BLUE CIRCULAR ECONOMY

Northern Periphery and Arctic Programme 2014–2020

EUROPEAN UNION
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European Regional Development Fund

CREATING BUSINESS OPPORTUNITIES FROM WASTE FISHING NETS

OPPORTUNITIES FOR CIRCULAR BUSINESS MODELS AND CIRCULAR DESIGN RELATED TO FISHING GEAR

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WDC

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BLUE CIRCULAR ECONOMY

The Blue Circular Economy project's mission is to generate sustainable business opportunities focussed on marine polymer based fishing gear solutions through informed, innovative and collaborative efforts, for the benefit of enterprises, local economies, and the environment in the Northern Periphery and Arctic (NPA) region.

The vision is to create the ecosystem, knowledge and industry necessary to address the waste problem associated with polymer fishing gear by fostering a vibrant industry for the recycling and reuse of used fishing nets, ropes, components and peripherals.

Established in 2018 the Blue Circular Economy is a partnership between Western Development Commission, Technical University of Denmark, Norwegian University of Science and Technology, The Centre for Sustainable Design® at University for the Creative Arts (UCA), and the Environmental Research Institute at the University of the Highlands and Islands. The three year programme is funded under the European Regional Development Fund (ERDF) NPA 2014-2020 programme (http://www.interreg-npa.eu/).

Full details on www.bluecirculareconomy.eu

CONTENTS

ACRONYMS

BIM	Bord Iascaigh Mhara
B2B	Business to Business
B2C	Business to Consumer
CfSD	The Centre for Sustainable Design ®
EC	European Commission
EU	European Union
EPR	Extended Producer Responsibility
FMEA	Failure Modes and Effects Analysis
FNRCPs	Fishing Nets, Ropes, Components and Peripherals
NPA	Northern Periphery and Arctic
P2P	Peer to Peer
PRFD	Port Reception Facilities Directive
SUPD	Single Use Plastics Directive
SMEs	Small and Medium sized Enterprises

EXECUTIVE SUMMARY

This report is a response to the widespread and enduring problem of waste fishing gear in the world's oceans. The problem and the proposed business opportunities are highlighted within this report. The European Commission (EC) Interreg funded Blue Circular Economy (BCE) project offers free help, including events, consulting and 1:1 mentoring, are available to start-ups, SMEs and entrepreneurs as well as co-operatives and social enterprises in the Northern Periphery and Arctic (NPA) region.

This report presents an overview of:

- Gear used for fishing for finfish, shellfish and aquaculture
- Extended Producer Responsibility (EPR) as it relates to waste fishing gear, as announced in the recent European Commission (EC) Single Use Plastics (SUP) Directive
- Opportunities that might arise for more circular business models (CBMs) and new products for start-ups, SMEs, entrepreneurs, co-operatives and social enterprises in port cities, towns and fishing communities in the Northern Periphery and Arctic (NPA) region, and beyond
- Strategies for improving the product circularity of fishing gear (circular design)

The report includes a look at threats posed by waste fishing gear in our oceans and at end of life, and, includes a short discussion on the implications for stakeholders and SMEs in the NPA region (see Appendix A). It addresses the Extended Producer Responsibility (EPR) scheme that was included in the EC's SUP Directive, new circular business models and circular design of fishing gear and finishes with overall conclusions.

Fishing gear are complex products, comprising nets, ropes, components and peripherals e.g. polymers, metals, rubbers etc. This report uses the term waste "fishing gear" when referring to fishing nets, ropes, components and peripherals (FNRCPs).

SUMMARY OF GEAR USED FOR FISHING FOR FINFISH, SHELLFISH AND AQUACULTURE

Summary of gear used for fishing for finfish, shellfish and aquaculture

A large variety of fishing gear is used to catch finfish and shellfish in fresh water, saltwater and in aquaculture farms. Table 1 gives a description of the different types of fishing activities and the related fishing gear. This gives an overview of the complexity and large variety of the fishing gear choices available.

Sources such as www.seachoice.org , www.msc.org and https://seafish.org/gear-database/ show that the type of fishing gear that is used by fishing operators depends on the size of the operators, the fishing gear available in their area, the targeted catch, geographical location and the need to avoid bycatch (typically untargeted or endangered fish and mammals).

Table 1 also distinguishes between passive and active fishing. In passive fishing, the fishing operator is stationary and waits for the fish to enter or entrap themselves, whereas active fishing involves the physical movement of the vessel to surround or catch the fish.

BACKGROUND

Report

This report is one of series of outputs from the EC Interreg funded Blue Circular Economy (BCE) project, and focuses on: (i) gear used for fishing; (ii) SUP Directive and the EPR scheme as it relates to waste fishing gear; (iii) opportunities for more circular business models (CBMs) and new products for companies; and (iv) design strategies for improving the product circularity of fishing gear (circular design).

Blue Circular Economy

The EC Interreg funded Blue Circular Economy project - https://bluecirculareconomy.eu focuses on translating the problem of waste fishing nets into business opportunities for companies in the NPA region (See Annex A). BCE builds on the EC Interreg funded Circular Ocean (CO) project - http://www.circularocean.eu - which ran from 2015 to 2018 and sought to inspire enterprises and entrepreneurs to realise the hidden opportunities related to discarded fishing nets and ropes in the NPA region.

The BCE project started in October 2018 and will end during September 2021. For the project's lifetime, start-ups, SMEs, entrepreneurs, co-operatives and social enterprises in the NPA region will have potential access to the free webinars, 1:1 mentoring, conferences, workshops and consultancy on how to convert waste fishing gear into business opportunities.

Note: The Circular Ocean project won an EC RegioStars Award in 2016 for excellence in its new approaches in regional development.

The Centre for Sustainable Design® (CfSD), part of the Business School for the Creative Industries at the University for the Creative Arts (UCA) is the UK partner in the BCE project and was also the UK partner in CO project. Partners in BCE include Norwegian University of Science and Technology [NTNU] (Norway), Technical University of Denmark [DTU] (Denmark/Greenland), Western Development Commission [WDC] (Ireland) and University of the Highlands and Islands [UHI] (Scotland). CfSD outputs and deliverables related to BCE can be found on www.cfsd.org.uk/projects/bce and for CO on www.cfsd.org.uk/projects/circular-ocean

The Research

The desk and primary research for this report built on existing research conducted by CfSD and involved reviewing published material, completing expert interviews, and attending conferences and exhibitions. - See Annex B for more information about the research.

Key insights gained from the research included:

- Fishing operators work to very tight margins and do not want their fishing gear to fail
- Fishing gear is expensive; with some individual fishing gear costing up to €200k
- Fishing gear design and development appears to often follow informal processes based on key people's knowledge and experience in the company rather than following a structured design and development process
- Fishing gear is often assembled in Europe with components procured from suppliers in India, China and South Korea
- Fishing gear is generally made to order; therefore, there is often a lot of dialogue between the fishing operators and fishing gear manufacturers and/or assemblers
- Customisation of fishing gear is very common, with adaption based on individual experience, leading to a variety of co-design of fishing gear
- Fishing gear are typically repaired and modified by the fishing operators and/or sometimes by the fishing gear suppliers as part of contracts with fishing operators

Type	Name	Active or Passive	How the fishing gear are used	What the fishing gear are made of	Position in the ocean	Catch		Notes
						Finfish	Shellfish	
Nets	Trawls (Pelagic)	Active	Nets are towed by one or two boats (pair trawling)	A cone-shaped net with a closed 'cod-end' to holds the catch	Midwater	Herring Hoki Mackerel	----------	Specific mesh sizes, exclusion devices and acoustic deterrents prevents bycatch
	Trawls (Demersal)	Active	Nets are towed by one or two boats (pair trawling)	A framed cone-like net with a cod-end bag	Ocean Bottom	Atlantic cod Rockfish Hake	Shrimp	----------
	Dredges	Active	Rigid structures rake the seabed to dislodge the catch into the net which is dragged over the sediment	A triangle iron frame with a front bar (with or without teeth). Has either fine nets or a metal collecting basket.	Ocean Bottom	----------	Scallops Oysters Clams	Specific mesh sizes and escape panels prevents bycatch. Highly regulated to prevent the loss of habitat
	Purse Seine	Active	A vertical net 'curtain' is placed in the water which traps the catch by drawing in the bottom of the net	Bottom-weighted nets	Midwater	Salmon Herring Tuna Mackerel	----------	----------
	Danish Seine	Active	Nets are towed by one or two boats (pair trawling)	Tunnel shaped net	Ocean Bottom	Tiger flathead Eastern school whiting	----------	----------
	Gillnets (Stationary)	Passive	Nets are placed in the water (in a line, a circle, left drifting, or stationary) and entangle	Wall or curtain of netting that hangs in the water - size of fish caught can be	Shallow Water	Manitoba Whitefish Salmon	----------	Attaches acoustic deterrents to nets to deter marine mammals

Type	Name	Active or	How the fishing gear are	What the fishing gear	Position	Catch		Notes
			the catch	determined by the mesh size				
Hook & Line	Longlines	Active	Lines are dragged behind boat	Long lines of baited hooks	All levels of depth	Swordfish Tuna Halibut Sablefish	----------	Weights are placed on lines and use tori lines to prevent unintended interactions with non-target fish, seabirds and other marine life
	Surface (Pelagic)	Active	Uses hooks to catch fish	Long lines of baited hooks	Surface & Midwater	Swordfish Tuna	----------	
	Bottom (Demersal)	Active	Uses hooks to catch fish	Long lines of baited hooks	Ocean Bottom	Halibut Rockfish Cod	----------	
	Pole & Line (Chumming)	Active	Creates the illusion of a school of prey fish by spraying water from the back of the boat and scattering small bait fish onto the sea surface	A hand-held wooden or fibreglass pole with a short line and barbless hook attached	Midwater	Tuna	---------	
	Handlines, Jigs & Trolls	Active	Uses hooks to catch fish yet the lines are shorter than longlines & in the water for a shorter time	One hook to one fishing line	All levels of depth	Tuna, Swordfish Mahi-mahi Cod Haddock	----------	
Traps	Pots	Passive	Stationary enclosed spaces	Consists of wood, wire	Ocean	----------	Lobster	Mesh walls should be sized so

