the fishing gear supply chain and life cycle

Currently there is not enough information available to understand exactly how (and how much) fishing gear reaches the market in the OSPAR Maritime Area, as well as how it is (and how much is) recycled / disposed of at the end of its life. However, with the implementation of the SUP Directive, this information should become available for EU Member States. Should Contracting Parties want to introduce measures to increase recycling of fishing gear, and subsequently reduce marine litter resulting from fishing gear, it will be necessary to understand the effectiveness of these measures and monitor progress. Therefore, a need to map the supply chain and life cycle of gear has been identified.

Potential next step for Contracting Parties / OSPAR

OSPAR Contracting Parties could undertake national mapping exercises for the 'life cycle of fishing gear', as many Contracting Parties who are also EU Member States may already be planning for implementation of the SUP Directive. A life cycle analysis could include an understanding of the following:

- the amount and type (including composition) of gear placed on the market;
- the relevant players / stakeholders involved;
- the different stages of the supply chain, repair systems and end of life processes (what happens when and where), including source of raw materials, import, assembling, retailing, repair and end-of-life management;
- a 'needs analysis' at port / harbour level with an understanding of the different constraints at different locations (i.e. proximity to existing waste / recycling infrastructure);
- consideration of the different scales involved (e.g. global, EU, national, regional, port level, etc.);
- best practice throughout the life cycle; and
- the (financial) value at each stage of the supply chain.

Once completed on a national scale, OSPAR could facilitate sharing of collected information and support cross boundary links between sections of the supply chain.

6.3. Analysis of existing national legal frameworks

The existing national legal frameworks create a barrier to the collection and recycling of fishing gear in some OSPAR Contracting Parties. For example, in Ireland, there is lack of classification of fishing gear as a "waste type", meaning it may automatically be considered as swill (animal food waste) for which special regulations apply.

There is a need to understand and identify potential barriers / conflicts and synergies between the various existing legal frameworks related to end of life fishing gear as waste, including classification under MARPOL Annex V and the EU's Port Reception Facilities Directive, Waste Framework Directive and the Single Use Plastics Directive. Furthermore, clarification is required on reporting requirements for each of these mechanisms, and if there are opportunities for harmonisation (for example the IMO is currently reviewing MARPOL Annex V sections to ensure that the reporting of accidental loss or discharge of fishing gear is undertaken). There is also a need to distinguish between waste produced on the vessel versus waste collected whilst fishing (e.g. fishing for litter projects).

Potential next step for Contracting Parties / OSPAR

Contracting Parties could evaluate whether existing national legal frameworks for collection and disposal of fishing gear are fit for purpose, and identify opportunities to remove barriers for effective end-of-life management, with particular consideration of the legal classification of waste fishing gear.

OSPAR Contracting Parties could also investigate the establishment of a uniform waste classification scheme for fishing gear or the development of harmonised categories of waste streams from fishing gear across Europe, with consideration of existing waste legislation.

6.4. Increased efficiency in recycling schemes

Currently in the OSPAR Maritime Area, end-of-life collection of fishing gear is not harmonised and therefore not reaching its full potential: it has been identified that with increased complexity, there is increased cost due to fractured organisation, which is also difficult to monitor. Therefore, there is a need for more efficient and centralised (at the appropriate level) organisation of end-of-life management of fishing gear.

Potential next step for Contracting Parties / OSPAR

Contracting Parties could develop measures to better organise end-of-life management of fishing gear, this could include the following:

- centralised sorting / dismantling (regional hubs) to separate materials before long-distance transport to existing recycling facilities;
- harmonize waste reception facilities for recycling of fishing gear, tailored to specific harbour requirements (noting space restrictions, location / distance from infrastructure, volume and type of fishing gear – as identified during mapping exercise);
- appropriate waste management in gear mending areas (at port / on board vessels / aquaculture facilities), specifically to target prevalence of rope and net 'cut-offs' found within the OSPAR Maritime Area;
- monitoring of gear placed on market and collected at end-of-life stage (this could be controlled / monitored by recording weight of gear on vessels);
- investigation of opportunities to connect to waste streams from other sectors (e.g. shipping and offshore energy) for more efficient waste management;
- Subsidised transportation of gear for recycling; and
- incentives (market and non-market) for stakeholders to participate in recycling schemes, by returning value to the sector. This could be financial incentives for collection, (pre) sorting and recycling, or through positive branding, for example linking appropriate disposal of fishing gear with sustainability certifications, such as the Marine Stewardship Council or the Aquaculture Stewardship Council certification.

Any mechanisms should be developed in collaboration with the key stakeholders (i.e. ports, harbours and fishers). Any proposal should undergo cost benefit analysis (which could be supported by OSPAR's experience on economic and social analysis).

6.5. Awareness raising to reduce fishing gear found as marine litter and increase uptake in fishing gear recycling schemes

Although this scoping study found that in some areas, fishers are already aware of the issues associated with marine litter, and are willing and actively searching for ways to dispose of their gear sustainably, this is not the case across the entire OSPAR Maritime Area. Therefore, there is a need to raise awareness on the issues of fishing gear as a source of marine litter, the characteristics of the different materials used, and the practical constraints and considerations when preparing gear to be recycled (i.e. cleaning, dismantling and separating to meet the requirement of the recyclers).

Potential next step for Contracting Parties / OSPAR

OSPAR Contracting Parties could, when implementing **OSPAR Recommendation 2019/01 on the reduction of marine litter through the Implementation of Sustainability Education Programmes for Fishers**, ensure the inclusion of 'appropriate disposal of end of life gear' and 'improving recycling of fishing gear' modules in to the training programmes.

OSPAR could develop tailored information packs / guidelines for fishers and ports, increasing awareness of the environmental impacts of discarded fishing gear (including the smallest items such as off-cuts), highlighting the need for increased recycling, and including a practical guide for pre-processing, sorting, dismantling and transport of end-of-life gear.

OSPAR could also develop information packs / guidelines for gear manufacturers, assemblers and repair shops, highlighting the issue of fishing gear as a source of marine litter, and explaining the requirements that need to be met to enable end of life gear to be recycled.

Both of these guidelines would need to be developed in collaboration with fishing gear recyclers and representatives from other key stakeholders, as well as in close collaboration with the European Commission.

6.6. Improved recyclability of fishing gear through design

This study concludes that currently fishing gear design is driven by cost, functionality and durability, as is the case in many commercial sectors. One possible way to tackle the issue of fishing gear as a source of marine litter, could be to move towards a more circular economy approach, by introducing 'ease of recyclability' as a driver in to the design phase. Any change of perspective should be cognisant of the waste hierarchy (prevention, repair /re-use, recycling, other recovery, followed by disposal as a last resort). Where possible, gear design should be simplified to make end-of-life processes easier, including:

- reducing the number of materials;
- making it easier to identify different materials;
- increasing the purity of materials (i.e. limiting the complex mixing of materials); and
- ensuring gear is easier to dismantle.

In some specific cases, alternative materials should be developed and tested, for example for hazardous materials (e.g. lead fishing weights, interwoven copper threads in ropes and lines, and non-recyclable antifouling coating on gear).

Potential next step for Contracting Parties / OSPAR

OSPAR could provide information for fishing gear designers, manufacturers and regulators to increase awareness on the impacts of marine litter and encourage a circular economy approach. This could be further enforced by legislative means, encouraged through financial incentives, or supported by voluntary certification schemes. Any information provided should reference the EU's Ecodesign Directive (2009/125/EC), where appropriate.

Contracting Parties could also support and facilitate pilot studies that consider alternative, more environmentally friendly materials, specifically related to replacing hazardous material.

6.7. Improved design to reduce environmental impact

When considering the drivers for fishing gear design (cost, functionality and durability), and further supporting the need to move towards a more circular economy approach, environmental impacts of fishing gear should also be considered. Design criteria to reduce environmental impacts include:

- design to make gear less prone to wear and tear;
- design to make gear less prone to getting lost; and
- design / material substitutions to reduce environmental impact in the event that gear is lost at sea.

In some specific cases, the use of sustainable marine biodegradable components of fishing gear could be considered to reduce harm (e.g. biodegradable hatches in lobster pots). However, currently the majority of marine biodegradables are not considered to be viable alternatives to replace materials such as polyethylene and polyamide, as the biodegradable alternatives are not 'like-for-like' when it comes to functionality and durability, and they are also often more expensive. Furthermore, and possibly most importantly, marine biodegradable products cannot be recycled, and questions still remain with regards to; how long is too long for a piece of gear to take to degrade under water? And how much damage is done during the degradation process (i.e. through the slow release of small pieces of plastic (microplastics) or by continued ghost fishing)?

One proposal to increase recyclability and reduce environmental impact would be to work with fishers to develop a scoring matrix for fishing gear, based on sustainability, durability, recyclability, harm to the environment, & transparency. This could improve fishing gear design, feeding in to an extended producer responsibility scheme(s).

Potential next step for Contracting Parties / OSPAR

OSPAR could explore ways to support a new business model for the life cycle of fishing gear, considering long term responsibility (i.e. through national licencing of fishing gear). The development of an extended producer responsibility scheme(s) also supports long term responsibility.

OSPAR could (as for section 6.6) provide information for fishing gear designers, manufacturers and regulators to increase awareness on the impacts of marine litter and encourage design for reduced environmental impact. This could be further enforced by legislative means, encouraged through financial incentives, or supported by voluntary certification schemes. An example could be through national legislation on specified lengths of lines between buoys and traps, with specified weights to reduce the risk of gear being swept away in a storm and a requirement for rescue kits that are triggered if lost (see Best practices 5.1 ResOunit project).

OSPAR Contracting Parties could explore feasibility / support pilot projects that use traditional / natural materials for passive fishing gear and / or expand the use of alternative materials / design for the practice of gear protection.

6.8. Gear marking as a means to increase recyclability and traceability

Gear marking can contribute to easier identification of materials for recycling, as well as reducing or preventing the amount of gear getting lost (if gear is marked for ownership). Considerations for gear marking include:

- develop smart gear marking to make sure fishing gear can be tracked back no matter how small sections abandoned are (e.g. automatic methods for material fingerprints);
- for the time being, use gear marking only in case there is a chance of loss of larger sections of fishing gear, or for specific gear like traps and pots, where gear marking can be applied;
- extend gear marking to assist retrieval of lost gear, e.g. through appropriate echolocation;
- investigate the use of marking systems (such as metal tags on gear sections) to support owner identification of torn fragments, and to increase awareness of careful handling at sea;
- improve legislation and enforcement for marking on gear deployed in high seas (e.g. FADs in the north Atlantic, where no marking scheme is implemented yet); and
- explore the feasibility of applying emerging technology to locate lost passive gear (e.g. gillnets, pots and cages).

Potential next step for Contracting Parties / OSPAR

OSPAR Contracting Parties could be encouraged to invest in the development of smart gear marking and evaluate existing gear marking requirements and explore what / if aspects of the FAO Voluntary Gear Marking Guidelines should be implemented / would be effective in their countries. Any conclusions drawn on the FAO voluntary gear marking guidelines by individual Contracting Parties could then be discussed further through the OSPAR channels to support, as much as is possible, a harmonised approach in the OSPAR Maritime Area.

6.9. Reducing marine litter from Aquaculture

Although this scoping study focuses mainly on commercial fishing gear, the following considerations have been concluded with regards to aquaculture:

- collect more data on plastic leakages from aquaculture;
- cooperate with and stimulate related work in FAO and RFMOs;
- encourage the use of retention devices around aquaculture facilities to capture plastics; and
- undertake risk assessment for aquaculture facility siting taking into account the risk of marine litter creation.

Potential next step for Contracting Parties / OSPAR

OSPAR Contracting Parties could consider further research in to the contribution of aquaculture to marine litter in the North-East Atlantic.

6.10. Marine litter from recreational fishing – potential next step

There is currently little information about the contribution of recreational fishing as a source for marine litter. OSPAR Contracting Parties could consider further research into this issue.

