Project UK Fisheries Improvements

Marine Stewardship Council FIP

Western & Channel Monkfish Fishery ETP Species Assessment

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4.1. Introduction

This report aims to provide an assessment of the Western & Channel Monkfish Fishery's interactions upon Endangered, Threatened and Protected (ETP) Species. The fishery is engaged in a fisheries improvement project (FIP) with the SEAFISH Project UK Fisheries Improvements (PUKFI) scheme. This initiative is a multi-stakeholder engaged process working towards achieving an environmentally sustainable future for UK fisheries. The PUKFI scheme aims to employ the strategic use of the Marine Stewardship Council's (MSC) Fisheries Certification Standards to develop credible FIPs with the goal to give the fishery the tools to implement ambitious changes to ensure the sustainability of the fishery. The fishery has since been subject to a pre-assessment performed by Acoura, in order to outline the current status of the fishery for a subsequent action plan to be laid out based on the potential knowledge gaps identified from the pre-assessment. The action plan has identified a gap in the information available of the fishery's interaction with ETP Species, a concern that this assessment aspires to resolve.

4.2. Background of the Fishery

The profile of the Monkfish fishery engaged in the PUKFI programme is summarised in Table. 1 below, this also includes the spatial extent of which ICES divisions the targeted stock occurs and the different types of gear used within the fishery.

Targeted Stock:	White anglerfish (*Lophius piscatorius*) in divisions 7.b–k, 8a–b, and 8d (southern Celtic Seas, Bay of Biscay)
Fishing Method / gear type:	1. Beam Trawl 2. Demersal Trawl 3. Trammel nets and entangling nets
Fishing Fleet	UK Registered vessels
Area:	UK & EU waters: ICES Area 7.b–k, 8a–b, and 8d (southern Celtic Seas, Bay of Biscay)

TABLE 1 PROFILE OF THE WESTERN & CHANNEL MONKFISH FISHERY

4.3. Assessment Area

As stated in Table. 1 the UoA covers the ICES Areas 7.b-k, and 8d, which will be considered for each gear type and can be observed in Fig. 1 below:

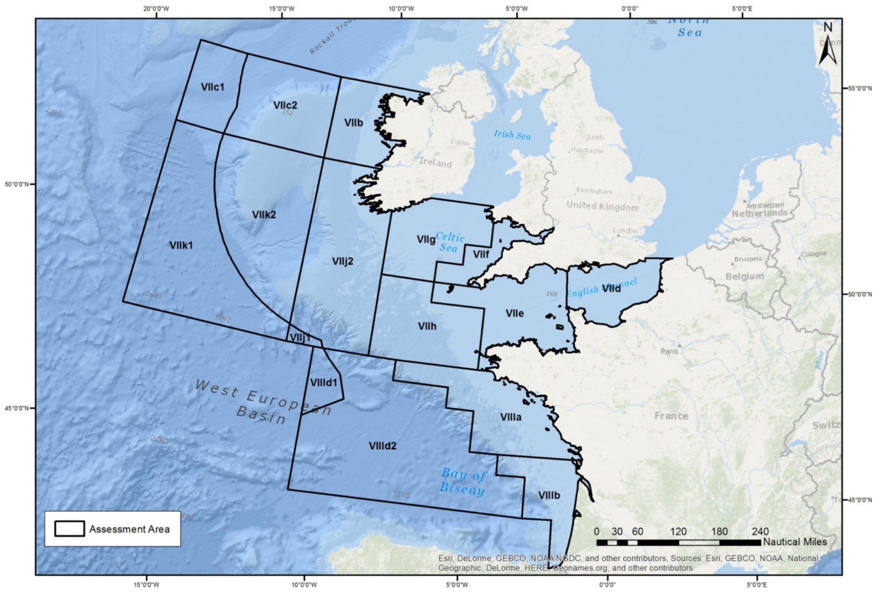

FIGURE 1 ASSESSMENT AREA OF THE FISHERY

4.4. Aims & Objectives

The study aims to detangle the fisheries interactions upon ETP Species by achieving the following key objectives.

- Identify the potential vulnerable ETP species that are within the fishery's assessment area.
- Understand the occurrence and distribution of the ETP species throughout the assessment area.
- Describe the potential for interactions between the ETP species and the activity of the fishery and those most at risk from the fishery's activity.

4.5. Defining and Identifying ETP Species

In the last three years the MSC has updated its Fisheries Standards with v2.0 Certification Requirements. These are now in effect and the ETP Species principles also now include species that are listed under the European Commission's fixing fishing TAC quota EU2017/127 regulation as prohibited in Article 41 and those species listed as 'VU', 'EN' or 'CR' through the ICUN's Red List. The original criteria of any binding international agreements or national legislation still applies.

Identifying ETP Species was approached by considering a number of sources; species listed on the UK's Biodiversity Action Plan, species regarded as ETP in previous MSC fishery assessments with similar spatial scales and gear types and various forms of scientific literature.

4.6. Key Vulnerable Species Identified

A number of different species of various taxa were identified as being vulnerable to the gears in use by the fishery, including a number of elasmobranchs, marine mammals, seabirds and fish species of conservational concern. The productivity and susceptibility risk assessment found that the ETP Species that were most at risk from the different gear type of the fishery are seen in Fig. 2 below:

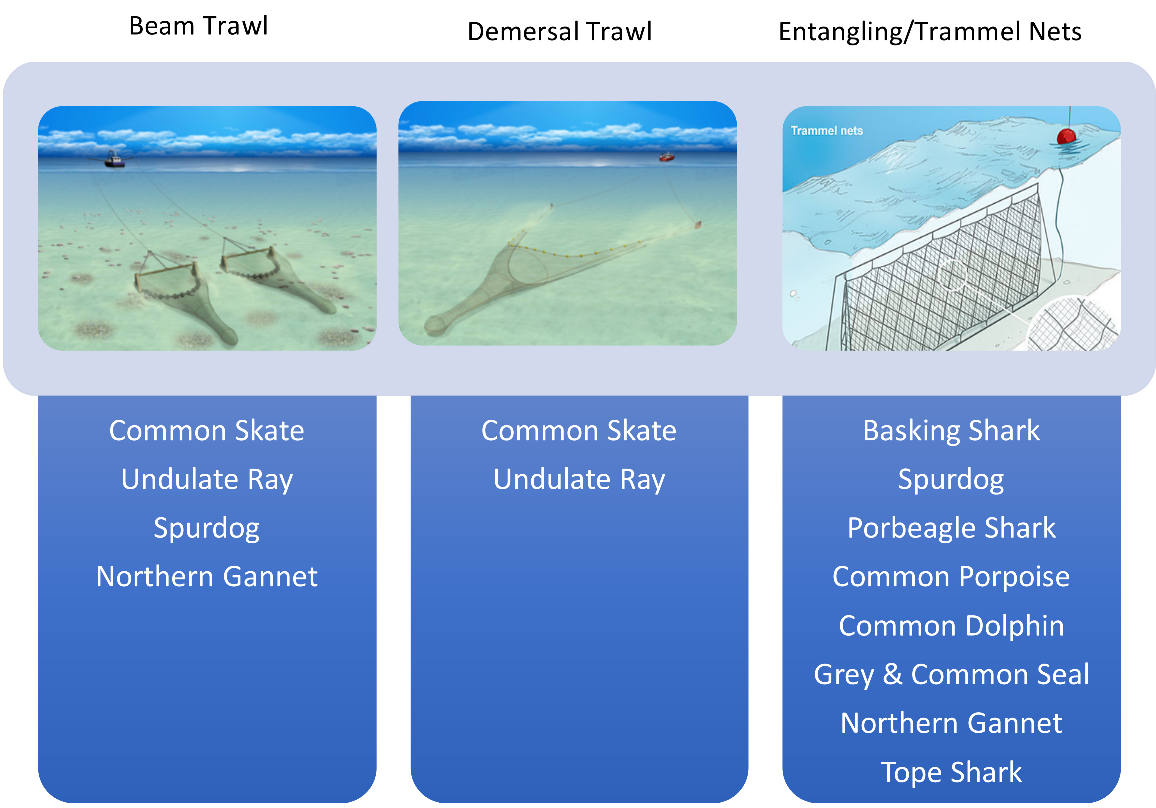

Figure 2 Key ETP Species for each Gear Type

4.7. Data Sources Used for Analysis

Various types of datasets have been acquired for the assessment process these include:

- Cefas observer data from observed trips on upon a number of fishing trips of the fishery from 2010-2016.
- Marine Management Organisation released Vessel Monitoring System (VMS) data of the fleet of the fishery which has been analysed. Analysis indicates that the beam trawl fishing effort is High

in VIIe, Medium in VIIf, VIIh, Low in VIId, VIIg. The demersal trawl effort is High in VIIe, Medium in VIIf. Whilst the entangling/trammel nets High in VIIe, VIIg, VIIf, VIIh, Medium in VIIj2, Low in VIIIa.

- European Ocean Biogeographic Information System and European Marine Observation and Data Network were also used to attain species specific data such as sightings.

4.8. Key Elasmobranchs Findings

Various species of elasmobranchs were recorded by Cefas on observer trips, with the beam trawl and the entangling/trammel nets exhibiting a larger impact on a wider number of species.

- The Common Skate was observed as bycatch in relatively significant amounts in both the beam trawl and the demersal trawl, where similar overall total numbers were observed of the Skate over the 2010-2016 period. However, catches were recorded annually for the beam trawl throughout the time period, whilst all of the observed demersal trawl Common Skate catches were recorded in 2016.
- Besides high rates of Common Skate catch in 2016, the demersal trawl gear exhibits relatively small numbers of bycatch of other vulnerable elasmobranchs.
- Trends for bycatch of other species of elasmobranchs in beam trawl gear suggest that the Undulate Ray was of previous concern in 2010, however this has now lessened and in recent years catch rates of the Nurse Hound, Starry Smooth Hound and Blonde Ray have increased.
- Bycatch of elasmobranchs in Entangling/Trammel Nets is much less pronounced than in the trawl gear of the fishery. Although it is important to note there are comparatively moderate catch rates of Spurdog and there are rare observations of bycatch interaction with the Porbeagle Shark and Basking Shark.
- Recoverability from mortality events by elasmobranchs are relatively poor due to their slow productivity and reproductive strategies, despite this studies on post capture survivability and sublethal impacts suggest that survivability for some elasmobranchs is high. Survivability from bycatch in Common Skates has been deemed by multiple studies as particularly high.

4.9. Key Fin Fish Findings

Two species of shad have been identified as an ETP Species vulnerable to impacts from the fishery, these consist of the Alosa Shad and the Twaite Shad.

- There was only one observed incident of Twaite Shad in 2013, and there were no recordings of observations of the Alosa Shad. Suggesting that shad species may have a high chance of escaping the fishing gear used by the fishery and that risk of capture is relatively low.

4.10. Key Marine Mammal Findings

There were no observations of bycatch of marine mammals in the trawl gear by Cefas. However, there are marine mammal bycatch observer data covered by the Sea Mammal Research Unit (SMRU) on set net fisheries of the UK. These are in the form of annual reports submitted to the European Commission regarding the EU812/2004 regulation that can be used for meta-analysis.

- The clients of the fishery state that pingers are in use on vessels over 12m, this is assumed to be the DDD-03L deterrent device that is authorised for use by the UK government under derogation.
- Analysis of the annual SMRU reports suggests that entangling and trammel set nets potentially have a relatively high risk to the Common Porpoise, Common Dolphin and Grey & Common Seal.
- Estimations by the SMRU of total bycatch by each UK métiers suggest that entangling & trammel nets of UK waters incidentally capture 550 Common Porpoise in 2016, if pingers were used in vessels over 12m.
- Estimations of total bycatch of Common Dolphin in 2016 by entangling & trammel nets were calculated to be slightly lower with total numbers bycaught estimated at 155. Grey/Common Seal total bycatch by entangling & trammel nets was estimated at 536 for 2016.
- These figures are below thresholds that are established by the ASCOBANS agreement.

4.11. Key Seabirds Findings

A handful of seabirds have been pragmatically identified as vulnerable to the fishery, although there is little quantitative evidence that is relevant and therefore meaningful conclusions are difficult to deduce.

- Four incidents of capture of the Northern Gannet was observed by Cefas by beam trawl gear were observed in 2013.
- Non-dedicated sampling collated by the SMRU in 812/2004 reports suggest that catches of seabirds are relatively low, however Gannets, Guillemots and Fulmars have also been observed in entangling/trammel net fisheries of the UK waters.
- Cefas only observed small numbers of the Sandeel (predominant food source for diving seabirds) in the beam trawl gear.
- On the whole seabirds were only recorded in relatively small numbers, interaction rates with these species and specifically diving seabirds may of course be low. But due to their observations mainly arising from non-dedicated sampling schemes, more information would be useful in ensuring interactions are infrequent.

4.12. Key Overall Highlights

- Common Skate bycatch has been observed to be high in the beam and demersal trawl gear of the fishery, with the Skate only recently becoming a problem with high catch rates in 2016 for the demersal trawl, although survivability is considered to be high.
- SMRU reports that the majority of marine mammal bycatch occurs in ICES divisions of VIId, VIIe and VIIf, and that Common Dolphin, Common Porpoise and Grey and Common Seal bycatch by nets used in the fishery should be more appropriately assessed.
- Catches of other species of elasmobranchs are comparatively lower with respect to that of the Common Skate, but post-capture survivability of other species such as the Porbeagle Shark and Tope Shark have been observed to much lower.
- Survivability of ETP elasmobranchs should be further studied.

5. Introduction

The Western & Channel Monkfish fishery has been engaged into a fisheries improvement project (FIP) with the SEAFISH Project UK Fisheries Improvements (PUKFI) scheme. This initiative is a multi-stakeholder engaged process working towards achieving an environmentally sustainable future for UK fisheries by engaging six different FIPs on specially selected UK fisheries for their importance to the UK market (in particular UK supermarket chains). The PUKFI scheme aims to employ the strategic use of the Marine Stewardship Council's Fisheries Certification Standards to develop credible FIPs with the goal to give each fishery the tools to implement ambitious changes to ensure the sustainability and future of the fishery. The Monkfish fishery has been selected as one of these candidates and has since been subject to a pre-assessment performed by Acoura (Southall 2017), to outline the current status of the fishery and to identify potential knowledge gaps for a subsequent action plan being laid out based on the findings from the pre-assessment. The development of the action plan is aimed towards providing objectives and guidance towards raising the standards of the fishery towards a level where the fishery can enter an MSC certification assessment.

5.1. Background of the Fishery

The profile of the Monkfish fishery engaged in the PUKFI programme is summarised in Table. 1 below, this also includes the spatial extent of which ICES divisions the targeted stock occurs and the different types of gear used within the fishery.

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TABLE 2 PROFILE OF THE WESTERN & CHANNEL MONKFISH FISHERY

There are total allowable catches (TACs) for anglerfish set for the Western & Channel fishery, this was set at 33,516 tonnes with 100% of this being allocated to the EU and the UK receiving a 18% initial share of the allocation with French fleet receiving the largest proportion of the quota.

	2014	2015
Total Allowable Catch (initial allocation)	33,516	33,516 t
UK Share of TAC (initial Allocation)		6,027 t
Beam trawl share of catch		2,223 t
Demersal trawl share of catch		2,500 t
Trammel & entangling/gill nets share of catch		1,565 t

TABLE 3 TAC AND LANDING DATA FOR WESTERN & CHANNEL MONKS / ANGLERS. (THOSE LANDINGS WITH >5% ANF)

5.2. Summary of Pre-assessment & Action Plan for ETP Species

The pre-assessment has identified a number of areas that the fishery could improve on if it were to be successful in entering an assessment under the MSC's certification standards (explained in section 5.1). One of the key areas the assessment has identified is the principle regarding Endangered, Threatened and Protected (ETP) species, here the assessment has provided a conclusion that the required standard of the MSC is not met.

> Catches of skate and ray species that are prohibited through EU legislation could potentially be at levels that impair a satisfactory score in the MSC certification standards. This could possibly be extended to include marine mammals and seabirds for trammel and entangling gill nets.
>
> Increased specific requirements for the entire fleet for the implementation of management strategies that support the impact of the fishery on ETP species, including minimising mortality of ETP species.
>
> The amount of interaction between the fishery on populations of skate, ray and wider ETP species prohibited through Article 13 of EU Council Regulation 2016/72.
>
> (Southall 2017)

6. Aims & Objectives

This study aims to understand what are the key ingredients to effectively assess a fishery using the MSC Sustainability Standard through the case study of the Western & Channel Monkfish Fishery ETP FIP project. Essentially working with two focuses, the study will carry out a scientific and ecological assessment of the fishery's impact on ETP species using the MSC Fisheries Standard v2.0.

Identify the potential ETP species within the fishery's assessment area.

Understand the occurrence and distribution of the ETP species throughout the assessment area.

Describe the potential for interactions between the ETP species and the activity of the fishery.

6.1. Assessment Area of the Fishery

The fishery uses three different types of gear to target the anglerfish, beam trawl, demersal trawl and gillnets. The third gear type involves two separate types of gillnet including trammel nets and entangling gillnets. The MSC FIP process requires a Unit of Assessment (UoA) to be defined which incorporates; the extent of the target stock, the extent of the contact of the fishing gear and the fishing fleet involved in pursuing the target stock. The assessment area is presented in Fig 1, and shows the ICES divisions that the assessment encompasses.

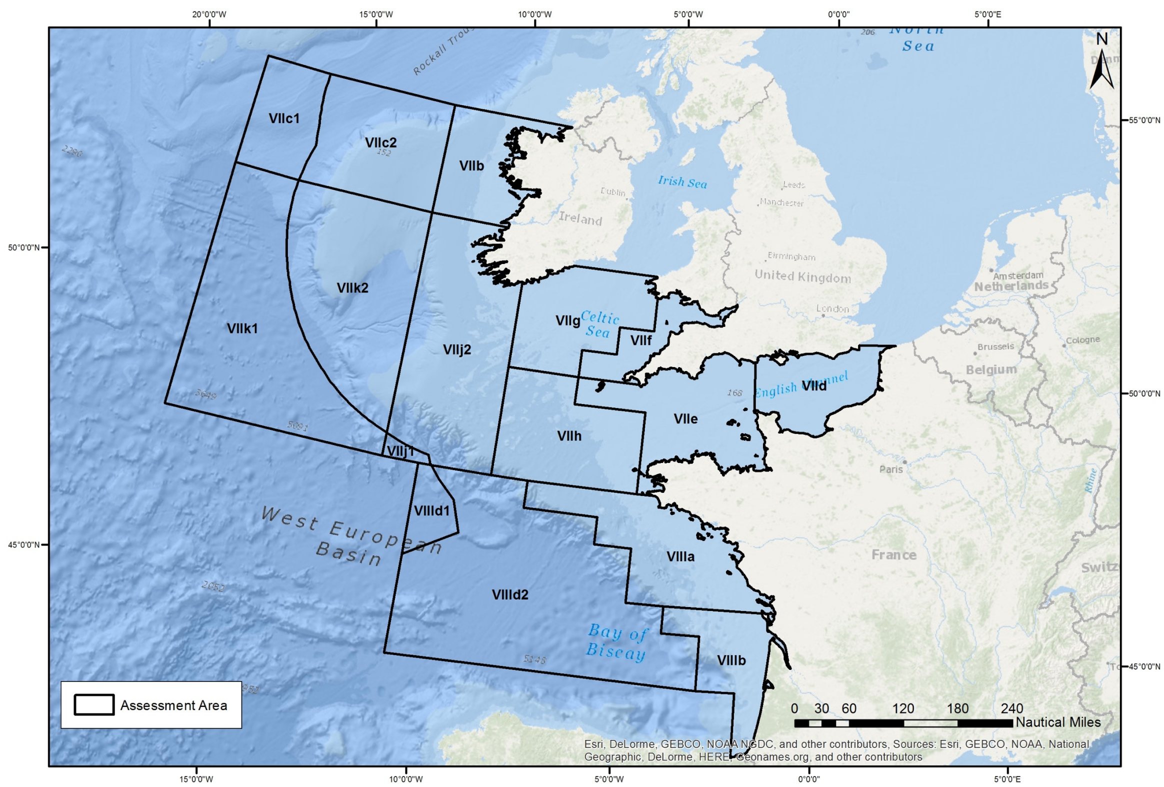

FIGURE 3 ASSESSMENT AREA OF THE MONKFISH FISHERY

7. Fishing Gear of The Western & Channel Monkfish Fishery

According to the pre-assessment performed by Acoura (Southall 2017), the Monkfish Fishery targets the monkfish/angler fish using three types of fishing gear including; beam trawls, demersal trawls and set gill trammel or entangling nets. For the basis of the MSC sustainability accreditation assessment requires each gear type to be considered against the standard within the UoA.

7.1. Beam Trawl Gear Type

Beam type trawling gear consists of heavy duty nets that are attached to steel beam (traditionally wooden) that holds the nets open. The 'belly' of the net (region in contact with the seafloor) is usually attributed with tickler-chains in sandy/mud based substrates or with heavy matting of chains in rocky substrates. These adaptations drag along the seabed ahead of the net and agitate the seabed in order to encourage species to employ an escape behaviour response and therefore move above the seabed increasing the likelihood of being captured within the net (Marine Conservation Society 2013).

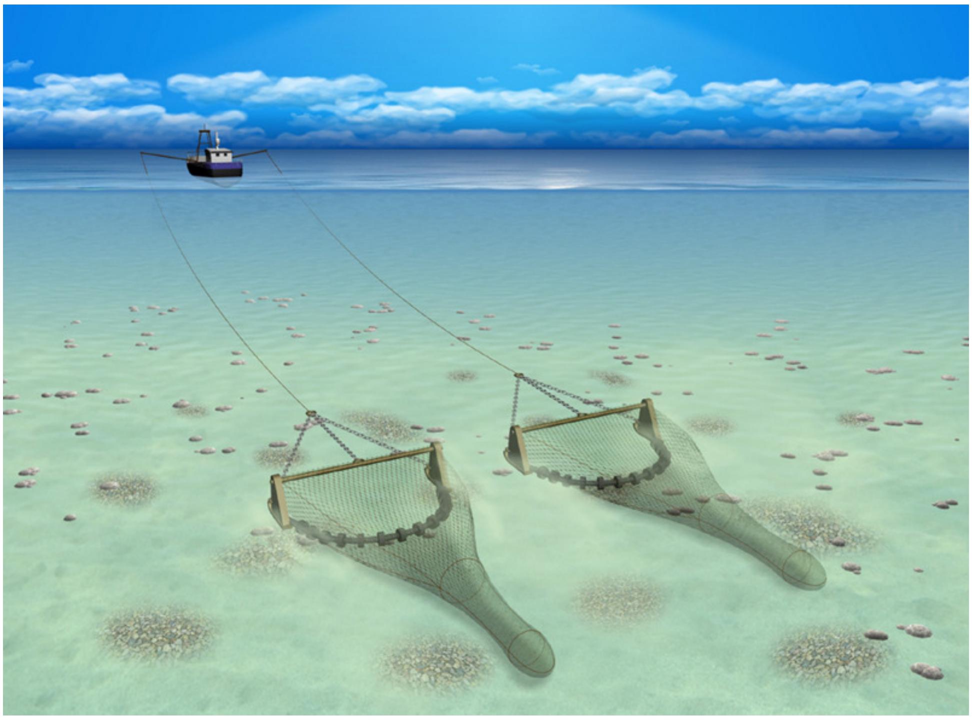

FIGURE 4 EXAMPLE OF TWO BEAM TRAWLS BEING TOWED PARALLEL (© SEAFISH)

(SEAFISH 2015)

Beam trawling gear is well documented to have known detrimental impacts especially towards seabed habitats, this subsequently can cause a reduction of the local biodiversity and habitat productivity of the exploited area particularly in areas that have not been previously targeted. Despite this, the gear is only intended for use on relatively soft areas of the seabed and due to the amount of many years fishing effort the majority of areas that are suitable for beam trawl exploitation have already been subject to being fished. These sandy and in some cases rocky seabeds are considered to be able to recover reasonably swiftly from the effects of beam trawls. There are also new discoveries from research that suggests that natural inputs of physical energy from wave action and tidal currents represent natural impacts that are likely to exceed the potential damage caused by beam trawl fishing effort (Diesing, Stephens & Aldridge 2013).

As the result of beam trawling equipment targeting bottom dwelling species and operating on the benthos the gear subsists for the most part of its subsea existence in the lower part of the water column of the benthic zone. This subsequently means there are little problems of bycatch of cetaceans and seals with beam trawling gear, but the gear does impose threats to rare species of sharks, rays and skates such as the common skate and angel shark and will also cause an impact to the benthic habitats that will support the surrounding ecosystem (Sewell & Hiscock 2005).

7.2. Demersal Trawl Gear Type

Demersal type trawl gears are often referred to as otter trawl or bottom trawl, this gear consists of a large net that is towed through the water while allowing the very bottom edge of the net to touch the seabed similarly to the beam trawl to target the bottom dwelling species that reside either on or near to the seabed. The forward or anterior end of the net the edges or 'wings' are usually kept open laterally by metal plates often called otter doors or boards, these components act as hydroplanes and in so doing pull the mouth of the net open. Fish are then 'herded' between these boards as the foot rope towards the front end of the net is towed through the water on top of the seabed unsettling any species above the benthos, here the fish continue to swim with the trawl until the fish eventually tire and when exhausted will fall back into the net. As they drift towards the rear of the trawl they will travel through the funnel of the net, along the narrow extension and into what is known as the cod-end, which is where the catch is retained during the haul.

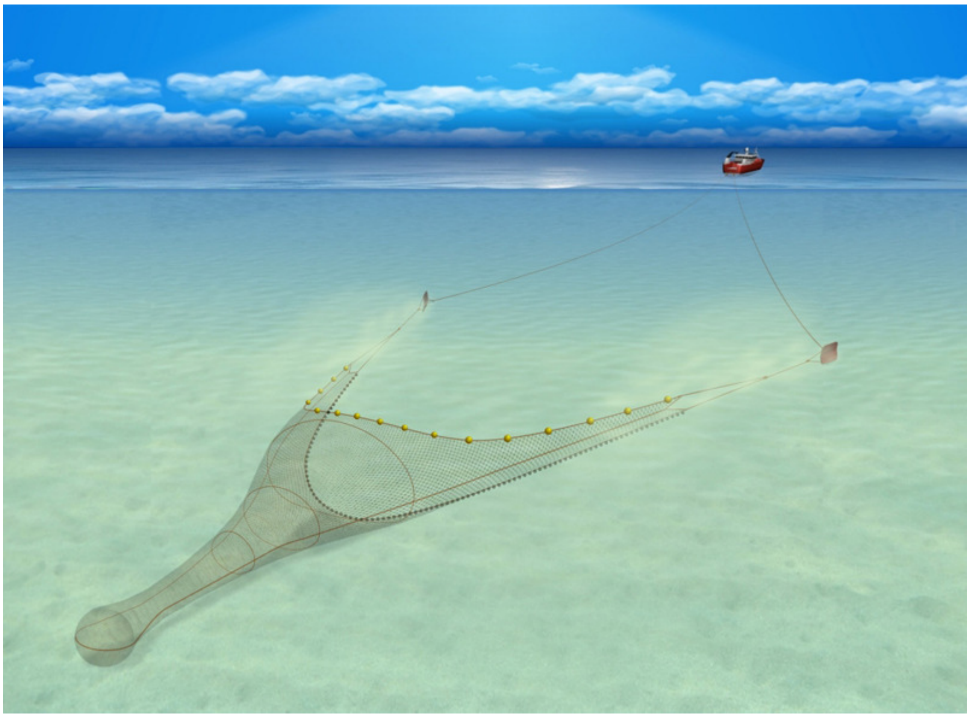

FIGURE 5 EXAMPLE OF A DEMERSAL TRAWL IN TOW (© SEAFISH)

(SEAFISH 2015)

Demersal trawling impacts to the environment are much the same to that of the beam trawl (Sewell & Hiscock 2005; Diesing, Stephens & Aldridge 2013), as the gear often remains near the seabed it can cause disturbance to the benthos and demersal organisms. As it is intended to slightly come into contact with the seabed, but not as heavy handed as the beam trawl it tends to have less of a scraping effect on the substrate to that of the beam trawl.

7.3. Static Net Gear Type

Gill nets are a generic umbrella name for various styles of fishing nets at the same time as being a unique style of net in itself, although many of these nets are referred to differently by fisheries in various geographical areas. On a general level gill nets are a type of gear that can be described as a curtain of fine netting being hung in the water, either anchored to the seabed or permitted to move with the tide (drift nets) for fish to swim into eventually becoming entangled or caught in the netting. As pictured in Fig 5 gill nets comprise of a layer of fine netting that is weighted along the bottom foot rope and held up by floats that are attached at the top by a rope headline, that subsequently allows the net to hang vertically in the water column.

