# Understanding commercial fishing gear use and disposal needs in Wales

## Welsh Government

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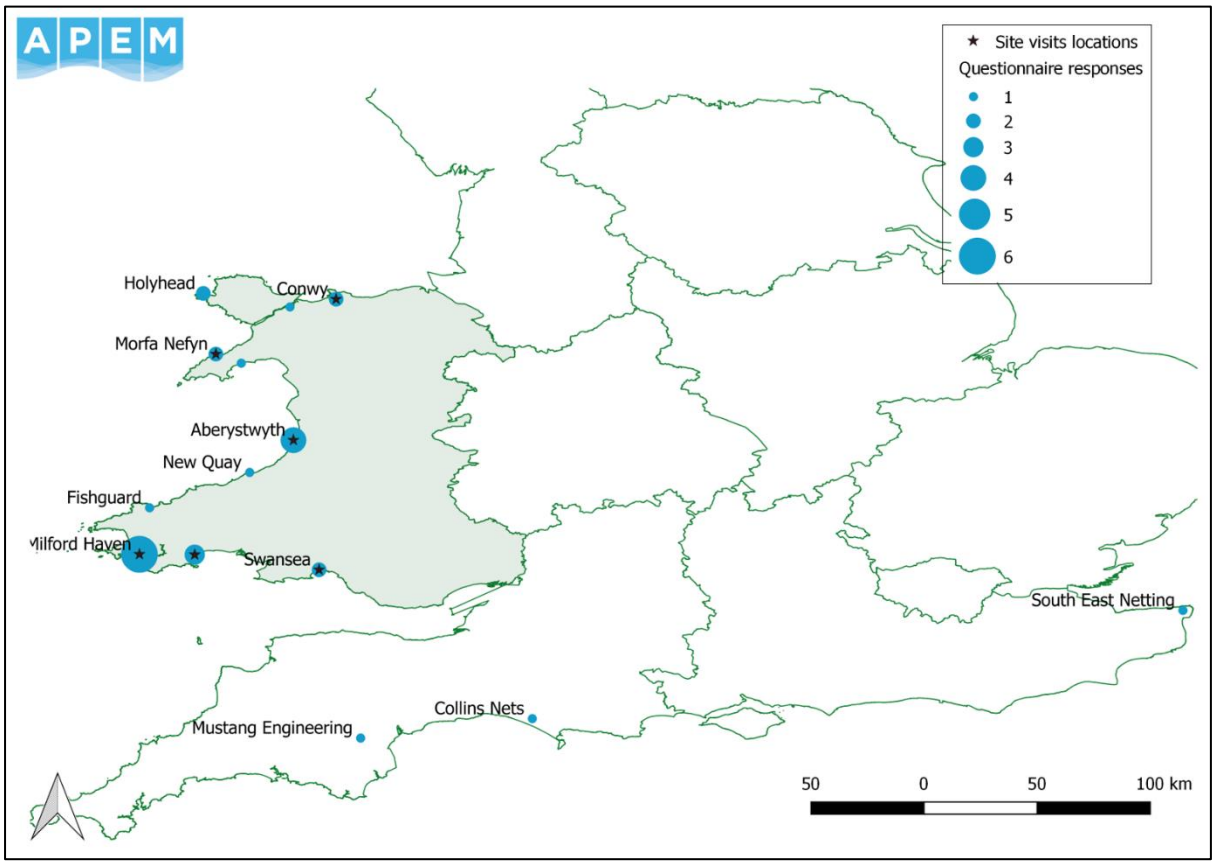
# 1. Executive summary

Research was conducted into the quantity and type of fishing gear used and collected by the Welsh commercial fishing fleet. This information has been used to understand the availability of, and need for, disposal facilities for fishing gear used and collected by commercial fishers. To address the disposal of fishing gear, an understanding of the quantity and type of fishing gear used is important. The aim of this project was therefore to collect data on the commercial fishing gear used by the Welsh commercial fishing fleet, and the current methods of disposal. The below map shows the geographic distribution of fishers and ports surveyed within the project.




Weighted geographical distribution of survey responses from fishers and harbour masters. Stars indicting ports visited. Contains OS data © Crown copyright and database right 2018.

The commercial fishing fleet in Wales is comprised of around 400 under 10m vessels and approximately30 over 10m vessels, all registered to Welsh ports. The main target species are shellfish; including whelks, lobsters, crabs and prawns, caught using pots, withsignificant landings of scallops caught from vesselsusing dredges. There are also landings of demersal fish species such as skates, rays and flatfish from trawl fisheries.. Pelagic species are not generally landed into Welsh ports.

Few disposal facilities are available to commercial fishers at Welsh ports, with the majority offering nominal or limited facilities. Several ports have previously provided permanent disposal facilities; however, these were subjected to illegal dumping, fly tipping, and inappropriate inclusion of hazardous waste creating additional expense and problematic removal. Ports which continue to offer permanent disposal facilities generally have separate

access-only areas many of which are locked. Skips are hired periodically in other ports to avoid this issue. Payment for these facilities varies among ports, with some ports covering this cost, others charging for waste disposal, whilst fishers organise and pay for disposal themselves in some ports.

There are very few recycling facilities at ports and no specific recycling programmes or schemes for fishing gear known of within Wales. Fishing gear suppliers in Wales are often small operations and do not have the resources to provide end-of-life solutions for the disposal and recycling of fishing gear. Some suppliers in the UK have offered recycling programs for the gear, however, fishers were either not interested or unable to transport the old gear to make use of the program. In order to dispose of end-of-life fishing gear, many fishers resort to transporting gear to local landfill facilities, storing end-of-life fishing gear, discarding municipal waste and small pieces of gear in public bins often situated on the port promenade or in domestic bins. Although there were expressions of wanting to recycle gear, few fishers made use of local council recycling facilities. The reason for this may be linked to accessibility, cost and materials accepted for recycling.

According to the Welsh fishers interviewed, they produce little end-of-life fishing gear. Many fishers extend fishing gear life by repairing the gear and use retrieved fishing gear for spare parts. Depending on the fishing gear used, and the fisher, fishing gear can last several years (nets and lines) to decades (prawn pots and mixed pots). However, according to the fishers surveyed, a larger scale of waste results from domestic waste found at sea, and to a lesser extent abandoned, lost or discarded fishing gear (ALDFG) brought back to land. Many fishers actively collect ALDFG and domestic waste encountered as it negatively impacts their resources and can be hazardous to the vessel or its gear. Disposal of this waste is not always practical with a lack of port facilities and often costly to the fisher who retrieved it to dispose of in landfills.

Conservation groups attempting to tackle ALDFG are available in the UK, however few operate in Wales, with some citing the high cost of operating in Wales as one of the main reasons. Furthermore, recycling fishing nets has been noted as not possible in the UK by one of the conservation organisations contacted, despite projects to upcycle such items existing. The conservation organisation Neptune's Army are active at removing fishing gear in Pembrokeshire. They work closely with fishers, and often assist fishers to retrieve lost gear.

This project has highlighted a need for a coordinated solution for the disposal of fishing gear used and collected by the Welsh commercial fishing fleet. The project has provided data to underpin the understanding of the current situation within several Welsh ports, and areas requiring development to provide a safe, secure and sustainable method of disposal and recycling for fishing gear. Specifically, existing methods of disposing ALDFG and municipal waste collected at sea, and facilities for pot and net gear appear to be insufficient to meet the needs of fishers. A disposal infrastructure which enables these aspects should be developed with an increased focus on the promotion of recycling. Further, in-depth engagement with fishers across more Welsh ports would aid this investigation and development.

# 2. Introduction

Abandoned, lost, or discarded fishing gear (ALDFG) and other marine debris (or litter) is a global concern due to the potential for causing damage to the marine environment and marine animals (Newman *et al.,* 2015). Where marine debris can be described as any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment. To address this issue within Welsh waters, the Welsh Government required a further understanding of the quantity and type of fishing gear used and collected by the Welsh commercial fishing fleet. This information is to be used by the Welsh Government to understand the availability and need for disposal facilities for fishing gear used and collected by commercial fishers. The aim of this project was therefore to collect data on the fishing gear used by the Welsh commercial fishing fleet, and the current methods of disposal.

To achieve the aim of the project, the project objectives were to:

1) Research the quantity and types of fishing gear used in Wales and the amount, method and infrastructure for disposal of fishing gear;
2) Assess the disposal infrastructure available at Welsh fishing ports;
3) Research and engage with environmental organisations available in Wales which focus on ALDFG and the recycling or reuse of this gear; and
4) Conduct desk-based studies and surveys of manufacturers and suppliers of fishing gear in Wales focusing on the type of commercial fishing gear produced and supplied to Welsh fishers, and if they provide support for sustainable disposal of fishing gear.

# 3. Background

The Well-being of Future Generations (Wales) Act 2015 (WFGA; Welsh Government, 2015) and the Welsh National Marine Plan (WNMP; Welsh Government, 2019a) include the need to consider the lasting impacts of anthropogenic activity on the marine environment as an aid to sustainable management of marine natural resources. As outlined in the goal of a Resilient Wales in the WFGA, Wales aims to be "A nation which maintains and enhances a biodiverse natural environment with healthy functioning ecosystems that support social, economic and ecological resilience and the capacity to adapt to change" (WFGA, 2015, p.4). Closely linked to this is the WNMP which notes an overarching objective which requires "taking account of the cumulative effects of all uses of the marine environment" (WNMP, 2019, p.5). And as outlined in Policy ENV_04 "This policy aims to contribute towards achieving the targets for reducing marine litter" and "aims to contribute towards the wider achievement of ecosystem resilience and to safeguard the coastal and marine environment from harm resulting from the release of marine litter" (WNMP, 2019, p.55).

ALDFG, an anthropogenic activity, is a riskto the health of the marine environment and marine natural resources. It impacts of marine pollution which  s the resilience of the marine environment and its uses. A wide body of literature exists which discusses the general impacts of ALDFG and emphasises problems such as entanglement of birds and marine animals, plastic pollution, micro plastics, and smothering of vulnerable ecosystems (Gilman *et al.,* 2016; Good *et al.,* 2009). These effects subsequently affect the ability of the marine environment to support social, economic and environmental resilience. It is widely acknowledged that we need to reduce the sources of marine litter. Therefore, we need to consider the sources of ALDFG in an attempt to reduce marine litter.

Around 80% of all marine litter originates from land-based waste, predominantly originating from densely populated or industrial areas (Derraik, 2002; Li *et al.,* 2016). A further 10% of all marine debris originates from other aquatic sources and finally approximately 10% from ALDFG (Derraik, 2002; Brown *et al.,* 2005; Li *et al.,* 2016). Although ALDFG only accounts for approximately 10% of all marine litter, globally, some of the 640,000t of fishing gear lost annually will continue to fish once lost. Lost gear which continues to fish is termed 'ghost fishing' (Macfadyen *et al*., 2009) and could represent a persistent and cumulative pressure over future years.

Ghost fishing can vary with fishing gear type, for instance, active gear such as seine nets and trawl nets generally have low catchability once lost compared to passive gear such as gill nets, pots and trammel nets (Santos *et al.,* 2003). Furthermore, the effectiveness of fishing tends to decrease with time as the gear deteriorates (Kaiser *et al.,* 1996; Macfadyen *et al*., 2009). Certain gear has been designed to mitigate against ghost fishing. For instance, pots with biodegradable panels with escape rings have been trialled and are found to be comparable with traditional methods, yet once lost, gear will eventually be disarmed thus reducing further fishing (Bilkovic *et al.,* 2012). Escape hatches that open after a period in sea water reduce the effective ghost fishing area of the gear. Markers such as underwater lights, acoustic transmitters and reflectors can assist fishers in finding and recovering fishing gear if lost (Wilcox and Hardesty, 2016). Encouraging the fishing community and raising awareness of methods available to reduce ghost fishing and gear loss can have a substantial positive effect.

Ghost gear remains a problem and finding a solution to completely eradicate this would be a challenge. Environmental organisations or businesses such as Global Ghost Gear Initiative (Fishing For Litter), Neptune's Army of Rubbish Cleaners, Sea Shepherd, and Fathoms Free aim to remove ALDFG and other items from the sea. Linked to this are organisations such as

The Olive Ridley Foundation and World Animal Protection which focus on rescuing and rehabilitating snagged and vulnerable animals from ghost gear. Finally, initiatives through organisations such as Fourth Element, Teko, RubyMoon, Interface and AFrayedKnot aim to reuse and recycle ghost gear into clothing, carpets, surfboards and other items have been developed. Despite these efforts to reduce lost fishing gear, ALDFG is still a considerable concern and large amounts of marine animals continue to be impacted by ALDFG (Richardson *et al.,* 2019).

The commercial fishing industry can also be negatively affected by ALDFG. For instance, lost gear can become trapped in propellers, cause navigational issues, and pose potential economic losses (Richardson *et al.,* 2018). As fishing gear can be a considerable investment, many fishers aim to reduce fishing gear loss, with fishers at times attempting to retrieve lost fishing gear, often with a high rate of success (Santos *et al*., 2003). Fishing gear loss was found to be predominantly due to external pressures such as environmental, spatial, operational, economic, and enforcement pressures (Richardson *et al.,* 2018). These pressures generally arise from common factors including poor weather, overcrowding, gear conflicts, improper gear storage, lack of shore-side collection facilities for end-of-life gear, high costs of gear disposal and vandalism or theft (Brown *et al*., 2005; Macfadyen *et al*., 2009; Richardson *et al.,* 2018).

There is a lack of data pertaining to the gear disposal practices of the Welsh commercial fishing industry, the life span of fishing gear used and how much gear is lost. This project aims to fill these knowledge gaps, providing foundations for targeted efforts to improve disposal of end-of-life fishing gear. Where fishing gear is disposed of at appropriate waste disposal facilities, the risk to the health of the marine environment is considerably reduced, and therefore this project and research will help to inform Welsh Government's future policies and actions for disposal of fishing gear used or collected by the Welsh commercial fishing fleet.

# 4. Methodology

To achieve the aim of the project, to gain a further understanding of the quantity and type of fishing gear used, collected, and disposed of in Wales, several tasks were conducted:

1) A desk-based review of quantity and types of fishing gear used in Wales and its disposal (amount, method, and infrastructure);
2) A desk-based review, including communication and data requests, of conservation organisations (such as Global Ghost Gear Initiative, Ghost Fishing UK and Neptune's Army) in and around Wales regarding the amount of commercial fishing gear they remove and recycle in Wales;
3) Engagement with the Task and Finish Group set up by Welsh Government for the project, which includes representatives from Welsh Government, Natural Resources Wales, SeaFish, the Welsh Fisherman's Association and members of the Welsh fishing industry;
4) A questionnaire survey of members of the Welsh commercial fishing industry, harbour masters and gear suppliers to collect primary data on gear usage and disposal; and
5) Site visits to a selection of chosen ports around Wales to gain an understanding of fishing gear used and disposal methods available at each port.