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Annex A: Questionnaire

Design and Recycling of Fishing Gear in the OSPAR Maritime Area

OSPAR has a target to 'substantially reduce marine litter in the OSPAR maritime area to levels where properties and quantities of marine litter do not cause harm to the coastal and marine environment by 2020'. OSPAR has taken steps to achieve this ambitious goal by implementing the Regional Action Plan (RAP) on marine litter, which was adopted in 2014.

Several of the actions within the RAP seek to address marine litter resulting from fishing activity. This questionnaire is concerned specifically with collecting information and best practice examples for the design and recycling of fishing gear, with the aim of moving towards a circular economy approach to producing, using and recycling of fishing gear in the OSPAR Maritime Area.

The results of this questionnaire will be used to inform OSPAR's future work on this issue.

From the answers you provide, we aim to:

- *Pool knowledge on the design and recycling of fishing gear in the OSPAR area*
- *Gather examples of best practice*
- *Identify knowledge gaps and key challenges*

1. Please provide us with your email address

We will not share your email address outside of our organisation. We may contact you to share the results of this work or to alert you of any future workshops or events relating to this project

2. What kind of organisation do you represent?

If you fulfilled more than one of these roles, please select the predominant one

Government Institution (Environment Ministry / Agency / National Authority)

Fishing Organisation

Commercial Fishing Company

Port / Port Authority

Fishing Gear Designer / Manufacturer / Assembler / Supplier

Waste Logistics Company / Transportation Company

Fishing Gear Recycler / Waste Handler

Non Governmental Organisation

Research Institute / Expert

Intergovernmental Organisation

Other

3. Please provide the name of the organisation you work for?

4. Please indicate which country you are based in / which Contracting Party you represent?

Belgium

Denmark

EU

Finland

France

Germany

Iceland

Ireland

Luxembourg

The Netherlands

Norway

Portugal

Spain

Sweden

Switzerland

UK

Other

5. Fishing gear chain of supply

The following 7 questions relate to the fishing gear supply chain.

We are interested in finding out about the different types of gear being used and how it reaches the end user.

a. What types of fishing gear are predominantly used in your country?

We want to get an understanding of the composition of fishing gear types across OSPAR waters (please include commercial and recreational fishing gear) – Choose as many as you like

Dredges

Bottom trawls

Pelagic trawls

Rods and lines

Long lines

Traps

Nets (trammel net / gill net / drift net)

Seine

FADs

Other

I don’t know

b. You selected '_____', please provide any further details about these fishing gear types and how they are used in your country?

(if you selected other - please specify)

c. Can you give us an indication of the relevance of commercial and recreational fisheries in your country?

Mainly recreational

Mainly commercial

Both

I don’t know

d. In your experience, where do fishers buy their gear?

Choose as many as you like

Manufacturers

Importers / traders

Assemblers / netting companies

Coop orations / fish auctions

Direct online ordering

other

e. What You selected '_____', please provide any further details, for example if this differs per gear type

(if you selected other - please specify)

f. Who are the main suppliers (manufacturers and importers / traders) of fishing gear used in your country?

If you don't know, leave blank. Please include a geographic location for each supplier mentioned - if known

g. If there are manufacturers located in your country, what types of fishing gear do they manufacture?

Please answer to the best of your knowledge – Choose as many as you like

Dredges

Bottom trawls

Pelagic trawls

Rods and lines

Long lines

Traps

Nets (trammel net / gill net / drift net)
Seine
FADs
Other
I don't know
There are none

h. You selected '_____', please provide any further details

(if you selected other - please specify)

i. Do you regulate how much fishing gear is put on the market?

Yes / No / Not applicable to me / I don't know

j. Are you aware of any systems in place for registration of new fishing gear?

If you don't know, leave blank.

6. ALDFG | Commercial fishing gear

There are various factors leading to Abandoned Lost or Discarded Fishing Gear (ALDFG). Often fishing gear is lost unintentionally. ALDFG is harmful to the marine environment by, for example, continued catching of species.

a. To the best of your knowledge, what types of fishing gear (ALDFG) are most often encountered in your country's waters?

b. In your experience, what are the main pathways / reasons for fishing gear becoming a source of marine litter?

Severe weather conditions
Snags beneath the surface
Conflict with other gear
Interaction with other vessels
Accidental loss during onboard repairs
Intentional discard

7. ALDFG | Recreational fishing gear

To what extent do you think recreational fishing gear contributes to marine litter in your country?

a. To what extent do you think recreational fishing gear contributes to marine litter in your country?

Not at all
To some degree
Quite a lot
To a large extent
I don't know

b. In your opinion, what kind of recreational gear poses a threat to the marine environment?

c. Are there existing examples for recycling these types of recreational fishing gear in your country?

Yes / No / I don't know

d. If yes, please provide some details.

8. Design of fishing gear

The design of fishing gear can be modified in a number of ways to reduce environmental impacts, including: • Design modifications to enable more efficient recycling of fishing gear components / material at the end of life (design for recyclability) - working towards a circular fishing gear chain • Design modifications to decrease the impact of fishing gear in the event that it is abandoned, lost, or otherwise discarded (e.g. use of biodegradable materials);

These objectives may or may not be mutually exclusive.

a. In your opinion, in which area should innovation be focussed for a more environmentally friendly and circular design of fishing gear?

For example, a reduction in the number of materials used to make recycling end of life gear more straight forward, or the addition of adequate gear marking to enable recovery of all lost gear, or perhaps the development of new materials which have no / limited impact on the marine environment should they be lost?

b. In your opinion, who should be responsible for stimulating / promoting design modifications?

Choose as many as you like

Designers

Material manufacturers

Producers of fishing gear

Fishery organisations

Independent fishers

EU

Regional / national authorities

Government

Other

c. Are you aware of any design innovations already developed / in development to reduce environmental impacts and/or increase recycling?

we are looking for best practice examples

Yes / No

d. if yes, please provide details, names of companies involved and if possible, any contacts details

9. Design | Materials & Recyclability

Fishing gear is comprised of a variety of material types (including a mix of plastic types). In order to recycle fishing gear, first the different material types must be identified and separated. This is due to the different processing techniques used to recycle the different materials. Separating and sorting end of life fishing gear in to material types is a costly and labour intensive process, as it is mostly done by hand.

a. Do you know of any examples where mixed materials in design have been replaced by monotype materials?

Yes / No

b. If yes, please indicate which material types and which type of fishing gear these apply?

c. Do you know of any examples where design has been adapted to facilitate future dissassembly of fishing gear?

Yes / No

d. If yes, please indicate which material types and which type of fishing gear these apply?

e. Do you know of any dangerous substances (lead, copper coatings, Substances of Very High Concern or POP's) used in the design of fishing gear which makes it unsuitable for recycling?

Yes / No

f. If yes, please indicate which material types and which type of fishing gear these apply?

g. In your opinion, which type of fishing gear is most suited to apply design modifications to increase its recyclability?

h. What are the most important barriers for (large scale) implementation of design for recyclability of fishing gear?

Choose as many as you like

Technological / engineering challenges

Social dimension / behavioural aspects

Organisational aspects

Logistical challenges

Cost challenges

Compromising the performance / efficiency of the gear

Other

I don't know

i. You selected '_____', please elaborate on your response and provide any additional details you feel are relevant

j. How do you think (further) standardisation in design and in the selection of applied material could enhance the recyclability of fishing gear?

k. Is it general practice in your country for fishers to customise gear after the point of purchase?

Yes / No

l. If yes, are additional material types added to the gear at this point (e.g. coatings or lead weights?)

please give some indication of the types of materials added

10. Design | Decreasing the environmental impact of ghost gear (or ALDFG)

a. What projects (concerning fishing gear design) are you aware of that aim to decrease the environmental impact of ALDFG?

we are looking for best practice examples - please provide details, names of companies involved and if possible, any contacts details

Biodegradable materials have the potential to contribute to reducing environmental harm by ALDFG. There are, however, two aspects involved which should be taken into consideration when referring to biodegradable materials. First, there are several biodegradable materials already on the market, however most will not degrade in the marine environment (under water). There is also a risk that the degradation process will still lead to the emission of microplastics into the marine environment. Second, even if materials are truly biodegradable in the marine environment, they will still be present for a limited time. In this time they could still be harmful.

b. What examples of biodegradable design in fishing gear do you know of?

we are looking for best practice examples - please provide details, names of companies involved and if possible, any contacts details

c. In what way do they contribute to a reduced environmental impact? What is their success rate?

11. Design | Gear marking

The United Nations Food and Agriculture Organization (FAO) define gear marking as:

i) an identifier, that allows the relevant authority to discern the person or entity ultimately responsible for the use of the fishing gear; and/or

ii) a means of providing an understanding of the presence, scale and nature of fishing gear in the water.

a. Is gear marking practiced in your country?

Yes, on a voluntary basis

Yes, it is compulsory

No

b. Please give some details about the gear marking systems in place or common practice in your country

we are looking for a descriptions of the system, the % engagement in the industry, who regulates the system, etc

c. Do you consider gear marking an effective measure to prevent losses of fishing gear?

Yes / No (please provide an explanation for your answer)

12. Collection / logistics of handling end of life fishing gear

a. Are you aware of any schemes in place to collect end of life fishing gear?

No scheme in place

Collected as generic mixed industrial waste stream

A combination of generic mixed wasteand separated fishing gear

Other

I don’t know of any schemes

b. You selected '_____', please give details

Such as: How is it organised from the initial point of collection to processing Are there costs for fishers associated with these schemes Please provide any specific company / organisation names that play a role in this process

c. Do you have any information on the amount of fishing gear (end of life gear or gear found and brought ashore) collected each year per harbour / port in your country?

We are trying to identify what information exists. If you have any estimations, please indicate the volume in weight, and the names of harbours / ports. If you can, please distinguish between end of life gear and gear found and brought ashore (ALDFG)

d. For end of life fishing gear, does any form of pre-processing take place?

Choose as many as you like

Pre-cleaning

Disentanglement

Sorting

Cut / separate different types of material (e.g. polypropelene ropes from nylon nets)

Removal of parts for re-use (metals, buoys etc.)

Removal of parts to meet acceptance by waste handler (leadlines, etc)

Other

None that I know of

e. You selected '_____', please provide any additional details

For example, who undertakes these tasks, where does the preprocessing take place, where is the fishing gear stored whilst waiting for processing / collection? (if you selected other - please specify)

f. In your opinion, what does the ideal logistics process look like for end of life fishing gear? Which current barriers should be removed to achieve this?

g. Are you aware of any other projects / initiatives / best practice schemes for collection and transport of end of life fishing gear? Please give details

We are looking for best practice examples - please provide details, names of companies involved and if possible, any contacts details

h. Are you aware of any existing cost-benefit analysis regarding the amount of returned fishing gear (end of life gear or gear found and brought ashore) and the costs for storing, transport and incineration, recycling?

Please provide as much information as you can, including contact details for following up on these examples

13. Recycling of fishing gear

a. Which types of fishing gear (or material streams originating therefrom) are currently recycled?

Choose as many as you like.

Dredges
Bottom trawls
Pelagic trawls
Rods and lines
Long lines
Traps
Nets (trammel net / gill net / drift net)
Seine
FADs
Other
None / I don't know

b. You selected '_____', please indicate where the gear (or material streams originating therefrom) are sent for recycling

we want to identify specific companies and their locations, if you don't know - please leave blank

c. Do you have any specific knowledge of recycling processes and materials recycling?

Yes / No

If yes go to question 13 (d), if no skip to question13(n)

d. Which different material streams from fishing gear are recycled?

Choose as many as you like.

metals
mixed plastics
PE/PP
nylon / PA
rubber
foams
hazardous waste
other

e. Which technologies are used to recycle the different material streams? (mechanical/chemical)?

f. Which are the different output streams of the recycling process?

g. What quality and purity of these output streams can be achieved?

h. Which output streams of recycling have a positive market value?

i. Are there types of fishing gear which can technically be recycled, but the cost is so high that its not worth the effort?

j. Which cost components for recycling can be influenced to improve economic feasibility? Which changes are required to lower these costs?

k. What measures can be taken to improve demand for secondary materials from recycling of fishing gear?

l. For which other types of end of life fishing gear (or material streams originating therefrom) would recycling be an effective waste treatment option?

m. For which other types of end of life fishing gear (or material streams originating therefrom) would recycling not be an effective waste treatment option?

n. In your opinion, what are the most important barriers for (large scale) implementation of recycling?

