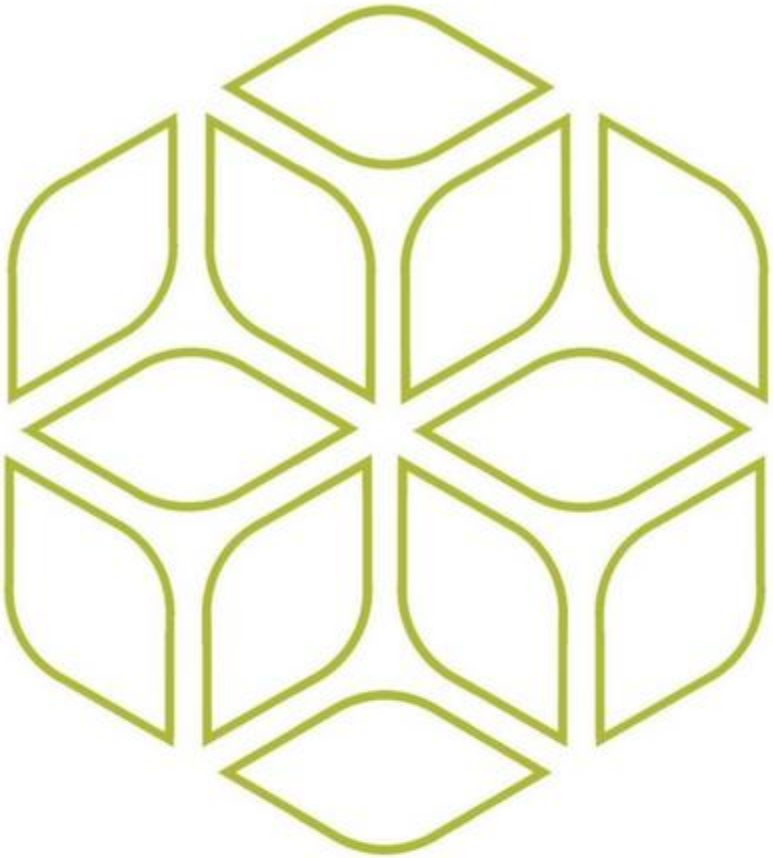

Mapping Economic, Behavioural and Social Factors within the Plastic Value Chain that lead to Marine Litter in Scotland

Commercial fishing gear report

The Scottish Government

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resourcefutures

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Executive Summary

Aims and approach

In the context of growing public concern around marine litter and a fast moving policy landscape of measures to address marine litter and plastic waste, this research sought to understand opportunities within the plastic value chain to help tackle marine litter. The factors and decisions that lead to marine litter in Scotland were researched with a focus on four products that are not fully addressed by current or planned marine litter and plastics waste policy measures. These four product categories were:

1. Commercial fishing gear
2. Crisps, snack and sweet wrappers
3. Artificial grass pitch
4. Menstrual products

The research findings are presented in six documents as follows:

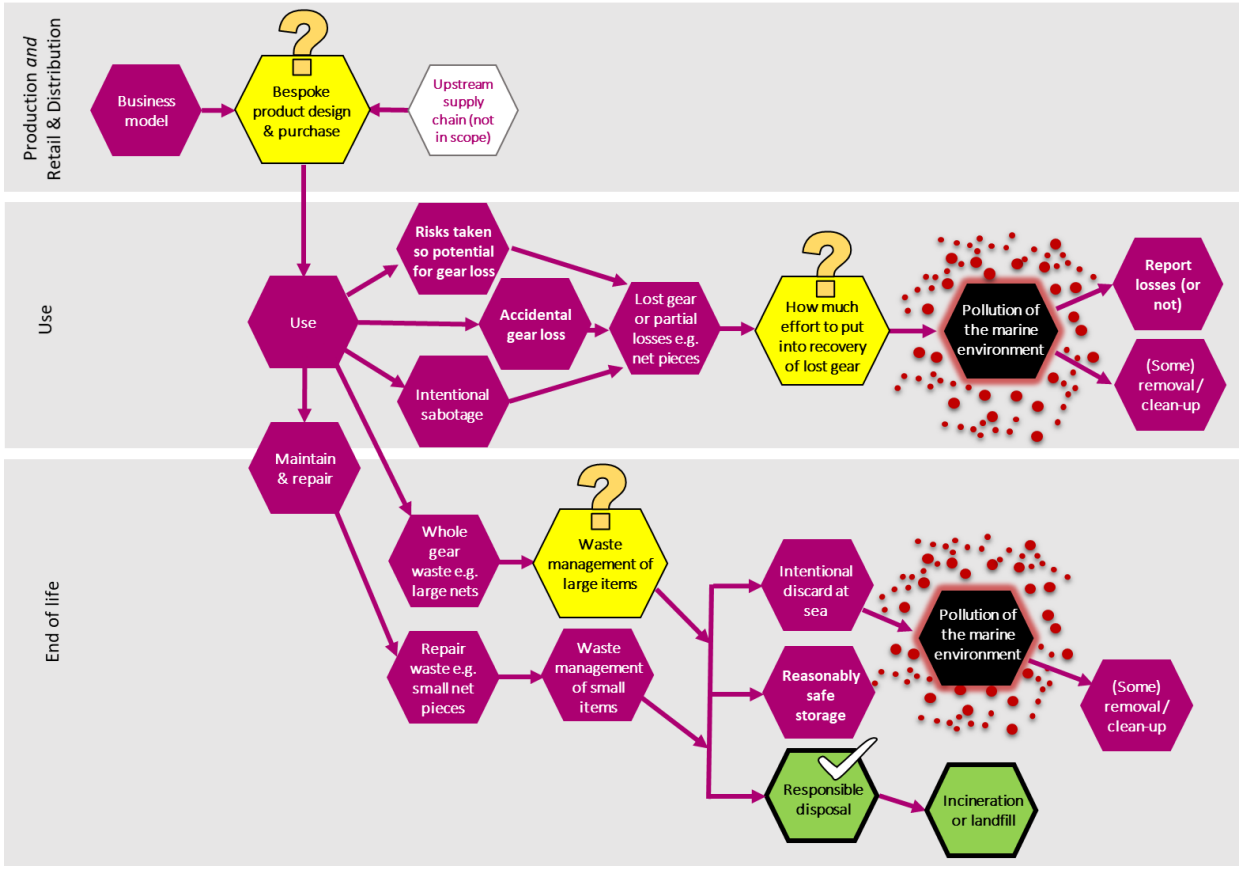
1. **Summary report**
2. **Commercial fishing gear**
3. **Crisps, snack and sweet wrappers**
4. **Artificial grass pitch**
5. **Menstrual products**
6. **Literature review**

This document is the *Commercial fishing gear report*. Key findings for are introduced below. Recommendations are presented for the Scottish Government. The recommendations presented have different potential efficacy, costs and timescales, and to some degree the likely impact is related to the resources and support invested in any single measure.

Commercial fishing gear

The first product group, commercial fishing gear, was researched in detail. It is commonly found in marine litter surveys and is particularly harmful in entangling wildlife. It can be lost accidentally or intentionally dumped at sea, although some stakeholders dispute whether the latter is widespread practice or happens at all in Scotland. The marine litter pathways and key decision points in the value chain to help tackle marine litter are illustrated in Figure E1. The findings are mapped against stages in the product life cycle, shown as grey boxes and described down the left hand side of the figure. Key decision points explored in this research are highlighted in yellow. Respective business models were also identified as potential key decision points, e.g. adopting reuse and circular economy business models. However, these are not highlighted and explored in detail in this research due to a lack of examples to draw upon.

Figure E1: Commercial fishing gear - Marine litter pathways and key decision points



A driver commonly raised by commercial fishing gear stakeholders is the effort required and cost of waste management, especially since other than nylon nets they have little or no recoverable value at present. Potential solutions focussed largely on communications and awareness raising across the supply chain and ensuring the waste retains some value or otherwise an incentive to manage it responsibly is provided. The quantity and type of gear purchased and the waste generated is a major knowledge gap, and mandatory reporting on this would be a valuable first step in implementing extended producer responsibility (EPR), as required by EU legislation in the Single-Use Plastics Directive. This information would help direct further measures to address marine litter. Supporting best-practice behaviours and new technology can also help reduce losses. Wider opportunities may be brought about by systems thinking and business model development, including design for end of life and even recovery of lost gear, or product service system innovation to address marine litter issues.

Table E1 presents an analysis of where potential solutions may have the most influence in relation to key decision points shown in Figure E1. Solutions will have varying degrees of impact, which will also be affected by their design and implementation. Recycling would aim to reduce the cost and effort to fishers in handling waste gear. Similarly, the 100% indirect fee would mean that waste costs are covered by harbour fees paid at a flat rate irrespective of the quantity of waste delivered. Gear marking and tagging can help in tracking and recovering lost gear and inform enforcement should this be progressed. Several forms of EPR are assessed.

Table E1: Commercial fishing gear - where solutions can most influence key decision points

Life cycle stage	Key decision point	Education and engagement	Recycling	100% indirect fee	Gear marking and tagging	EPR takeback scheme	EPR advance disposal fee	EPR modulated fee	EPR deposit return scheme
Production *and* Retail & distribution	Bespoke product design and purchase	✓	✗	✗	✗	✓	✗	✓	✗
Use	Recovery effort for lost gear	✓	?	✓	✓	✓	✓	✓	✓
End of life/Recovery	Waste management of large items	✓	?	✓	✗	✓	✓	✓	✓

✓ = Yes, ✗ = No, ✓ = Yes - if solution designed with this in mind, ? = Unknown

On the basis of the research findings, the following recommendations are made for the Scottish Government and the private sector to tackle marine litter from commercial fishing gear:

1. Support education and engagement measures. Priority areas are engaging fishers on waste management options and the impacts of marine litter. Also advice on life cycle costs of more durable, repairable equipment to influence their procurement and design.
2. Evaluate feasibility and efficacy of EPR, recycling, and other waste management options
    a. Mandate reporting of products placed on market, and data on the collection and treatment of waste
    b. Understand current (baseline) waste management costs to fishers
    c. Evaluate EPR options for fishing gear
    d. Research recycling enablers and conduct cost-benefit analysis
    e. Gather industry views on 100% indirect fee, EPR and recycling measures in a combined consultation
3. Support best-practice and new technology

Recommendation 2 suggests evaluating the feasibility and effectiveness of EPR, recycling, and other waste management options as further work is needed to understand if they will be effective, how best to design to prevent marine litter and, in the case of recycling, how it will be funded.

Contents

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1 Introduction

Whilst there is significant activity on reducing marine litter in Scotland, there are some products which cause marine litter that are not fully addressed by current activities. The aim of this research study was to identify these problem products and investigate opportunities throughout the value chain to tackle marine litter issues, with Government support or interventions where necessary.

The research findings are presented in six documents: an overarching summary and discussion, a separate report for each of the marine litter product groups researched in detail, and a literature review. The list of six report documents is as follows:

1. **Summary report**
2. **Commercial fishing gear**
3. **Crisps, snack and sweet wrappers**
4. **Artificial grass pitch**
5. **Menstrual products**
6. **Literature review**

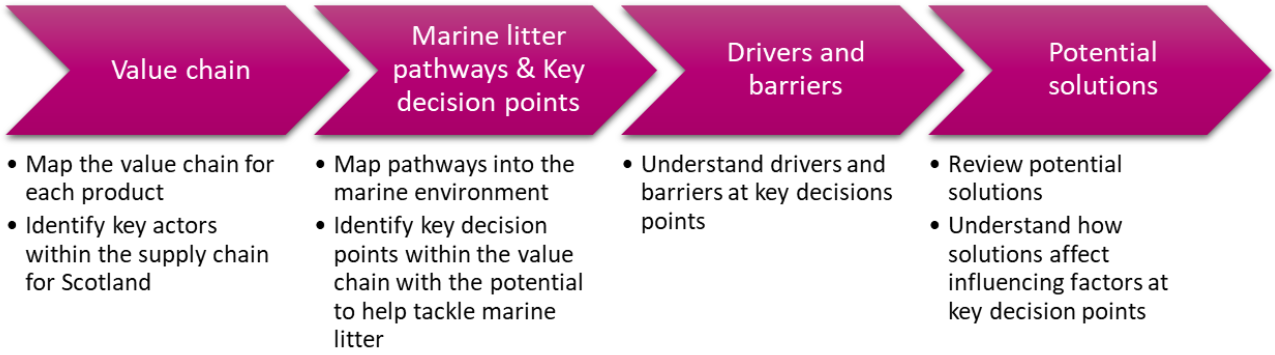
This document is the *Commercial fishing gear report* and is structured as follows:

- **Methodology** - section 2
- **Introduction to product and marine litter issue** - section 3
- **Value chain and stakeholder engagement** - section 4
- **Marine litter pathways and key decision points** - section 5
- **Drivers and barriers** - section 6
- **Potential solutions** - section 7
- **Recommendations** - section 8
- **Comparable products** - section 9

2 Methodology

Over the product life cycle, materials and products pass through multiple actors in the Scottish economy, from raw materials extraction and product manufacturing to the point when products are discarded and recycled or disposed of. The pathways a specific product takes are dictated by decisions taken by the actors in the value chain. This raises an important question: why do some products become marine litter, i.e. what decisions have been made and by whom, *throughout* the product's value chain, that result in 'leakage' into the marine environment? To answer this question, it is necessary to understand decision making in the value chain. Whilst actors may already be aware of marine litter issues and may want to address them, there may be barriers or more dominant drivers that dictate how key decisions are currently made. With an understanding of key decision points in the value chain it is possible to consider how potential solutions can affect decision making to help tackle marine litter. This is the basis of the research framework used in this study, as summarised in Figure 1. The research framework is reflected in the structure of this report and referred to throughout.

Figure 1: Outline of research framework



The framework above outlines the approach taken within the research. To gather this information to inform the study, research activities were conducted in four stages:

1. Scoping study
2. Literature review
3. Interviews and workshops
4. Public survey

Products made from bioplastics were considered out of scope in this research. Research and innovation in material science is leading to the development of many new polymers marketed as biodegradable plastics. However, there is ongoing debate over the efficacy of these polymers to biodegrade in the marine environment over short enough timescales to reduce the impacts of marine litter. This is a complicated subject worthy of a dedicated research project, and so was considered outside the scope of this study to assess. Instead, the research scope starts after polymerisation at the point in the value chain where plastic products, or semi-finished products, are manufactured.

The main product life cycle stages are used as the structure for value chain analysis, to represent and understand the sources of marine litter, marine litter pathways and key decision points within the value chain. This enables a clear and consistent structure for analysis and comparison between products that have different value chains and marine litter pathways. The stages in the product life cycle described in this research are:

- Raw materials
- Production
- Retail & distribution
- Use
- End of life/recovery

Further details on the methodology and engagement approach are given in the *Summary report* document for the study as a whole.

3 Introduction to product and marine litter issue

Fishing is an important industry in Scotland, with around 4,800 fishers employed on 2,065 active Scottish-based fishing vessels in 2017, landing 466,000 tonnes of catch worth £560 million[1]. Marine litter directly impacts upon the fishing industry when litter gets caught in propellers and nets affecting fishing operations and potentially endangering lives. Public and scientific concerns around microplastics entering the food web also risks damage to the confidence in fish products.

Many actors in the fishing industry are active in tackling marine litter. For example, KIMO's fishing for litter scheme engages fishers in bringing to shore any litter found at sea and caught in nets.[2] However, the fishing industry is also a contributor to marine litter. Statistics vary, but fishing gear is consistently one of the main categories identified in marine litter surveys. The subsequent sections analyse the issue and potential solutions, following the research framework set out in Figure 1.

4 Value chain and stakeholder engagement

The following sections discuss the value chain and the specific stakeholders engaged within this study. This relates to the starting point of the research framework, shown below.

4.1 Value chain

The value chain for commercial fishing gear starts with producers of raw materials, mostly plastics and metals. Fishing gear components, such as ropes and nets are then constructed. There is a market for selling components directly to fishers who then assemble the final fishing gear themselves, or use the components to replace or repair parts of other gear. Other fishers purchase fully assembled fishing gear directly from manufacturers and suppliers, and are often involved in the gear design and specification. At end of life the waste management activities are initiated by fishers and their agents and managed by ports and waste management companies. These actors are mapped on to the product life cycle stages in Table 1.

[1] Marine Scotland (2017), Scottish Sea Fisheries Statistics 2017, https://www.gov.scot/publications/scottish-sea-fisheries-statistics-2017/

[2] KIMO (Kommunenes Internasjonale Miljøorganisasjon). KIMO is an NGO whose mission is the development of sustainable coastal communities, and has worked extensively with fishing communities on the topic of marine litter.

Table 1: Commercial fishing gear - Mapping actors within the value chain onto life cycle stages

<table>
<tr><th>Life cycle stage</th><th colspan="2">Value chain actors</th></tr>
<tr><td>Raw materials</td><td colspan="2">Producers of plastic pellets, metals and other raw materials</td></tr>
<tr><td>Production</td><td rowspan="2">Commercial fishing gear & component manufacturers</td><td></td></tr>
<tr><td>Retail & distribution</td><td>Suppliers</td></tr>
<tr><td>Use</td><td colspan="2">Fishers & fishing industry</td></tr>
<tr><td>End of life/recovery</td><td colspan="2">Port authorities
Waste management companies</td></tr>
</table>

A list of manufacturers and suppliers relevant for Scotland is provided in Appendix A.1. This research focusses on creels and trawl nets as marine litter items, and a major supplier for each was interviewed. A creel is used to target shellfish species, and example is shown in Figure 2. Type of fishing nets commonly used in Scotland are illustrated in Figure 3.

Most creels are manufactured overseas, predominantly sourced from China due to competitive pricing, lack of UK manufacturers and high labour costs in the UK.[3] However, at least one company is manufacturing creels in Scotland, and their locally manufactured creels account for roughly half their sales despite being more expensive as customers perceive them to be better quality.[4] The most commercially active vessels typically purchase between 50 and 300 creels a year, weighing 20kg to 30kg each. Creels cost £50 to £100 new and there is an established second-hand market. Plastics used on the netting, rope, hoops and frame coating account for 30-35% of the total creel weight, the rest is steel.[5] PVC and PP are the main polymers used, chosen as strong long lasting materials. Most creels are sold assembled but some fishers prefer to assemble them themselves. A fishing industry representative indicated creels are typically deployed in strings of 10 to 30, 8 fathoms apart and last five to ten years in use.

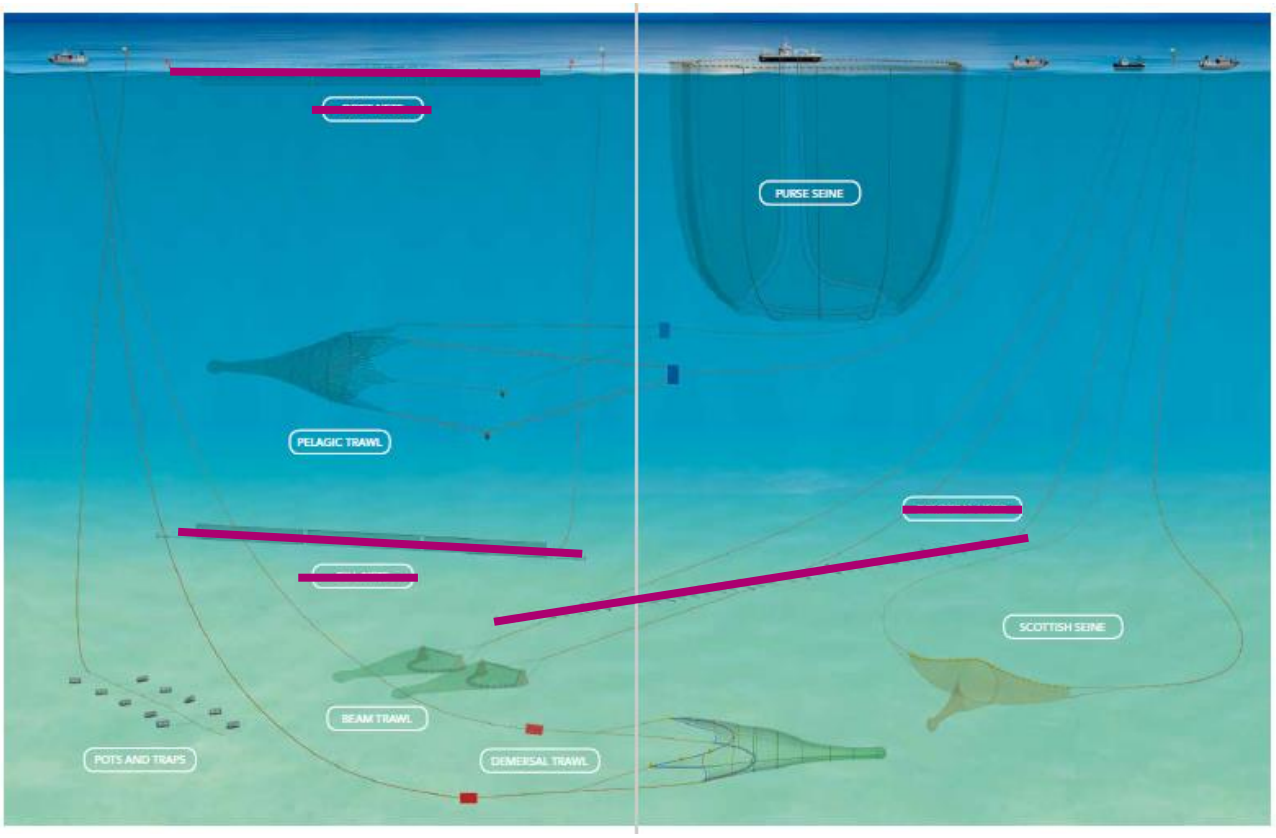
[3] Interview with Scottish creel supplier
[4] Interview with Scottish creel supplier
[5] Interview with Scottish creel supplier

Figure 2: Example of creel pot[6]

A common supply chain for nets was illustrated in interviews with one of the largest suppliers of fishing gear components, employing around 1,000 staff.[7] The supplier makes the components (netting, ropes etc). These are then typically assembled into the finished product, such as a bespoke trawl net, by other companies, and sold onto the end user (fishers). The company sells to Jacksons Trawl (Peterhead), Caley Fisheries (Peterhead), Brixham Trawl Makers (Devon), Coastal Nets (Bridport, Dorset) and others. These companies assemble the final fishing nets and sell them on. The supplier estimates that a skipper may typically invest £2,000 - £20,000 per annum on components alone, not accounting for the mark-up for assembling components into finished products.[8] Fishing nets are built for catch efficiency, strength and durability, and some can last up to two to three years heavy use.[9] On the other hand nets can be lost on their first use. Taking this into account, the manufacturer reports that on average nets last one or two years. A Cornish recycler reports that nylon monofilament nets typically last 3-6 months, but this type of net is not used in Scotland.[10] [11]

[6] Seafish (2015) Basic Fishing Methods
[7] Interview with a major supplier of fishing gear components
[8] Interview with a major supplier of fishing gear components
[9] Interview with a major supplier of fishing gear components
[10] Interview with a major supplier of fishing gear components
[11] https://fishyfilaments.com/our-filament/

Figure 3: Examples of commercial fishing gear used in Scotland[12]



Note: drift nets and monofilament gill nets are illegal in Scotland and so have been 'struck through' to remove them from the figure. There are no Scottish longline fisheries and so they have also been struck through, although some foreign fishing vessels do use longline gear in Scottish waters.

It was noted that fishing gear manufacturers and suppliers are competing in a global marketplace and any marine litter solutions must consider the global supply chain.[13] Products manufactured on a production line are often sold in multiple countries. Setting country-specific requirements will diversify the product range and possibly require new production lines increasing costs. However, solutions developed for one market could be used elsewhere to the manufacturers advantage, potentially giving them first mover advantage.