The approach followed for each task is detailed in Sections 4.1 to 4.5 below.

## 4.1 Review of Welsh fishing, gear usage and disposal facilities

A desk-based review of the available literature and data on fishing activities by the Welsh commercial fishing fleet was conducted to understand the vessel composition of the Welsh fishing fleet, species caught, and fishing gears used. Port websites and other literature resources were reviewed to investigate current fishing gear disposal methods available at ports around Wales. Information on the composition material of the fishing gears and the types of species the gears are used to target was also obtained from a review of the available literature. This enabled further research to be conducted into the recyclability of fishing gear based on the ease of recycling various materials.

Landings data for European registered vessels landing into Welsh ports was sourced from the Marine Management Organisation (MMO, 2020a) in which vessel nationality was not disaggregated beyond the definition of UK  it was considered to be the best available dataset to identify the composition of catches likely from the Welsh commercial fishing fleet. At the time of review the most recent complete annual landings dataset was for 2018. Data on vessels registered at Welsh ports was also obtained from the MMO, for May 2020, which included their size (MMO, 2020b; MMO, 2020c).

## 4.2 Review of active conservation organisations addressing ALDFG in Wales

A desk-based review of the available literature and data, as well as engagement with the Task and Finish Group (see Section 4.3 below), was conducted to identify conservation

organisations which may have data on lost fishing gears in Welsh waters. Upon identification of relevant organisations, research on available information provided by the conservation organisations was conducted. Where further information or clarification was required, pertaining to the amount of gear they found and removed in and around Wales, organisations were contacted.

## 4.3 Engagement with Task and Finish Group

A Task and Finish Group was formed by the Welsh Government for this project. The group comprised of the Welsh Government, Natural Resources Wales, APEM, the Welsh Fisherman's Association, SeaFish and key members of the industry.

## 4.4 Industry questionnaire survey

Three anonymous questionnaires were created in collaboration with the Task and Finish group to engage with the Welsh commercial fishing industry, fishing gear suppliers and harbour masters. The recent *Design and Recycling of Fishing Gear in the OSPAR region* questionnaire (OSPAR, 2020; unpublished) was used as a reference when developing the questionnaires.

The harbour master and commercial fishing industry questionnaires aimed to gain information on the dominant fishing gear(s) used by each port, local methods of waste gear disposal available, and any knowledge of locations available to recycle fishing gear. The questionnaire for fishing gear suppliers aimed to gain an understanding of what types of fishing gear are being sold to Welsh commercial fishers and if suppliers assist in the disposal of waste gear. Seventy-eight questionnaires were distributed, 40 to fishers, 25 to harbour masters, and 13 to suppliers. Additionally, questionnaires were made available through social media accounts, however, the distribution of this was not measured. The questionnaires distributed are provided in Appendix I. To maintain anonymity, full questionnaire responses have not been provided within the report. The aim was to distribute questionnaires electronically (through social media and emails), telephonically and in person. Questionnaires were made available through APEM, some willing harbour masters and fishers and the Welsh Government. Certain contacts to assist with questionnaire distribution were provided by fishers and online searches.

## 4.5 Port/site visits

Site visits provided a deeper understanding of the practical disposal methods available at Welsh ports and were arranged with either the harbour master and or a prominent member of the local fishing industry. To maximise the utility of the site visits, harbour masters and commercial fishers were also interviewed using the questionnaires as talking points where possible.

The following six ports were selected for site visits as they represent ports with a variety of fishing activities, range of landing volumes, number of registered vessels, port ownership models and geographical regions of Wales (as shown in Figure 1):

- Milford Haven;
- Swansea;
- Conwy;
- Saundersfoot;

- Aberystwyth; and
- Holyhead.

The site visit to Holyhead was cancelled due to the COVID-19 outbreak emerging at the time of the visit, and Morfa Nefyn (including nearby Hells Mouth and Pothdinllaen) port was selected as an alternative.

The different types of port ownership models in Wales are as follows (BPA and UKMPG, 2016; Garner, personal communication 23 March 2020):

1. Trust port (Milford Haven and Saundersfoot): independent statutory body controlled by an independent board and governed by its own local legislation. These ports are generally considered to have a high degree of accountability, closely follow government guidelines regarding accountability and commercial progress;
2. Privatised port (Swansea, Porthdinllaen and Hells Mouth): privately owned port. These ports may form part of a larger port group; and
3. Municipal ports (Conwy, Aberystwyth and Morfa Nefyn): run by local authorities. These ports have their own governance guidelines and emphasise financial independence through ring-fencing of accounts and have corporate structures (with traditional board approach).

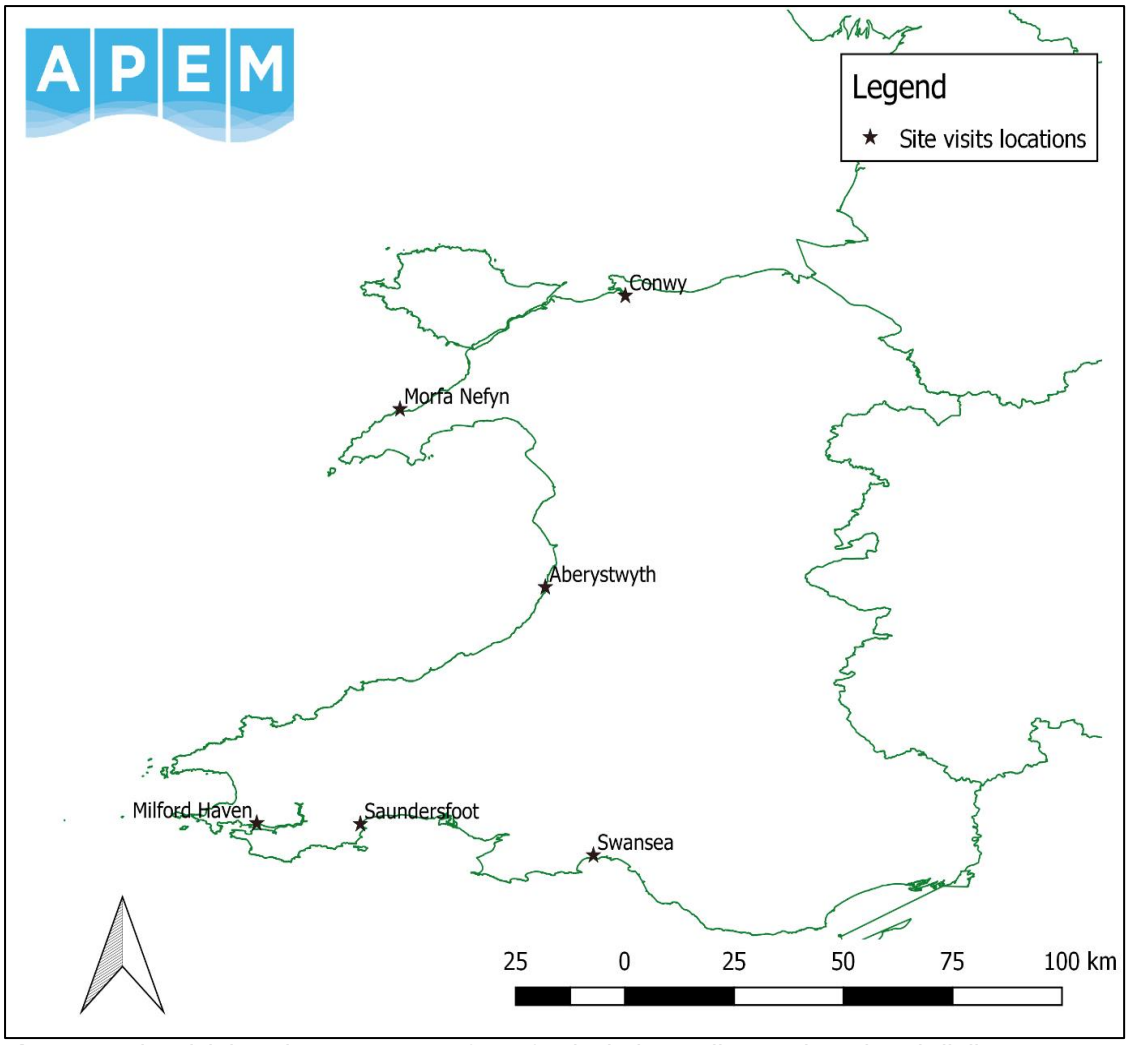



**Figure 1:** Site visit locations. Note: Morfa Nefyn includes Hells Mouth and Pothdinllaen ports. Contains OS data © Crown copyright and database right 2018.

# 5. Results

The results of each of the tasks described in the methodology in Section 4 are presented in Sections 5.1 to 5.5 below.

## 5.1 Review of Welsh commercial fishing activities, gear usage and disposal facilities

### 5.1.1 Welsh commercial fishing fleet

Although the number of fishing vessels fluctuates, the Welsh commercial fishing fleet is comprised of approximately 400 licenced and registered fishing vessels(

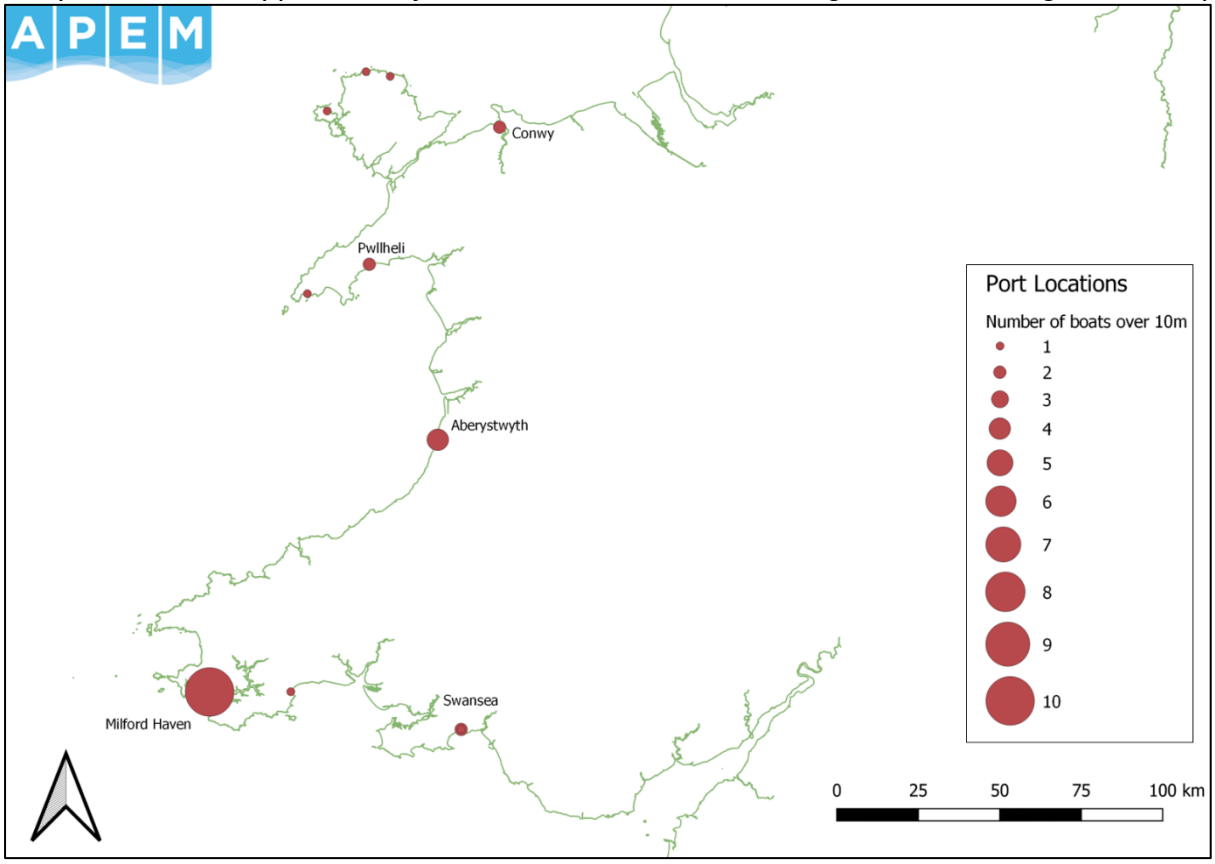



Figure 2 and Figure 3), 90% of which are under 10m (MMO, 2020b; Welsh Government, 2019b). At the beginning of 2018, only 29 vessels were greater than 10m in length and were registered in one of just 10 ports.

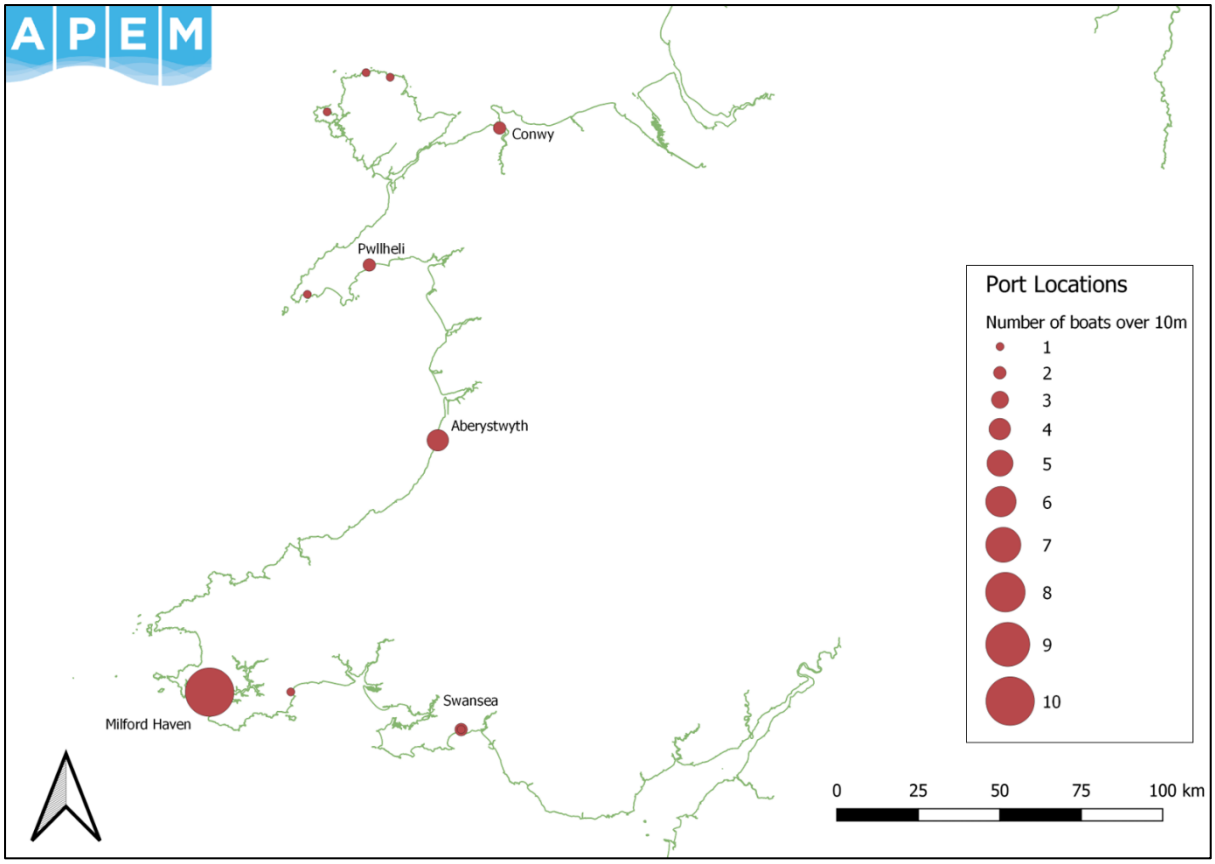



**Figure 2:** Welsh ports where boats over 10m in length are registered in 2018 (data adapted from MMO, 2020c). Contains OS data © Crown copyright and database right 2018.