Type	Name	Active or	How the fishing gear are	What the fishing gear	Position	Catch		Notes
	Stow Bag Nets Fixed Traps		with cone-shaped entrance tunnel that are laid on the seabed for 24 hrs then are hauled onto a boat for harvesting and re-baiting. Laid in strings (with traps attached to a long rope)	netting or plastic & rope	Bottom		Crabs Shrimp and Sablefish	that small fish can escape. Exclusion devices prevent larger marine animals becoming entangled

Table 1: Classification of Fishing Gear

REVIEW OF THE EPR APPROACH TO WASTE FISHING GEAR ANNOUNCED IN THE SUP DIRECTIVE

REVIEW OF THE EPR SCHEME FOR WASTE FISHING GEAR ANNOUNCED IN THE SUP DIRECTIVE

Background

Challenges caused by macro and micro marine plastics prompted the EC to introduce a new directive – SUP Directive adopted on the 5th June 2019 which aims to ban a range of single use plastics items frequently found on European beaches [1]. The main thrust of the directive is preventing macro marine plastics i.e. relatively large particles of plastic > 5mm found in the marine environment, from entering the ocean.

However, an important element of SUP Directive is also to implement an EPR scheme (for waste fishing gear containing plastic) to tackle the many challenges posed by waste fishing gear.

The EPR scheme seeks to increase the collection rate of waste fishing gear, thus reducing disposal at sea as well as disposal by landfilling and incineration, and the associated environmental and economic impacts of marine plastics.

The SUP Directive (i) encourages the use of mechanisms to improve the management of waste fishing gear containing plastic once it's returned to shore; and (ii) recommends EPR schemes to be established at member state level that cover the cost of preventing fishing gear from being discarded.

In the EU, 27%* (by count) of marine litter comprises plastic fishing gear, with single use plastics making up a further 43% (http://europa.eu/rapid/press-release_IP-18-3927_en.htm). Fishing gear[2] containing plastic poses a significant risk to marine ecosystems, biodiversity and human health. There are additional risks to marine-related economic activities including tourism and shipping.

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[1] Single use Plastics includes food containers; beverages cup, containers, caps & lids; packets & wrappers, tobacco product filters, sanitary items & wet wipes; lightweight plastic carrier bags

[2] The definition of 'fishing gear' is aligned to the definition used in the SUP Directive – see Box B: Legal terms and definitions associated with EPR scheme for fishing gear (see page 18)

In 2009 the United Nations Food and Agriculture Organization (FAO) and United Nations Environment Programme (UNEP) stated that, globally, waste fishing gear comprised some 640,000 tonnes per annum, or 10% of the overall marine plastics problem [http://www.fao.org/3/i0620e/i0620e00.pdf and, https://www.reuters.com/article/us-oceans-ghost-fishing/ghost-fishing-by-lost-nets-damages-seas-u-n-idUSTRE5446NS20090505]. Analysis completed within the Circular Ocean (CO) project indicated there were many assumptions in this report. . A separate analysis was highlighted in a report published by UNEP that suggested that 70%, by weight, of floating macro plastic debris, in the open ocean, was fishing-related. [Page: 61 http://wedocs.unep.org/bitstream/handle/20.500.11822/7720/-Marine_plasctic_debris_and_microplastics_Global_lessons_and_research_to_inspire_action_and_guide_policy_change-2016Marine_Plastic_Debris_and_Micropla.pdf?sequence=3&isAllowed=y]

The Global Ghost Gear Initiative (GGGI) has estimated that 5-30% of global harvestable fish stocks are impacted by ghost gear every year, depending on the region, making ghost gear a significant threat to coastal economies and global food security. GGGI is the world's largest cross-sectoral alliance dedicated to solving the problem of ghost gear globally. GGGI was established in 2015 as programme within World Animal Protection and in 2019 moved its affiliation to Ocean Conservancy. "Ghost gear" relates to a cycle where a fish or marine animal and predators/scavengers get caught in abandoned or discarded fishing gear. The GGGI stated in its 2018 Annual Report that ghost gear is the most harmful form of marine debris. When a fish or marine animal gets caught in gear, it can attract predators/scavengers which can then also get caught in the gear, resulting in a cycle known as "ghost fishing".

In an attempt to improve the understanding of ghost gear problem, the GGGI's Build Evidence Working Group has developed the GGGI Data Portal – the largest collection of ghost gear data with dozens of partners submitting data from around the world. GGGI are working to revise the above quoted 640,000 tonnes per year figure, but a major challenge is that there are still geographical areas around the world areas where studies have not been completed. For example, National Oceanic and Atmospheric Administration (NOAA) found that ghost gear is directly responsible for a 5% reduction in total cod catch in the Baltic Sea and a 30% reduction of Greenland halibut off the coast of Norway. The GGGI is working with its 100+ member organizations around the world to gather more data and encourage more studies to be done in data poor regions such as Africa, South America and the Caribbean.

In November 2019, Greenpeace produced a report entitled “Ghost gear: the abandoned fishing nets haunting our oceans” https://www.greenpeace.org/international/publication/25438/ghost-gear/ .It stated that 12 million tonnes of plastic ends up in the oceans every year, with abandoned, lost or discarded fishing gear [also known as “ghost gear”] inadvertently killing a significant variety of marine wildlife.

The Greenpeace report also quotes the FAO and UNEP report figure of 640,000 tonnes of ghost gear that enters the oceans every year which is equivalent in weight to more than 50,000 double decker buses. The same study repeated the figure that fishing gear comprises up to 10% of the plastic waste in the oceans, “but represents a much higher proportion of large plastics found floating at the surface…”

Greenpeace adds that in some specific ocean areas, fishing gear makes up most of the plastic waste, including more than 85% of the rubbish on the seafloor on seamounts and ocean ridges, and in the Great Pacific Gyre.

> *Greenpeace states: “‘Ghost fishing’ effectively competes against fishers for their catch. Ghost gear is also a hazard to ship navigation and safety at sea.”*

To summarise, there is definitional problem related to waste fishing gear in the oceans. One study suggests that 10% of all marine plastics is waste fishing gear and a second suggests that 70% of floating macro plastics is fishing related, with the EC now using a figure of 27% (by weight) of marine plastics being waste fishing gear. A key issue is the lack of an evidence-based definition of the magnitude of problem: “if you can’t measure it, you can’t manage it”.

The “polluter pays” principle

The SUP Directive is based on the “polluter pays” principle. The aim is to make fishing gear producers and/or assemblers responsible for the end-of-life phase of their plastic-based products by taking on the costs of managing the products’ waste streams.

Currently in Europe, no organisation involved in the fishing industry is responsible for ensuring waste fishing gear is returned to shore. Under the EPR scheme, within the SUP Directive, costs will include separate collection, treatment, recycling, as well as re-use of waste fishing gear and associated awareness-raising activities. It is important to note that

fishing operators and fishermen that are small-scale makers of plastic fishing gear will not be held responsible under the EPR scheme https://ec.europa.eu/fisheries/new-proposal-will-tackle-marine-litter-and-%E2%80%9Cghost-fishing%E2%80%9D_fi. Those that will be responsible are the producers, assemblers and distributors of fishing gear ('producers') e.g. those that "place fishing gear on the market" (see Box B: Legal terms and definitions associated with EPR scheme for fishing gear). However, fishing operators will need to liaise with the producers over EPR, due the nature of fishing gear being closely designed to the needs of the fishing operators. This could result in some of the port reception facilities costs also being borne by fishing gear producers. This link - https://seas-at-risk.org/issues/shipping/waste-from-ships.html - gives a definition of port reception facilities within a waste fishing gear context.

The SUP Directive will also:

Complement the measures already envisaged under the EC's European Strategy for Plastics in the Circular Economy (2018/2019) https://ec.europa.eu/environment/circular-economy/pdf/plastics-strategy-brochure.pdf and Circular Economy Action Plans (2015 and 2020) - https://europa.eu/rapid/press-release_IP-18-5_en.htm and https://ec.europa.eu/commission/presscorner/detail/en/ip_20_420

- Address the identified gaps in the existing actions and legislation
- Further reinforce the EC's systemic approach to waste fishing gear

Further, the SUP Directive will complement the existing Port Reception Facilities (PRF) Directive[3] that wasamended and adopted on 17th April 2019 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2019.151.01.0116.01.ENG&toc=OJ:L:2019:151:TOC
The PRF Directive introduced an indirect cost for fishing operators for waste delivery to ports including bringing their waste fishing gear to port without incurring any direct cost. The revised PRF and SUP directives are expected to complement the Fisheries Control Regulation[4], which includes a provision for reporting on and retrieving lost fishing gear.

[3] https://ec.europa.eu/transport/modes/maritime/news/2018-01-16-plastic-waste_en

[4] https://ec.europa.eu/fisheries/cfp/control_en

SUP Directive Implementation

The date by which the SUP Directive must be passed into member state national legislation is 2023. In that year, importantly, member states will have to introduce EPR schemes. Member states will be able to design and implement tailored legal, administrative and economic instruments to create local solutions at their ports and/or within their fishing communities

In addition, member states will have to electronically report data on quantity and volume of fishing gear sold on the market, waste fishing gear collected and "passively fished" gear collected as per the PRF Directive [5]. Member states will be responsible for defining the methodology for collecting and reporting this data to the EC. In 2026, the EC will evaluate the SUP Directive and may include new legislative proposals or binding collection targets.