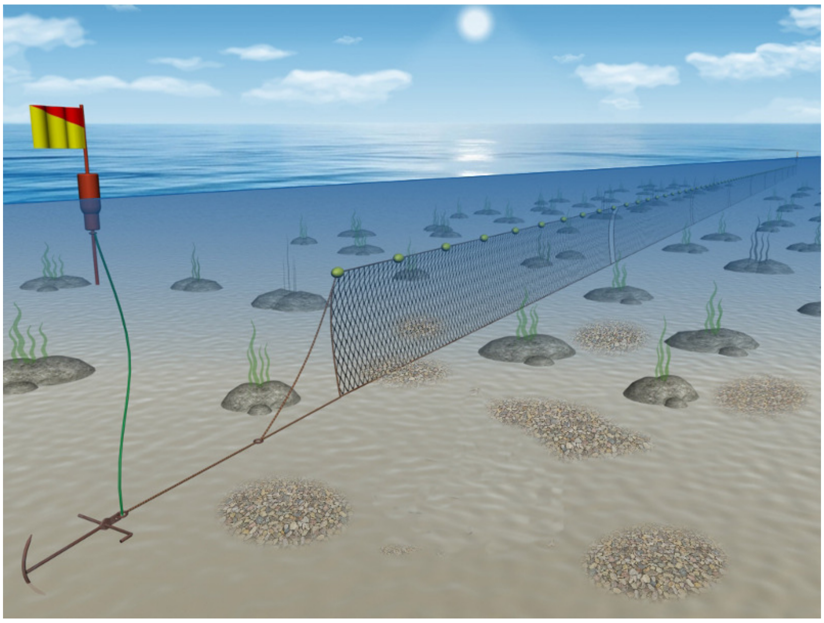

FIGURE 6 GILL NET ANCHORED TO THE SEABED (© SEAFISH)

(SEAFISH 2015)

Gill nets have evolved over time but some of the earliest forms of gill nets have been known to be used for many thousands of years by fishermen, but now the efficiency of the gear has developed dramatically with the introduction of modern twines. Traditionally the nets were made of natural resources and fibres such as cotton or twisted nylon, in contrast the fishing industry of today the nets comprise of monofilament or multi-monofilament materials. Gill nets are used widely across the world, with different nets being modified to suit both the size of the fishery and vessel using the gear and to target specific species within the geographic area. The Monkfish Fishery under assessment and the PO's that operate the fishery currently target the anglerfish using two different types of set gill nets: trammel nets and entangling nets.

7.3.1.Set Trammel Nets

Trammel nets similar to a standard gill net, albeit they are made up of three layers of netting with two larger layers of outer mesh that sit either side of small finer sheet of mesh. The smaller mesh positioned in the middle layer of the trammel net is hung onto the headline and foot rope with a greater amount of slack than those of the two outer larger layers; on top of this the inner layer is also set much deeper compared to the outer layers. These physical design implementations create a large amount of slack netting that ultimately creates a difficult situation for a marine organism to escape from if the subject swims into the net eventually being tangled in the pockets of the outer layers. To most fish the netting is almost completely invisible, and the capture process can be described in 3 stages; firstly, swimming through the first larger outer layer of mesh, into the inner slacked finer mesh, which in turn causes the inner mesh to pass through the mesh of the second outer layer of larger sized mesh leading the fish to be entrapped in a pocket of the inner finer mesh netting. This process can also be seen depicted in Fig 6, trammel nets are regarded to be more efficient at both catching and retaining a large range of species and size of fish than that of a single wall type of gill net.

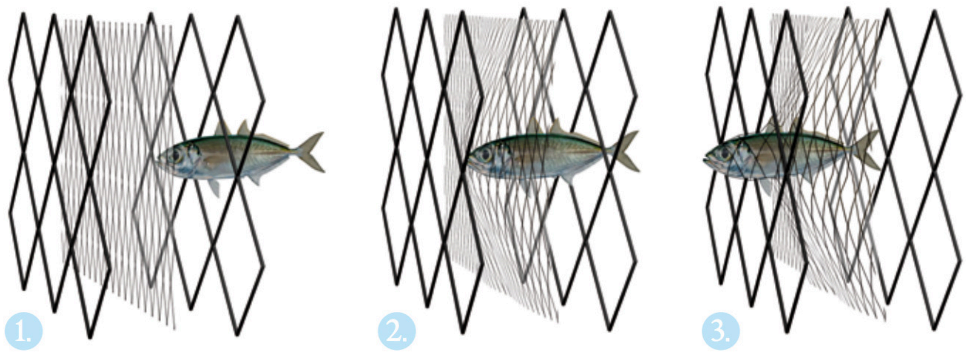

FIGURE 7 PROCESS OF FISH CAPTURE IN TRAMMEL NETS

(SEAFISH 2015)

7.3.2. Entangling Nets

Entangling nets or tangle nets are much more similar to the standard type of gill net by possessing a single wall of netting compared to the multi-layered design of the trammel net. Although in entangling nets the rig is slightly different, the net is hung onto the headline ropes which helps the create an increased amount of slack in the hanging net. Fishermen usually adopt and deploy entangling nets to create a steeper profile of net, this profile is created due to the lack of flotation on the headline ropes and therefore does not stand as tall as the average gill net when deployed. This creates a looser wall of netting which is far more effective for catching bottom dwelling fish such as flatfish, anglerfish and shellfish, which are not usually captured easily in a standard taut gill net but are retained with greater success in a net which has a higher amount of slack. The factors of mesh size and the degree of slacking of the net will be tweaked towards the species being targeted and are regularly rigged using a mesh that is larger and has greater durability than most over types of gill nets which increases the chances of retention of larger captured species with less damage to the gear.

8. An Introduction to Bycatch

Commercial fishing is widely regarded as one of the most urgent and pressing threats to the world's current remaining fish stocks (Pauly *et al.* 1998, 2002; Worm *et al.* 2006), even further threatening is the risk it poses to non-target organisms often referred to as bycatch (Biju Kumar & Deepthi 2006) and occasionally captured indiscriminately. While bycatch can be sold, it is often unusable or undesirable for various reasons of both regulatory and economic nature and is therefore usually thrown back into the sea where the bycatch is likely to perish (Harrington, Myers & Rosenberg 2005). This proportion or sub-set of the bycatch is referred to as discards.

Bycatch is so ubiquitous that it can impact almost the entire spectrum of marine fauna across any kind of fishing gear, whether that be the collateral damage of turtles on fishing hooks, benthic invertebrates captured in bottom trawls or juvenile fish caught up in nets. Bycatch has become one of the most worrying character in damaging marine ecosystem has meant that it has become a significant focus within nature conservation concerns in the world today (Hall, Alverson & Metuzals 2000). Bycatch and discards have also been highlighted as fishing impact that should take priority in being reduced in a multi-criteria assessment of six different stakeholders (Innes & Pascoe 2010). These fears and shifts in focus are hardly surprising with bycatch imposing serious implications on the security of food of nearly 1 billion people worldwide who depend on fish as their primary source of protein (Kelleher, Willmann & Arnason 2009).

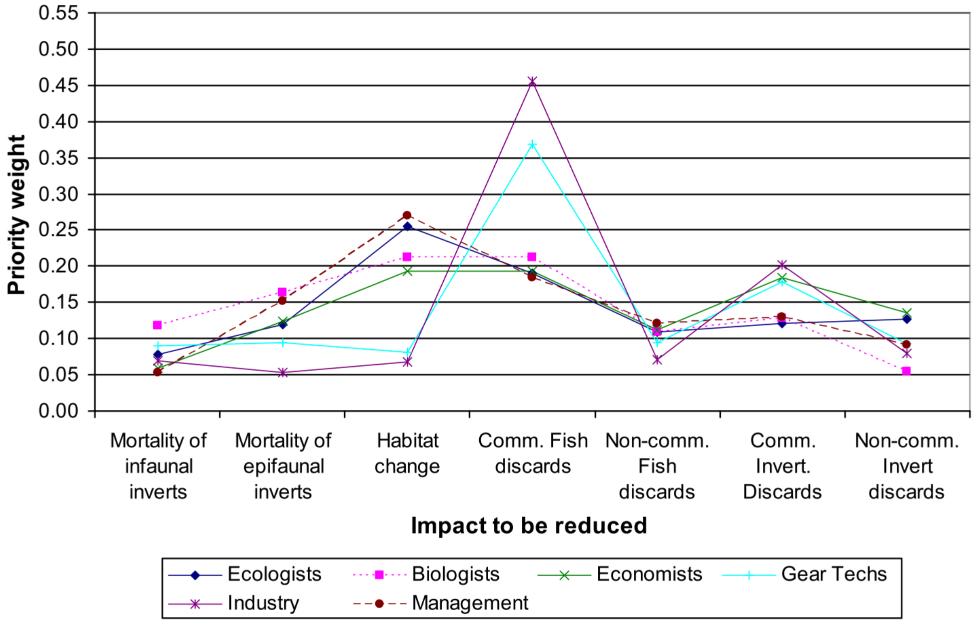

FIGURE 8 PRIORITY FISHING IMPACTS TO BE REDUCED

(Innes & Pascoe 2010)

Bycatch for the most part has always been considered as the element of the catch which is not targeted, although it has been noted that this definition cannot always be taken for granted. Davies *et al.* inform that in some cases this definition can be inconsistent when applied to an emergence of new fisheries in certain parts of the world where there is no specific species that is targeted (Davies *et al.* 2009). Tropical shrimp trawl fisheries are an example of this phenomenon, where the proportion of the catch that is not shrimp has traditionally been regarded as bycatch and regularly discarded. Nevertheless, a dwindling resource base and other socio-economic factors created a use for the bycatch and successively discards have begun to reduce, a development first recognised by Kelleher (Kelleher 2005). This can be seen as from the perception of the fishermen; these previous discards are now regarded less as a bycatch and more that they make up part of what may be thought as a multi species fishery.

"Yesterday's bycatch may be tomorrow's target catch".

(Murawski 1992)

Due to these reasons in defining bycatch it is inherently difficult to estimate the amount of bycatch produced on a global scale. But Davies *et al.* endeavoured to make an assessment of worldwide fisheries bycatch by developing a definition of bycatch in the study that incorporates both discarded catch and unregulated fish. The study analyses data across Central America, The Caribbean and African Coastal states and estimates that up to 38.5 million tonnes (around 40.4% of the estimated total catch of the study) of bycatch was amassed in a four year period between 1999 and 2003 (Davies *et al.* 2009). It is also thought that the magnitude of the problem of bycatch is worse than this estimate portrays due to the number of countries not included within this study, and highlights that bycatch does not only have detrimental consequences upon the ocean's ecosystems it also removes enormous quantities of biomass without any form of effective management.

8.1. Marine Mammals

Fishing activity can pose a number of threats towards marine mammal species of cetaceans and pinnipeds, these air breathing species are often referred to as megafauna. These members of the ocean have little if any commercial value and yet are commonly found in the nets and trawls of commercial fishing vessels. The main concern of marine mammals and fisheries is that when populations are subject to incidental bycatch they can exhibit declines over short time periods (i.e. decades) (Casey & Myers 1998). Most species of marine mammals will interact in some form with fisheries, and on top of this virtually every species has been known to perish from their incidental capture in fishing gear (Northridge & Hofman 1999).

Modern technology has also helped improve the efficiency of commercial fishing by providing sonar and fish-finders have made the detection of shoals much easier. Synthetic materials, such as monofilament fibres for gear netting have helped reduce the chances of escape one fish are captured. Whilst this has improved the abundance of the target species within the catch it has also led to increases of marine mammals being found in nets as bycatch (Northridge 2009).

Over the last decades there has been much debate about the mechanisms of how cetaceans are incidentally captured. In particular there is speculation with how individuals respond to various types of net and their ability to negotiate such an obstacle (Kastelein, Au & de Haan 2000). Discussion has continued with whether entanglement occurs because the individual cannot or did not detect the net in that instance, or the individual does not perceive the net as impenetrable wall or for that case a threat, or they identify the presence of the net as a threat but are too heavily distracted by their prey (DEFRA 2003).

Bycatch is one of the main concerns to conservationists' due to the fact that most marine mammal interactions with fishing nets are almost always fatal, and therefore do not permit an ability for scientist to create a learning process. There is also a demand within discussion to highlight where in the fishing activity process mammals become captured in nets and when in this process are they most susceptible (Couperus 1997). Although the problem with bycatch and species of marine mammals is that it is difficult to identify, for example an individual could be captured and subsequently freed (either independently or by fishermen) and eventually discovered floating at sea or washed up on the coast. In this scenario, it is thought to be difficult to be able to diagnose the post-mortem as a bycatch related death, mainly because the condition of the carcass will be heavily decomposed and the clearest evidence of bycatch (net marks on skins) will not obvious (Kuiken 1994).

In the event of a marine mammal being captured and retained underwater within the netting of the fishing gear the individual will usually die of asphyxiation. In the event that the individual breaks free and escapes entanglement, the individual may suffer trauma of pain and debilitation of injuries for extended periods of time of up to months or longer. Whales, dolphins and porpoises caught as bycatch often endure cuts or abrasions to the skin, an injury that is subsequent of the individual's efforts to escape the net and results in the rope scraping or incising the animal as it struggles to escape. In netting of fishing gear which is very fine such as loosely set gillnets, the animal will twist and squirm causing the net to tighten around them and it is therefore fairly common for species of dolphins in bycatch to be recorded with injuries such as broken jaws, beaks and teeth. These injuries are also prevalent in trawling fishing gear where the animal is trapped instead of tangled and therefore attempt to push through mesh that is kept taut when towed, in such instances a dolphin for example will try to force their way through the meshes of the net with such power that fractures can be suffered (Spencer, Santos & Pierce 2000).

Species	Gill Nets	Pelagic Trawls	Demersal Trawls	Longlines	Pot Lines
Minke Whale	•	•			•
Lon-finned Pilot Whale	•	•	•	•	
Short-beaked Common Dolphin	•	•	•		
Atlantic-white Sided Dolphin	•	•			
Bottlenose Dolphin	•	•	•		
Harbour Porpoise	•		•	•	
White-beaked Dolphin	•	•			

TABLE 4 MARINE MAMMALS AND TYPES OF FISHING GEAR THAT POSE THREAT

(Northridge 2009)

8.1.1. Direct Impacts

Both demersal trawling and gill nets have an association with the bycatch of marine mammals, each target commercially valuable species that are also prey that form the dietary composition of cetaceans and other marine mammals (Würtz, Poggi & Clarke 1992). Though one of the key differences that has been derived by many fisheries and marine mammal scientists between the two gear types is the species of mammal that are incidentally captured, for the most part it is highlighted that dolphins are more notorious within the bycatch of trawler type fishing gear than gill nets (Evans & Hinter 2012).

8.1.1.1. Trawling

Fishing activity will impose a number of stressors to marine mammals, besides the engine noise of the vessel itself there are several parts of a trawling fishery set up that will vibrate when in operation. These components (e.g. chains, ropes and pennants) will strum in turn producing a high frequency reverberation. It is therefore considered that in such conditions it is likely cetaceans should be able to be aware of the fishing gear (De Haan *et al.* 1997). However, it should be noted that cetaceans do not echolocate on a continuous basis, especially within a school only a handful of the individuals may be echo locating at any given time (Akamatsu *et al.* 2005).

Demersal trawling fisheries will often operate through the night deploying the use of lights to entice target species to the surface (Sequeira & Ferreira 1994). Interestingly it has also been documented that the majority of cetacean entanglement occurrences happen more frequently in twilight hours than in the daylight hours (De Haan *et al.* 1997). De Haan *et al.* also found that cetaceans generally keep larger distances from a fishing vessel during the day and exhibit less inclination to interact with the trawl gear. Furthermore, the study used a hydrophone array to assess the behaviour of dolphins with a simulated trawl and observed that the individuals used in the study were attracted to the deck lights of the vessel when used at night and that when the lights were switched off the dolphins retreated from the vicinity of the vessel.

8.1.1.2. Gill Nets

Whilst it is suggested that both dolphins are porpoises are able to detect gillnets in the water column when in a heightened state of awareness (Kastelein *et al.* 1995), more recently it has been theorised that individuals may not detect the presence of the net until they are too close to the net to avoid being entangled (Kastelein, Au & de Haan 2000).

In Northern Europe, the Harbour Porpoise and the Short-beaked Common Dolphin are thought to be the biggest victim of gillnet fishing gear. Gill Nets and Trammel Nets are deployed on the seabed targeting bottom species, the Harbour Porpoise’s feeding behaviour is concentrated predominantly near to or on the seabed and therefore makes these gill nets being strongly associated with high mortalities of the Harbour Porpoise (Northridge & Hofman 1999).

8.2. Seabirds

Seabird populations are thought to be worsening faster than any other bird groups, and fisheries and the impact of bycatch is considered to be one of the predominant causes of their demise (Croxall *et al.* 2012). In particular the sensitivity of seabirds towards bycatch in gill nets has been well recognised for a long period of time, and the fishing gear has been the cause of some the biggest recorded mortalities of seabirds globally. For example, in the North Pacific, around 500,000 seabird deaths per year were attributed to the use of drift nets (Degange *et al.* 1993). Regional research into the Baltic and North Sea Regions have discovered that between 100,000 and 200,000 seabird deaths may occur annually as a direct result of gillnet fishing methods (Žydelis *et al.* 2009). However, it is alarming that the global scale and significance of bycatch of seabird species is generally unknown (Žydelis *et al.* 2009).

8.2.1. Direct Impacts

Most of the literature suggests that many species are susceptible to incidental capture by all kinds of fishing gear, but the majority of the research insinuates that gill nets are the most notorious for high rates of bycatch for seabirds.

8.2.1.1. Gill Nets

The species that are most susceptible to being entangled in gill nets are those that forage for prey by diving either for fish or other benthic fauna (Žydelis, Small & French 2013). Žydelis et al undertook a comprehensive review of the incidental capture of seabirds in gill nets in different oceans regions of the world. In the study susceptibility was defined as a characteristic that is regardless of population size and indicates a higher risk of being captured by gill nets than those species that are less susceptible, Table 4 summarises the findings.

Taxonomic Group	Total number of species	Number of susceptible species	Number of species reported as bycatch
Steamerducks	4	4	0
Diving ducks	1	1	1
Seaducks	13	13	11
Penguins	18	18	5
Loons	5	5	5
Albatrosses	22	3	8
Giant-petrels	2	0	2
Fulmars	2	2	2
Petrels	54	10	4
Shearwaters	22	22	13
Storm-petrels	23	0	3
Diving petrels	4	4	0
Grebes	4	4	4
Tropicbirds	3	0	0
Frigatebirds	5	0	0
Pelicans	3	0	1
Gannets & boobies	10	10	3
Cormorants	29	29	12
Phalaropes	2	0	0
Gulls, terns, skuas, jaegers, kittiwakes	94	0	11
Auks	23	23	19

TOTAL	343	148	104

TABLE 5 TAXONOMIC GROUPS OF SEABIRDS SUSCEPTIBLE TO GILL NETS

(Žydelis, Small & French 2013)

The study identifies that in the Northeast Atlantic (where the assessment area is located), the species of concern are the Northern Gannet *(Morus bassanus)* and the Northern Fulmar *(Fulmarius glacialis).*

8.3. Elasmobranchs

Elasmobranchs are also a subset of marine fauna that are at grave risk of fishing activity impacts, the combination of their low productivity alongside recorded declines in species populations has sparked major concern of their sustainability (Stevens *et al.* 2000; Dulvy *et al.* 2008). It is estimated that around 50% of the global catch of elasmobranchs is comprised of bycatch (Stevens *et al.* 2000), and that it does not appear in fisheries statistics at all or because elasmobranchs are hardly recorded at species level (Clarke *et al.* 2006).

8.3.1. Direct Impacts

Elasmobranchs species of sharks, skates and rays that occur in the assessment area are all vulnerable from entanglement in beam trawl, demersal trawl and gill net fishing gear. Predominantly due to the species occurrences generally being similar to that of the demersal orientated target species. This is particular the case for species of skates and rays in Northeast Atlantic waters. The main impacts for elasmobranchs from fishing gear regard potent effects upon species abundance due to their k select life history characteristics. Historically over the last 3 decades there has been a significant decline in the populations of ray species. For example, the Common Skate *(Dipturus batis)* populations in the Irish Sea were nearly taken beyond the brink of extinction by trawling activity in 1980 (Brander 1981).

8.4. Indirect Impacts

The direct impact of fisheries bycatch on a single type of species from the incidental capture by a particular type of fishing gear can also bring about indirect impacts, such as changes at the ecosystem or community level. These are often referred to as higher-order effects (Lewison *et al.* 2004).

8.4.1. Species Specific Population Impacts on The Wider Community

The clearest consequence of bycatch is population decline (due to the time scale of these impacts these could be argued to be direct & indirect). When a decline is detected, the first port of call is to identify the demographic effect the fishery may be imposing. However, deducing this impact is incredibly challenging for marine megafauna due to number of reasons. Firstly, population changes require a large amount of time to detect, secondly there is the uncertainty surrounding sublethal effects and thirdly the difficulty in surveying marine organisms (Lewison *et al.* 2004). Time lagging can occur, which is a result of slow generation time, can prolong the response of a population to a disturbance event by years. This in some cases can range from 10 to 30 years for large number of long-live marine bycatch species (Heppell, Caswell & Crowder 2000).

8.4.2.Higher Order Effects

Bycatch of non-target species may also bring about high order effects, but are even more difficult to detect. Various studies and research have concentrated on the impact of target species harvest and the exploitation of apex species has been linked to extensive ecosystem and community effects. Particularly the case when there is intense harvest of species at the higher trophic level (Pauly *et al.* 1998). Apex species such as marine megafauna play highly important roles within the food-web structure and a responsible for a wide range of ecosystem functions. The incidental removal of these species may trigger catastrophic cascading ecological changes (Springer *et al.* 2003).

8.4.3.Ghost Fishing

Ghost fishing is another form of indirect fishing impact, it derives from abandoned, lost and discarded fishing gear. It is estimated that around 6.4 million tonnes of debris enter the global seas every year (UNEP 2005). Fishing gear is thought to make up a 10% proportion of this marine debris (i.e. vol. at the global scale), although these vary dramatically over relatively small spatial areas (Pham *et al.* 2014). Ghost fishing is a rising occurrence that threatens marine life when abandoned, lost and discarded fishing gear continues to capture marine organisms (Matsuoka, Nakashima & Nagasawa 2005). Passive gear such as set gill nets are considered to be notorious for ghost fishing (Gilman 2015).

8.4.4.Sublethal Impacts

Fisheries bycatch has always primarily focused upon the direct mortality of species from fishing gear, but there are also impacts of delayed mortality and sublethal injuries, impacts that are exceptionally hard to monitor. This is mainly due to the small amount of knowledge regarding these impacts at the organism level. Wilson et al composed a general species level of the sublethal effects of incidental capture on marine mammals. The study found that there were two bases of these effects; of immediate effects and delayed effects. Immediate effects generally concern physiological disturbance and injury to the organism, and delayed sublethal effects generally comprise of immunological impairment, worsening growth and reproduction and locomotion and behavioural impairment (Wilson *et al.* 2014). The study summarised these effects and classified them as either short term effects (e.g. acute stress), that have the potential to become long-term or delayed effects (e.g. growth impairment). Both of which are directly pertinent to the species fitness and therefore could lead to changes in population structure. These findings are summarised in Fig 8.

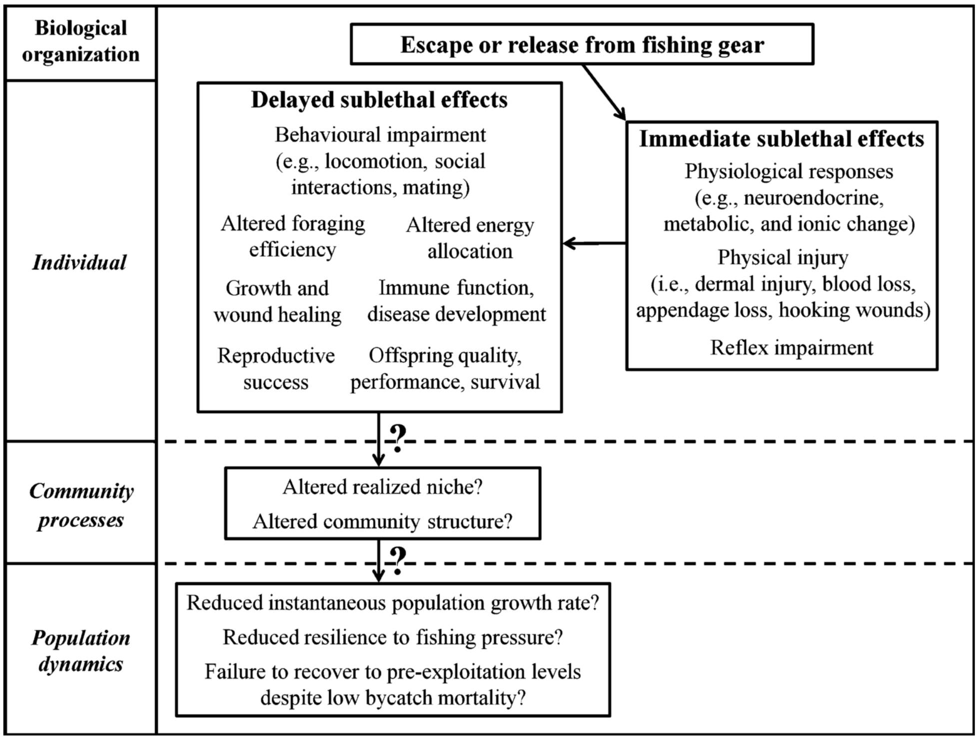

FIGURE 9 DIAGRAM OF IMMEDIATE AND LONG-TERM IMPACTS OF INTERACTION WITH FISHING GEAR

(Wilson *et al.* 2014)

9. Defining ETP Species

The MSC's Fisheries Certification Standards give guidelines to the CABs to be able to identify ETP Species with a set of criteria. The guidance section outlines the general requirements for the assessment for Principle 2.3 and states that:

- The team should consider all ETP species that are vulnerable to being impacted by the fishery in the assessment area.

The Standards v2.0 define ETP species as follows:

- Species that are recognised by national ETP legislation;
- Species listed in the binding international agreements given below:
- Appendix 1 of the Convention on International Trade in Endangered Species (CITES), unless it can be shown that the particular stock of the CITES listed species impacted by the UoA under assessment is not endangered.
- b. Binding agreements concluded under the Convention on Migratory Species (CMS), including:
    - Annex 1 of the Agreement on Conservation of Albatross and Petrels (ACAP);
    - Table 1 Column A of the African-Eurasian Migratory Waterbird Agreement (AEWA);
    - Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS);
    - Annex 1, Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS);
    - Wadden Sea Seals Agreement;
    - Any other binding agreements that list relevant ETP species concluded under this Convention.
- Species classified as 'out-of scope' (amphibians, reptiles, birds and mammals) that are listed in the IUCN Redlist as vulnerable (VU), endangered (EN) or critically endangered (CE).

For the basis of the assessment performed in this research ETP Species were designated by following the UK's Biodiversity Action Plan list of marine species, and cross referencing any key national and international legislation that may afford the species any kind of legal protection in the jurisdictional of the assessment area.

Once a list was collated it was referenced to that of previous MSC Certification Reports of Fisheries that occur in the same geographical area for validity, most comparable is that of the Hake Fishery which operate under the same vessels that the Western & Channel Monkfish Fishery operates. The final ETP Species list is supplied in Appendix A.

As the fishery is engaged in a Fishery Improvement Project, the MSC's definition of a credible FIP requires those employed within the fishery to be heavily involved throughout the improvement process. This is primarily considered important in ensuring that the fishermen do not feel estranged by the scientific process and become alienated with a sense of guilt about their livelihood. Therefore, the three Producer Organisations that operate the fishery (Interfish, South West PO & Cornish PO) were consulted and discussions took place in order verify the list and clarify which species the fishery do not feel are of any concern to the fishery and show no interaction with the fishery in any form.

9.1. Relevant ETP Protective Legislation

There are a number of key legislative instruments that permit a species to become labelled as ETP in the eyes of the Marine Stewardship Council. Some of these are already stated within the MSC's definition of an ETP species but the definition also includes other policy instruments as discussed in Table 7:

Protective Legislation	
CITES Appendix I	Further international protection is provided by CITES. All species of cetaceans in UK waters are listed in the CITES appendices, which restricts international trade in these species. At a more practical level, trade in any cetaceans in Europe is prohibited by the EC Regulation of Trade in Endangered Species.
EU Habitats Directive	Many marine species (including all cetacean species) are listed within the Annex II, IV and V. Those species listed within Annex II protection through designated conservation areas are required. In this case Specials Areas of Conservation (SACs MPAs or MCZs) that form the EU's wider network of Natura 2000.
EU Birds Directive	Seabirds have strong protection through the EU Birds directive (one of the first European conservation legislation instruments). First released in 1979, the species listed in Annex I are

	afforded the most protection where member states must designate areas with these species into Special Areas of Protection (SPAs) that also help provide the EU's ecologically coherent network of nature reserves named 'Natura 2000'.
ASCOBANS	The Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) came into force in 1994. ASCOBANS currently has ten parties (including UK). It requires parties to: *"undertake to cooperate closely in order to achieve and maintain a favourable conservation status for small cetaceans".* The instrument also identifies the risk of fisheries bycatch for marine cetaceans. The second ASCOBANS Meeting of Parties (MoPs) resulted in a definition of the "unacceptable interaction" described in Annex 1 Article 1(b) as being the total anthropogenic removal above 2% of a cetacean population. After a consultation in 1999 with the IWC-ASCOBANS Working Group surrounding harbour porpoise bycatch, in 2000 the MoPs responded by reducing the level to new threshold of 1.7% to resolve the debate. Furthermore, the MoPs agreed that a lower level should be agreed for depleted populations of cetaceans.
COUNCIL REGULATION (EU) 812/2004	In 2004, the EC introduced Regulation 812/2004. This Regulation requires, inter alia, member states to deploy the use of Acoustic Deterrent Devices (ADDs, otherwise known as "pingers")

“laying down measures concerning incidental catches of cetaceans in fisheries and amending Regulation (EC) No 88/98”.	on specified types of gill nets, tangle nets and drift nets deployed from vessels that are of 12m length or longer. The regulation also underlines requirements for on-board observer programmes for monitoring cetacean bycatch on fishing vessels of 15m or more and pilot projects to monitor the impact and effectiveness of the use of pingers. The regulation also requires levels of bycatch to be monitored in smaller <12 m vessels.
Council Regulation (EU) 2017/127 **“fixing for 2017 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters.”**	Article 41 of the regulation outlines It shall be prohibited for Union fishing vessels to fish for, to retain on board, to trans-ship or to land the following species for the UoA: Angel Shark, Basking Shark, Common Skate, Porbeagle Shark, Starry Ray, Tope Shark and the White Skate.
Wildlife & Countryside Act 1981	The Act consolidates and amends the existing national legislation in order to implement and transpose the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) and the EU Council’s Bird Directive. The legislation has two schedule’s that are pertinent to some ETP Species found in the fishery’s UoA.