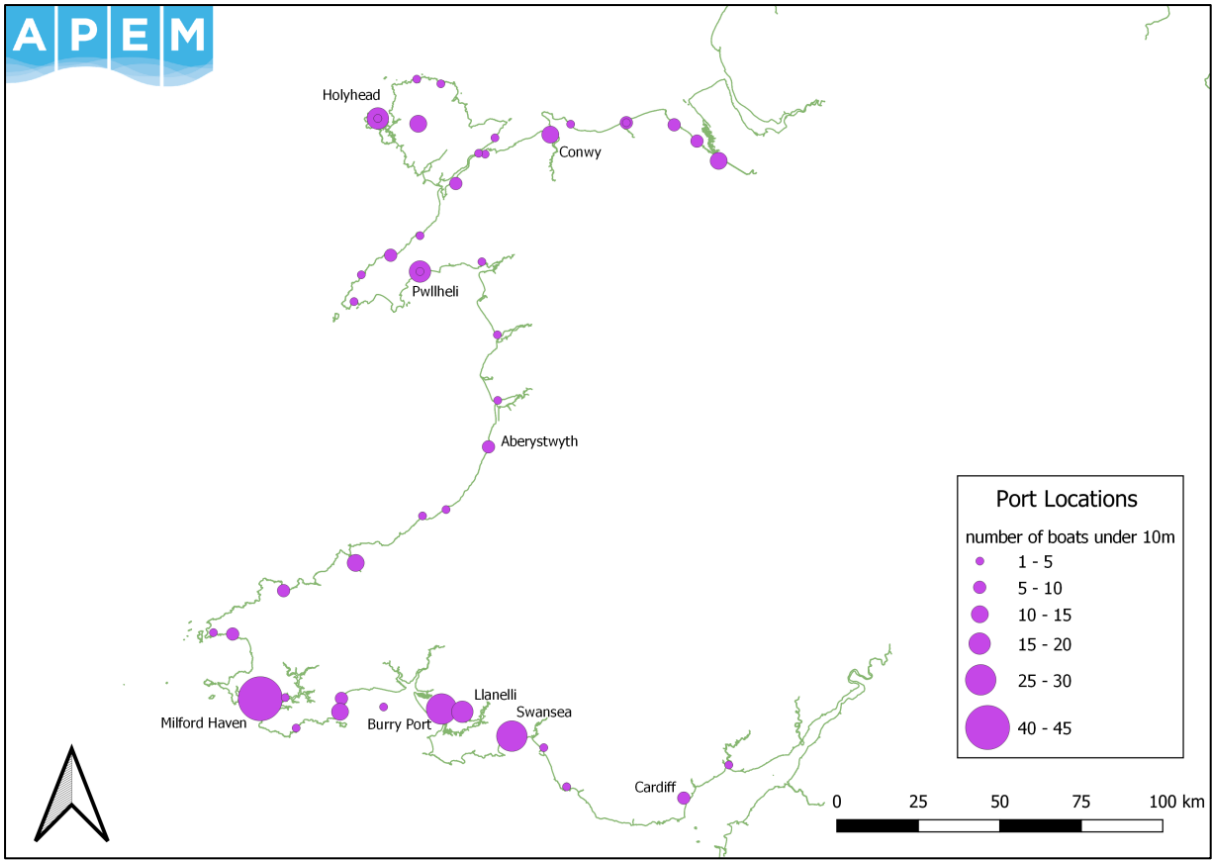



**Figure 3:** Welsh ports where boats under 10m in length are registered in 2018 (data adapted from MMO, 2020b). Contains OS data © Crown copyright and database right 2018.

### 5.1.2 Commercial fishing gears

In general, smaller, under 10m vessels are limited to the use of passive gears including pots, gill nets, trammel nets, and tangle nets. This is often due to the power limitations of the vessel meaning actively towed gear can't be deployed. Larger vessels, those over 10m, typically have greater power and can use either passive gear or towed gear including otter trawls, beam trawls, dredges and longlines.

A variety of fishing gear is utilised by the Welsh commercial fishing fleet. For the purposes of this project, gears have been grouped into four main types based on deployment method used in Wales. These types are dredging, trawling, static or non-fixed, and hand gathering (CCW, 2010; Table 1).

**Table 1:** Fishing gear types used by the Welsh commercial fishing fleet

| Gear Type | Gear Description |
|---|---|
| Dredging | Scallop dredges, Mussel dredges, Hydraulic suction dredges |
| Trawling | Demersal trawl, Beam trawl, Rock-hopper trawl, Pelagic trawl, Otter trawl, Seine netting |
| Static or non-static | Drift nets, Tangle Nets, Whelk pots, Lobster Pots, Gill nets, Trammel nets, Crab pots, Prawn pots |
| Hand-gathering | Cockles, Rod and line fishing, Mussel raking |

Different gear types can be used by fishers to target particular species or species groups, meaning that gear used can, to some degree, infer what species may be caught and visa versa. Table 2 summarises the fish species typically caught by the gears used by the Welsh commercial fishing fleet (Walmsley and Pawson, 2007). Note: not all the species and or gears in the table are commercially fished in Welsh ports.

**Table 2:** Summary of the main species caught in inshore waters around England and Wales and the types of fishing gear used during capture (Walmsley and Pawson, 2007).

| Category | Sub-category | Species | Gear for Capture |
|---|---|---|---|
| White fish | Round fish | Cod, Whiting, Haddock, Saithe, Pollack, Dogfish | Demersal otter trawl, pair trawl, seine net, gill net, trammel net, longline, and handline |
| | Flatfish | Dover sole, Plaice, Flounder, Turbot, Monkfish, Rays | Beam trawl, demersal otter trawl, seine net, tangle net, trammel net, longline |
| Pelagic fish | Small pelagic | Mackerel, Herring, Sprat | Gill net, pelagic trawl, handline |
| | Large Pelagic | Bass, Mullet | Gill net, pelagic and demersal trawl, beach seine, trolling and handline |
| Shellfish | Crustacea | Lobsters, crabs, crawfish, *Nephrops*, shrimp | Pot, tangle net, beam trawl, demersal otter trawl |
| | Molluscs | Cockles, mussels, scallops, oysters, clams, whelks, periwinkles, cuttlefish, squid | Dredge, trawl, pot, hand-gathering, pots and traps |

### 5.1.3 Material composition of commercial fishing gear

Fishing gear Fis made from a variety of materials. The materials are chosen based on durability, accessibility, weight and cost. The main material in current commercial fishing gear is plastic (Stolte and Schneider, 2018). Chemical analysis on a range of ALDFG found four expected dominant polymer types, namely: PA6 and PET (polyethylene) as high-density polymers, and PP (polypropylene), PE (polyethylene) as polyolefins. The specific plastic varies greatly, with many gears constructed from more than one type (Stolte and Schneider, 2018). Due to the mixed materials found in ALDFG, pre-processing prior to recycling is important. Pre-processing includes washing, shredding, manual separation, density separation and a final washing. However, fishing gear disposed of responsibly can often be cleaned and separated thus reducing processing procedures (Stolte and Schneider, 2018). Table 3 and Table 4 detail the typical material composition of common fishing gear types using by the Welsh commercial fishing fleet and the recyclability of each material.

**Table 3:** Materials used in the main types of fishing gear in England and Wales.

| Gear for capture | Component | Materials Used |
|---|---|---|
| Beam trawl, demersal trawl, pelagic trawl, pair trawl, seine net, gill | Nets | Synthetic materials such as nylon, polyethylene, polysteel, and polypropylene (Fritts, 2017; Gael Force Marine Equipment, 2020). |
| | Ropes | Synthetic materials such as polyester, polyethylene, polypropylene, and nylon. Some ropes will be lead-lined with a |

| | | |
|---|---|---|
| net, trammel net | | lead centre to add weight to the rope (Gael Force Marine Equipment, 2020). |
| Longline, trawling, handline, rod and line | Lines | Polyethylene, polyester, and polysteel (Gael Force Marine Equipment, 2020). |
| Pots | Lobster and crab pots (mixed pots) | Pots can be composed of several materials, varying in composition, such as plastic-coated steel, steel wire, rope, netting, hard plastic and tyre rubber (Coastal nets, 2020; Gael Force Marine Equipment, 2020). |
| Pots | Prawn pots | Depending on design, prawn pots are often made of hard plastic (Coastal nets, 2020). Likely made from PP5 (Polypropylene; Sustainability Guide website, 2018). |
| Pots | Whelk pots | Depending on the design, whelk pots are often made largely of a type of hard plastic. Sometimes old plastic drums are converted with a plastic netted entrance (SeaFish, 2020). Likely made from PP5 (Polypropylene; Sustainability Guide website, 2018). |
| Dredge | Dredge | Primarily heavy steel (Catherall and Kaiser, 2014) |

**Table 4:** Recyclability of materials commonly used in Welsh fishing gear.

| Material | Materials Used |
|---|---|
| Nylon | Can only be recycled at facilities that are specially equipped to handle nylon. Most standard recycling plants are not prepared to process nylon (Entire Recycling Limited, 2019) |
| Polyethylene (Low and high density; LDPE, HDPE) | Polyethylene is a commonly recyclable plastic and can be disposed of in most standard recycling receptacles (Sustainability Guide website, 2018) |
| Polypropylene (PP) | Polypropylene is a commonly recyclable plastic and can be disposed of in most standard recycling receptacles (Sustainability Guide website, 2018) |
| Polyester | There is a process for recycling polyester, but it must be done at a special facility, normal recycling centres cannot process polyester (Schwartz, 1995) |
| Tyre rubber | The major form of recycled rubber is still ground rubber. This is produced either by cryogenic, ambient, or wet grinding. Tyre rubber can also be used to create tyre derived fuel, an additive to asphalt, and can be used in the production of items such as mats, floor tiles, and carpet under cushion (Myhre et al., 2012) |
| Polysteel | Recyclability of this material requires further research |
| Plastic coated steel | The plastic would have to be removed and recycled separately; steel can be brought to a scrap yard for recycling (Recycle-More, 2020) |
| Steel wire and Heavy Steel | Steel is 100% recyclable and can be brought to scrap yards for disposal (Recycle-More, 2020) |
| Lead | Lead is readily recyclable and can be recycled indefinitely. It has one of the highest recycling rates in the world (ILA, 2014). The lead is generally found in lead lines which need to be separated from other fishing gear and processed separately due to the toxic nature of lead (Stolte and Schneider, 2018). |

### 5.1.4 Commercial fishing landings into Welsh ports

In 2018, a total of 9641t of primarily shellfish and demersal species were landed into 41 Welsh ports (MMO, 2020a),comprised of landings from UK and EU (Belgian) vessels. Very few pelagic species were landed into Welsh ports, just 350kg by vessels less than 10m. Milford Haven is the Welsh port with the greatest number of registered vessels (both over and under 10m; 11 and 50 respectively), and the greatest landings in 2018 (3541t). The lowest landing

weight was reported into Trefor (with 124kg) which is indicative of the number of vessels operating in rural areas and the size of individual ports used by the Welsh commercial fishing fleet.

Breaking the data down by vessel size and species group (Table 5), and then considering the species landed by these combinations (Table 6) it is possible to provide proxies for the broad types of fishing gears used. In general, under 10m vessels typically employ passive gears such as pots and gill or trammel nets, while vessels over 10m are more likely to use actively towed gears such as otter trawls, beam trawls and dredges.

Overall, shellfish dominate landings in Welsh ports, accounting for nearly 70% of landings. In 2018 shellfish landings comprised 2011t and 4752t from vessels under and over 10m respectively. Vessels, both under and over 10m, primarily target whelks using pots. Over 10m vessels land dredged scallops. Lobster and crab landings comprise a large proportion of the under 10m vessels, caught using pots. *Nephrops*, cuttlefish and squid make up the majority of remaining shellfish landings, normally by over 10m vessels with towed gears such as otter trawls.

Demersal species make up almost all the remainder of landings, and is highly regional, with 98% reported in southern ports, and predominantly by over 10m Belgian vessels. Flatfish are most important species within these landings and most likely caught with otter trawl or beam trawl gears, although some can be caught in passive nets. Some round fish species are also landed which are typically caught with otter trawls or passive nets. Demersal landings by under 10m vessels are dominated by bass, skates and rays, dogfish, and mullet. These would likely have been caught by hook and line, or passive netting given the limited power of small vessels to tow trawl nets.

In terms of landings into specific ports, Saundersfoot received 515t of shellfish species from under 10m vessels, whilst over 1000t were landed by over 10m vessels into each of Fishguard and Milford Haven (including ~150t from Belgian vessels). The latter also received the greatest demersal landings by these larger vessels (2211t; of which the majority were from Belgian vessels), while Swansea reported the most demersal landings by smaller vessels (~60t).

In general, catch is seasonal, decreasing in winter except for the north and west Wales winter scallop fishery landings (Figure 4). This seasonality can be linked to vessel size, with most vessels under 10m limited to near shore fishing and constrained by poorer weather conditions experienced in winter. This seasonality also affects the levels of activity within ports throughout the year.