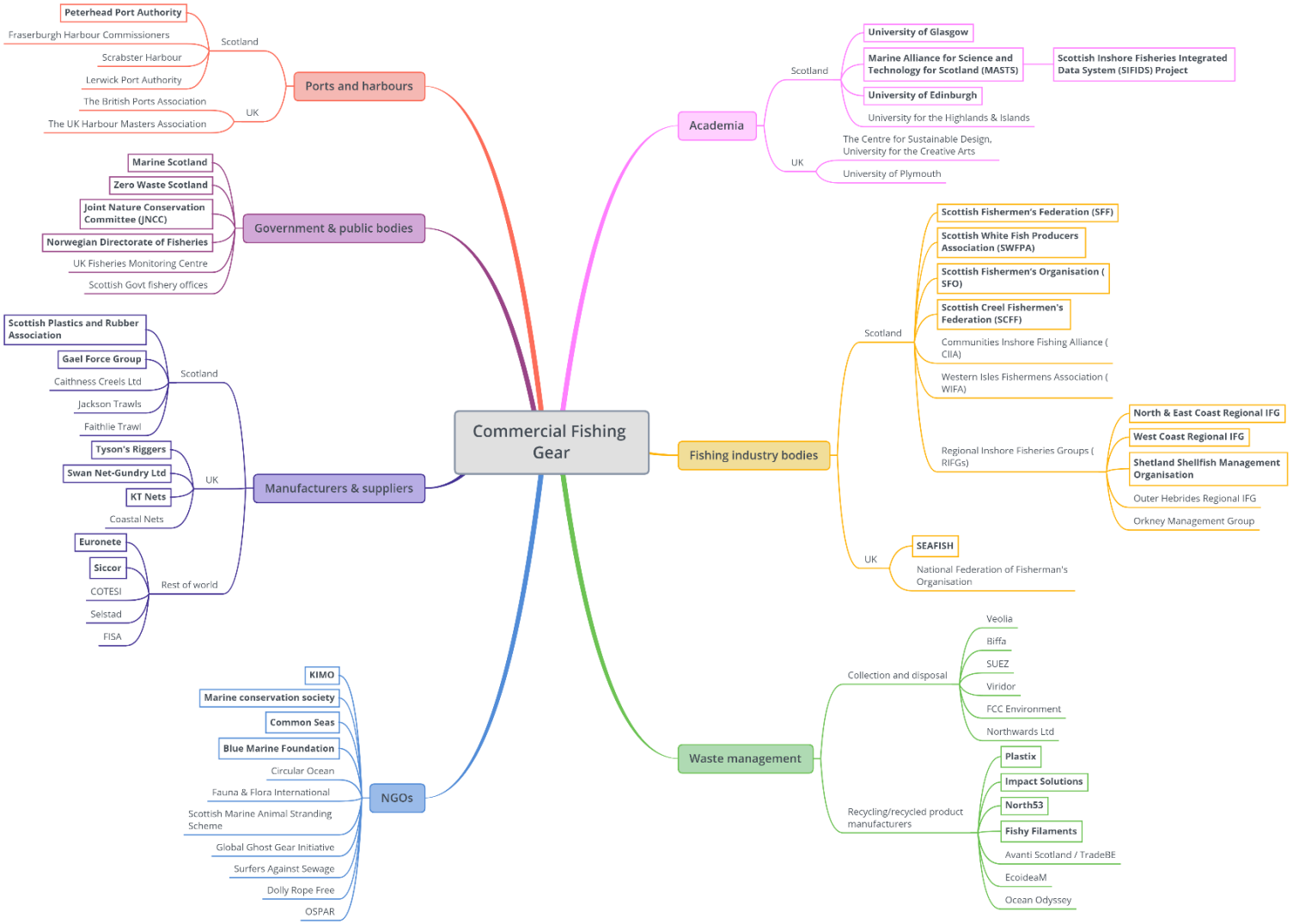
Public data was not available to estimate the quantity of fishing gear sold in Scotland and stakeholders were unable to provide an estimate. One manufacturer reported that there are around 300 producers in Europe, with roughly 50,000 tonnes of European-made fishing gear sold annually in Europe and around 15,000 tonnes imported from manufacturers outside Europe.[14] However, they were unable to estimate what proportion of this gear is used in Scotland, and previous research to determine tonnages was unsuccessful.

[12] Seafish (2015) Basic fishing methods, p. 96-97
[13] Interview with Scottish creel supplier
[14] Interview with a major supplier of fishing gear components

4.2 Stakeholder engagement

Many stakeholders outside of the value chain for commercial fishing gear are engaged or affected by fishing gear as a marine litter issue. This includes Government and public bodies, academia, NGOs, coastal communities and the wider fish product industry. A mapping of the wider stakeholder groups relevant for Scotland is shown in Figure 4.

Figure 4: Commercial fishing gear – Stakeholder mapping



Note: Organisations that engaged in the research activities are denoted with a square surrounding box and bold text

Figure 4 shows the organisations that engaged with the research activities in this study, denoted with a square surrounding box and bold text. A high level of awareness and interest in the issue was found across all stakeholder groups. Common themes raised by stakeholders focussed on waste management at end of life. Views differed amongst some stakeholders over the cause of the issue and the solutions needed, in part reflecting some of the major knowledge gaps. These themes are explored in later sections.

5 Marine litter pathways and key decision points

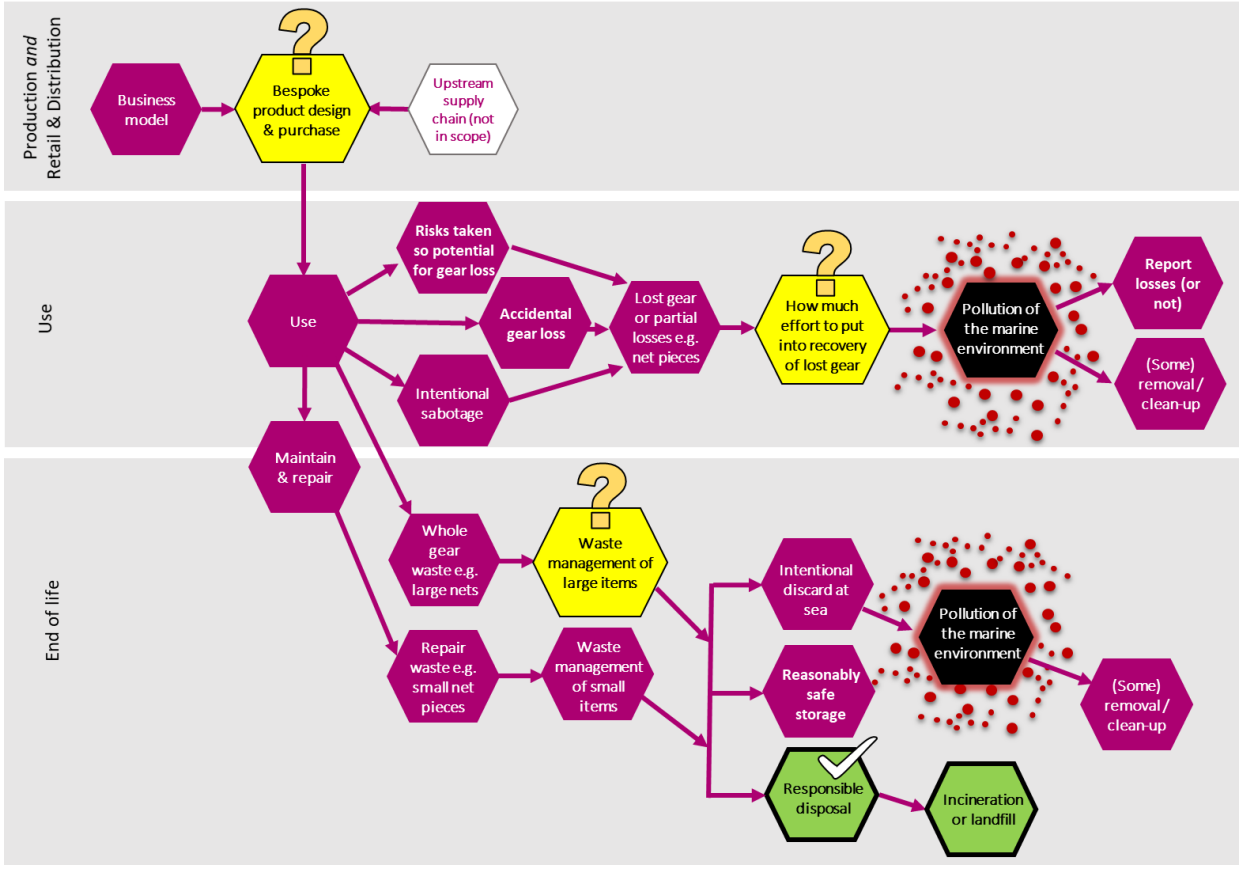
The following section discusses the marine litter pathways and key decision points, as per the second stage in the research framework, shown below.

The marine litter pathways for commercial fishing gear were investigated in the literature and stakeholder engagement. Figure 5 shows how these pathways stem from key decision points where one choice results in marine litter and another does not. For example, when whole gear reaches end of life a fisher must decide how to manage that waste. In simple terms, they can either store the waste, arrange to dispose of it responsibly or dump it at sea. Several pathways are shown in the product use phase. For example, taking risks such as trawling close to sea floor features where nets can become snagged or working in very poor weather conditions, other forms of accidental loss without risk taking, and intentional sabotage. This can lead to losses of whole gear items or partial losses such as net pieces. It is recognised that there will also be losses through deterioration, e.g. microplastic losses through abrasion from gear in use. This study focusses on macro-plastic losses, although some solutions such as improving durability will also address losses from deterioration.

Other key decision points are found further up the value chain. For example, the product design and business model of manufacturers and suppliers could help tackle marine litter. It is recognised that certain business models have the potential to help tackle marine litter. However due to the lack of relevant examples found it was not possible to explore this in detail. It will be important to consider how best to support beneficial new business models as they emerge in this context.

The drivers and barriers at key decision points are explored in the next section.

Figure 5: Commercial fishing gear - Marine litter pathways and key decision points



6 Drivers and barriers

The following section discusses the drivers and barriers at key decision points, as per the third stage in the research framework, shown below.

Stakeholder engagement highlighted three key decision points as the most important for commercial fishing gear, and are as follows:

1. Bespoke product design and purchase decision
2. Waste management of large items
3. Recovery effort for lost gear

These key decision points are discussed in the sections below, drawing upon stakeholder engagement in the workshop and interviews.

6.1 Bespoke product design and purchase decision

In this specific value chain, the fisher is typically involved in the product design when purchasing a new net to create a bespoke product that suits their needs, working closely with the manufacturer or net maker or assembling the net themselves. For example, fishers specify the target species (and therefore mesh size), overall size of net and opening, size of cod end, etc. informed by regulation on technical conservation measures designed to protect sustainable fisheries management. Creel pots are purchased whole from suppliers or assembled by fishers, but tend to be less bespoke in design. The key actors at this decision point are manufacturers, suppliers and fishers. The point of bespoke product design and purchase is illustrated in Figure 6 as an extract from the full mapping of marine litter pathways and key decision points in Section 5.

Figure 6: Decision point - bespoke product design and purchase decision

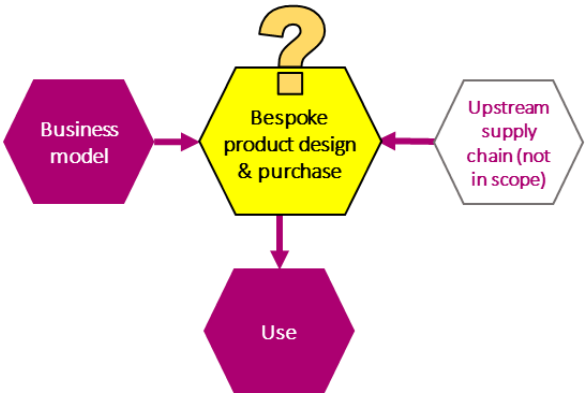
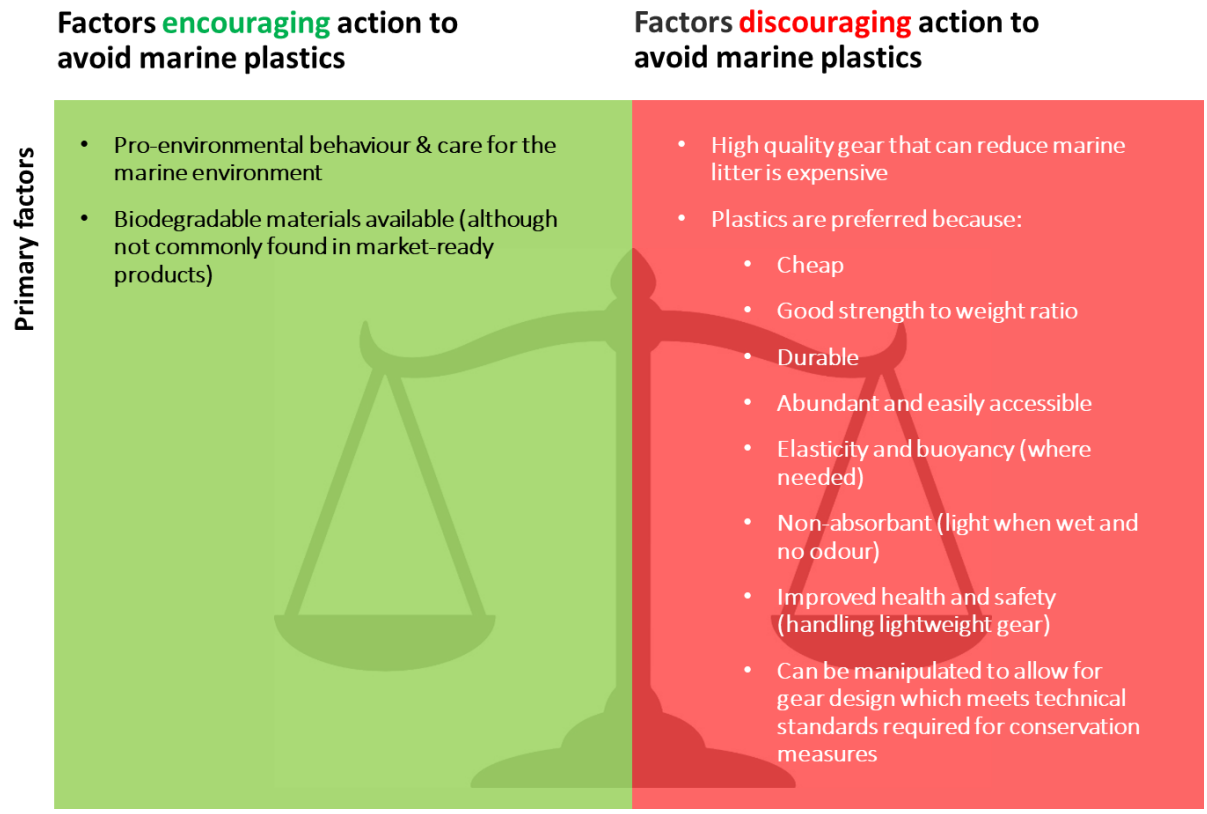


Figure 7 shows drivers and barriers identified in bespoke product design and purchase decision. The information is largely derived from stakeholder interviews.[15] Primary and secondary factors are distinguished based on an overall assessment of stakeholder engagement on the topic. On the left of the figure, the awareness of marine litter and the desire to act is represented for both manufacturers and consumers. On the right, it is acknowledged that this may make gear more expensive, and that plastics offer many practical benefits that will be difficult to match when looking for alternative materials.

[15] The topic was not discussed at the workshop as fishing gear manufacturers and suppliers were not present, although they were invited and were later consulted individually.

Figure 7: Drivers and barriers in bespoke product design and purchase decision



A small number of products that reduce the risk of marine litter are readily available on the market and in widespread use. Rock hoppers reduce the risk of trawl gear snagging on the sea floor[16], although these products can become sources of marine litter themselves. Nets and pots with biodegradable escape hatches are also readily available, in which a small area of the gear will eventually biodegrade and create an opening so that trapped animals can escape from lost gear, although timescales of biodegradability are important.

Systems thinking

In most cases, manufacturers and net makers are not currently connected or responsible for end of life impacts. Some companies do organise recycling for high value pelagic nylon nets but these appear to be the exception, and other products and polymers are the responsibility of the waste producer (the fisher). There is an opportunity for systems thinking – not just upstream and consumer experience, but designs for safe and resource efficient downstream end of life or recovery options. However, this would require much greater stakeholder communication and collaboration across the value chain, or policy interventions for shared responsibility at end of life.

Durability

The overall quality of the gear was cited as a factor in marine litter. Using better quality gear increases performance and reduces storm damage and breakages.[17] High-end gear is expensive but well-designed, durable, less likely to be lost or damaged, and because it is often more repairable it

[16] https://seafish.org/gear/gear/profile/demersal-trawl-rockhopper-trawl
[17] Interview with a major supplier of fishing gear components

less likely to be abandoned.[18] Using new engineering polymers is one way to increase strength and durability, and subsequently incentivise recycling as the polymer is more valuable.[19] Minimum product standards are set, for example in ISO 1805 and ISO 1806 (fishing net determination of break force), ISO 16663 (mesh dimensions), EU REACH[20] regulations. One manufacturer commented that cheap gear often does not meet these standards, particularly imports from outside the EU, although the particular example given was for gill nets which are not used in Scotland.[21] It is clearly important that standards are applied to all gear, whether produced inside or outside the EU, to avoid a market distortion for manufacturers bearing the cost of complying with the standards.

Material choice

The choice of material in fishing gear is important. The products are technical in design and the fishing industry reported that the gear needs cleaning and careful handling to ensure that it retains optimal performance. Plastics are generally preferred for their strength to weight ratio, and properties that can be controlled through polymer choice and use of additives such as resistance to abrasion, buoyancy, and the ability to stretch and absorb shocks.[22]

Netting is typically made of polyethylene (PE) or nylon (polyamide, PA). Nylon is used for pelagic trawl nets, which targets fish in the mid water column and surface water.[23] It is chosen for its elasticity, which is important as pelagic nets are not towed in a straight line and need to manoeuvre, turn and recover, and because nylon sinks which helps keep the net open. Polyethylene is typically used for bottom trawling. The material floats and does not give much stretch, properties which help keep the net open and remain taught[24]. Polyethylene is stronger than nylon and is therefore preferred for bottom trawling nets because it is better able to resist snagging and physical knocks sustained from being dragged along the seabed. A manufacturer reported that nylon would not be appropriate for bottom trawl nets as nylon shrinks when dry and this property could risk illegally small mesh size at times. Polypropylene (PP) and high-density polyethylene (HDPE) are also used in some gear, and new polymers such as ultra-high molecular weight polyethylene (UHMwPE) are starting to be adopted.

Natural fibres are rare and less durable than plastic polymers.[25] For example, a 5mm diameter plastic cable is comparable to a 20mm diameter cable of natural material in strength and reliability.[26] This is important when considering the difficulty and health and safety implications of handling much heavier gear, and the storage space requirements for bulkier products. Furthermore, natural fibres are likely to need coating to stop them rotting, and can lose strength in use. [27]

[18] Interview with a major supplier of fishing gear components
[19] Interview with DSM, manufacturer. Dyneema fiber is reported to be 15 times stronger than steel on a weight-for-weight basis, https://www.dsm.com/corporate/about/business-entities/dsm-dyneema.html
[20] EU regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals
[21] Interview with a major supplier of fishing gear components
[22] Interview with a major supplier of fishing gear components
[23] Interview with a major supplier of fishing gear components
[24] Personal communication with fishing gear manufacturer
[25] Interview with a major supplier of fishing gear components
[26] Interview with a major supplier of fishing gear components
[27] Interview with a major supplier of fishing gear components

Biodegradable plastics

There is ongoing debate around whether material science can be used to tackle the issue and there have been trials of biodegradable gear.[28] [29] The design challenge is a difficult one: design a material that is strong and durable, resistant to microbial attack, and resistant to degradation from sun, wind and sea while in use, but that will fully biodegrade in a short time period if lost and leave no harmful residue.

Product design and material choice can play a part and manufacturers reported ongoing research and development in this area.[30] Research includes biodegradable and bio-based polymers polybutylene succinate (PBS), which has similar properties to polypropylene (PP), and polyhydroxyalkanoates (PHA), which is produced in nature by numerous microorganisms. One manufacturer commented that use of biodegradable materials is three to five years away from a marketable product.

Fishing nets and creel pots are particularly harmful as they are designed to entangle and trap marine life when in use and continue to do so when they become litter. Timescales are especially critical for fishing net as lost nets are most effective at trapping animals when still 'open', i.e. similar in shape and arrangement as when the net is in use, but the weight of trapped animals then collapses the net and the entanglement rate drops.[31] [32] Biodegradable materials are unlikely to act in this crucial window when the lost net is still open, suggesting that other solutions are needed.

6.2 Waste management of large items

When a large piece of fishing gear reaches end of life the fisher must decide how to manage that waste. The decision making, and the pressures on the fisher, are thought to be quite different when handling large items of waste as opposed to, for example, small pieces of repair waste. Large items of fishing gear are either stored at harbours, intentionally discarded at sea (resulting in marine litter) or undergo collection and responsible waste management, typically landfill or incineration. The key actors at this decision point are fishers, their agents, ports and waste management companies. Waste management and end of life impacts are not currently high priority in product design but this will change in the future, particularly through some of the EPR measures discussed in section 7, in which case manufacturers would become an important actor too. This decision point is illustrated in Figure 8, as an extract from the full mapping of marine litter pathways and key decision points in Section 5.

[28] Norwegian Directorate of Fisheries is engaged in long-term R&D with fishing gear manufacturers and academic institutes.
[29] https://www.lifegate.com/people/news/biodegradable-nets-tackling-ghost-fishing
[30] Interview with a major supplier of fishing gear components
[31] http://www.fao.org/3/i0620e/i0620e03.pdf
[32] https://ieep.eu/uploads/articles/attachments/4a24b509-013d-44ca-b26e-47c8f52e29c4/ghostfishing.pdf?v=63664509699

Figure 8: Decision point - waste management of large items

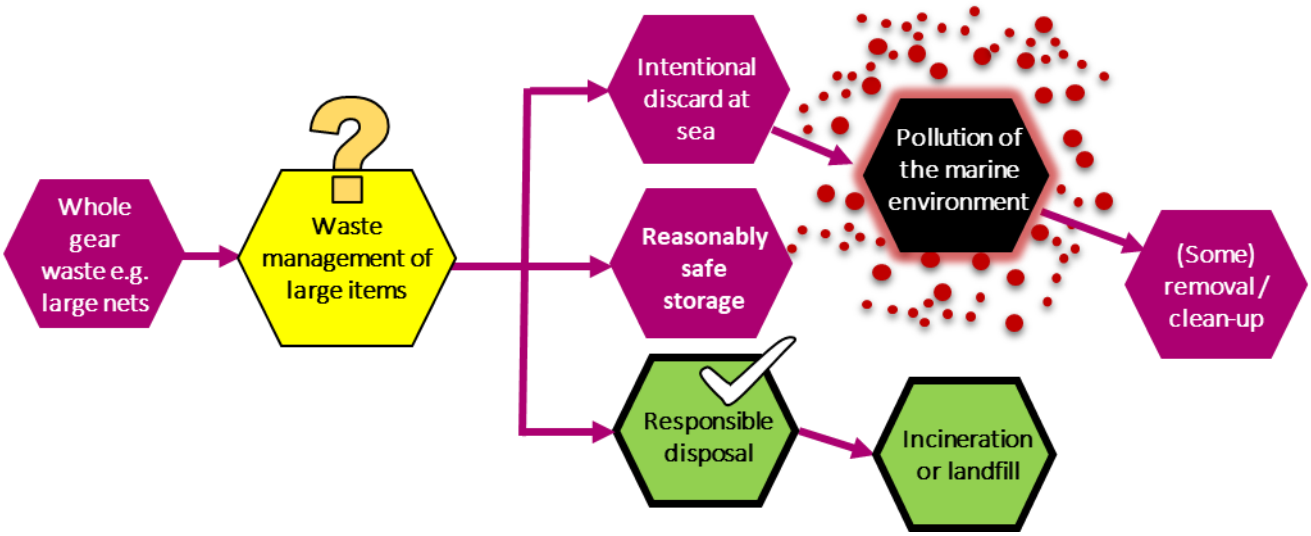
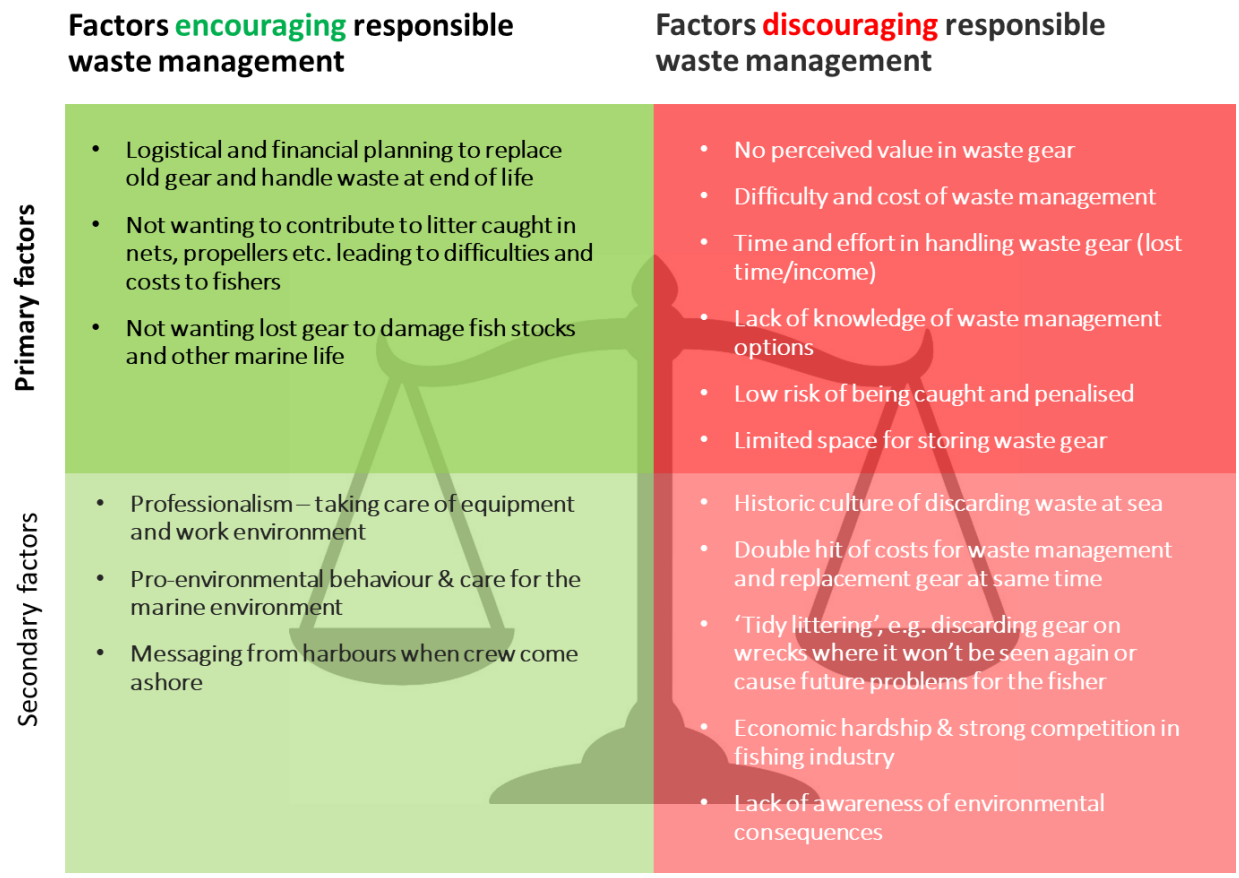


Figure 9 presents drivers and barriers for waste management of large items, as raised by stakeholders in the workshop and interviews. Primary and secondary factors are distinguished based on an overall assessment of stakeholder engagement on the topic. However, it is extremely difficult to find a fisher who freely admits to dumping waste at sea. The drivers and barriers presented here are the opinions of the stakeholders engaged in the research, rather than primary data collected from fishers dumping waste at sea. However, these stakeholders are well-informed on the issue and the pressures on fishers, which adds weight to the opinions expressed.