Table 6 Relevant Protective Legislation for ETP Species

10. Obtaining Relevant Data

Obtaining quantitative data for environmental monitoring can be an arduous task, this is especially the case for marine matters. Fisheries data however is somewhat more bountiful, primarily because fisheries is one of the most established of marine sectors. Management of fisheries and the monitoring of its components, and the means and standards to which those are undertaken within the industry have increased rapidly (stock assessments, catch statistics, etc.). This has also led to increased governance at international, national and regional level, with many countries now running compartmentalised departments that are fully dedicated to the country's coastal and offshore fishing activities. Such interfaces can ensure that essential monitoring takes place on a regular basis, but can create difficulties in ensuring the data is made available for the means it is collected for in the first place.

In the UK, fisheries are managed and monitored by the government's Department for Environment, Food and Rural Affairs (DEFRA) and the Marine Management Organisation (MMO). The MMO is an executive non-departmental public body which is sponsored by DEFRA, and was created as a product of the implementation of the Marine and Coastal Access Act 2009. The MMO's duties are to license, regulate and plan the marine activities that take place around the seas of England are carried out in a sustainable fashion.

Upon consultation and request of relevant data the MMO agreed to provide the following datasets:

- Landings statistics and logbook figures for the vessels attributed with the Western & Channel Monkfish Fishery.
- Vessel Monitoring System (VMS) data of the vessels attributed with the Western & Channel Monkfish Fishery.

Cefas were also consulted and agreed to provide the following dataset:

- Observer data from the 3 PO's of the fishery (Interfish, South West PO, Cornish PO), this specifically included the observed bycatch of species listed in the UK's Biodiversity Action Plan.

10.1. Observer Data Analysis

Cefas accepted to disclose their anonymised observer data of trips aboard vessels of the three PO's of the fishery, a dataset that is fairly comprehensive and spans over a 6-year period. Cefas collect this data through their Observer Programme, but did not/could not specify the proportion of trips that were surveyed.

	Beam Trawl	Demersal Trawl	Entangling/Trammel Nets
Number of Trips Observers were Present	146	53	18
Total Number of Hauls/Nets Sampled	3701	175	221

TABLE 7 NUMBERS OF TRIPS AND TOTAL NUMBERS OF HAULS/NETS OF THE FISHERY SAMPLED

The premise of assessing the fishery's impacts on non-target species and particularly ETP species requires a more narrowed approach and where possible a species by species analysis will be needed. For this the data needs to be collated and organised before it can be prepared for analysis.

Firstly, data were split into the three different gear types of beam trawl, demersal trawl and set gill/trammel nets. The data are recorded at the haul level and a certain number of hauls within the trip is sampled. Bycatch was recorded in the form of observed individuals and is then multiplied based on a unique haul raising factor which is deduced during the count for the haul. As the data is time logged a catch per unit of effort (CPUE) per is calculated based on time, with the haul start and end times for both the beam and demersal trawl gears, and similarly using the anchoring and retrieval time series of the gill net fishing gear.

CPUE per hour values were calculated for every species observed in each haul, zero records had to be added to the dataset for instances when a particular species that were not observed in a certain haul but was captured by the gear in a different haul. This was achieved by using the trip id and the haul number to create a unique identity for every haul sampled for each gear type, zeros records could then be scripted into the dataset.

For statistical analysis, a general linear model GLM was produced of the log of CPUE/hour of each species for the different gear types was tested against the variables of year and quarter (factored to explore the temporal effects), ICES Rectangle (to explore a spatial effect) and overall vessel length (explore the effect of engine power). The ANOVA Type II analysis of deviance statistical test was used to investigate whether any of these variables were significant in their relationship to the catch rate of the species.

All statistical analysis was carried out using the R Statistical software (R 2008), GLMs were produced using the 'Stats' package (R 2017) and the 'Car' package was used to perform the ANOVA Type II test (Fox & Weisberg 2011). Individual Results for each species and gear type can be seen in Appendix F.

10.2. Species Distribution Mapping

The pre-assessment and action plan have identified the practicality of the knowledge of the spatial patterns of the ETP species that interact with the fishery. There are number of ways to isolate the spatial distribution of species and to unveil locations of where the species may frequently occupy, but a straight forward species distribution assessment may not necessarily be useful in mitigating both the direct and indirect impacts that the fishing activity has upon the species.

However, a different approach can be taken, for instance the observer data provided by Cefas is referenced with the ICES Rectangles. ICES Statistical Rectangles are used to apply a grid to the world seas in order to simplify analysis and visualisation, and have been in use since the 1970's.

Therefore, the analysis performed on the observer data can also be used for a separate application, through the use of the general linear regression analysis. The general linear model (GLM) performed on each species within a statistical software package, produces a set of coefficients that can be used to attain what is known as fitted values. These were used to provide a CPUE index for each ICES rectangle that standardises for year, seasonal and vessel length effects. These were then able to be loaded into Geographical Information Software (GIS) as a raster layer, portraying the ICES Rectangle location and the CPUE index for each species. These can be seen in Appendix D.

10.3. VMS Mapping

The VMS data supplied by the MMO, the dataset included the pings from the fishing vessels targeting monkfish in the UoA in the last 4 years. The datasets were interrogated and processed in R to complete the following tasks:

- Remove points that were not recorded as being on 'globe', latitude > 90 & longitude > 180
- Remove points that were recorded as being on land.
- Remove points that were recorded whilst in the vicinity of a harbour. This was achieved using a dataset that contains the coordinates of all registered harbours in Europe.

After the initial cleaning process, the dataset was processed further by splitting the dataset into the different gear groups of Beam, Demersal and Nets. These groups were then explored further to define which of the observations were recorded when fishing, in order to achieve this a fishing state variable was created splitting the points into the categories of 'floating', 'fishing' and 'steaming'. These were defined as follows:

- Trawling: floating < 3, fishing >= 3 & < 6, steaming >= 6
- Nets: floating < 0.5, fishing 0.5 >= & < 3, steaming >= 3

Histograms were plotted to reveal the frequency of observations at different speeds, these can be seen below:

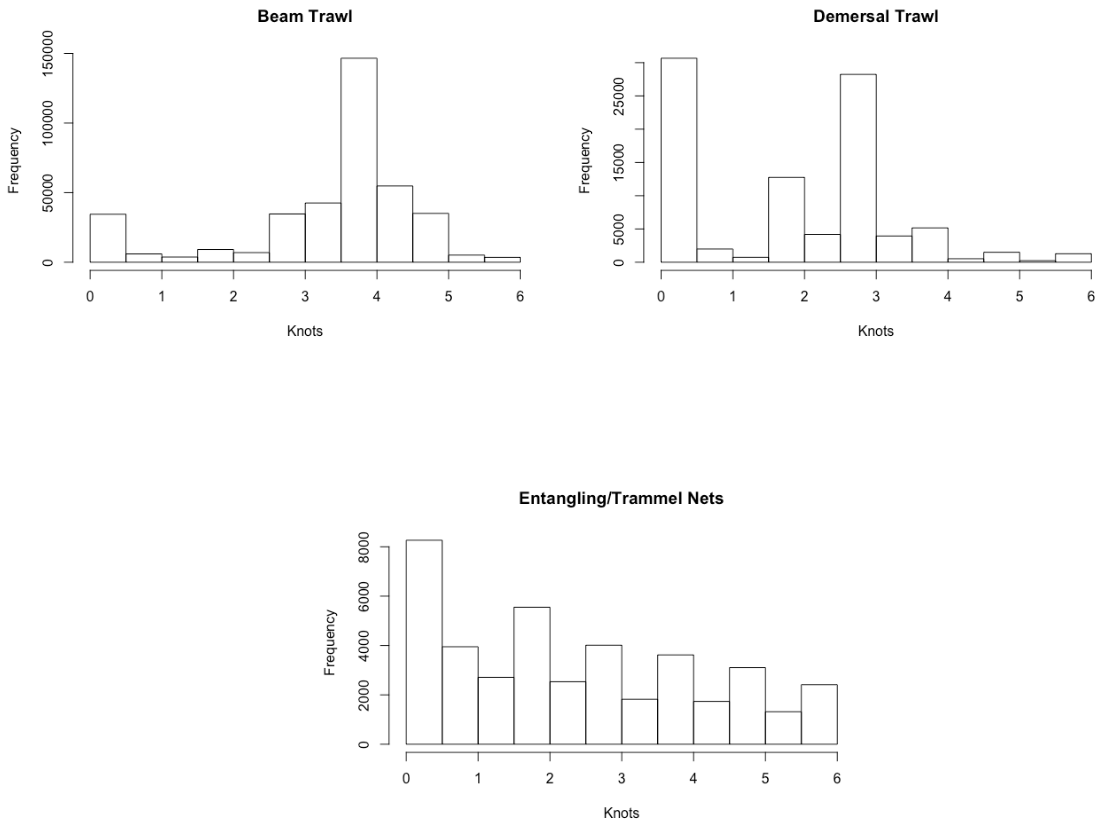

Figure 10 Histograms to Show Frequency of Pings at various Speeds

These histograms show that for trawling there are generally two peaks in the dataset, with one peak surrounding slower speeds of 0-2 knots where vessels may be deploying or retrieving the fishing gear and another peak between 3-6 knots which could be attributed to the large number of pings recorded when towing the trawling gear. The histogram for the nets is slightly different with fewer pings recorded at higher speeds and higher number of pings attributed to lower speeds which may be where vessels are travelling slowly to deploy and set the bottom nets on the seabed or retrieving the fishing gear.

Once the data was processed and sorted, they were exported for further analysis in GIS software, the data points were plotted as a point layer, where each point represented a single ping. These points were then analysed using the point density tool to create a raster layer. The point density tool calculates the density of point features around each output raster cell, conceptually a neighbourhood is defined around each raster cell centre and the number of points that fall within the neighbourhood is totalled and divided by the area of the neighbourhood. The resultant layer is a raster layer that uses a pseudo colour classification ramp to display the data as a heat map.

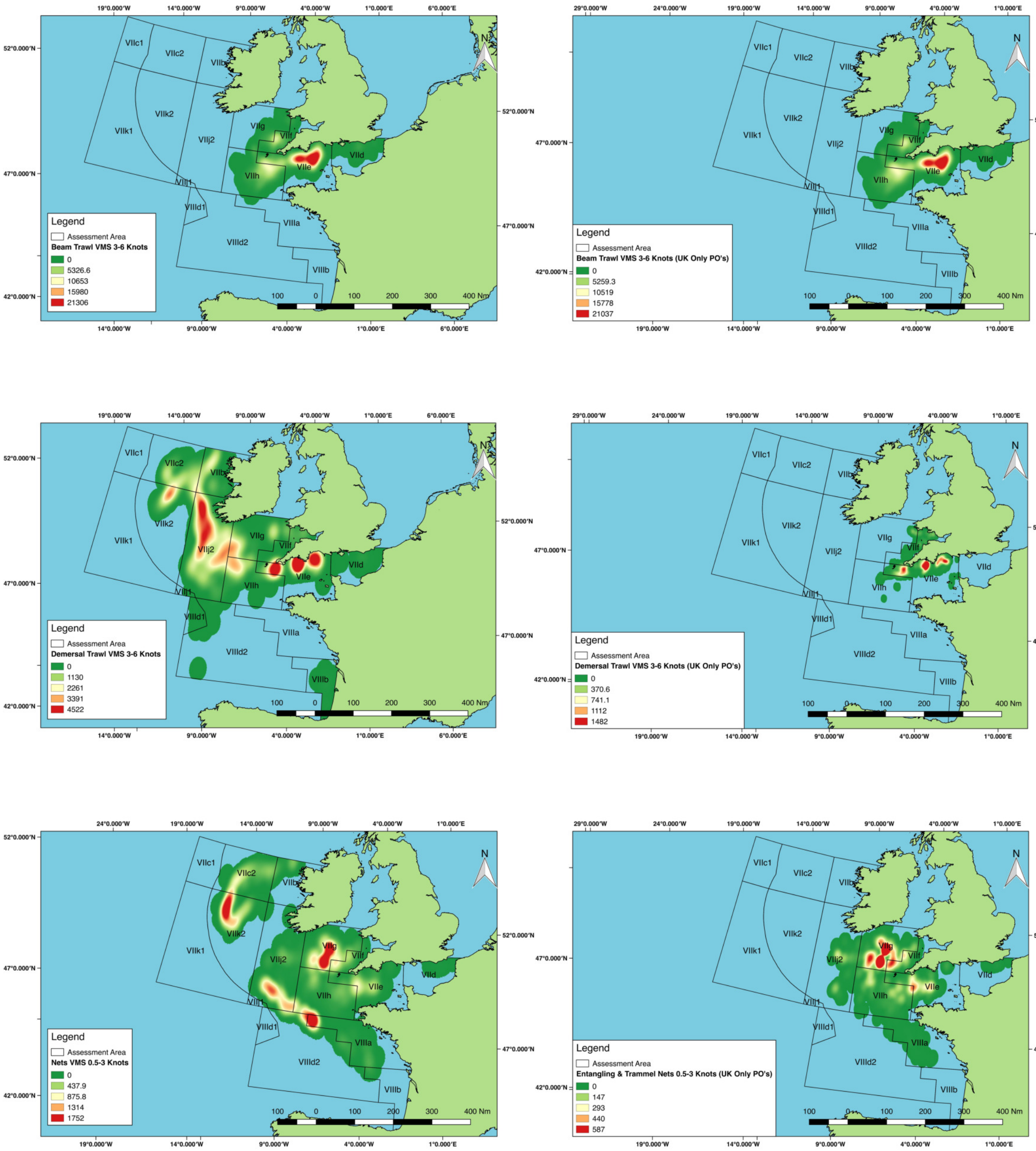

Figure 11 VMS Maps to Show the Fishing Effort by Ping Density

During the research process and at the steering group meeting it was highlighted that the original data provided by the MMO contained also contained vessels that were not of UK nationality, as the FIP has only engaged with UK vessels it was advised that the data should be filtered to only contain that of UK vessels. Therefore, in the figure above the left-hand side displays data for all vessels targeting monkfish in the UoA and the right-hand side shows only the UK PO's engaged in the FIP. The former has been presented by request of the MSC, to show how other vessels currently not engaged in the process currently target monkfish if they were to be included in the FIP at a later date.

An overview that describes the areas in which fishing activity occurs has been discussed in the table below:

Fishing Gear	Areas of the UoA where fishing Activity Occurs
Beam Trawl	High in VIIe, Medium in VIIf, VIIh, Low in VIId, VIIg
Demersal Trawl	High in VIIe, Medium in VIIf
Entangling/Trammel Nets	High in VIIe, VIIg, VIIf, VIIh, Medium in VIIj2, Low in VIIIa

TABLE 8 SUMMARY OF THE ICES AREA WHERE FISHING ACTIVITY OCCURS

10.4. Species Sightings Mapping

Species sightings data was acquired from the EMOD-Biology database. Similarly, to the VMS data these were analysed using the point density tool in GIS to formulate a map of the distribution of the species in the assessment area and to show hot spot areas of high numbers of sightings.

Although in this instance the observed number of sightings is used as a population field in the algorithm, the item's value determines the number of times to count the point. This enables a point attributed with more than one sighting of the species to be weighted higher in the algorithm which gives the resulting cell a higher density score.

Data for each species was acquired from the EMOD-Biology toolbox with geo referenced entries filtered to only include data from the last twenty years. These maps were created to inform the risk assessment of the spatial availability of the Species in the UoA, all maps for each species can be seen in Appendix E.

10.5. Habitats Mapping

Habitats information was also assimilated from the EMOD-Seabed Habitats database, here the broad scale EU Sea Map layers were mapped in GIS to inform the assessment of the Biozones and Substrate habitats in the UoA. The resultant maps can be viewed below:

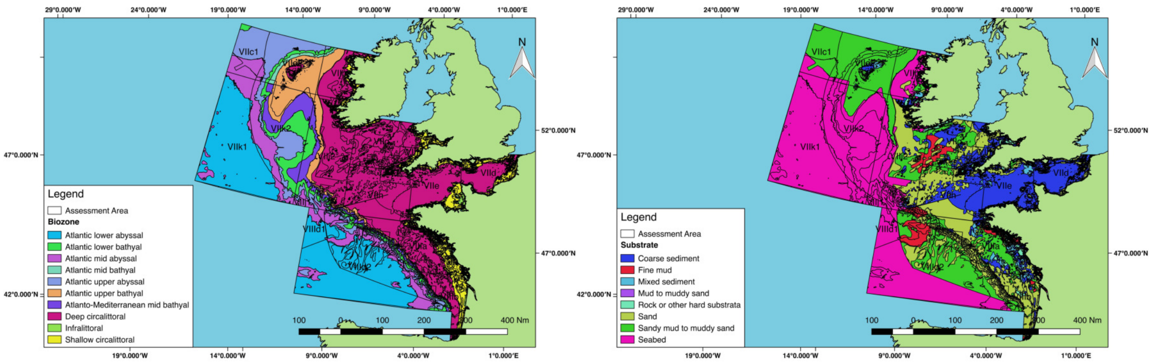

FIGURE 12 HABITATS MAPS IN THE UOA OF BOTH BIOZONES AND SUBSTRATES

10.5.1. Overlay Analysis

Being able to overlay these polygon layers with the raster layers of the VMS data it is possible to estimate the type of habitats in the UoA where there is a high density of fishing pressure. These overlay maps are seen below:

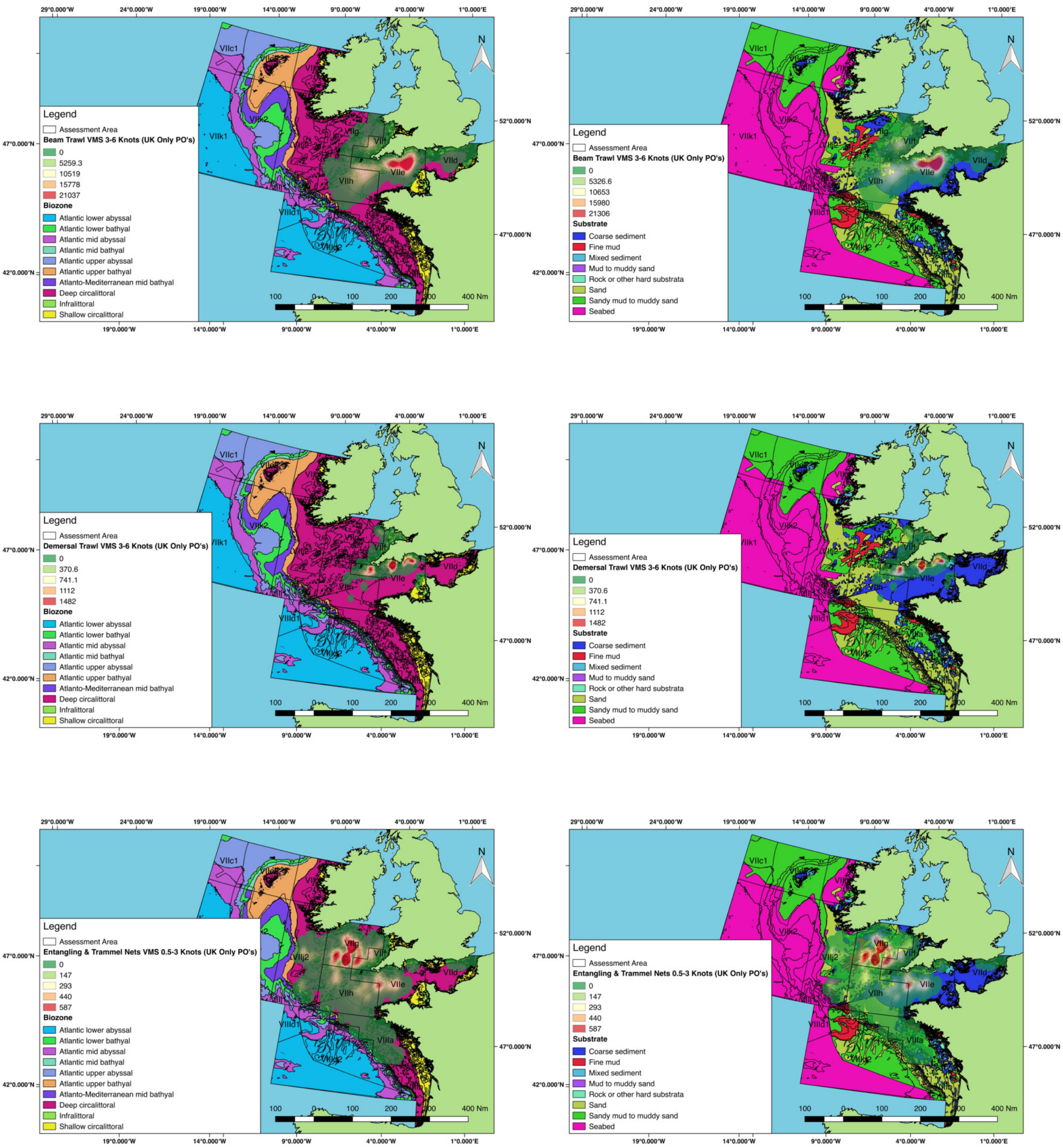

FIGURE 13 VMS AND HABITATS OVERLAY MAPS

Using these maps, we can calculate the total area of the different biozones and substrates, and calculate the percentage of each habitat type in each ICES Area to help inform the productivity and susceptibility risk assessment analysis. The results of this can be seen in the tables below:

Area	Biozone								
	Deep Circa-littoral	Infra-littoral	Shallow Circa-littoral	Atlantic Lower Abyssal	Atlantic Lower Bathyal	Atlantic Mid Abyssal	Atlantic Upper Abyssal	Atlantic Upper Bathyal	Atlanto-Mediterranean mid bathyal
VIIe	50.40	20.69	28.91	0.00	0.00	0.00	0.00	0.00	0.00
VIIg	92.35	0.75	6.90	0.00	0.00	0.00	0.00	0.00	0.00
VIId	17.70	12.53	69.77	0.00	0.00	0.00	0.00	0.00	0.00
VIIf	38.68	3.74	57.59	0.00	0.00	0.00	0.00	0.00	0.00
VIIh	71.57	0.23	1.65	0.00	2.39	0.00	0.34	16.14	7.67
VIIj2	70.98	1.69	10.09	0.00	3.45	0.09	2.72	6.63	4.36
VIIIa	43.64	4.53	33.90	0.01	3.90	1.07	2.54	5.31	5.10

Area	Substrate							
	Coarse Sediment	Fine Mud	Mixed Sediment	Mud to Muddy Sand	Rock or other Hard Substrata	Sand	Sandy Mud to Muddy Sand	Seabed
VIIe	29.31	0.12	16.11	0.00	14.44	35.16	4.54	0.32
VIIg	23.97	0.95	2.34	0.00	7.65	31.86	32.44	0.79
VIId	54.58	0.01	0.51	0.06	10.12	32.48	1.89	0.34
VIIf	45.82	0.99	2.05	0.06	14.48	35.11	1.33	0.16
VIIh	25.15	22.18	2.88	0.00	1.89	39.86	6.40	1.64
VIIj2	27.47	14.10	1.92	3.07	10.48	17.84	9.25	15.87
VIIIa	23.28	6.34	13.82	0.00	12.14	30.43	13.99	0.01

Table 9 Tables to show the Percentage Cover of Differing Habitats in the ICES Areas of the UoA

Fishing Gear	Dominant Biozones & Substrates
Beam Trawl	Deep Circa-littoral zone with Sandy and Coarse Sediment substrates.
Demersal Trawl	Deep & Shallow Circa-littoral zone with Sandy and Coarse Sediment substrates.
Entangling/Trammel Nets	Deep & Shallow Circa-littoral zone with Sandy, Coarse Sediment, Fine Mud & Muddy substrates. Some Overlap with Atlantic Upper Bathyal Zone.

TABLE 10 DESCRIPTION OF THE PRIMARY HABITATS WHERE HIGH FISHING ACTIVITY OCCURS BY GEAR TYPE

10.6. Conservation Areas

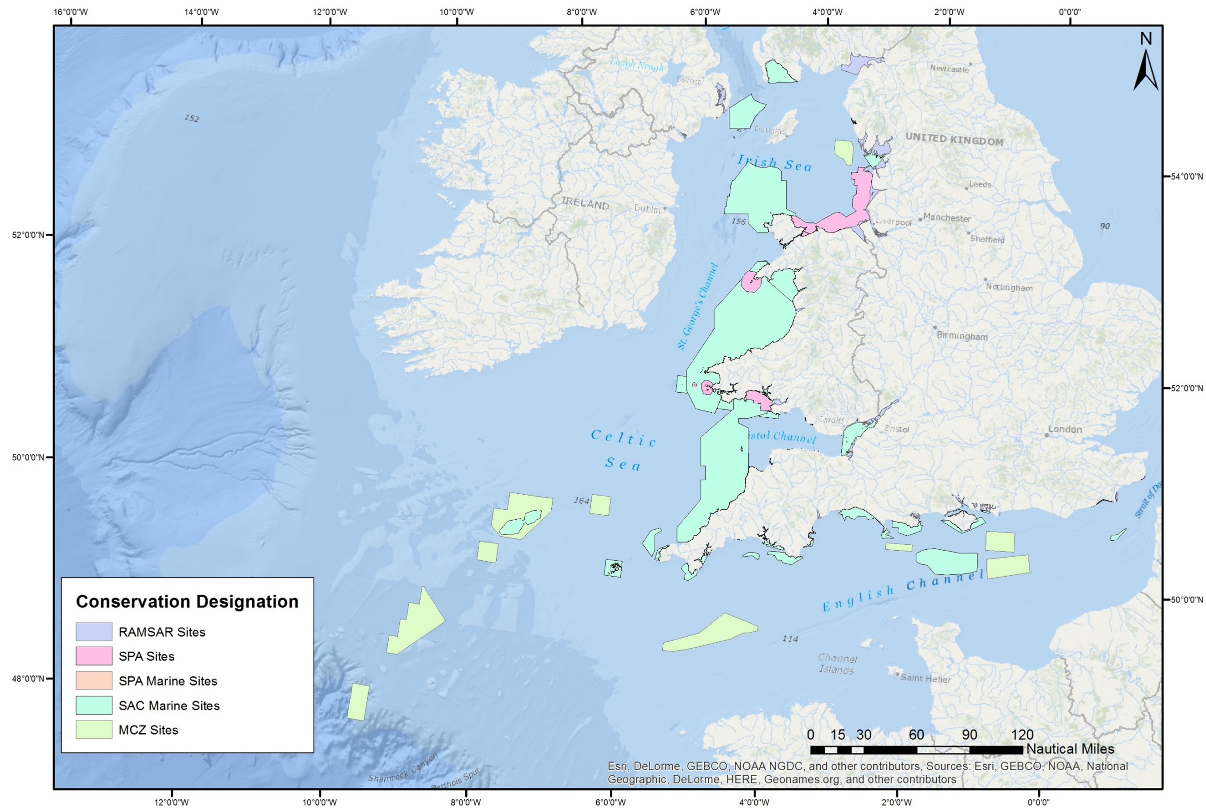

FIGURE 14 CONSERVATION AREAS IN THE VICINITY OF THE FISHERY

Spatial Overlap of MPA and Fishery Assessment Area	
Assessment Area	947,936 km
Conservation Areas	20,877 km
Spatial Overlap	2.2%

TABLE 11 SPATIAL OVERLAP OF MCZS WITH THE ASSESSMENT AREA OF THE FISHERY

Spatial analysis using Geographical Information System (GIS) software can give an accurate estimation of the geographical area that the MPAs and the Assessment Area cover, from this a percentage of the spatial overlap can be deduced. As seen in Table 8 the area of the MPAs that are found within the boundary of the assessment area make up 2%. Although this a very small proportion of the area, these MPAs may have been designated for the importance to species that may be considered as ETP under the assessment and therefore fishing activity in these areas could be considered as has having a higher risk towards ETP species. Thus, it is important to understand how the fishing activities are distributed within the overall assessment area.