**Table 5:** Breakdown of 2018 UK and EU (Belgian) landings into Welsh ports by species group (demersal, shellfish, and pelagic) and vessel size category, data adapted from MMO (MMO, 2020a). Note, 167t have been excluded from this table due to unknown vessel length.

| Port of landing | Species group | Landed weight (t) | | Port of landing | Species group | Landed weight (t) | |
|---|---|---|---|---|---|---|---|
| | | Vessels under 10m | Vessels over 10m | | | Vessels under 10m | Vessels over 10m |
| **Aberdaran** | Demersal | 0.03 | - | **Milford Haven** | Demersal | 6.22 | 2,211.47 |
| | Shellfish | 16.52 | - | | Shellfish | 120.08 | 1,035.68 |
| | Pelagic | - | - | | Pelagic | 0.18 | - |
| **Aberdovey** | Demersal | 0.21 | - | **Morfa Nefyn** | Demersal | - | - |
| | Shellfish | 6.31 | - | | Shellfish | 467.21 | - |
| | Pelagic | - | - | | Pelagic | - | - |

| Port of landing | Species group | Landed weight (t) | | Port of landing | Species group | Landed weight (t) | |
|---|---|---|---|---|---|---|---|
| | | Vessels under 10m | Vessels over 10m | | | Vessels under 10m | Vessels over 10m |
| **Aberffraw** | Demersal | 0.15 | - | **Mostyn** | Demersal | 0.28 | - |
| | Shellfish | 0.09 | - | | Shellfish | - | - |
| | Pelagic | 0.08 | - | | Pelagic | - | - |
| **Abersoch** | Demersal | - | - | **New Quay** | Demersal | - | - |
| | Shellfish | 4.31 | - | | Shellfish | 13.42 | 4.73 |
| | Pelagic | - | - | | Pelagic | - | - |
| **Aberystwyth** | Demersal | 0.09 | - | **Newport (Monmouthshire)** | Demersal | 0.75 | - |
| | Shellfish | 33.29 | 279.11 | | Shellfish | - | - |
| | Pelagic | 0.01 | - | | Pelagic | - | - |
| **Amlwch** | Demersal | - | 0.08 | **Neyland** | Demersal | 0.73 | 0.04 |
| | Shellfish | 121.90 | 475.62 | | Shellfish | 101.98 | 60.75 |
| | Pelagic | - | - | | Pelagic | - | - |
| **Bangor** | Demersal | - | 32.81 | **Penrhyn** | Demersal | - | - |
| | Shellfish | 1.14 | 64.94 | | Shellfish | 14.47 | 25.61 |
| | Pelagic | - | - | | Pelagic | - | - |
| **Bagillt** | Demersal | 1.62 | - | **Porth Colmon** | Demersal | 0.01 | - |
| | Shellfish | - | - | | Shellfish | 4.01 | - |
| | Pelagic | - | - | | Pelagic | - | - |
| **Barmouth** | Demersal | 0.14 | - | **Porthcawl** | Demersal | 24.89 | - |
| | Shellfish | 2.30 | - | | Shellfish | 0.10 | - |
| | Pelagic | 0.02 | - | | Pelagic | - | - |
| **Beaumaris** | Demersal | 0.19 | - | **Porthgain** | Demersal | - | - |
| | Shellfish | - | - | | Shellfish | 15.10 | - |
| | Pelagic | - | - | | Pelagic | - | - |
| **Burry Port** | Demersal | 44.44 | - | **Pwllheli** | Demersal | 0.13 | 0.02 |
| | Shellfish | 19.47 | - | | Shellfish | 17.07 | 175.61 |
| | Pelagic | 0.03 | - | | Pelagic | - | - |
| **Caernarvon** | Demersal | - | - | **Rhoscolyn** | Demersal | 0.01 | - |
| | Shellfish | 140.70 | - | | Shellfish | 0.54 | - |
| | Pelagic | - | - | | Pelagic | - | - |
| **Cardiff** | Demersal | 0.93 | - | **Rhosneigr** | Demersal | - | - |
| | Shellfish | - | - | | Shellfish | 0.30 | - |
| | Pelagic | - | - | | Pelagic | - | - |
| **Cardigan** | Demersal | 0.04 | - | **Rhyl** | Demersal | 0.07 | - |
| | Shellfish | 30.62 | - | | Shellfish | 6.05 | - |
| | Pelagic | - | - | | Pelagic | - | - |
| **Connahs Quay** | Demersal | 4.66 | - | **Solva** | Demersal | - | - |
| | Shellfish | - | - | | Shellfish | 19.19 | - |
| | Pelagic | - | - | | Pelagic | - | - |
| **Conwy** | Demersal | 9.34 | 0.46 | **Saundersfoot** | Demersal | 9.22 | - |
| | Shellfish | 33.75 | 29.98 | | Shellfish | 515.07 | 255.56 |
| | Pelagic | - | - | | Pelagic | - | - |
| **Fishguard** | Demersal | - | - | **Stackpole Quay** | Demersal | 0.51 | - |
| | Shellfish | 78.13 | 1,327.43 | | Shellfish | 13.60 | - |
| | Pelagic | - | - | | Pelagic | - | - |
| **Holyhead** | Demersal | 12.93 | 0.11 | **Swansea** | Demersal | 57.96 | 301.99 |
| | Shellfish | 81.02 | 979.35 | | Shellfish | 103.40 | 35.33 |
| | Pelagic | - | - | | Pelagic | 0.01 | - |
| **Llanelli** | Demersal | 6.03 | - | **Tenby** | Demersal | 11.12 | - |
| | Shellfish | - | - | | Shellfish | 29.91 | - |
| | Pelagic | - | - | | Pelagic | 0.01 | - |
| **Menai Bridge** | Demersal | 0.29 | - | **Trefor** | Demersal | 0.01 | - |
| | Shellfish | 0.05 | 2.72 | | Shellfish | 0.11 | - |
| | Pelagic | 0.02 | - | | Pelagic | - | - |

**Table 6:** List of species (alphabetical) landed into Welsh ports during 2018 separated by species group and vessel size, data adapted from MMO (MMO, 2020a).

| Vessels under 10m | | | Vessels over 10m | | |
|---|---|---|---|---|---|
| **Demersal** | **Pelagic** | **Shellfish** | **Demersal** | **Pelagic** | **Shellfish** |
| Bass | Mackerel | Crabs | Bass | NA | Crabs |
| Bream | Herring | Cuttlefish | Bream | | Cuttlefish |
| Brill | | Lobsters | Brill | | Lobster |
| Cod | | Mussels | Cod | | *Nephrops* |
| Dogfish | | Oysters | Dogfish | | Scallops |
| Gurnard | | Scallops | Gurnard | | Squids |
| Haddock | | Shrimps and Prawns | Haddock | | Whelks |
| Hake | | Squid | Hake | | |
| Lemon Sole | | Whelks | Lemon Sole | | |
| Ling | | | Ling | | |
| Monkfish | | | Megrim | | |
| Mullet | | | Monk or Angler | | |
| Plaice | | | Mullet | | |
| Pollack (Lythe) | | | Plaice | | |
| Skates and Rays | | | Pollack | | |
| Sole | | | Saithe | | |
| Turbot | | | Skates and Rays | | |
| Whiting | | | Sole | | |
| | | | Turbot | | |
| | | | Whiting | | |
| | | | Witch | | |

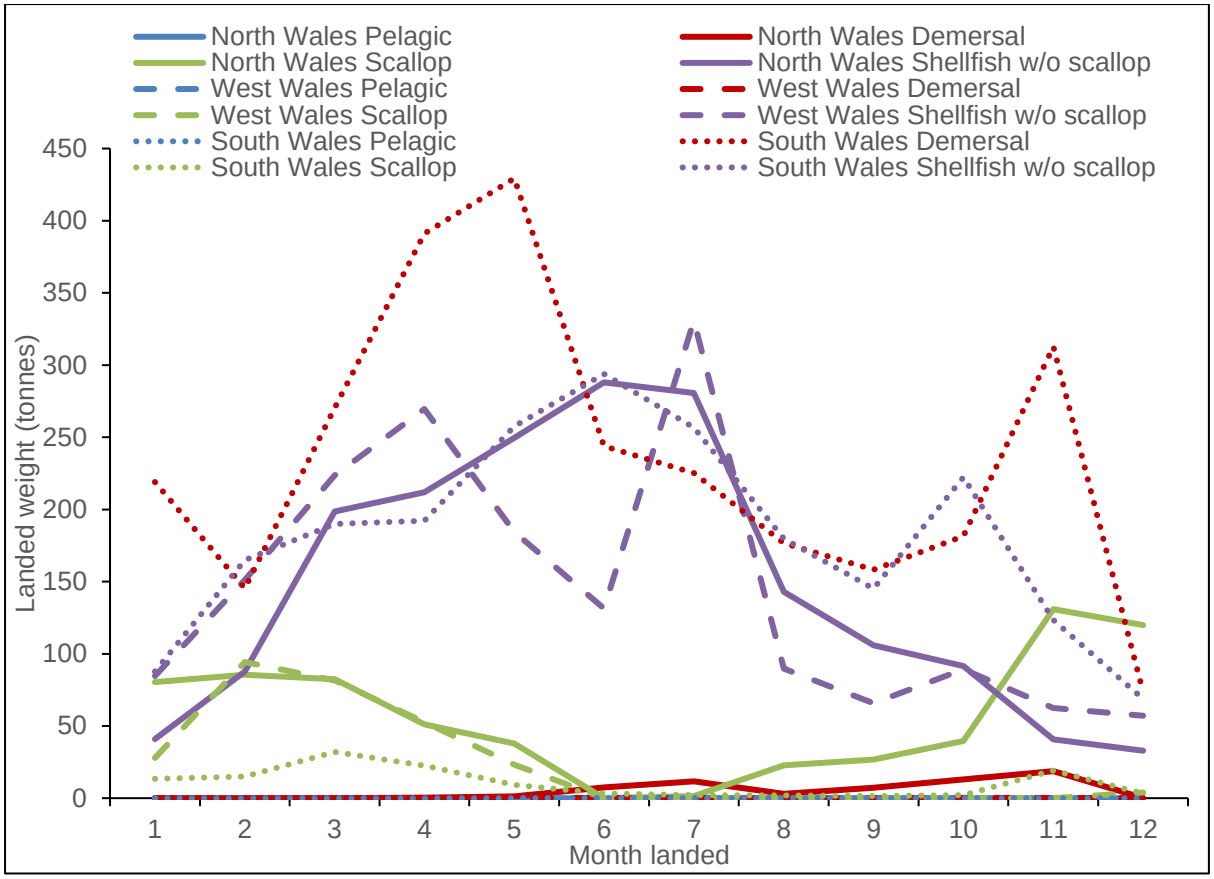



**Figure 4:** Monthly UK vessel landings in Wales for 2018 (data adapted from MMO; MMO, 2020a).

### 5.1.5 Disposal methods

Limited literature was identified or available from the review on fishing gear disposal or disposal facilities within Wales, furthermore, limited information was found regarding the disposal facilities provided by Welsh harbours for fishers.. However, in the UK, every harbour authority and terminal operator needs to provide sufficient waste facilities for the vessels (including fishing vessels) which routinely are situated at the harbour or terminal. The Merchant Shipping and Fishing Vessels (Port Waste Reception Facilities) Regulations 2003 (UK Statutory Instruments, 2003) states:

***"Requirement to provide adequate waste reception facilities***

***4.***—*(1) Every harbour authority and terminal operator shall provide waste reception facilities adequate to meet the needs of ships normally using the harbour or terminal in question without causing undue delay to ships.*

*(2) In paragraph (1) "adequate" means capable of receiving the types and quantities of prescribed wastes from ships normally using that harbour or terminal taking into account the operational needs of the users of the harbour or terminal, its size and geographical location, the types of ships calling there and any exemptions provided for under regulation 15.*

*(3) A harbour authority or terminal operator may, in discharging their duty under paragraph (1), join with any other person in providing the waste reception facilities, and references in these Regulations to the provision of such facilities by a harbour authority or terminal operator shall be construed accordingly; and any such power shall also include power to arrange for the provision of such reception facilities by any other person.*

*(4) This regulation is subject to regulation 15(1)."*

The International Convention for the Prevention of Pollution from Ships 1973, and its 1978 Protocol (MARPOL 73/78) aims to regulate and minimise pollution from ships. MARPOL 73/78 covers the five main forms of ship generated waste in five specific annexes. Fishing gear falls within Annex V "garbage from ships" and examples given list fishing gear under operational waste

In the Associated British Ports (ABP) South Wales Waste Management Plan (ABP, 2014), provision of waste reception facilities is the responsibility of the port authority, stating:

"*ABP South Wales has the duty to prepare and revise this Port Waste Management Plan to ensure that adequate and convenient garbage-reception facilities are available throughout the port estate. By consultation and agreement, the provision of certain facilities in specific areas may be undertaken by terminal operators and port users. ABP may recover a significant proportion of the costs involved in waste management from the ships visiting its ports. This will be done via a Mandatory Waste Fee levied on all eligible vessels. Finally, ABP has the duty to maintain records of waste landed in the dock estate, whether or not the reception facilities used are provided or arranged by the Company."*

ABP details the location of disposal facilities available at its ports in South Wales in the Waste Management Plan (ABP, 2014). Milford Docks in Milford Haven also has a Waste Management Plan which contains links to the Fishing For Litter Scheme and waste facilities provided at the port for a variety of disposal and recycling needs of the fishing fleet (Port of Milford Haven, 2013).

## 5.2 Review of ALDFG active conservation organisations in Wales

There are multiple conservation organisations operating in the UK working in the area of marine litter and ALDFG, some have links to Wales, others work exclusively in Wales. Some of the conservation organisations operating in Wales focusing on ALDFG, marine pollution, beach clean ups and improving fishing practices include Neptune's Army of Rubbish Cleaners (NARC), Anglers National Line Recycling (ANLR), Welsh Fishermen's Association – Cymdeithas Pysgotwyr Cymru, Sea Shepherd Conservation Society, Marine Conservation Society (MCS), Keep Wales Tidy, Global Ghost Gear Initiative (GGGI), Pembrokeshire Sustainable Shellfish Pilot Initiative (2016/2018), Surfers Against Sewage and a variety of others. Many of the conservation organisations are interlinked and have formed further links with retailers. For instance, GGGI have linked retailers such as Sainsbury's, Morrisons, Marks and Spencer, Waitrose, Lidl and Tesco. GGGI was originally established by World Animal Protection and assists by funding NARC. For events, many organisations will partner with others increasing coverage of the community and therefore volunteers.

There are several start-up companies around the world using collected ALDFG to create products. Within the UK some of the companies include Teko, RubyMoon, Interface, Fourth Element and AFrayedKnot. Teko, located in Scotland, use nylon sourced from discarded fishing line to produce running and compression socks (https://www.tekoforlife.co.uk/). RubyMoon and Fourth Element use recycled nylon from fishing nets to create swim and active wear (https://rubymoon.org.uk/, https://fourthelement.com/). Interface uses collected fishing nets to produce carpet tiles (https://www.interface.com/). AFrayedKnot uses washed up or donated fishing ropes to create floor mats (http://www.circularocean.eu/opportunities/a-frayed-knot/). Both Teko and RubyMoon source their materials from Aquafil, an Italian company that recycles nylon from fishing nets to produce nylon yarn (Charter *et al.*, 2018). According to recent email correspondence with Ghost Fishing UK, there are no current locations which recycle abandoned lost discarded fishing nets (ALDFN) in the UK. One of the

few places that will accept and recycle ALDFN are Nofir and Aquafil in Slovenia and if nets are not shipped to Slovenia, they will go to the landfill.