Figure 9: Drivers and barriers in waste management of large items



Differing views amongst stakeholders

Intentionally discarding, or dumping, fishing gear into the ocean is commonly discussed in the literature as a source of marine litter. However, some stakeholders dispute whether fishers in the Scottish fishing industry are intentionally discarding waste gear into the ocean. Representatives of fishing industry bodies argue that no Scottish fisher would intentionally dump waste where it can later cause problems for themselves and other fishers, entangling their nets, propellers and other gear if at all avoidable. Furthermore, they would not cause harm to the environment which they respect and supports their livelihood. This view was also supported by a representative of an NGO who has worked closely with the fishing industry. Some argued that it is not Scottish fishers but foreign fleets that are causing the problem in Scottish waters. Unfortunately, no data or studies were found that could clarify this key point with empirical evidence. On the weight of other stakeholder opinion this has been identified as a key point for the research, but also one that has the greatest uncertainty.

Key drivers – time and cost to fishers

Representatives from NGOs, government departments, ports and other groups highlighted the considerable cost and difficulty in handling waste gear as a factor that might lead to dumping waste at sea, with the exception of nylon nets that retain sufficient material value to incentivise recycling and can be sent abroad for processing. The nets have no perceived value at end of life and are costly to manage as waste. There are currently no recycling facilities for waste nets in Scotland and typically the only viable waste destination is landfill. Even so, landfill operators are reportedly not keen to accept nets as they get caught in the machinery used to move and compact the landfill waste. [33] This is cited as a significant disincentive to manage waste responsibly and a dominant driver in marine litter. Furthermore, limited information on waste management options was highlighted as a barrier at workshop. A representative of the creel fishing industry reported a market for waste creels with local individuals who take the waste for free and sell to a scrap merchant. Where this exists it would remove the waste management cost to fishers but raises concern around the fate of materials in a creel that are less valuable, such as plastic netting and hoops.

A key knowledge gap needs to be addressed in understanding the cost of managing different types of waste gear in more detail: which actors bear the direct costs of waste management and indirect costs such as time spent handling the waste and arranging for storage, collection and treatment. Many of the solutions proposed aim to address this point and so it is of utmost importance to gain better understanding of the current situation. It is recommended this research be undertaken by engaging ports, harbours, fishing vessels and their agents.

Other drivers

Other drivers and barriers were discussed. A ‘double hit’ of costs in a short period of time, purchasing new gear and waste management of old gear, could put financial strain on fishers and influence decision making for the worse. However, fishing industry representatives pointed out that fishers know when they’re going to buy new gear and plan accordingly to manage finance and also logistics for managing the old gear.

[33] Comments provided by two recycling industry stakeholders

Anecdotally, stakeholders reported that a great quantity of old nets are stored in ports and harbours. Stakeholders did not consider this a marine litter risk, and reported that they were typically safely stored in containers. It is not clear whether the cost of waste management is a contributing factor to storing old nets rather than sending for treatment. The limitation of available space at ports and harbours, particularly if already full of old nets, was raised in the workshop as a factor in the decision to discard nets at sea.

The low risk of being caught and penalised does not help. Fishers can easily avoid observation if they wish to discard of waste gear, and it is practically impossible to trace litter back to a vessel and prove it was intentionally discarded. There was even an anecdote of 'tidy littering', dumping nets on a wreck where they would be 'out of the way' and not cause problems for fishers.

However, professionalism was raised by representatives of the fishing industry. This included taking care of equipment and work environment, taking pride in the work, wanting to set a good example to others, and supporting a good industry reputation. Pro-environmental behaviour was often discussed, in reference to the Blue Planet II 'Attenborough' effect, and the need to preserve the natural environment for future generations (i.e. bequest value). Younger generations of fishers were highlighted as particularly conscientious and environmentally aware, and a potential driver of behaviour change.

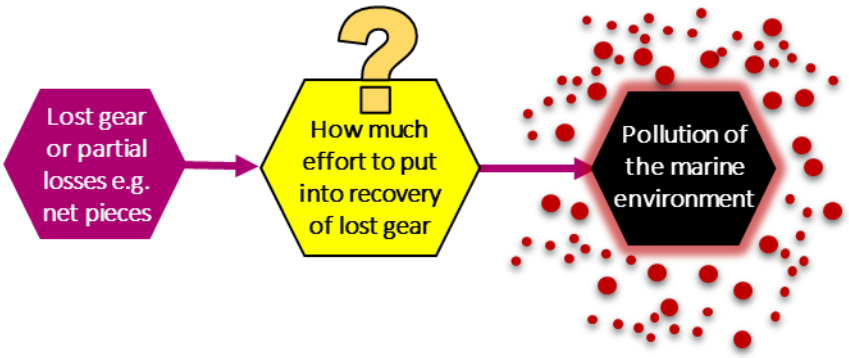
Many stakeholders recognised the historic culture of discarding waste at sea but commented that it has improved significantly. The literature review identified economic hardship in some fishing communities, which can exacerbate other economic drivers.[34] A lack of awareness of environmental consequences will also be a limiting factor for some fishers.

6.3 Recovery effort for lost gear

Fishing gear is accidentally lost for a wide range of reasons. For example, static gear can be moved by bad weather or other vessels, and fishers sometimes cut gear free if snagged on sea floor features or bad weather makes conditions dangerous. When fishing gear is lost the fisher must decide how much effort to put into attempting to recover it, a commercial time cost-benefit decision complicated by the risk of health and safety to crew as well as potentially not recovering fishing gear even if attempts are made. Currently fishers are the main actor involved in this decision point, although there is scope to involve other organisations, such as Government. This decision point is illustrated in Figure 10, as an extract from the full mapping of marine litter pathways and key decision points in Section 5.

[34] Fishers experience considerable financial pressure due to the unpredictable nature of their earnings and 61% of port neighbourhoods are classed as deprived, as measured by the Index of Multiple Deprivation. Seafarers UK (2018) 'Fishing for a Future', p. 1 https://www.seafarers.uk/wp-content/uploads/2018/01/Fishing-for-a-Future.pdf

Figure 10: Decision point - recovery effort for lost gear



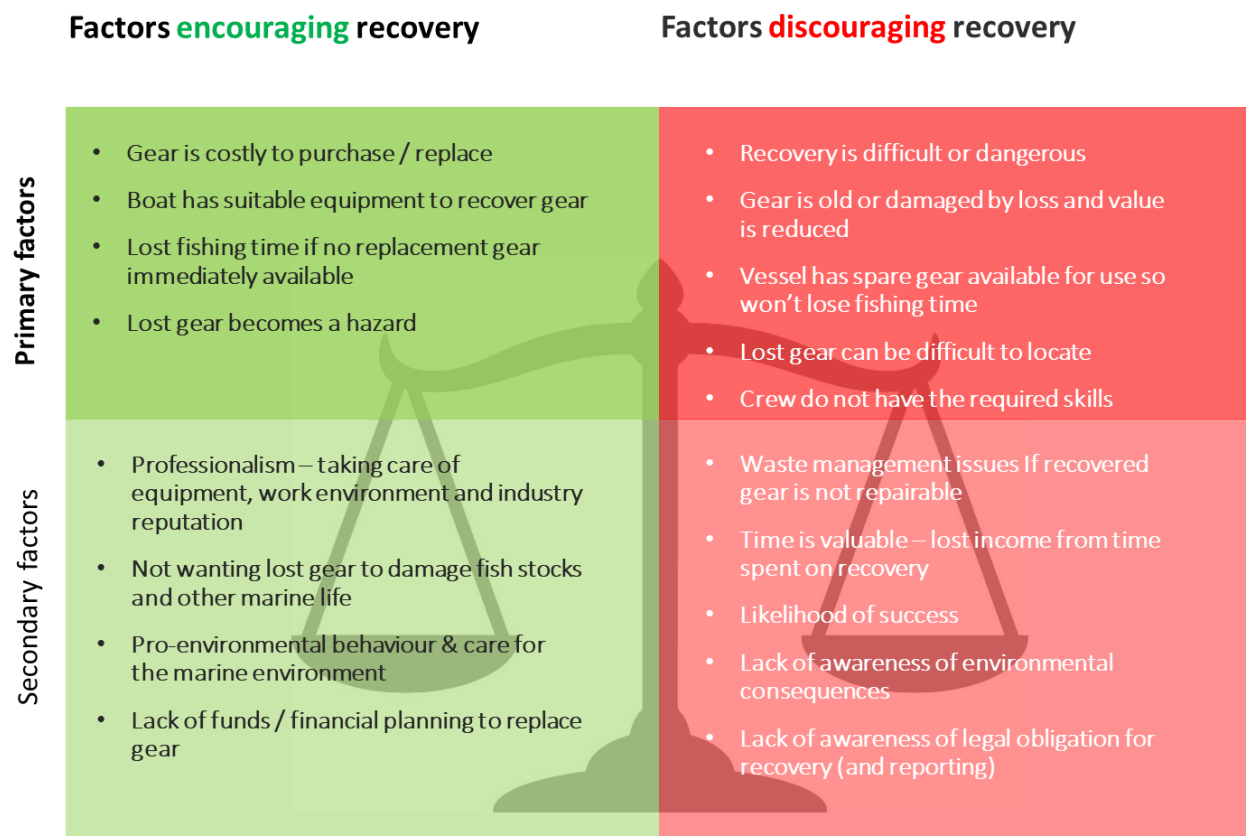
Bad weather is typically cited as the main cause of accidental gear loss. [35] Static gear such as creel pots can be moved by bad weather and become lost or entangled in other gear and sea floor features. Static gear can also be accidentally caught and moved by other vessels, e.g. by trawl gear or boat propellers. Trawl gear may need to be cut loose from a vessel in bad weather if the conditions are considered dangerous to the vessel and its crew.

Workshop participants highlighted that a lack in information and communication can also contribute to accidental losses. Fleets may not know the location of static gear when communication is ad hoc and gear is not clearly marked.

Once gear is accidentally lost the skipper must decide how much effort to put into recovery. The drivers and barriers at this decision point are outlined in Figure 11, informed by the commercial fishing gear workshop and stakeholder interviews. Primary and secondary factors (drivers and barriers) are distinguished based on an overall assessment of stakeholder engagement on the topic.

[35] A view also given by stakeholders in the commercial fishing gear workshop.

Figure 11: Drivers and barriers in recovery effort for lost gear



Workshop participants highlighted that creel pots and fishing nets are valuable items, and a fisher will be highly incentivised to retrieve this gear when lost. An essential enabling condition is having suitable equipment to recover the gear, which stakeholder interviews indicated was true of most vessels. Time was also highlighted as a valuable resource, particularly if it results in a loss of income and so could motivate recovery if no replacement gear is readily available and fishing time is lost. Fishers are further motivated to recover items by a "moral duty of care" both for the environment and the profession. The requirement to attempt recovery and report losses was also recognised.[36] A lack of funds to replace the lost gear could make recovery all the more important.

However, the fisher must make a cost-benefit analysis of the amount of time and resources to invest in recovery efforts weighed against the likelihood of success and the value of the recovered gear (which may be old or damaged). Risk management and health and safety must be considered when recovery is difficult or dangerous, e.g. dealing with snagged or broken gear. In addition, the fisher may be able to continue fishing if the lost gear is only a section of the net or a spare is available in the vessel or close by on shore, as is often the case. Time spent on recovering gear has an opportunity cost of not spending that time fishing and gaining revenue. Stakeholder interviews revealed it can be difficult to locate lost gear.[37] Furthermore, if the recovered gear is not repairable then it will carry all the waste management issues discussed above, which would further discourage recovery. A lack of awareness around environmental consequences and legal obligations of lost gear was also raised as a discouraging factor.

[36] MARPOL Annex V and Common Fisheries Policy
[37] Particularly raised by creel fishers and specialist waste management sectors

7 Potential solutions

The following sections discuss the potential solutions, the final stage in the research framework, shown below.

At the workshop, stakeholders from across the value chain discussed future action. Participants emphasised that all actors have a stake in this issue and must be involved if solutions are to be successful. In particular, they highlighted that pilot programmes, education and collaboration are needed, sought leadership, especially from Government, and thought legislation could be necessary.

Each potential solution is evaluated below in terms of how it would help tackle marine litter and how it addresses specific drivers and barriers identified in section 6. Table 2 presents a summary of the likely influence solutions can exert on key decision points. The scale of the impact of each solution will depend largely on its design and implementation.

Table 2: Commercial fishing gear - where solutions can most influence key decision points

Life cycle stage	Key decision point	Education and engagement	Recycling	100% indirect fee	Gear marking and tagging	Takeback scheme	Advance disposal fee	Modulated fee	Deposit return scheme
Production *and* Retail & distribution	Bespoke product design and purchase	✔	✘	✘	✘	✔	✘	✔	✘
Use	Recovery effort for lost gear	✔	?	✔	✔	✓	✓	✓	✔
End of life/Recovery	Waste management of large items	✔	?	✔	✘	✔	✔	✔	✔

✔ = Yes, ✘ = No, ✓ = Yes - if solution designed with this in mind, ? = Unknown

7.1 Education and engagement

The International Maritime Organisation's (IMO) MARPOL Annex V prohibits the discharge of all types of rubbish (including commercial fishing gear and synthetic ropes) into the sea from ships. More than 150 countries have signed up to the convention and ships (12 metres or more in length) are required to display placards which notify the crew and passengers of the discharge requirements and, amongst other things, carry a waste management plan. In 2018, the IMO adopted an Action Plan to address marine plastic litter from ships. These and other developments have helped raise the profile of marine waste among the fishing community. However, offshore, out of sight of others and in many cases beyond the reach of coastguard and law enforcement agencies, regulatory enforcement is not a straight-forward matter, and if marine litter is to be minimised, fishermen's altruism and sense of social responsibility may be a more valuable resource than a rulebook full of regulations.

There is already significant awareness of marine waste among fishermen. Mouat et al, in a 2010 study[38], estimated that on average marine litter costs each Scottish fishing vessel between €17,000 and €19,000 per year, two-thirds of which was incurred through time lost clearing litter from nets. Aggregated, the authors found this would have been enough to knock 5% off the fleets' total annual revenue. Cognisant of these costs, each vessel carries a net store and over 200 Scottish vessels are now engaged in the KIMO administered 'Fishing for Litter' scheme, by which any items of waste caught in fishermen's nets are brought up on deck and voluntarily stored in a special container on board before being brought back to harbour and discarded via a dedicated 'Fishing for Litter' skip. Another initiative, the Responsible Fishing Scheme (RFS), is an independently audited scheme operated by Seafish, intended to demonstrate that a vessel and its skipper are implementing best practice in five core areas, including Care of the Catch and Care for the Environment, which specifically address the sound management of litter and recovery of lost fishing gear[39]. Stakeholders spoke positively about these initiatives, in particular the 'Fishing for Litter' scheme which was mentioned by several consultees. One person, indicating the scale of the marine waste problem (and its inconvenience to the industry itself), reported a fisherman had told him the most unusual (and largest) item he had 'caught' was a helipad. This had been too heavy to bring on board and the crew had no choice other than to cut their nets – resulting in losses of tens of thousands of Euros in catch and equipment. Figure 12 below, courtesy of the Scottish White Fish Producers Association, shows two fishermen with some waste fishing gear they found in the sea and brought back to harbour.

As the economic impact of marine litter has become more prominent within the sector, fishermen have voluntarily changed their behaviour. A commentator working in the static sector believed that most creels, when they are fished up, are generally kicked back into the sea, as lost creels were very seldom recovered. More commonly heard was the view that fishermen used to dump waste at sea but now, more often than not, they bring it back. A third stakeholder, from the mobile fleet, told us that increasingly in recent years, fishermen understand the nature of the social contract which binds them. A fourth, from a recycling business, reported his belief that though fishermen are often blamed for marine waste, he did not believe they were responsible for it – and certainly not the current generation. He pointed out that younger

[38] Mouat et al, The Economic Impact of Marine Litter, www.kimointernational.org/wp/wp-content/uploads/2017/09/KIMO_Economic-Impacts-of-Marine-Litter.pdf

[39] https://www.seafish.org/article/what-is-rfs

fishermen in particular have a strong awareness of what is happening in the environment, and also, as waste has built up over the years, it presents a greater threat to their livelihood as old gear is increasingly trawled up in nets. It is clear that the fishing industry, whilst being a source of marine litter, is also a victim.

Despite the advances in understanding of issues related to marine litter – and the fact that (as one observer noted) 'everyone is keen on recycling and doing the right thing', there remains scope for education and engagement, to ensure that all of those engaged in commercial fishing understand the implications of careless disposal. Several stakeholders mentioned the need for increased education, training and engagement, and it could be this policy tool which could help a busy trawlerman (who may be operating at night, in poor lighting and in storm conditions) resist the temptation to kick a broken float overboard, or throw overboard some waste found in the net, and instead put it in an equipment store for safe carriage back to harbour for disposal.

Education and training, ideally face to face and perhaps funded by government, or alternatively through revenues from a future EPR scheme, should be delivered to fishers, manufacturers, co-operatives, and net-makers in order to communicate best practice approaches to minimising both accidental and deliberate losses. Likely venues would be at fishing harbours, and/or in net-maker's premises (themselves often a hub of commercial fishing activity). The impacts of plastics in the ocean should be emphasised and during the sessions, aimed at raising the profile of marine litter and promulgating best practice, stakeholders would be encouraged to take responsibility for the industry's waste and do whatever they could to reduce the prevalence of litter – including commercial fishing gear.

Figure 12: Recovered Fishing Gear

Fishing gear recovered to the west of Scotland, caught by a vessel called Audacious and landed into Kinlochbervie

Such an education programme, together with an appropriate incentivisation scheme (see section 7.2.2), could form a 'two–pronged' process for helping to motivate fishermen to bring their waste back to shore. Topics could be strategic or generalist, and/or fishery or area specific (creelers face different challenges to

the mobile fleet[40]). One government representative told us that he believed some harbours provide waste skips and containers but the location of which is not widely known by fishermen. Since having a clear channel of disposal (preferably free of additional charge) is critical in motivating fishermen to bring waste back to harbour, educating stakeholders in matters as simple as this could pay good dividends. This example could guide fishermen in waste management of large items (see figure in section 5), however the aspect of education and training arguably extends to broader decision points – including product design; influencing purchasing decisions; implementing best practice in fishing (e.g. fishing carefully and in good conditions to avoid risk of loss); reporting of losses and recovery effort.

Table 3 summarises the text above, highlighting the effect that education and engagement may have on key decision points to help tackle marine litter and drivers and barriers from Section 6.

Table 3: Desired effect of education and engagement on key decision points

Key decision point	Driver/barrier	Effect of solution
All	Pro-environmental behaviour and care for the marine environment	Amplify and spread pro-environmental behaviour
Bespoke product design and purchase decision	High quality gear that can reduce marine litter impacts is expensive	Promote benefits and value for money of investing in high quality gear
Recovery effort for lost gear *and* Waste management of large items	Lack of knowledge of waste management options	Educate and inform on waste management and consequences of dumping waste at sea
	Lack of awareness of environmental consequences	
Recovery effort for lost gear	Lost gear becomes a hazard	Educate on the direct risks and costs of marine litter to vessels and crew
	Crew do not have the required skills	Support training to recover lost gear safely and efficiently
	Lack of awareness of legal obligation for recovery (and reporting)	Educate and inform on legal obligations
	Boat has suitable equipment to recover gear	Promote best practice
	Professionalism – taking care of equipment, work environment and industry reputation	Recognise and support professional conduct and pride

[40] One commentator told us there are EU/FAO guidelines indicating how fleets of creels should be marked (e.g. with different coloured buoys at either end), the objective of this is to reduce losses by signalling to other fishermen that these grounds are being actively fished. However the approach is seldom used and may be little known, as a result of which its effectiveness is reduced. Another respondent, who worked for a large net manufacturer, noted that fishermen should be educated about the advantages of using better quality trawling gear – which is harder to lose, more likely to be tagged, increases the value and quality of the catch (by reducing by-catch through mesh design improvements) and because of its higher cost and increased repair feasibility, is less likely to be abandoned.

Key decision point	Driver/barrier	Effect of solution
	Logistical and financial planning to replace old gear and handle waste at end of life	Encourage and promote best practice
Waste management of large items	Not wanting lost gear to damage fish stocks and other marine life	Educate on financial, economic and environmental impacts
	Not wanting to contribute to litter caught in nets, propellers etc. leading to difficulties and costs to fishers	
	Messaging from harbours when crew come ashore	Supporting and reinforcing messaging from harbours
	Wanting to set a good example	Encourage fishers' role as best practice exemplars, mentors to others and stewards of the sea
	Bequest value – the satisfaction of preserving the natural environment for the next generation	Encourage fishers' role as best practice exemplars, mentors to others and stewards of the sea
	Historic culture of discarding waste at sea	

7.2 Waste management

Waste management of fishing gear was one of the most common topics raised by stakeholders. The issues relating to waste management are discussed in section 6, which focus around the financial and time cost and difficulty, particularly handling large nets, and a lack of information on waste management options.

Two solutions are presented below that address these issues: recycling waste fishing gear and a 100% indirect fee for waste management (i.e. fishers pay a fixed and indirect fee irrespective of whether they deliver many tonnes of waste or nothing at all).

7.2.1 Recycling

The need for fishing gear recycling was raised by many stakeholders, typically within the fishing industry, Government and public bodies. Disposal through landfill or incineration is not ideal in terms of carbon impacts and resource efficiency, and the high cost can act as a barrier for fishers. Recycling schemes are available in Iceland and Denmark[41] [42], but transportation costs are often prohibitive and can be seen as a missed opportunity, as one stakeholder phrased it "we need to keep the material in Scotland".

Recycling of nylon pelagic nets is commonplace and profitable, or at least cost neutral, and subsequently none are intentionally discarded at sea. This supports the idea that the cost of waste management is a primary driver in marine litter and, understandably, stakeholders would like to see a similar value given to

[41] Interview with recycling company
[42] http://plastixglobal.com/about/what-we-do/

other types of waste gear to incentivise recycling and keep it out of the oceans. There are examples of such recycling schemes, Plastix in Denmark recycles polypropylene and HDPE from fishing gear, and recycled products, such as the Euronete 'Pic Net' table.[43] [44]

However, recycling waste gear is not necessarily straight forward. The waste would need to be stored until a sufficient quantity warranted onward transport, and storage space at ports and harbours was raised as an issue by many stakeholders. Even if the gear is well cared for, it will likely have biofouling that needs to be cleaned off. One recycling expert said the energy costs of washing nets was prohibitive in the UK at around £280 per tonne in their experience, which is considerably more expensive than landfill at the current rate of around £110 per tonne[45]. Nets and creels are constructed of multiple components and materials, which need to be separated, and potentially use a mixture of polymers that must be identified and sorted. Nets in particular, being large and bulky, require time and space to disassemble and process. Not all of the components will be recyclable and inevitably some waste will still require disposal in landfill or incineration.

The nylon-6 used in pelagic nets is a valuable material, and the sale of the recyclate covers the cost of waste storage, transport, and processing. One net manufacturer reported that nylon degrades more slowly in UV light than other polymers commonly used, polypropylene the quickest, and so the nylon is likely to be in better condition at end of life.

Attempts have been made in the past to introduce wider recycling but have not proven to be economically viable[46]. One recycler ran a trial in Scotland but found that the costs were considerably higher than landfill. Another recycling expert, having investigated net recycling in Scotland, commented that it will be impossible to create a recycling system with gate fees under £100 per tonne, and so recycling will struggle to compete with landfill on pure economic terms.

In February 2019, The British Irish Council pledged to develop a solution for recycling fishing gear[47]. This work will need to address the economic viability of such treatment, and to influence littering behaviour should seek to remove or significantly reduce waste management costs for fishers.

Economies of scale could help reduce costs and manufacturers could improve product design for recyclability, whether voluntarily or incentivised through EPR as discussed in section 7.4 below. Material choice is important, and whilst nylon is inappropriate for many applications, the industry is researching different materials. Interestingly, adopting biodegradable polymers may increase costs, depending on the polymer used, if specialist recycling facilities are required or process outputs are less valuable. Alternatively, new technology may help recycle existing materials. Chemical feedstock recycling can treat traditional polymers used in fishing gear to produce oil products such as bitumen that can be used for fuel or to create new plastics. Project Beacon presents one such opportunity in Scotland – the world-leading project supported by Zero Waste Scotland co-locating different recycling technologies in one site, processing waste in order of suitability and cost-efficiency of technology including chemical recycling.[48] Fishy Filaments is a Cornwall-based firm that recycles nylon-6 nets to produce 3D printing filaments, and in

[43] http://plastixglobal.com/about/what-we-do/
[44] https://www.lankhorst-recycling.com/en/recycled-plastic-picnic-tables
[45] Accessed September 2019, https://www.letsrecycle.com/prices/efw-landfill-rdf-2/
[46] Interview with recycling company
[47] https://merrionstreet.ie/en/News-Room/Releases/Minister_Murphy_attends_British_Irish_Council_Symposium_on_Marine_Litter.html
[48] https://www.zerowastescotland.org.uk/case-study/project-beacon

interview suggested that local small-scale processing is the key to recycling all types of plastic gear, removing the costs of storage and long distance haulage, and potentially producing valuable goods that can be used by the fishers themselves or sold locally.