Box A: Summary of key targets and dates

Below is a summary of the key targets associated with the EPR scheme for waste fishing gear across member states. See Annex C for SUP Directive mechanisms that were considered in relation to the EPR scheme but not enacted.

[5] Passively fished gear is any waste fishing gear – i.e. not their own - that fishing operators recover from the sea.

Summary of key targets and dates

Year	Description
17/04/2019	Entry into force of the revised Port Reception, Facilities Directive [PRFD]
05/06/2019	Entry into force of the SUP Directive
2022	Year that member states need to electronically report to the EC data on fishing gear (containing plastic) that is placed on the market and on waste fishing gear collected
31/12/2024	EPR around SUP schemes to be established
07/2027	Evaluation of the SUP Directive by the EC – if appropriate, the EC will propose binding collection targets for waste fishing gear following a study of the feasibility of establishing such binding targets

Notes

1. The EC shall carry out an evaluation of this Directive by 3 July 2027.

2. The EC shall submit a report on the main findings of the evaluation carried out in accordance with paragraph 1 to the European Parliament, the Council and the European Economic and Social Committee. The report shall be accompanied by a legislative proposal, if appropriate. That proposal shall, if appropriate, set binding quantitative consumption reduction targets and set binding collection rates for waste fishing gear.

Box B: Legal terms and definitions associated with EPR scheme for fishing gear

Within the SUP Directive, key definitions are highlighted in Article 3 that relate explicitly to the EPR scheme for waste fishing gear. https://ec.europa.eu/environment/circular-economy/pdf/single-use_plastics_proposal.pdf

- "Fishing gear" means any item or piece of equipment that is used in fishing and aquaculture to target or capture marine biological resources or that is floating on the sea surface and is deployed with the objective of attracting and capturing such marine biological resources

- 'Waste fishing gear' means any fishing gear covered by the definition of waste in Directive 2008/98/EC, including all separate components, substances or materials that were part of or attached to such fishing gear when it was discarded
- “Producer” means any natural or legal person that, irrespective of the selling technique used, including distance contracts within the meaning of Directive 2011/83/EU of the European Parliament and of the Council of 25 October 2011, places on the market single-use plastic products and fishing gear containing plastic except persons carrying out fishing activities as defined in Article 4(28) of Regulation (EC) No 1380/2013 of the European Parliament and of the Council[6]

[6] [https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013R1380 In the Council of the European Union, government ministers from each EU country meet to discuss, amend and adopt laws, and coordinate policies. The ministers have the authority to commit their governments to the actions agreed on in the meetings. *Together with the European Parliament, the Council is the main decision-making body of the EU*

BUSINESS OPPORTUNITIES - FOR CIRCULAR BUSINESS MODELS AND NEW PRODUCTS

Start-ups, SMEs, entrepreneurs, co-operatives and/or social enterprises

BUSINESS OPPORTUNITIES - FOR CIRCULAR BUSINESS MODELS AND NEW PRODUCTS, START-UPS, SMES, ENTREPRENEURS, CO-OPERATIVES AND/OR SOCIAL ENTERPRISES

Under EPR, member states have flexibility to develop their own EPR schemes in consultation with stakeholders including fishing operators, producers and assemblers of fishing gear, SMEs, entrepreneurs, co-operatives or social enterprises. This flexibility gives member states the opportunity to consider:

- Rewarding existing fishing gear repair and component reuse activities by fishing operators, fishing gear producers or other parties
- Penalising dumping, landfilling and incineration of recyclable fishing gear
- Providing incentives to stakeholders in the wider innovation system, on a local and national level

EPR schemes in member states could become a trigger for innovative solutions for start-ups, SMEs, entrepreneurs, co-operatives and social enterprises:

- Ports**,** coastal cities and towns, and fishing communities might establish initiatives to support local SMEs in the reuse, upcycling, repurposing and recycling of waste fishing gear. This could include setting up innovation challenges, hackathons or similar, to help kick-start the process
- Centralised collections might be established to facilitate public-private partnerships to undertake larger scale repair, servicing, remanufacturing and recycling activities

The schemes could result in the development of new products, new businesses and jobs (for examples, see “Products from Waste Fishing Nets” www.circularocean.eu/wp-content/uploads/2018/02/Circular-Ocean_Research_Products_FINAL_02-02-18.pdf). For the purpose of this report, these products have been categorised into two main headings:

- Upcycling of fishing gear into sunglasses, socks, clothes, footwear, carpet tiles, skateboards, toys and surfing and fishing accessories.

- Repurposing of fishing gear into bracelets, keyrings, necklaces, dog leashes, bike, garden accessories and mats.

EPR schemes could also encourage existing fishing gear producers to explore new circular business models (CBMs) including:

- Service or performance-based models
- Remanufacturing

GGGI reports that, for example, in British Columbia, Canadian fishing operators will often take salvageable/usable pieces of old fishing nets (that would otherwise have been discarded) and use them to splice patches in their current fishing nets .

> *"They used to do this all the time in our net repair facility at Steveston Harbour. They'd stretch the net out and cut pieces of used web to fit, then splice it together with nylon twine/thin rope. You can always tell where there's a splice/patch in a seine net, for example, as the seine body web tends to be black, but the rope/twine used to splice the patch in was typically white".*
>
> Joel Baziuk, Deputy Director, GGGI (referencing his previous experience of organising fishing gear recycling in Steveston Harbour, British Columbia, Canada)

For more information, see section Tables 2 and 3 – see section covering CBMs

OVERVIEW OF CURRENT DESIGN AND MANUFACTURING CONTEXT OF FISHING GEAR

With fishing gear ranging in size from small and cheap single use for hobbyists to large industrial scale fishing, the existing market is large and varied (see Table 1: Classification of Fishing Gear).

Typically, nets and ropes are produced by hand or weaving machines. Although some producers are based in the NPA region, it is unclear how many of them are manufacturing, assembling or importing fishing gear from other regions in Europe and beyond. It's clear that fishing gear can be time - and therefore cost - intensive to assemble and disassemble.

For example, one fishing net producer in Ireland suggested that an average large fishing net takes between 150 to 200 hours to assemble, with full disassembly estimated at half that time; however, the assumption over the number of individuals to complete this was not stated. In discussion with a harbour master, also in Ireland, it was suggested that the stripping down process for material recycling of two large fishing nets can take two people a day assuming that there is access to an appropriate facility to complete the work.

One fishing net producer suggested that members of its fishing gear design and development team (fishing gear technologists) will typically have worked their way up from production to design and development without necessarily having a formal design, engineering or related qualification. However, there are indications of formalised education and training programmes in gear design and development in Iceland, but other examples were not found.

Initial research indicated many design and development teams in fishing gear producers and/or assemblers will have not have formalised processes for product design and development and be users of formal design and development training, tools and methodologies; or be trained in ecodesign and circular economy tools and strategies, unless they are required to do so by customers and/or policy drivers. Informal discussions with fishing gear manufacturers have indicated that many design and development processes are informal. However one gear technologist indicated that some use Computer Aided Design (CAD) to help design the gear but current software does not include any environmental content or modules (as exist for other types of products). Presently, there are still many unknowns about design and development processes within fishing gear producers and/or

assemblers and the potential for the ecodesign or more specifically circular design of fishing gear.

Key design and development considerations for fishing gear include:

- **Functionality:** The design of fishing gear should target specific fish, the respective water environment conditions and fishing techniques
- **Cost:** Fishing operators work to tight margins including the fluctuation of global prices for catch.
- **Customisation/tailoring:** The design of fishing gear should generally be tailored to a fishing method and a fishing operator activity such as those outlined in Table 1: Classification of Fishing Gear.
- **Material selection/durability:** Fishing gear needs to survive harsh conditions. Fishing nets and ropes are therefore typically made from nylon, polypropylene and polyethylene (polymers) which are either braided or twisted. Newer plastics, such as Dyneema® have been developed to improve the efficiency and productivity of fishing or to increase the lifespan of the fishing nets and ropes. However, these advanced technical materials raise additional challenges at end-of-life. From informal discussions with experts there were indications that this type of rope includes mixed polymers and metals that were designed to reduced energy use and fuel cost on board fishing boats, but end-of-life issues were not considered in the development. Therefore, in this example, the principle of life cycle thinking and trade-offs inherent in ecodesign were not factored into development decisions.
- **Failure modes and effects:** Key failures come from tearing and stretching. Durability is key but depends on external factors that cannot be overcome through design, e.g. entanglement of nets in ocean debris, sabotage from competing fishing operators, destructive fishing practices or unskilled fishing operators.

Fishing gear uses a variety of materials including metals, especially when a rigid structure is required, e.g. for traps or hooks and weights. Additional components such as audio deterrents are added to fishing gear to reduce or eliminate by catch by releasing a sound to ward off large fish or mammals. At a recent expert workshop, a representative from Plastix Global stated that over 700 combinations and permutations of materials are used in the design and development of fishing gear based on their experience of the mechanical recycling of waste fishing gear.

NEW CIRCULAR BUSINESS MODELS (CBMS)

The following section presents existing and potential CBMs for fishing gear stakeholders: see Tables 2 and 3. The models are based on Clause 6 ("Guidance on enabling mechanisms and business models") in BS8001:2017 - Framework for implementing the principles of the circular economy in organisations – that was further developed to focus on fishing gear in a chapter by Charter and McLanaghan in "Designing for the Circular Economy" edited by Charter (Routledge, 2018) https://www.routledge.com/Designing-for-the-Circular-Economy-1st-Edition/Charter/p/book/9781138081017. The authors of this report have further developed the thinking and this is highlighted in Tables 2 and 3 below.