Communication was made with Sea Shepherd Conservation Society, KIMO/ Fishing For Litter, Ghost Fishing UK and Fathoms Free requesting further information regarding their activities in Wales. Of these organisations, Fathoms Free, Ghost fishing UK, KIMO/ Fishing for Litter cited never having done work in Wales. Sea Shepherd Conservation Society noted having removed two nets in North Wales. Both Sea Shepherd and Ghost Fishing UK noted that their lack of work in Wales was due to the expense of licencing costs required to remove ghost nets. Fathoms Free referred us to their Welsh partners NARC.

NARC is a conservation organisation which operates along the Pembrokeshire coast. NARC hosts regular dive trips to collect ALDFG and other marine debris. Since 2005, NARC have launched over 1000 underwater clean up dives and lead or been closely involved in multiple awareness raising projects (NARC annual report, 2018). NARC work closely with the fishing industry and help retrieve pots lost in storms or snagged during fishing activities. Where possible, NARC return lost fishing gear to the original owners. Most of the shellfish pots collected are due to the information provided by the fishers. If possible, the pots are later returned to the owners. Many of the shellfish found in the pots were alive and therefore released (NARC Annual Report, 2018). NARC report their findings each year in their annual report (Table 7). It is reported that the main litter found on dives is dependent on the dive location. For instance, when diving at popular recreational angling sites, the main litter items are angling equipment including rods, line, hooks, weight etc. When working in an easily accessibly estuarine area, fly tipped litter is common and when working with commercial fishers, commercial fishing gear is common (NARC Annual Report, 2018).

**Table 7:** Shellfish pots removed from Welsh waters between 2016 to 2018 by Neptune's Army of Rubbish Cleaners in Pembrokeshire (data adapted from NARC annual reports, Neptune's Army 2016, 2017, 2018).

| Year | 2018 | 2017 | 2016 |
|---|---|---|---|
| Divers | 144 | NA | NA |
| Shellfish pots | 77 | 66 | 92 |
| Shellfish released | 256 | 85 | 48 |
| Fish released | 15 | 6 | 2 |
| Shellfish deceased | 2 | 16 | NA |
| Fish deceased | 1 | 2 | NA |

Certain conservation groups or campaigns are targeted at recreational fishers. These include Marine Conservation Society "Hang onto your tackle" campaign, and Anglers National Line Recycling Scheme (ANLRS, 2020). ANLRS has recycling points for recreational fishing at several sites throughout Wales. The sites which include collection points and ports where fishing vessels are registered include Cardiff, Swansea, Llanelli, Cardigan, Aberystwyth, and Holyhead (ANLRS, 2020).

## 5.3 Engagement with Task and Finish Group

On the 24th February 2020, a meeting of the Task and Finish Group was held with Welsh Government, Natural Resources Wales, APEM, the Welsh Fisheries Association, and Sea Fish. APEM presented ideas for the questionnaires and site visits along with background information regarding the need for this research. The Task and Finish Group provided advice

to ensure that the work was relevant to the Welsh commercial fishing industry, and that questionnaires to fishers were formulated to maximise response. The group advised and aided on a variety of project aspects including site-visit selection, visit facilitation and identification of relevant conservation groups active in ALDFG.

## 5.4 Industry questionnaire survey

Surveys were distributed by the Welsh Government's and APEM's social media accounts, Welsh Fisheries Association representatives as well as through email, telephonic interviews and directly by APEM staff. Additionally, during site visits help from harbour masters and influential fishers was requested to assist with the distribution of the surveys. Of the 78 questionnaires known to be distributed (40 to fishers, 25 to harbour masters, and 13 to suppliers). A total of 29 responses were received. Of these responses, 17 were from Welsh fishers, 8 were from harbour masters and 4 were from fishing gear suppliers. The majority (80%) of responses were collected either through face-to-face or telephone interviews. The remainder of responses were returned either through email or online.

### 5.4.1 Commercial Welsh fisher survey responses

The questionnaire responses were collected from a broad range of locations across Wales, and from site visits conducted at a variety of port types (trust, municipal and private ports; Figure 5).

Question 1 addressed the type of gear that fishers deployed. This enabled an understanding of the type of gear used and inferred the target species. Eight gear types were reported, three of which were types of pot gear, two net types (gill and tangle nets), otter trawl, unspecified trawl, scallop dredge, and long line. One or more varieties of pot gear were reported by 13 of the 17 responses. This type of gear implies shellfish catches targeting species such as whelks, lobsters, crabs, and prawns as seen in the landings described above.

Several of the fishers reported use of multiple gear types, indicating a polyvalent segment of the fleet, most switching between pots and either passive net fishing (gill net or trammel net), trawling, or scallop dredging. Use of scallop dredges results in a very targeted catch of scallops while the use of nets and trawls will primarily be targeting demersal species such as round fish, and flatfish, *Nephrops* can also be caught with trawl gear.

Question 2 of the survey requested further information regarding the amount of fishing gear deployed over the course of a year to give an understanding of how much gear is set within Welsh waters and the quantities which will ultimately need to be disposed of. The length of netting and number of pots deployed by each fisher varied in the responses received. For the most reported gear, pot and mixed pots were deployed in the largest quantities, with fishers on average deploying 1055 (± 992; Figure 6a) pots targeting crab and lobster. Of the net gear usage reported, gill nets were deployed in the largest quantity with on average 1500m (± 707m) of net (generally comprised of smaller sections of 50 to 100m long) being deployed (Figure 6b). Those trawl or otter trawl gears used were on average 19m (± 11m; Figure 6c) Note: These figures are based on the information obtained in the questionnaire and fishers generally provided an estimation for the quantity of gear they deployed. To improve clarity one gear type and one response was excluded from Figure 6, namely scallop dredges which deployed on average 9 (± 4.24) dredges and longline gear (5000 m of line made up of 100m sections) as this gear was no longer used due to changes in spurdog legislation.

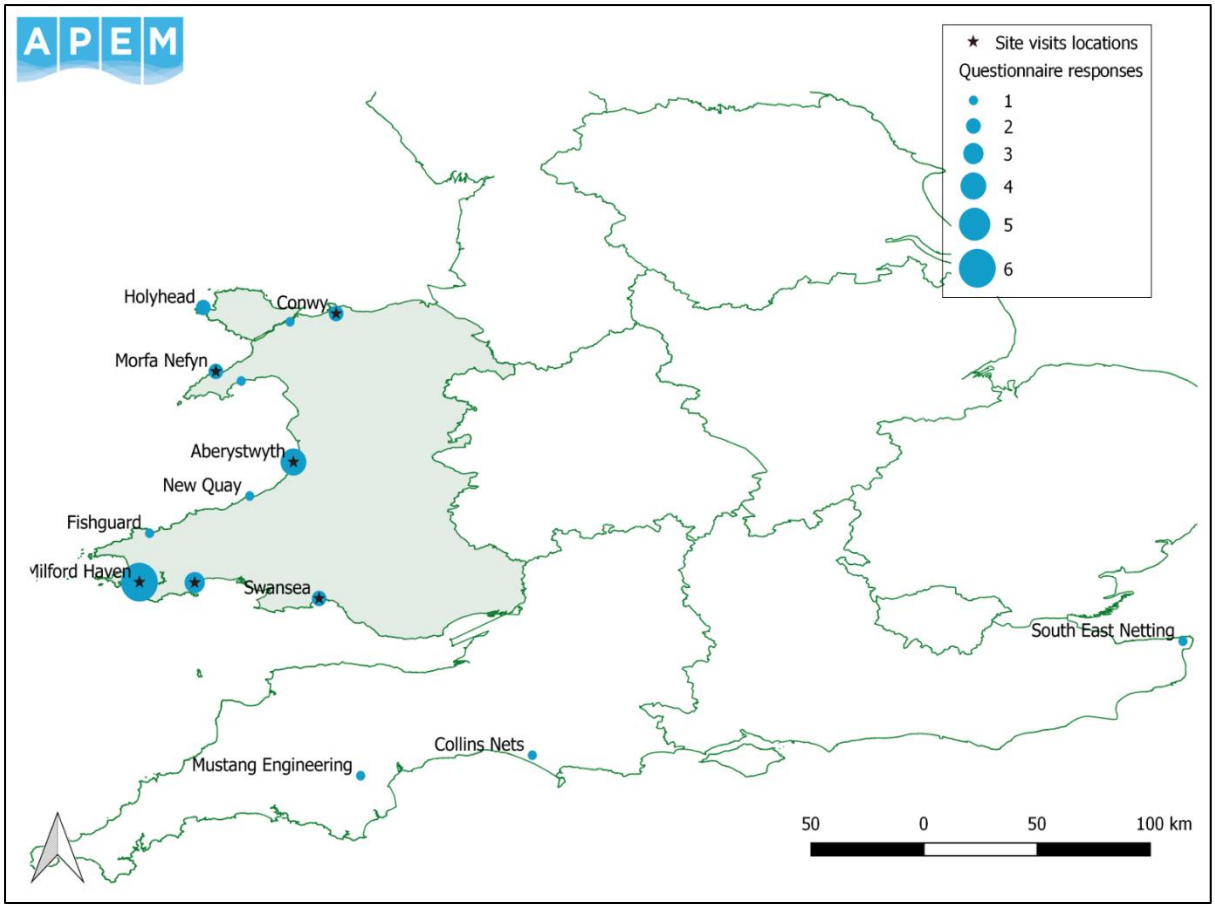



**Figure 5:** Weighted geographical distribution of survey responses. Stars indicting sites visited.


Question 3 of the survey requested information regarding the working life span of the fishing gear. Through this information and the total amount of gear fishers own, the amount of gear that fishers need to dispose of yearly can be estimated. Fishers spoke of factors which could influence the life span of fishing pots or nets. These factors included the location of the fishing ground, the type of sediment gear was deployed on (rocks, wrecks or mud), the weather, theft, and if the fisher repaired, kept and or sold gear. The life span of scallop dredges, in particular, varied considerably as different components degraded at different rates needing to be replaced at different intervals. The average lifespan of gear types were used is given in Figure 7 based on the minimum and maximum values given by fishers. If only one value was given, then it was used as both the minimum and maximum life span to ensure accurate representation. Some qualitative responses were given but generally could not be included within the analysis to generate average durations.

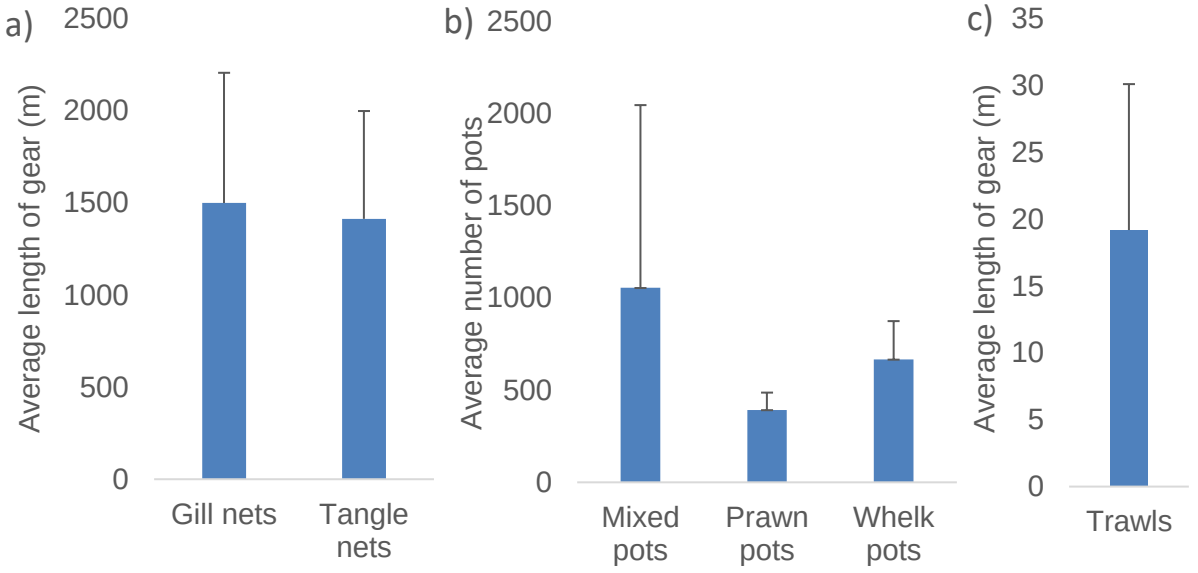



**Figure 6:** Average quantity (± standard deviation) of gear deployed by fishers: a) pot gear, b) net gear, c) trawl gear.

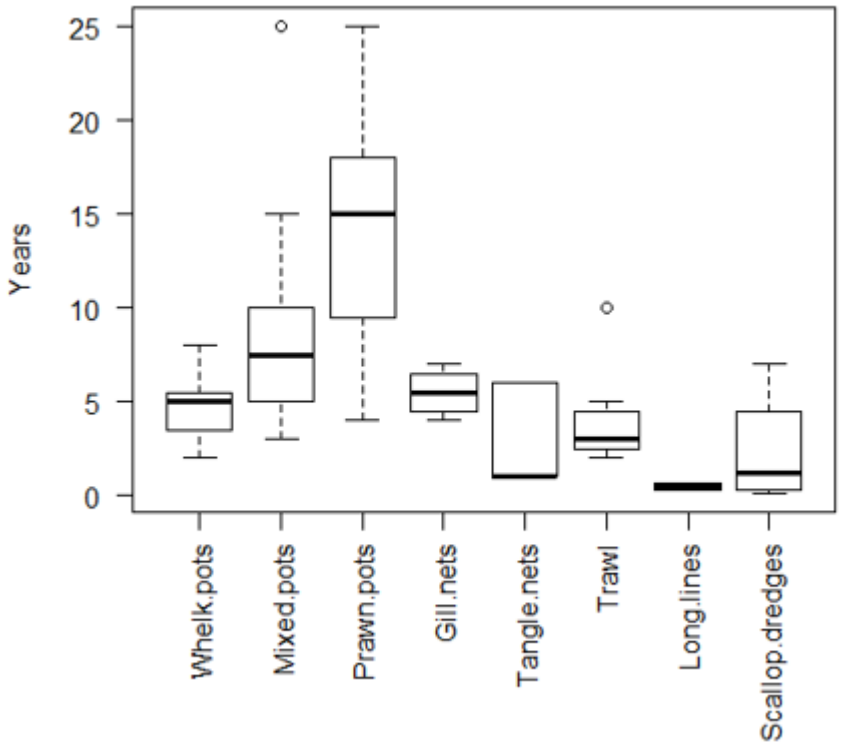



**Figure 7:** Box plot of working life span (end-of-life and sold) of the different varieties of fishing gear deployed by Welsh fishers.