Other measures that may improve the homogeneity, provenance, and cost-efficiency of recycling operations include labelling and sorting, gear tracking / product passports, localised dismantling, shredding and sorting, and transport efficiency savings from dedicated storage, waste aggregation and reverse logistics.

It may be some time before these ideas come to fruition and sufficiently alter the economics of fishing gear recycling to make it financially sustainable. If widespread recycling capability is required in the short term then it is important to consider the financing options and who ultimately will pay for it, as it is highly unlikely fishers will change practices unless it is the more attractive option. Whilst Government could choose to subsidise recycling, this would not be financially sustainable and it would not be in keeping with the polluter pays principle unless the costs were somehow levied from the waste producers. Viable mechanisms to do so via EPR are discussed in section 7.4. If subsidised, there would need to be controls to prevent fishers from other countries abusing the system.

However, the impetus to recycle fishing gear must be carefully assessed. If recycling needs to be subsidised, is this the best use of the money and resources? Other solutions are arguably more effective at addressing waste management costs and other drivers and barriers leading to marine litter as discussed below, and there are other waste streams where investment could increase recycling and produce higher quality material more efficiently.

Landfill bans have been used for specific materials to increase recycling. However, this is not recommended for fishing gear as there are currently very few recycling opportunities and not all areas of Scotland are well served by incinerators capable of taking this waste and would generate fossil carbon, providing a net contribution to greenhouse gas emissions. A landfill ban would likely increase the cost and difficulty of dealing with this waste and result in more marine litter.

Table 4 summarises the text above, highlighting the effect that recycling may have on key decision points to help tackle marine litter and drivers and barriers from section 6. However, the efficacy of recycling and it's potential to change waste management behaviour will ultimately depend on the financial viability and cost to the fisher.

Table 4: Desired effect of recycling on key decision points

Key decision point	Driver/barrier	Effect of solution
Recovery effort for lost gear	Waste management of large items - if recovered gear is not repairable (as below)	Incentivise fishers to manage waste responsibly by creating a recycling system that is free for fishers to use, or even pays for waste delivered, is widely available, simple to use, and requires minimal time and effort.
Waste management of large items	No perceived value in waste gear	
	Difficulty and cost of waste management	
	Time and effort in handling waste gear (lost time/income)	
	Lack of knowledge of waste management options	

7.2.2 100% indirect fee

Ports and harbours vary in how they charge vessels for waste management at port reception facilities. This can mean vessels pay a 'direct fee' where costs increase when delivering larger quantities of waste, creating an economic disincentive to deliver all waste to port. Others use a flat fee to cover all or part of the waste management costs, i.e. an 'indirect' charging mechanism. With a 100% indirect fee, vessels are charged the same fee irrespective of whether they deliver a large quantity of waste or none at all. Currently ports and harbours may not wish to charge a flat fee, thus raising basic harbour dues, as they will look uncompetitive with neighbouring ports charging indirect fees and so lose the custom of vessels. The 100% indirect fee has been proposed as mandatory in revisions to EU Port Reception Facilities Directive, with the necessary expansion of port reception facilities potentially carried by producers under EPR (see section 7.4). [49] Such a system could continue to rely on landfill, or recycling could be mandated or incentivised with economic measures and targets.

The 100% indirect fee system removes the direct cost of waste management from fishers at the point of waste disposal. However, the costs are likely to be ultimately paid by fishers, albeit indirectly, through port fees or EPR as producers transfer the costs onto increased prices for fishing gear. Removing the direct cost will diminish or entirely remove the incentive to dump waste at sea to avoid waste management costs. However, some argue that further measures are needed to create a significant positive incentive to bring waste gear to shore, in particular to overcome the time and effort for fishers in handling waste gear and habitual factors around historic dumping of waste.

Table 5 summarises the text above, highlighting the effect that a 100% indirect fee may have on key decision points to help tackle marine litter and drivers and barriers from section 6.

Table 5: Desired effect of 100% indirect fee on key decision points

Key decision point	Driver/barrier	Effect of solution
Recovery effort for lost gear	Waste management of large items - if recovered gear is not repairable (as below)	Incentivise fishers to manage waste responsibly by creating a system that is free for fishers to use, or even pays for waste delivered, is widely available, simple to use, and requires minimal time and effort
Waste management of large items	Difficulty and cost of waste management	
	Time and effort in handling waste gear (lost time/income)	
	Lack of knowledge of waste management options	

7.3 Gear marking and tagging

Gear marking and tagging was a relevant topic of research within the scope of the project because where gear is marked or tagged, (a) being marked with its owner's ID, the gear may be less likely to be intentionally discarded into the sea in the first place; (b) being marked with the vessel's ID number, name and port means if it is fished up by another fisherman at a later date, it is more likely to be possible to find

[49] https://ec.europa.eu/fisheries/new-proposal-will-tackle-marine-litter-and-%E2%80%9Cghost-fishing%E2%80%9D_en

its owner; (c) once the owner has been identified, the gear has a greater chance of being returned (and, in jurisdictions where owners are penalised for losing fishing gear, a fine may be practically levied) and (d) if the gear incorporates a technological tag of some kind, it has a greater chance of being recovered, either by the vessel which has just lost it, or later, as part of a deliberate exercise to recover it. In these ways, the marking of gear has the potential to influence at a number of the decision points shown in the diagram in section 5. Because of these advantages, the practice of gear tagging is well known and though the basic technique is often not successful in identifying the owner of lost kit or in recovering it, more advanced tagging and ongoing technological development is delivering significant advantages now as well as scope for future benefits.

One criticism raised several times during our research was voiced from a respondent working in the mobile fleet who stated simply that 'gear labelling tends not to happen and is probably pointless anyway'. His, and another's – argument is that one of the more prevalent reasons for gear loss is that the gear is snagged on an obstacle located on the sea bed which causes it to break, meaning that component sections of commercial fishing gear may become separated from the rest of the unit and lost. Often the missing part may not be the part with the marking or tagging on it, so even if it is found, it is not possible to identify the owner.[50] Even where the lost item can be identified and retains some use (e.g. a creel), the return of the item both to the owner and/or to the vessel's home port relies on the goodwill of the finder.

Notwithstanding this criticism, given the advantages of gear tagging listed in the opening paragraph, it should be clear that this view is not universally held, and some respondents are of the belief that all gear (especially static gear) should be marked so that people can tell to whom it belongs. Indeed, as technological innovations are rolled out the advantages of gear tagging become stronger. Radio frequency identification (RFID) tracking describes the use of a Radio Frequency Identifier which is a small device used for tracking or identification. A typical tag consists of a chip, memory and antenna; as they are small it is possible to fit them onto fishing gear, component parts or lobster/crab creels. RFID tags have been distributed to static fishermen in Scotland in an EU operated European Fisheries Fund project in order to tag their lobster pots[51].

[50] In the case of creels, an electronic tag may be placed on the associated buoy instead of the creel, so that in the event of their separation, the tag is necessarily separated from part of the gear.

[51] SAFEGEAR electronic fishing gear marker for automatic identification system (AIS). Winner of Waitrose Plastic Challenge Fund, aiming to get proof of concept at £100 or less to fishers, http://www.scottishcreelfishermensfederation.co.uk/Succorfish%20F&Q_1%20Aug_2014.pdf

Figure 13: SAFEGEAR electronic fishing gear marker[52]

The principal benefit of tagging technology is that it offers the potential for tracking and tracing of fishing equipment and therefore the possibility of locating lost or ghost gear, which can then be put back in use, recycled or at least disposed of properly. However advanced tagging equipment is more likely to be sold with and work with good quality trawling and purse-seine gear (which commands high prices of tens or hundreds of thousands of Euros) than with cheap gear, first because it is less cost effective to fit it to cheap equipment, and secondly because the loss of cheap gear is easier to countenance than the loss of high-end equipment.

Looking to the future, acoustic tagging is a practical method which has been proven in trials. Successfully applied to high performance netting (an R&D specialist working for a gear manufacturer told us other tests using different technologies have not been successful), the approach is not yet commercially available. The tag emits signals that are detected through use of technology, and while acoustic tagging offers potential, the challenge is to ensure it is economically attractive by making it cheaper. A respondent working for a commercial fishing gear manufacturer estimated the technology is about 18 months away from established commercial viability. Regardless of viability, more research of different technologies is required – and the goal for all of them (as well as commercial feasibility) will be to ensure that any new technologies built into the gear does not turn into new marine litter (use of batteries is potentially problematic for that reason).[53]

[52] https://www.bluemarinefoundation.com/2019/05/16/blue-and-waitrose-partner-to-fight-ghost-gear/

[53] Research is ongoing – including, for example, an EU funded €400,000 research project involving Newcastle University amongst others. The project, known as NetTag, is a UK (Newcastle University)/Spanish/Portuguese initiative to develop and test new technologies (acoustic device and robotic recovery systems) to reduce lost gear and organise awareness-raising activities on marine litter for fishermen. Its title is 'Tagging Fishing Gears and Enhancing on-Board Best Practices to Promote Waste Free Fisheries' and it is due to report in Dec 2020.

Assuming a tracking system is adopted, several commentators have talked of the potential for the gear, having been found, to be located and subsequently retrieved by a drone having a special grab system. Whilst the use of drones to locate missing gear is realistic, a more likely future scenario will be the employment of specially equipped vessels rather than drones. In future such vessels – provided with winches, storage facilities, specialist retrieval equipment, detection technology/drones and much more room than is usually found on a fishing vessel – would collect ghost or lost gear and bring it to port (such an approach is known as active, rather than passive, collection). These vessels could initially be government funded, and then later, once EPR is established, via EPR.

Table 6 summarises the text above, highlighting the effect that gear marking and tagging could have on drivers and barriers from Section 6 to help tackle marine litter. For example, electronic beacons could be used on static gear, or attached to mobile gear that needs to be cut free, to help later locate the lost gear. However, there are a number of factors that limit the effectiveness of gear marking and tagging. As mentioned above, the cost of electronic beacons may mean they tend to only be used for tagging more expensive gear. Gear tagging or marking is unlikely to act as a disincentive to dumping waste at sea, fishers could claim the gear was lost accidentally and in most cases avoid or remove tags if they are in the habit of dumping waste gear at sea. In all cases, simply adding marks or tags is insufficient, they must be actively monitored and managed, and the costs of the whole system must be considered.

Table 6: Desired effect of promoting gear marking and tagging on key decision points

Key decision point	Driver/barrier	Effect of solution
Bespoke product design and purchase decision	High quality gear that can reduce marine litter impacts is expensive	Encourage buyer to 'trade up' to better quality gear with a higher probability of recovery in event of loss
Recovery effort for lost gear	Lost gear becomes a hazard	Gear is easier to avoid and so hazard risk is reduced
	Lost gear can be difficult to locate	Using electronic beacons on gear will promote loss reporting and also help locate lost gear
Waste management of large items	Low risk of being caught and penalised	If gear tagging or marking cannot be removed then marine litter can be traced back to the vessel

7.4 Extended producer responsibility

Extended producer responsibility (EPR) is a policy approach to place a significant responsibility on producers in the supply chain to manage their products at end of life, either physically managing the waste or financial responsibility for funding waste management. EPR is implemented in different ways but typically as variations around four common systems:

https://ec.europa.eu/easme/en/nettag-tagging-fishing-gears-and-enhancing-board-best-practices-promote-waste-free-fisheries

- Advance disposal fee
- Takeback scheme
- Modulated fee
- Deposit return scheme

Circular economy principles are a crucial aspect that should be considered in any EPR scheme. The basic operation of these systems, and their pros and cons are discussed in more detail in the Appendix of the *Summary report* of the study, as they apply to other products as well as commercial fishing gear.

An advance disposal fee could be paid on fishing gear at the point of sale or import. The fee could cover all waste management costs so that fishers bear zero costs at the point of disposal, and so removing a potentially strong driver to dump waste at sea. Manufacturers are unlikely to adopt the system voluntarily as their product prices would increase significantly and they would lose market share to the competition. Even if some fishers realise the total costs across purchase and waste management are the same, they are unlikely to elect to pay disposal fees in advance (time value of money) and certainly those most at risk of dumping waste at sea would not engage with the system. A legal mandate would therefore be required so that all manufacturers and products are treated equally, including imported goods. Table 7 highlights the effect that an advance disposal fee may have on key decision points to help tackle marine litter and drivers and barriers from section 6.

Table 7: Desired effect of an advance disposal fee on key decision points

Key decision point	Driver/barrier	Effect of solution
Recovery effort for lost gear	Waste management of large items - if recovered gear is not repairable (as below)	Fishers pay for disposal in advance. If widely adopted, e.g. via legal mandate, it would remove incentive to dump waste at sea to avoid waste management costs.
Waste management of large items	No perceived value in waste gear	
	Difficulty and cost of waste management	
	Time and effort in handling waste gear (lost time/income)	
	Lack of knowledge of waste management options	

A takeback scheme would require manufacturers to collect and process their products at end of life at no direct cost to the fisher. This removes the incentive to dump gear at sea to avoid waste management costs. Involvement in the physical and financial responsibility for waste management can help prioritise end of life considerations in business model and product design, for example design for disassembly and recyclability to reduce costs. Joint schemes, managed through producer responsibility organisations (PROs) can reduce costs through economies of scale, but may weaken the link between manufacturers and end of life and lessen the potential to influence product design. The takeback scheme is also an opportunity to encourage repeat customers. Manufacturers can offer discounts or incentives on new sales when customers return their waste gear, funded in part by savings from reverse logistics for waste collection. Table 7 highlights the effect that an advance disposal fee may have on key decision points to help tackle marine litter and drivers and barriers from section 6.

Table 8: Desired effect of a takeback scheme on key decision points

Key decision point	Driver/barrier	Effect of solution
Bespoke product design and purchase decision	Pro-environmental behaviour & care for the marine environment	Incentivise design for durability, loss prevention, repair and end of life
Recovery effort for lost gear	Waste management of large items - if recovered gear is not repairable (as below)	Remove barriers for fishers to manage waste responsibly by creating a system that is free for fishers to use, is widely available, simple to use, and requires minimal time and effort
Waste management of large items	No perceived value in waste gear	
	Difficulty and cost of waste management	
	Time and effort in handling waste gear (lost time/income)	
	Lack of knowledge of waste management options	

EPR typically requires producers to cover the costs of waste management, and in recent EU legislation, also the cost of cleaning up litter, reporting and awareness raising.[54] [55] A modulated fee system, as set out in the EU Waste Framework Directive, sets the different fees for products taking into account durability, recyclability and other factors taking a lifecycle approach to understand which products have reduced environmental impacts.[56] If implemented well, lower fees will incentivise manufacturers to change their product design and take other measures to improve environmental outcomes. This would be most effective if a manufacturer can individually qualify for a lower fee rather than collective responsibility as a product group wherein, for example, all nets are assessed as a whole and the entire industry must make changes to qualify for a lower fee, and so the incentive is dispersed amongst producers and collective inertia prevents change. The system would need to be supported with a means of tracing products back to individual producers (e.g. gear marking and tagging) and a national reporting system. Data on marine litter cleanup could also be used to modulate the fee, charging a proportionate amount to producers of the products found littered, and potentially driving further innovation to prevent litter. Table 9 highlights the effect that a modulated fee may have on key decision points to help tackle marine litter and drivers and barriers from section 6.

[54] Single-use Plastic and Fishing Gear Directive, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019L0904&from=EN
[55] Amendments to article 8a, EU Waste Framework Directive, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L0851&from=EN
[56] Amendments to article 8a, EU Waste Framework Directive, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L0851&from=EN

Table 9: Desired effect of EPR modulated fee on key decision points

Key decision point	Driver/barrier	Effect of solution
Bespoke product design and purchase decision	Pro-environmental behaviour & care for the marine environment	Incentivise design for durability, loss prevention, repair and end of life, and to reduce marine litter
Recovery effort for lost gear	Waste management of large items - if recovered gear is not repairable (as below)	Remove barriers for fishers to manage waste responsibly by creating a system that is free for fishers to use, is widely available, simple to use, and requires minimal time and effort
Waste management of large items	No perceived value in waste gear	
	Difficulty and cost of waste management	
	Time and effort in handling waste gear (lost time/income)	
	Lack of knowledge of waste management options	

A deposit return scheme (DRS) could be used to provide a positive incentive to return nets at end of life. To be effective, the deposit would have to provide a greater incentive than the cost of waste management and other issues identified that might act against it. This could pose a problem if the system locks up large sums of deposit money as diminishing the financial reserves of operators could harm the fishing industry. One stakeholder suggested the deposit could be linked to the fishing license and quota, and this would provide a very strong incentive to minimise losses. This idea was not explored in detail in the research and would require further thought and consultation, for example to establish an 'acceptable' level of loss and not unfairly penalise vessels for accidental losses that could not be prevented or recovered. Table 10 highlights the effect that a DRS may have on key decision points to help tackle marine litter and drivers and barriers from section 6.

Table 10: Desired effect of DRS on key decision points

Key decision point	Driver/barrier	Effect of solution
Bespoke product design and purchase decision	Pro-environmental behaviour & care for the marine environment	Potentially incentivise design for durability, loss prevention, repair and end of life, and to reduce marine litter to avoid loss of deposits. However, this effect may be very weak in practice.
Recovery effort for lost gear	New incentive to recover lost gear	The deposit should be designed as a significant incentive to recover lost gear
	Waste management of large items - if recovered gear is not repairable (as below)	See below

Key decision point	Driver/barrier	Effect of solution
Waste management of large items	New incentive to manage waste responsibly	The deposit should be designed as a significant incentive to manage waste responsibly
	No perceived value in waste gear	
	Difficulty and cost of waste management	
	Time and effort in handling waste gear (lost time/income)	
	Lack of knowledge of waste management options	

Manufacturers were typically supportive of EPR when asked so long as measures were applied fairly and to all products, including imports, so as to not create a market distortion. EPR will benefit some manufacturers by internalising externalities not accounted for in the price of low-quality products. One manufacturer saw the cheapest products (from Asia and India) as a threat both to the manufacturing industry and to wider sustainability in the sector. EPR may therefore favour local manufacturers to be more competitive on price and, most importantly, support R&D to reduce environmental impacts if these efforts are recognised in lower EPR fees.

Manufacturers are unlikely to absorb EPR costs, which will ultimately be passed on to their customers. EPR levels the playing field by removing the financial advantage of fishers dumping waste at sea to avoid waste management costs, which damages the reputation of the rest of the fishing industry who are paying to responsibly manage their waste. This supports the polluter pays principle and will benefit the industry as a whole, although the fishing industry may initially be resistant to introducing policies that appear from their perspective to add costs. Any EPR should be designed minimise burden on industry. In financial terms, the main effect of EPR for most fishers is moving the point at which waste management costs are paid to beneficially rebalance incentives/disincentives to tackle marine litter throughout the value chain. The largest increases in costs should be ideally felt by fishers who are currently avoiding these waste management costs to the detriment of the environment and other fishers.

Engagement and consultation will be crucial to gain industry support and to help design the most effective system with minimal burden. One manufacture highlighted the need explain to and educate customers about why EPR is happening, and that there needs to be a 'payment circle' – when you pay, you get something back. If what fishers/firms get is a cleaner sea, better gear, recycling opportunities and potentially, financial incentives from bringing waste in, EPR could have a positive impact in the industry.

The EU Single-use Plastic and Fishing Gear Directive has already set the precedent for EPR for fishing gear containing plastic.[57] For other products the Directive requires producers to cover the cost of cleaning up litter and subsequent treatment of that litter. However, for fishing gear the requirements are simply made

[57] Single-use Plastic and Fishing Gear Directive, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019L0904&from=EN

in accordance with the Article 8 and 8a of the Waste Framework Directive, in which with producers' responsibilities include: [58]

- Costs of waste collection, transport and treatment;
- Costs of awareness raising - informing waste holders about waste prevention measures, take-back and collection systems, and the prevention of littering;
- Costs of data gathering and reporting.

Furthermore, the Member States are required to: [59]

- Define clear roles and responsibilities of all relevant actors involved;
- Set quantitative targets and/or qualitative objectives that are considered relevant for the EPR scheme;
- Ensure a reporting system is in place to gather data on products placed on market and subject to the EPR, and data on the collection and treatment of their waste;
- Ensure equal treatment of producers without placing disproportionate regulatory burden on producers, including SMEs, of small quantities of products;
- Establish an adequate monitoring and enforcement framework;

The Single-use Plastic and Fishing Gear Directive also states, in the context of proportionality:[60]

> the fishermen themselves and artisanal makers of fishing gear containing plastic should not be considered as producers and should not be held responsible for fulfilling the obligations of the producer related to the extended producer responsibility.

This will need to be considered in the context of fishers who buy materials and components from manufacturers and assemble the gear themselves, to ensure that the benefits of EPR are as strong for these actors and placing the producer responsibility on their suppliers.

The analysis of different EPR approaches presented above raises interesting considerations for the single EPR framework proposed for all product types with EPR obligations in the 2016 Circular Economy Strategy for Scotland[61]. Primarily Government will need to consider how much flexibility there is within the single EPR framework to tailor solutions to specific product groups. Ultimately, there will be a trade-off between standardising the approach to make it easier to administrate and comply with vs. variation to have the most impact on specific product groups in terms of their value chain, decision drivers, waste treatment, marine litter pathways (where relevant) and environmental impacts.

In terms of commercial fishing gear, EPR will also need to be designed and coordinated with other countries, particularly countries that Scottish vessels might visit or purchase gear from, to ensure that the weakest system is not exploited. The deployment and lead-in times for EPR will also be relevant. Coordination through OSPAR or the EU is recommended. Lessons can be learnt from existing EPR schemes

[58] Amendments to article 8a, EU Waste Framework Directive, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L0851&from=EN
[59] Amendments to article 8a, EU Waste Framework Directive, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L0851&from=EN
[60] Amendments to article 8a, EU Waste Framework Directive, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L0851&from=EN
[61] https://www.gov.scot/publications/making-things-last-circular-economy-strategy-scotland/

for other countries and different products, assessing their applicability to commercial fishing gear in Scotland.

7.5 Other measures

The solutions described and analysed in detail above represent the most viable found in the research. However, a number of other potential solutions were identified during this research; including gear recovery programmes, alternative materials for nets, spatial separation of mobile and static gear, and sustainability standards on fish products as a means to increase consumer awareness of positive actions the commercial fishing industry is taking to tackle marine litter. These are briefly discussed below.

Fishing for Litter schemes are already in place across the UK[62]. The behaviour change impacts are considerable - fishers engaged with this scheme were found much less likely to throw their waste overboard than those not engaged[63]. Comments were made about the appreciation for[64], and prevalence of this scheme[65]. However, there was also some confusion around whether fishers were charged for managing the waste after bringing the litter back to shore[66]. Other countries, including Iceland, offer a financial reward to fishers bringing old gear they have collected passively (while trawling) to land[67]. However, this reward is often only enough to compensate them for the additional fuel used[68]. Multiple suggestions were made to improve engagement with these schemes, all of which involved increasing financial incentives[69], and some considered accreditation/certification schemes[70] which could be linked to sustainability standards as discussed below. Incentives were recommended to be in the form of either tax credits, or credit towards port or mooring fees, with the amount dependant on the volume of waste retrieved[71]. If desirable, such an incentive could be funded through EPR or voluntary industry schemes.