Table 2 highlight existing CBM practices and highlights potential additional opportunities that may be becoming more relevant, particularly given current trends and policy changes.

Table 3 identifies new CBMs and outlines opportunities and threats. It considers the stakeholders owning and implementing the business model, the opportunities provided by the models, and threats that could hinder the models' introduction.

Strategies related to - and aimed at improving the business and product circularity of fishing gear - are embedded in the respective tables. The tables have been designed to initiate discussion. After reviewing the tables, the authors welcome any feedback and ideas related to CBMs and fishing gear via mcharter@uca.ac.uk

Circular Economy Business Model	Existing Practices	Additional Opportunities
Produce on Demand (made to order and custom made)		
Producing a product or providing a service only when customer demand has been quantified and confirmed.	Fishing gear is often custom made to the needs of individual fishing operators based on their fishing practices.	• Emerging digital production technologies (e.g. adopted from textile industry) could reduce production times and costs while increasing customisation potential. • Adopt ecodesign strategies to reduce resource consumption across products' life cycle. • Combine with other CBMs for additional revenue streams. Examples: repair, remanufacturing and reconditioning; reuse, market brokerage and storage; product service system
Product Life-extension		
New products designed for a long lifetime (durability).	Producers provide fishing operators with a fishing net plan as well as repair patches. Durable materials such as Dyneema® are becoming more common, increasing the lifespan of the fishing gear.	• Combine with other CBMs for additional revenue streams. Examples: refurbish, repair, remanufacturing and reconditioning services. • Combine with modular design and ecodesign strategies to facilitate high quality and commercially viable reuse. • Adopt ecodesign strategies to reduce resource consumption across products' life cycle.
Facilitated Reuse		
Reuse with or without repair / upgrade (supplied, either free of charge or resold).	Producers and fishing operators frequently reuse many of the components of fishing gear such as weights and buoys.	• Reuse of complete fishing gear systems is high unlikely due to their customised nature. However, there is potential for greater reuse of key components of fishing gear than currently taking place. Commercialising reusable components could be undertaken by the fishing operators, producers, centralised/localised market brokerage and storage or a separate reuse network. • Combine with other CBMs for additional revenue streams. Examples: refurbish, repair, remanufacturing and reconditioning , recycling, downcycling, upcycling and repurposing • Combine with other circular business models (e.g. modular design, product life extension) and ecodesign strategies to facilitate high quality and commercially viable reuse.

Circular Economy Business Model	Existing Practices	Additional Opportunities
Product Modular Design		
Products designed to be modular so that components are updated.	Fishing gear can be produced so that key components can be easily removed and replaced.	• Combine with other CBMs for additional revenue streams. Example: repair, remanufacturing and reconditioning • Combine with other CBMs (e.g. product life extension) and ecodesign strategies to facilitate high quality and commercially viable reuse.

Table 2: Existing Circular Business Models and additional opportunities

Business Models	Opportunities	Threats
Incentivised Return		
Incentivises customers to return used/unwanted items to the producer. The Producer then either recycles materials or remanufactures the product. Incentives are usually in the form of a discount offered on a new product for surrendering the old one.	• Enables producers to meet upcoming SUP and PRF Directives without paying additional EPR fees. • Could facilitate an increase in repeat orders for the producer when combined with take back discounts or a deposit scheme. • Could increase the collection rate of fishing gear thus reducing illegal dumping at sea. • Could increase the likelihood of fishing gear entering circular resource flows if combined with reuse, remanufacturing and recycling, especially if producers can commercialise circular business models.	• Producers could incur additional costs due to extra logistics demands, sales discounts or labour and storage demands to handle returning used fishing gear. • To ensure fishing gear enter circular resource flows producers will require additional resources to undertake diagnostics to assess retainable value.
Lease agreement		
Leasing access to and not selling ownership of a product/service. This can be on a business to business (B2B) or business to consumer (B2C) basis. In general, an “operating lease” model is likely to be best suited for product service system models in the context of a circular economy, because ownership of the asset is retained by the lessor and can be combined with service or performance-based business models. The lessee’s capital outlay is typically lower when compared to outright purchase when taking depreciation, maintenance and disposal/replacement costs into account. The lessor typically benefits from higher overall profitability during the lease period and retains ownership.	• Enables fishing operators access to consistent high quality fishing gear with lower capital investment and potentially a lower lifespan costs when taking depreciation, maintenance and disposal/replacement costs into account. Because the fishing operators lease fishing gear from the producers and pay a regular fee for their use, repair and replacement guaranteeing, they will also have a suitable fishing gear available for use. • Enables producers to retain ownership of fishing gear enabling them to: • Ensure fishing gear are returned at end-of-life to meet SUP Directive requirements	• Requires resources (capital investment) to transfer producer's accounting (upfront sales profit) and sales (bonuses) practices from one-off sales to leasing. • Fishing operator cash flows, grants, accounting (depreciation) could hinder monthly payments. • Service contract will require legal clarity on responsibility / liability disputes between producers and fishing operators on maintenance / repair / handling/ training etc. • Producers underwrite liability of uncontrollable damages, entanglements or misuses etc. which could reduce profitability.

	• Conduct real world failure mode and effects analysis (FMEA) to improve durability of their fishing gear • Increase profit from individual fishing gear by employing multiple life strategies for fishing gear with product life-extension, modular design, reuse, repair, refurbishing and remanufacturing. • Obtain additional revenue streams by selling end-of-life fishing gear to recyclers • Regular payments could provide consistent cash flow for producers.	• Culture and perception of control through ownership amongst fishing operators could result in a low uptake..
Business Models	**Opportunities**	**Threats**
Performance based (Pay for Success)		
Company delivers product performance or defined results rather than the product/service itself. The customer purchases a defined level of performance, where the company's primary revenue stream comes from payments for performance delivered or demand-fulfilment. Ownership remains with the operating company.	• Enables fishing operators to reduce costs if faced with a low catch performance as they pay for key fishing gear performance-catch productivity (by volume, quality etc.). Especially, it could result in a lower capital investment and potentially a lower lifespan costs when taking depreciation, maintenance and disposal/replacement costs into account. • Enables producers to retain ownership of fishing gear enabling them to: • Ensure fishing gear are returned at end-of-life to meet SUPD requirements. • Conduct real world FMEA (Failure Modes and	• Requires resources (capital investment) to transfer producer's accounting (upfront sales profit) and sales (bonuses) practices from one-off sales to performance-based pay. • Producers underwrite catch productivity which is determined by many factors upon which they have no control over, e.g. fishing operator skills or dwindling fish stocks etc. • Irregular catch productivity would result in irregular cash flow and lower profit for the producer. • Service contract will require legal clarity on responsibility / liability disputes between fishing

	Effects Analysis) to improve durability of their fishing gear. • Increase profit from individual fishing gear by employing multiply life strategies for fishing gear with product life-extension, modular design, reuse, repair, refurbishing and remanufacturing. • Obtain additional revenue streams by end-of-life fishing gear to recyclers.	gear producers and fishing operators on maintenance / repair / handling/ training, etc. • Producers underwrite liability of uncontrollable damages, entanglements or misuses etc. which could reduce profitability. • Culture and perception of control through ownership among fishing operators could result in a low uptake.. • Volatile market prices create uncertainty for both producer and fishing operator, affecting how to cost models and agree to suitable prices for performance.
Sharing platforms/resources		
Shared access or “collaborative consumption” among users, individuals or organisations, but where some form of transactional arrangement (which could be financial) is provided. Enable increased utilisation rate of products and services by making possible shared use/ownership among consumers. Enabling customers to access a product, rather than owning it outright, and use it only as needed.	• Enables small scale fishing operators to gain additional revenue streams by renting out their irregularly used, underutilised or port-based fishing gear. • Enables small scale or start-up fishing operators to reduce costs, removing capital investment by paying per use for irregular used or port-based fishing gear. • Opportunity for a digital platform to generate revenue (on a % of rental prices) for providing intermediate services between parties, thus reducing the risks to fishing operators. • Opportunity for a community co-operative to rent port-based fishing gear or end-of-life treatment equipment to local fishing operators.	• Requires open, collaborative and highly trustful industry culture, which may be a significant challenge in a highly competitive commercial fishing industry. • Requires legal clarity on who takes responsibility for incorrect use, maintenance and damages. • Challenges could arise if fishing gear are required at the same time, e.g. fishing is tidal based in small ports.

Business Models	Opportunities	Threats
Peer to Peer (P2P) lending		
P2P lending of products/services is mainly between members of the public or between businesses, but where no direct financial transaction occurs, or income is secured. More socially driven, rather than commercial, where access might strengthen community relationships. For B2B lending, business benefits might include reduced costs over directly sourcing the products /services concerned.	• Enables fishing gear producers to reduce costs by substituting virgin raw materials with recyclate, especially if the producer retains ownership of fishing gear through enacting lease agreements, performance-based pay and incentivised return. • Additional revenue stream for fishing operators to sell used fishing gear. • Opportunity for start-up either for collection or recycling used fishing gear.	• Requires open, collaborative and highly trustful industry culture which may be a significant challenge in a highly competitive commercial fishing industry. • Requires legal clarity on who takes responsibility for incorrect use, maintenance and damages. • Challenges could arise if fishing gear is required at the same time, e.g. fishing is tidal based in small ports.