Choose as many as you like

technological challenges

organisational aspects

logistical challenges

cost challenges

legislation

lack of information (sharing)

other

o. You selected '_____', please elaborate on your response and provide any additional details you feel are relevant

(if you selected other - please specify)

p. In your opinion, what steps are necessary to increase the recycling rate of fishing gear in the OSPAR Maritime Area

14. Any final thoughts

a. Are there any project examples, initiatives or best practices you think we should be aware of?

Specifically anything relating to the following topics: Fishing gear supply chain information Design of fishing gear to reduce environmental impact Collection and transportation schemes of end of life fishing gear Recycling of fishing gear

b. Is there anything else that you would like to add?

Annex B: Responses to questionnaire

Country respondent is based in / Contracting Party represented by respondent[8]	Name of organisation
Belgium	Eurocord AiSBL
Belgium	ILVO
Belgium	Rederscentrale
Belgium	VVC-Equipment
Belgium	Federal public service Health, health safety and environment
Belgium	Flanders Marine Institute (VLIZ)
Denmark	Ministry of Environment and Food
Denmark	Ministry for the Environment and Food
Denmark	Danish Fishermen Producer Organisation
Denmark	Cosmos Trawl A/S
Denmark	Plastix, Denmark
Denmark	Government of Greenland
Denmark	Institute of Aquatic Resources, Technical University of Denmark
Other	North 53 Limited
France	Cap Bourbon
France	Ministère de l'agriculture et de l'alimentation - Direction des pêches maritimes et de l'aquaculture
France	CFTO
Germany	Niedersächsisches Ministerium für Ernährung, Landwirtschaft und Verbraucherschutz
Germany	WWF Germany
Germany	Landwrtschaftskammer Niedersachsen
Germany	Fraunhofer Institute for Environmental, Safety, and Energy Technology UMSICHT
Germany	EO Küstenfischer Nordsee GmbH
Iceland	Hampidjan Iceland
Iceland	Fisheries Iceland
Ireland	Irish South and West Fish Producers Organisation CLG LTD
Ireland	Irish Seal Sanctuary
Ireland	The Marine Institute
Ireland	Bord Iascaigh Mhara
Ireland	Bord Iascaigh Mhara
Norway	Norwegian Environment Agency
Portugal	Regional Fisheries Directorate
Portugal	Direção Regional das Pescas - Açores
Portugal	Cotesi SA
Portugal	Câmara Municipal de Leiria
Portugal	APRAM
Portugal	Associação para o Estudo e Conservação dos Oceanos

[8] Note that 'other' is a response from a fishing gear recycler / waste handler based in UK but operating across Europe, and that for international NGO's the location of the NGO representative who filled out the questionnaire was used, although the views provided represent the views from across the countries the NGO operates in.

Country respondent is based in / Contracting Party represented by respondent[8]	**Name of organisation**
Portugal	Câmara Municipal de Viana do Castelo
Spain	Spanish Fishing Confederation (CEPESCA)
Spain	Asociación Empresarial de Acuicultura de España (APROMAR)
Spain	AZTI
Spain	Greenpeace
Spain	ARVI
Sweden	Marine center, an development center own by Municipality of Simrishamn
Sweden	Swedish University of Agricultural Sciences, Department of Aquatic Resources
Sweden	Swedish agency for marine and water management
Sweden	FF Norden
The Netherlands	VisNed
The Netherlands	IJmuiden Stores Holland BV
The Netherlands	Nederlandse Vissersbond
The Netherlands	Gemeente Goeree-Overflakkee
The Netherlands	Municipality Noord-Beveland
The Netherlands	KIMO
The Netherlands	Rijkswaterstaat
The Netherlands	Tauw
UK	Anglo North Irish Fish Producers Organisation
UK	Northern Ireland Fishery Harbour Authority
UK	CEFAS
UK	Cefas (Centre for Environment, Fisheries and Aquaculture Science
UK	Marine Scotland
UK	marine scotland compliance
UK	Scottish Fishermens Federation
UK	Marine Scotland Compliance
UK	West Coast Regional Inshore Fisheries Group (WCRIFG)
UK	Independent fisherman
UK	Joint Nature Conservation Committee
UK	Eshcol Enterprise
UK	AANGLO SCOTTISH FISHERMEN'S ASSOCIATION
UK	Zero Waste Scotland
UK	University of St Andrews
UK	Scottish White Fish Producer's Organisation
UK	Sea Fish Industry Authority
UK	Peterhead Port Authority

Annex C: List of consulted stakeholders

The table below provides an overview of people that were interviewed or provided extensive information (e.g. regarding best practices) to compile the information for this report.

Name	Organisation
Ben Wensink	IJmuiden Stores, , The Netherlands (part of Euronete Portugal, gear manufacturer/distributor)
Kenny Baas	Bek & Verburg, The Netherlands (waste handler)
Caroline van Beelen; Jeroen Dorenbosch; Huig van Duijn; Erik de Graaf; Albert Hartman	Van Beelen Group BV; IJmuiden Stores; Van Duijn Nettenfabriek; Martitiem; VCU Urk, the Netherlands (fishing gear manufacturers)
Ingrid Giskes	Global Ghost Gear Initiative
Georg Haney	Marine and Freshwater Research Institute, Iceland
Mathilde Gueguen	Coopération Maritime, France (fishers cooperation)
Uwe Lichtenstein	Thünen Institute, Germany (fisheries research)
Thord Görling	Fisheries Association Norden, Sweden
Erik Goksøyr	Sotenäs municipality, Sweden
Peter Buhl	Plastix Global, Denmark

Annex D: Further information on best practices

Throughout this study, various best practices were collected and elaborated upon in the different sections. This annex provides additional information on a number of selected best practices, that are either well established, of larger scale, or can serve as role models. Note that this list is not exhaustive.

Further best-practice examples can be found in Section 4 and Section 5, in the GGGI best practice framework, and in the Circular Oceans report.

The structure of this annex is as follows:

D.1 Best practices for recycling of fishing gear

4.1 Plastix Global A/S, Lemvig, Denmark

Contact person: Hans-Axel Kristensen (CEO), Peter Buhl (Technical lead)

Country/region: Lemvig, Denmark

This best practice is related to:

☒ recycling ☐ design for more environmentally friendly gear ☐ design for more circular gear

And aims at solving the following issue:

Recycling of waste from the fisheries sector, including fishing gear (nets, ropes, floats) and fish boxes made from polyethylene (PE) and polypropylene (PP).

For this type of fishing gear:

☐ dredges ☒ bottom trawls ☒ pelagic trawls ☒ traps ☐ rods and lines
☐ long lines ☒ seine ☒ nets (trammel net / gill net / drift net)
☐ FADs ☒ other, namely fish boxes, floats

Region of implementation

Fishing gear and fish boxes are collected from North European fisheries, including Sweden, Norway, Iceland, among others. End-of-life FG was also collected from Canadian harbours and shipped in unused sea containers for economic viability.

Project description

Description of Best Practice

Plastix recycles plastics from fishing gear, including nets, lines, ropes, and trap netting, and from fish boxes and floats. The pre-requisite for processing is that the base materials are pure PE and PP, and that materials are moderately clean and pre-sorted by polymer type. Mixed plastics cannot be processed because this would compromise the material properties and the quality of the marketable recyclate. The aim of Plastix was also to establish a market around fishing gear recyclates.

In order to process netting and ropes, Plastix had to develop a highly specialised technology with dedicated machinery that allows for fibre washing, sediment and organic matter extraction, shredding, agglomeration and granulation (extrusion). This process allows Plastix to provide >95% pure HDPE, LDPE and PP recyclates for the pellet market. Because the process is technically challenges, fishing gear according to Plastix cannot easily be mixed with other waste streams.

Products range from packaging materials and water pipes to cosmetic jars. The comparably high purity of the output recyclates, which follow strict REACH standards, allow for a wide range of uses. Recently, Plastix has developed the technology to produce monofilament line from netting and rope fibres, which demonstrates that the overarching aim of a circular economy for fishing gear can, in principle, be reached.

4.1 Plastix Global A/S, Lemvig, Denmark

Involved stakeholders, organisations and other parties

Fisheries associations and fishing harbours worldwide, including FF Norden in Smögen (Sweden), Nofir collection in Norway and dismantling in Lithuania, Fisheries Iceland, Stevenson Harbour (Canada) and others for the collection and pre-processing of end-of-life fishing gear.

Scale

3000 tonnes of fishing gear processed in 2019, with the aim to double the amount of recycled fishing gear by 2021.

Funding

Initially project and private funding, e.g. through the EU project reTRAWL. Today, funding from selling the recyclates to the recycling market.

Process

Plastix was founded in 2012. Since then, processing strands for three polymer types were developed: High-density polyethylene (HDPE), low-density polyethylene (LDPE), and polypropylene (PP). The process consists of mechanical dry spinning to remove sediments, shredding, metal extraction, wet fibre washing and density separation, and finally granulation.

Outcomes

The granulates from fishing gear netting, ropes, floats and fish boxes are sold as OceanIX and NordIX. Material fact sheets and a description of the process are available on the Plastix Global website.

Further information

Website: https://plastixglobal.com
Contact: info@plastixglobal.com

4.2 Aquafil/Econyl yarn recycling

Contact person: **-**

Country/region: Italy, Slovenia

This best practice is related to:

☒ recycling ☐ design for more environmentally friendly gear ☐ design for more circular gear

And aims at solving the following issue:

Recycling of nylon fibres, including polyamide 6 fibres from fishing gear.

For this type of fishing gear:

☐ dredges ☒ bottom trawls ☒ pelagic trawls ☒ traps ☐ rods and lines
☒ long lines ☒ seine ☒ nets (trammel net / gill net / drift net)
☐ FADs ☐ other, namely …

Region of implementation

Polyamide 6 (nylon) fishing gear, in particular monofilament netting, is collected worldwide with a focus on the European Economic Area and the USA. Aquafil headquarters are located in Italy, fibre/yarn and carpet production plants are based in Slovenia and USA.

Project description

Description of Best Practice

Aquafil is a globally operating company producing, among others, polyamide fibres for carpets. Carpets are produced for the European and the US American markets. Chemical recycling of polyamide 6 fibres was developed to enable carpet recycling. Aquafil's recycling yarn "Econyl" consists of 50% pre-consumer and 50% post-consumer polyamide, with pre-consumer nylon originating from their own carpet production plants. Post-consumer PA6 is composed of carpet fibres mixed fishing gear fibres. The fraction of PA6 from fishing gear as compared to carpet fibres is not provided. Chemical recycling is used to split PA6 polymers into the caprolactam monomer, which forms the basis of nylon. PA6 nylon yarn is then re-extruded from caprolactam, which gives the material a virgin quality. Econyl is used for textile and carpet production, e.g. for outdoor sports wear. A fraction of the revenue is used to support Aquafil's NGO "Healthy Seas", which coordinates lost fishing gear retrieval campaigns in collaboration with trained diving teams of ghostfishing.org.

Involved stakeholders, organisations and other parties

Nylon nets, monofilament and twisted netting, and ropes are collected from harbours worldwide. Input materials have to be clean and pure PA6 in order to be accepted into the recycling process. Aquafil Slowenia sources, e.g., from the Nofir dismantling plants in Lithuania and Turkey, from Fisheries Association Norden in Smögen (Sweden), from the Icelandic fisheries recycling scheme and from other harbours and fishing associations operating with nylon netting. Material has to be pre-dismantled or will not be accepted for further processing. Aquafil states that the collection of end-of-life fishing gear initially started around the North Sea in The Netherlands, Belgium, and the UK, with sourcing extended to Greece and Italy in subsequent years.