An exemplar gear recovery programme has been developed by the Norwegian Directorate of Fisheries, which estimates it has removed somewhere in the order of up to 1,000 tonnes of lost gear in the last 10 years[72]. In Norway, fishers are legally obliged to report when they have lost gear[73]. To get the 100% reporting of lost gear, which they now believe they have, they have engaged the fishing industry, showing that the Government is not punishing gear loss, but instead clearing up lost gear and, as of 2018, returning it to the fishers who lost it – further incentivising fishers to report losses[74]. Challenges had to be overcome to achieve these results, including developing the systems to report gear losses, finding suitable solutions

[62] Fishing for Litter, Project Areas, http://www.fishingforlitter.org.uk/project-areas
[63] DEFRA (2014), Evidence Project Final Report, http://sciencesearch.defra.gov.uk/Document.aspx?Document=13666_ME5418FishingForLitterEvid4FinalReport.pdf
[64] Interview with seafood organisation
[65] Interview with a fishing association
[66] Interview with a major supplier of fishing gear components suggested charges existed, interview with a seafood organisation suggested generally there was no charge, interview with a fishing association suggested that there was no charge as this is covered as part of mooring fees
[67] Interview with a major supplier of fishing gear components
[68] Interview with a major supplier of fishing gear components
[69] Interviews with a major supplier of fishing gear components,
[70] Interview with a major supplier of fishing gear components
[71] Interview with a major supplier of fishing gear components
[72] Interview with Norwegian Directorate of Fisheries
[73] Interview with Norwegian Directorate of Fisheries
[74] Interview with Norwegian Directorate of Fisheries

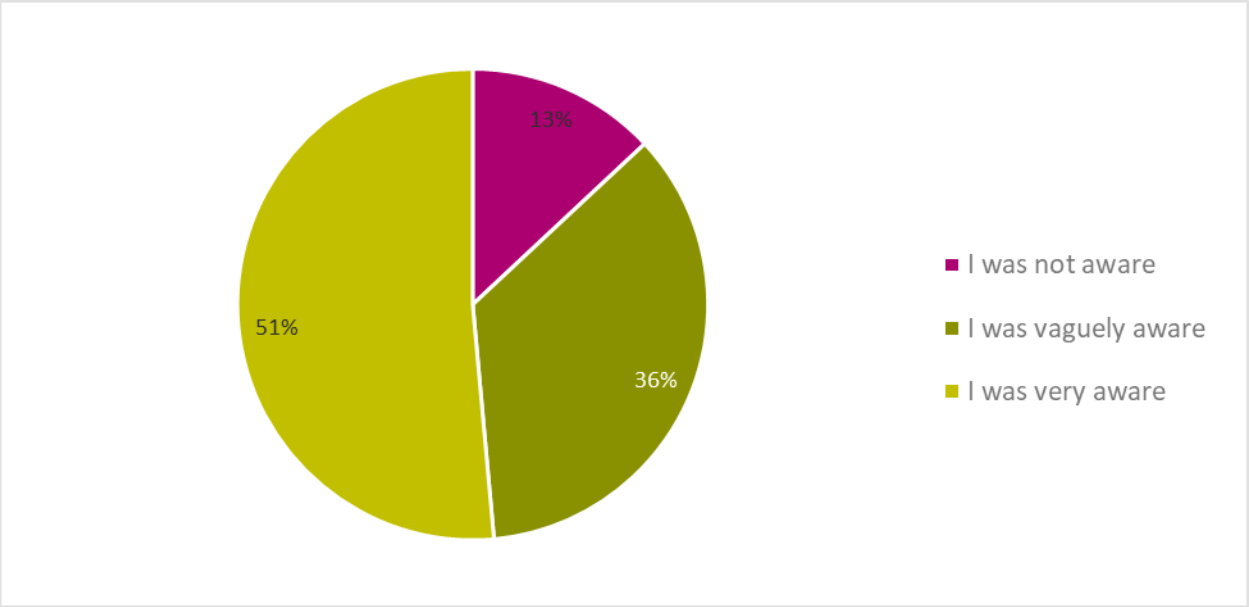
to retrieve gear (which is different at different depths) and opening and maintaining dialogue with fishers (which can be assisted by industry bodies and designed around how fishers and government interact at present)[75]. Fishers are now engaging in conversations about this issue in Norway as a result of this improving reporting and motivation[76]. Adding any disincentives or punishments for reporting lost gear, was not favoured having been shown in Iceland to be a barrier to reporting gear loss [77]. It was also felt that this scheme was made successful by working closely with fishers – using local knowledge was essential to ensure the scheme worked on the ground and commercial vessels were hired to retrieve materials[78]. They believe that seeing government taking action to address the issue by actively retrieving waste from the sea floor has also encouraged voluntary cooperation[79].

Spatial separation of different fishing techniques was highlighted, particularly by representatives of creel fishers, as a solution to gear conflict[80]. Spatial separation is a much broader fisheries management topic than just relating to marine litter. The Scottish Government has already considered the issue in detail with consultation[81]. Spatial separation is part on ongoing fisheries management discussion and strategy (e.g. Future Fisheries Management Plan, optimal allocation of quotas), and potential marine litter benefits should be part of this discussion.

A public survey was conducted to investigate public awareness of fishing gear as a marine litter issue and potential support for solutions that may affect them. Full details are given in Appendix C. Survey responses suggest a high public awareness of lost fishing gear and marine plastics linked to the fishing industry, as shown in Figure 14, but that further awareness raising could have an impact.

[75] Interview with Norwegian Directorate of Fisheries
[76] Interview with Norwegian Directorate of Fisheries
[77] Interview with Norwegian Directorate of Fisheries
[78] Interview with Norwegian Directorate of Fisheries
[79] Interview with Norwegian Directorate of Fisheries
[80] For example, accidentally moving or damaging static gear by boats passing or trawling through them
[81] https://www2.gov.scot/Topics/marine/Sea-Fisheries/InshoreFisheries/GearConflict

Figure 14: Survey Q9- Before this survey, were you aware of the issues of lost fishing gear/marine plastics linked to the fishing industry? (n=521)



Almost half of survey respondents ranked sustainability as a factor of highest importance when purchasing fish. The majority (83%) also stated they were willing to pay more for their fish to ensure the fishing methods didn't contribute to marine plastics, and so this could provide added value for fisheries that can demonstrate results. The most common response was willing to pay 10% more (reported by 36% of respondents). Within sustainability considerations, meeting sustainability accreditations were also popular (roughly half respondents ranked this as a factor of highest importance), and although survey responses suggest there is some confusions around what these standards cover, 69% thought it would be very important to include it in sustainability standards.

Almost half of survey respondents ranked sustainability of fishing methods as a very important decision driver when purchasing fish, the joint second most popular option behind quality (74% respondents) and supporting local fishing industries (also roughly 50%). This was higher for respondents who indicated they are very keen recyclers. Interestingly, within the sustainability factors presented, lost and discarded fishing gear was ranked almost as important and maintaining sustainable fish stocks and protecting endangered species, which formed the top three answers. Roughly half of respondents ranked meeting sustainability accreditations as a very important factor when purchasing fish, however respondents reported they didn't know which issues were included in sustainability accreditations for fish (63% for the MSC Certified standard) .

There is also work underway developing alternative materials for fishing gear. This has long been a problem as material must be durable when in use but break down quickly if lost. If alternative materials are pursued, this has the potential to reduce the negative impacts of marine litter, however it must be ensured that a full lifecycle analysis is undertaken, and steps are taken to prevent similar issues to those developing

around compostable packaging[82, 83]. One stakeholder interviewed reported having developed a biobased, biodegradable dolly rope which has more abrasion resistance than traditional PE so lasts longer but degrades in between 3 months to 3 weeks depending on which area of the sea it is lost in[84]. This product now needs large scale testing and marketing, which if successful could then lead to development of alternatives for other products including mussel nets. Whilst dolly rope is not considered an issue for Scottish fisheries this highlights industry innovation in response to marine litter risks[85]. Another manufacturer reported their long-term innovation project into a biodigestible fibre for marine environments. Whilst the polymer is already produced on commercial scale its application in fishing gear is thought to be 15-years away from commercialisation.

8 Recommendations

The analysis above presents clear opportunities for Government to support industry in addressing this marine litter issue. The value chain recognises the problem of commercial fishing gear as marine litter and is willing to act, but the right conditions need to be created to empower actors, without the proactive bearing unreasonable costs whilst others do not. Government intervention is therefore recommended in order to create the right business and regulatory framework to significantly reduce commercial fishing gear losses.

Based on the research findings, the following recommendations are made to the Scottish Government in Table 11, with some broken down into smaller tasks. The recommendations presented have different potential effectiveness, costs and timescales. To some degree the likely impact is related to the resources and support invested in any single measure. The recommendations are presented in a logical order to address. Supporting education and engagement measures was a common request from stakeholders and could be initiated in short timescales. Subtasks for evaluating the potential of EPR outline iterative steps of information gathering to evaluate the case for EPR and for its design to be effective, fair and well-received by industry.

[82] Footprint (2019), https://www.foodservicefootprint.com/footprint-investigation-parliament-burnt-by-compostable-pledge/
[83] The Guardian (2019), 'Biodegradable' plastic bags survive three years in soil and sea, https://www.theguardian.com/environment/2019/apr/29/biodegradable-plastic-bags-survive-three-years-in-soil-and-sea
[84] Interview with plastic polymer producer
[85] Information on dolly rope use provided by Marine Scotland

Table 11: Recommendations to address marine litter from commercial fishing gear

Recommendation	Details
1. Support education and engagement measures	Education was one of the most common suggestions from the stakeholder engagement process, and can address a broad range of issues. Many of the organisations engaged in the research are currently playing an active role in education and want to do more. Priority areas are waste management options available to fishers and the impacts of marine litter. Also advise on life cycle costs of more durable, repairable equipment to influence procurement and design. Such work can deliver results quickly and lay the foundation for further policy measures. Industry engagement is necessary to inform and direct other interventions, and to gain industry support.
2. Evaluate feasibility and efficacy of EPR, recycling, and other waste management options	
a) Mandate reporting of products placed on market, and data on the collection and treatment of waste	This information is a prerequisite to better understand the issue and design the best solutions. This reporting could be implemented in short timescales as the first step in EPR, and therefore funded by producers, as required by EU legislation. The data could support enforcement activity and identify fishers who have a lot of old gear unaccounted for that require further investigation. This could act as a deterrent if perpetrators think they are more likely to be caught. Fishers could prove the location of gear either in storage or by producing waste transfer notes to show they have been disposed of.
b) Understand current (baseline) waste management costs to fishers	It is critical to understand how much these costs act as a drive in marine litter. Engage ports, harbours, fishing vessels and their agents to understand the current systems and costs of managing waste fishing gear, particularly large nets. The research should seek to understand the cost of managing different types of waste gear, which actors bear the direct costs of waste management and indirect costs such as time spent handling the waste and arranging for storage, collection and treatment, as well as how the situation varies across the country. The research should indicate how great a burden waste management is on the fisher, e.g. by comparing costs to the revenue and profit of a vessel using that type of gear, accounting for large and small boats, and the range of financial performance within the fleet.

Recommendation	Details
c) Evaluate EPR options for fishing gear	EPR is the most comprehensive solution found in our analysis for addressing waste management issues, addressing pivotal drivers at key decision points that lead to marine litter, and has the potential to create a strong positive incentive to manage waste responsibly. It is arguably the fairest solution, in that costs are borne by actors across the value chain, and should be designed so that no actor can avoiding waste management costs. EPR can redress the balance of incentives/disincentives at key decision points to affect widespread behaviour change and prevent marine litter. Recent EU legislation requires EPR be developed for fishing gear containing plastic, although as shown in our analysis there is considerable variation in how this might be implemented, with pros and cons to each approach. It is recommended Government develop practical scenarios for EPR to understand their potential to reduce marine litter and the costs and benefits for different stakeholders in the value chain. Lessons can be learnt from existing EPR schemes for other countries and different products, assessing their applicability to commercial fishing gear in Scotland.
d) Research recycling enablers and conduct cost-benefit analysis	Investigate enablers for recycling end of life fishing gear, particularly new technology and economies of scale from a national scheme. Estimate costs to the fisher under best and worst case scenarios, relative saving over landfill, and therefore how much this may incentivise responsible waste management over dumping at sea. Estimate financial support needed for the system to be cost neutral to fishers or even pay them for waste gear.
e) Gather industry views on 100% indirect fee, EPR and recycling measures in a combined consultation	These measures intrinsically overlap and cannot be discussed in isolation. Detailed consultation across the full value chain is a prerequisite to policy design, implementation and participation. Timescales of implementation, cross-border issues, and coordination with other countries adopting similar measures are also important considerations.
3. Support best-practice and new technology	In particular, gear marking and tagging, tracing lost gear back to its owner and manufacturer which can support policy measures above, such as takeback schemes and EPR modulated fee. Wider opportunities are around systems thinking, including design for end of life and even recovery of lost gear, or product innovation to address marine litter issues.

9 Comparable products

Fishing gear was examined in some detail in the research, but the findings of this research are likely to have some relevancy amongst other types of product and value chains. Possibly the closest comparable product to commercial fishing gear is the netting used in aquaculture - the farming of fish, crustaceans, molluscs,

aquatic plants, algae, and other organisms. Fish farming nets, used to hold sea creatures in saltwater 'tanks', and to protect them from wild predators on the other side of the net, are generally made from nylon[86], a material also commonly used in the manufacture of pelagic fishing nets[87]. Polyethylene is also commonly used in fishing gear for its greater strength, and also by many fish farms. While both nylon and polyethylene can be recycled, coated polymers (such as copper coated nylon used in aquaculture) are harder to recycle, so that copper coated nylon needs to be chemically recycled – making uncoated polyethylene easier to deal with at end of life. Neither are biodegradable and therefore both, if lost at sea, are likely to remain there for very long time periods.

Ropes (usually made of polyethylene) are used in shipping as well as in fishing and can be lost overboard in operation just like in commercial fishing, and some of the same decision making processes apply for these whether they are used in commercial shipping or in fishing (i.e. discarding of waste, recovery effort when lost and reporting of losses)

Steel cables for holding trawl nets do not contribute to the plastics problem but they may be viewed as a comparable product to plastic marine waste as they are used in commercial fishing and still end up as marine waste. Our understanding of what happens to these at end of life is unclear as one respondent (a fisherman) stated that 'wire and other gear are always taken back to port' while another (who worked within a government organisation) told us that trawl cables are a consistent problem at the end of their life (generally after 18-24 months use) as they are heavy, awkward, up to 800m long and are routinely disposed of at sea. The respondent from the government organisation told us that in Denmark he has seen reels on the quayside onto which the cables are wound from trawlers at end of life. This may not be an easy operation for a 5-6 tonne cable but the introduction of such a scheme in Scotland could be achieved with some investment in reels and winding gear, may present a recycling opportunity and will avoid dumping at sea.

There may also be comparable products used on land. Agricultural film was one of the products investigated in the scoping study, which suggested similar waste management issues: lack of viable waste management options, particularly in remote areas, exacerbated by time and cost to the waste producer in managing the waste.

The fishing sector may be a good area to trial the feasibility of takeback systems, having a relatively small number of product consumers and so easier in theory to monitor and control. If successful, schemes could be developed for aquaculture and agriculture plastics.

The comparable solutions are likely to be around education and engagement, and gear marking and tagging with the aim of influencing decisions around operational best practice, waste management, recovery effort for lost gear, and reporting of losses.

[86] Discussion with a plastic recycler, 30 May. See also aquaculture netting manufacturers' websites, https://www.vonin.com/en/aquaculture/cage-nets/; https://www.akvagroup.com/pen-based-aquaculture/pens-nets/plastic-pens,

[87] PA tends to be more expensive than PE, but as PA stretches, it is considered advantageous for pelagic trawl nets, because it avoids damaging the fish. PE, which is stronger, is more commonly used for bottom trawling.

Appendix A Key organisations in the value chain for Scotland

A.1 Commercial fishing gear

Table 12 outlines key private sector organisations for Scotland in the role of manufacturing and supply of commercial fishing gear, identified in this research.

Table 12: Commercial fishing gear - Key organisations in manufacturing and supply

Key organisations	Location	Role in the supply chain
Faithlee Trawl	Fraserburgh, Scotland	Manufacture of cordage, rope, twine and netting
Jackson Trawls	Peterhead, Scotland	Manufacture of nets, wire rope stockist
Caley Fisheries Group	Peterhead, Scotland	Manufacture and repair of nets, amongst wider fishery services
Euronete UK	Aberdeen, Scotland	Manufacture of netting, steel wire and fibre ropes
Tyson's Riggers	Grimsby, UK	Supplier of wire and synthetic ropes, and netting
Gael Force Group	Inverness and Stornoway, Scotland	Manufacture and supplier of creels
Caithness Creels Ltd	Wick, Scotland	Manufacture of creels
Swan Net-Gundry Ltd	Killybegs, Ireland	Manufacture of trawling nets
KT Nets	Carnmore, Ireland	Manufacture of pelagic nets
Coastal Nets	Dorset, UK	Stockist of ready-made equipment, imported nets and rope
Advanced Netting Ltd	Essex, UK	Stockist of ready-made equipment, imported nets and rope
Renco Nets	Lincolnshire, UK	Import / export of netting and rope
Sicor International	Dorset, UK	Supplier of net and rope (worldwide)
Comfish Marine	Cornwall, UK	Stockist of commercial fishing equipment
Southern Ropes	South Africa	Synthetic rope manufacturer
Van Beelen	The Netherlands	Netting and rope manufacturer

Appendix B Workshop activities

B.1 Introduction

Workshops were conducted to engage actors across the value chain and facilitate discussion of the marine litter issues. The workshops followed the research framework of the project, and informed by preliminary findings from the literature review and 1-2-1 interviews, focussed on key decision points in the supply chain to understand the drivers and barriers that lead to marine litter. This was followed by a discussion of solutions and a prioritisation exercise to help identify which of the points discussed were felt to be most pertinent by the participants in the room. A workshop was conducted for each of the following product categories:

- Commercial fishing gear
- Menstrual products
- Artificial grass pitch

The workshop aims, agenda and participant lists are given in the sections below. The agenda was tailored to the product group and so workshops for each product in the study varied slightly, and reflected key knowledge gaps and discussion points that needed to be addressed.

The authors would like to thank all participants of the workshops and interviewees who contributed enormously to the research.

B.2 Commercial fishing gear workshop

Workshop aims

- Cross- value chain discussion on influencing factors at key decision points that contribute to marine plastics
- Identify favoured solutions, generated from cross-value chain dialogue
- Note differences of opinion across stakeholder groups / supply chain points

Workshop agenda

Part 1 – Drivers and barriers that contribute to marine plastics:

- Hypothetical situation 1 – a fisher has accidentally lost their main fishing gear
- Hypothetical situation 2 – a fisher has intentionally discarded worn-out fishing gear at sea
- Hypothetical situation 3 – waste management on land of worn out gear

Part 2 - Potential solutions:

- Mix up the stakeholder groups.
- What solutions might be used to help tackle accidentally lost fishing gear?
- What solutions might be used to help tackle intentionally discarded fishing gear?
- What solutions can address the difficulty and cost of handling fishing gear waste?
- Discuss how feasibility of solutions and if they would work across the supply chain

Part 3 - Prioritisation:

- Voting exercise on:
    - Where in the value chain is the greatest opportunity to tackle marine litter issues
    - Most favoured solutions
- Discussion of reasons for choices made

Table 13: Commercial fishing gear workshop attendees

Organisation	Sector	Attendees
Scottish Fishermen's Federation (SFF)	Fishing industry	1
Scottish White Fish Producers Association (SWFPA)	Fishing industry	1
Shetland Shellfish Management Organisation (SSMO)	Fishing industry	1
Peterhead Port Authority	Ports and harbours	1
Marine Conservation Society	NGO	1
Independent marine litter activist	NGO	2
Scottish Inshore Fisheries Integrated Data System (SIFIDS) Project	Academia	2
MASTS Fisheries Forum	Academia	1
Marine Scotland	Government and public bodies	3
Zero Waste Scotland	Government and public bodies	1
Joint Nature Conservation Committee (JNCC)	Government and public bodies	2
SEAFISH	Government and public bodies	2

Appendix C Commercial fishing gear public survey results

C.1 Introduction

A survey to collect public responses on the topic of ghost fishing gear was built on Survey Monkey and advertised to potential respondents through Facebook Advertising. Three questions relating to the 2008 WRAP committed recycler metric[88] were included to provide a baseline for comparison in relation waste reduction awareness. The adverts were targeted towards people aged 18+, living in Scotland and whose interests included eating, food or grocery stores. Some adverts were targeted specifically towards respondents who were interested in eating fish. A variety of adverts were tested and the most successful ones were continued. An example of a successful advert is shown in Figure 15.

A full breakdown of the responses to each question is included below.

Figure 15: Facebook advert publicising the ghost fishing gear survey

C.2 Targeting and demographics

The ghost fishing gear public survey received 764 responses. The number of responses to each question reduced as people progressed further through the survey, and 524 completed all fish related questions. Respondents were older than average, with 40% over the age of 65 and 71% between the ages of 55 to 74. Respondents were slightly more likely to be female, very likely to be retired (45% respondents), and very likely to have no dependants (61%). We also found that 59% of respondents lived within 10 miles of the

[88] WRAP (2008), Barriers to recycling at home, http://www.wrap.org.uk/sites/files/wrap/Barriers_to_Recycling_at_Home_Technical_Report.pdf

coast. Respondents to this survey were slightly more engaged with recycling (83% recycle even if it requires additional effort, compared to 74% in the WRAP study).

C.3 Summary of results

Q1: The results indicated that respondents were likely to eat fish **more than once a week** (81%, n=764).

Q2: This question was a disqualification question for those who never ate fish and is not applicable for analysis.

Q3: Respondents were most likely to rank **quality** as a very important decision driver when purchasing fish (74%, n=413). **Supporting local fishing industries** was also ranked as very important (50%, n=279), and a similar ranking for **the sustainability of the fishing methods** (49%, n=273). When compared to the committed recycler metrics covered in demographics questions Q6 to Q8, respondents who selected **I recycle everything that can be recycled** to the question *which of these statements best describes how much you recycle* were 14% more likely to report **sustainability** as a very important decision driver (54%, n=165) than those who selected any other answers (40%, n=66).

Q5: Results showed 66% of respondents ranked **maintaining sustainable fish stocks** as a very important sustainability factor when purchasing fish (n=367). This was followed by **protecting endangered (red list) species** (62%, n=347) and then **fishing gear that is lost or discarded at sea – causing marine plastic pollution and sometimes trapping wildlife** (61%, n=341) (Figure 24). This indicates that respondents perceive lost fishing gear as more important than *line or net caught fish*, where *the fish was caught*, and *meeting sustainability accreditations*. Two additional comments were made on this question around lost and discarded fishing gear – one respondent stated that fishing gear should be disposed of in the port and another stated that you cannot completely control for lost and discarded fishing gear.

Q6: Respondents were asked to list *additional sustainability factors you consider when purchasing fish*. 81 comments were made and the majority of these were repeating responses already accounted for in question 5 or were irrelevant. Two comments were made around fishing gear:

- one stated the **gear should be disposed of in the port**,
- and another stated that you **cannot completely control for lost fishing gear**.

Q7: Respondents were asked about three sustainability accreditations, and what they think are included within these. The sustainability accreditations included were Marine Stewardship Council (MSC) Certified, the Sustainable Seafood Coalition and the Royal Society for the Prevention of Cruelty to Animals (RSPCA) Assured. Within this question, multiple respondents reported not knowing what was included in these accreditations: 63% for MSC certified (n=353), 51% for the Sustainable Seafood Coalition (n=284) and 41% for RSPCA assured (n=228). Respondents were least likely to report that **lost and discarded fishing gear** was included in the MSC certification, with only 39% (n=219) reporting it as being included. Similarly, respondents did not believe it was included in the Sustainable Seafood Coalition (33%, n=16) or in the RSPCA assured criteria (36%, n=199).

Q8: 69% of respondents responded to the question, *if the risk of lost and discarded fishing gear from fishing activities is not included, how important would it be to include,* with the response **very important** (n=355). An additional 25% (n=128) believed this was **important** and only 1% (n=3) believed it was **not important**. Those who ranked sustainability as an important decision driver were more likely to respond with the answer **very important** (80%, n=207) than those who didn't (56%, n=148).

Q9: Respondents were asked, *before this survey, were you aware of any of the issues of lost fishing gear/marine plastics linked to the fishing industry*. Respondents reported high levels of previous awareness, with 52% being **very aware** (n=268), 36% (n=185) being **vaguely aware** and only 13% (n=68) not aware of the issue.

Q10: Finally, respondents were asked how much more they would be willing to pay for their fish to ensure the fishing methods didn't contribute to marine plastics. Respondents were most likely to select the option of **10% more** (36%, n=189) whilst only 7% (n=34) reported they would not pay any additional money to ensure their fish did not contribute to marine plastics pollution. Respondents who were very aware of the issue before the survey were started were 9.8% more likely to be willing to spend 10% or more to ensure the fishing methods didn't contribute to marine plastics. This indicates awareness of the issue has an impact on willingness to reduce the problem.