Refurbish, Repair, Remanufacture and Recondition			
Product gets a next life after remanufacturing: the process of restoring the product or part functionality to "as-new" quality; facilitated by design for disassembly. Enables the fishing gear producer to put the products back into the market to earn a second,	Refurbish: aesthetic improvement of a product, component or material, which might involve making it look like new, with limited functionality improvements.	• Opportunity for a port-based cleaning services by co-operatives or social enterprises. • Enables fishing operators to reduce fishing gear replacement costs.	• Low market demand could reduce the potential to cover operational costs. • Will require quick turnaround to tie in with fishing operator's downtime.
	Repair: returning a faulty or broken product, component, or material back to a usable state.	• While some fishing gear producers provide repair services, that are either port-based or at their facilities, and the majority of fishing operators self-repair there fishing gear there is an opportunity for a more joined-up approach to repair in the sector.	• Labour intensive work could make repair and reconditioning costs not viable. • Will require quick turnaround to tie in with fishing operator's downtime.

or subsequent income, from a second or subsequent user.		• Opportunity for port-based repair services by co-operatives or social enterprises.	
	Recondition: return of a used product to a satisfactory working condition by rebuilding or repairing major components that are close to failure.	• Opportunity for port-based reconditioning services by co-operatives or social enterprises.	
	Remanufacture: return a used product to at least its original performance with a warranty that is equivalent or better than that of the newly manufactured product.	• Opportunity for port-based or centralised remanufacturing services by co-operatives or social enterprises. • Opportunity for additional revenue streams for producers if combined with other circular business models such as product life-extension, modular design, lease agreement, performance-based pay and incentivised return. • Enables fishing operators to reduce costs with lower priced fishing gear	• Resource-intensive work could increase costs beyond the price of new fishing gear e.g. inspection, storage, disassembly, restoration and replacement of components, testing etc. • Hindered by material degradation especially on plastic components. • Low and sporadic rates of used fishing gear collection could result in an unreliable supply chain.

Business Models		Opportunities	Threats
Recovery of Secondary Raw Materials / By-Products			
Creating products through secondary materials from recovered waste.	Recycling (closed loop): material is broken down to its chemical components, reproduced and manufactured into the same product, i.e. fishing gear.	• Enables producers to reduce costs by substituting recyclate with virgin raw materials, especially if the producer retains ownership of fishing gear through enacting lease agreements, performance-based pay and incentivised return. • Additional revenue stream for fishing operators to sell used fishing gear. • Opportunity for start-up either for collection or recycling used fishing gear.	Challenges include: • Material degradation, irregular collection rates, material toxicity, contamination from salts, moisture, ultraviolet (UV) light, oil spills, chemicals etc. • Labour intensive disassembly and material separation. • High capital investment and operational costs of recycling often cannot compete against low virgin raw materials costs. • High risks of producing a lower grade material that's not fit for the required performance. • Unrealistic potential for perpetual recycling due to material entropy. • Increased costs and red tape required to obtain waste licences to collect, transport and recycle waste fishing gear. • Large mix of material types.
	Downcycling (open circular loops): material is broken down to its chemical components, reproduced and manufactured into the any product i.e. low-grade plastic products like street bollards.	• Opportunity for a port-based start-ups or centralised system to downcycle fishing gear into low grade fishing related products, e.g. crates, labels etc. • Additional revenue stream for fishing operators to sell used fishing gear.	
	Upcycling (open circular loops): material is broken down to its chemical components, reproduced and manufactured into products, e.g. high-grade plastic products such as performance running shoes.	• Opportunity for port-based start-up or centralised system to upcycle fishing gear into new products, e.g. sunglasses, socks, clothes, footwear, carpet tiles, skateboards, toys and surfing and fishing accessories, etc. • Additional revenue stream for fishing operators to sell used fishing gear.	

	Repurposing (open circular loops): components are disassembled, and individual materials treated and reformed into new products e.g. keyrings and bags made from fishing nets and ropes.	• Opportunity for port-based start-up or centralised system to repurpose fishing gear into new products, e.g. bracelets, keyrings, necklaces, dog leashes, bike, garden accessories and mats etc. • Additional revenue stream for fishing operators to sell used fishing gear.	Challenges include: • material degradation, irregular collection rates, material toxicity, contamination from salts, moisture, UV light, oil spills, chemicals etc. • Labour intensive disassembly and material separation.

Table 3: New Circular Business Models' opportunities and threats

NEW DESIGN STRATEGIES

80% of a product's environmental impact is determined at the design and development stage. Ecodesign was established as process to reduce product-related environmental impacts in design and development, and has been practised by leading companies in various industry sectors since the nineties. Other terminology is used worldwide that is equivalent to ecodesign which includes environmentally conscious design (ECD), design for environment (DfE), green design and environmentally sustainable design. The term ecodesign is used below and throughout the report.

> *"Ecodesign is the systematic approach which considers environmental aspects in the design and development with the aim to reduce adverse environmental impacts throughout the life cycle of a product"*
>
> Sources: Identical definitions in IEC 62430:2019[7] and ISO 14006:2020[8]

There are two international standards on ecodesign that have recently been published:

IEC 62430:2019 and ISO 14006:2020. IEC 62430:2019 provides guidance on ecodesign for those who perform design and development tasks within the design and development process. ISO 14006:2020 provide guidance for managers on the management of ecodesign within the context of environmental management systems. In ISO14006: 2020, there are specific references to the linkages to clauses in ISO 14001:2015 and ISO 9001:2015. It is unclear as to the extent of the adoption of any of these standards by fishing gear producers/assemblers.

As indicated previously, another key issue that has emerged from exploratory research amongst a small number of fishing producers/assemblers is that gear design and development seems to be often an informal process based on personal experience and learning rather than formalised design and development processes.

In addition, initial research amongst fishing gear producers/assemblers has indicated that ecodesign has not been practised in relation to fishing gear design and development; but a discussion has been initiated by the European Commission with fishing gear producers/assemblers

[7] See https://webstore.iec.ch/publication/30879

[8] See https://www.iso.org/standard/72644.html

and fishing operators in relation to the development of a new European standard on circular design of fishing gear. At the time of writing the report, no examples of fishing gear producers/assemblers applying ecodesign and/or specifically circular design have been found. Evidence to date suggests that environmental considerations have not been proactively incorporated into fishing gear design and development.

Ecodesign, and within it circular design, are new concepts in the fishing gear sector and there appears to be lack of awareness and understanding of the principles of lifecycle thinking that is embedded in ecodesign. The biggest environmental impacts associated with fishing gear are production of the materials in the supply chain e.g. polymers and metals and waste at 'end of life'. Therefore supply chain strategies to reduce the embedded carbon in materials and increase dismantlability and repairability of fishing gear should be further investigated. In addition, designing 'closed loop' and 'open loop' strategies to extend the life and value of fishing gear, components, materials and peripherals in economic and social systems will be increasingly important.

However, if we broaden our thinking to the 'fishing system' (e.g. boat and the fishing gear in operation), there are other issues that need to be considered including the energy e.g. fuel used to power the boat and the winches, etc and the associated emissions and air and water pollution. Therefore lightweighting of fishing gear e.g. making fishing gear less heavy may reduce the weight on board boats and energy required to retrieve fishing gear via winches; and therefore lightweighting might enable the reduction of energy consumption, and any associated emissions or pollution in the 'fishing systems'.

A key consideration in fishing gear design and development should be to proactively 'design for product life extension' incorporating durability. Materials recycling should be thought as the 'end of life' of fishing gear. In this context, as indicated above product circularity should be thought of as a process to design and develop fishing gear to retain the value in fishing gear, components, materials and peripherals for as long as possible in economic and social systems. From a design perspective, it is thinking about how to proactively design for .... maintenance, repairability, remanufacturing, refurbishment, upcycling and finally material recycling. The terms remanufacturing and refurbishment maybe more synonymous with modification of fishing gear. Upcycling of fishing gear is happening in the 'open loop' and various products have been produced

around the world [9]. In BS 8001:2017,[10] there is an extensive listing of terms and definitions that are useful to consider in relation to the design and development of fishing gear. Increased clarity over terminology associated with circular economy (CE) will emerge within ISO/TC 323[11] that is focused on establishing international standards related to CE including a specific standard on terms and definitions. At the time of writing, national comments on a series of four proposed standards have been fed back to the TC 323 Secretariat for further discussion in an online meeting in June 2020.

The diagram below illustrates various options to extend the life of fishing gear prior to materials or chemical recycling at 'end of life'. Thinking about 'closed loop' design may lead to contracts between fishing gear producers/assemblers and fishing operators where the fishing gear is sold as service rather than as a physical product with, for example, take-back, and repair and modication services built into contracts. 'Open loop' design will mean that fishing gear is designed to be reused directly in different applications e.g. Vedura shoes; and/or polymers from fishiing gear are recycled into pellets for injection moulding into products e.g. Bureo skateboards, or into filament for 3D printing e.g, Fishy Filaments. However, the products produced from the waste fishing gear in the 'open loop' are generally not part of a designed system, as such, but are collected and/or procured by designers and entrepreneurs, as 'end of life' waste materials from the fishing system.