The average percentage (± SD) of gear disposed of and/or sold by fishers could be estimated from the lifespan of each gear type and the amount that each fisher estimated was owned. The working lifespan of gear differed considerably among fishers (Figure 7). From the completed responses, this equated to an annual average disposal or sale by a fisher owning the relevant gear of 302m (±176m) of gill netting, 997m (± 959m) of tangle netting, 6m (± 1m)

trawl nets, 197 (± 239) mixed pots, 47 (± 48) prawn pots, and 217 (± 182) whelk pots. For scallop dredgers, the quantity or percent discarded per annum depends on the part of the gear discarded as different components have different lifespans. For instance, the teeth on the dredge need to be replaced regularly. One fisher stated that he replaced the teeth daily/every fishing trip. While the belly of the dredge was stated to last between 6 months and 2 years, and the frame lasts from 1 to 7 years (depending on the fisher, substrate and fishing intensity). Figure 8 depicts the estimated average percent of gear disposed of and sold annually by gear type. The sale of gear to another fisher was represented separately to enable visualisation of annual percent of gear discarded. Longline gear usage and life span was excluded as this gear is no longer used due to prohibitive fishing restrictions on the species targeted (spurdogs).

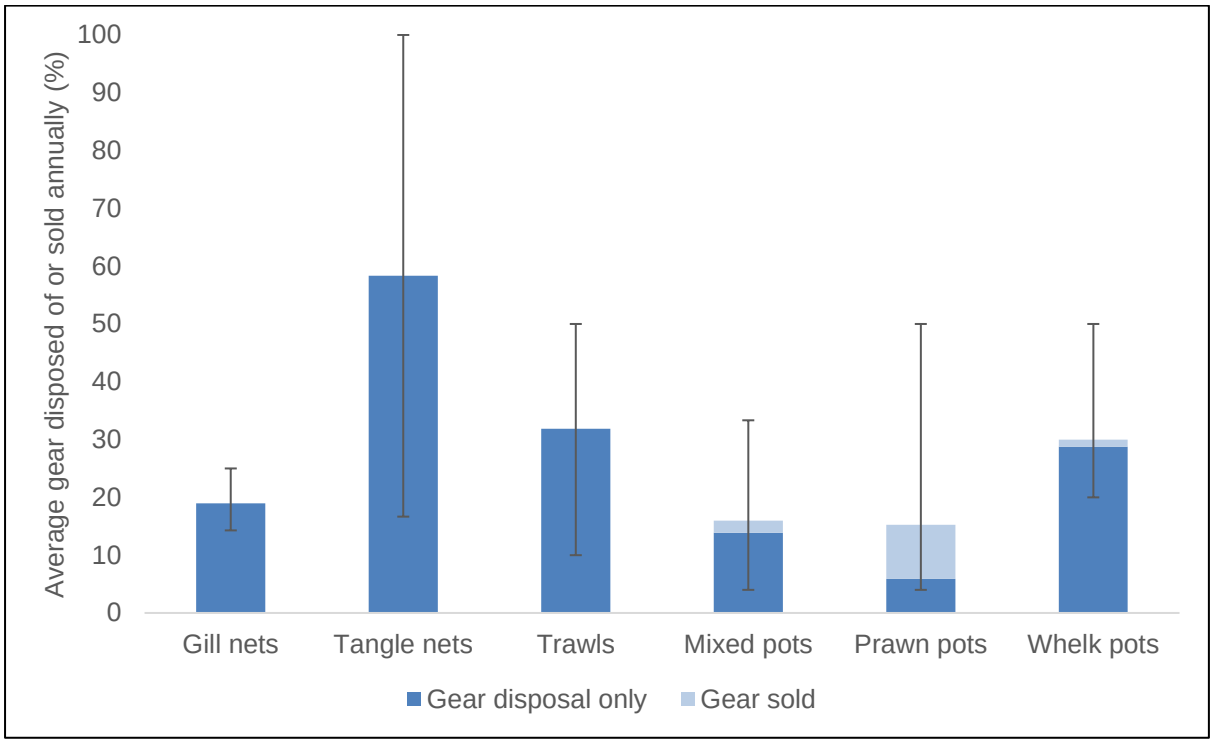



**Figure 8:** Average percentage of gear disposed of or sold annually for each gear type. Whiskers show minimum and maximum values reported.

Question 4 and Question 8a requested information regarding the methods used to dispose of end-of-life fishing gear (Question 4) and retrieved lost gear (Question 8a). Multiple disposal methods were highlighted in the responses and fishers typically use several methods (Table 8). Only three explicitly stated that they recycle gear, though a number stated that they sell on or upcycle gear. However, a large portion of fishers (70.59%) reported repairing their gear in the first instance and 24% noted having donated or selling their old fishing gear specifically for upcycling (flowerpots, furniture, decoration etc.).

Less than half of the fishers surveyed (41.18%) make use of port facilities for gear disposal. Additional facilities listed included use of private bins, promenade bins (Appendix 2 Figure 18), and landfill. The majority of those using port facilities also listed use of public bins and landfill.

**Table 8:** Summary of answers noted by fishers as methods used to dispose of end-of-life or retrieved fishing gear.

| Method of "disposal" | Total (%) of fishers |
|---|---|
| No disposal | 5.88 |
| Sell | 23.53 |
| Repair/ reuse | 70.59 |
| On-site disposal facilities | 41.18 |
| Promenade bins | 35.29 |
| Private disposal | 35.29 |
| Recycling | 17.65 |
| Scrap | 11.76 |
| Landfill/ Council | 29.41 |
| Upcycle | 23.53 |
| Loss | 76.47 |
| Theft | 17.65 |
| Storage | 29.41 |

Question 5 sought to understand the knowledge of Welsh recycling facilities or schemes accepting fishing gear within the Welsh commercial fishing industry. Three responses highlighted their use of local council recycling centres and one stated use of a scrap metal yard. There was little knowledge of local or national (Welsh) schemes. One fisher was aware of a specific conservation organisation, Fishing For Litter, who assist in collection of found fishing gear, although this organisation is not operational in Wales. Two fishers referred to the SeaFish responsible fishing scheme. Although the responsible fishing scheme does include policies on correct waste management, it does not assist or provide facilities for disposal or recycling.

Question 6 of the survey requested information as to where fishers purchased gear. Little was elaborated on in relation to method of purchasing new gear though one response stated they shopped online while another simply stated shopping around for the best value. A total of 17 suppliers were mentioned with Mustang Engineering, Gael force and Mendleys being highlighted most frequently. Several smaller Welsh businesses were noted, such as Parry's Pots in Aberystwyth and Strawsons Fishing Gear in Anglesey.

Questions 7 and 8 relate to the encounter and treatment of lost gear encountered at sea. These are important questions to help determine any additional capacity future facilities may require for subsequent disposal of ALDFG. The questions included request for details of the types and quantities encountered, if the gear was retrieved and what they do with lost gear upon return to shore. All respondents stated they encounter lost fishing gear, including pots, buoys, fenders, drift nets, trawl nets, and ropes. The amount of gear which fishers encountered ranged from "not much" and "seldom" to an estimation of 100kg per year. 94% of respondents reported collecting ALDFG. Around half of respondents highlighted that there are instances of observed lost gear which they have been unable to collect. Reasons for this include found gear being too heavy to lift or too bulky to fit on their boat, remembering that most Welsh vessels are under 10m and are unlikely to have much free space. Some fishers stated they always returned lost gear to shore, and in some instances even when it meant towing the found gear.

Once on shore, 59% of the fishers noted that where possible the retrieved gear is repaired and put back into use by the collector and 12% sold the collected ALDFG. 89% of found gear, beyond repair, was stated to be disposed of primarily within private bins, public bins, and landfill. Table 9 summarises the range of methods that fishers reported using to dispose of or make use of ALDFG. Cost was also highlighted as an issue here; in that it is expensive to dispose of ALDFG gear in landfill and that sometimes the gear is left in the port on the dock side.

**Table 9:** Breakdown of fisher responses received regarding the methods they employ to deal with collected ALDFG.. Note, fishers reported use of multiple methods, as such percentages are discrete per method values.

| Methods of "disposal" | Total (%) of fishers |
|---|---|
| Repair/ reuse | 59 |
| Return gear to owner | 12 |
| Sell | 12 |
| Upcycle/ repurpose | 6 |
| Waste disposal | 82 |

Question 9 of the survey requested estimates on amount of gear lost annually. Over half of the fishers reported losing gear, primarily due to storms or snagging. Fishers reported that the amount of gear loss has reduced over time as gear, positioning, and weather technology has improved. Many fishers reported attempting to recover lost gear through diving and fishing. Not all responses were quantitative. Of those which were quantitative, prawn pots were reportedly the most frequently lost with an average (± SD) of 2.75% (± 4.39%) pots lost annually. Between 0.82% (± 1.86%) and 0.17% of mixed pots and whelk pots respectively were reported lost annually. No respondents reported losing gill nets, tangle nets or otter trawl nets during fishing (Figure 9). However, one of these fishers did note that if/ when he lost a trawl net, he always ensured that the net was recovered. This indicates that that losses may occur, yet not reported as losses in response to this question due to their subsequent recovery and therefore not represented in the table below.

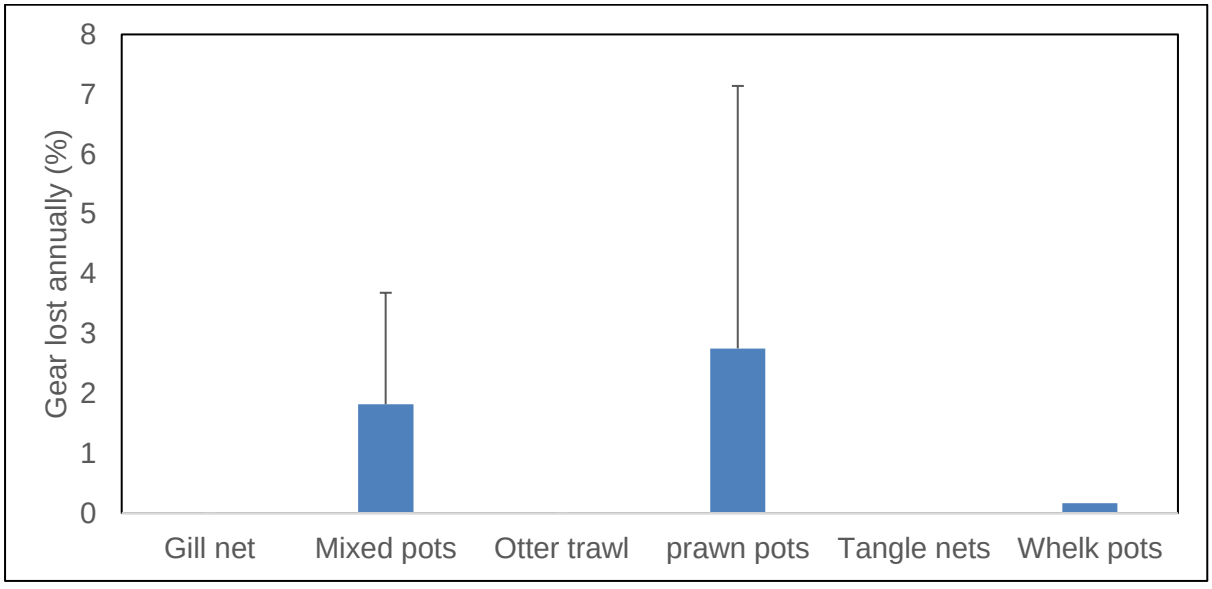



**Figure 9:** Percentage of gear lost annually by respondent fishers.

Question 10 was an open-ended question asking if there was anything else the respondent wished to add. Most fishers chose not to answer this question. Some fishers chose to include information regarding the problems they were having with domestic waste and others noted inventions which would help reduce ghost fishing of lost pots. For example, one respondent took this opportunity to note an award from Sea Change for a pot modification. The modification incorporates a weak link (a key ring) which, when the pot is lost, will rust and open the pot's door effectively reducing ghost fishing.

### 5.4.2 Harbour master responses

Eight harbour master's provided responses to the questionnaire. Of these, 75% of the ports were reported as having some form of disposal facilities available to fishers. Of these, 83% had permanent disposal facilities and 7% had semi-permanent disposal facilities. Those with semi-permanent facilities relate to those ports which provide a skip once or twice a year for disposal of fishing gear. The ports with no disposal facilities stated disposal facilities had previously been available. Provision was stopped due to fly tipping and general abuse of facilities.

None of the harbour master's were aware of recycling facilities or schemes specifically for fishing gear. None of the ports under their management had recycling facilities beyond council led municipal recycling programs and only 25% had on-site municipal recycling available.

### 5.4.3 Supplier responses

Four suppliers completed the survey. One supplier (Mustang Engineering, the supplier most mentioned by fisher responses) can recycle whelk pots. However, no fisher had yet used this facility, despite the program being in place for several years. One supplier noted that they would like to have a recycling facility, but that cost would make it prohibitive. This was also highlighted by a second supplier for which the cost and time required would be prohibitive for small scale supply companies. However, the other two suppliers highlighted that they have previously assisted in repairing damaged gear, prolonging its life span, and have used old gear for spare parts.

One of the suppliers would not consider recycling and one supplier noted the longevity of their gear and therefore the low resale and return prospects.

## 5.5 Port site visits

Six port site visits were completed to gain a fuller understanding of the practical operation of different types and sizes of ports and their facilities along with obtaining first-hand information from fishers. As detailed in Section 4, ports were chosen based on their ownership model (municipal, trust and private ports), geographical location, the amount and type of fishers, and the availability of harbour masters and fishers.

### 5.5.1 Milford Haven

Milford Haven is one of the largest ports in Wales. There were a total of 56 commercial fishing vessels and the main catches are demersal fish and shellfish in 2018 (MMO, 2020a; 2020b;

2020c). Skates, rays and sole are the most fished demersal fish species, while crab and lobster are the most landed shellfish species. Milford Haven is a Trust port.

On the 5th March 2020 a site visit at Milford Haven was conducted. The Harbour Docks and Marina Supervisor met with APEM staff showing the facilities available to fishers and provided an introduction to a number of commercial fishers. As a result, five separate interviews were conducted with commercial fishers.

The waste facilities at Milford Haven include general landfill waste and recycling bins for electronic waste, glass, paper and cardboard. The area is fenced off and the gate is locked by the harbour master's office (Figure 10). Fishers contact the harbour office when access is required and payment is made for the amount disposed of. According to the Harbour Docks and Marina Supervisor, this is not always what is practised; sometimes fishers will leave waste outside the fence for the harbour staff to gather and dispose of. Fishers are also known to collect and dispose of their own waste by additional means (Figure 11).


**Figure 10:** Port provided waste disposal and recycling collection point at Milford Haven Harbour. Located at the Milford Haven fishing docks.


**Figure 11:** Despite the availability of a waste facility, some fishers still chose to collect and dispose of their own refuse (Milford Haven).

### 5.5.2 Saundersfoot

Saundersfoot is a Trust port. In 2018, there were a total of 11 fishing vessels and into which 780t were landed (MMO, 2020a; 2020b; 2020c). The main catches were crab, lobster and whelks.