C.4 Responses to the fish survey

Figure 16: Fish Q1- How often do you eat fish? (n=942)

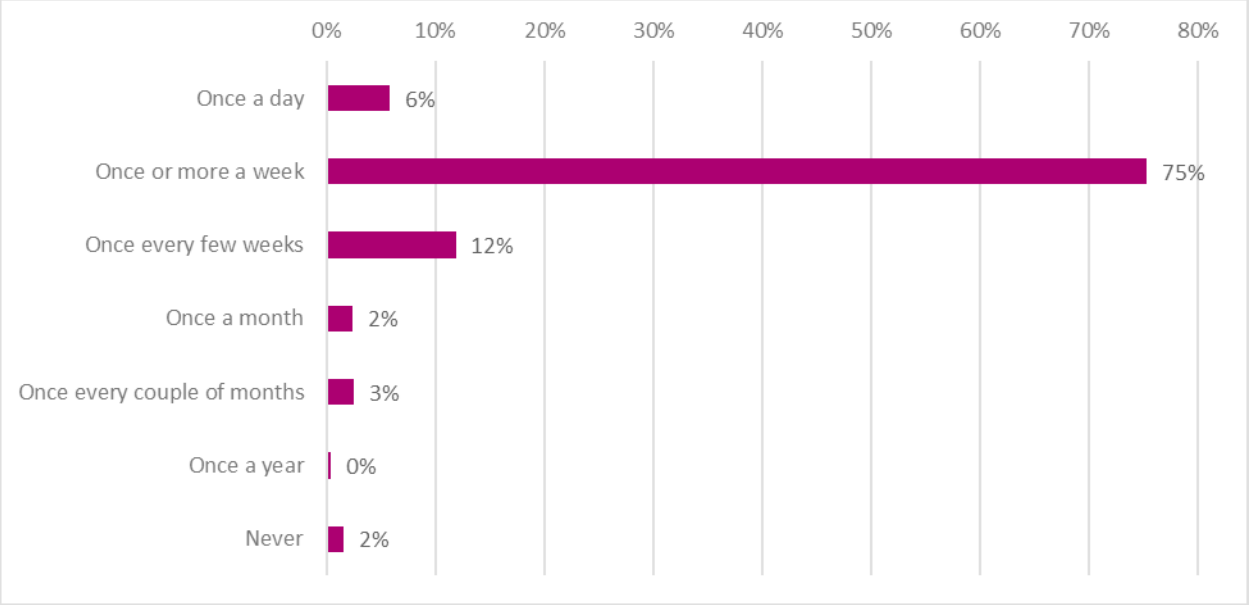


Figure 17: Fish Q3- Please rank the following decision drivers in order of importance when purchasing fish (1 being the lowest importance, 6 being the highest importance) (n=558)

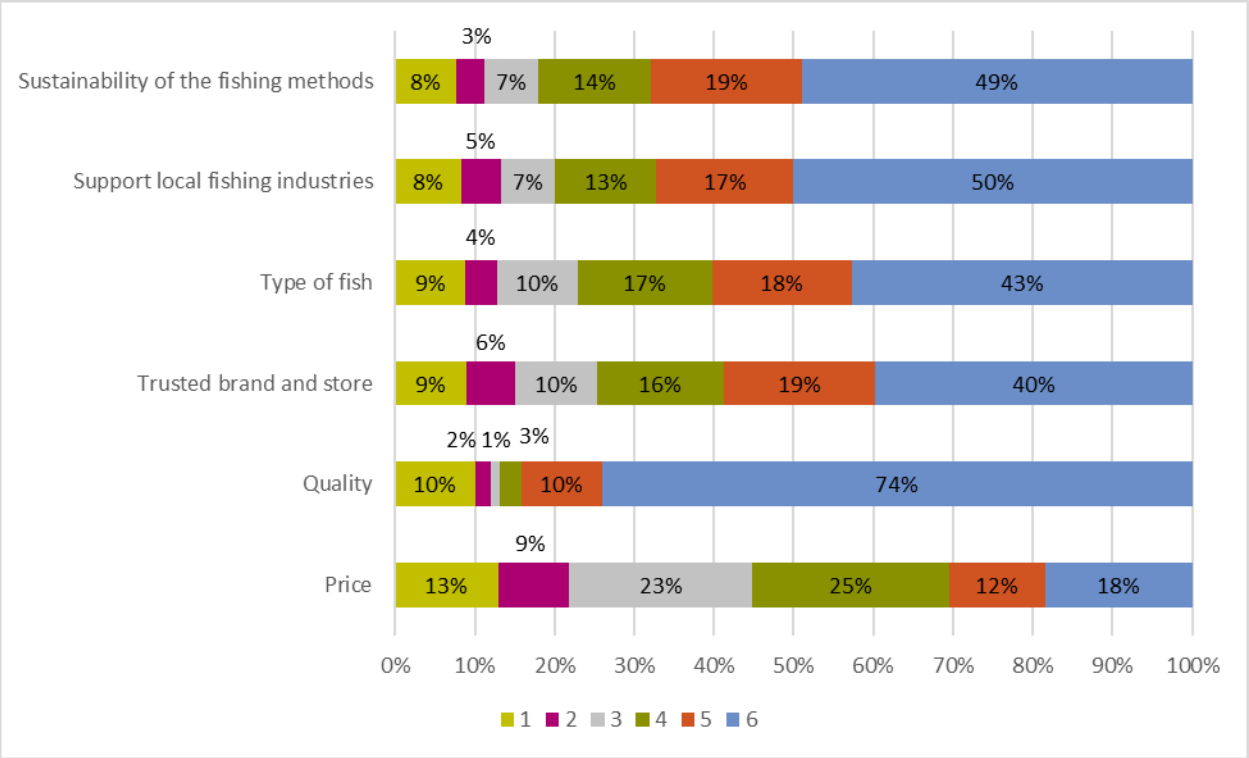


Figure 18: Fish Q5- Please rank these sustainability factors in order of how important you think they are when purchasing fish (1 being the lowest importance, 6 being the highest importance) (n=558)

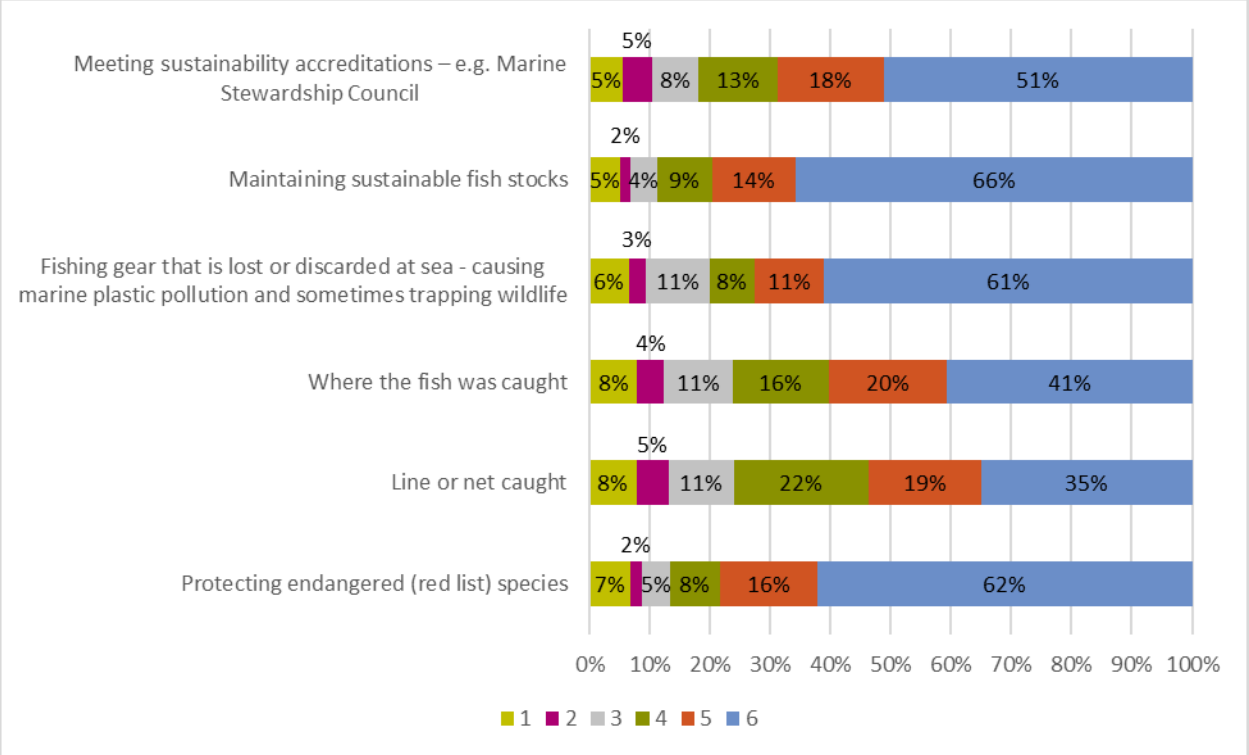


Figure 19: Fish Q7- Which of the following issues do you think are currently included in these sustainability accreditations for fish? (Please tick all that apply) (n=558)

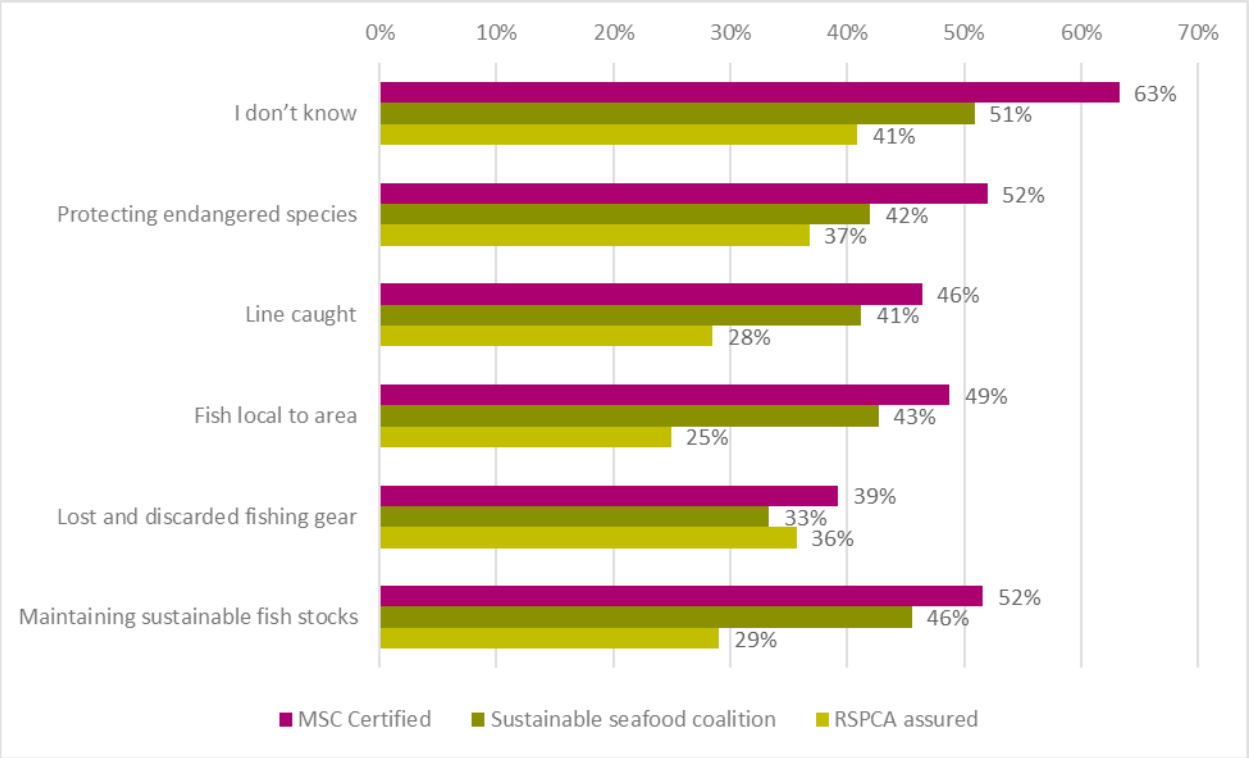


Figure 20: Fish Q8- If the risk of lost and discarded fishing gear from fishing activities is not already included in sustainability standards and accreditations, how important would it be to include it?

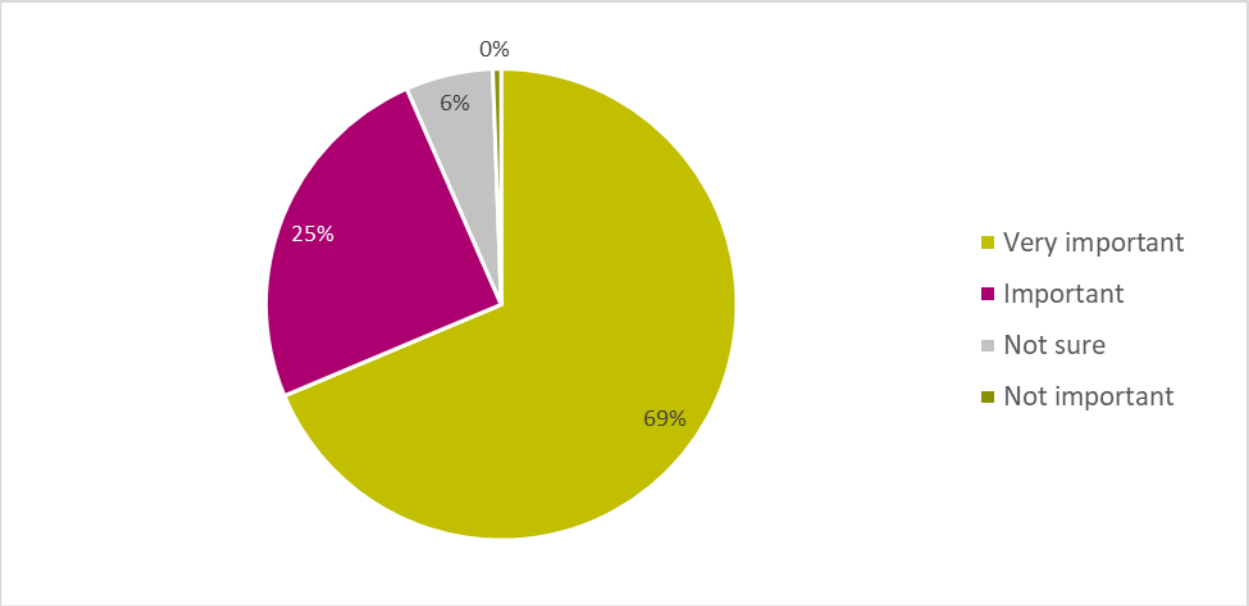


Figure 21: Fish Q9- Before this survey, were you aware of the issues of lost fishing gear/marine plastics linked to the fishing industry? (n=521)

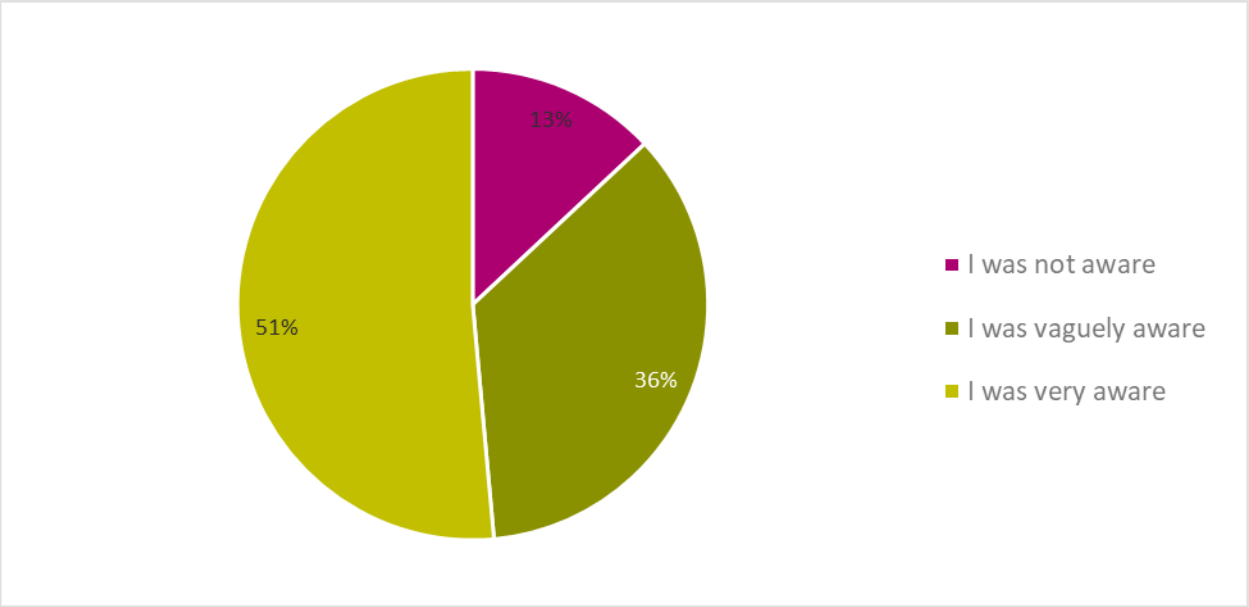
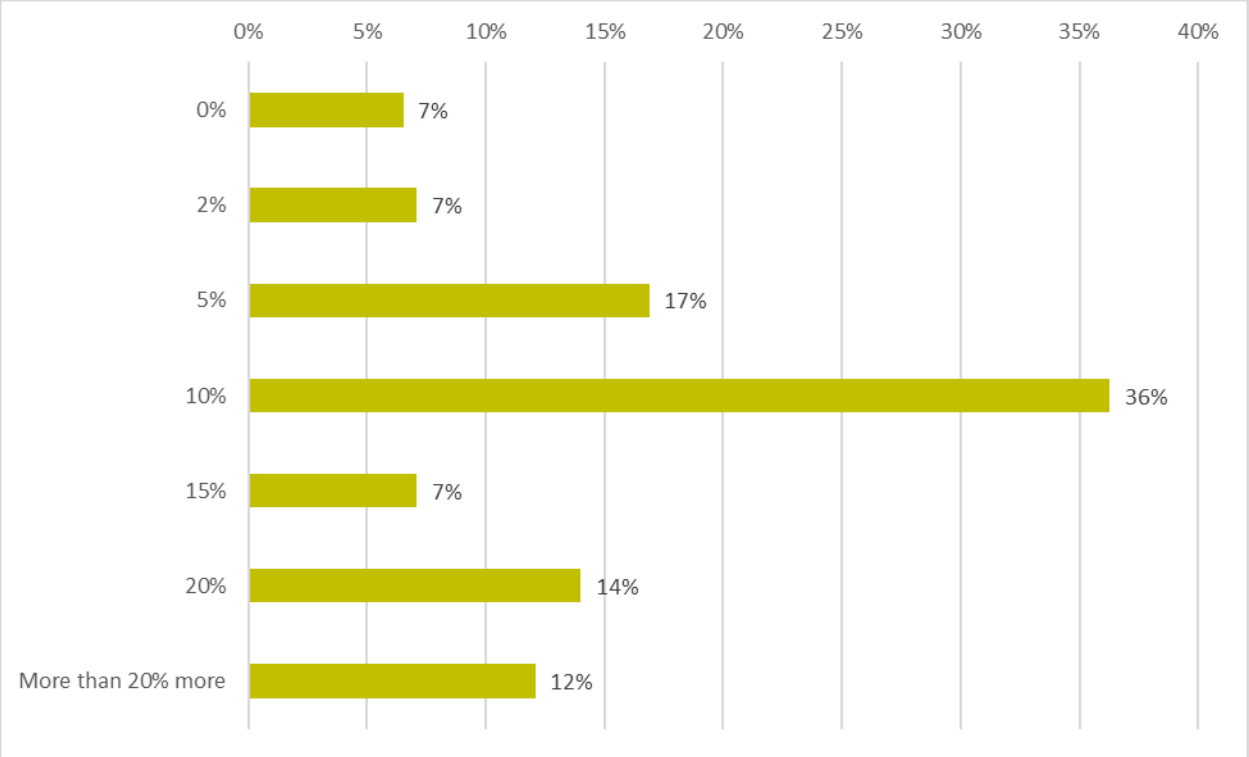


Figure 22: Fish Q10- What percentage more would you be willing to pay for your fish to ensure the fishing methods didn't contribute to marine plastics? (n=521)



C.5 Demographics of fish survey respondents

Figure 23: Demographics of fish survey respondents Q1-What is your age? (n=521)

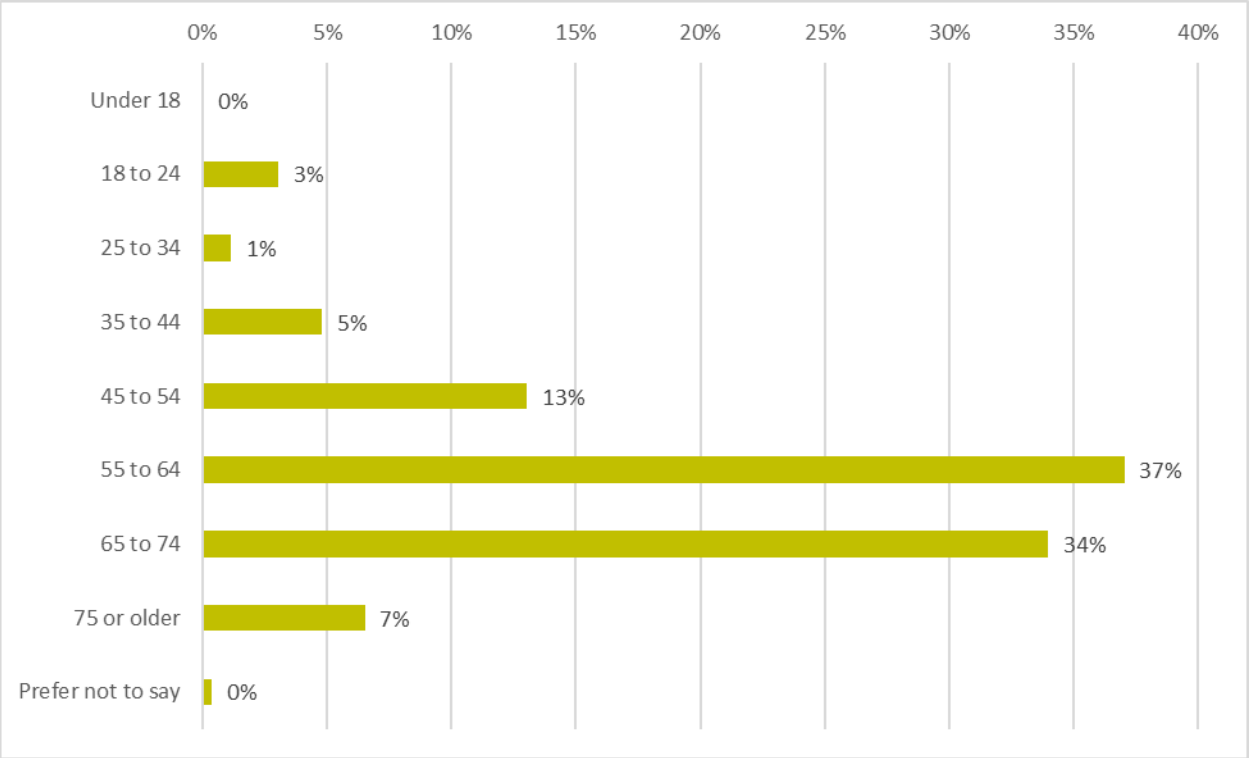


Figure 24: Demographics of fish survey respondents Q2- What gender do you identify with? (n=486)

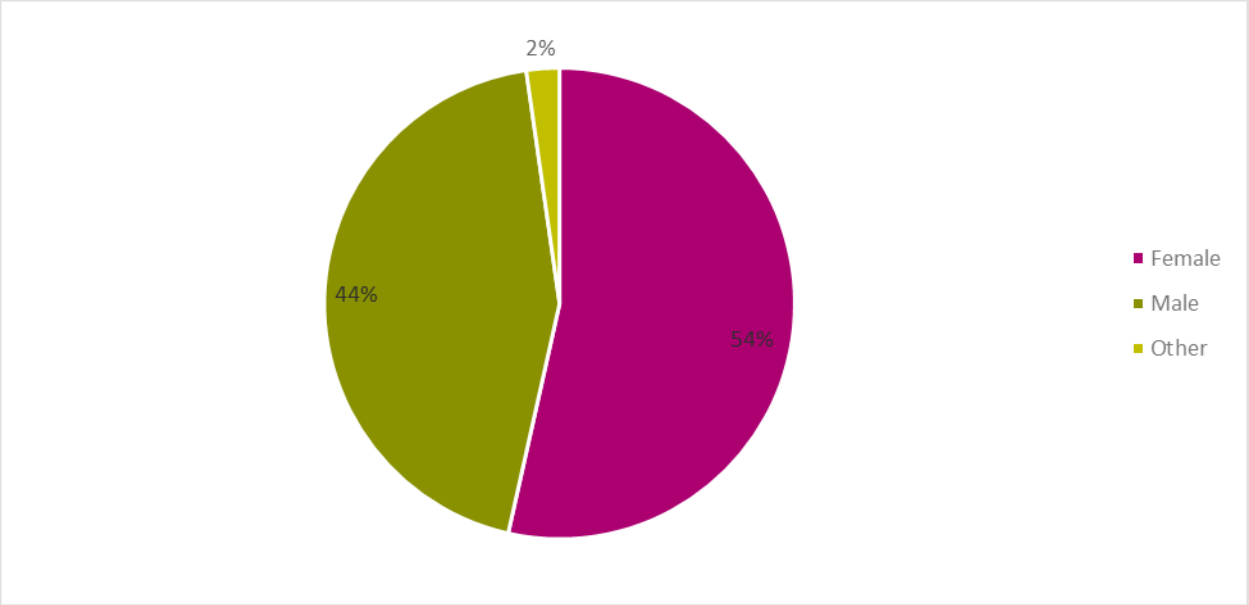


Figure 25: Demographics of fish survey respondents Q3- What is your current employment status? (n=486)

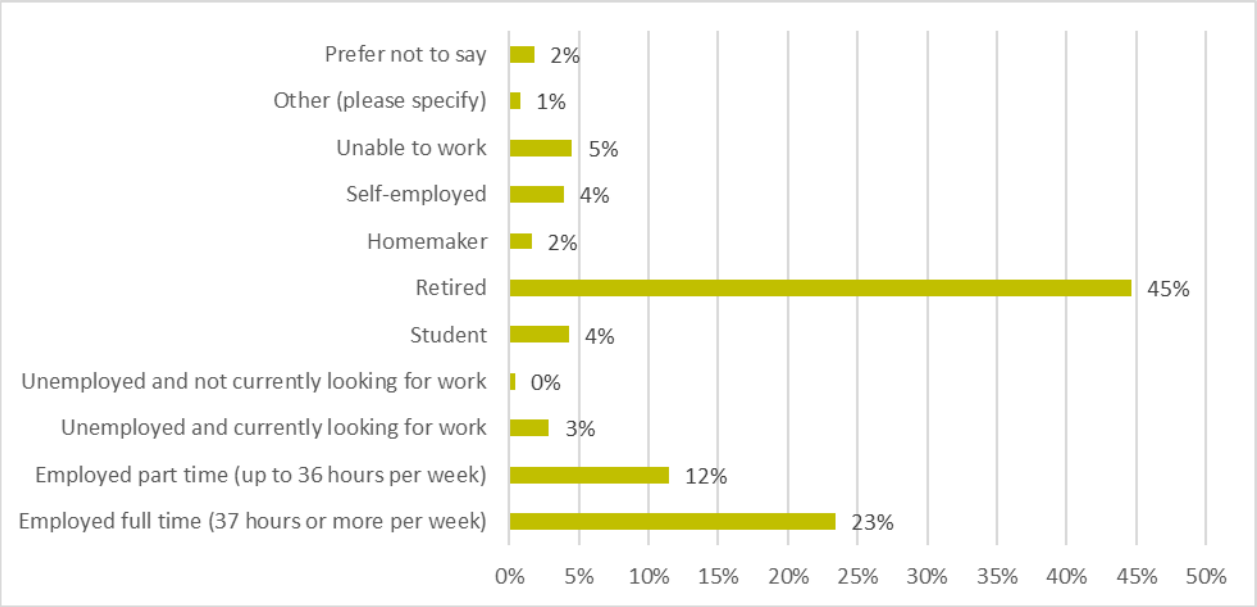


Figure 26: Demographics of fish survey respondents Q4- How many dependants do you have? (n=486)