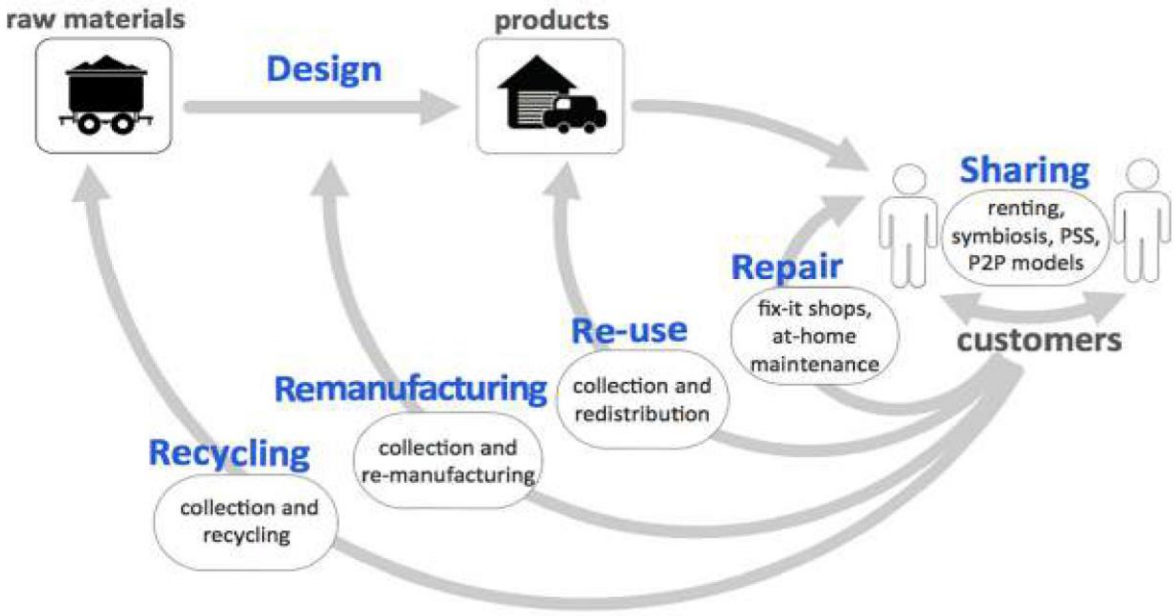
For more information see Tables 2 and 3

[9] See report https://cfsd.org.uk/wp-content/uploads/2016/10/Circular-Ocean_Research_Products_FINAL_23-04-18.compressed.pdf

[10] See https://www.bsigroup.com/en-GB/standards/benefits-of-using-standards/becoming-more-sustainable-with-standards/BS8001-Circular-Economy/

[11] See https://www.iso.org/committee/7203984.html

CIRCULAR ECONOMY AND FISHING GEAR DESIGN, AND DEVELOPMENT



Source: Eco-innovate (2016), The Eco-innovation Observatory

In life cycle thinking terms, the *use* phase is key to extension of the life of fishing gear and it appears that a significant amount of repair and modification of fishing gear is already practised by fishing operators and fishermen. However, this is not optimal, as initial research indicates that design for repairability and modification are not generally considered at the design and development stage of fishing gear. Therefore, communication between the fishing gear producers/assemblers and users e.g. fishing operators is key to improve the process. Fishing gear could be proactively designed to have multiple lives e.g. taken back in a 'closed loop' by fishing gear producers/assemblers, repaired and/or modified and returned to fishing operators and/or repaired by fishing operators, directly. However, in the 'open loop', fishermen often use different polymers to repair fishing gear from those that are used in the original production and this creates problems in the final material recycling process – see example from Steveston Harbour, Canada on p.24

Another key issue is the diversity of materials (e.g. polymers, metals, etc) that are used in the current design and development, production and/or assembly of the fishing gear resulting from the different types of fishing that is undertaken in different parts of Europe. As indicated earlier, Plastix

Global highlighted in a recent workshop that over 700 combinations and permutations of materials are used in fishing gear. Simplifying the types and numbers of materials used in fishing gear will enable more effective recycling at the ‘end of life’ when reuse options are no longer feasible.. . A key issue will be to develop appropriate chemical and materials recycling infrastructure especially as EPR becomes implemented within member states: at present there is one chemical recycler and mechanical recycler in Europe that specialist in recycling of polymers from fishing gear. However, as previously mentioned it is not just about thinking about the materials used but it is about thinking about product life extension for ‘multiple lives’.

Table highlights design strategies aimed at improving the product circularity of fishing gear and influencing the circularity of the businesses that offer them. Effective implementation of these strategies requires a life cycle perspective that considers ‘multiple lives’. Some additional considerations include:

- Identifying potential trade-offs between material durability and circular material loops such as recyclability
- Assessing commercial viability of reusable components, given the labour-intensive nature of fishing gear assembly and disassembly, and the unpredictable supply of used fishing gear
- Determining key components to “make (fishing gear) modular” without impacting on fishing gear performance

Table 4 provides examples of design strategies that might be considered in relation to improving the product circularity of fishing gear. Finally, there is a need for awareness raising over the business and environmental benefits of ecodesign (and within it circular design) of fishing gear and there is need for new education and training courses.

Table 4: 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

A BRIEF LOOK AT THE IMPLICATIONS FOR DIFFERENT STAKEHOLDERS IN THE NPA REGION - IN PARTICULAR FOR START-UPS, SMES, ENTREPRENEURS, CO-OPERATIVES AND SOCIAL ENTERPRISES.

It is currently unclear how the SUP Directive's EPR approach for fishing gear will be implemented. The EC has not clearly set out the methods for calculating a producer EPR fee, and has not, so far, established minimum collection or recycling rates. This may change after the initial directive evaluation in 2027.

Member states could reduce the risk of the SUP Directive on the fishing gear producers and assemblers - as well as influence the EC's evaluation - by taking a proactive, multi-stakeholder response (see Annex D), for example by ensuring the inclusion of modulated fees that encourage CE and ecodesign practices. The member states could also draw on previous experience of implementing EPR related policy e.g. Waste from Electrical and Electronic Equipment, End-of-Life Vehicles and Packaging directives

Emerging Circular Business Models (CBMs) have significant implications for different stakeholders in the NPA region (Annex D)

The implementing of EPR in the NPA and other regions in Europe will require fishing gear producers and assemblers, fishing operators, port authorities and others to rethink their present mode of operation - from the current way fishing gear is produced to how it is used through to the final 'end of life'. This will take significant time, resources and finance. It will also require cultural change and capacity building across all key stakeholders in the fishing gear lifecycle and system. To fully address both the opportunities and challenges related to the issue of waste fishing gear there will be a need to bring together direct and indirect stakeholders in ports and related coastal areas from the fishing sub-system together with stakeholders from the business and innovation sub-systems in in ports and related coastal areas (see Annex D). In the EC Interreg funded Blue Circular Economy such workshops have been organised in Alesund, Norway and Galway, Ireland. The key benefits of these events have been to facilitate networking between stakeholders who have never previously met..

Driven by EPR and increase in CE practices this could result in waste fishing gear being “harvested”, e.g. cleaned and stored into materials banks, presenting an opportunity for start-ups, SMEs, entrepreneurs, co-operatives or social enterprises to develop new products (e.g. clothing) from the materials, new services (e.g. training, cleaning, repair) and new business models (e.g. rental of fishing gear). Combined with advances in technology (e.g. additive manufacturing or 3D printing) and tapping into local innovation systems, the possibilities could be substantial.

Finally, green public procurement could be used by local authorities (that host ports and harbours) to kick-start the demand side and stimulate innovation of, for example, incentivising the reuse of waste fishing gear in building and construction products in coastal areas.

The key issue will be changing the mindset from thinking about waste fishing gear to maximising the value in fishing gear products, components and materials for as long as possible in economic and social systems. This change in approach will require all key stakeholders to buy into a more systems driven strategy.

CONCLUSIONS

The challenges of implementing EPR schemes in the fishing sector cannot be understated. However, in tandem, and, more positively, legislative change presents significant opportunities in terms of embracing new circular business models and ecodesign (and within it circular design) of the fishing gear across the life cycle of fishing gear.

Parties benefiting from disruptions to the sector are likely to include start-ups, SMEs, entrepreneurs, co-operatives or social enterprises, with a focus on converting waste fishing gear into products and, of course, establishing sustainable and circular new businesses.

To ensure long-term benefits, the fishing gear sector should adopt a joined-up, Europe-wide approach, and not just at the port or regional level. It is also recommended, that the fishing gear sector develop a clear vision, strategy and action plan that addresses CE and -EPR that is aligned to other global challenges.

There is a significant opportunity to develop new circular business models to address the near-future adoption of EPR schemes at member state level.

The new business models, design strategies and innovation presented in this report provide a good starting point for supporting stakeholders in the next stage regardless of whether they are in the fishing industry - or in business/innovation in or outside of ports or in or outside the NPA region as a whole.

To recap: (i) EPR schemes could become a trigger for innovative solutions for and by start-ups, SMEs, entrepreneurs, co-operatives and social enterprises; and (ii) free assistance is available to help with exploring and realising business opportunities in the NPA region. The assistance includes webinars, conferences, workshops and consultancy on how to convert waste fishing gear into business opportunities.

To take advantage of the free help and resources, or if you seek further information on any aspect of this report - or if you want to contribute to the debate about how to turn waste fishing gear into new circular business models, products and services – email Martin Charter mcharter@uca.ac.uk

ANNEX A: NPA REGION

The NPA Programme 2014-2020 covers a vast area, as shown on the map below. The programme partner countries are the EU Member States of Finland, Ireland, Northern Ireland, United Kingdom and Sweden and Non-EU Member States Faroe Islands, Greenland, Iceland and Norway.