11. Assessment of ETP Species

11.1. Cefas Observer Data Profiling

Observers were present on vessels of the three PO's of the fishery, data was anonymised and observers completed sampling on all three of the gear types of the fishery. The observer records span from 2010 to 2016. Overall sample rates can be seen in the table below:

	Beam Trawl	Demersal Trawl	Entangling/Trammel Nets
Number of Trips Observers were Present	146	53	18
Total Number of Hauls/Nets	5907	194	264
Total Number of Hauls/Nets Sampled	3701	175	221
Overall Sample Rate	0.626544777	0.902061856	0.833333333

TABLE 12 NUMBER OF OBSERVED HAULS/NETS AND SAMPLE RATES

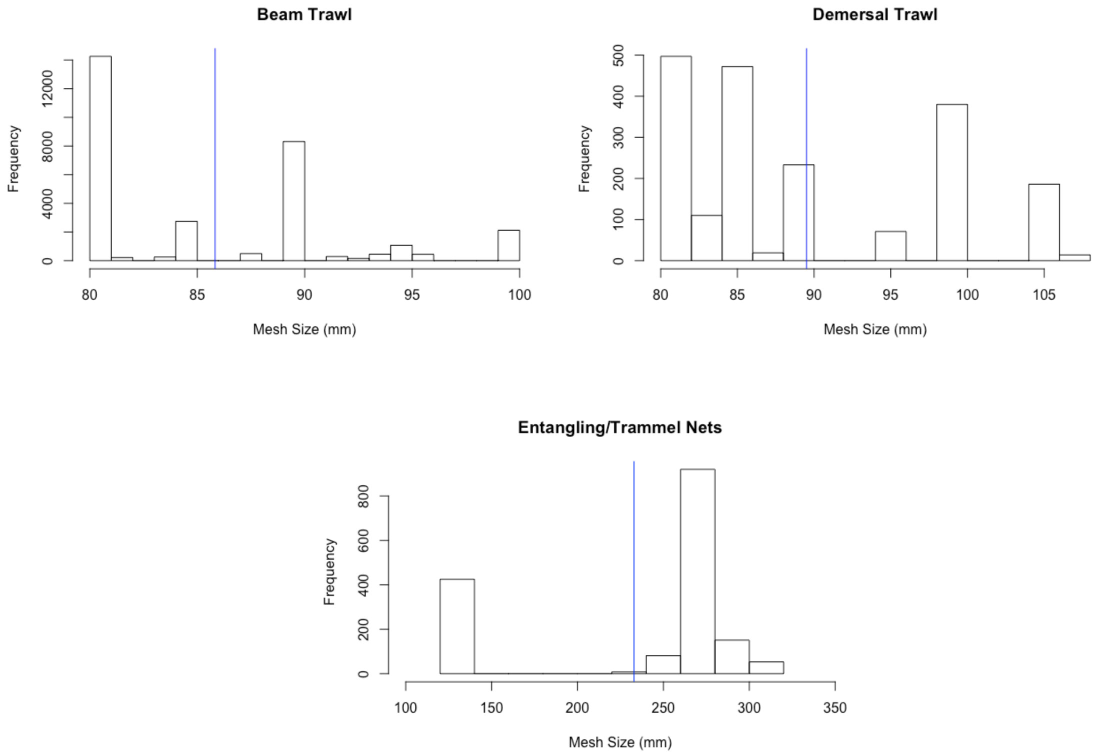

Figure 15 Histograms to Show the Frequency of the Mesh Size used in the different ear types

The histograms show the range of mesh sizes used by each of the different gear types and the blue lines represents the average size used. In the beam trawl the average mesh size is around 87mm but the plot shows that the most commonly used mesh size is nearer to 80mm.

The average mesh size used by the demersal trawls was around 88mm but the plot reveals that mesh sizes between 80-90mm are the most frequently used.

Average mesh size by the entangling/trammel nets is around 240mm with mesh sizes ranging between 250 to 300mm being the most often-used mesh size.

12. Assessment of Elasmobranchs Interactions

Elasmobranchs are now extensively renowned to be susceptible to overexploitation (Ellis et al 2008). Numerous stocks within European waters are regarded as depleted and in some extreme cases, for example species such as the White Skate (*Rostroraja alba*) and the Angel Shark (*Squatina squatina*) have been completely eradicated from previous occupied habitats (ICES 2015). Because of the high conservation interest in elasmobranch stocks various national and international management measures have been put in place to protect elasmobranchs in particular the more vulnerable species whilst ensuring that exploitation of commercially important species is sustainable.

The introduction of EU Total Allowable Catch regulation (fixing for 2017 the fishing opportunities for certain fish stocks and groups of fish stocks EU2017/127) includes a number of prohibited elasmobranch species in Article 41, which qualifies some species as ETP in an MSC assessment.

12.1. Beam Trawl

Species	2010	2011	2012	2013	2014	2015	2016
Blonde ray	525	238	135	199	90	914	168
Common skate	81	202	789	2146	967	624	2906
Long-nose skate	0	29	0	0	2	6	2.5
Nurse hound	20	9	34	72	0	213	11
Smalleyed (painted) ray	7	6	20	7	28	81	65
Smooth hound	0	3	0	31	6	13.5	35
Spurdog	11	6	1	3	1	0	25
Starry ray	0	0	0	4	0	0	6.06
Starry smooth hound	15	30	75	132	27	107	101
Tope shark	0	0	0	1	0	0	0
Undulate ray	233	34	111	177	67	394	164

TABLE 13 NUMBERS OF ELASMOBRANCHS OBSERVED EACH YEAR IN BEAM TRAWLS

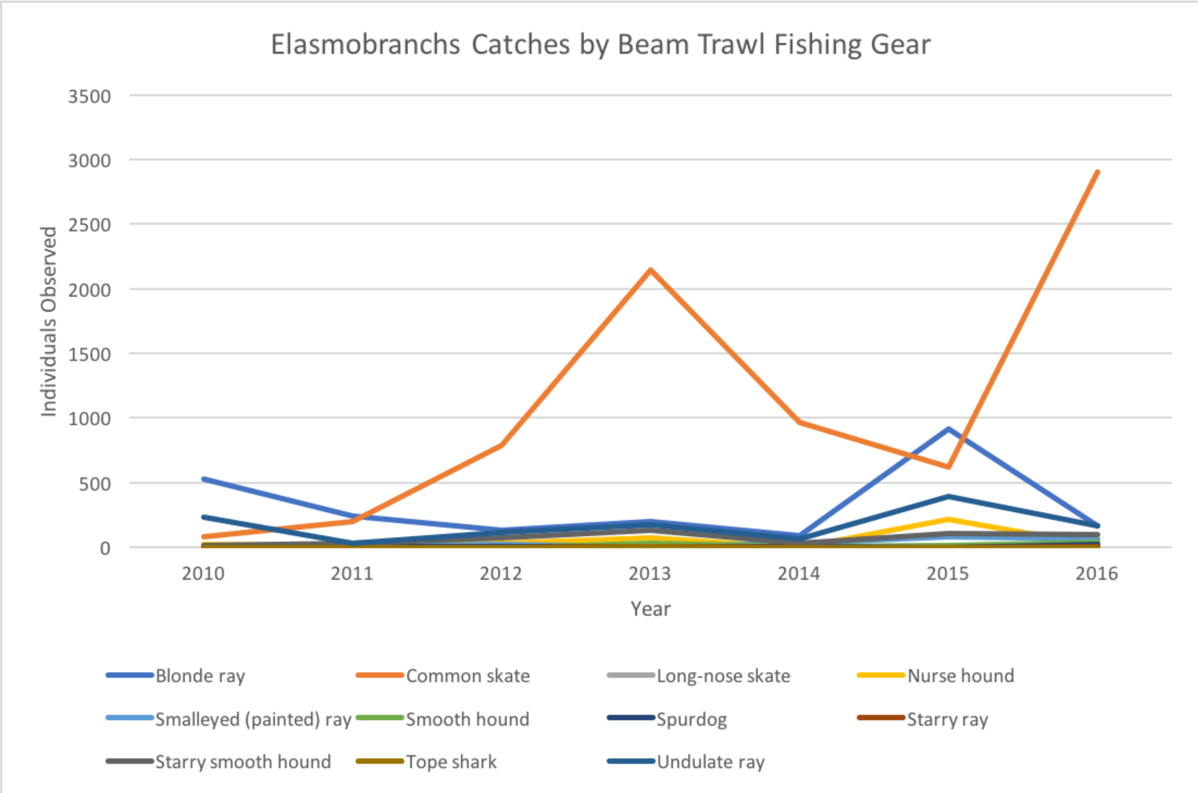

FIGURE 16 NUMBERS OF ELASMOBRANCHS OBSERVED EACH YEAR IN BEAM TRAWLS

The observer data from Cefas indicates that the elasmobranch species that are consistently captured are that of the Common Skate (*Dipturus batis*), Undulate Ray (*Raja undulata*) and the Blonde Ray (). Particular concern in this fishing gear is the significantly high numbers of Common Skate bycatch with peaks of 2146 and 2906 individuals bycaught in 2013 and 2015 respectively. The Blonde Ray and Undulate Ray also show similar trends to each other whereby the species were recorded with more than insignificant numbers in 2010 and in 2015.

12.2. Demersal

Elasmobranchs	2010	2011	2012	2013	2014	2015	2016
Blonde ray	14	1	20	1	13	35	16
Blue shark	0	0	0	0	0	0	1
Common skate	0	0	0	0	0	0	3589
Nurse hound	0	0	0	0	0	1	23
Smalleyed (painted) ray	0	0	1	6	2	12	1
Smooth hound	2	0	0	0	1	0	2
Spurdog	0	0	0	0	2	0	0
Starry smooth hound	13	2	2	14	11	19	110
Tope shark	0	0	0	0	0	2	2
Undulate ray	0	0	0	16	0	1	55

Table 14 Numbers of Elasmobranchs Observed each year in Demersal Trawls

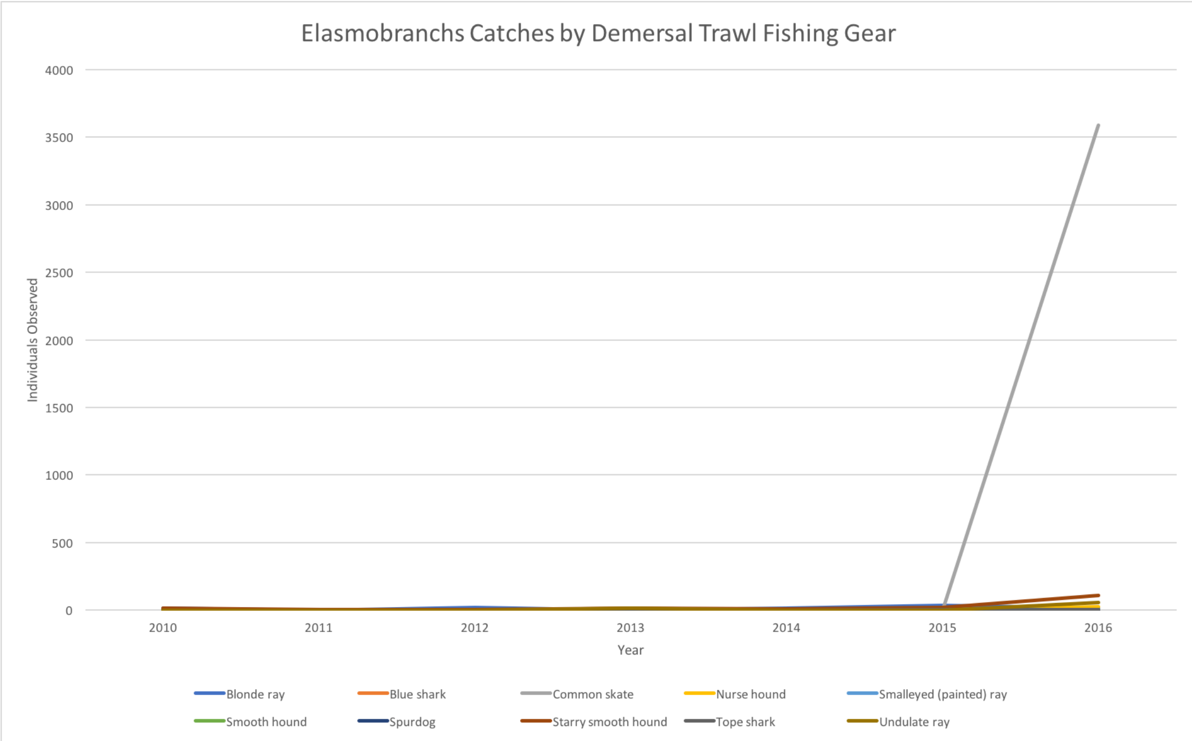

FIGURE 17 NUMBERS OF ELASMOBRANCHS OBSERVED EACH YEAR IN DEMERSAL TRAWLS

The observer data suggests that bycatch of elasmobranchs is much less of a problem in the demersal fishing gear of the fishery. Throughout the majority of the 2010-2015 period catches of vulnerable elasmobranch species was observed at less than 35 individuals each year. Although in the most recent available year of 2016, there was a dramatic increase of the incidental capture of the Common Skate whereby 3589 individuals were recorded.

12.3. Entangling Trammel

Elasmobranchs	2010	2011	2012	2013	2014	2015	2016
Basking shark	0	0	1	0	0	0	0
Blonde ray	2	0	3	14	0	4	0
Blue shark	1	3	3	6	0	0	2
Common skate	21	116	3	2	1	0	0
Nurse hound	0	0	0	33	0	1	0
Porbeagle shark	1	5	0	2	0	0	0
Smalleyed (painted) ray	0	0	4	0	0	0	0
Smooth hound	0	6	0	20	0	0	0
Spurdog	6	18	6	0	0	0	1
Starry smooth hound	305	15	41	61	0	0	0
Tope shark	80	15	8	22	0	0	0
Undulate ray	0	0	0	0	0	0	3

Table 15 Numbers of Elasmobranchs Observed each year in Entangling/Trammel Nets

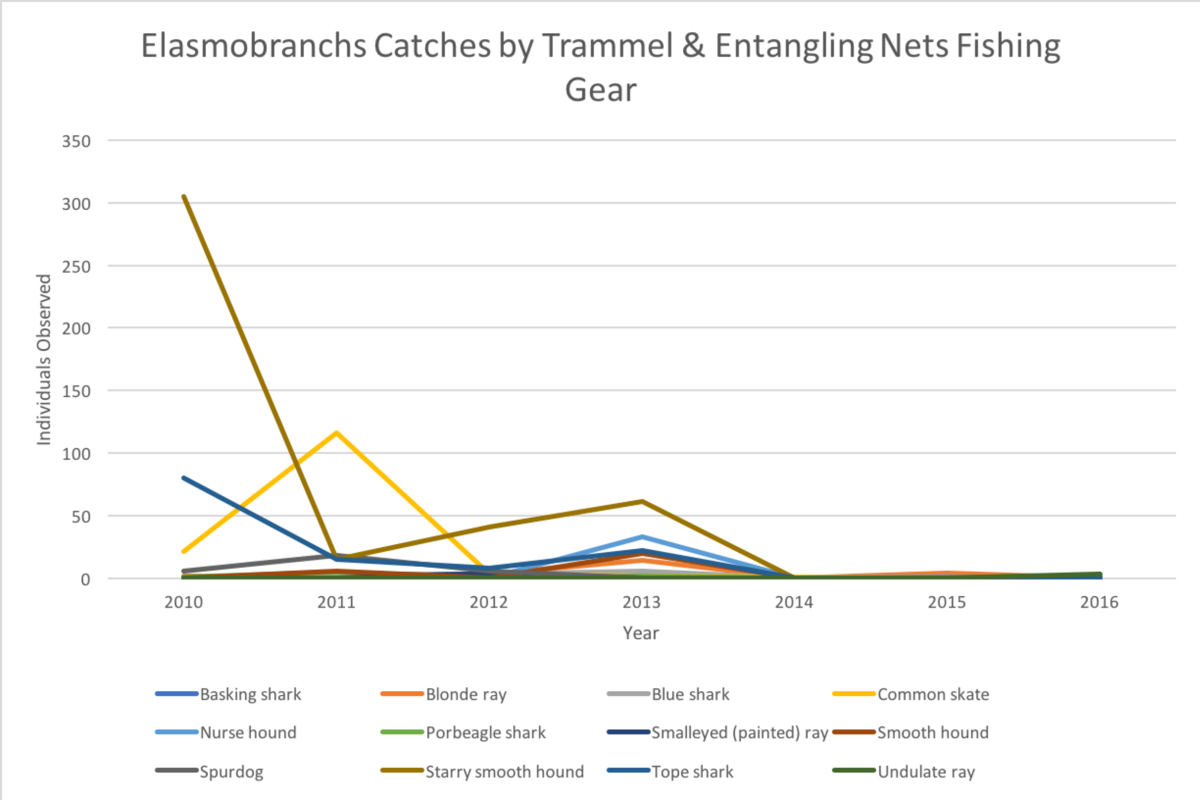

FIGURE 18 NUMBERS OF ELASMOBRANCHS OBSERVED EACH YEAR IN ENTANGLING/TRAMMEL NETS

The observer data for the entangling and trammel set nets indicate a slightly different trend for elasmobranch bycatch. The Fig 16 suggests that bycatch of vulnerable species of elasmobranch was prevalent from 2010 up until 2013, where bycatch of the Starry Smooth Hound (*Mustelus asterias*) was recorded in moderately high numbers in 2010 and 2013. The Common Skate and the Tope shark are also of notable attention with 116 individuals of the Skate observed in 2011 and 80 individuals of the Tope Shark found in nets in 2010. The single incident of the bycatch Basking Shark in 2012 should also be highlighted due to its almost certain mortality at capture. Although recently vulnerable elasmobranch bycatch has not been a consistent occurrence in the last few years with only 12 individuals of elasmobranchs recorded between 2014 and 2016.

12.4. Common Skate

The Common Skate was previously widely distributed throughout the majority of the North Sea however it has now rarely encountered, usually in the northern North Sea (ICES Advice 2008). The batoid is the largest in European waters, reaching lengths of up to 285cm and weights around 100kg. As a demersal species, it often inhabits coastal areas and shelf seas (lower-infralittoral, lower-circalittoral, upper-infralittoral and upper-circalittoral). ICES Working Group reports indicate a depth range of between 85-1000m (ICES 2016a), but the Marlin database suggests the species inhabits up to depths of 600m (Neal & Pizzolla 2006).

The decline in the Common Skate has been well documented for numerous areas, but the magnitude of the decline has been observed severely in most shelf areas (ICES 2002). As in the Irish Sea for example where the Skate has been commercially extinct for a number of years (Brander 1981), and has also declined greatly in the North Sea (Walker & Hislop 1998). The exploitation of the Common Skate has become the first example of a fish species that has been brought to the near brink of extinction through commercial fishing (Brander 1981). The species was previously listed under the IUCN Redlist as 'endangered' in 2000 but was relisted as 'critically endangered' in 2006.

They are highly likely to be incidentally captured in fisheries as bycatch especially in trawl and set net fisheries that target high value teleosts such as monkfish. ICES do not have any stock information regarding the Common Skate in the assessment ecoregions, but do recommend that a precautionary approach should be deployed for management of the species (ICES 2016b).

In terms of recoverability from a mortality event the Common Skate is very slow; the species can continue to live for at least twenty years and reach maturity at around 11 years. The females usually produce clutches with around 40 eggs every other year, meaning that they only produce at least 160 eggs in a life span. This suggests a very low fecundity and that even in a scenario where the majority of juveniles born following a mortality event were to survive it would take years for the population to recover to its original level (Neal & Pizzolla 2006).

Catch Rates

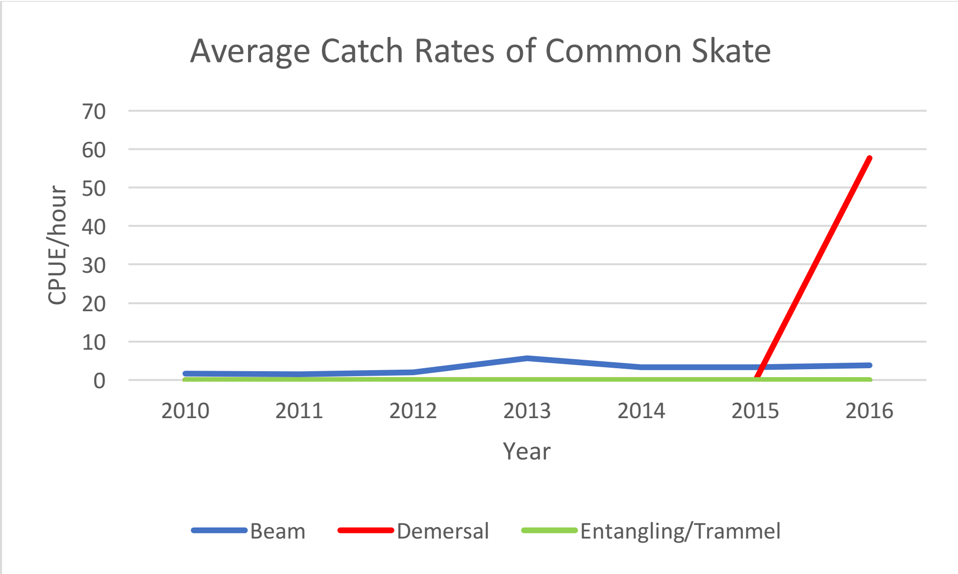

FIGURE 19 AVERAGE CPUE/HOUR OF COMMON SKATE FROM HAULS/NETS IN WHICH THE SPECIES WAS RECORDED ACROSS GEAR TYPES

	Beam Trawl	Demersal Trawl	Nets
Number of Hauls/Nets Sampled	3701	175	220
Number of Common Skate Observed	7715	3589	143
Overall Catch Rate	2.084571737	20.50857143	0.65

TABLE 16 TOTAL NUMBERS & OVERALL CATCH RATES OF COMMON SKATE OBSERVED FROM 2010-2016 ACROSS GEAR TYPES

12.5. Porbeagle Shark

The Porbeagle Shark is robust and streamlined shark reaching up to 350cm in length (Barnes 2008a), that is widely distributed throughout British and Irish waters. The Shark is an epipelagic oceanic and coastal species, and is often found in a large range of the water column from the surface waters down to depths of over 700m, but also ventures infrequently into inshore waters. They are highly migratory and often move along continental shelves, individuals that were tagged in southern English waters were recaptured in northern Norwegian, Danish and Spanish waters, travelling distance of up to 2,370km (Stevens 1976).

Recent stock information for Porbeagle Sharks comes from the ICES Working Group on Elasmobranch Fisheries and ICES also provides advice for fisheries on the species. To summarise there has been a fishery for Porbeagle Sharks using longlines prior to 2010, later there has been strict control of fishing in EU waters. Initially this came in the form of a TAC of zero between 2010 to 2015, the species has now subsequently been listed as prohibited through Article 41 of the EU 2017/127.

ICES advise that the precautionary approach should also be applied for the Porbeagle Shark in the ecoregions of the assessment. Exploratory assessments of the stock from ICES and ICCAT suggest that the current biomass is less than the B_{MSY} and that latest fishing mortality is thought to be above or close to the F_{MSY}. ICES regard most of the northern parts of the ICES area to be depleted. Furthermore, the ICES WG notes that stock projections derived from CPUE data from Spanish and French longline fisheries suggest that if catches of the Shark are kept below 200t per year the stock could increase and that B_{MSY} could be reached in 25-30 years (ICES 2016a). However, uncertainty must be exercised and that the low productivity of the species must be acknowledged.

With respect to recoverability from mortality events, the Porbeagle Shark has a very low productivity. Porbeagle Sharks are live bearers and females reaching maturity at 13-18 years, usually birthing around 1-4 pups, with a gestation period of 8-9 months, whereby mating occurs in the summer and pups born in the spring of the following year.

Catch Rates

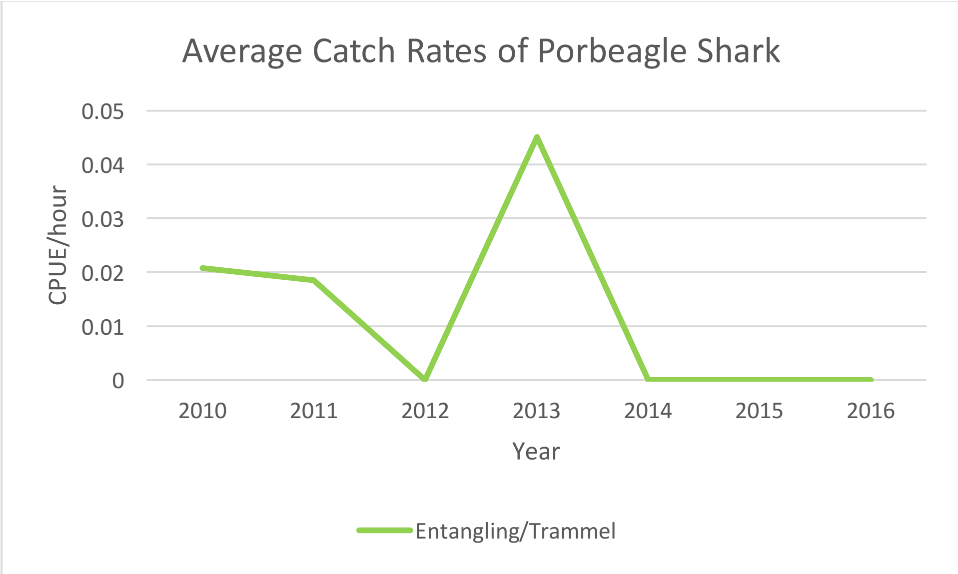

FIGURE 20 AVERAGE CPUE OF PORBEAGLE SHARK FROM HAULS/NETS IN WHICH THE SPECIES WAS RECORDED ACROSS GEAR TYPES

	Beam Trawl	Demersal Trawl	Nets
Number of Hauls/Nets Sampled	3701	175	220
Number of Porbeagle Shark Observed	0	0	8
Overall Catch Rate	0	0	0.036363636

TABLE 17 TOTAL NUMBERS & OVERALL CATCH RATES OF PORBEAGLE SHARK OBSERVED FROM 2010-2016 ACROSS GEAR TYPES

12.6. Spurdog

The Spurdog is listed as vulnerable under the IUCN's Red list and can reach up to lengths of 1.6m, and is widely distributed through British and Irish Waters. The Spurdog is considered a benthopelagic species and occurs in both inshore and offshore areas of continental shelves and is tolerant towards a range of salinities in depths of between 50-300m.

ICES suggest that there is a single stock in the North East Atlantic, and that spawning stock biomass (SSB) and recruitment has declined greatly since the 1960s to where the lowest levels were observed in 2005. Despite this the last decade the species has shown signs of recovery mainly due to the reduced harvest rate where it is thought to be below the MSY level. (MSY harvest rate at 0.03, where catch was a proportion of the total biomass). Fisheries that target the species have now been prohibited in Norway and EU waters since the year 2011, with a TAC of zero.

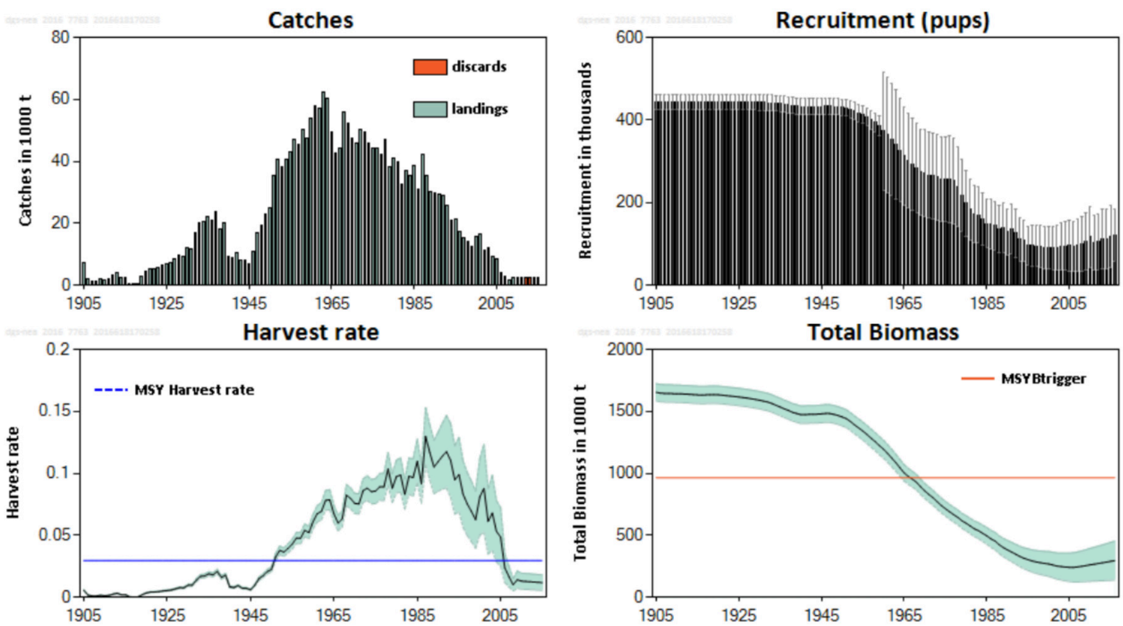

FIGURE 21 SUMMARY OF ICES' STOCK ASSESSMENT OF SPURDOG IN THE NORTHEAST ATLANTIC, LONG-TERM TRENDS IN CATCHES, MEAN HARVEST RATE (AVERAGE AGES 5–30), RECRUITMENT (NUMBER OF PUPS), AND TOTAL BIOMASS (ICES 2016C).

ICES advice suggests that the precautionary approach should be applied and that there should not be in any fisheries that target Spurdog in the Northeast Atlantic in 2017 and 2018. ICES also state that the most recent estimation of annual catches are around 2468 tonnes and that at this level the stock could recover and increase at rates that are similar to those estimated at zero catch (ICES 2016d).

There is no formal management plan for the stock, however in the MSC Certified Cornish Hake Fishery, there is a multi-stakeholder management strategy to reduce impacts of the fishery upon the species.

These include Cefas, the MMO, the Shark Trust and the Cornish Fishery Producer Organisation, in this initiative 3 CFPO vessels are currently reporting bycatch of Spurdog to Cefas on a daily basis, who subsequently provide management advice to the entire Unit of Certification fleet on how to mitigate Spurdog catch incidents in future hauls. As the CFPO are one of the three PO's of the Monkfish Fishery, this approach should be adopted easily by the CFPO and recommended for the remaining PO's.