4.2 Aquafil/Econyl yarn recycling

Scale

According to a 2016/2017 report, a total of approximately 20,000 tonnes of Econyl yarn was produced in 2016 from recycled fibres. The amount of fishing gear recycled since the industrial development of the recycling process in 2011 over the first 4 years was 300 tonnes, or less than 1% of the total production, such that the dominant source of Econyl yarn has to be assumed carpet fibres. Production rates appear to have increased significantly from year to year. The extensively marketed product has a high visibility on the sports clothing market, which demonstrates the attractiveness of recycling products created from fishing gear for consumers.

Funding

Aquafil is a profitable company, and the Econyl process generates revenues because of the high market value of the "fishing gear yarn" product.

Process

Chemical recycling of polyamide by splitting into the base monomer caprolactam is a known recycling process for nylon. The advantage in comparison to mechanical recycling is that disturbances are removed and the output is a highly pure polyamide 6 granulate or yarn. The process requires a high level of purity in the input fraction, which might not contain substantial levels of disturbances or be mixed with other polymers. Dismantling implies extraction of PA6/nylon netting or monofilament from fishing gear and pre-cleaning before material is fit to enter the washing and chemical recycling process in the Slowenian facility. The ability to process fibres as an input waste stream is exceptional in Aquafil's Econyl production. The output purity allows yarns in clothing quality to be produced.

Outcomes

Econyl yarn for the recycling yarn market, predominantly used in sports and outdoor clothing.

Further information

Website: https://www.aquafil.com/
https://www.aquafil.com/assets/uploads/ENG_Aquafil_RS2016_DEF_20170919.pdf
https://www.aquafil.com/assets/uploads/20181206_RS_Aquafil_ENG_2017_def.pdf
https://www.aquafil.com/products/Econyl-2/
https://www.Econyl.com

Contact: info@Econyl.com

4.3 Nofir Recycling of end-of-life fishing gear

Contact person: -

Country/region: Norway, Lithuania, Turkey

This best practice is related to:

☒ recycling ☐ design for more environmentally friendly gear ☐ design for more circular gear

And aims at solving the following issue:

End-of-life and smaller amounts of retrieved fishing gear is collected from Norwegian and other European fisheries, dismantled, cleaned and sorted for recycling.

For this type of fishing gear:

☒ dredges ☒ bottom trawls ☒ pelagic trawls ☒ traps ☐ rods and lines
☒ long lines ☒ seine ☒ nets (trammel net / gill net / drift net)
☐ FADs ☒ other, namely metal parts

Region of implementation

Started initially in Norway, but material is now collected from fisheries throughout Europe.

Project description

Description of Best Practice

Nofir is a Norwegian company that started with the motivation to collect the large amounts of fishing gear discarded by the intensive Norwegian fishing and aquaculture industry each year and enable material recycling. As a smaller percentage, lobster traps retrieved from the sea during yearly retrieval campaigns coordinated by the Norwegian Ministry of Fisheries (Fiskeries Direktorat) are also recycled. According to their webpage:
"Nofir was founded in 2008 with the purpose of establishing a nationwide system for collecting discarded equipment in Norway. 15 000 tons of plastic equipment from the fishing and fish farming industry is discarded each year in Norway alone. In 2012 Nofir were granted support from European Union through the Eco Innovaton scheme. Since then we have collected material all over Europe."

Nofir sustains two dismantling facilities, one in Lithuania for material collected in Northern Europe and one in Turkey for material collected from Mediterranean fisheries. In both facilities, metals are extracted for regional scrap metal recycling, and plastic materials are sorted and pre-cleaned to facilitate chemical or mechanical recycling with as much nets, ropes and hard plastics as possible. PE and PP polymers are then shipped to Plastix in Denmark for mechanical recycling. Predominantly, Nofir operates in close collaboration with Aquafil in Slowenia and collects nylon (PA6) fishing gear to be chemically recycled in Aquafil's fibre regeneration plant. The process requires a high level of material purity and cleanliness, which is achieved in the dismantling plants before shipping to Aquafil. At the Slowenian Aquafil facility, fishing gear fibres are mixed with post-production industrial carpet residues along with some post-consumer carpet fibres to be recycled into Econyl yarn (see Aquafil/Econyl best practice).

The initially Norwegian system established by Nofir is now well-known worldwide and receives materials e.g. from the UK, Swedish (see Smögen best practice), Canadian (Steveston Harbour), Dutch, Belgian and other fisheries and is hence likely the most extensive fishing gear collection system worldwide.

4.3 Nofir Recycling of end-of-life fishing gear

Involved stakeholders, organisations and other parties

Nofir Norway, with facilities in Lithuania and Turkey, Aquafil and Plastix as recycling partners, fishing harbours and fisheries associations worldwide for end-of-life gear collection, regional scrap metal dealers.

Scale

For the starting years of the international collection project, Nofir states that from 2011 to 2019, 41 634 tonnes of end-of-life fishing gear were collected from fisheries in 17 countries on four continents. Of these, 37 000 tonnes were collected from Norway alone.

Funding

Partially by EU innovation grants, furthermore self-sustaining from revenues of sold recyclable materials.

Process

The dismantling process involves substantial manual labour, which is likely the major reason for the process to have been established in Lithuania and Turkey, where manual labour is substantially less expensive than in Norway. The process is well-established and delivers recyclable metals and plastics to recycling companies, which provides sufficient revenue to be self-sustainable. The collection and dismantling/cleaning steps taken on by Nofir are crucial prerequisites to achieve significant recycling rates for fishing gear.

Outcomes

End-of-life, and to a lesser extent retrieved, fishing gear can be recycled on an industrially meaningful scale.

Further information

Website: https://nofir.no
Contact: post@nofir.no

4.4 PECHPROPRE

Contact person: Mathilde Gueguen
Country/region: France

This best practice is related to:

☒ recycling ☐ design for more environmentally friendly gear ☐ design for more circular gear

And aims at solving the following issue:

PECHPROPRE 1: Assess the technical and economic feasibility to set up a national used plastics management system for fishing

PECHPROPRE 2: Create shared responsibility system of used plastic fishing gear (UPFG; a kind of voluntary extended producer responsibility) by consensus

For this type of fishing gear:

☒ dredges ☒ bottom trawls ☒ pelagic trawls ☒ traps ☒ rods and lines
☐ long lines ☒ seine ☒ nets (trammel net / gill net / drift net)
☐ FADs ☐ other, namely …

Region of implementation: France

Project description

Description of Best Practice

The French « Coopération Maritime » (French association defending the artisanal fishing sector), with the support of the French government and the French Plastic value chain, performed a project named "PECHPROPRE" (pêche propre = Fishing activity is clean). The scope of the first project (2016/2018) was to make an inventory of all used plastic fishing gear (UPFG) in the French fishing activity, and of all collection systems in place to collect those products at the end of their life. The goals of PECHPROPRE 1 were to:

- Obtain national reports on the state of plastics used in the fishing sector;
- Present environmental issues and legal constraints with regard to waste treatment;
- Identify different types of fishing waste management;
- Assess technical & economic feasibility to set up a national UPFG management system;
- Work with agents to establish the necessity for an appropriate management of fishing used plastics and propose a national plan for sustainable management.

PECHPROPRE 1 consisted of:

1. A nation-wide survey, aiming to find out the amount, content and destination of waste streams from the fishing sector - both from fishers / fishing harbours and from producers of fishing gear
2. A 5-month pilot study testing a new harbour management regime in 4 smaller harbours in the Mediterranean, with separate collection of different waste streams (PA, PP etc.)

PECHPROPRE 2 (2019/2020) aims to set up a shared responsibility system of UPFG (i.e. like a voluntary EPR), by organising meetings with the fishing sector (harbour masters, fishermen, fishing gear producers) about the SUP directive and the French law against waste and its impact.

Involved stakeholders, organisations and other parties

The aim of the project was to work with all territorial projects in France; a certain number of territories have taken up the subject and have developed local projects with which the PECHPROPRE projects worked in partnership (**Figure 1**). PECHPROPRE 1 was also supported by the French Committee of Plastics in Agriculture (CPA) as experts in plastic and in the plastic waste treatment sector. PECHPROPRE 2 is also working with all French fishing gear producers.

4.4 PECHPROPRE

Scale

The project studied fisheries harbours in seven regions (**Figure 1**); 67 fishing harbours were included, of which 60 gave information. The total budget was over 350.000€ for 22 months.

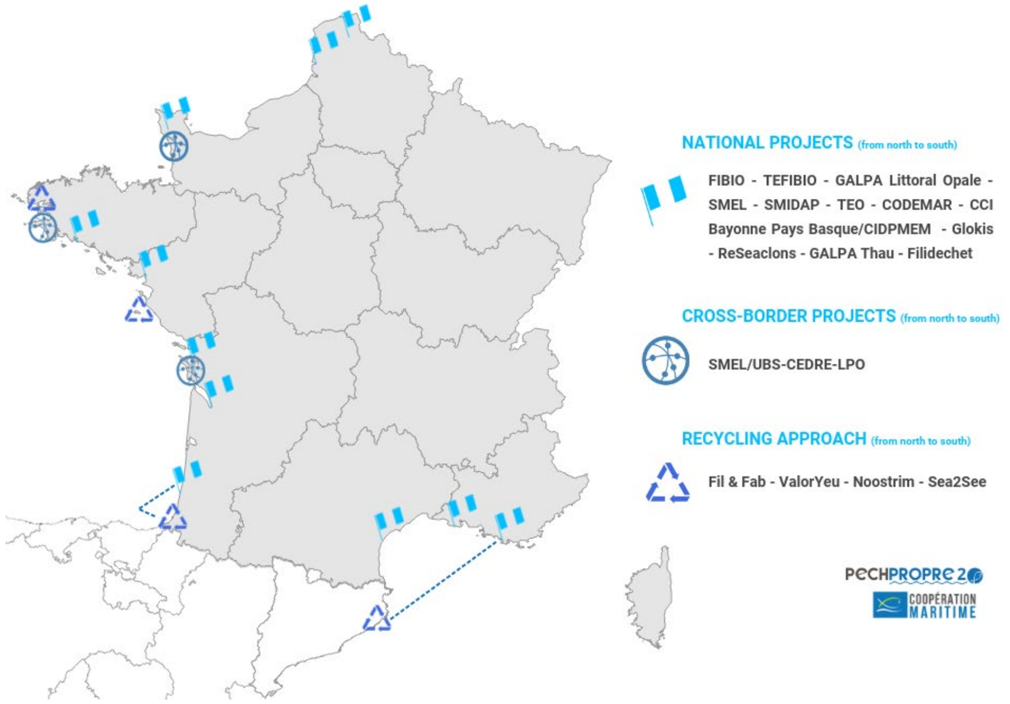

***Figure 1**: Regions and local projects involved in PECHPROPRE 1 & 2*

Funding

The French ministry of Environment (MTES) and of Agriculture (MAA) and the Environmental Agency (ADEME) provided most of the funding. Coopération Maritime funded around 20%.

Process

The first project ran from 2016 to 2018. PECHPROPRE 2 began in March 2019 and will be finish in summer 2020.

Outcomes

Conclusions of PECHPROPRE 1 on how to improve collection & handling of UPFG in France were:

- A number of French harbours wishes to be more involved in fishing gear collection, but knowledge on how to organise this is lacking
- Many local project are running already in France, and should be preserved
- Further steps should support all local initiatives; therefore, a bottom-up approach should be taken
- It is important to have everyone in the fishing chain involved / participating
- Next steps should also involve other types of fishing gear. E.g., lines & traps were also studied, but data on these types of gear is lacking, as lines are often disposed of in normal trash bins
- Next step: organise pilot study in a bigger harbour with separate bins for PP / PA nets, lines etc.

Overall, it was concluded that a suitable next step for France would be to introduce a **voluntary** Extended Producer Responsibility (EPR) scheme on all fishing gear containing plastics – similar to the French agricultural sector, where this has proven an effective measure. These conclusions drive PECHPROPRE 2, of which the expected result is a letter of intent signed voluntarily by producers concerned by the SUP directive.