On the 5th March 2020 a site visit to Saundersfoot port was conducted. At Saundersfoot, the harbour master and deputy harbour master assisted with the APEM site visit. Local fishers were also available for further discussions. According to the harbour master, 85% of the fishing industry at Saundersfoot is potting with whelk, crab, and lobster pots, in addition to a few using rod and line to catchbass. The port is equippedequiped with a large skip for general waste which, during busy times (particularly summer), is emptied every two weeks (Figure 12). Saundersfoot is in the process of building new facilities and plans to provide recycling areas at the port under this development.


**Figure 12:** Skip available at Saundersfoot to fishers. Fishers generally use skip to dispose of old bait bags and may dispose of larger items elsewhere

### 5.5.3 Aberystwyth

At Aberystwyth port, the main catches are scallops, crab, and lobster. In 2018, 11 vessels were reported and 312t were landed into the port (MMO, 2020a; 2020b; 2020c). Aberystwyth is a Municipal port.

On the 6th March 2020, a site visit at Aberystwyth port was conducted by both a Welsh Government representative and an APEM staff member. The harbour master and a fisher were interviewed. The harbour master for Aberystwyth is also the harbour master of New Quay and Aberaeron ports.

Whelk pots and mixed pots (for crabs and lobsters) are the primary fishing gears deployed by vessels at these ports with some spider crab andbass fishing also conducted, as well as scallop dredging between November and April (Figure 13).

**Figure 13:** Fishing pots ready to be deployed after the storms (left). Stacked scallop dredging teeth (right).

### 5.5.4 Swansea

Swansea port is a Private port in Wales with 30 registered vessels (2018; MMO, 2020a; 2020b; 2020c). In 2018, 498t were landed into the port. The main catches landed into Swansea are demersal, including skates, rays, and sole.

On the 6th March 2020, a site visit at Swansea port was conducted. Local fishers and their port representative were met and interviewed. According to the fishers and port representative, Swansea does not provide gear disposal facilities to fishers. Fishers do have access to a refuse bin on the pontoon (size of a bath) which the marina provided out of necessity. According to the fishers, this bin is emptied when it is over capacity. However, once a year the fishers hire a skip (at their own expense) for the disposal of larger items (Figure 14). The fishers are not aware of any recycling facilities at the port.


**Figure 14:** Skip filled with end-of-life fishing gear and waste items recovered at sea (Swansea).

### 5.5.5 Conwy

Conwy port is situated in North Wales (Figure 15). In 2018, there were a total of 17 vessels which landed a total of 74t (MMO, 2020a; 2020b; 2020c). However, according to the deputy harbour master, there are only 7 active fishing boats. Conwy is popular for access to the mussel farm, potting for whelk, lobster and crab, and gill netting. Conwy and Rhos-on-Sea are jointly managed Municipal ports. Rhos-on-Sea has no facilities and is not maintained/managed.

On the 16th March 2020, a site visit at Conwy port was conducted. Conwy previously had waste facilities, however, despite the skip having a lock and key, the system was abused. The skip experienced fly-tipping and items such as batteries and old oil were disposed of incorrectly in the skip. The port now has no such facilities. Conwy port does have a storage area for fishers and when the area seemingly has too much waste, the port has in the past provided a skip.

**Figure 15:** Image of Conwy port, showing moorings for commercial and recreational boats.

### 5.5.6 Morfa Nefyn and Pothdinllaen

Morfa Nefyn is one of the smaller ports in Wales. There were 8 vessels registered in 2018 and the main landings are crab, lobster, and prawns (MMO, 2020a; 2020b; 2020c). Morfa Nefyn is managed by the council meaning that certain activities such as launching of boats are charged. Additionally, a number of the boats fish from nearby Pothdinllaen which is owned by the National Trust. The privately-owned port Hells Mouth is also nearby.

On the 17th March 2020, a site visit at Morfa Nefyn and some of the surrounding areas (including Pothdinllaen and Hells mouth) was conducted. A member of the Welsh Fisherman's Association and another local fisher were interviewed. Both fish in locations where there are limited or no facilities. Small boats are often used to access their fishing vessels and any catch must be loaded onto the small vessels before being transferred to land (**Error! Reference source not found.** and Figure **16**). Fishers store their waste and later transport it to the recycling centre in Pwllheli (Figure 17).

**Figure 16:** Beach in Pothdinllaen where fishers moor their boats.

**Figure 16:** Hell's Mouth, near Aberdaronwhere fishers launch their boats

**Figure 17:** End-of-life fishing gear and marine debris at Nefyn (right) and Hell's Mouth (left). Fishers take turns to dispose of items at the recycling facility in Pwllheli.

# 6. Discussion

### 6.1.1 Fishing gear lost or disposed of by the Welsh commercial fishing fleet

From the results presented in Section 5, the desk-based reviews generated information regarding commercial fishing activity in Wales, gear and port use, gear disposal information, and ALDFG conservation organisation activities in Wales. The questionnaire and site visits were able to provide detailed information regarding fishing activities and gears used, as well as available gear disposal options.

There are around 430 commercial fishing vessels across 41 Welsh ports (MMO, 2020a; 2020b; 2020c). Landings information provided by the MMO does not specify nationality beyond the UK classification on publicly available data, however, given around 90% of the vessels landing into Welsh ports are under 10m in length it is likely these UK vessels are local Welsh registered fishers operating on local fishing grounds. Landings information highlighted a relatively small amount of UK over 10m landings and the use of some southern Welsh ports by over 10m EU (Belgian) vessels .

Using the combination of vessel size and landings the general gear type used by vessels can be inferred. The high level of shellfish landings particularly lobster, crab, and whelk in combination with the small vessel size leads to the assumption that pots are the primary gear used by Welsh commercial fishers. The presence of scallop landings infers use of dredge gear by vessels powerful enough to tow these gears (vessels typically over 10m). There are also landings of demersal species such as skates, rays, flatfish, and round fish. Typically, these species are caught with passive netting gears (gill, trammel, or tangle nets) by small vessels or trawls by larger vessels.

Questionnaires returned by fishers confirm pots are the dominant gear used by the Welsh commercial fishing fleet, with smaller numbers of passive net, trawl and dredge gears used. The questionnaires also highlighted the polyvalent nature of the Welsh commercial fishing fleet, with many fishers using multiple gear types, the most common pairing was pots and passive nets. This provides clear steering of the types of gear for which disposal facilities are required within and around Welsh ports.

There are certain aspects which add to the complexity of fishing gear disposal. These include the life span of gear, the variety of constituent materials which have different degradation rates and recyclability, the loss of gear at sea, and the collection of ALDFG from the sea. The collection of ALDFG from the sea may require additional facilities for disposal if it is classified as contaminated waste. Where possible any contaminated waste should be separated, however, this can be difficult and or time-consuming (Stolte and Schneider, 2018). The fishers interviewed expressed their observation that the practice of discarding end-of-life gear into the sea is uncommon and that such dumping is an older stereotype linked with previous generations. Fishers hold each other accountable at certain ports and question someone if they appear to have less waste than expected when returning to port. This was particularly true for the bait bags and fishers returning without these bags could be subjected to questioning by their colleagues.

The questionnaires completed by fishers indicate that gear lifespan varies by type, with pots lasting longer than nets (around 8 and 4 years respectively). It was remarked by one fisher that trawl nets need to be replaced approximately every two years, however, another fisher noted that a trawl net can last between five and 10 years. On average, trawl gear was found to last (± standard deviation) 4 (± 2.62) years. A common remark among several of the fishers

was that they only replace and dispose of gear when they absolutely have to, repairing as much of their gear as possible, prolonging its life, due to the expense required to replace it. One pot shown was estimated to be 20 years old following multiple repairs (Appendix 2 Figure 19). Typically, a fisher's gear will not all reach its end-of-life at the same time (unless lost or stolen). In general, the fishers do not consider they personally produce a large amount of waste. One tactic employed by some larger pot fishers is to sell their older pots to fishers with a lower capacity. Swansea fishers noted, in general, more gear is stolen or lost and fishers have very little to dispose of. Fisher responses indicated that an average of 14% (117) of mixed pots, 6% (21) prawn pots and 29% (217) whelk pots are disposed of annually per fisher.

As it is expensive to replace and poses a risk to the vessel, it is in a fishers own interest to prevent their gear from being lost and will operate in ways to prevent loss of gear as much as possible, including avoiding areas which have the potential to snag their gear. One fisher highlighted that enhancements in technology have reduced the likelihood of gear loss, such as those used in positioning and weather prediction. The fisher responses were able to indicate the amount of gear lost and indicate only 1% of the pots were lost at sea per annum, however, this number can increase considerably during storms or if another boat moves the pots (runs over the buoys). For instance, in the February 2020 storms, a fisher noted that 200 pots were lost (approximately 7% of their total pots).

In other similar studies, trammel and gill net operators reported losing approximately 1% of their gear per vessel per year (Gilman *et al.,* 2016). Additional data from logbooks, observer programs and experiments would assist in validating the quantity of lost gear (Gilman *et al.,* 2016). Fishers stated that when gear is lost every effort is made to actively search for, and recover it, including in some instances the hiring of divers.

### 6.1.2 ALDFG collected by the Welsh commercial fishing fleet

Many fishers were found to actively collect ALDFG and general refuse found in the sea. If these items are left, they may become tangled in their gear or the boat's propeller and or reduce fishing potential by harming habitats and wildlife. This is reinforced by fishers' awareness of the impact of plastics on the ocean along with societal pressure to prove responsible fishing practices.

Although fisher responses confirmed that they all encounter ALDFG, the frequency is not common and the volumes reported implied it is rare to encounter a large number of lost nets or tangle of pots (>50kg), with volumes more likely to be in the range of a few meters of net or individual pots. Not all gear can be retrieved due to the size and weight of the gear. This is particularly true for smaller boats. However, all but one fisher said that they generally make an effort to collect ALDFG.

Pots were reported to be encountered most often. This is consistent with the dominant fishing practice carried out by Welsh fishers and implies gear recovered is lost locally. Depending on the fishing community, an attempt is made to return the pots to their original owner. The owner can be identified by the method in which the pots have been assembled (their unique pot tying method) or repaired. Non-returned found gear is often reused, or parts are integrated into the repair of old gear. If trawl nets are found, these will generally be reused if in good condition or used to fix or re-enforce pots, while found rope can be used for various tasks, thus reducing the volume for disposal. Gear not able to be repaired, repurposed or sold is disposed of. Although seldom the case, finding lost fishing pots in good repair was considered a positive event by fishers due to the expense of purchase and can generally be used or sold.

In addition to ALDFG, fishers reported collection of approximately one refuse bag of general municipal waste with some other fishing waste items such as small pieces of net and bait bags per fishing trip, which they collect and return to land for disposal.

The positive attitude for responsible guardianship of the sea by removing ALDFG should be supported and encouraged. Many responses highlighted that at present they are having to dispose of this collected ALDFG at personal cost to themselves. Other responses highlighted that rather than pay to dispose of the gear, the found and collected gear was left on the keyside for the port or others to remove further. One noted a net was left for several months on the dock side. One way to encourage and support collection would be to look at the provision of specific waste disposal facilites available to fishers to recycle retrieved ALDFG.

### 6.1.3 Available fishing gear disposal facilities for the Welsh commercial fishing fleet

Of the six ports visited within this project, few had permanent waste disposal facilities beyond a public refuse bin found in many public areas. Milford Haven and Saundersfoot were the exceptions providing fishers with a separate waste facility which is located near the fishing docks. Milford Haven had separate waste bins (cardboard, plastic, wood and general) for recycling of items. In order to manage this facility, the area is locked and can only be accessed upon request. Users are charged for the amount they dispose.

Several ports have previously provided skips for waste disposal, but these became the target of fly-tipping, such as at Aberystwyth, or were used to dispose inappropriate material, such as oil and vehicle batteries. To avoid fly-tipping, skips are sometimes hired for a short period once or twice a year, dependent on demand. In some ports, this skip is provided by the port authority, as is now the case in Aberystwyth. In other ports groups of fishers pay the hire costs, such as at Swansea. Between these periods, fishers are required to store items or dispose of it themselves. Fishers in Aberystwyth believe that this system, though inconvenient at times, works and caters well for the demand. Though there is a preference for a permanent facility, fishers in other ports take gear to landfill tips for disposal. These last examples can be costly to fishers and prevent gear from being considered for recycling. For smaller items, such as municipal waste and small pieces of ALDFG collected at sea, the fishers make use of the public refuse bin(s) or take it home for disposal in household waste. The disposal of ALDFG and retrieved municipal waste was noted to be the largest concern and the main need for permanent disposal facilities.

Whilst most ports reported having some form of disposal facilities available to fishers, the response of the fishers indicates a view that disposal facilities are generally either not present, or limited. No contaminated or toxic waste disposal facilities were observed or highlighted at any of the ports connected with this project. The lack of an adequate place to discard contaminated waste poses a problem for the disposal of any mixed ALDFG which could be considered contaminated. Currently, ALDFG is typically repaired, reused or disposed of into general waste. Fishers noted the desire for improved on-site waste disposal and recycling facilities. Fishers in Conwy, for example, estimated that two large bins (emptied weekly) would be suitable. Further discussions between ports and fishers is needed to communicate the disposal requirements of fishers and harbours need to improve communication regarding what facilities are available.

### 6.1.4 Recycling and repurposing of fishing gear

Welsh Government has the third highest recycling rate in the world for municipal waste (Wales Recycles, 2019). The Welsh municipal recycling centre is capable of processing and dealing with a wide variety of products including plastic, glass, paper, cardboard, tins, textiles, batteries and other items (Recycle for Wales, 2020). Items such as oil and petrol need to be disposed of separately (Oil Care, 2020).

Recycling end-of-life fishing gear appears to be limited in Wales, however, based on the findings of the research. Availability and knowledge of recycling facilities and schemes was relatively low among fisher responses. The diversity of composite materials in fishing gear may hinder recycling efficiency or inclination to recycle. Few of the visited ports had recycling facilities available on-site, none specifically for fishing gear. Relatively few of the fishers reported using of on- or off-site recycling facilities. When specifically mentioned, it was limited to the use of council run public municipal recycling centres to dispose of gear.

Fishers using dredges reported making use of scrap metal yards and selling end-of-life metal components. Dredge teeth, for example, were highlighted as having to be replaced regularly, with one scallop dredger stating that approximately 100 pounds of metal was sent for scrap every few days. There were no known net recycling facilities within Wales. When contacted, conservation organisations (including Ghost Fishing UK) which focus on converting and recycling old fishing gear, stated there are no suitable recycling facilities available within the UK. These organisations are forced to use facilities in other countries where net recycling facilities are available, such as that in Aquafil in Slovenia (Ghost Fishing UK, pers. comm.). Aquafil predominantly recycles nylon found in Gill nets and seine nets (Fritts, 2017). Gill nets are generally comprised of high-value polymers PA6 and PET (Stolte and Schneider, 2018). Both ALDFG and end-of-life fishing gear can be recycled, however recycling of ALDFG is slightly more complicated than end-of-life fishing gear which has already been sorted and stripped of other materials such as lead based lines (Stolte and Schneider, 2018). Transportation of end-of-life fishing gear can be restrictive and for this reason, a UK based fishing gear recycling facility would enable an increase in recycling possibilities. A UK based facility could variety of UK based organisations using recycled ALDFG as materials in a variety of their products creating a demand.