Catch Rates

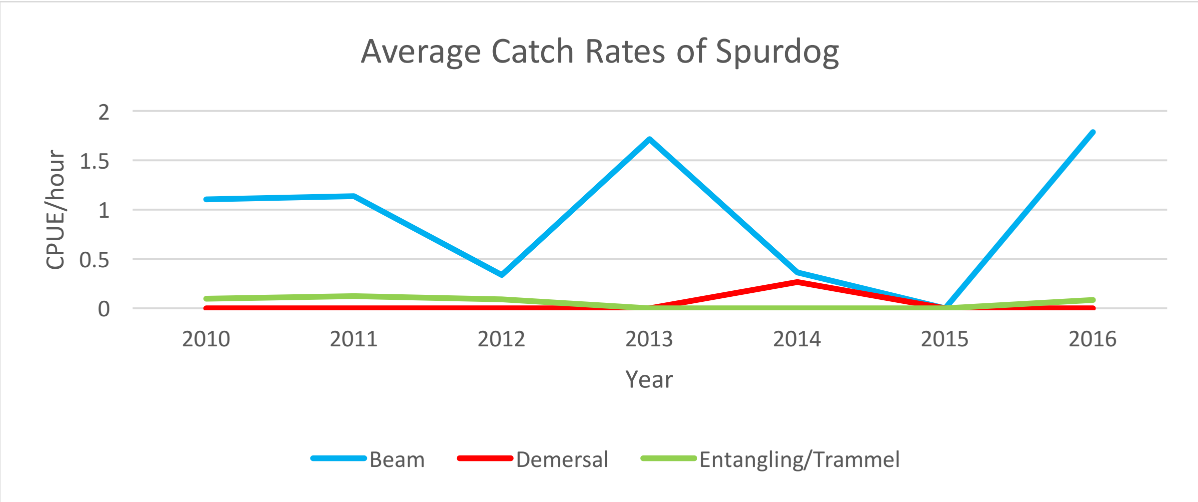

FIGURE 22 AVERAGE CPUE OF SPURDOG FROM HAULS/NETS IN WHICH THE SPECIES WAS RECORDED

	Beam Trawl	Demersal Trawl	Nets
Number of Hauls/Nets Sampled	3701	175	220
Number of Spurdog Observed	47	2	31
Overall Catch Rate	0.01269927	0.011428571	0.140909091

TABLE 18 TOTAL NUMBERS & OVERALL CATCH RATES SPURDOG OBSERVED FROM 2010-2016 ACROSS GEAR TYPES

12.7. Basking Shark

The Basking Shark is the largest species of fish in British waters reaching lengths of up to 12m, the Shark usually live in open waters but migrate towards the shore in the summer. In Britain and Ireland, they are often sighted in areas of western Ireland, the Clyde and western Scotland, centrally in the Irish Sea, the approach of the Bristol Channel and the western English Channel (Wilson & Wilding 2017).

They are a pelagic and migratory species and most often observed when feeding along tidal fronts on continental shelves and the edge of the shelf. But can occupy a range of vertical depths of between 0-1264m, with common dive depths of 80-500m (Gore *et al.* 2008). In terms of Plasticity of the diving behaviour Sims *et al.* found that the Basking Shark will display normal diel vertical migration DVM in deep stratified water and reverse DVM in tidal fronts due to the subsequent movement of copepod prey (Sims *et al.* 2005). In terms of migratory patterns in British and Irish waters migration is thought to be somewhat ambiguous, however there is evidence for a north south seasonal migration which is a response to a change in thermal conditions. Where a northerly movement early in the summer and a southerly movement in the later summer and early autumn (Sims *et al.* 2003; Sims 2008). A seasonal west to east migration is also thought to occur.

Heavy exploitation of the Shark in the 1700s, 1800s and 1900s has led to a strict intervention, whereby the UK protected the species under schedule 5 of the Wildlife and Countryside Act in 1998 and Norway reduced the landing quota for the species to zero in 2001 (Sims *et al.* 2015). In 2006 ICES advised for a zero catch of the species and later stressed the importance of reducing the impacts of bycatch (ICES 2016a). Furthermore Article 41 of the EU 2017/127 regulation prohibits EU vessels landing the species and there is no formal stock assessment of the species.

In terms of recoverability the Basking Shark, it is a large and slow-growing, reaching sexual maturity between 12-20 years of age varying with sex. The generation time is thought to be very slow at around 35 years (Sims *et al.* 2015), and it is thought that females produce a litter of about 6 pups (Sund 1943).

Catch Rates

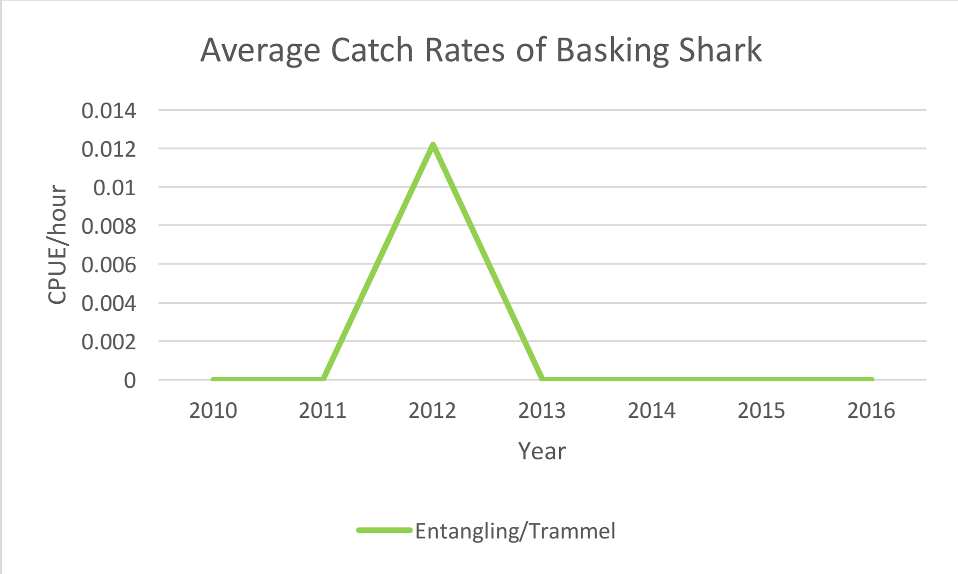

FIGURE 23 AVERAGE CPUE OF BASKING SHARK FROM HAULS/NETS IN WHICH THE SPECIES WAS RECORDED ACROSS GEAR TYPES

	Beam Trawl	Demersal Trawl	Nets
Number of Hauls/Nets Sampled	3701	175	220
Number of Basking Shark Observed	0	0	1
Overall Catch Rate	0	0	0.004545455

TABLE 19 TOTAL NUMBERS & OVERALL CATCH RATES OF BASKING SHARK OBSERVED FROM 2010-2016 ACROSS GEAR TYPES

12.8. Tope Shark

The Tope Shark is widely distributed around the coasts of Britain and Ireland and is listed as 'vulnerable' by the IUCN Red List. It is benthopelagic species that reaches up to 190cm in length and often inhabits the upper continental shelves down to depths of around 550m. It is most often observed near the seabed, and at higher latitudes for example in European waters the species are highly migratory. Usually moving to poles in the summer and the equator in the winter (Barnes 2008b).

The Shark is extremely vulnerable to fishing pressure and was one of the most widely fished shark species. In the years between 1936 and 1944, the Tope Shark was the predominant target of a large fishery in the eastern Pacific whereby 10,886.22 tonnes of the shark were landed for their high vitamin A content. The fishery terminated abruptly when the synthesis of vitamin A was achieved (Walker *et al.* 2006). Even though there is no large-scale fishery targeting Tope Shark in European waters, the species are frequently captured as bycatch in a number of mixed demersal and pelagic fisheries. Populations have rapidly declined in England and Wales and whilst ICES have analysed abundance and biomass catch rates a formal stock assessment has not been performed due to data deficiency (ICES 2017).

Tope Shark are ovoviviparous meaning they are live bearers, reproductive maturity is reached at lengths between 120-179cm for males and 130-185cm for females. In terms of age this equates to around 8 years for males and 11 for females (Compagno 1984). Groups are usually sex segregated for most of the year apart from mating periods in the spring months (Shark Foundation 2005). Gestation usually takes around 12 months, and birth usually takes in place in shallower waters such as bays to give litters of between 6-52 pups (Walker *et al.* 2006).

Catch Rates

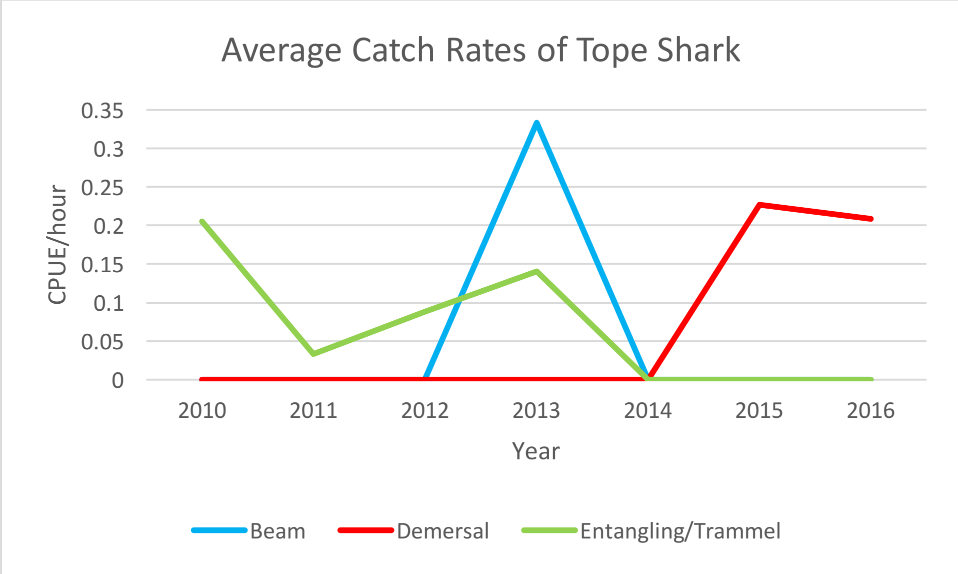

FIGURE 24 AVERAGE CPUE OF TOPE SHARK FROM HAULS/NETS IN WHICH THE SPECIES WAS RECORDED ACROSS GEAR TYPES

	Beam Trawl	Demersal Trawl	Nets
Number of Hauls/Nets Sampled	3701	175	220
Number of Tope Shark Observed	1	4	125
Overall Catch Rate	0.000270197	0.022857143	0.568181818

TABLE 20 TOTAL NUMBERS & OVERALL CATCH RATES OF TOPE SHARK OBSERVED FROM 2010-2016 ACROSS GEAR TYPES

12.9. Undulate Ray

The Undulate Ray is a moderately sized skate that reaches lengths of up to 1m, it is distributed from the southern and western coasts of England and Wales and around the Irish coasts, although is most commonly observed in the English Channel. In terms of habitat it occupies the Undulate ray is an offshore demersal species that can range in depths of 50-200m most commonly in areas with sandy bottoms. In 2008, it was listed as 'endangered' in the IUCN's Red List.

ICES advise the precautionary approach should be used in management of the Undulate Ray and that there should be zero catches of Undulate Ray stocks in the UoA except from divisions Viid and Viie (English Channel). In these divisions landings should not exceed more than 65 tonnes in each the years 2017 and 2018 (ICES 2016e), ICES also highlight that since 2009 the stock size indicator has been increasing in these regions (increased more than 20% between 2009-2013 and 2014-2015).

In terms of sensitivity and recoverability, the Undulate Ray has a patchy distribution and low productivity, males usually reach sexual maturity at lengths of 73cm in males and 75cm in females. Undulate Ray lay eggs and are therefore oviparous and females usually lay paired eggs from March to September (Barnes 2008b).

Catch Rates

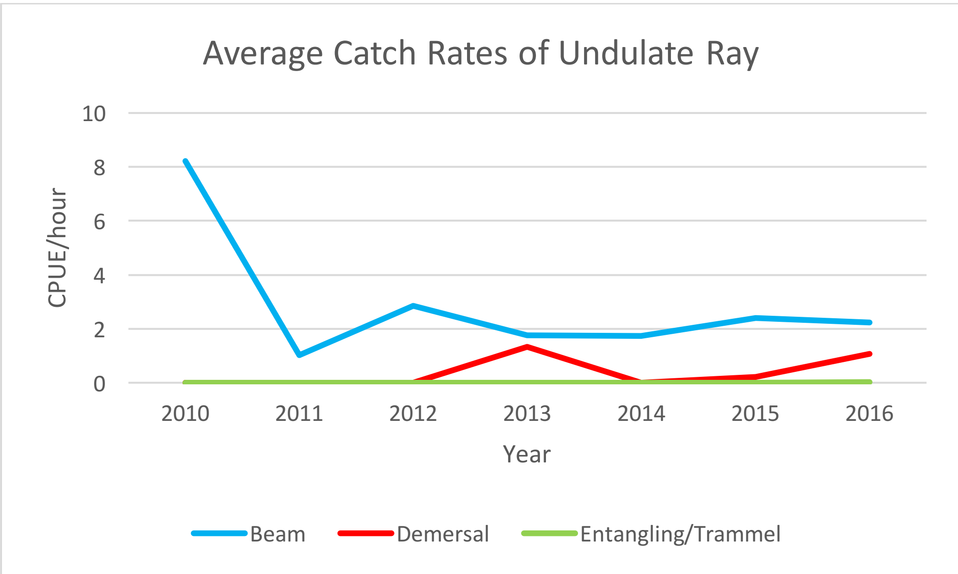

FIGURE 25 AVERAGE CPUE OF UNDULATE RAY FROM HAULS/NETS IN WHICH THE SPECIES WAS RECORDED ACROSS GEAR TYPES

	Beam Trawl	Demersal Trawl	Nets
Number of Hauls/Nets Sampled	3701	175	220
Number of Undulate Ray Observed	1180	72	3
Overall Catch Rate	0.318832748	0.411428571	0.013636364

TABLE 21 TOTAL NUMBERS & OVERALL CATCH RATES OF UNDULATE RAY OBSERVED FROM 2010-2016 ACROSS GEAR TYPES

13. Fish

13.1. Twaite & Aliss Shad

The Twaite and Allis Shad are members of the herring family, they are planktivorous fish that are generally between 20-40cm but can be recorded with lengths of up to 60cm (Freyhof & Kottelat 2008a). Usually found in coastal waters where it spends most of its life, but due to the species' anadromous life history can be found in rivers where they return to spawn in freshwater. In the UK, they can be found offshore around most of the coastline with known populations in rivers flowing into the Severn Estuary, along with a number of spawning sites in the south west of England and in the Solway Firth.

Due to the rarity of the Shad species both the Twaite and Allis Shad are afforded substantial protection, particularly through Schedule 5 of the Wildlife and Countryside Act 1981. Only the Twaite Shad was recorded in the fishery by the Cefas Observer Programme.

Catch Rates

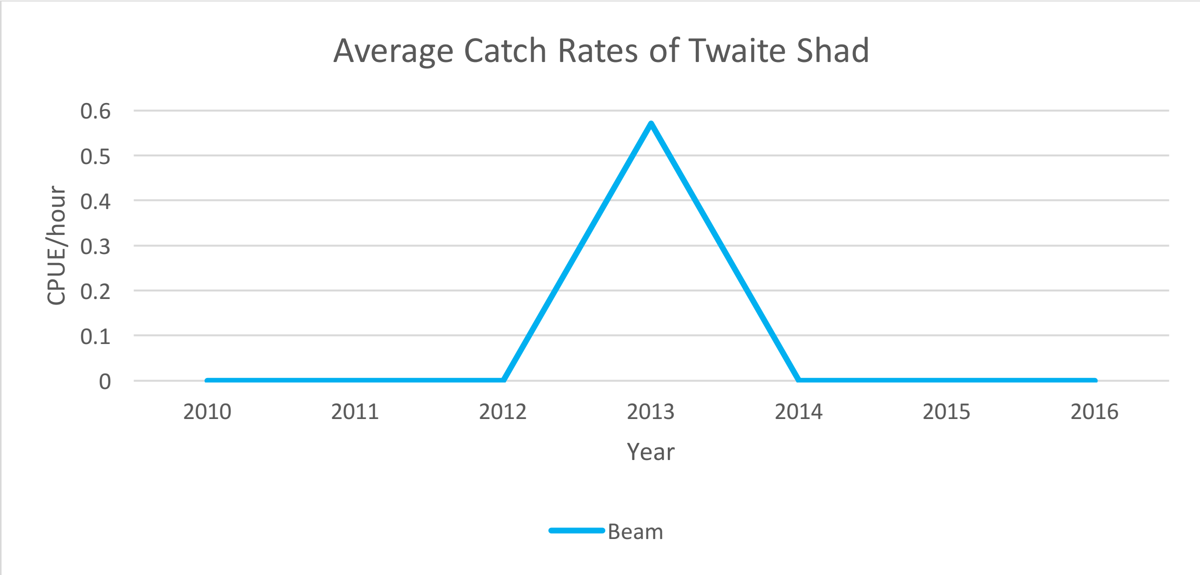

FIGURE 26 AVERAGE CPUE OF TWAITE SHAD FROM HAULS/NETS IN WHICH THE SPECIES WAS RECORDED ACROSS GEAR TYPES

	Beam Trawl	Demersal Trawl	Nets
Number of Hauls/Nets Sampled	3701	175	220
Number of Twaite Shad Observed	1	0	0
Overall Catch Rate	0.000270197	0	0

TABLE 22 TOTAL NUMBERS & OVERALL CATCH RATES OF TWAITE SHAD OBSERVED FROM 2010-2016 ACROSS GEAR TYPES

13.2. European Eel

The European Eel is a catadromous species with a snake like body, the species are usually recorded with lengths surrounding 1, but can develop up to 1.5m (Avant 2007). They are widely distributed around the coasts of both Britain and Ireland, mostly abundant in estuaries and low salinity pools but are also found on the lower shore and shallow sublittoral areas. In terms of habitat and behaviour the Eel is nocturnal and is inactive during the day where it resides under rocks, weeds or in softer sediments. The life history of the species is still not well understood, the Eel undergoes migration of mature adults from rivers around in Europe to the Sargasso Sea in the west Atlantic where they spawn with the subsequent return of the juveniles. Metamorphosis occurs twice and part of the life is spent in fresh water and then estuarine or salt water (Whitehead *et al.* 1986).

Abundance of the species has been decreasingly rapidly, where numbers in London's rivers has dropped 95% since the 1980s (Jacoby & Gollock 2014). Since 2008 it has been listed as 'critically endangered' in the IUCN'S Red List.

Catch Rates

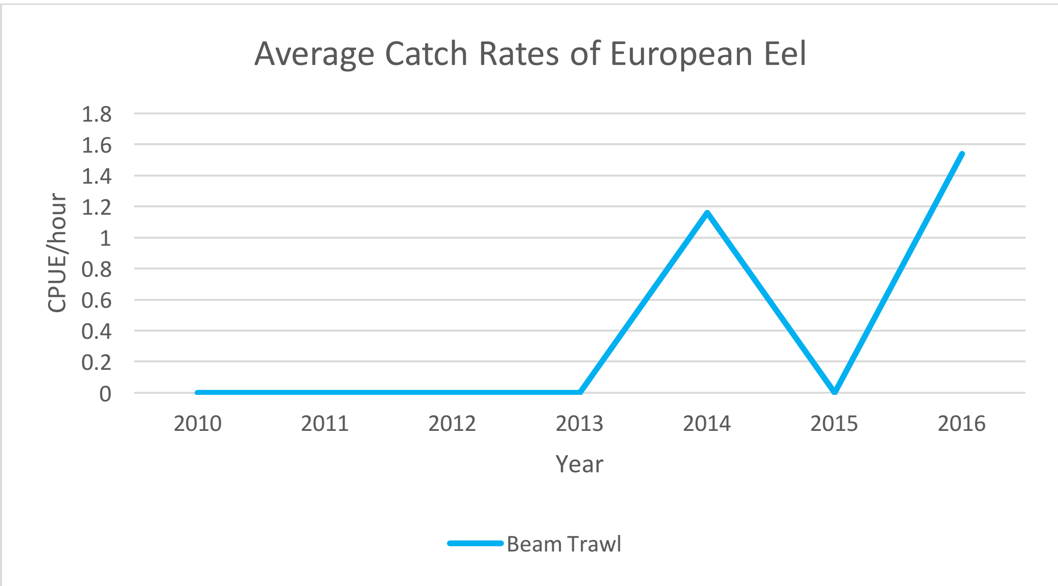

FIGURE 27 AVERAGE CPUE OF EUROPEAN EEL FROM HAULS/NETS IN WHICH THE SPECIES WAS RECORDED ACROSS GEAR TYPES

	Beam Trawl	Demersal Trawl	Nets
Number of Hauls/Nets Sampled	3701	175	220
Number of European Eel Observed	8	0	0
Overall Catch Rate	0.002161578	0	0

TABLE 23 TOTAL NUMBERS & OVERALL CATCH RATES OF EUROPEAN EEL OBSERVED FROM 2010-2016 ACROSS GEAR TYPES

14. Marine Mammals

The fishery is certain to have an impact upon marine mammal species in the UoA of the fishery. As seen in the literature review in the previous sections of this report, static gear types are of most concern when it comes to bycatch of marine mammal species.

For the most part surveillance and data is limited when it comes to interactions with the fishery and marine mammals. However, the Cefas Observer Programme did find that in the 2011-2016-time series there was 4 observed Common Porpoise individuals and 3 Common Seal individuals observed in entangling/trammel set nets of the fishery.

Species	Number of Individuals in Beam Trawls Observed in the Cefas Programme 2011-2016
Common Porpoise	4
Common Seal	3

TABLE 24 NUMBERS OF MARINE MAMMALS OBSERVED IN BEAM TRAWLS BY CEFAS OBSERVERS

However, the Cefas Observer Programme is mainly dedicated towards observing catches of commercial and out of scope commercial species and therefore may not be the best representation of marine mammal interactions. Fortunately, there are other sources of quantitative information such as the Sea Mammal Research Unit's (SMRU) yearly reports to the European Commission (Northridge, Kingston & Thomas 2013, 2014, 2015, 2016, 2017).

These have come about due to the European Union's intervention on bycatch of marine mammals in the Union's waters. This has been through the introduction of the EU812/2004 regulation to address the bycatch of cetaceans, this legislation as previously described mainly enforces the mandatory use of 'pingers' in vessels over 12m and the monitoring of marine mammal bycatch in fisheries (MMO 2014). This predominantly has allowed an increased understanding of the interactions between fisheries and marine mammals and mandatory monitoring reports of the Member States to the Commission make for a good reference in gauging the levels of impact a fishery can pose.

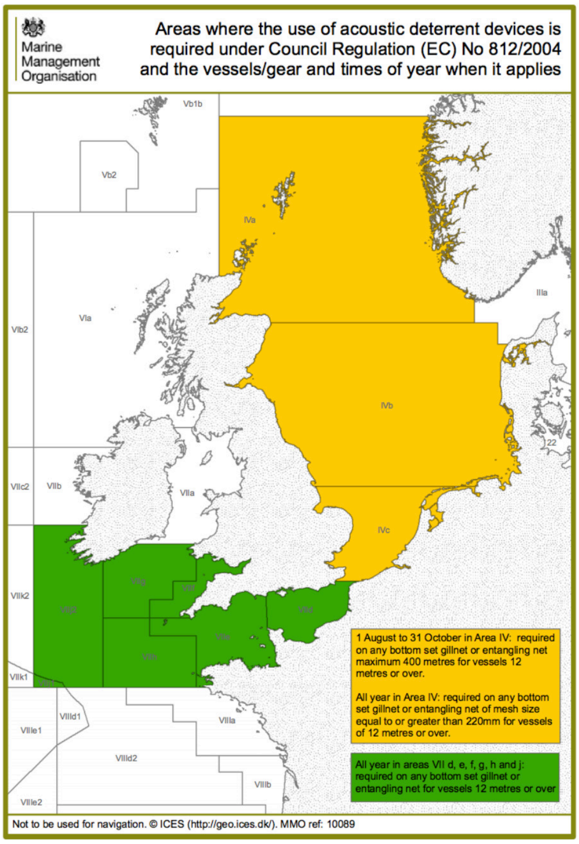

FIGURE 28 AREAS WHERE 'PINGER'; ARE REQUIRED BY LAW IN UK WATERS AND THE VESSELS/GEAR AND TIMES OF YEAR IT APPLIES

In the UK, these reports are carried out by the SMRU on the effects set net and drift net fisheries pose. It is important to note that these reports are based on métiers to aggregate and organise the data, the métiers used are type of fishing gear or ICES division. This allows the SMRU to make estimations of the entire UK fishery fleet, in the meta-analysis for this assessment the métier used is the gear type (entangling/trammel nets). This includes all UK fisheries using entangling/trammel nets to target any kind of commercial species.

The most recent report for the 2016 period suggests that the only marine mammal species recorded more than twice are the Common Porpoise, Common Dolphin and Grey/Common Seal species.

14.1. Common Porpoise

The SMRU reports suggest that UK entangling and trammel net fisheries account for the highest figures of estimated Common Porpoise bycatch. The table below shows how the average bycatch rates have been deduced for the last 5 years of available data (at time of writing).

	2012	2013	2014	2015		2016	
	without pingers	without pingers	without pingers	without pingers	with pingers	without pingers	with pingers
Number of hauls observed (since 2010 for 2013-16 and since 2005 for 2012)	21527	1855	2221	2497	213	2962	237
observed porpoises caught (since 2010)	57	45	52	59	1	65	1
average bycatch rate	0.021	0.0243	0.023	0.0236	0.0047	0.0219	0.0042
estimated bycatch	458	812	730	635	491	651	550
95% LCL	339	598	551	486	363	506	418
95% UCL	605	1076.8	949	814	758	826	785
one sided upper CL 90%		1033.1	913	784	712	797	745

TABLE 25 CATCHES OF COMMON PORPOISE BY UK VESSELS IN ENTANGLING/TRAMMEL METIER OVER 2010-16 (NORTHRIDGE, KINGSTON & THOMAS 2013, 2014, 2015, 2016, 2017)

The SMRU uses these bycatch rates to estimate the total number of individuals bycaught in the given year by using the number of hauls in a trip factor which can be seen in the table below:

Metier	Single Day Trips	Multiday Trips
Hauls per day in Tangle/Trammel Fisheries	4.63	2.57

Table 26 Estimated Hauls per type of trip in UK Entangling/Trammel Net Fisheries in 2016 (Northridge, Kingston & Thomas 2017)

SMRU can use these average rates and hauls per day raising factors to calculate the overall estimates of the Common Porpoise by the UK entangling and trammel nets of the UK. These can be seen in the Fig 27 below where 'pingers' and non pinger nets are considered.

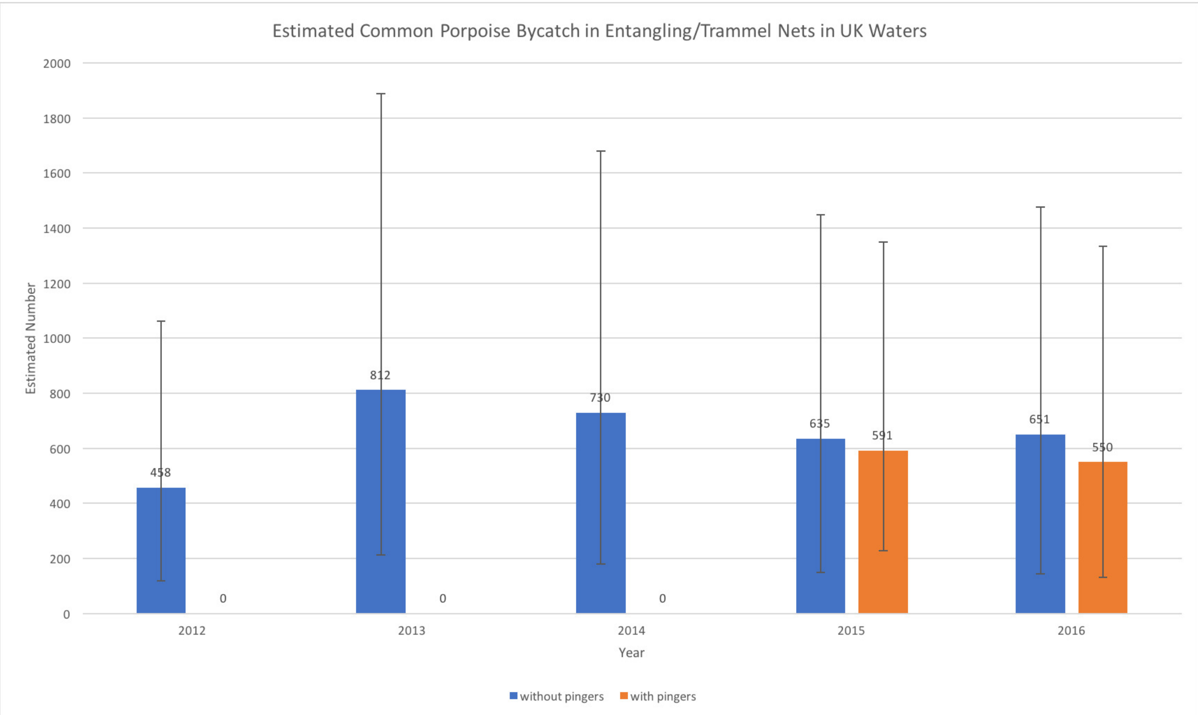

Figure 29 Estimated Common Porpoise Bycatch by UK Entangling/Trammel net fisheries by year with two sided 95% upper and lower confidence limits

The SMRU suggests that in the latest available information, the number of Common Porpoise individuals captured in entangling and trammel nets of the UK fleet are estimated at 651 for nets without pingers and 550 with pingers.