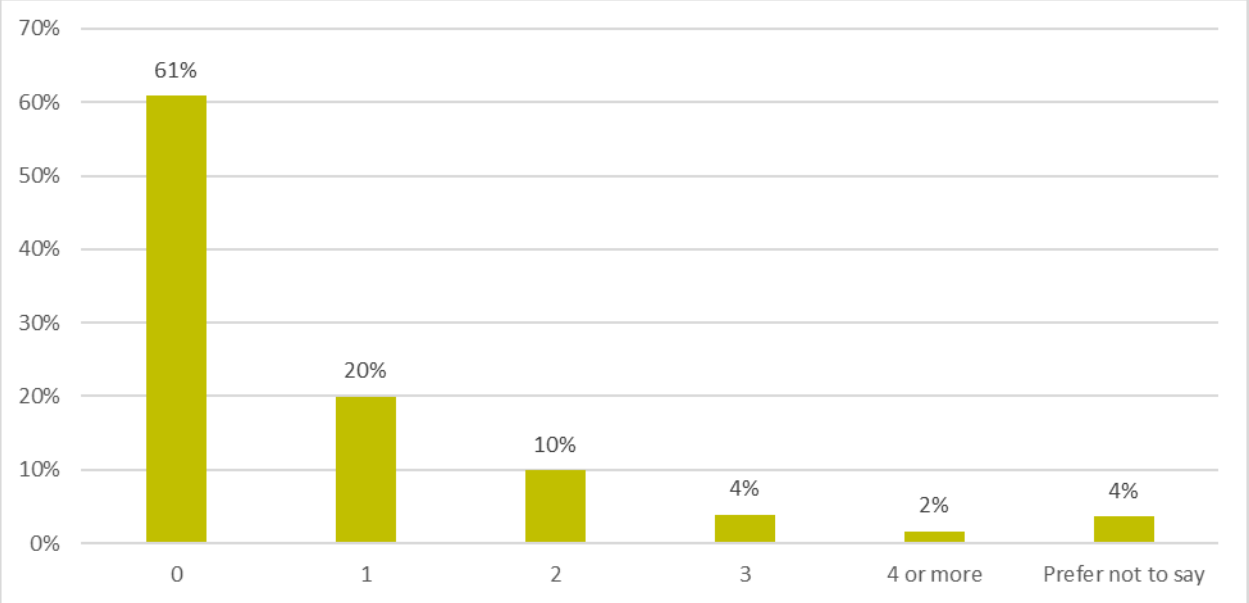


Figure 27: Demographics of fish survey respondents Q5- How far away from the coast do you live to the nearest mile? (n=486)

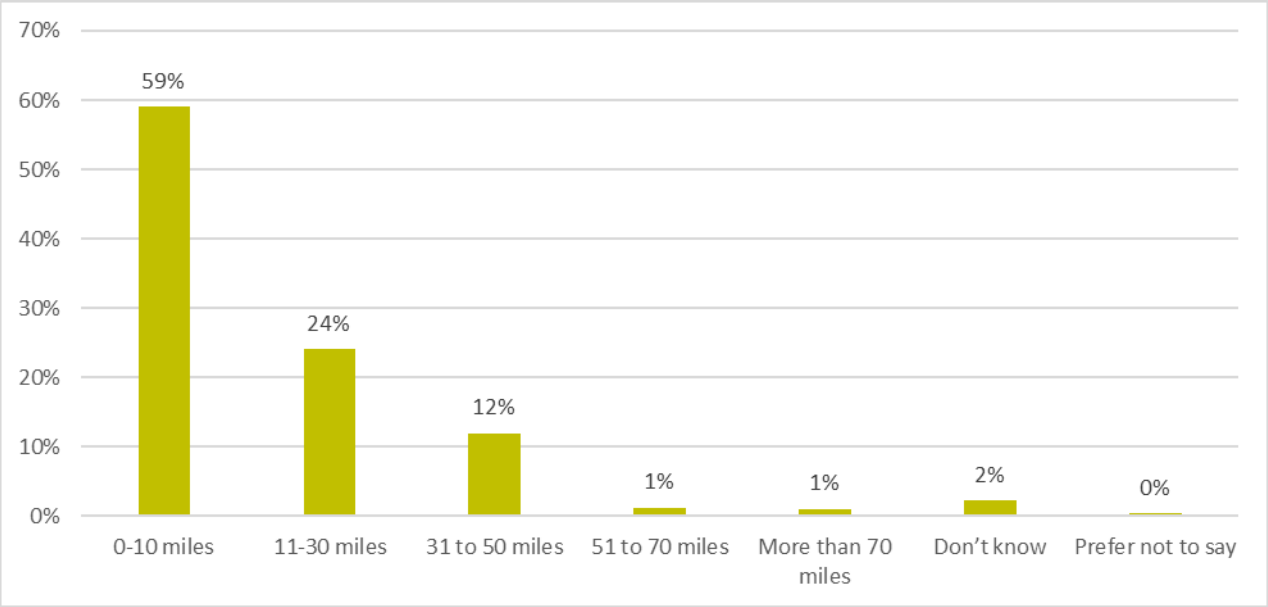


Figure 28: Demographics of fish survey respondents Q6- Thinking about recycling household waste, which of these statements best describes how important recycling is to you personally? (n=486)

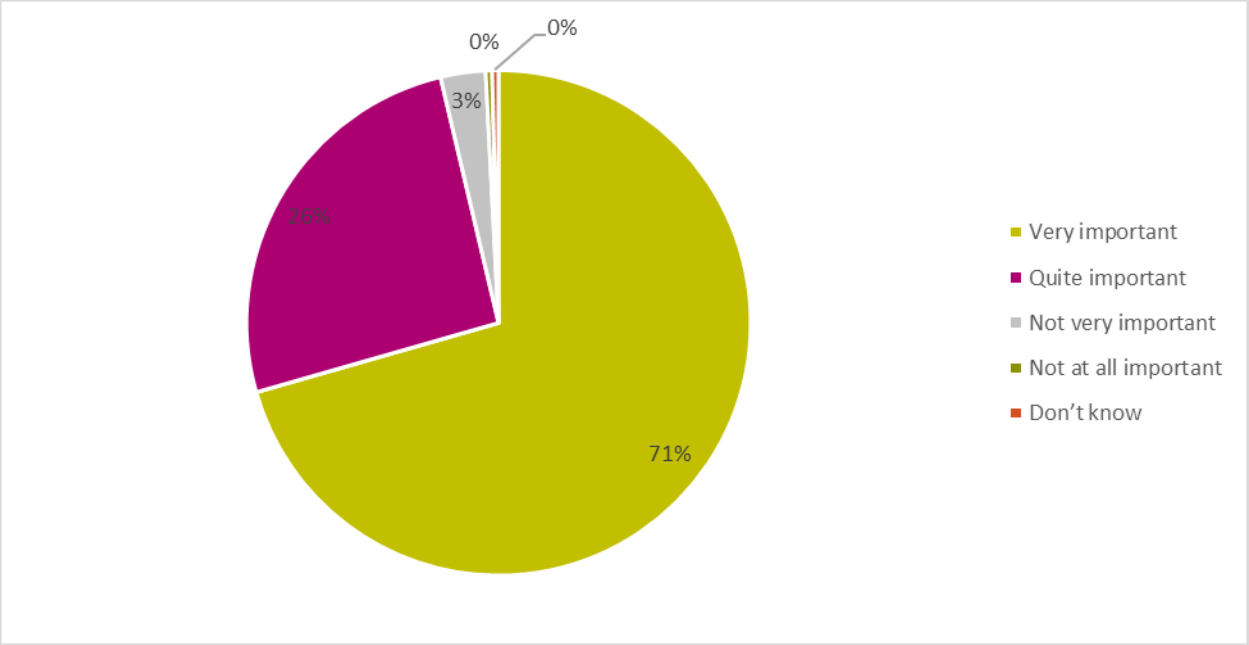


Figure 29: Demographics of fish survey respondents Q7- Which of these statements best describes your attitude to recycling? (n=486)

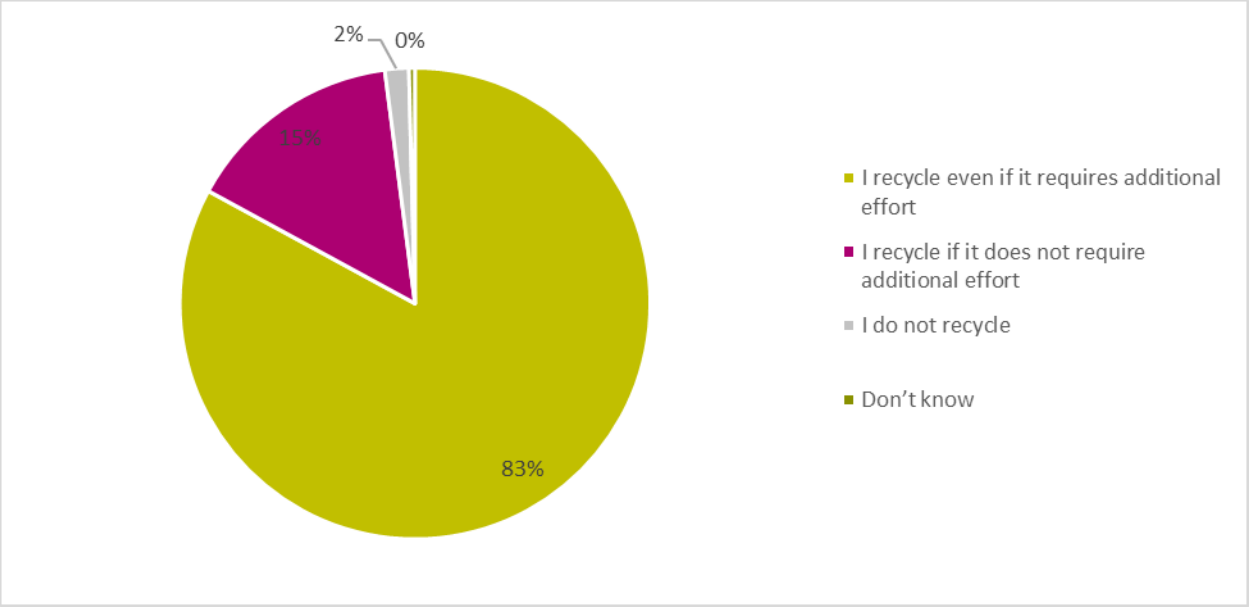


Figure 30: Demographics of fish survey respondents Q8- Which of these statements best describes how much you recycle? (n=486)

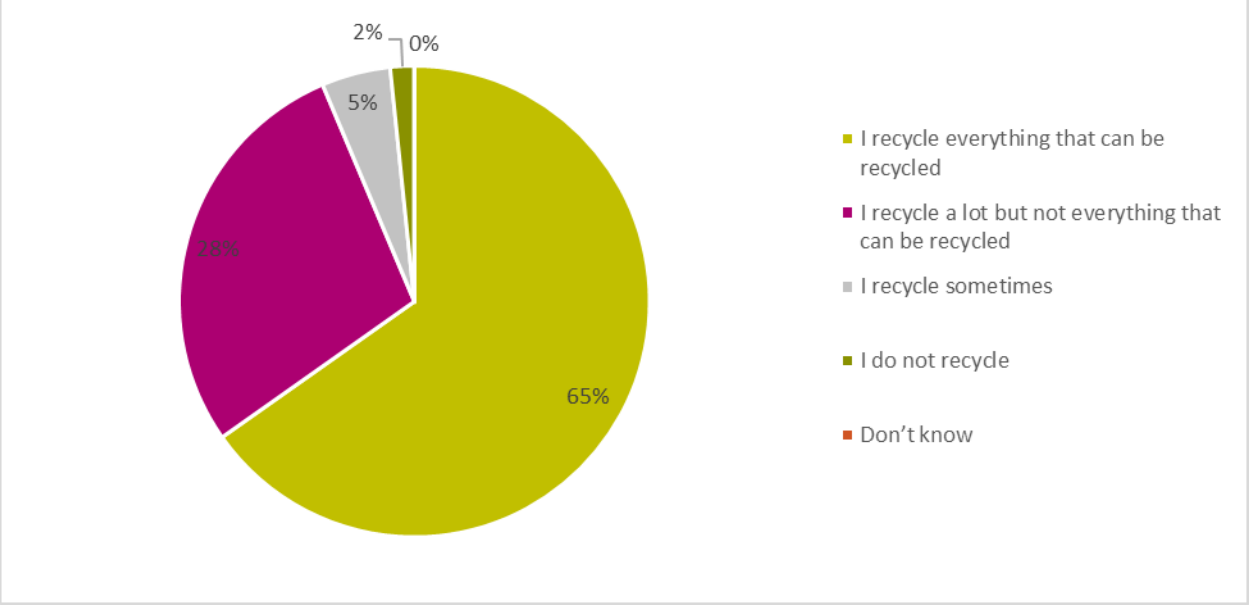
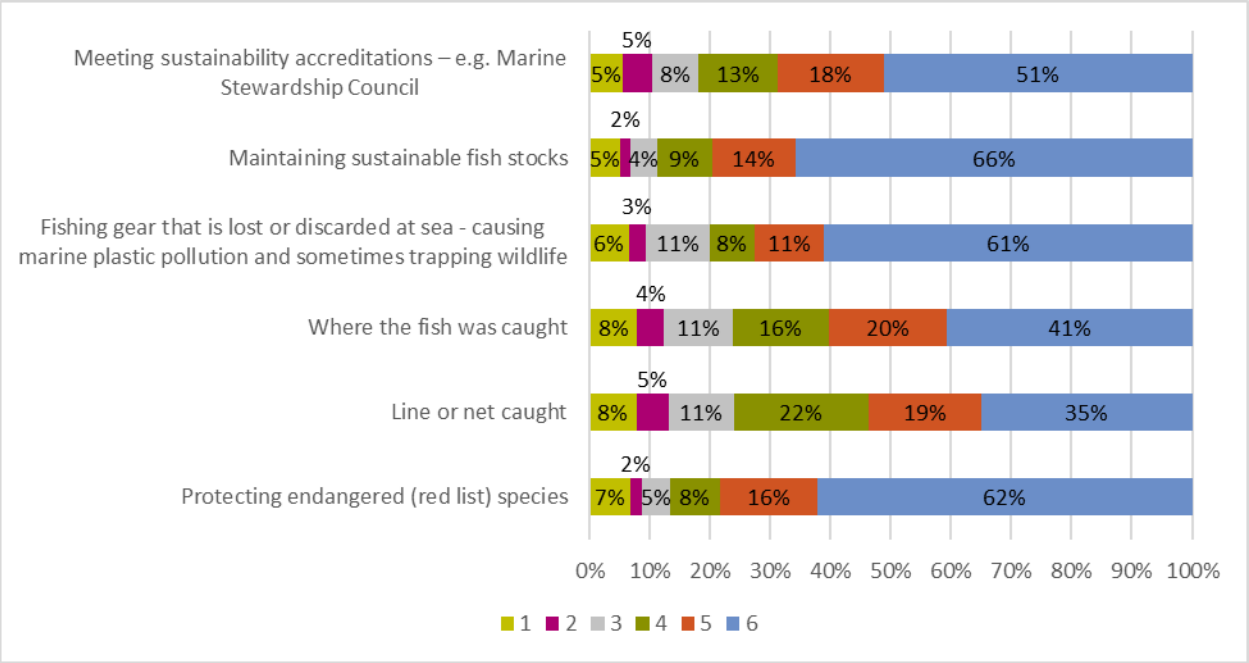


Figure 31: Fish Q5- Please rank these sustainability factors in order of how important you think they are when purchasing fish (1 being the lowest importance, 6 being the highest importance) (n=558)



Commercial fishing gear

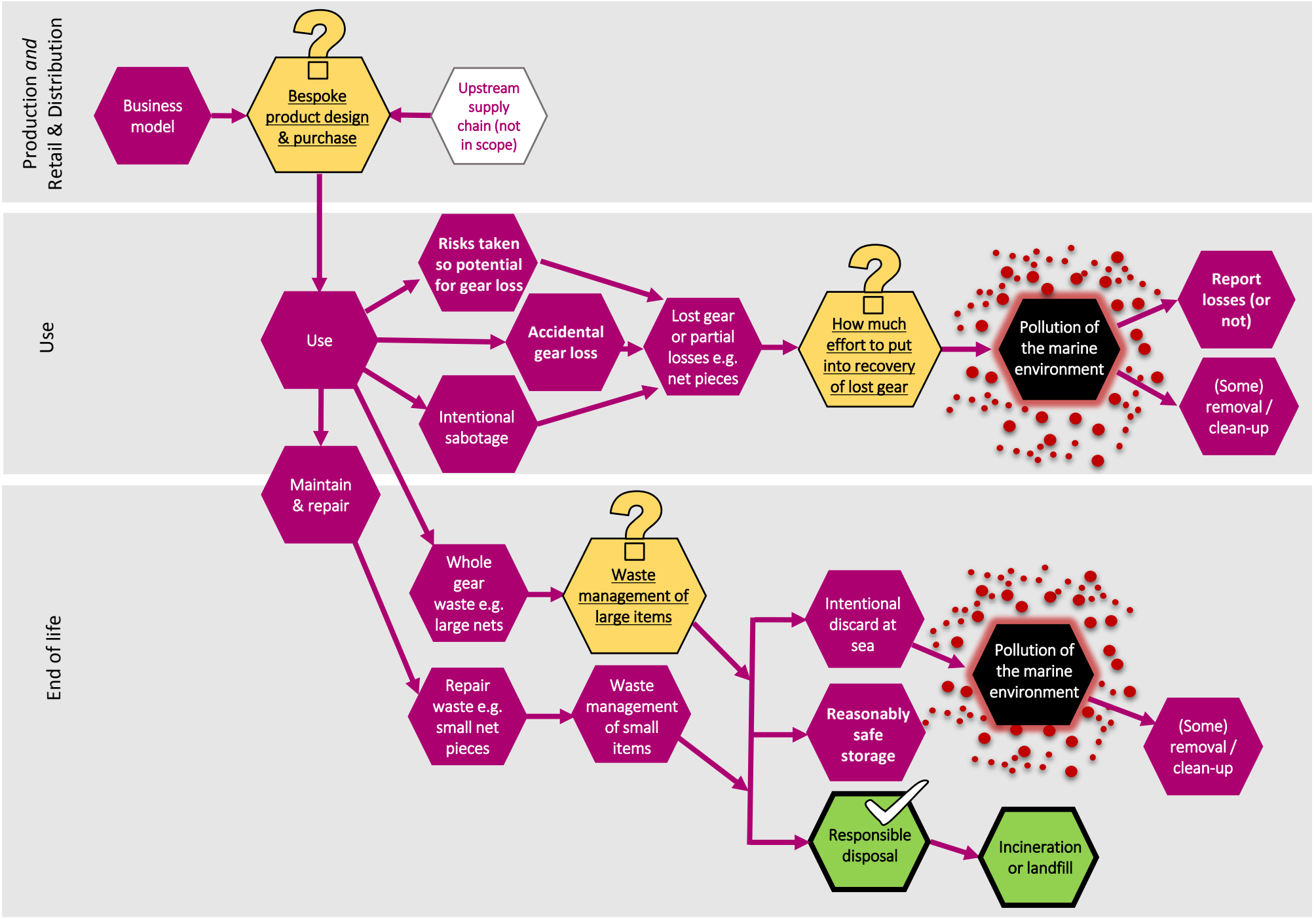
Commercial fishing gear

The main pathways to the marine environment are illustrated on the next slide.

Key decision points in the value chain have been identified where there is opportunity to help tackle marine litter.

Click on the yellow decision points to view more, including drivers and barriers and potential solutions.

Images: Creel pot (SEAFISH) and nets (Marine Scotland)


Production and Retail & Distribution
Business model
Bespoke product design & purchase
Upstream supply chain (not in scope)
Use
Use
Risks taken so potential for gear loss
Accidental gear loss
Intentional sabotage
Lost gear or partial losses e.g. net pieces
How much effort to put into recovery of lost gear
Pollution of the marine environment
Report losses (or not)
(Some) removal / clean-up
End of life
Maintain & repair
Whole gear waste e.g. large nets
Waste management of large items
Repair waste e.g. small net pieces
Waste management of small items
Intentional discard at sea
Reasonably safe storage
Responsible disposal
Pollution of the marine environment
(Some) removal / clean-up
Incineration or landfill

Key decision point

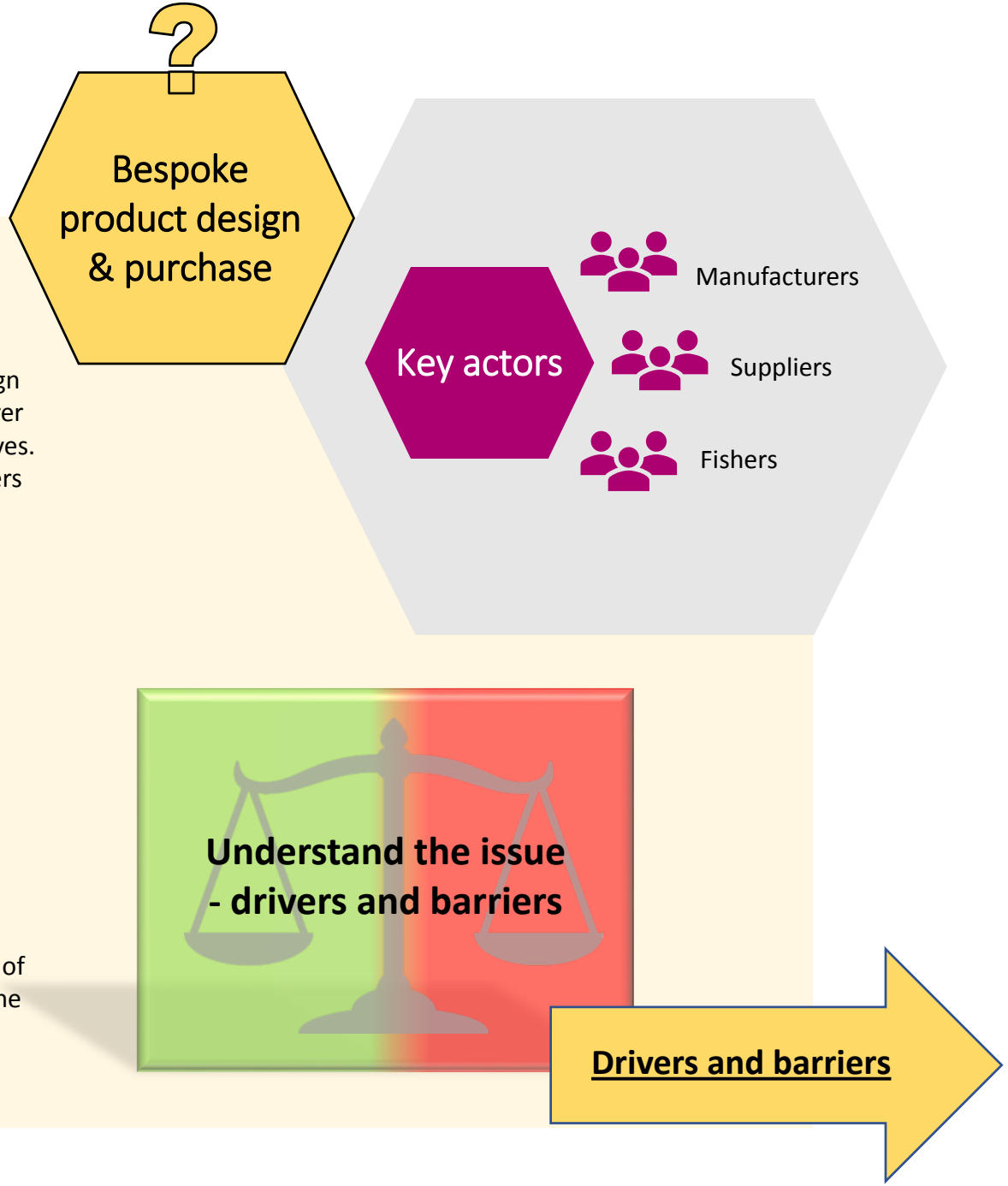
Fishers are typically involved in product design of nets, working closely with the manufacturer or net maker or assembling the net themselves. Creel pots are purchased whole from suppliers or assembled by fishers but tend to be less bespoke in design.

The key actors at this decision point are manufacturers, suppliers and fishers.

Opportunity

Wider opportunities are around systems thinking, including design for end of life and even recovery of lost gear, or product innovation to address marine litter issues.

There is also opportunity to encourage sales of products that are more durable and less prone to loss, however this is already common practice.