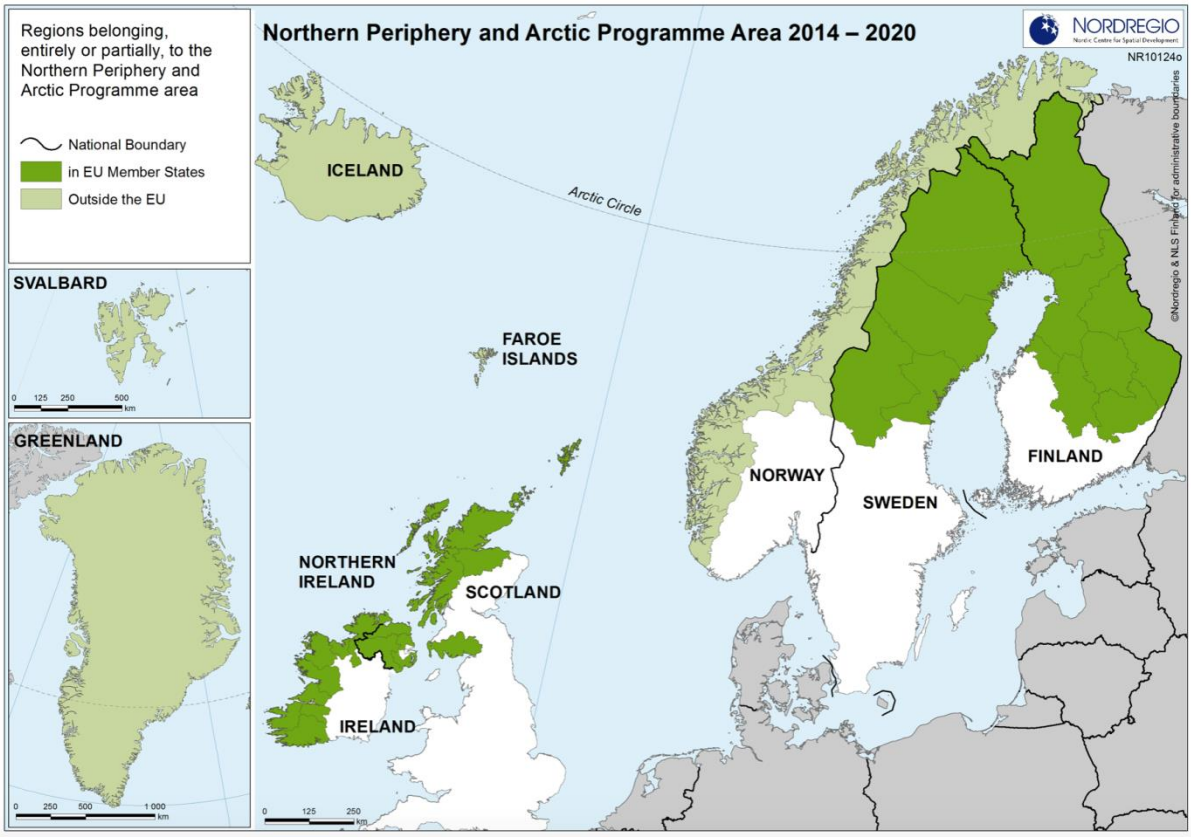


Figure 1: NPA region (sourced from http://www.nordregio.org/maps/interreg-v-b-northern-periphery-and-arctic-region-programme/)

The NPA region covers a large programme area and despite the geographical differences shares several common features, such as low population density, low accessibility, low economic diversity, abundant natural resources, and high impact of climate change. This unique combination of features results in joint challenges and joint opportunities that can best be overcome and realised by transnational cooperation.

Eligible regions within the NPA are highlighted below (also see above map)

EU Member States

Finland

- FI19 Länsi-Suomi (Keski-Suomi)
- FI1D Pohjois-ja Itä-Suomi

Ireland

- IE01 Border, Midland and Western (County Donegal, County Galway, County Leitrim, County Mayo, County Sligo)
- IE02 Southern and Eastern (County Clare, County Cork, County Kerry, County Limerick)

Northern Ireland

- UKN0 Northern Ireland (excluding Belfast and Outer Belfast)

Scotland

- UKM32 South Western Scotland (Dumfries and Galloway)
- UKM6 Highlands and Islands

Sweden

- SE32 Mellersta Norrland
- SE33 Övre Norrland

Non EU Member States

Faroe Islands

- FO Faeroerne

Greenland

- GL Greenland

Iceland

- IS Island

Norway

- NO43 Rogaland
- NO05 Vestlandet
- NO06 Trondelag
- NO07 Nord-Norge
- SJ Svalbard and Jan Mayen

ANNEX B: EXPERT INTERVIEWS

The desk and primary research for this report built on existing research conducted by CfSD and involved reviewing published material, completing expert interviews, and attending conferences and exhibitions

(i) Reviewing published material

- Reports
- Outputs from the Circular Ocean project
- SUP Directive documentation and related websites
- Websites about fishing gear and related websites
- News items and articles

(ii) Attendance at events

A series of exhibition and conferences was attended including Seafest, Ireland's largest maritime festival- www.seafest.ie ; the keynotes/sustainability sessions of the Ocean Wealth Summit (Cork, 10th June 2019 -https://www.ouroceanwealth.ie/oow-summith; BIM workshop on improving the circularity of plastics in fishing gear event (Cork, 11th June 2019 - http://www.bim.ie/our-work/projects/improving-circularity-fishing-gear/

(iii) Expert interviews

Interviews were held with Dr Deirdre Brophy, Centre Leader, Marine and Freshwater Research, Department of Natural Sciences, Galway Mayo Institute of Technology, Ireland; Lucy Hunt, Project Leader, BIM-funded MARplas project, Ireland; and Dr Anita McKeown, Associate Researcher, SMARTlab, Dublin, Ireland

Contact	Organisation
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Expert interviews

Dr Deirdre Brophy (Marine and Freshwater Research Centre Leader at the Galway Mayo Institute of Technology) was selected because of the key role the centre plays in marine research in Ireland, along with her proximity to one of the key ports (Galway) that is based in the NPA region. Dr Brophy recommended linking up with the Bord Iascaigh Mhara (BIM) team. Dr Brophy also recommended to:

- Engage with fishing gear manufacturers

- Seek specific expertise on fishing gear technology, including knowledge gained from trials of new fishing gear

Dr Anita McKeown and Lucy Hunt were identified as being involved in a waste fishing gear project

related to design in the west coast of Ireland and were selected as expert interviewees in part because of their participation at Seafest, Ireland's largest maritime festival, in Cork (7-9 June 2019 - www.seafest.ie)

ANNEX C: SUP DIRECTIVE MECHANISMS THAT WERE CONSIDERED

The Impact Assessment prepared for the SUP Directive https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52018SC0254 considered several mechanisms to implement the legislation. These options were discarded for the following reasons.

Deposit Scheme: the high cost and administrative burden of implementing a **deposit scheme and a recycling target** as well as the high risk of losing the deposit would diminish the impact of such a scheme.

Recycling target: the complexities of defining a recycling target as well as the administrative burden and monitoring costs were considered disproportionate to the potential positive impacts.

Retrieval scheme: the costs of compulsory retrieval scheme were considered to be disproportionate, duplicative and unworkable.

Waste port fee: the indirect waste port fee envisaged under PRF Directive already removes barriers to fishing operators returning waste fishing gear to ports.

ANNEX D: STAKEHOLDERS IN THE LOCAL FISHING SYSTEM (LFS) AND LOCAL INNOVATION SYSTEMS (LIS) IN PORT AREAS THAT HAVE POTENTIAL DIRECT/INDIRECT INTEREST IN WASTE, 2ND AND NTH LIFE FISHING GEAR

Assumption: ports are based in local cities/town/conurbations

In this context, a Local Innovation System (LIS) is defined as including potential stakeholders involved “getting ideas to the market” within a port and its locality (X miles of the port)

Note 1: Very few ports will have a LIS that has been designed

Note 2: Very few ports will have a designed system to manage waste/2nd life fishing gear

Note 3: At present there appears to be no ports/port environments with LIS focused on waste/2nd life fishing gear in Norway

Explanation

The below is a list of types of organisations that could be considered to be part of Local Innovation Systems (LIS) and Local Fishing Systems (LFS) that have a potential interest in collecting, processing andmanaging waste fishing gear; and then potentially transforming polymers and other materials from waste fishing gear into products through pellets (for injection moulding), filament (for 3D printing) and/or re-use or upcycling into new products. This is then broken down by stakeholders that have direct or indirect interest in waste fishing gear. Readers should use the checklist(s) to firstly, identify stakeholders in the systems and analyse what potential role they might play in the creation of value chains related delivering business models, products and services using waste fishing gear. This checklist can also be used to help construct a new systems perspective focused on delivering and retaining value in fishing gear products, components and materials for as long as possible in economic and social systems: fundamentally its about moving towards a ‘mindset of value’ from a ‘mindset of waste’.