- The most recent population estimate for Common Porpoise in the Celtic / Irish Sea region is 104,695 animals (MACLEOD *et al.* 2009; Hammond *et al.* 2013).
- ASCOBANS set an unacceptable anthropogenic removal of cetaceans at 1.7%, in 2016 if 'pingers' were used by vessels over 12m the removal percentage by entangling/trammel nets of the Common Porpoise would be 0.525%.

14.2. Common Dolphin

The same approach was used by the SMRU for Common Dolphins, whereby smaller numbers were predicted than that of the Common Porpoise by entangling and trammel nets in UK waters.

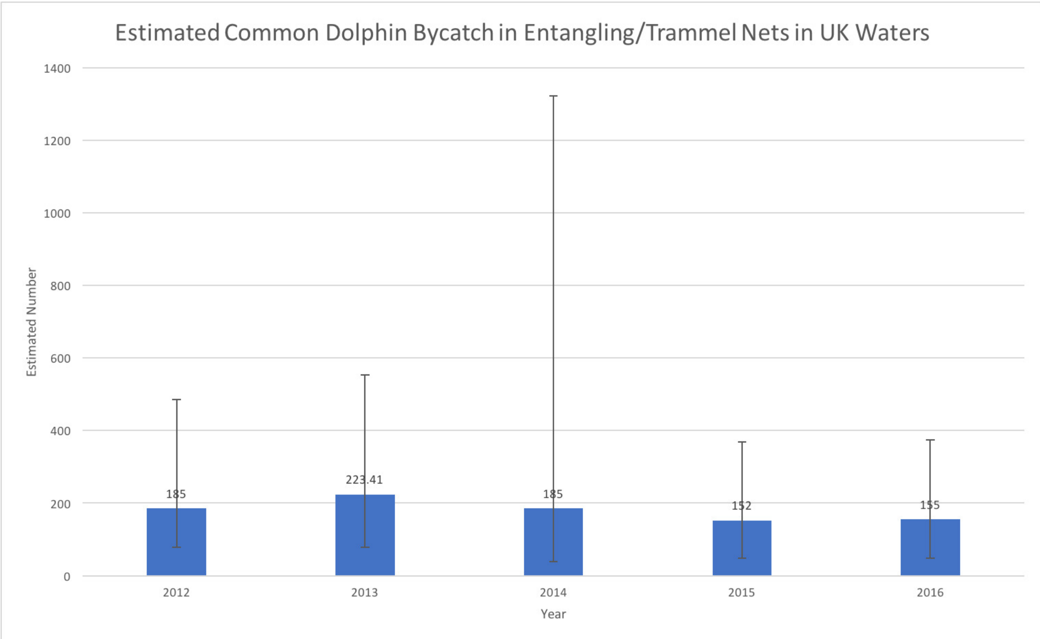

Figure 30 Estimated Common Dolphin Bycatch by UK Entangling/Trammel net fisheries by year with two sided 95% upper and lower confidence limits

The Fig. 28 depicts that over the last 5 years Common Dolphin catch estimates by entangling/trammel nets have been fairly consistent, with the highest prediction of 223 individuals in 2013. More recently this figure has settled at 152 and 155 for 2015 and 2016 respectively. The SMRU derives these estimates as nets without using pingers as there is limited data on Common Dolphin interactions with static net gear attributed with pingers.

- The abundance of common dolphins around the British Isles is estimated to be 51,800 animals (SCANS II 2008; CODA 2009).

- ASCOBANS set an unacceptable anthropogenic removal of cetaceans at 1.7%, in 2016 the removal percentage by entangling/trammel nets of the Common Dolphin would be 0.299%.

14.3. Common/Grey Seal

Again, the same approach was used by the SMRU for Common and Grey Seals, whereby smaller numbers were predicted than that of the Common Porpoise by entangling and trammel nets in UK waters. The SMRU state that the species of seal cannot be easily identified as often an entanglement of a pinniped is often unfortunately a juvenile, grey and common seal pups are almost impossible to distinguish and for this reason the SMRU have assumed that the majority of these interactions are to be collectively concerned as Seals but the majority are considered to be Grey Seals.

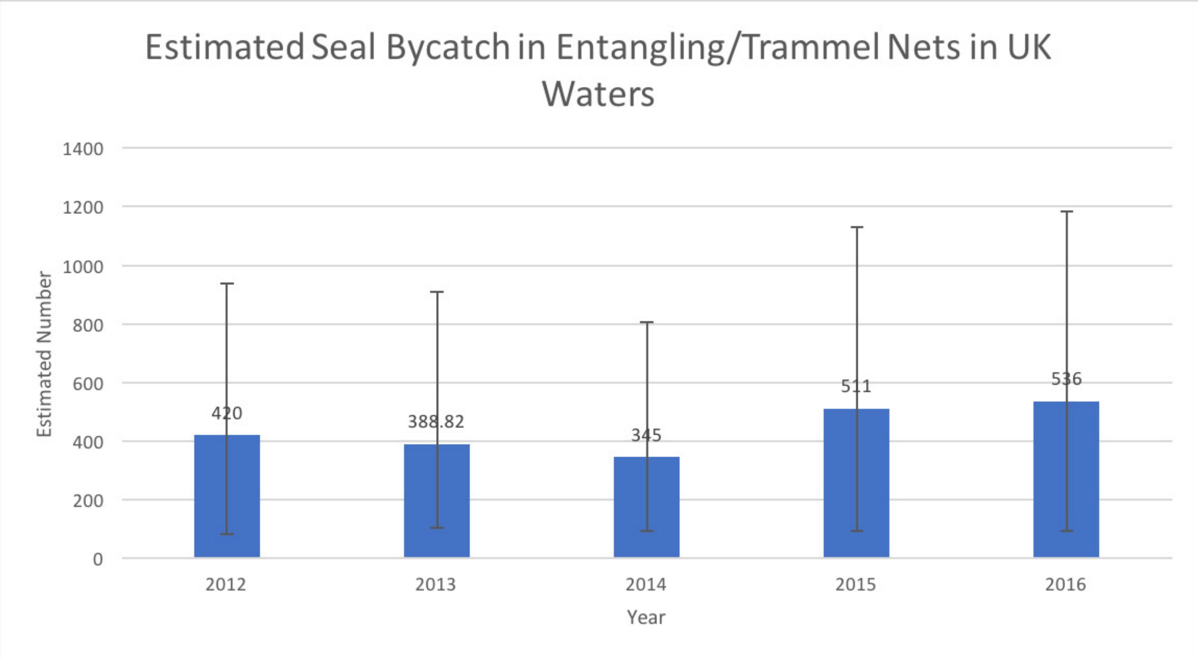

FIGURE 31 ESTIMATED SEAL BYCATCH BY UK ENTANGLING/TRAMMEL NET FISHERIES BY YEAR WITH TWO SIDED 95% UPPER AND LOWER CONFIDENCE LIMITS

The Fig 29 shows that estimations of Seal bycatch by entangling and trammel nets over the last 5 years have shown a general increase. In the last two years show the highest estimates of bycatch of the available surveillance evidence, with the entangling and trammel nets estimated to be responsible for 511 and 536 Seal interactions in 2015 and 2016 respectively.

- Grey seals (*Halichoerus grypus*) are common in many parts of the Celtic Seas ecoregion, with population estimates ranging from approximately 50 000 to 110 000 animals (SCOS 2005).

- ASCOBANS set an unacceptable anthropogenic removal of cetaceans at 1.7%, in 2016 if the lower population figure is used the removal percentage by entangling/trammel nets of the Grey Seal would be 1.072%.

15. Seabirds

As described in the literature review section earlier seabirds are among the most threatened group of birds, with 29% of seabird species being listen as VU, EN or CR in the IUCN Red List (Žydelis, Small & French 2013). Seabird interactions with the fishery is considered to be low but there is data and evidence of direct interaction through the Cefas Observer data and metadata from the Annual SMRU reports.

The Cefas Observer data discloses that beam trawl hauls by the fishery has incidentally captured the seabird Northern Gannet.

	2010	2011	2012	2013	2014	2015	2016
Northern Gannet	0	0	0	4	0	0	0

TABLE 27 NUMBERS OF NORTHERN GANNET OBSERVED IN BEAM TRAWLS OF THE FISHERY

	Beam Trawl	Demersal Trawl	Nets
Number of Hauls/Nets Sampled	3701	175	220
Number of Northern Gannet Observed	4	0	0
Overall Catch Rate	0.001080789	0	0

TABLE 28 TOTAL NUMBERS & OVERALL CATCH RATES OF NORTHERN GANNETL OBSERVED FROM 2010-2016 ACROSS GEAR TYPES

These individuals were captured in four separate hauls in 2013 with three in the third quarter of the year and one in the final quarter of the year, and although this an incredibly small interaction rate it does provide quantitative evidence for the potential fishery to interact with species in the future.

As mentioned, the SMRU are responsible for submitting reports to the European Commission on the monitoring of marine mammals for the 812/2004 directive also monitor UK fisheries for Seabird bycatch during the observer trips and non-dedicated sampling sources. The data is analysed in a similar procedure to that of the marine mammals and the whole UK set net fishery is stratified by métier (gear type).

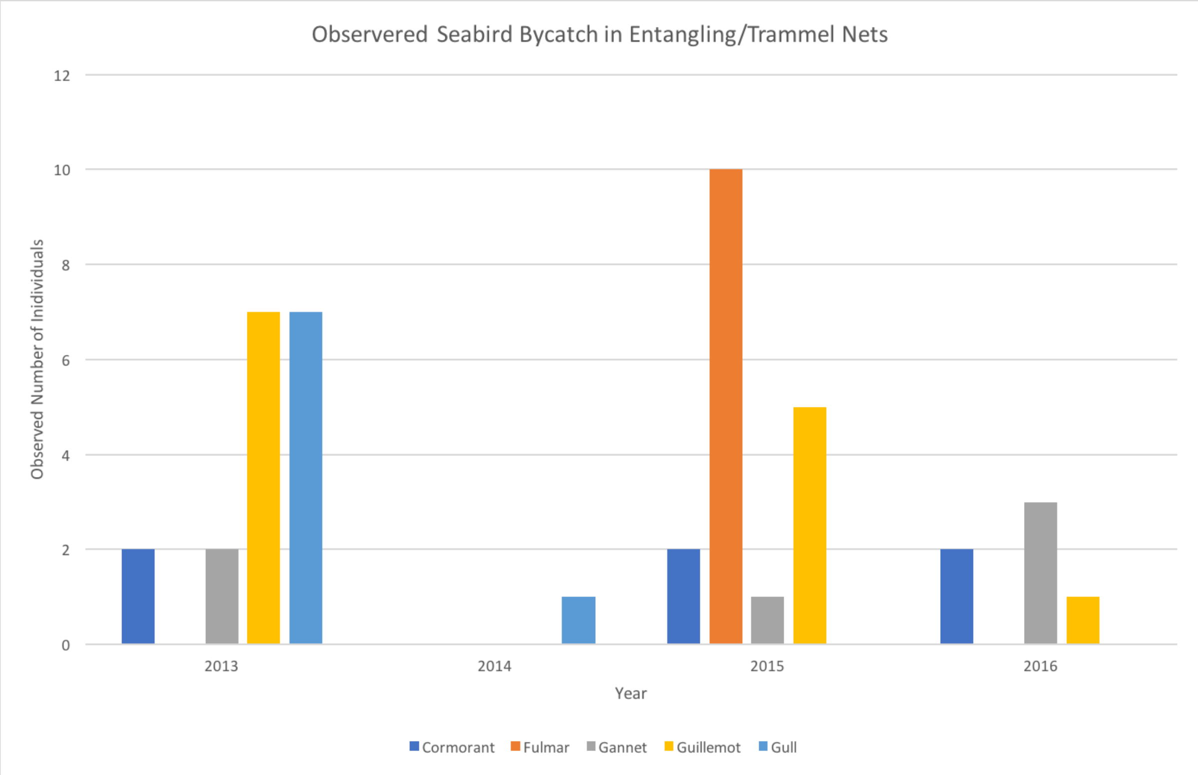

FIGURE 32 OBSERVED SEABIRD BYCATCH BY UK ENTANGLING/TRAMMEL NETS BY YEAR

The Fig 30 above shows the collated data from the last five reports from the SMRU to the EC, the graph shows that in the entangling and trammel nets have captured seabirds in small numbers across the UK waters. Observed individual catches of a species did not exceed 10 per year throughout the time period and the most regularly captured species are the Northern Gannet, Guillemot and Cormorant, with a spike of Northern Fulmars being observed in the year 2015.

15.1. Northern Gannet

The Northern Gannet is listed in Annex I of the EU Birds Directive and is widely distributed throughout English seas in the winter, and most of the breeding colonies are located in Scotland with a single colony in England at the Bempton Cliffs in Yorkshire (BirdLife International 2016).

The Gannet is migratory and have a large spatial range, adult birds wintering offshore in UK waters and sometimes as far as the Bay of Biscay, Iberia and the Mediterranean Seas (Lloyd, Tasker &

Partridge 2010). To breed Gannets nest on steep cliffs as colonies and on the ground at offshore islands. These often have large densities of the seabird and females only lay a single egg.

Foraging behaviour of Gannets is varied, their diet consists of prey including fish and squid and can feed by plunge-diving into the sea from great heights of between 10 and 40m, and exhibit this type of behaviour whether solitarily or in a group. They also swim with their heads immersed in the water and dive for food from the surfaces waters, the maximum foraging depth recorded is 34m and the average dive depth is around 8.8m (Natural England 2012). Gannets also are also effective scavengers and have become accustomed to targeting discards from fishing vessels and the Landings Obligation under the Common Fisheries Policy reform is likely to have long-term effects on the species.

16. Susceptibility Assessment

As the previous sections considered the available quantitative data regarding the fishery's contact with potential ETP Species, it is practical to assess the sensitivity of the ETP Species towards the activity of the fishery to support the empirical observer data from Cefas.

For this analysis, the framework of the SEAFISH ecological risk assessment for the effects of fishing has been adopted (SEAFISH). This framework outlines the necessary methods for assessing the risk imposes on the certain components of the fishery. The Endangered, Threatened and Protected Species component of the fisheries is regarded as high risk and therefore an analysis of the productivity and susceptibility is strongly advised for the basis of the assessment. Consequently, these members can be subjected to the Productivity and Susceptibility Analysis (PSA) procedure formulated and devised by Milton, Stobutzki and Hobday to illuminate the amount of ecological risk (Stobutzki, Miller & Brewer 2001; Milton 2001; Hobday *et al.* 2007).

The analysis process considers and scores the productivity of the components of the fishery's life history parameters among other attributes and the component's susceptibility towards the known effects of fishing activity.

- The Productivity is thought to represent the capacity of the population of a species to recover after fishing pressure.
- The Susceptibility is thought to represent the vulnerability of a particular species towards a specific type of fishing gear.

The premise of the PSA is to form an indicative measure from the two attributes described above that can inform the capacity to sustain fishing pressure (Stobutzki, Miller & Brewer 2001). When these two variables are plotted on a graph with productivity ratings ranging from high to low the overall risk towards a particular species is signified by what is known as the Euclidean distance from the origin, which can be obtained using the Pythagoras theorem.

16.1. Productivity

There are seven different intrinsic parameters that are required for assessing the productivity of species as recommended in Hobday et al. PSA (Hobday *et al.* 2011). These are explicitly outlined in the table below.

Attribute	High Productivity Signaled By	Low Productivity	Medium Productivity	High Productivity
Average Max Length	Small Size	>300 cm	100-300 cm	<100 cm
Average Max Age	Low Age	>25 Years	10-25 Years	<10 Years
Average Size at Maturity	Small Size	>200 cm	40-200 cm	<40 cm
Average Age at Maturity	Low Age	>15 Years	5-15 Years	<5 Years
Reproductive Strategy	Broadcast Spawner	Live Bearer (inc. birds)	Demersal Egg Layer	Broadcast Spawner
Fecundity	High Fecundity	<100 Eggs Per Year	100-20,000 Eggs Per Year	>20,000 Eggs Per Year
Trophic Level	Low Trophic Level	>3.25	2.75-3.25	<2.75

Table 29 Life History Attributes for Productivity Assessment and Cut off Scores for Risk Levels.

The table shows how these attributes are scored in a three-tiered system of Low, Medium and High productivity and the intervals/bands in which these attributes relate to a Low, Medium or High score. The parameters (life-history traits) that help score these attributes have been obtained from a number of sources including the online database FishBase and other academic and scientific sources.

16.2. Susceptibility

The ERAEF framework suggests that susceptibility can be appropriately assessed using a myriad of attributes (Stobutzki, Miller & Brewer 2001). However in for the basis of the assessment of this fishery four attributes have been selected to derive the potential susceptibility of species towards the fishing activity, these four are summarised below.

- Availability
- Encounterability
- Selectivity
- Post Capture Survivability

16.2.1. Availability

Availability of a species can be scored in terms of the potential size of area the species occupies, for instance if the species is globally distributed the risk would be classed as low, if the species is widely distributed beyond the confines of the fishery the risk would be classed as medium and if the species' distribution is somewhat strictly confined to the constraints of the assessment area the risk would be classified as high.

Hobday et al. suggests that when species distribution maps are available these can be used to indicate the level of availability attribute. In this scenario, the risk level will be classified by the amount of spatial overlap with the fishery assessment area. For this particular assessment, spatial knowledge has been assimilated in this report in GIS of both ETP Species sightings and the spatial density of the fishing effort from the VMS data. The spatial overlap risk level classifications that are recommended by Hobday are stipulated below.

Availability	Low	Medium	High
Spatial Overlap	<10%	10-30%	>30%

TABLE 30 SPATIAL OVERLAP RISK SCORING LEVELS FOR THE AVAILABILITY ATTRIBUTE

16.2.2. Encounterability

The encounterability attribute refers to the likelihood of the fishing gear coming into contact with a particular species. Hobday et al. recommends using information obtained from scientific sources regarding knowledge of the species' depth and habitat preferences to inform an estimation of the chances of the fishing gear interacting with the species. The classification for these parameters are now specified below.

Encounterability	Low	Medium	High
Habitat	Small Overlap with Fishing Gear	Moderate Overlap with Fishing Gear	Large Overlap with Fishing Gear
Depth	Small Overlap with Fishing Gear	Moderate Overlap with Fishing Gear	Large Overlap with Fishing Gear

TABLE 31 HABITAT OVERLAP AND WATER COLUMN OVERLAP RISK SCORING LEVELS FOR THE ENCOUNTERABILITY ATTRIBUTE

Again, in this scenario it is advised that knowledge of habitat preference should be used as more accurate parameter for deducing the encounterability component. Therefore, overlay analysis of the habitats map, VMS map and knowledge inferred regarding the ecology of the species was used to indicate the level of overall overlap for the encounterability score.

16.2.3. Selectivity/Catchability

This attribute regards to the likelihood of the species being captured once being encountered by the fishing gear, in which Hobday et al. recommend that the length of species should be considered as assessing this particular assessment. In this assessment, these recommendations have enforced with the average size of the species at maturity being used as the principle method for indicating the level of risk for this attribute. Furthermore, the information gathered from the analysis of the Cefas observer data in the previous section will be used to supplement the classification process appropriately, the risk level classifications are detailed in the table below.

Catchability	Low	Medium	High
Average Size at Maturity	Species < mesh size, or >5 m in length	Species 1–2 times mesh size, 4–5 m in length	Species >2 times mesh size, to say, 4 m in length

Catch Data	Evidence of Small/Infrequent Catch Rates of Species	Evidence of Capture of Species	Evidence of High/Regular Catch Rates of Species

TABLE 32 RISK SCORING LEVELS FOR THE CATCHABILITY ATTRIBUTE

16.2.4. Post Capture Mortality

The post capture mortality attribute for the susceptibility analysis refers to the probability of a particular species surviving the fishing process. With the premise being that if there is reliably informed knowledge of the species surviving the capture and discarding process it may be justifiable to give the species a low risk score. The rationale for the classification of this attribute is explained in the table below.

Post Capture Mortality	**Low**	**Medium**	**High**
Survivability	Available Evidence of Species Surviving Post Capture	Evidence of Species Released Alive	Species Primarily Released Dead

TABLE 33 RISK SCORING LEVELS FOR THE POST CAPTURE SURVIVABILITY ATTRIBUTE

Post capture mortality information is dependent on the species and the availability of scientific studies. With regards to marine mammals and seabirds post capture mortality in the assessment is scored as low due to the widespread acknowledgement that most incidences for these species almost universally result in death. The three ETP fish species have been classed as high survivability due to their high chances of escaping due to their average and max sizes and general morphology.

Some species of elasmobranchs on the other hand have been subject to studies of the post-capture survivability towards demersal fishing gear. The Fisheries Science Partnership have completed a study surrounding the survival of the Spurdog, Porbeagle Shark and Common Skate, concluding that the Common Skate and the Spurdog showed high survivability whilst the Porgbeagle showed a higher vulnerability with a much lower survivability rate towards set net fishing gear (Bendall *et al.* 2012).

Species	Evidence of Post Capture Mortality	Deduced Survivability
Spurdog	73% of individuals (n = 389) survived survived bycatch by set net gear in Cornish Waters (Bendall *et al.* 2012).	High Survivability
Common Skate	92% of individuals (n = 1206) survived bycatch by set net gear in Cornish Waters (Bendall *et al.* 2012).	High Survivability
Porbeagle Shark	20% of individuals (n = 20) survived bycatch by set net gear in Cornish Waters (Bendall *et al.* 2012).	Low Survivability
Undulate Ray	72% Rajidae Survived (n = 249) survived beam trawl bycatch in the NE Atlantic after 65-80h (Depestele 2014).	High Survivability
Tope Shark	72.7% at vessel mortality (n = 1361) when captured as bycatch by set nets in Australian Waters. (Braccini, Van Rijn & Frick 2012).	Low Survivability
Angel Shark	34.4% *Squatina australis* at vessel morality (n = 651) when captured as bycath by tangle nets in Australian waters (Reid & Krogh 1992).	Medium Survivability
Basking Shark	Low survivability due to its low rate of escape.	Low Survivability
White Skate	72% Rajidae Survived (n = 249) survived beam trawl bycatch in the NE Atlantic after 65-80h (Depestele *et al.* 2014).	High Survivability

TABLE 34 ELASMOBRANCH SURVIVABILITY STUDIES FOR POST CAPTURE SURVIVABILITY SCORING

17. Productivity Scoring

Species Name	Average Max Length	Average Max Age	Average Size at Maturity	Average Age at Maturity	Strategy	Fecundity	Trophic Level	References	Arithmetic mean
Mammals									
Common Porpoise	2m	20	1.38m	4.35	Live Bearer	1 Pup/2 years	4.1	(Learmonth *et al.* 2014)	2.285714286
Common Dolphin	2.5m	28 males/30 females	1.95-2.33m males/ 1.88m females	11.9 male/8.2 females	Live Bearer	1 Pup/2 years	4.2	(Murphy, Eunice & Jepson 2013)	2.714285714
Common Seal	1.83m	31 males/36 females	1.3m	5-6 males/2-5 females	Live Bearer	1 Pup/2 years	4.8	(SMRU 2004)	2.428571429
Grey Seal	3.05m	25 males/35 females	2.20m	10 males/4-7 females	Live Bearer	1 Pup/2 years	4.9	(Bowen 2016)	2.857142857
Elasmobranchs									
Common Skate	2.85m	50-100	1.975m males/1.855m females	11	Demersal Egg Layer	40 eggshells/year	3.5	(Dulvy *et al.* 2006; Neal & Pizzolla 2006; LUNA 2009)	2.428571429

Porbeagle Shark	3.5m	30	1.75m	8-11	Live Bearer	4 Pup/1 year	4.5	(Stevens *et al.* 2006)	2.571428571
Spurdog	1.6m	75	0.814m	35.5	Live Bearer	1-21/Litter	4.4	(Fordham *et al.* 2016)	2.571428571
Basking Shark	7m	50	0.5-0.98m	12 males/16 females	Live Bearer	1 Pup/1-3.5 years	3.2	(Fowler 2005)	2.857142857
Angel Shark	1.524	25-35	1.56m	8 males/12 females	Live Bearer	8-25 Pups/Litter	4.1	(Ferretti *et al.* 2015)	2.714285714
White Skate	2.3m	50	2.3m	16.26 males/23.47 females	Demersal Egg Layer	Large Cases of Eggs/18 Months	3.1	(Dulvy 2006)	2.571428571
Tope Shark	1.93	55	1.45m	8 males/11 females	Live Bearer	6-52 Pups/year	4.3	(Walker *et al.* 2006)	2.571428571
Undulate Ray	1m	20	0.8m	7.5 males / 9 females	Demersal Egg Layer	88 eggshells/year	3.5	(Coelho *et al.* 2009)	2.285714286
Fin Fish									
Twaite Shad	0.6m	25	0.325m	2-5 males/3-7 females	Broadcast Spawner	50,000-200,000	4	(Freyhof & Kottelat 2008a)	1.571428571

Allis Shad	0.69m	10	0.481m	3-7 years	Broadcast Spawner	250,000-350,000	3	(Freyhof & Kottelat 2008b)	1.428571429
European Eel	1.22m	88	0.45m	Can spawn at 7 years.	Broadcast Spawner	2,000,000,000-3,000,000	3.6	(Jacoby & Gollock 2014)	2
Seabirds									
Gannet	1.75-1.79m	37.4	1.6m	4males/3females	Oviparous	1 Egg/1 year	3.7	(BirdLife International 2016)	2.571428571

TABLE 35 PRODUCTIVITY ATTRIBUTES SCORES FOR ETP SPECIES

Beam Trawl Susceptibility					
Species Name	Post Capture Survivability	Water Column/Ecological Occupancy	Catchability	Spatial Occupancy	Geometric Mean
Mammals					
Common Porpoise	Low	Demersal when forage on the seabed. / Often sighted in shallower coastal waters.	Medium	Medium	2.449489743
Common Dolphin	Low	Pelagic / Often sighted in shallower coastal waters.	Low	High	2.059767144
Common Seal	Low	Demersal when forage on the seabed. / Often sighted in shallower coastal waters.	Medium	Medium	2.449489743
Grey Seal	Low	Demersal when forage on the seabed. / Often sighted in shallower coastal waters.	Low	Medium	2.059767144
Elasmobranchs					
Common Skate	High	Demersal / Inhabits circalittoral and Infralittoral biozones in the demersal part of the water column, prefers sandy and muddy substrates.	High	Medium	2.059767144
Porbeagle Shark	Low	Pelagic-Oceanic	Low	High	2.059767144
Spurdog	High	Benthopelagic	Medium	Medium	1.681792831

Basking Shark	Low	Pelagic-Oceanic	Low	High	2.059767144
Angel Shark	Medium	Demersal / Often buried in benthos in sandy and muddy substrates.	Low	High	2.059767144
White Skate	High	Demersal / Sandy or Rocky substrates.	Low	Low	1.316074013
Tope Shark	Low	Demersal/ Continental Shelves with Sandy Muddy Bottoms	Low	Medium	2.059767144
Undulate Ray	High	Demersal/ Continental Shelves with Sandy Bottoms.	High	Low	1.732050808
Fin Fish					
Twaite Shad	Medium	Pelagic / Often present at coastal waters near mouths of rivers.	Low	Low	1.414213562
Allis Shad	Medium	Pelagic / Often present at coastal waters near mouths of rivers.	Low	Low	1.414213562
European Eel	High	Demersal / Little Known of Marine Life Phase	Medium	Low	1.56508458
Seabirds					
Gannet	Low	Upper Waters/ Demersal When foraging in Coastal Areas /	Medium	High	2.449489743

TABLE 36 ETP SPECIES SUSCEPTIBILITY ATTRIBUTE SCORE TO BEAM TRAWL

Demersal Trawl Susceptibility					
Species Name	Post Capture Survivability	Water Column/Ecological Occupancy	Catchability	Spatial Occupancy	Geometric Mean
Mammals					
Common Porpoise	Low	Demersal when forage on the seabed. / Often sighted in shallower coastal waters.	Low	Medium	2.059767144
Common Dolphin	Low	Pelagic / Often sighted in shallower coastal waters.	Low	High	2.059767144
Common Seal	Low	Demersal when forage on the seabed. / Often sighted in shallower coastal waters.	Low	Medium	2.059767144
Grey Seal	Low	Demersal when forage on the seabed. / Often sighted in shallower coastal waters.	Low	Medium	2.059767144
Elasmobranchs					
Common Skate	High	Demersal / Inhabits circalittoral and Infralittoral biozones in the demersal part of the water column, prefers sandy and muddy substrates.	High	Medium	2.059767144
Porbeagle Shark	Low	Pelagic-Oceanic	Low	Medium	1.861209718
Spurdog	High	Benthopelagic	Low	Medium	1.414213562

Basking Shark	Low	Pelagic-Oceanic	Low	High	2.059767144
Angel Shark	Medium	Demersal / Often buried in benthos in sandy and muddy substrates.	Low	High	2.059767144
White Skate	High	Demersal / Sandy or Rocky substrates.	Low	Low	1.316074013
Tope Shark	Low	Demersal/ Continental Shelves with Sandy Muddy Bottoms	Low	Medium	2.059767144
Undulate Ray	High	Demersal/ Continental Shelves with Sandy Bottoms.	High	Low	1.732050808
Fin Fish					
Twaite Shad	Medium	Pelagic / Often present at coastal waters near mouths of rivers.	Low	Low	1.414213562
Allis Shad	Medium	Pelagic / Often present at coastal waters near mouths of rivers.	Low	Low	1.414213562
European Eel	High	Demersal / Little None of Marine Life Phase	Low	Low	1.316074013
Seabirds					
Gannet	Low	Upper Waters/ Demersal When foraging in Coastal Areas	Low	High	2.059767144