Further information

Website: http://www.pechpropre.fr
Contact: mathilde.gueguen@cooperationmaritime.fr

4.5 Fisheries Iceland return scheme

Contact person: Georg Haney, Icelandic Fisheries Research Institute

Fisheries Iceland

Country/region: Iceland

This best practice is related to:

☒ recycling ☐ design for more environmentally friendly gear ☐ design for more circular gear

And aims at solving the following issue:

End-of-life segments of the Icelandic fishing industry are collected for re-use and recycling, diverting EOL FG from landfill.

For this type of fishing gear:

☐ dredges ☒ bottom trawls ☒ pelagic trawls ☐ traps ☐ rods and lines
☐ long lines ☒ seine ☐ nets (trammel net / gill net / drift net)
☐ FADs ☒ other, namely metal parts

Region of implementation: Iceland

Project description

Description of Best Practice

Fisheries Iceland cooperates with the Icelandic net manufacturer Hampidjan to recover used net materials for recycling. Smaller net segments and trawls on smaller vessels are presumably repaired at sea on the way into the harbour, and net segments are returned to Hampidjan or to the fishing gear collection at the Icelandic recycling facility. The Icelandic fisheries are mostly composed of larger trawlers focussing on pelagic trawling and purse seines. Pelagic trawls last for many years and because of low abrasion only minor repairs are usually required. Purse seines are too large to be repaired on board and are returned for repairs and mending to the net loft. Cut-out material mostly from purse seine and bottom trawl repairs is collected for recycling. The Icelandic industrial fishing fleet is predominantly fishing with PE/PP and PA netting, with about half of the netting send for recycling in 2016 being composed of PE/PP and half being composed of PA6 (nylon). PE and PP nets and ropes are send for recycling to Plastix in Denmark. It is not clear where nylon multifilament netting is send. Each fishing company collects their own materials or the materials are collected at the net loft, but it is likely that the collection facility and the fishing companies and net manufacturers cooperate to fill transport containers. Plastix pays for the transport, but no extra revenue is generated by providing the recycling material to the fishing industry or the collection facility.

The system was set up as a response to new government legislation requiring a recycling scheme for fishing gear which was implemented in 2005/2006. This legislation would require an import tax per each kg of imported net material. The fishing industry opted to set up their own system to take care of fishing gear waste materials. The government supported this approach, yet the legislation would be enacted in case that the recycling system would not function.

The researcher who provided the information suspects that the system operates so efficiently because it is co-ordinated and managed by the fishing industry itself. Hence there are no complaints from the fishing sector, and no additional funding is required to allow for authorities to manage the collection and dismantling. The direct pathways between the fishing companies,

4.5 Fisheries Iceland return scheme

the collection facility, the net manufacturers and the recycler in Denmark are the key to the efficiency, cost-neutrality and success of the Icelandic fishing gear management system. [Information in this section provided by Georg Haney from the Icelandic Fisheries Research Institute and from Fisheries Iceland 2017.]

Involved stakeholders, organisations and other parties

Fisheries Iceland, Hampidjan net manufacturer, sorting and recycling facility in Iceland for collection, Plastix Global in Denmark as the material recycler for PE and PP netting and ropes.

Scale

According to the latest public report by Fisheries Iceland on the Environmental and Economic benefits of the Icelandic fishing fleet from 2016/2017, 8400 tonnes of end-of-life fishing gear was send for recycling during the 10 years since the legislation came into place. In 2016 alone, more than 500 tonnes of PE/PP netting and the same amount of nylon netting were send for recycling. The actual collected amounts since 2017 are not yet publicly available.

Funding

The project operates most likely cost-neutral without direct revenues. Fishers are employed by the fishing companies and carry out dismantling as part of their regular work. Plastix pays for the transport costs, but no revenue is paid for PE or PP nets and ropes. It is not clear whether any revenue is generated from nylon netting. The fishing sector benefits from the positive image generated by end-of-life gear recycling and from savings because EOL FG would otherwise have to be deposited in landfills (incineration or other thermal conversion to energy is not available in Iceland).

Process

According to the Institute of Fisheries Research, smaller repairs take place on the fishing vessels on the way into port. For large purse seines, this is not possible and the nets are regularly returned to the net loft for check-up and repairs. Along the entire value chain, netting and ropes are collected and sorted into individual polymers. Each PE or PP batch is send to Plastix in Denmark for recycling once a container is full.

Outcomes

End-of-life fishing gear of the Icelandic fleet is recycled. The recycling rate by weight is estimated by Fisheries Iceland to be about 90% including metals.

Further information

https://sfs.is/wp-content/uploads/2018/09/Environmental_report_2017.pdf

4.6 GREEN DEAL FISHERIES FOR A CLEAN SEA

Contact person: Ewoud Kuin
Country/region: The Netherlands

This best practice is related to:

☒ recycling ☐ design for more environmentally friendly gear ☐ design for more circular gear

And aims at solving the following issue:

Organising collection and recycling of waste from fishing vessels, to prevent marine litter

For this type of fishing gear:

☐ dredges ☒ bottom trawls ☒ pelagic trawls ☐ traps ☐ rods and lines
☐ long lines ☐ seine ☒ nets (trammel net / gill net / drift net)
☐ FADs ☐ other, namely …

Region of implementation: The Netherlands

Project description

Description of Best Practice

Since 2014, a number of different stakeholders collaborate in the 'Green Deal Fisheries for a Clean Sea' in the Netherlands, with the aim of working together for a cleaner sea. In the Green Deal, parties from across the entire value chain of the fishing sector are involved & collaborate.

Four different waste streams are addressed: dolly rope, Fishing for Litter, domestic waste, and discarded (end-of-life) fishing nets. Fishers can hand in discarded fishing nets free of charge. The waste is collected in harbours and then transported to a number of regional facilities, where it is cleaned, sorted and dismantled by the waste management company Bek & Verburg. From here, materials are forwarded to various recyclers: metals to metal recycling, PA to Aquafil in Slovenia, and PE/PP to a mechanical recycling plant in Vietnam.

Involved stakeholders, organisations and other parties

The Green Deal (one of 3 marine Green Deals out of an overall figure of 180) was signed on November 20th, 2014. In this Green Deal a number of sectors collaborate collectively, including:

- the fishing industry
- port authorities
- waste disposal company (Bek & Verburg); and
- a number of environmental organisations.

The secretarial task is commissioned by Rijkswaterstaat (the Dutch Water Management Office, part of the Ministry of Infrastructure and the Environment), The association of coastal municipalities (KIMO) acts both as secretarial body and project partner.

Scale

The involved parties include most fisheries harbours in the Netherlands, several coastal municipalities, NGO's and the two main demersal fisheries organisations within which most of the Dutch demersal fisheries sector is represented.

Funding

The secretariat,), as well as an annual budget meant for pilots and research, is paid for by the national government (Rijkswaterstaat). Usually other parties (NGO's, fisheries sector) also finance certain projects or initiatives.

Process

4.6 GREEN DEAL FISHERIES FOR A CLEAN SEA

Under the framework of the Dutch Green Deal Fisheries for a Clean Sea, a number of pilots have been run. In 2015/2016, three pilots started:

1. The collection of waste dolly rope in fishing ports:
Dolly rope is a protective layer of tiny fibres that are attached to a net to protect it from wear. Dolly rope is made of plastic and wears out as well, furthermore a lot of old dolly rope ends up in sea, through this plastic microfibers enter the marine ecosystem. By means of the project fishers can hand in dolly rope that has worn out. With the dolly rope project fishers get a small compensation for all the dolly rope they hand in, this compensation is given to the KNRM (the sea rescue society). Meanwhile, another partner is experimenting with the development of an alternative for plastic dolly rope (see best practice DollyropeFree / VisPluisVrij).

2. The collection of domestic waste:

- The normal garbage bags (galley waste) are too vulnerable, both during storage on board as after placement on the quay in the port. Using the infrastructure of the Fishing For Litter project KIMO has started to distribute a smaller type of "big bag" for the purpose of the collection and storage of domestic waste.
- These bags can be attached to a pole on board preventing these to be blown overboard and made of stronger material so the seagulls cannot tear them open.

In 2016 these projects have been integrated in one system and rolled out in the ports of Harlingen and Stellendam. The goal is to develop a system for an integrated way of collection and storage of fisheries related waste in ports.

3. The creation of the "Afvalspoorboekje" (a waste management guide for fishers visiting ports)
Given that every harbour has slightly different customs and arrangements for waste management, and that fishermen at times visit different harbours, a clear overview of practices per harbour could be helpful. In 2016 a project started, involving KIMO and the harbours of Groningen, Den Helder Harlingen, Lauwersoog and Den Oever to create a flyer which presented the waste management facilities per harbour. The idea is that the flyer contains all the information (which containers, where they are, who to contact) a fishermen needs to get rid of his/her waste as efficiently as possible.

Outcomes

Protective bags work well for protecting household waste against the weather and seagulls. In other harbours using closed containers also works. An important lesson here was that every harbour has its own unique characteristics, and therefore also its own ideal solution (e.g., not every harbour has enough space for closable waste containers). Custom made solutions based on best practices therefore seem to be the way forward. The flyer, as mentioned under project 3, turned out to be a useful method to accompany this approach. By 2019 all fisheries harbours in the Netherlands make use of a custom made flyer, representing their waste management solutions. They help raise awareness and increase separately collected waste streams.

Further information

Website: www.visserijvooreenschonezee.nl
Contact: ewoud.kuin@rws.nl

4.7 Fisheries Association Norden, Smögen, Sweden

Contact person: Thord Görling
Country/region: Municipality of Smögen, Sweden

This best practice is related to:

☒ recycling ☐ design for more environmentally friendly gear ☐ design for more circular gear

And aims at solving the following issue:

Collection of end-of-life fishing gear for re-use and recycling.

For this type of fishing gear:

☐ dredges ☒ bottom trawls ☒ pelagic trawls ☒ traps ☐ rods and lines
☒ long lines ☒ seine ☒ nets (trammel net / gill net / drift net)
☐ FADs ☒ other, namely floats, fish boxes

Region of implementation: Swedish west coast, all fishing harbours participate.

Project description

Description of Best Practice

Fishing gear collection started as a pilot project in 2012 and increased in the collection of end-of-life netting each year. Since 2015, most of the pre-processed material was send to Plastix. In 2018, a marine recycling centre was installed to move operations away from the touristic harbour area. Sotenäs municipality now manages the pre-sorting of collected end-of-life fishing gear with support from FF Norden and organises beach clean-ups.

Fisheries Association Norden has set up a system to collect end-of-life and, to a lesser extent, retrieved fishing gear for re-used and recycling. It started as a system to collect production waste netting for recycling. As of 2018, seven regional fishing harbours and 37 fishing vessels on the West Coast of Sweden participate. The material is either collected by members of FF Norden or brought to the municipality or to Norden harbour for dismantling. Initially, all dismantling took place at Norden fisheries harbour and was carried out by fishers of FF Norden. In 2018, a pilot facility dismantling center was opened at a nearby location in Sotenäs municipality, next to the municipal regular recycling central (RAMBO), where the smell of end-of-life FG would not impact tourism, harbour visitors and personnel.

Collected materials are checked for re-use possibilities and, if re-use is not feasible, are sorted into metals and different plastic types. Polyethylen (PE) and Polypropylen (PP) nets and ropes are send to Plastix in Denmark for mechanical recycling. Polyamide (PA6, nylon) from pots and fishing net is sent to Plastix to at the moment, who then resends this further. Logistics to send the PA directly to other recycling plants are currently under investigation. Metals are recycled at a local scrap metal facility, including steel parts and lead from sink lines, though this is quite rare since gillnets are not that commonly used on the Swedish west coast. Since 2019, however, a collection initiative covering all of Sweden to collect DFG was started, so from areas where gillnets are more commonly used an increased collection is expected.