Direct

Port-based Stakeholders	Stakeholder interest in waste fishing gear	Organisation(s): Collection/Sorting (Fishing Gear)	Organisation(s): Processing (Fishing Gear)	Organisation(s): Design (Products)	Organisation(s): Manufacturing/ Assembly (Products)	Organisation(s): Start-ups/Market (Products)
Stakeholders in LFS						
Fishermen	Buy/use/repair/dispose fishing gear					
Aquaculture farms	Commercial production/ management of fish/shellfish					
Fishing gear manufacturers/ assemblers	Producing and/assembling of fishing nets/other collection devices e.g. crab pots					
Local fishermen associations	Networks of fishermen					
Citizens	Economic benefits resulting from the fishing industry?					
Beach clean groups	Keeping beaches clean					
Diving clubs	Monitoring ocean environment					
NGOs - local	Protecting local environments/ocean/marine mammals					

Port-based Stakeholders	Stakeholder interest in waste fishing gear	Organisation(s): Collection/Sorting (Fishing Gear)	Organisation(s): Processing (Fishing Gear)	Organisation(s): Design (Products)	Organisation(s): Manufacturing/ Assembly (Products)	Organisation(s): Start-ups/Market (Products)
Port authorities - managers	Interest in efficient running of ports					
Port authorities - owners	Running profitable ports					
Harbour masters	Managing and controlling the operations of the port					
Stakeholders in LIS						
Online social networks – local	Online social networks focused on local issues					
Media - local	Newspaper/online/radio/TV					
Local government – economic department	Supporting existing/new business sectors					
Local government – environmental department	Environmental protection					
Regulators - port	Specific local stakeholders involved in regulation in ports					
Waste management	Management of solid waste and					

Port-based Stakeholders	Stakeholder interest in waste fishing gear	Organisation(s): Collection/Sorting (Fishing Gear)	Organisation(s): Processing (Fishing Gear)	Organisation(s): Design (Products)	Organisation(s): Manufacturing/ Assembly (Products)	Organisation(s): Start-ups/Market (Products)
	materials recycling					
Recyclers	Local SMEs					
Banks – port area	Funding/supporting local start-ups/SMEs for financial return					
Investors – port area	Investing in start-ups for financial return					
Retail – port area	Local retailers/distributors					
Retail – outside area						
Tourist stakeholders	Hotels and other outlets					
Local chambers of commerce	Networking of local SMEs					
Local business networks	Networking of local SMEs					
Waste fishing gear entrepreneurs	New business opportunities: customers, suppliers, funders, etc					
Craftsperson	Individuals or networks					
Logistics/reverse	Companies that distribute/collect					

Port-based Stakeholders	Stakeholder interest in waste fishing gear	Organisation(s): Collection/Sorting (Fishing Gear)	Organisation(s): Processing (Fishing Gear)	Organisation(s): Design (Products)	Organisation(s): Manufacturing/ Assembly (Products)	Organisation(s): Start-ups/Market (Products)
logistics companies	fishing gear					
Storage companies	Companies that provide storage facilities for 1st and 2nd life fishing gear					
Plastics manufacturers	Manufacturing plastic products					
Plastics moulders	Producing moulds for plastics producers					
Fab Labs	Community workshop involved in making products					
Makerspaces	Community workshop involved in making products					
Hackerspaces	Community workshops producing job or batch items using 3DP, etc					
Repair Cafes	Community workshops repairing products					
Business Incubators	Community places aimed at incubating start-ups					
Business	Community places aimed at					

Port-based Stakeholders	Stakeholder interest in waste fishing gear	Organisation(s): Collection/Sorting (Fishing Gear)	Organisation(s): Processing (Fishing Gear)	Organisation(s): Design (Products)	Organisation(s): Manufacturing/ Assembly (Products)	Organisation(s): Start-ups/Market (Products)
Accelerators	accelerating start-ups					
Local universities - students	New projects/jobs/start-ups					
Local universities – staff/researchers	New students/projects/research					
Local technical colleges - students	Campus of local technical colleges					
Local technical colleges - staff	New students/projects/research					
Local art and design colleges	New students/projects/research					
Other						

Indirect

Port-based Stakeholders	Stakeholder's in LFS and LIS	Organisation(s): Collection/Sorting (Fishing Gear)	Organisation(s): Processing (Fishing Gear)	Organisation(s): Design (Products)	Organisation(s): Manufacturing/ Assembly (Products)	Organisation(s): Start-ups/ Market (Products)
Stakeholders in LFS						
NGOs – regional/national/ international	Protecting local environments/ocean/marine mammals					
Regional/county government – economic department	Supporting existing/new business sectors					
Regional/county government – environment department	Environmental protection					
Regulators – outside port area	Specific stakeholders out of ports involved in regulation in ports					
Central government – innovation agencies	Funding R&D and knowledge transfer related to innovation in processes, products and technologies					
Stakeholders in LIS						
Media – regional/national	Newspaper/online/ radio/TV					

Banks – outside port area	Funding/supporting local start-ups/SMEs for financial return					
Investors – outside port area	Investing in start-ups for financial return					
Crowdfunding platforms	Platforms that support crowdfunding campaigns					
Other						

BACK PAGE

The Centre for Sustainable Design ®, Business School for the Creative Industries, University for the Creative Arts

The Centre for Sustainable Design ® (CfSD) was established in 1995 in Farnham, Surrey, UK at what is now the University for the Creative Arts (UCA). CfSD is based within the Business School for the Creative Industries (BSCI). The Centre has led and participated in a range of high quality research projects and has organised hundreds of conferences, workshops and training courses in Europe, Asia and North America focused on sustainable innovation and product sustainability. CfSD is recognised worldwide for its knowledge and expertise, having worked closely with business, policy making and research communities for two decades. CfSD has built world-class knowledge and expertise of sustainable innovation and product sustainability. The Centre researches, develops and disseminates understanding of present and future sustainability impacts and solutions related to innovation, products, technologies, services and systems through projects, training, events, networks and information. CfSD works with partners in Europe, Asi and North Americato deliver high quality results. CfSD have led and partnered in 15+ European Commission funded projects (www.cfsd.org.uk/projects) and has actively worked with 500+ eco-innovative SMEs.

The Centre is an internationally recognised centre of excellence. CfSD has two areas of core competence based on extensive research since the mid 90s (www.cfsd.org.uk/research):

- Sustainable Innovation (Understanding the policy and business implications of sustainable innovation; and working with companies to develop sustainable solutions
- Product Sustainability (Understanding the organisational, management, development and design implications of product sustainability)

CfSD integrates Circular Economy into its activities related sustainable innovation and product sustainability http://cfsd.org.uk/news/circular-economy-innovation/

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anois

Established in 2016 anois is a leading global design agency creating value through design for sustainability and the circular economy. Having successfully worked in most industrial sectors anois has proven expertise and experience in the co-creation of responsible brands, products, packaging, business models, policies and strategies. anois provides specialist training and development and capacity building programmes, stakeholder engagement, consultations, communications, horizon scanning & forecasting. The anois team have worked across Asia, Africa, Europe and Americas with recent clients include large and small companies, the European Commission, United Nations Industrial Development Organisation, national governments, industry associations and higher educational institutes. All projects are carefully tailored towards the precise needs of anois clients, and under pinned by research, analysis and synthesis.

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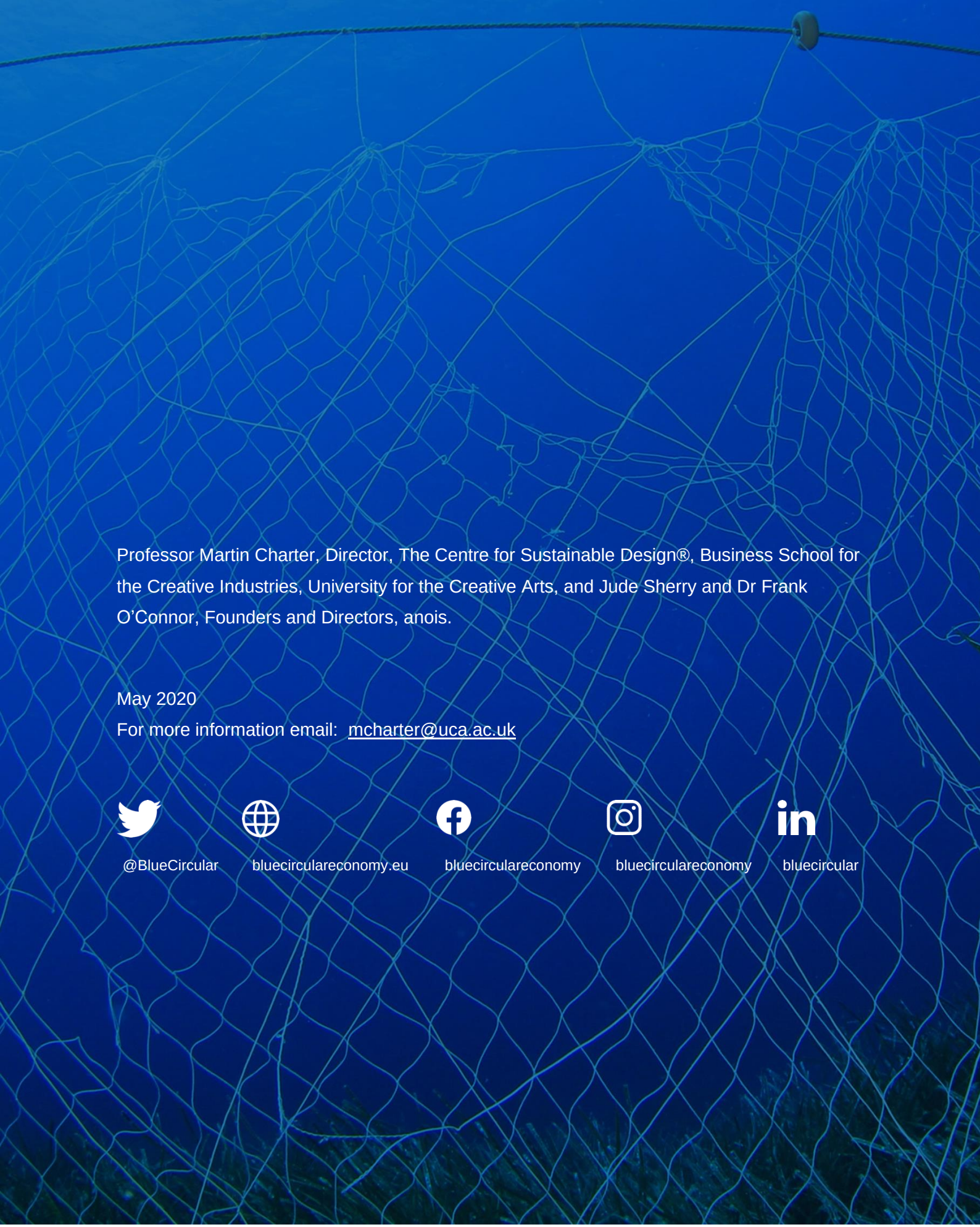

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