Table 37 ETP Species Susceptibility Attribute Score to Demersal Trawl

Entangling/Trammel Nets Susceptibility					
Species Name	Post Capture Survivability	Water Column/Ecological Occupancy	Catchability	Spatial Occupancy	Geometric Mean
Mammals					
Common Porpoise	Low	Demersal when forage on the seabed. / Often sighted in shallower coastal waters.	High	High	3
Common Dolphin	Low	Pelagic / Often sighted in shallower coastal waters.	Medium	High	2.449489743
Common Seal	Low	Demersal when forage on the seabed. / Often sighted in shallower coastal waters.	High	Medium	2.710806011
Grey Seal	Low	Demersal when forage on the seabed. / Often sighted in shallower coastal waters.	High	Medium	2.710806011
Elasmobranchs					
Common Skate	High	Demersal / Inhabits circalittoral and Infralittoral biozones in the demersal part of the water column, prefers sandy and muddy substrates.	Medium	High	2.059767144
Porbeagle Shark	Low	Pelagic-Oceanic	Medium	High	2.449489743
Spurdog	High	Benthopelagic	Medium	High	1.861209718

Basking Shark	Low	Pelagic-Oceanic	Mediu m	High	2.44948 9743
Angel Shark	Medium	Demersal / Often buried in benthos in sandy and muddy substrates.	Low	High	2.05976 7144
White Skate	High	Demersal / Sandy or Rocky substrates.	Low	Low	1.31607 4013
Tope Shark	Low	Demersal/ Continental Shelves with Sandy Muddy Bottoms	Mediu m	High	2.71080 6011
Undulate Ray	High	Demersal/ Continental Shelves with Sandy Bottoms.	Low	Medium	1.56508 458
Fin Fish					
Twaite Shad	Medium	Pelagic / Often present at coastal waters near mouths of rivers.	Low	Low	1.41421 3562
Allis Shad	Medium	Pelagic / Often present at coastal waters near mouths of rivers.	Low	Low	1.41421 3562
European Eel	High	Demersal / Little None of Marine Life Phase	Low	Low	1.31607 4013
Seabirds					
Gannet	Low	Upper Waters/ Demersal When foraging in Coastal Areas /	Mediu m	High	2.44948 9743

TABLE 38 ETP SPECIES SUSCEPTIBILITY ATTRIBUTE SCORE TO ENTANGLING/TRAMMEL NETS

18. PSA Risk Assessment Results

Once scored the overall productivity and susceptibility were calculated, for this the average was taken for the scores for each sub attribute for each species for all three of the gear types in the fishery. It was recommended by Smith that the arithmetic mean should be calculated for the productivity attribute and the geometric mean should be calculated for the susceptibility attribute (Smith *et al.* 2007). These were then plotted on a graph with productivity risk (high to low productivity) on the x axis and susceptibility risk on the y axis, these can be used to estimate Euclidean distance using the Pythagoras theorem to formulate the overall risk score. The plots can be seen below:

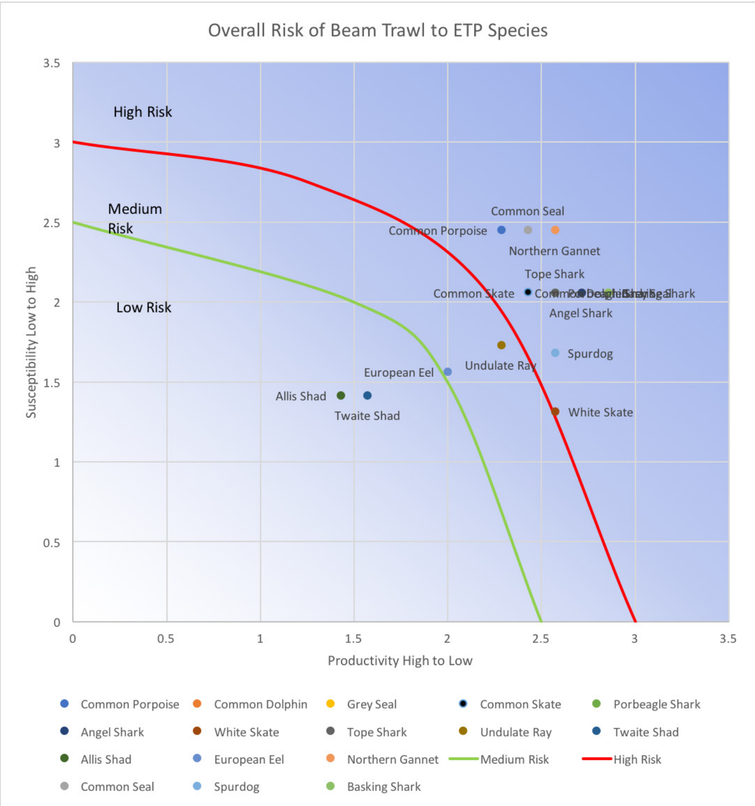

Figure 33 Overall Risk of Beam Trawl to ETP Species

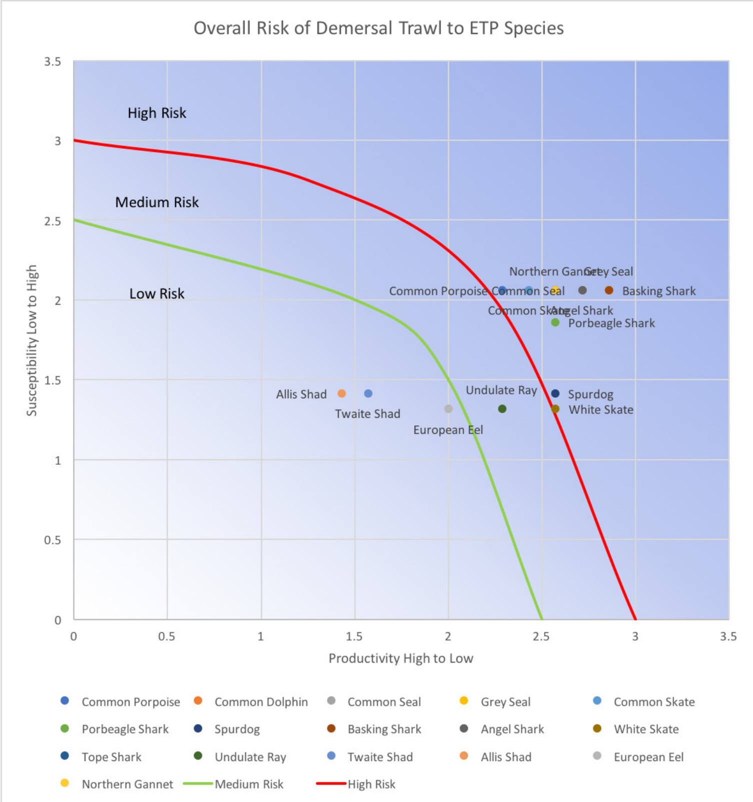

FIGURE 34 OVERALL RISK OF DEMERSAL TRAWL TO ETP SPECIES

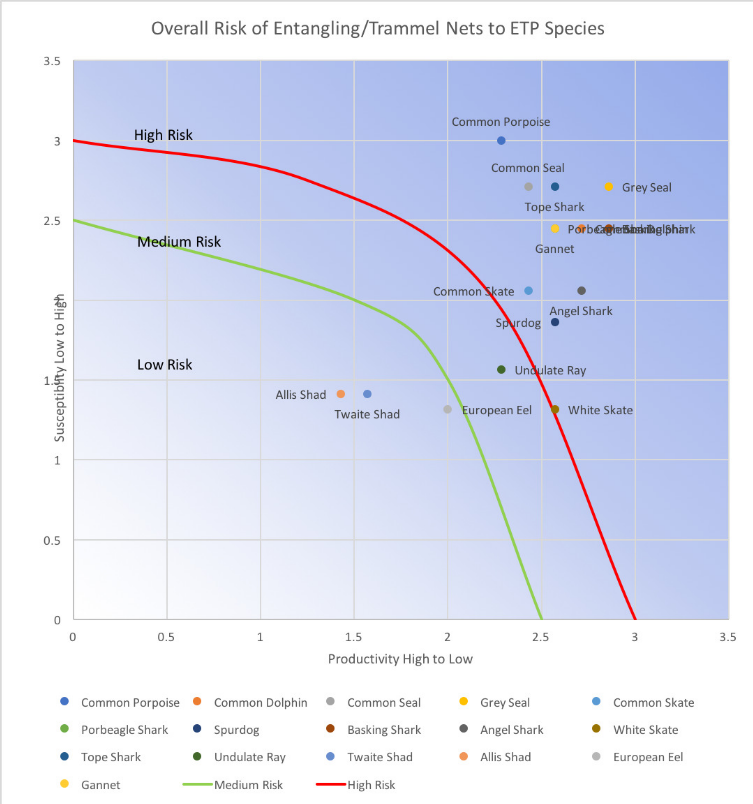

FIGURE 35 OVERALL RISK OF ENTANGLING/TRAMMEL NETS TO ETP SPECIES

	Beam	Demersal	Nets
Common Porpoise	3.350296971	3.076870242	3.771536795
Common Dolphin	3.407343192	3.407343191	3.656138255
Common Seal	3.449341848	3.184430855	3.639564316
Grey Seal	3.522201867	3.522201867	3.938493942
Common Skate	3.184430855	3.184430855	3.184430855
Porbeagle Shark	3.294675338	3.174326151	3.551372256
Spurdog	3.07256766	2.934662655	3.174326151
Basking Shark	3.522201867	3.522201867	3.763411392
Angel Shark	3.407343192	3.407343191	3.407343192
White Skate	2.88864946	2.88864946	2.88864946
Tope Shark	3.294675338	3.294675338	3.736403903
Undulate Ray	2.867837129	2.867837129	2.770194856
Twaite Shad	2.114092655	2.114092655	2.114092655
Allis Shad	2.010178183	2.010178183	2.010178183
European Eel	2.539584561	2.394170171	2.394170171
Gannet	3.551372256	3.294675338	3.551372256

Table 39 Final PSA Risk Scores

Low: >2.5 Medium: 2.5 – 3 High: =>3

18.1. Summary of Results

The PSA and risk analysis indicates the species that are most at risk from fishing pressure, including their recoverability from removal through fishing. The results show the risk for the ETP Species against the pressure for each of the three different gear types of the fishery.

First of all, the marine mammal species represent a high risk across all 3 of the gear types due to their extremely low productivity and high level of spatial and ecological overlap with the fishery. Despite this catchability evidence for the trawling gear types shows that catch rates in these gear is much lower than that of bottom set net gear types.

The marine mammal species score the highest risk scores for the entangling/trammel nets gear type. This is due to the evidence from the SMRU annual reports that entangling/trammel nets in UK regular catch a considerable number of cetaceans and pinnipeds every year. Whilst this surveillance might not be directly attributable to the fishery, it provides a strong basis that the gear type does pose a real threat to these species. Despite this worst-case scenarios estimates suggest that these figures are still below ASCOBANS anthropogenic population removal limits.

The Common Skate scored high risk levels across all three gear types, predominantly due to the high ecological and spatial overlap with the fishery and the high catch rates of the species in both the trawl and set net gears. Despite this, there is sufficient evidence that suggests that Common Skate demonstrates a resilience to fishing pressure due to its high survivability.

Porbeagle Shark also scored a high risk in both the beam and demersal trawl, this is due to the species' low survival rate. The Cefas observer data showed that the Porbeagle Shark was only recorded in Entangling/Trammel set nets of the fishery, therefore increasing the risk score of the species in this gear type.

The Tope Shark scored similarly, although scoring higher risk scores for the demersal trawl and the entangling/trammel nets fishing gear. The species is most at risk from the static net fishing gear of the fishery where catchability is highest amongst the different types.

Basking Shark represents a high risk to all the gear types as it has the longest generation time of all the ETP Species in the study with very slow productivity. The species is most at risk from the entangling/trammel nets, due to being scored higher on the catchability attribute where a single observed individual was recorded in the Cefas Observer Programme.

The Spurdog scored high risk levels for the beam trawl and the entangling/trammel nets of the fishery due to their vulnerability to capture by these gear types is high. The species scored a lower risk with the demersal trawl gear where incidental capture of the elasmobranch was much lower than that of the other gear types of the fishery. However, studies on the post capture mortality of the species suggest that there is strong evidence that the species will survive the fishing methods used by the fishery.

Both the White Skate and Undulate Ray exhibit the lowest risk levels for elasmobranch species in the study. Risk to White Skate is low, mainly because the stock of the species in UK waters has already been decimated resulting in availability of the species being fairly low. There were no records of the White Skate being captured in any of the gear types in the Cefas observer data.

The Undulate Ray also shows a similar level of risk, with higher risk scores for the beam and demersal trawl due to the higher catch rates seen in these gear types. Risk for the ray by entangling/trammel nets is slightly lower, catches by this gear are lower than that of the trawling gear of the fishery but despite this the spatial overlap of the nets is higher. Overall risk levels are lower than other ETP elasmobranchs due to the evidence that Rajidae species have displayed a high rate of survivability in studies with similar gear types of the fishery.

The Allis and Twaite Shad fish score the lowest risk level out of all the ETP species of the study, evidence of catch of the species is rare with only 1 individual of the Twaite Shad being recorded in the observer data by the beam trawl. Alongside low catchability the species maximum length is smaller than the average mesh sizes used in all the gear types. The Shad is migratory and anadromous travelling to estuaries and rivers for spawning, meaning that the species is not highly available.

The European Eel scored similar low risk scores to that of the Shad species, although scored slightly higher due to its lower productivity. Catchability of the species in the fishery is low, with the highest risk score being the beam trawl; the only gear in which the species was recorded in the Cefas observer data with low catch rates. Spatial overlap with the fishery is low, however the species often occupies habitats where activity of the fishery occurs.

The Northern Gannet, scores high risk level across all gear types of the fishery due to its low productivity attributes and almost certain mortality in a capture scenario, but the beam trawl and entangling/trammel nets show the highest risk scores. Available direct evidence of capture is present in the beam trawl through the Cefas observer data where 4 individuals were recorded in 2013. Indirect evidence through the SMRU annual reports on cetacean bycatch also revealed bycatch of the Gannet in entangling/trammel nets. Spatial overlap of the species is high with all gear types and although encounterability is generally low, the species can come into contact with the gear in shallower coastal waters.

19. Limitations

There are a number of features that render some limitations of this study, the key restrictions are the nature and availability of data for the basis of this assessment.

The biggest limitation are the constraints of the Cefas data, mainly the restriction lies on the lack of knowledge surrounding the proportion that the observer data covers of the overall fleet activity of the fishery. If the number of total trips were known and the percentage of trips covered by the observers and an estimation could be made of the fishery's impact at the fleet level could be made.

Secondly the Cefas observer data does not show uniform sampling across all of the gear types, where a higher number of sampled trips for the beam trawl gear and much lower numbers of trips observed with demersal trawl and entangling/trammel net gears. Whilst a higher sampling rate was achieved in the demersal trawl and entangling/trammel nets the number of trips observed and total numbers of hauls fished were much lower than that of the beam trawl gear.

There is limited direct surveillance data regarding the fishery and marine mammals, meaning that inferences and assumptions have to be made to estimate the fishery's impact on cetaceans and pinnipeds.

The precarious and qualitative approach to the productivity and susceptibility risk assessment means that it can be a very pragmatic method to assess the fishery. In this case any ill judgement in scoring the sub attributes of the productivity and susceptibility can result in a heavy or over estimation of the risk level. Nevertheless, when good quality data such as the Cefas observer, and spatial data such as the VMS and EMOD-Net Biological sightings data a good basis can be made for the scoring process.

20. Summary, Future Recommendations and Conclusion

To summarise the Monkfish poses a risk to a number of ETP Species particularly some species of elasmobranchs and marine mammals.

20.1. Elasmobranchs

- Common Skate catch rates are high across all gear types, yet there is good evidence that the species has a high rate of survival once captured. Which may relieve the recoverability of the species from fishing pressure.
- Undulate Ray catch rates are also high in both the trawling gears of the fishery, catch rates are lower with the entangling/trammel nets gear. There is also available evidence that species shows a strong resistance to mortality from fishing pressure and post capture survivability may also keep the threat to the species low.

- The Tope Shark which is vulnerable due to its poor post capture survivability rate is at high risk from the entangling/trammel nets of the fishery with a high overall total catch rate for the 2010-2016 period.
- Porbeagle Shark studies on survivability reveal that the species suffers from a high mortality rate when incidental capture occurs. Whilst the species was only observed in the static gear of the entangling/trammel nets of the fishery in small numbers and has not been recorded since 2013.
- Spurdog catch rates were more pronounced in the beam trawl and entangling/trammel nets of the fishery with only a handful of observations of the elasmobranch in the demersal trawl. Although studies suggest the species is resilient to fishing pressure with a high post capture survivability.
- A single Basking Shark interaction was recorded with the entangling/trammel nets of the fishery, highlighting a low risk of capture but underlining the potential risk of the gear with the species due to its high mortality rate.
- Survivability of the bycaught species of elasmobranch should be further studied to ensure that recoverability of the species are not impaired.

20.2. Marine Mammals

- Common Porpoise, Common Dolphin and Grey & Common Seals all have the potential to interact frequently with the fishery.
- Indirect evidence from the SMRU 812/2004 suggests that the catch rate of these species could be high in the Common Porpoise and Seal species.
- Despite this worst-case scenario assumptions imply that these interactions are lower than the ASCOBANS anthropogenic removal limit of 1.7% of the population. Although this come into question if UoC's of near vicinity fisheries combine to breach this threshold.

20.3. Seabirds

- Northern Gannet is the only species of seabird directly recorded as bycatch in the fishery, with 4 individuals captured by the beam trawl in 2013 with a low catch rate.
- Indirect evidence curated in the annual SMRU 812/2004 reports also provide evidence that the entangling/trammel nets of the UK catch a variety of seabird species.

20.4. Future Recommendations

There are a number of insights for the future of the fishery and its interactivity with ETP species from this report.

- Gain knowledge of the total number of fishing trips of the fishery to assist in standardizing a fleet level catch rate for the ETP species.

- Maintain a good level of sampling in the observer programme to ensure long term trends in ETP interactions can be identified.
- For all three PO's to adopt the collaboration the CFPO has led with the Shark Trust, Cefas and the MMO on the Spurdog initiative across all high-risk elasmobranchs identified in this assessment.
- An independent site visit from SMRU, to properly assess and estimate the magnitude of impact of the fishery on the high risk marine mammal species.
- Ensure good practice and pertinent use of available equipment that can mitigate the impacts of fishing pressure on ETP species, such as the refined beam trawl gear from the Cefas/Seafish Project 50% and acoustic deterrent 'pingers' on the static bottom set gear of the fishery.

20.5. Conclusion

The objective of the study was to assess the risk the fishery imposes on ETP species, the main findings of the report reveal that the fishery poses a threat to a number of elasmobranch species particular those with low survivability rates such as the Tope Shark and Porbeagle Shark and there are concerns with high catch rates of the species Common Skate and Undulate Ray. Furthermore, clarity is needed on the fishery's impact on marine mammal and seabird species, as indirect data was required to inform the assessment process. Largely the outcomes of this report provide a strong basis of reasoning that the fishery poses the most threat to elasmobranch species in particular Common Skate, Undulate Ray, Spurdog, Porbeagle Shark and Tope Shark.

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22. Appendix A

22.1. ETP Species List with Designation

Species Name	UK BAP	CITES	Bern Convention	Bonn Convention	EU Birds Directive	EU Habitats Directive	ASCOBANS	Wildlife & Countryside Act	EU 2017/127	IUCN Red-List
Allis Shad *(Alosa alosa)*								Schedule 5		
Angel Shark *(Squatina squatina)*	•							Schedule 5	Article 12	CR
Basking shark *(Cetorhinus maximus)*	•		Appendix 2					Schedule 5	Article 12	VU
Common Dolphin *(Tursiops truncatus)*	•	Annex A	Appendix 2	Appendix 2		Annex IIII	•	Schedule 5		
Common Seal *(Phoca vitulina)*				Appendix 2						
Common Skate *(Dipturus batis)*	•								Article 12	
Common Porpoise *(Phocoena phocoena)*	•	Annex A	Appendix 2	Appendix 2		Annex II & IIII	•			
Common Seal *(Phoca vitulina)*						Annex II & V				

Grey Seal *(Halichoerus grypus)*						Annex II & V				
Northern Gannet *(Morus bassanus)*				AEWA	Migratory Species					
Porbeagle Shark *(Lamna nasus)*	•								Article 12	VU
Spurdog *(Squalus acanthias)*										VU
Tope Shark *(Galeorhinus galeus)*	•								Article 12	VU
Twaite Shad *(Alosa fallax)*								Schedule 5		
Undulate Ray *(Raja undulata)*										EN
White Skake *(Rostroraja alba)*									Article 12	EN

TABLE 40 FULL ETP DESIGNATION LIST

23. Appendix B Spatial Monkfish Landings Maps

23.1. Beam Trawl Landings Map 2015

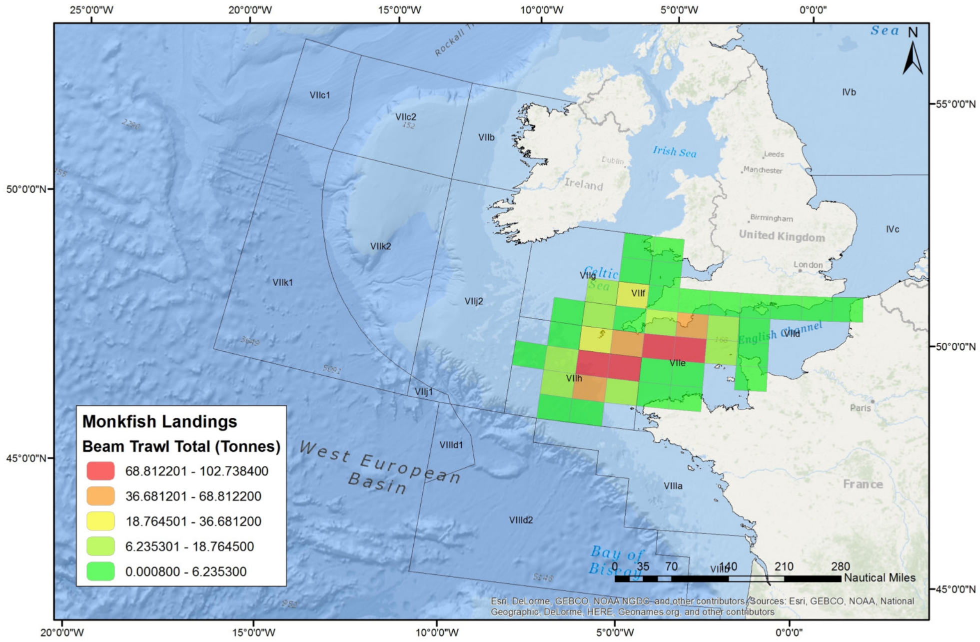


FIGURE 36 BEAM TRAWL MONKFISH LANDINGS 2015

23.2. Demersal Trawl Landings Map 2015

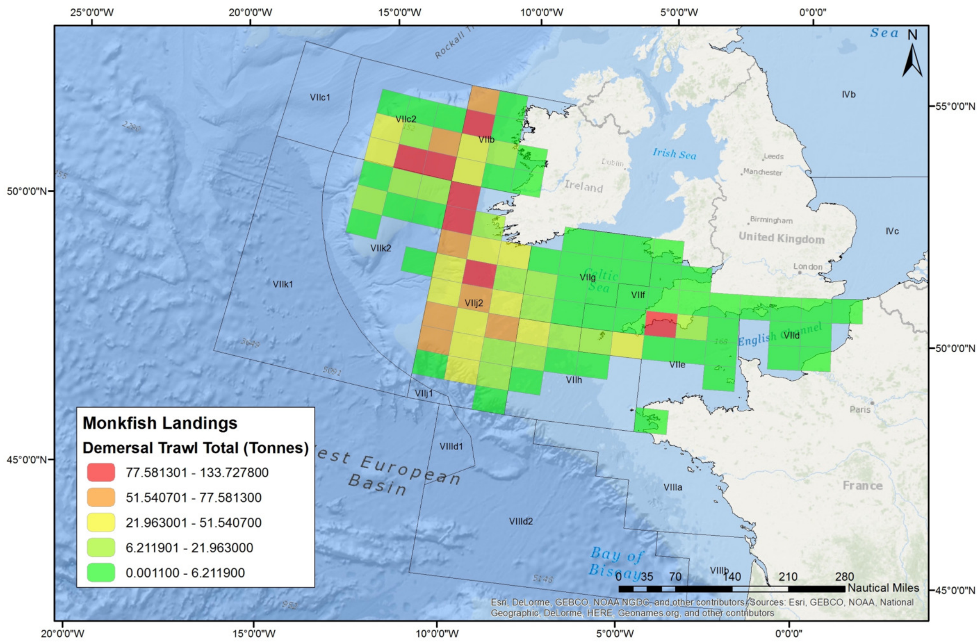


FIGURE 37 DEMERSAL TRAWL MONKFISH LANDINGS 2015

23.3. Gill Nets Landings Map 2015

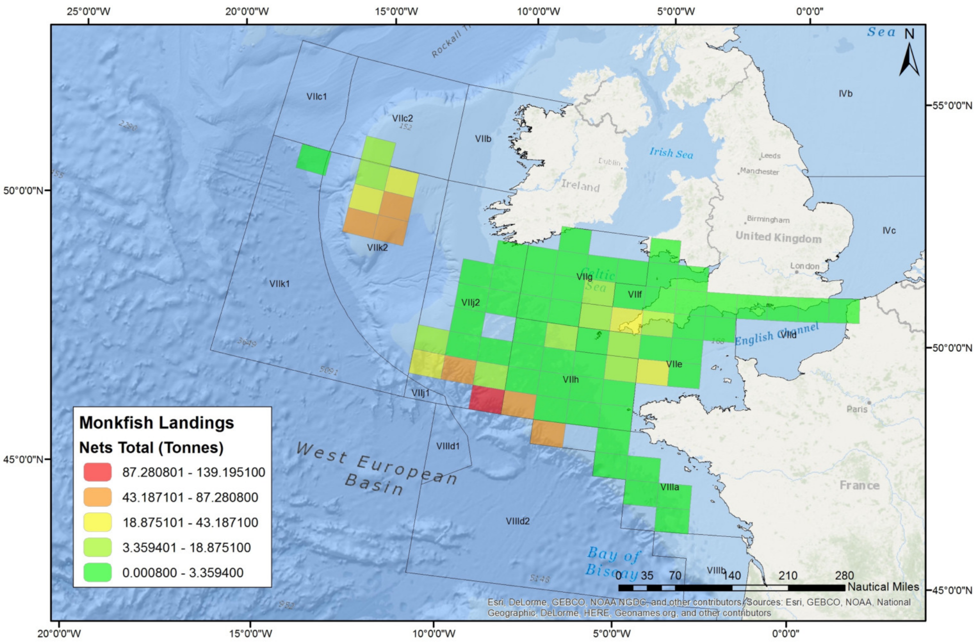


FIGURE 38 GILL NETS MONKFISH LANDINGS 2015

24. Appendix C ETP Species Mapping Guide

24.1. Assessment Area and ICES Rectangle Finder

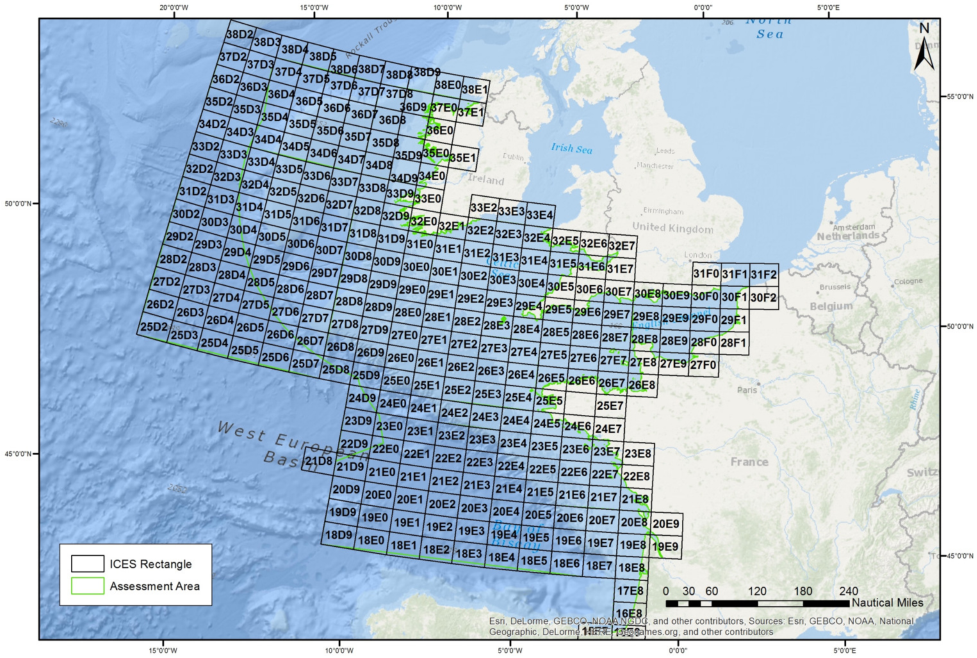
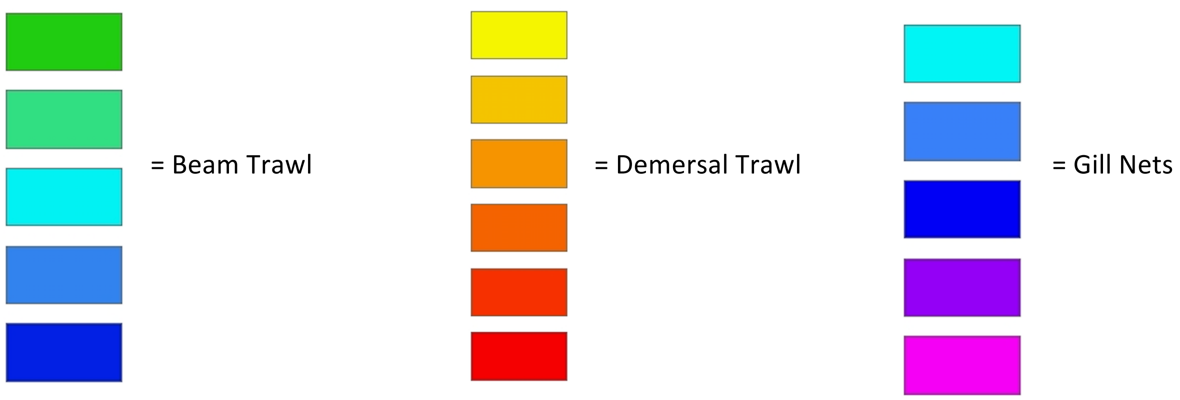