Some special equipment has been invested in to be able to take care of as much material as possible, such as a wire-cutting machine, a mill to reduce the size of the fishing gear etc. Since 2018, Norwegian lobster traps are also compressed for steel recycling, while energy is generated from the polymer net material. According to FF Norden, 20-30% of fishing gear by weight is fit

4.7 Fisheries Association Norden, Smögen, Sweden

for re-use, mainly creeper balls and rubber chains are re-used. 70-80% of material is prepared for recycling, and 0-10% is incinerated for energy recovery.

Involved stakeholders, organisations and other parties

Fisheries Association FF Norden, Smögen/Norden fishing harbour, municipality of Sotenäs, pilot sorting facility in Sotenäs municipality, Plastix as receptors of recycling materials, local metal recycling plant.

Scale

Seven fishing harbours along the Swedish West Coast, at least 37 fishing vessels participate in regular collection of end-of-life FG. Since December 2019, a national collecting initiative, called Fiskereturen was started by FF Norden, Sotenäs Municipality, Båtskroten and Keep Sweden tidy, to collect DFG from all over Sweden. This is financially supported by HaV, Swedish agency for marine and water management.

Amounts were 1-2 containers per year until 2016, which has risen to 3-4 containers per year, with a weight of 10-15 tonnes of fishing gear in each container. The total yearly turnover depends on the condition and the types of gears collected (pers. communication, Thord Görling).

Funding

Initially, the project started "with enthusiasm and private funding" in 2012. Later, some project/EU/EMFF funding was used to set up the system, and the marine recycling centre is currently also run on a project-funding basis. Although the fishing gear collection and dismantling is not yet operating self-sustainably according to FF Norden, a small revenue is generated by selling especially scrap metal and some of the plastics from fishing gear for recycling. The fishers of FF Norden dedicate a significant fraction of their time and manual labour voluntarily.

Process

The collection and pre-processing/dismantling and sorting system has been in place for several years, and is now self-sustaining, though not financially. Pre-processing and sorting of the materials, and where necessary pre-cleaning, is key to the success: only properly sorted and pre-cleaned materials can be send to the recycling facilities Plastix.

Outcomes

All end-of-life fishing gear and production waste netting and ropes are collected in participating harbours along the West Swedish Coast. This includes waste FG occurring during operations at sea. To hand over fishing gear is at a no-cost for the fishermen, there are no further cost applied to them, which leads to a high participation rate and incentivises collection of end-of-life materials also at sea. It is expected that the system leads to less cut-offs and netting accidentally lost at sea, because of the incentive that all material is brought back to shore, the value of the material given by the project, and the raised awareness through the project. In addition to dismantling and sorting the Fishing gear, a testbed for developing new innovations and products from the resources found in the fishing gear was started in 2020. Hopefully this will lead to that the material is reused more locally and at the same time increases the value of the marine plastic while also raising awareness of the issue.

Further information

Website: http://www.ffnorden.se/
Contact: info@ffnorden.se

4.8 Fiskereturen, Sweden

Contact person: Alexander Hassellöv, Fiskareföreningen Norden

Country/region: Sweden/Smögen

This best practice is related to:

☒ recycling ☐ design for more environmentally friendly gear ☐ design for more circular gear

And aims at solving the following issue:

The purpose of the project is to establish a national system for the collection of end-of-life or lost fishing gear

For this type of fishing gear:

☐ dredges ☒ bottom trawls ☐ pelagic trawls ☒ traps ☒ rods and lines
☒ long lines ☒ seine ☒ nets (trammel net / gill net / drift net)
☐ FADs ☐ other, namely …

Region of implementation

Sweden

Project description

Description of Best Practice

The goal is to create a national system where end-of-life fishing gear is handled according to a quality-assured and environmental friendly process. This reduces the occurrence of degrading fishing gear. Abandoned fishing gear and fishing gear that are degraded by UV radiation or processes in nature have been identified as a significant source of microplastics. The long-term goal is therefore that fishing gear should be taken care of as soon as they have become degraded through the establishment of a recycling system which in turn supports a better circular economy system as described in "Lost and worn fishing gear from a circular economic perspective" (see the report in Swedish).

Procedure

The work is broadly based on informing both recreational and professional fishermen, locating need areas, coordinating the existing system of subcontractors, establishing cost model systems, establishing pre-treatment systems, adapting existing (boat scrapping and professional fisheries networks, possible transports, network transports, computer systems for registration, implementation support and follow-up, investigate the possibilities of environmental certification, establish a quality assurance system and establish information dissemination activities.

Transports go to Sotenäs Marine Recycling Centre for sorting and then on to recycling, material recycling and ultimately energy recycling. Even now, the goal is for at least 80% of the materials to go to material recycling. The collection will take place through six fixed collection sites at strategically selected locations, through campaigns where fishing ports are visited and via collection from reported needs through the End of Life Boat recycling system, Båtretur. There will be campaigns at strategic dates before and after fishing seasons.

Sorting for recycling will be carried out by the municipality of Sotenäs, with the support of the Fisheries Association Norden, FF Norden, with its knowledge of how different types of materials can be sorted and broken into suitable fractions.

Results from all activities will be collected and entered into the IoT hub developed by Sotenäs municipality. The material will form the basis of the final report that will be delivered.

4.8 Fiskereturen, Sweden

Involved stakeholders, organisations and other parties

Fisheries Association Norden, Båtretur and Sotenäs municipality.

Scale

We estimate to collect around 165-200 ton from Dec 2019 to Dec 2020.

Funding

Funded by the Swedish Agency for Marine and Water Management.

Process

We have started to collect and as well established a website.

Outcomes

The outcome so far is positive in the sense that we have collected a lot already.

Further information

More information about the project can be read on www.fiskereturen.se

Fiskareföreningen Norden, Alexander Hassellöv alexander@smogensnat.se

4.9 Best practices to reduce inputs of cuttings of nets and cord to the marine environment, KIMO International

Contact person: Ryan d'Arcy Metcalfe, KIMO International

Country/region: The northern part of the OSPAR region

This best practice is related to:

☒ recycling ☐ design for more environmentally friendly gear ☐ design for more circular gear

And aims at solving the following issue:

Cuttings from rope, cord and nets discarded or disposed of irresponsibly have a significant impact on our marine environment, one that has not been much in the public eye. These items are within the top ten items found during beach surveys in the OSPAR area and as reported in Marine Beach Litter in Europe – Top Items (2016). Pieces of nets, fishing rope and cords are items that are found in abundance in coastal areas and present an opportunity that, if addressed effectively, could significantly reduce marine litter from fisheries waste and thus contribute towards meeting (inter alia) the goals of the European Marine Strategy Framework Directive, the Single-Use Plastics Directive[9], the United Nations Sustainable Development Goal 14 and the G7 Action Plan on Marine Litter. This project will also address OSPAR RAP ML Action 36 and can be used to address HELCOM's Marine Litter Action Plan, specifically Action RS5.

For this type of fishing gear:

☐ dredges ☐ bottom trawls ☐ pelagic trawls ☐ traps ☐ rods and lines
☐ long lines ☐ seine ☒ nets (trammel net / gill net / drift net)
☐ FADs ☒ other, namely rope and cords

Region of implementation

The project deliverables will initially target fishers, ports and harbours bordering the North Sea but are easily adapted for any region sea basin or any sea where commercial fishing takes place. Case studies have been conducted in Sweden, Denmark, Scotland and the Netherlands.

Project description

Description of Best Practice

The project made an initial study of existing information and resources, current best practices and techniques. Then we used KIMO's international network to contact port authorities and explore relevant case studies. A survey of questions was drafted and translated into four languages. Dialogue meetings were held with fishers, fishery associations and ports/harbours staff to explore current practices and ways in which these waste items can be better managed. KIMO then documented best practices for cuttings of rope, nets and cord. Finally, KIMO produced a project report, best practices guide and awareness-raising materials.

Involved stakeholders, organisations and other parties

Stakeholders in ports, harbours and in fisheries communities; fisheries associations, participating fishers, fisheries colleges.

Scale

The survey was conducted with a sample size of 12 fishers and staff from 8 harbours in 4 OSPAR

[9] DIRECTIVE (EU) 2019/904 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 5 June 2019 on the reduction of the impact of certain plastic products on the environment

4.9 Best practices to reduce inputs of cuttings of nets and cord to the marine environment, KIMO International

contracting parties; however, the project recommendations and other deliverables are suitable for dissemination and implementation in any sea region where commercial fishing takes place.

Funding

The Swedish Agency for Marine and Water Management

Process

All steps in the project description have been taken. We are in the final part of the process. The project period has been November 2019 to March 2020.

Outcomes

Project report, best practices guide and awareness-raising materials.

Below is a list of best practices on how to reduce inputs of cuttings of nets and cord to the marine environment at harbours and on board fishing boats:

Fisher's initiatives at port or on board of a fishing vessel

- Pouches or pockets for cuttings
- Systematic sweeping of areas to removing cuttings after work
- Enclosed areas where repair work/ mending of nets can be done
- Avoid repairing nets in stormy weather
- Waste management planning of containers and bins on board a fishing vessel
- Captain's attitude and effective waste management
- Incentives and recognition
- Other innovations – tarps and traps

Port authority initiatives at the harbour:

- Raised border at the quayside
- Reparation areas (designated areas) for repairing nets and trawls
- Dedicated containers/bins with cleaning equipment readily available
- Frequent inspection and cleaning of the quayside (sweeping machines/vacuum cleaners)
- Cuttings included in waste management plans
- Clear signage about binning litter/cuttings
- Awareness campaigns
- Application of 'Polluter pays' principle

Further information

Ryan d'Arcy Metcalfe, Coordinator, KIMO Denmark, rydm@varde.dk
Arabelle Bentley, KIMO International Executive Secretary, arabelle.bentley@shetland.gov.uk

D.2 Best practices for design of fishing gear

5.1 ResQunit project

Contact person: Helge Trettø Olsen, Global CEO

Country/region: Norway

This best practice is related to:

☐ recycling ☒ design for more environmentally friendly gear ☐ design for more circular gear

And aims at solving the following issue:

Loss of fishing gear; difficulties in tracking lost gear

For this type of fishing gear:

☐ dredges ☐ bottom trawls ☐ pelagic trawls ☒ traps ☐ rods and lines
☐ long lines ☐ seine ☐ nets (trammel net / gill net / drift net)
☐ FADs ☐ other, namely …

Region of implementation: Norway

Project description

Description of Best Practice

Resqunit is a floatation device that is attached to fishing gear like lobster traps and crab pots using cotton twine (rot-cord) that biodegrades in 80-120 days. If the trap is lost at sea, the cotton disintegrates and releases the Resqunit. This leaves an escape hatch for wildlife and enables fishers at the surface to retrieve their lost gear.

The current version, ResQunit S50 costs around USD $22 and is made for shallow water crab pot and lobster trap fishing down to 50m. The company is working on other products for different depths and types of fishing gear, including an electronic version with potential for warning and positioning capabilities.

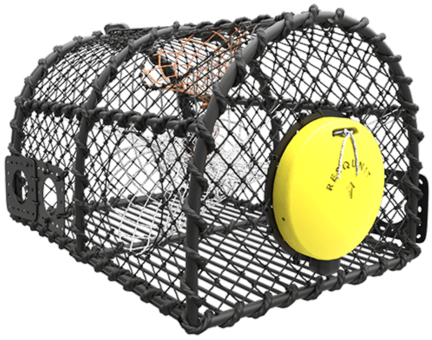

Figure 1: ResQunit device attached to a lobster trap, source: www.resqunit.com

Scale

As of March 2020, ResQunit has established a subsidiary in Halifax, Nova Scotia, Canada. In 2020, they are planning on expanding the company to the UK, Australia, USA and Spain.

From 2020-2025, under an assumption of 7.5% market adoption in selected regions (Norway, Canada, Australia, UK and USA), ResQunit estimates it could prevent 30,000 tonnes of lost biomass from ghost fishing (worth $92 million) and 11,000 tonnes of plastic pollution (providing $36-360 million in societal economic benefit).