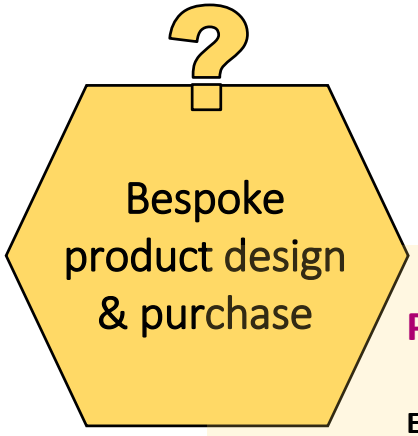
Primary factors

Factors encouraging action to avoid marine plastics

- Pro-environmental behaviour & care for the marine environment
- Biodegradable materials available (although not commonly found in market-ready products)

Factors discouraging action to avoid marine plastics

- High quality gear that can reduce marine litter is expensive
- Plastics are preferred because:
  - Cheap
  - Good strength to weight ratio
  - Durable
  - Abundant and easily accessible
  - Elasticity and buoyancy (where needed)
  - Non-absorbant (light when wet and no odour)
  - Improved health and safety (handling lightweight gear)
  - Can be manipulated to allow for gear design which meets technical standards required for conservation measures



Potential solutions

Education and engagement

- Amplify and spread pro-environmental behaviour
- Promote benefits and value for money of investing in high quality gear for reduced risk of loss, and increased repairability to encourage recovery of losses

Advance disposal fee

- Incentivise design for end of life by making manufacturers responsible for the waste, in line with EPR set out in the EU Single Use Plastic Directive

EPR takeback & EPR modulated fee

- Incentivise design for durability, loss prevention, repair and end of life, with reduced fees for the best performing products in these areas

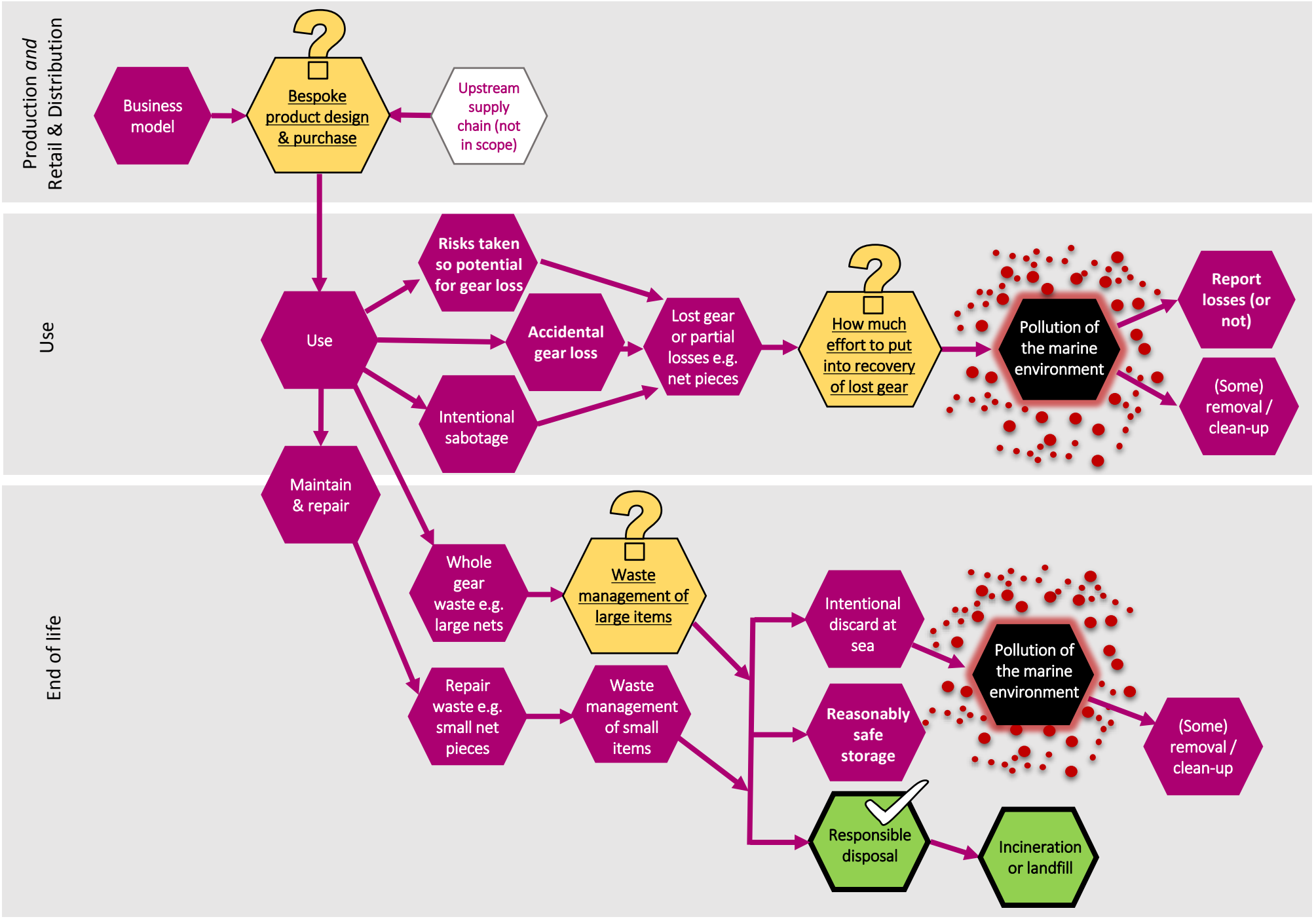
EPR modulated fee

- Incentivise all reduction in marine litter, with reduced fees if less commonly found as litter

EPR deposit return scheme

- Potentially incentivise design for end of life and to reduce marine litter to avoid loss of deposits. However, this effect may be very weak in practice.

Back to start


Production and Retail & Distribution
Business model
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Waste management of small items
Intentional discard at sea
Reasonably safe storage
Responsible disposal
Pollution of the marine environment
(Some) removal / clean-up
Incineration or landfill

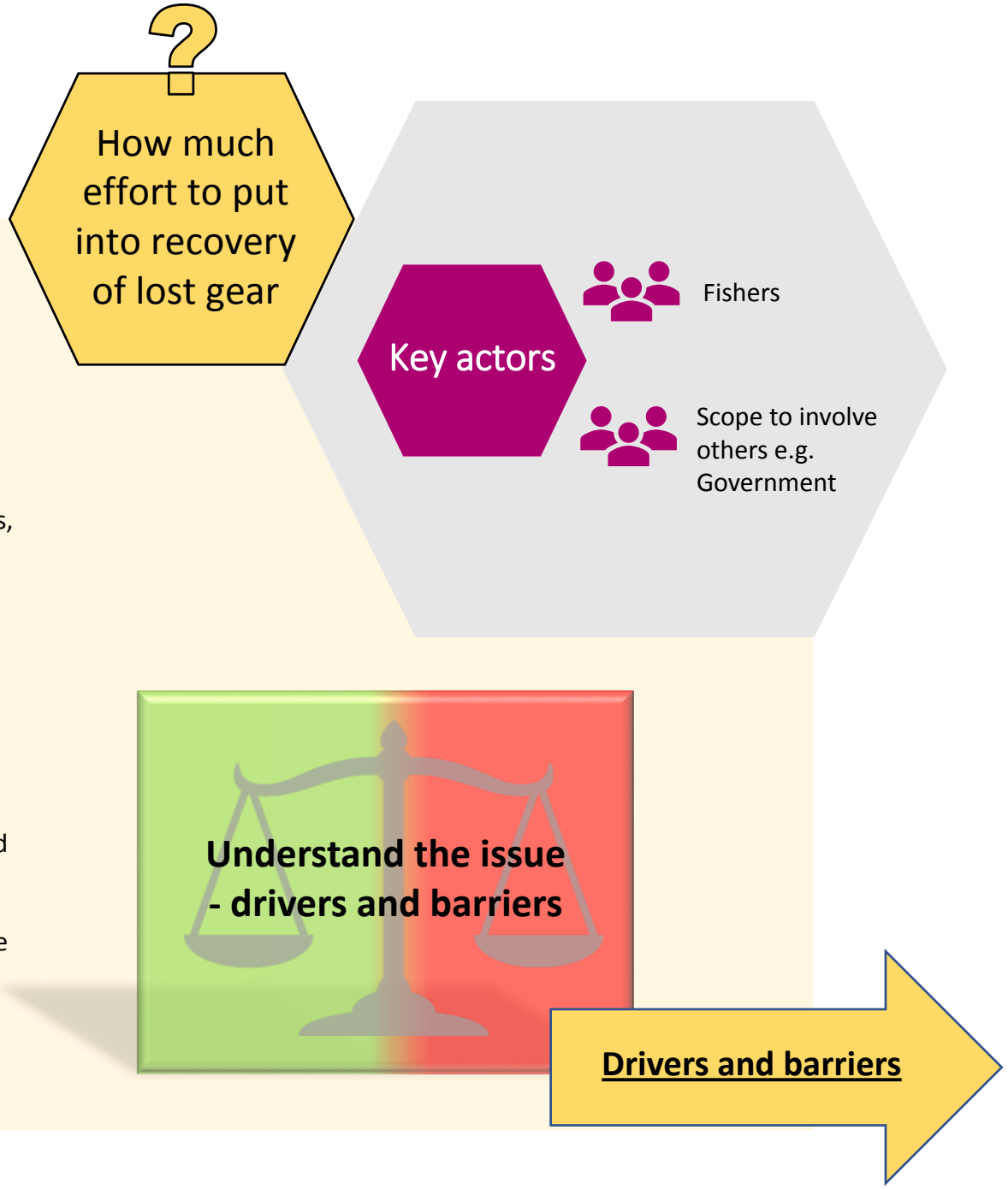
Key decision point

Fishers take a commercial cost-benefit decision on how much effort and resources to put into recovering lost gear.

Currently the only actors involved are fishers, but there is scope for other actors to be involved in recovery as occurs in the Norwegian government model.

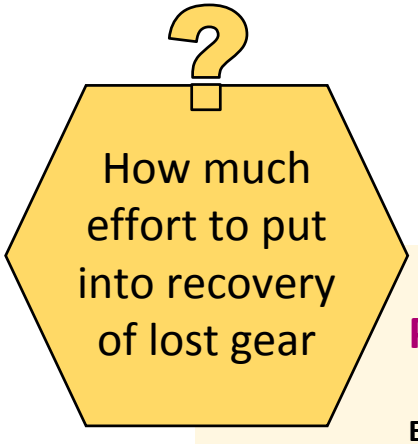
Opportunity

Recovery operations can be supported by removing barriers and using enabling technology. Fishers can be further motivated to recover the lost gear by increasing its value when recovered, particularly where the gear is old, damaged or would otherwise have little value.



	Factors encouraging recovery	Factors discouraging recovery
Primary factors	• Gear is costly to purchase / replace • Boat has suitable equipment to recover gear • Lost fishing time if no replacement gear immediately available • Lost gear becomes a hazard	• Recovery is difficult or dangerous • Gear is old or damaged by loss and value is reduced • Vessel has spare gear available for use so won't lose fishing time • Lost gear can be difficult to locate • Crew do not have the required skills
Secondary factors	• Professionalism – taking care of equipment, work environment and industry reputation • Not wanting lost gear to damage fish stocks and other marine life • Pro-environmental behaviour & care for the marine environment • Lack of funds / financial planning to replace gear	• Waste management issues If recovered gear is not repairable • Time is valuable – lost income from time spent on recovery • Likelihood of success • Lack of awareness of environmental consequences • Lack of awareness of legal obligation for recovery (and reporting)

Potential solutions



Potential solutions

Education and engagement

- Educate and inform on legal obligations
- Promote best practice on suitable equipment to recover gear
- Recognise and support professionalism – taking care of equipment and work environment

Recycling & 100% indirect fee & EPR

- Reduce waste management costs if recovered gear is not reusable

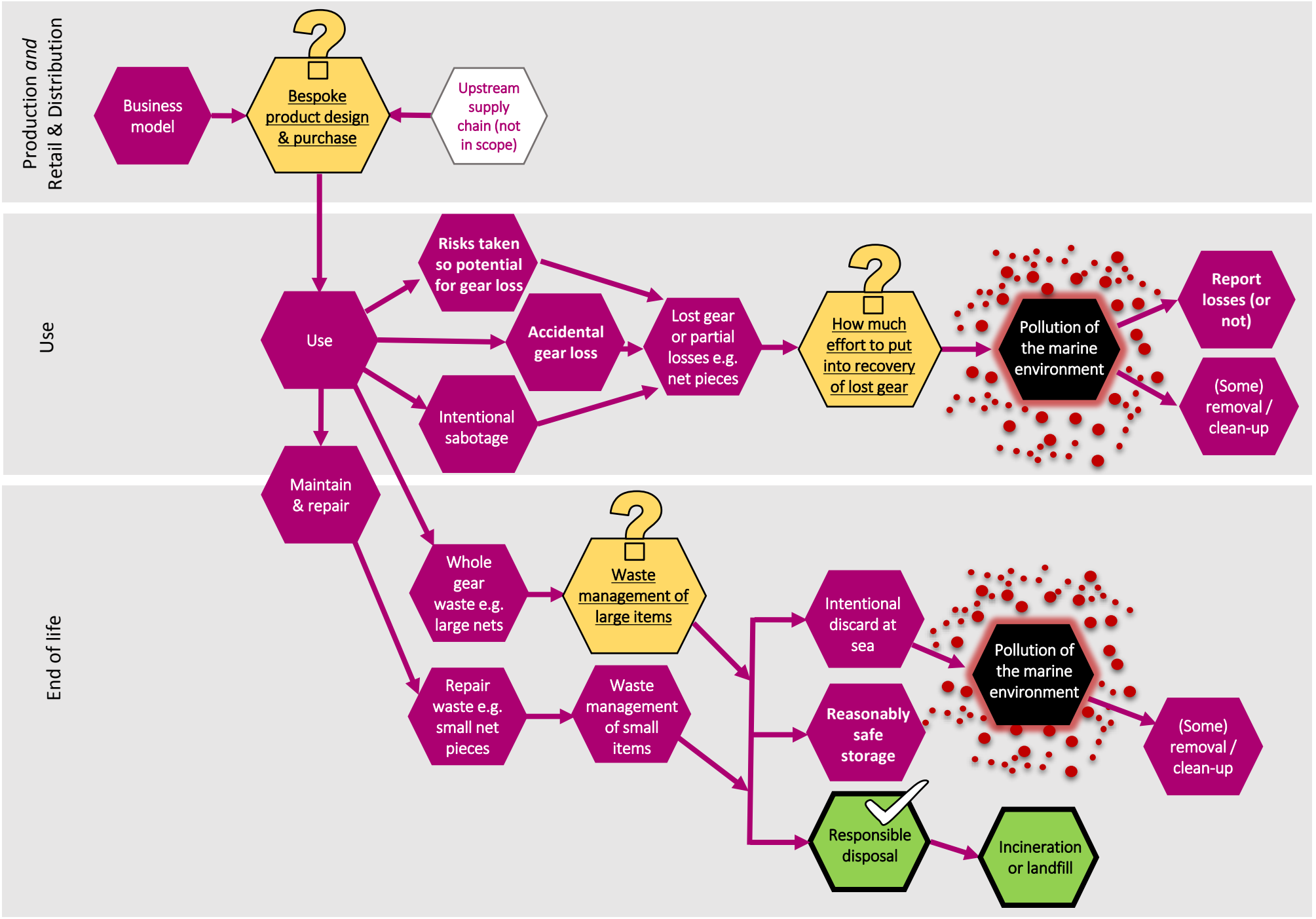
Gear marking and tagging

- Using electronic beacons on gear will promote loss reporting and also help locate lost gear

EPR deposit return scheme

- The deposit should be designed as a significant incentive to recover lost gear

Back to start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Accidental gear loss
Intentional sabotage
Lost gear or partial losses e.g. net pieces
How much effort to put into recovery of lost gear
Pollution of the marine environment
Report losses (or not)
(Some) removal / clean-up
End of life
Maintain & repair
Whole gear waste e.g. large nets
Waste management of large items
Repair waste e.g. small net pieces
Waste management of small items
Intentional discard at sea
Reasonably safe storage
Responsible disposal
Pollution of the marine environment
(Some) removal / clean-up
Incineration or landfill

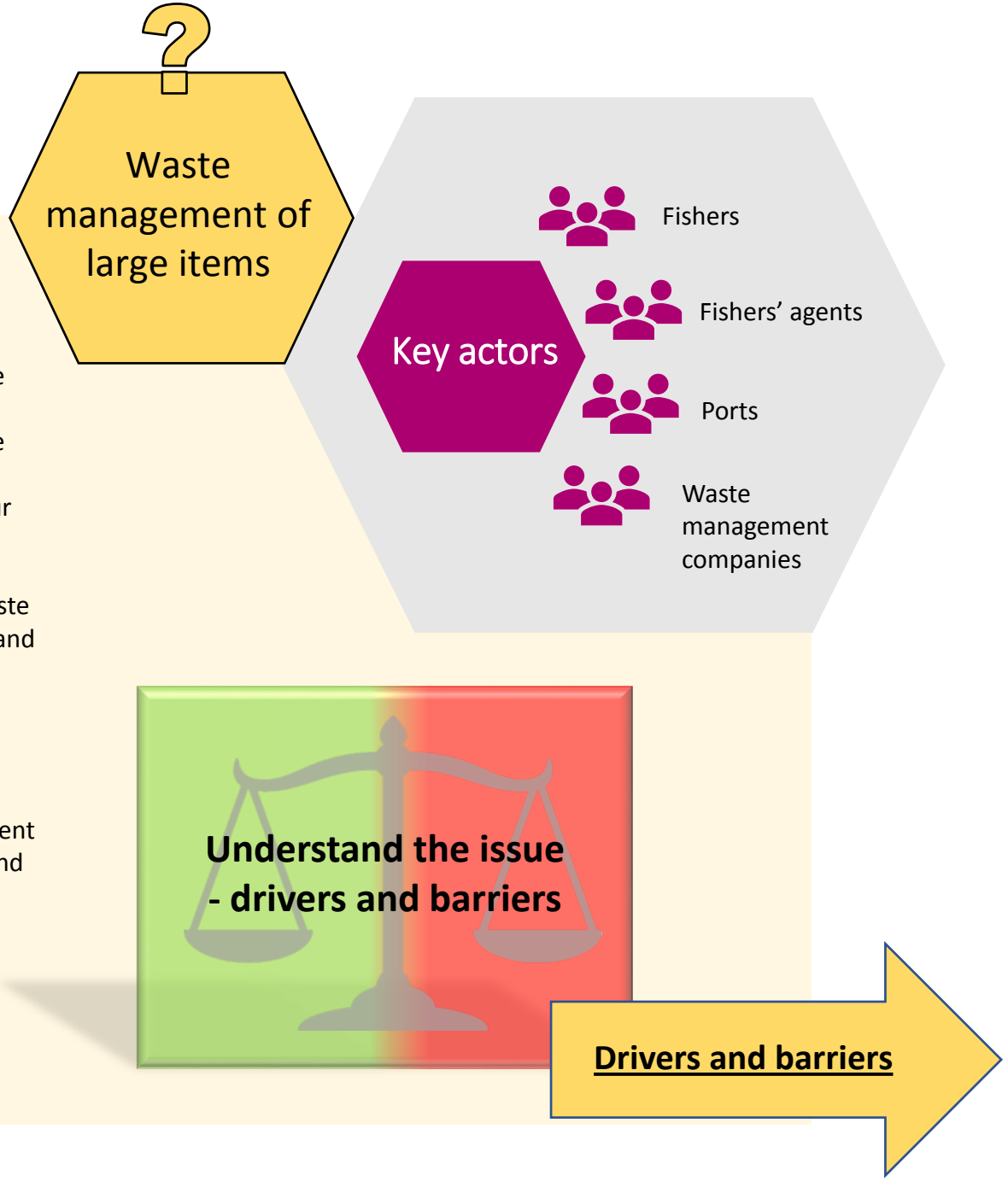
Key decision point

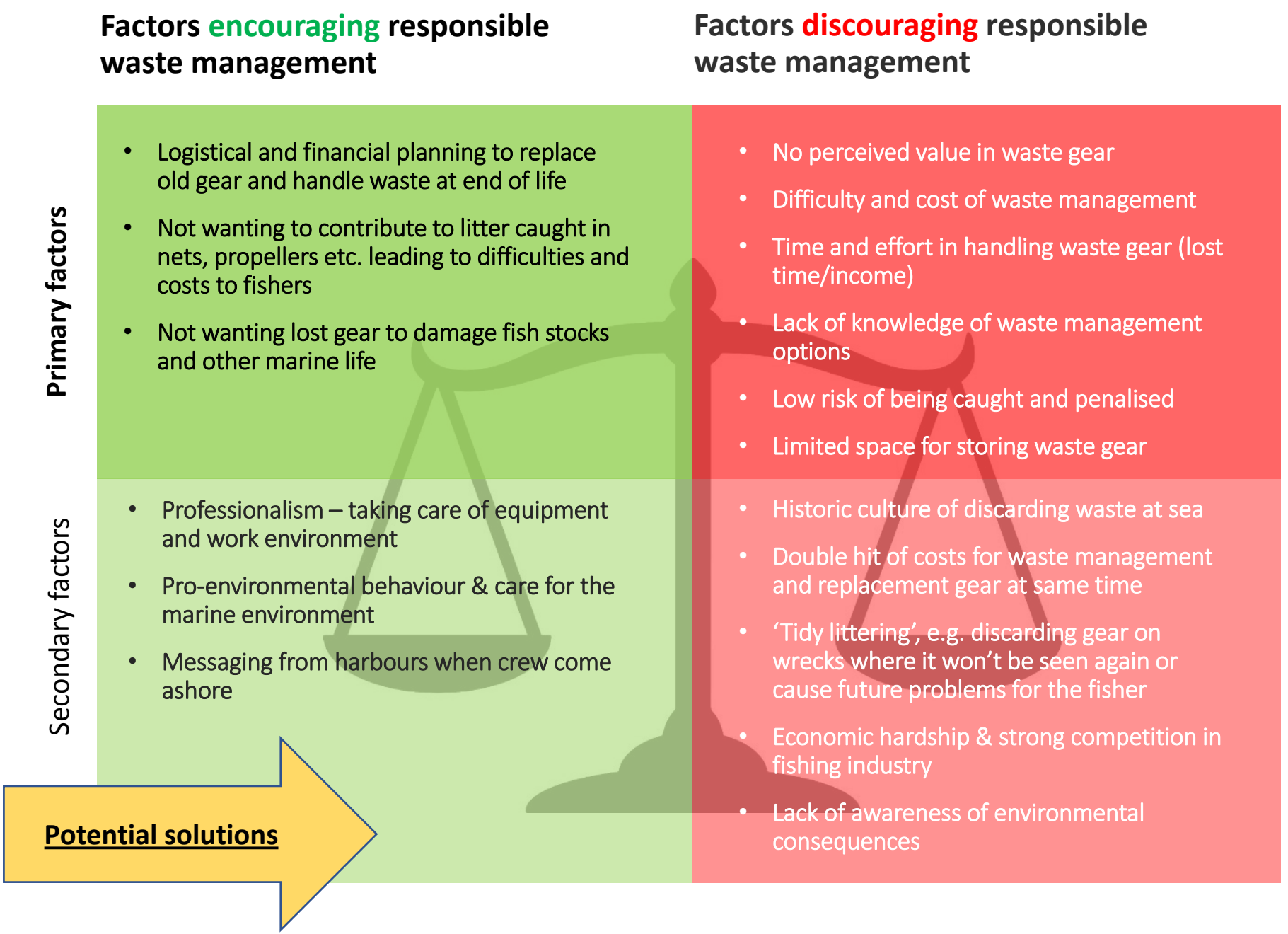
The fisher must decide how to manage large gear items at end of life. Whilst responsible disposal should deal with the waste in a safe and timely manner, a number of factors can lead to waste being put in storage at harbour or even intentionally discarded into the sea.

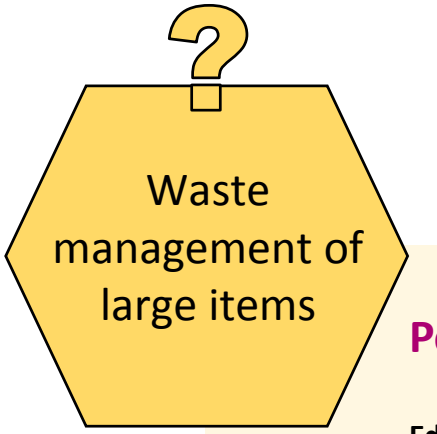
The actors responsible for managing the waste are typically the fisher or their agent, ports and waste management companies.

Opportunity

The barriers to responsible waste management can be removed, particularly the difficulty and cost of managing large waste items. Fishers can be further motivated to manage waste responsibly, e.g. by associating the consequences with rewards and penalties, awareness raising and other measures.




Factors encouraging responsible waste management
Factors discouraging responsible waste management
Primary factors
Logistical and financial planning to replace old gear and handle waste at end of life
Not wanting to contribute to litter caught in nets, propellers etc. leading to difficulties and costs to fishers
Not wanting lost gear to damage fish stocks and other marine life
No perceived value in waste gear
Difficulty and cost of waste management
Time and effort in handling waste gear (lost time/income)
Lack of knowledge of waste management options
Low risk of being caught and penalised
Limited space for storing waste gear
Secondary factors
Professionalism – taking care of equipment and work environment
Pro-environmental behaviour & care for the marine environment
Messaging from harbours when crew come ashore
Historic culture of discarding waste at sea
Double hit of costs for waste management and replacement gear at same time
'Tidy littering', e.g. discarding gear on wrecks where it won't be seen again or cause future problems for the fisher
Economic hardship & strong competition in fishing industry
Lack of awareness of environmental consequences
Potential solutions



Potential solutions

Education and engagement

- Educate on financial, economic and environmental impacts of marine litter
- Encourage fishers' role as best practice exemplars, mentors to others and stewards of the sea

Recycling & 100% indirect fee & EPR

- Create a system that is free for fishers to use, or even pays for waste delivered, widely available, simple to use, requiring minimal time and effort

Gear marking and tagging

- If gear tagging or marking cannot be removed, then marine litter can be traced back to the vessel

EPR deposit return scheme

- The deposit should be designed as a significant incentive to manage waste responsibly

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