The only recycling scheme highlighted by a small proportion of fisher responses and noted on the Milford Haven ports website was the NGO Fishing For Litter recycling scheme. However, this NGO has not operated in Wales before (Fishing For Litter, pers. comm.). Additional organisations such as Ghost Fishing UK and Sea Shepherd Conservation Society communicated having little or no work programmed in Wales. The reason for this was given to be as a result of high licencing costs and lack of recycling facilities (Sea Shepherd, pers. comm.; Ghost Fishing UK, pers. comm.). It would be valuable to discuss further with these NGOs how their operation within Welsh waters may be made possible. These NGOs operate various forms of collection and disposal of marine litter, dealing with aspects of ALDFG, rather than the general recycling of end-of-life fishing gear.

For Wales to find a solution to dealing with end-of-life fishing gear, recycling facilities need to be accessible and affordable to use. The dominance of shellfish fisheries in Wales and the associated hard plastic waste produced from fishing (through prawn pots, whelk pots, certain fishing buoys and plastic fishing crates) means that a first step towards greater recycling of fishing gear could focus on hard plastic recycling. With additional materials being assessed and introduced over time, for example rope. Recycling of hard plastic is already conducted within the country at municipal recycling works. Increasing awareness of the capabilities and

enabling correct disposal locations for fishers would help reduce the amount of fishing gear waste entering landfills.

Finally, one imaginative way fishers have employed to dispose of end-of-life gear has been through repurposing. Old fishing gear has been donated or sold to businesses as decoration (Appendix 2 **Figure 20**) or repurposed into other items including furniture, garden ornamentation (Appendix 2 Figure 21), and the use of old trawl netting to cover ponds.

### 6.1.5 Innovating fishing gear to reduce unwanted entrapment and the effect of ALDFG

As most of the fishing conducted by the Welsh commercial fishing fleet is conducted in shallow waters, lost gear will be subjected to the effects of wind and current, and become entangled reducing its ability to ghost fish at a faster rate than if lost in deeper water (Brown *et al*., 2005). Some Welsh fishers noted that pots are often deployed on muddy substrate, having the opinion that if lost they soon become buried in the mud and similarly lose the ability to catch prey. However, gear innovation can be used to further reduce the likelihood of ghost fishing, where lost gear continues to impact the target species once lost.

Organisations such as Sustainable Shellfish Initiative demonstrated that many modifications to fishing gear can be incorporated with minimal cost and effort (Pembrokeshire Sustainable Shellfish Initiative, 2018). This echoed a fisher in Conwy and Morfa Nefyn regarding incorporation of escape hatches for juvenile crabs and lobsters into their lobster pots. The fisher mentioned that they either have or could easily modify their current pots to incorporate this (Figure 22). However, this may not prevent ghost fishing of larger sized shellfish. Despite this, Pembrokeshire Sustainable Shellfish Initiative found that incorporating a “weak link” into fishing gear (Figure 23) was a preferred method to escape hatches as they are less likely to fail and could help prevent the pot from continuing to fish once lost (PPSI, 2018).

### 6.1.6 Methodology limitations

This project minimised bias through a multi-method approach, using published landings information and other literature to infer gear usage and scale of fishing operations within Welsh ports. Questionnaires were distributed to three different aspects of the Welsh commercial fishing industry (fishers, harbour masters and gear suppliers) to provide a representative sample of the industry, and site visits to directly observe facilities.

Publicly available information of UK and EU landings into Welsh ports was available from the MMO (MMO, 2020a) in an aggregated format, to ensure confidentiality. This data did not include information on nationally beyond the UK classification, or gear type. Therefore, expert knowledge was used to infer gear type based on a combination of vessel size category and species landed. Through the use of the MMO vessel register and information on the vessel categories associated with UK landings into Welsh ports, landings were assumed to be part of the Welsh commercial fishing fleet.

A small, though informative, number of questionnaire responses were obtained within this project. Of the responses obtained, fishers noted that their answers would be mirrored by many of the fishers within their port. The low level of response was considered to result from a number of factors, including the short time window available for inquiry, and a low level of targeted fisher survey distribution. The latter in part resulting from limited availability of the

Welsh Fisherman's Association and as a result of restrictions due to the COVID-19 global pandemic affecting the fishing community. Survey responses were therefore obtained exclusively by APEM staff members with most targeted fisher surveys distributed through site visits and personal communication. While harbour master and supplier surveys were distributed after online searches of contact information.

Questionnaire based surveys are acknowledged to have inherent bias, often being qualitative, interpretive, and subject to external forces which may impact their responses. In this instance, fishers and suppliers noted their reluctance to share information for fear of it being used against them or that it may lead to the creation of more restrictive policy and legislation. When APEM staff were introduced to fishers by the harbour masters, fishers were reluctant to share the methods they use to dispose of fishing gear, particularly if the harbour master was present during the interview. In general, people are reluctant to share information related to illegal activities even if told that their identity would remain anonymous.

It is recommended to take discussions on gear loss, retrieval and disposal forward with a wider group of fishers, harbour masters, and suppliers to gain detailed insight into port specific requirements. One possibility is to approach Marine Enforcement Officers and fisheries observers to either spread the request for fishers to complete questionnaires or request them to ask the questions when with fishers. Many of these samplers have working relationships with fishers and may be seen to be more approachable. An alternative would be to hold port based open meetings on disposal requirements and facilities. In either case, further investment and engagement is required to expand the dataset further, and a better understanding of the disposal needs of the Welsh commercial fishing fleet would add value to any future policy or programme implemented by the Welsh Government.

# 7. Conclusions

Fishers use their gear for as long as possible to avoid buying new, expensive gear. Many will in the first instance attempt to prolong the life of their fishing gear by avoiding factors that increase the risk to their gear, including poor weather conditions and substrates which may cause gear to become snagged or entrapped. Once gear is damaged or old many will repair damaged gear for several years. There is also a common trend of reusing found gear and using it for repairs. Line and net gear tend to have a shorter life span than pots and is often implemented to repair crab or lobster pots. If fishers are unable to repair gear due to time constraints, they will often sell used fishing gear onto smaller fishers, thus saving costs which increases the fishing gear's life span.

Of the interviewed fishers, the majority routinely collected waste encountered at sea and ensured their own waste was returned to land for disposal, expressing a desire to act responsibly. Fishers who lose fishing gear attempt to retrieve it, in some cases even paying for others to retrieve it. Fishers also report gathering general waste they encounter such as plastic bottles and bags along with any fishing gear within the space available on their vessel. Current fishers understand that ALDFG is a problem which can personally affect their activities and impact their livelihoods. There is a common understanding that any lost fishing gear will eventually cause them problems, and thus is in their best interest to prevent loss of fishing gear and collect encountered ALDFG.

Waste disposal facilities within Wales do not appear to be keeping pace with the attitudes of fishers. Of the ports visited and discussed in this project many had no facilities beyond a public rubbish bin such as those found in public places. Recycling facilities were rarely present although several made use of local council recycling centres for some gear components. Fishers were unaware of any Welsh recycling schemes designed for fishing gear. Ports are legally required to provide suitable waste disposal facilities and infrastructure should be implemented to support fishers responsibly disposing of-life gear. Methods to dispose of ALDFG without additional cost to fishers should be considered to encourage the continuation of this behaviour.

Given the high level of plastic and metal within fishing gear, recycling would often be possible and should, therefore, be encouraged. Having more recycling and general waste facilities at the ports will help to encourage fishers to dispose their gear appropriately. However, one size fits all solutions will not be practical around Wales, and a variety of options should be considered based on port size and demand. Small scale ports, for example, have limited ability to house, empty, and police improper use of permanent onsite facilities and are unlikely to have the same level of demand as a large port with 24-hour staff presence and more registered active fishing vessels. In these situations, having lockable waste and recycling facilities such as at Milford Haven where fishers contact the harbour master for access may be a viable option. However, a facility more targeted at recycling fishing gear would be beneficial, such as at a minimum collection for hard plastics, something already collected at many council run recycling centres. To avoid the issue of port size, disposal demand, and increase the level of recycling, a possible solution would be development of a specialised fishing gear waste and recycling collection infrastructure with either scheduled or on demand port collections and removal to relevant recycling centres.

An alternative solution would be that proposed by an EU single use plastic bill where the supplier takes responsibility for the adequate disposal of end-of-life gear. The ability of suppliers to aid in this disposal may be limited based on the feedback from this project. Small scale suppliers would be unable to deal with the time and cost associated with accepting end-

of-life gear. While larger suppliers may be willing and able to recycle gear, if a “return to supplier” scheme is to be the primary method of gear disposal a suitable inexpensive method of returning will need to be considered. For example, bins could be provided in port funded by fishing gear suppliers to make them responsible for ensuring that their product can be disposed of responsibly.

This project has highlighted a need for a coordinated solution for the disposal of fishing gear used and collected by the Welsh commercial fishing fleet. The project has provided data to underpin the understanding of the current situation within several Welsh ports, and areas requiring development to provide a safe, secure and sustainable method of disposal and recycling for fishing gear. Specifically, existing methods of disposing of ALDFG and municipal waste collected at sea, and facilities for pot and net gear appear to be insufficient to meet the needs of fishers. A disposal infrastructure which enables these aspects should be developed with an increased focus on the promotion of recycling. Further, in-depth engagement with fishers across the variety of Welsh ports would aid this investigation and development.

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# Appendix 1 Questionnaires

## a. Fishing industry questionnaire

# RESEARCHING FISHING GEAR DISPOSAL NEEDS FOR WELSH COMMERCIAL FISHING INDUSTRY

## Commercial Fishing Industry Questionnaire

*This survey is anonymous*

The Welsh Government, in partnership with APEM, is researching the fishing gear used by the Welsh commercial fishing fleet. This information will be used to better understand the use, recycling and disposal of fishing gear in Wales, gather examples of retention, recycling and disposal best practice and identify knowledge gaps and key challenges regarding end-of-life fishing gear.

1. **What types of fishing gear do you use aboard your vessel? (circle all that apply)**
   Dredges, whelk pots, crab pots, lobster pots, traps, tangle nets, trammel nets, drift nets, gill nets, beam trawl, otter trawl, pelagic trawl, longline, seines, handline, rod & line or other_____

2. **How many of each type of fishing gear do you deploy over the course of a year?**
   Please include information such as the number of pots, meters of line or net etc.

3. **What is the working life span of your fishing gear / how often do you replace your fishing gear?**

4. **How do you dispose of your fishing gear? Is there anything that would make disposal easier?**
   Please include information on whether you recycle or repurpose your gear.

5. **Are you aware of any recycling facilities or schemes for fishing gear? Either at your home port or at other Welsh ports?**

6. **Where do you buy your fishing gear?**
   Please provide as much detail as possible, including whether purchases are online, at auctions, from manufacturers or from importers/traders, and the names of companies if relevant.

7. **Do you encounter lost fishing gear during your fishing activities? If so, how much and of what type?**

## 8. What do you do with this gear found at sea?

If you dispose of it then where?
If you reuse/sell it then what type of lost gear do you reuse/sell?

## 9. How much of the fishing gear you use do you estimate is lost in a year?

Please include information such as the number of pots, meters of line or net etc.

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

## b. Harbour master questionnaire

# RESEARCHING FISHING GEAR DISPOSAL NEEDS FOR WELSH COMMERCIAL FISHING INDUSTRY

### Harbourmaster Questionnaire

The Welsh Government, in partnership with APEM, is researching the fishing gear used by the Welsh commercial fishing fleet. This information will be used to better understand the use, recycling and disposal of fishing gear in Wales, gather examples of retention, recycling and disposal best practice and identify knowledge gaps and key challenges regarding end-of-life fishing gear.

### Port name and type of port (circle all that apply)

Trust port, privatised port, municipal port or other_____

### Main fishing gear(s) deployed on vessels from this port? (circle all that apply)

Dredges, whelk pots, mixed pots, traps, tangle nets, trammel nets, drift nets, gill nets, beam trawl, otter trawl, pelagic trawl, longline, seines, handline, rod & line or other_____

### Are there facilities available for disposal of fishing gear at your port? If not, how is fishing gear disposed?

Please include information such as type, size and access to disposal facilities

### Do you encounter problems with the disposal of fishing gear?

Please describe what problems, type of problematic gear and type solution used/ solution proposed.

### Are you aware of any recycling facilities or schemes for end of life fishing gear at other Welsh ports?

### Is there anything else that you would like to add?

## c. Gear supplier questionnaire

# RESEARCHING FISHING GEAR DISPOSAL NEEDS FOR WELSH COMMERCIAL FISHING INDUSTRY

## Fishing Gear Supplier & Retailer Questionnaire

The Welsh Government, in partnership with APEM, is researching the fishing gear used by the Welsh commercial fishing fleet. This information will be used to better understand the use, recycling and disposal of fishing gear in Wales, gather examples of retention, recycling and disposal best practice and identify knowledge gaps and key challenges regarding end-of-life fishing gear.

### Business name?

### What type of fishing gear do you supply? (circle all that apply & please add a link to stock list)

Dredges, whelk pots, mixed pots, traps, tangle nets, trammel nets, drift nets, gill nets, beam trawl, otter trawl, pelagic trawl, longline, seines, handline, rod & line or other_____

### Do you supply gear to Welsh commercial fishermen? If so, what are the main ports and gear types supplied?

### Does your company currently help with the disposal of fishing gear?

If yes, please expand on methods and quantity of gear removal and main obstacles encountered?

If no, have you helped previously, or would this be a future consideration?

### Is there anything else that you would like to add?

# Appendix 2 Supplementary photographs


**Figure 18**: Example of promenade bin cited to be used by 35% of the fishers for waste disposal.

**Figure 19:** Repaired fishing pot. Note the different netting used for repair over the years. Life of the fishing pot has been extended by replacing the support beams with plastic piping and re-enforcing the base with re-purposed bread trays. This pot is estimated to be 20 years old.


**Figure 20:** Old fishing gear repurposed as decoration.

**Figure 21:** Old lobster and crab pots re-purposed in fisher's garden in Morfa Nefyn

**Figure 22:** Escape hatches can be easily incorporated into existing fishing pots

**Figure 23:** Pot modification example. If the pot is lost, the keyring will begin to rust, and the door of the pot will open thus allowing animals to escape (awarded Sea Change Champion for world animal protection (2015) due to modification).