Funding

Innovation Norway; Retailers Environment Fund; Norwegian Government; Private shareholders

Further information

www.resqunit.com

5.2 DollyropeFree

Contact person: Wouter Jan Strietman, Wageningen Economic Research
Country/region: The Netherlands

This best practice is related to:

☐ recycling ☒ design for more environmentally friendly gear ☐ design for more circular gear

And aims at solving the following issue:

Loss of plastic string (dolly rope) to the marine environment due to abrasion during use of trawls

For this type of fishing gear:

☐ dredges ☒ bottom trawls ☒ pelagic trawls ☐ traps ☐ rods and lines
☐ long lines ☐ seine ☐ nets (trammel net / gill net / drift net)
☐ FADs ☒ other, namely dolly rope

Region of implementation: The Netherlands

Project description

Description of Best Practice

In the European beam trawl fishery, strands of Polyethene woven in to the lower panel of the trawl are widely used as abrasion protection. These - so called - 'dolly ropes' fray away very easily and consequently need to be replaced frequently. Usually, more dolly rope is being applied in fishing areas with a rocky or stony seafloor, whereas less dolly rope is usually used in fishing areas with a sandy or clay seafloor.

Dolly rope frays easily and 10–25% of dolly rope ends up tearing off. In this way, annually, at the (very) least 25.000 kilograms of dolly rope threads end up in the North Sea alone, worldwide much more. Besides dolly rope tearing off, potentially a similar amount ends up overboard during operational practices such as mending the nets, either intentionally or unintentionally. As a result of this, in northern Europe, dollyrope threads are one of the most encountered items during beach litter surveys, especially in Belgium, the Netherlands, Denmark, Germany, southern Sweden and Norway.

In addition to the general litter problem, dolly ropes pose a direct danger to marine wildlife, because sea birds use these strands as nesting material and therefore risk to get entangled in them. Last but not least, the fishery itself suffers, as the twines wrap around the ships propellers and the trawl gear, resulting in safety issues, damage and difficult and often lengthy removal procedures.

The use of dolly rope is common amongst different types of demersal fisheries all over the world, but mainly in Europe around the North Sea, Channel, Irish Sea and the Bay of Biscay. It is also being used by pelagic trawlers in the Barents Sea and other areas.

In Europe, currently two projects are aiming towards solutions: the "DollyropeFree" project and "DropS". Both are described in this report as a best-practice. In this section, the DollyropeFree project will be described, which is running in the Netherlands since 2014.

Involved stakeholders, organisations and other parties

In 2014, VisNed, the Dutch fishermen's organization, the North Sea Foundation (an environmental NGO) and the Dutch government expressed their concerns about the issue of

5.2 DollyropeFree

dolly rope. Coordinated and facilitated by Wageningen Economic Research and (earlier) Wing, these organizations teamed up, joined forces and invited material specialists and scientists to develop solutions.

Scale

The project is currently in its last phase and involves several fishing vessels that participate in the sea trials.

Funding

The project has been funded by the different organisations involved in the project.

Process

Within the DollyropeFree project, the approach has been to develop solutions for the three main reasons why dolly rope ends up in the sea:

1. Developing alternative materials and net protection methods. The challenge here is to find alternatives that are much less prone to wear and tear and/or biodegradable, and/or are designed in a different way than threads, but in such a way that they also protect the net.
   The last couple of years, tens of different materials and variations in design have been tested both in controlled conditions and out at sea. These have included natural fibres (i.e. sisal, manila), (yak) leather, rubber, biopolymers (both compostable and certified as marine biodegradable materials), and non-degradable polymers (but stronger and more durable and therefore less prone to wear and tear). Several options came through as being more sustainable alternatives to conventional dolly rope, notably yak leather, marine biodegradable polymer fibres and a protective layer of specially designed netting that is wrapped around the cod-end of a bottom-trawling net.
2. Developing alternative net designs (lifting the cod-end of the net). In this approach, the focus is on improvements in the design of the cod-end to prevent it from scraping along the seafloor. Together with industrial designers, fishermen and other experts, alternative net designs are currently being developed in Germany by the Thünen Institute in the DropS project.
3. Improving litter management onboard fishing vessels. The focus in this approach is on engaging with fishing vessel crews to raise awareness regarding litter management onboard (including dolly rope) and engage with the relevant stakeholders to develop practical solutions improve litter collection at fishing harbours. Currently, as part of the 'Green Deal Fisheries for a Clean Sea' in The Netherlands, stakeholders related to fisheries litter have committed themselves to improve waste management practices on board fishing vessels and fishing harbours.

Outcomes

These latest alternative materials and designs are in the process of being tested by several ships to see how they perform in practice in different seabed conditions and by various types of fishery. Sea trials are currently (March 2020) ongoing and the results are expected to be published by the summer of 2020

Further information

https://www.vistikhetmaar/vispluisvrij (in Dutch; an English version will be published soon)
Contact: Wouter Jan Strietman – Wageningen Economic Research: wouterjan.strietman@wur.nl

5.3 DropS

Contact person: Uwe Lichtenstein, Thünen Institute

Country/region: Germany

This best practice is related to:

☐ recycling ☒ design for more environmentally friendly gear ☐ design for more circular gear

And aims at solving the following issue:

Preventing plastic loss to the marine environment from dolly rope abrasion during trawls use

For this type of fishing gear:

☐ dredges ☒ bottom trawls ☐ pelagic trawls ☐ traps ☐ rods and lines
☐ long lines ☐ seine ☐ nets (trammel net / gill net / drift net)
☐ FADs ☐ other, namely …

Region of implementation: Germany

Project description

Description of Best Practice

The project "Dolly Rope Suspension, DRopS" is aiming to find alternative design of beam trawl nets that makes any kind of abrasion protection (i.e., dolly rope) superfluous - especially under the assumption that the abrasion protection is also affecting the fishing gear's selectivity. To identify reasons for ground contact of beam trawl nets and to develop and test potential solutions for avoiding such bottom contact, DRopS focuses on the North Sea beam-trawl fishery, targeting brown shrimp (*Crangon crangon*). As the intended catch is more or less neutrally buoyant, the two main reasons for the trawl being dragged over the seafloor are heavy sediment and benthos getting into the trawl, and the shape of the net and codend during towing. Within the project, four approaches are considered minimize the ground contact of the trawl:

1. Use of passive (e.g. floats) and active (e.g. kites) buoyancy at the rear part of the net:
2. Reshaping the actual trawl design by using a special net cutting that results in an ascending trawl or using round straps to avoid ballooning of the codend;
3. Reduction of the amount of sediment that is swirled up by the ground gear using alternative groundgear designs; and
4. Reduction of the amount of sediment in the trawl by releasing sediment, e.g. using benthos release panels or larger mesh sizes in the front sections of the lower panel.

Several of these possibilities have been tested in various set-ups so far, helping identify the most promising solutions that we are going to endeavor further within the project. Today already, the use of dolly ropes or abrasion protection in general used in the German brown shrimp fisheries depends on the specific fishing grounds of each fisher.

The intended outcome is to present a toolbox with different solutions that help to minimize bottom contact of the trawl net, and that have proven to work sufficiently in terms of catchability. Fishers can then choose which (combination of) solution(s) works best for them or their fishing grounds. During the course of the project it turned out that a number of the options considered are already known, or have been applied before. Therefore, one of the goals is to make the community of shrimp fishers aware of the options or look at older options again from a current perspective.

Examples

Example 1: adding extra buoyancy

The first example is the option of using 'kites', which can provide a hydrodynamic lift to the codend. These did not perform optimally in their standard configuration, and thus have to be adapted in order to fit to the net and fishery. These adjustments relate not only to kite size and kite shape, but also to material.

Floats attached to the codend, in combination with a codend buoy (**Figure 1**), provided an almost straight ascending net shape. The net was straightened even further by attaching additional floats in front of the codend (**Figure 3b**).

Figure 1: Codend floats and codend buoy

The distance between the filled codend of the ascending net and the seabed was about 30 cm (**Figure 2**). In contrast, the codend of the standard trawl had permanent contact with the seabed.

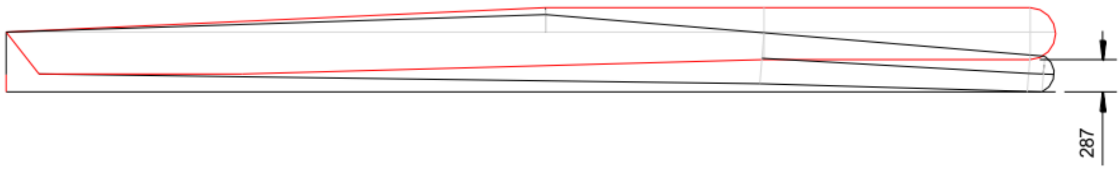

Figure 2: Schematic side view from the measurements of the ascending (red) and the traditional (black) beamtrawl net.

With no ring reinforcements attached to the codend, it took on the expected pear shape when filled with catch. Four evenly distributed ring reinforcements on the codend ensured an almost cylindrical shape (**Figure 3**), therefore reducing the diameter.

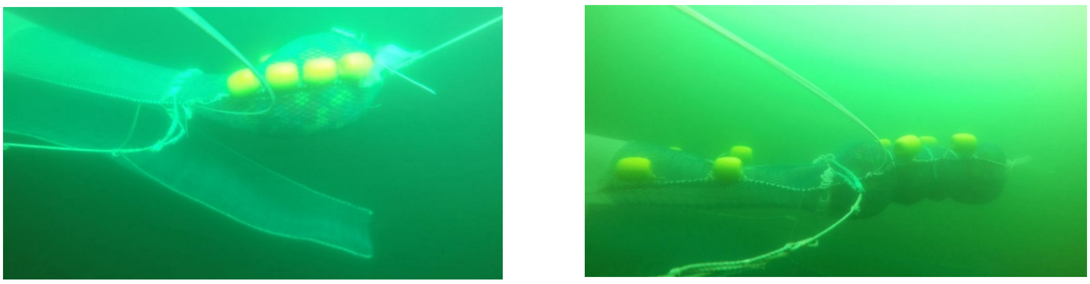

Figure 3: Left: Codend in pear shape without ring reinforcements. Right: Codend in cylindrical shape with four ring reinforcements.

Example 2: reducing the amount of sediment stirred up by the ground gear

It has been proven that the lateral rollers in the ground gear stir up large amounts of sediment due to their inclination (**Figure 4**). This sediment ends up in the net later on. Furthermore, underwater video showed that the middle chain of the bridle (**Figure 4**) stirred up a lot of sediment. This has been rectified immediately. Also some fishermen changed their gear accordingly.

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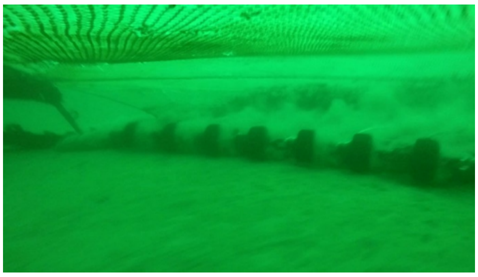

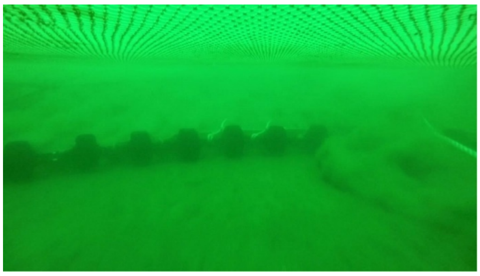

Figure 4: Left: Strong resuspension of sediment by lateral rolls. Right: Strong sediment turbulence caused by the middle chain of the bridle.

To reduce the amount of sediment stirred up by the ground gear, two ways of modification are considered (**Figure 5**). To reduce the amount of sediment that already entered the trawl, two options have been tested during research cruises. The first was to implement benthos release windows just in front of the sieve net. These proved to have no effect as sediment travelled beyond that position before starting to settle again. The second option tested was to use big mesh netting for the under panel of the trawl. The first try with this design did not work as intended and it will most likely be revised for further tests.

Figure 5: Left: Straight ground gear (left) and comparison of regular ground gear with axial-offset roller ground gear (von-Holdt type, right).

Involved stakeholders, organisations and other parties

Fisheries and Producer associations, Fishermen, the Ministry of Food, Agriculture and Consumer Protection in Lower Saxony and the Ministry for Energy Policy, Agriculture, Environment and Rural Areas in Schleswig-Holstein

Scale

Numbers suggest that about one third of the German brown shrimp fishing fleet uses dolly ropes as abrasion protection. An updated evaluation of that number just commenced.

Funding

The project is financed by the German federal states Lower Saxony and Schleswig Holstein through EMFF funding.

Process

The initial ideas, have been discussed with fishermen and their representatives at various occasions in the early phase of the project and are still up for continuous discussions together with the results. The results presented here have been yielded by trials during research cruises on board German fisheries research vessel “Solea”.

Contacts have been established with brown shrimp skippers who will test the most promising modifications in future. This step is essential to the project and allows answering our research

5.3 DropS

questions of suitability in commercial long-term use – both in terms of handling and in terms of catchability.

So far, testing of the following options is about to commence in April 2020:

- Straight ground gear
- Axial offset roller ground gear
- Sieve mat
- Double codend trawl to minimize diameter of codend
- Novel design for floatation distribution/combination of flotation and abrasion protection
- Modified sieve net

Outcomes

Showing ways and options to minimize the use of abrasion protection or even make it superfluous, especially when it comes to dolly ropes, which can be successfully replaced or left off these days;
Transfer of the results to other fisheries like Sole fishery.

Further information

Website: https://www.thuenen.de/en/of/projects/fisheries-and-survey-technology/reduction-of-plastic-waste-from-the-brown-shrimp-fishery-through-gear-modifications-drops/

Contacts: uwe.lichtenstein@thuenen.de, constanze.hammerl@thuenen.de, daniel.stepputtis@thuenen.de

D.3 List of best practices for aquaculture

	Name of project / best practice	Details
General	AQUA-LIT project	The AQUA-LIT project is investigating preventive measures for averting the discarding of litter in the marine environment from the aquaculture industry, with a geographical focus on the North Sea, Mediterranean and Baltic Sea. Sandra M., Devriese L., De Raedemaecker F., Lonneville B., Lukic I., Altvater S., Compa Ferrer M., Deudero S., Torres Hansjosten B., Alomar Mascaró C., Gin I., Vale M., Zorgno M., Mata Lara M. (2019). Knowledge wave on marine litter from aquaculture sources. D2.2 Aqua-Lit project. Oostende, Belgium. 85 pp. https://aqua-lit.eu/
	Revision of ASC standards	Aquaculture Stewardship Council (ASC) is looking to revise current standards to include plastic waste management as a criteria. ASC is also involved in the Global Ghost Gear Initiative (GGGI), pledging to develop scientific knowledge on the impact of plastic waste and aquaculture gear used in farming.
Recycling	Polycrub	Polycrub (Shetland, UK) uses strong polyethylene pipes, recycled from the aquaculture industry, to build storm-resistant greenhouses. This diverts the pipe from landfill. https://www.polycrub.co.uk/
	Scotland aquaculture practice	Various practices aimed at reducing marine litter are being developed in Scotland. For shellfish farming, these include e.g. the use of seawater biodegradable mussel socks, and localised annual beach clean up day to get staff involved. With respect to distribution and logistics, examples include replacing transport boxes (i.e. polystyrene) with waxed cardboard boxes (not yet possible for long-distance markets); and modifying packaging materials (e.g. MAP packs) to use less plastic and/or to recyclable alternatives.
Design to reduce impact on the marine environment	BIOGEARS	BIOGEARS is a project developing biobased ropes for the European aquaculture sector. https://cordis.europa.eu/article/id/413319-new-emff-project-biogears-launched-to-develop-biobased-ropes-for-aquaculture
	Biodegradable mussel socks	Machinefabriek Bakker (Yerseke, The Netherlands), a manufacturer of mussel processing equipment. has won an innovation price for a mussel sock, made of bio polymer that degrades completely in seawater. Currently tests are being carried out with this material in the Blackshell mussel farm in Ireland. The Firm works with Senbis Polymer Innovations (Emmen, Netherlands) who has also developed an alternative

	Name of project / best practice	Details
		biodegradable material for dolly rope, tested in the project DollyropeFree. http://wbakker.com/index.php/en/home
	Pleine Mer – natural materials for mussel cultivation	Pleine Mer (Gouville sur Mer, France) uses natural materials for the cultivation of a certain type of mussel, the 'Moules de Bouchot', in France. They use, natural raw materials like hemp- and/or coco's ropes to farm baby mussels (spat). These ropes are then attached to poles (bouchots) which are placed vertically in the water. The spat grows until they are harvested. (personal communication Margaux Eder) www.pleinemer.com/mussel-work.htm
	Development of storm-resistant fish farms	Various manufacturers are developing aquaculture farms that are better suited to endure severe weather conditions. An example is the Norwegian company Aqualine. https://aqualine.no/en
Design for better traceability	Furuno Gear Finder	The Norwegian company Furuno recently developed the "Lost gear finder" for exact positioning of fishing gear, within a range of 5000m. A transponder is attached to the gear, and a transducer is installed on board. In case of gear loss, the user can search for lost gear's position underwater. www.furuno.no

Annex E: Summary expert workshop

On 19 and 20 February 2020, a joint EC-OSPAR workshop was organized on the topic of Design and Recycling of Fishing Gear. Results and preliminary conclusions from this project were presented there, and the conclusions and recommendations of the workshop were incorporated into the various chapters of this scoping study.

For the EC, this workshop fed into their work on the development of harmonised standards for circular design of fishing gear. The objective of their project was to provide the background and information necessary in supporting the Commission in requesting the European standardisation organisation to develop harmonised standards relating to the circular design of fishing gear to encourage preparation for re-use and facilitate recyclability at end-of-life.

47 participants attended the workshop, including representatives of companies / organisations with experience in fishing gear design and manufacture; companies / NGOs that have undertaken projects and / or have advisory roles for marine plastics; companies undertaking collection, recycling, eco-labelling, and / or reuse of fishing gear; the fishing industry; public authorities; academic research on ALDFG or EOL fishing gear; and institutions with expertise in ISO certification for fishing gears.

DAY 1

On the first day, presentations were given on the preliminary results of both the OSPAR and the EC project. Bernard Merckx from Plastix Global gave a presentation on the obstacles for fishing gear and ropes to go circular, introducing the principles of eco-design and circular design, and how these might apply to fishing gear. Martin Charter from University of Creative Design then gave a further explanation on eco-design and circular design of fishing gear. Lastly, Viktor Aggarwal from BASF presented technical possibilities representing the potential of circular design for fishing gear components.

A pdf with all presentations can be downloaded from this news article (bottom of page).

Four discussion sessions were held in a world-café format, discussing challenges and barriers (legal and practical), and solutions and best practices for:

1. Collection and logistics for recycling;
2. Practical recycling (EOL & ALDFG);
3. Design for recyclability and reuse; and
4. Design to reduce impact on the marine environment.

Examples of commonly found fishing related litter items were displayed at the workshop

DAY 2

The second day focused on defining and prioritizing recommendations for the abovementioned four topics. Building on the results from the first day, a list of recommendations were defined for each of the topics in a first discussion session (world café setting). As a prioritization exercise, participants were then given individual stickers to vote on the recommendations that they deemed most promising (five stickers per stakeholder per topic). The top five recommendations per topic are presented below.

Top five recommendations for collection and logistics for recycling

1. Perform mapping exercise of the fishing gear supply chain. Approach per country, and potential to address cross-border issues through regional sea conventions (43 votes). Including:
    a. links to money flow;
    b. different stakeholders;
    c. different levels (e.g. EU, national, port); and

   d. needs analysis for ports/locations.

2. Develop incentives for collection & (pre-)sorting of fishing gear where benefits return to the fishermen (returning value to the sector) (29 votes).
3. Include waste management procedures in certification scheme for fisheries and aquaculture (e.g. MSC or ASC) to recognize and incentivise good practice; involve certification bodies in discussion (24 votes).
4. Centralize dismantling & sorting in dismantling stations / (regional) hubs, with harbours as a starting point; including aquaculture hubs (21 votes).
5. Develop schemes for awareness raising & education of fishermen e.g. through ambassadors (20 votes).

Top five recommendations for practical recycling (EOL & ALDFG)

1. Collect data/weight on gear inventory in all member states with a standardized methodology (42 votes)
2. Harmonize waste reception facility best practices for different sizes of harbour (25 votes)
3. Set up a reward system for recyclate % in new fishing gear and for fishers returning EOL FG (25 votes)
4. Study and quantify the business case for each material and the opportunity to connect to different waste streams, using existing fg recyclers as best practices (23 votes)
5. Set up a uniform waste classification scheme for fishing gear (19 votes)

Top five recommendations for design for recyclability and reuse

1. EMFF blue economy calls or similar (51 votes) for funding on:
   a. R+D for dismantling (mechanization);
   b. Joint EU call for material developing considering new materials and coatings;
   c. test for implication of using high quality recyclates; and
   d. research and innovation for design for recyclability which includes pilots with expert inputs and advice.
2. Specific designs for materials (36 votes):
   a. Alternatives to lead;
   b. alternatives to copper coating; and
   c. alternatives to other metals (zinc, etc).
3. Create a web platform for cooperation between different stakeholders and for knowledge sharing (including best practices) (26 votes).
4. Education and awareness to understand types of fibers and their recyclability (e.g. capturing potential project) (19 votes).
5. Economic incentives for less materials and less contamination (16 votes).

Top five recommendations for design to reduce impact on the marine environment

1. Promote durability into design. Development, material for longer performance, reuse/recycling (59 votes)

2. Explore emerging technologies to locate lost gear (34 votes)
3. Explore the feasibility of new business models related to improving the life cycle of fishing gear, e.g. long term responsibility such as licensing fishing gear (20 votes)
4. Integrate marine litter aspects/risks of ALFDG into technical working group discussions (ICES/FAO/GESAMP/STECF). For example in the ICES/FAO working groups on fishing technology and fish behaviour (18 votes)
5. Explore the feasibility of using traditional materials for passive fishing gear (17 votes)

Annex F: Checklist with criteria for eco-design

Table 1: Generic eco-design checklist that might be applied to fishing gear with product circularity considerations highlighted in *italics* (non exhaustive)

Design Focus Area	Options for Design Improvement
Design for Material Sourcing	*Reduce weight and volume of product*
	Increase use of recycled materials to replace virgin materials
	Increase use of renewable materials
	Increase incorporation of used components
	Eliminate hazardous substances
	Use materials with lower embodied energy and/or water
Design for Manufacture/Assembly	Reduce energy consumption
	Reduce water consumption
	Reduce process waste
	Use internally recovered or recycled materials from process waste
	Reduce emissions to air, water and soil during manufacture
	Reduce number of parts
Design for Transport and Distribution	*Minimise product size and weight*
	Optimise shape and volume for maximum packaging density
	Optimise transport and distribution in relation to fuel use and emissions
	Optimise packaging to comply with regulation
	Reduce embodied energy and water in packaging
	Increase use of recycled materials in packaging
	Eliminate hazardous substances in packaging
Design for Use (Including installation, maintenance and repair)	Reduce energy in use
	Reduce water in use
	Increase access to spare parts
	Maximise ease of maintenance
	Maximize ease of reuse and disassembly
	Avoid design aspects detrimental to reuse
	Reduce energy used in disassembly
	Reduce water used in disassembly
	Reduce emissions to air, water and soil
	Eliminate potentially hazardous substances that can be released during use
	Maximize ease of materials recycling
Design for End of Life	*Avoid design aspects detrimental to materials recycling*
	Reduce amount of residual waste generated
	Reduce energy used in materials recycling
	Reduce water used in materials recycling

Source: Adapted from Charter M, Designing for the Circular Economy, Routledge, 2018

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