FIGURE 39 ASSESSMENT AREA AND ICES RECTANGLE FINDER MAP

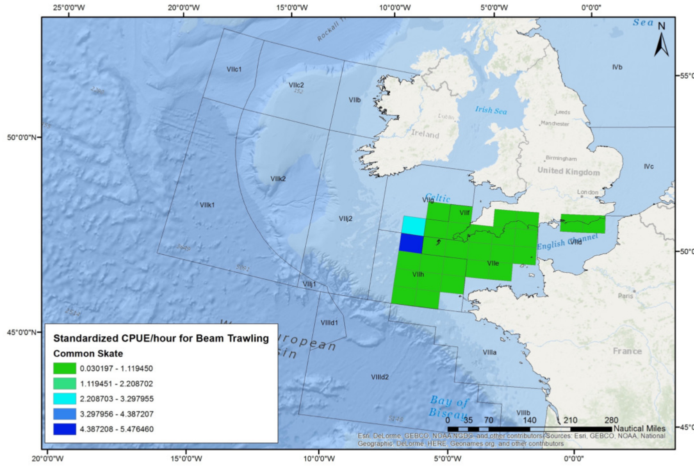
24.2. Key Codes for Species Mapping

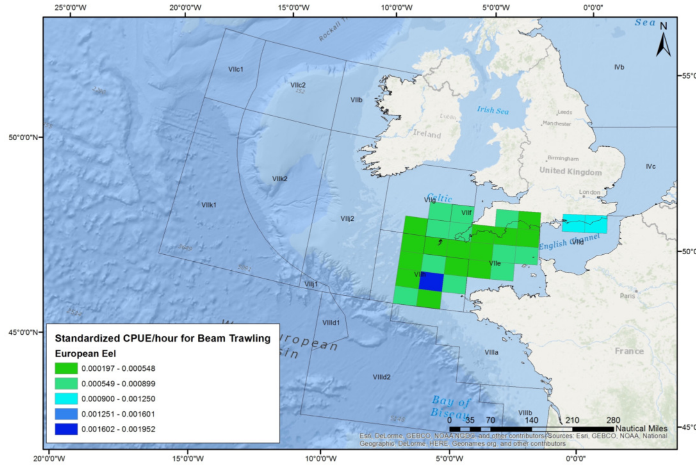
Below show the different colour power ramps for each gear type for easy viewing

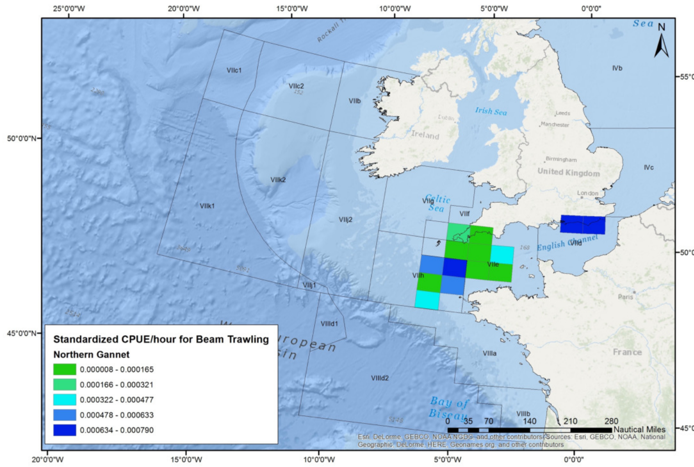


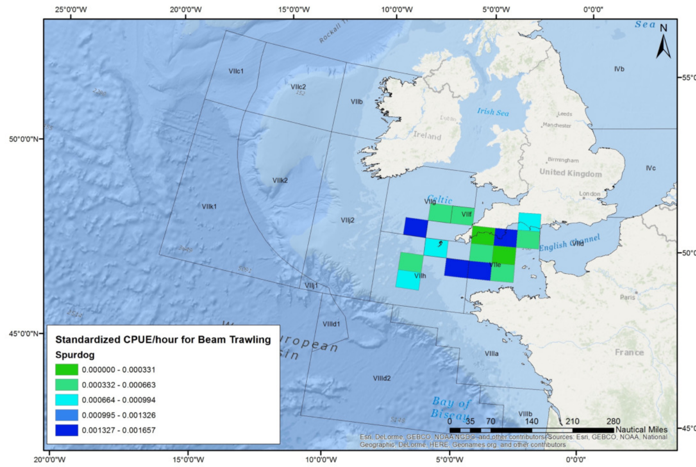
25. Appendix D Spatial Occurrence of Species Mapping

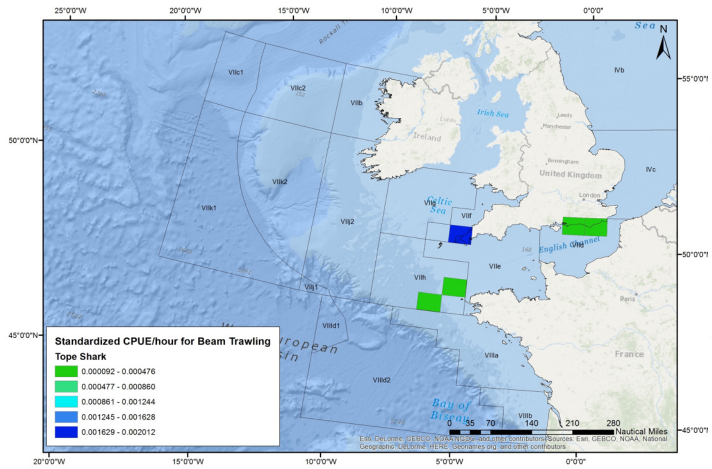
25.1. Beam Trawl Maps

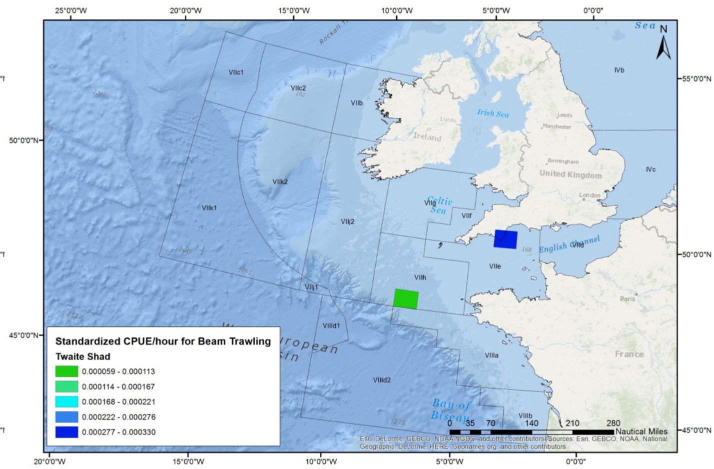


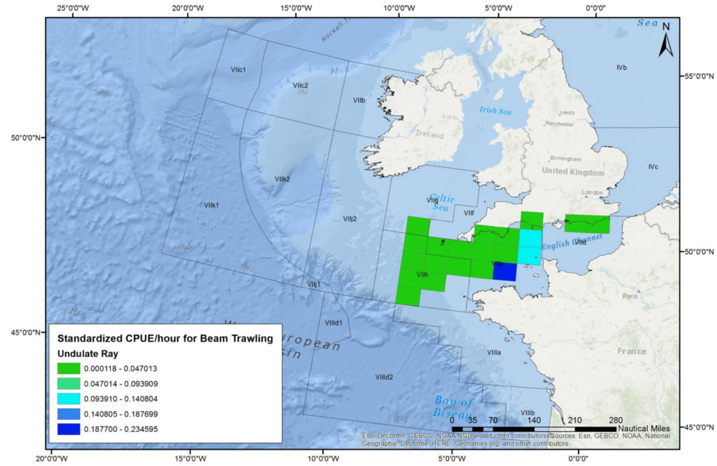




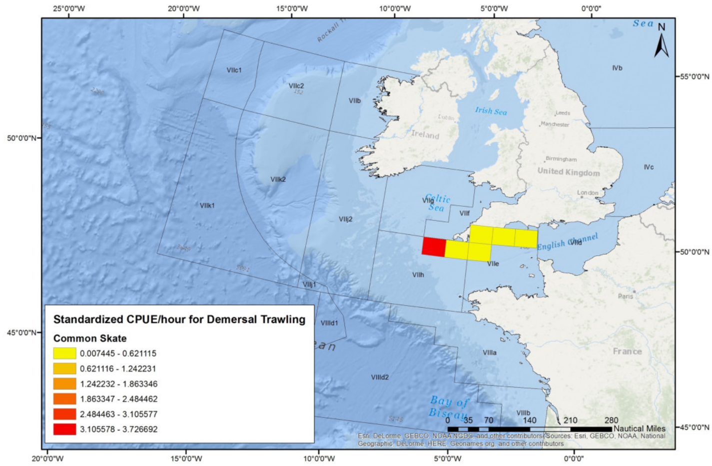


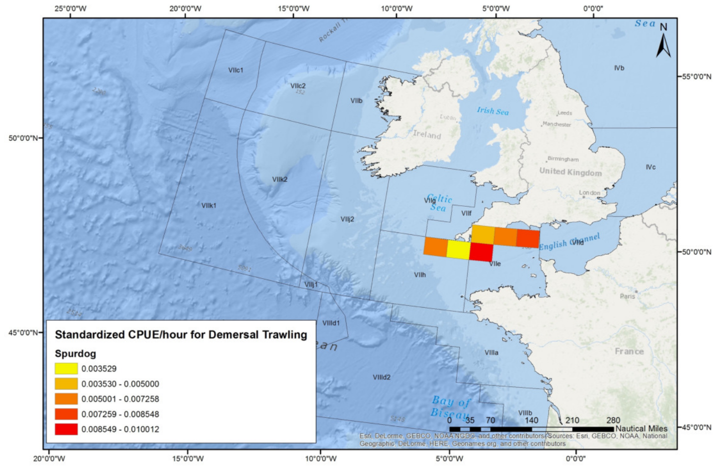


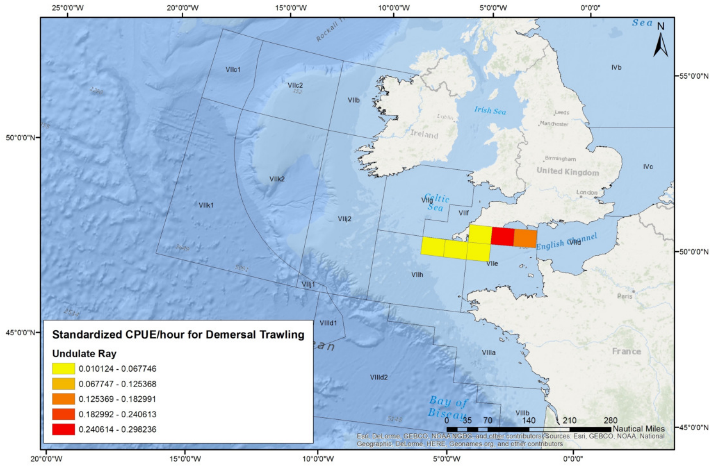


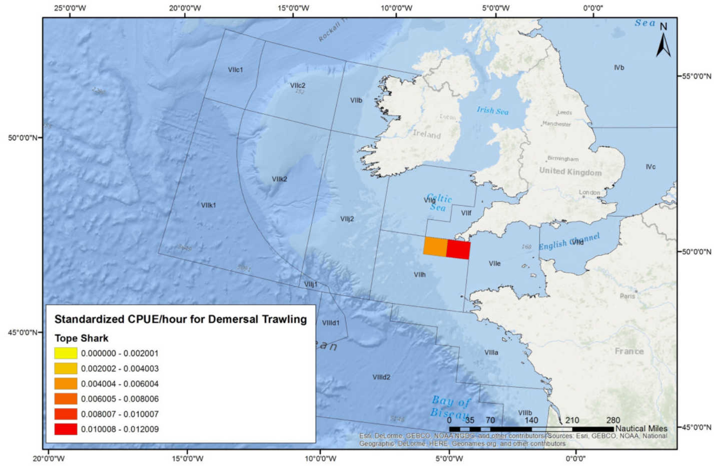

Standardized CPUE/hour for Beam Trawling
Undulate Ray
0.000118 - 0.047013
0.047014 - 0.093909
0.093910 - 0.140804
0.140805 - 0.187699
0.187700 - 0.234595
Ireland
United Kingdom
France
Irish Sea
Celtic Sea
English Channel
Bay of Biscay
VIIc1
VIIc2
VIIb
VIIk1
VIIk2
VIIj2
VIIj1
VIIg
VIIf
VIIh
VIIe
VIId
IVb
IVc
VIIId1
VIIId2
VIIIa
VIIIb
0 35 70 140 210 280
Nautical Miles
25°0'0"W
20°0'0"W
15°0'0"W
10°0'0"W
5°0'0"W
0°0'0"
55°0'0"N
50°0'0"N
45°0'0"N

25.2. Demersal Trawl Maps

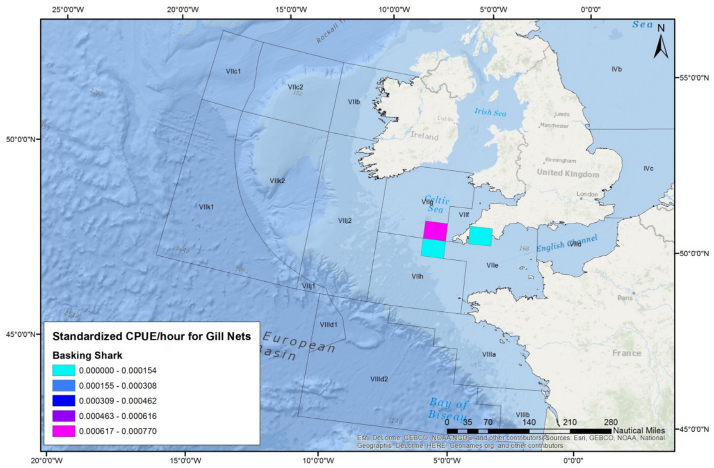


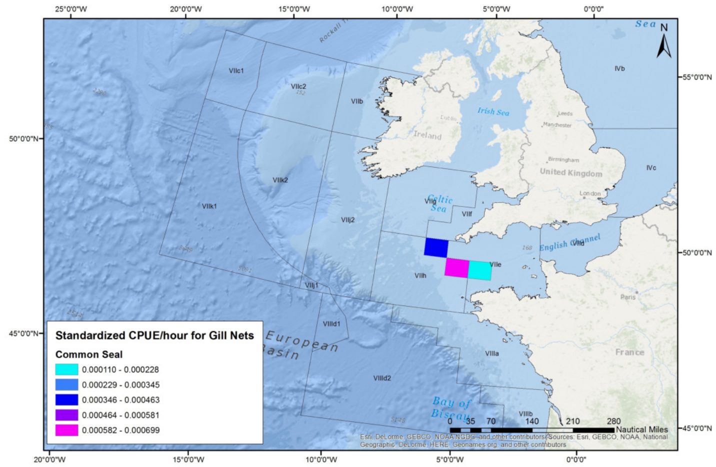


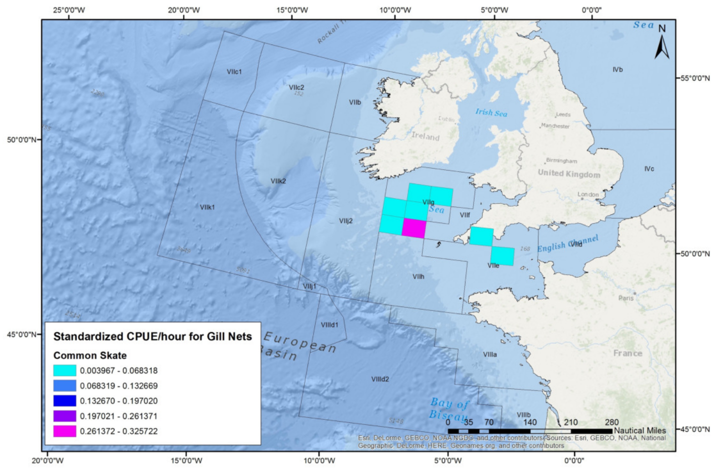


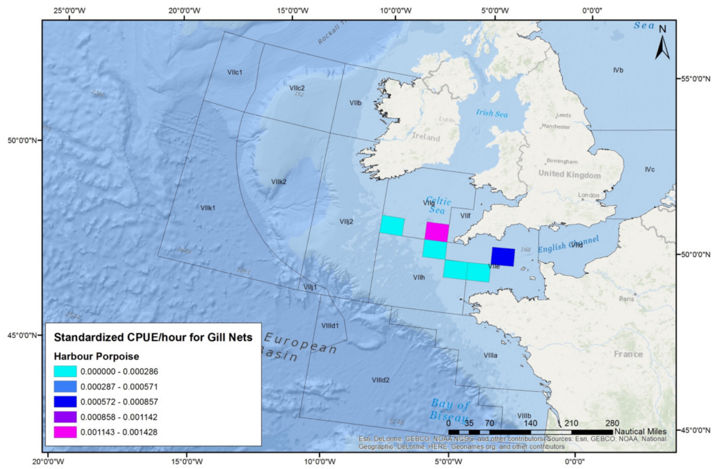


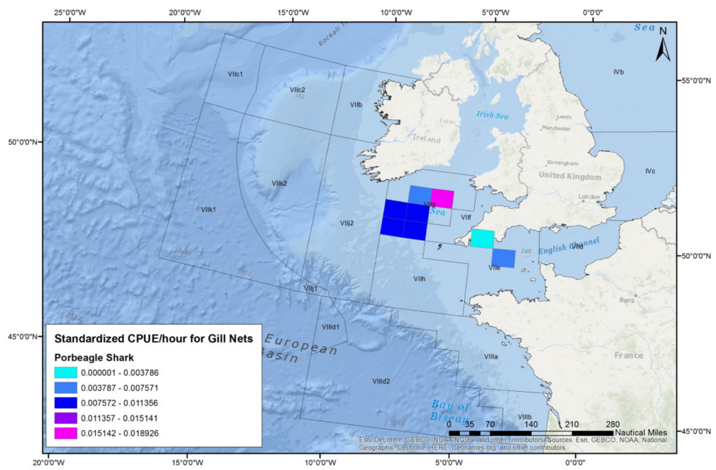
25.3. Entangling/Trammel Nets Maps

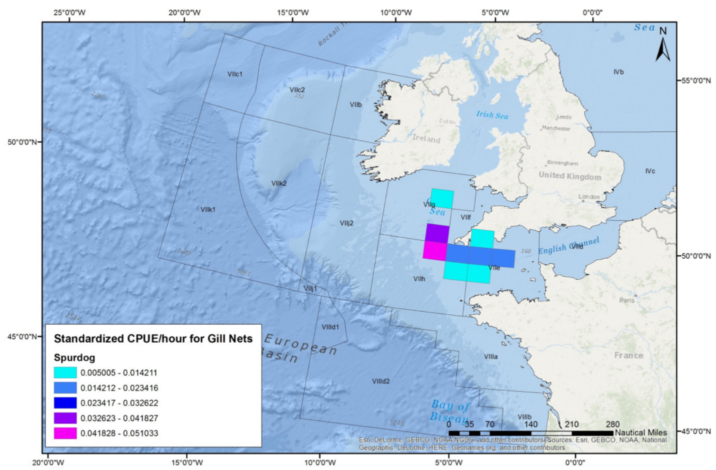


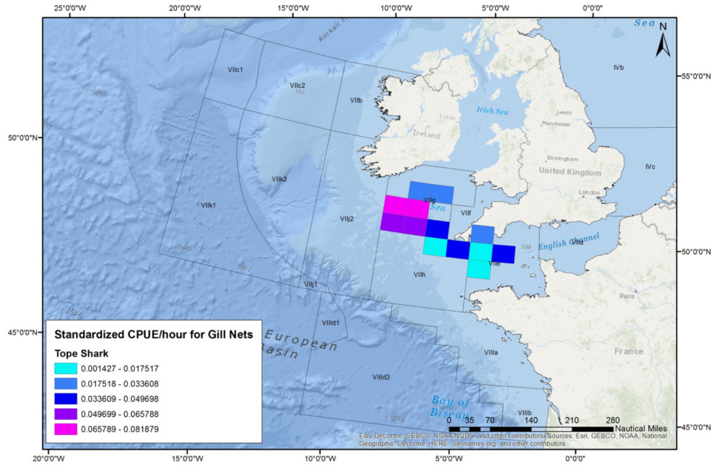


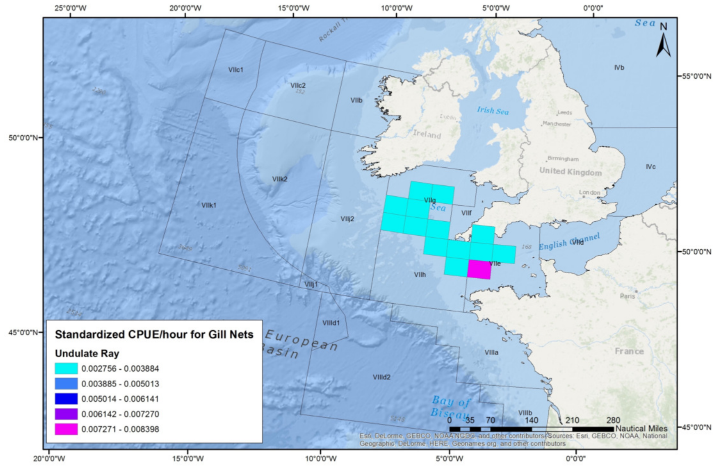




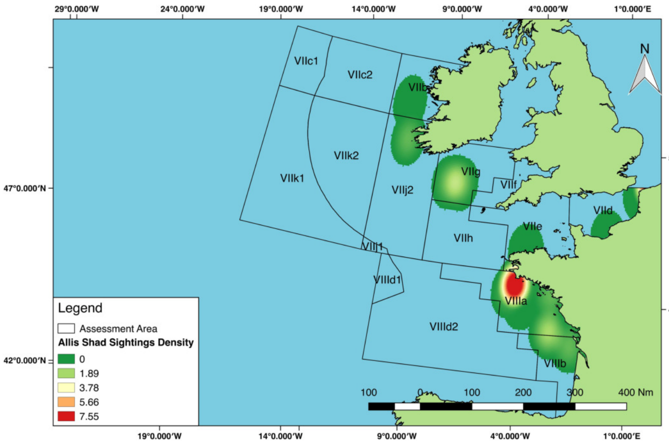


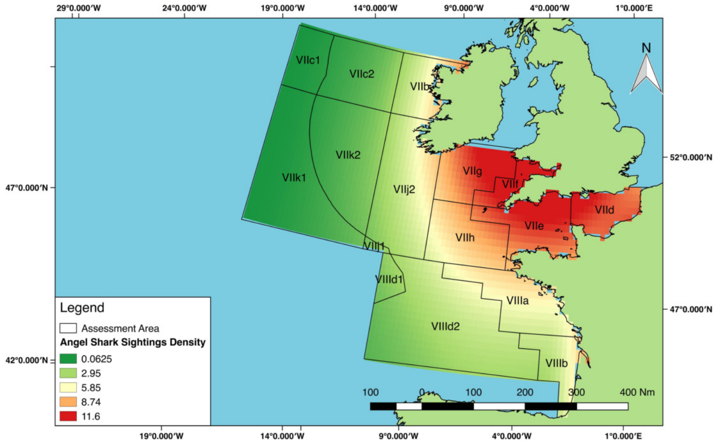


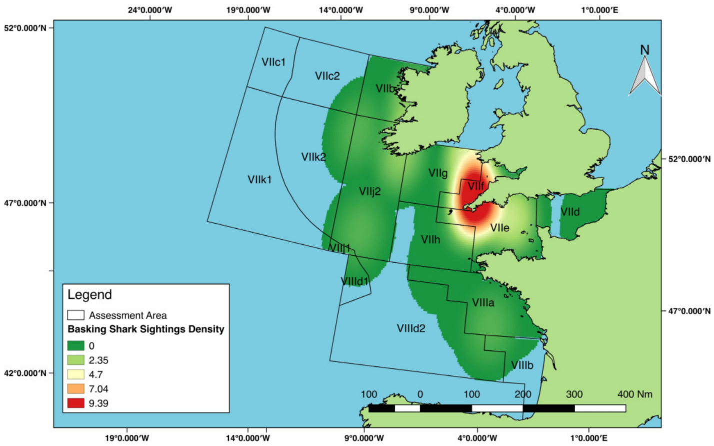

Standardized CPUE/hour for Gill Nets
Tope Shark
0.001427 - 0.017517
0.017518 - 0.033608
0.033609 - 0.049698
0.049699 - 0.065788
0.065789 - 0.081879
Nautical Miles

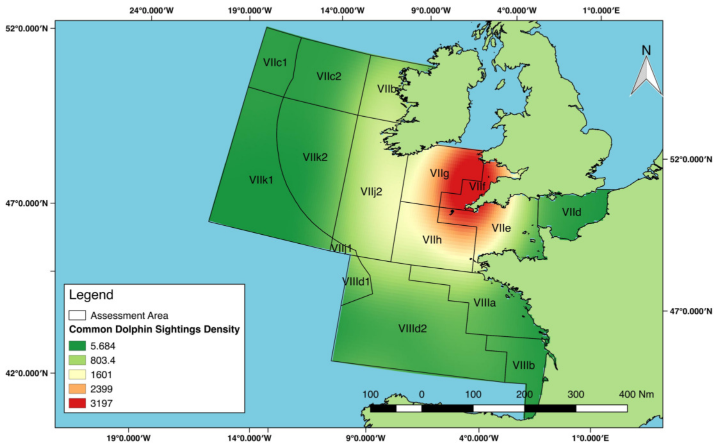

Standardized CPUE/hour for Gill Nets
Undulate Ray
0.002756 - 0.003884
0.003885 - 0.005013
0.005014 - 0.006141
0.006142 - 0.007270
0.007271 - 0.008398
Nautical Miles

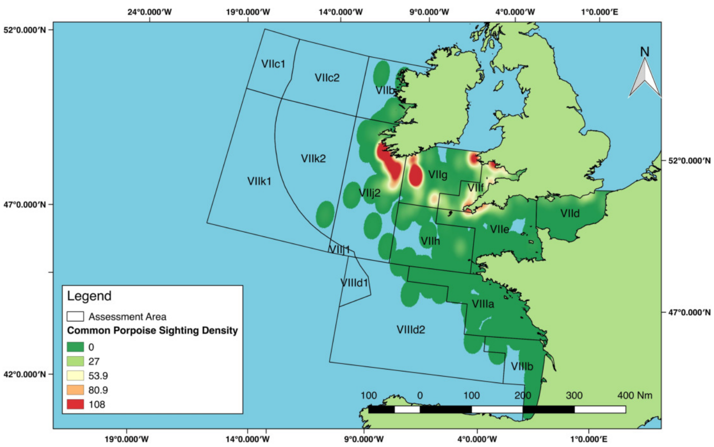
26. Appendix E Species Sightings Maps

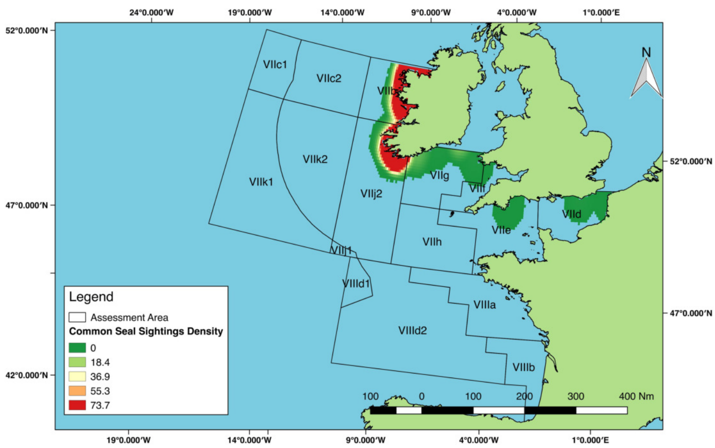


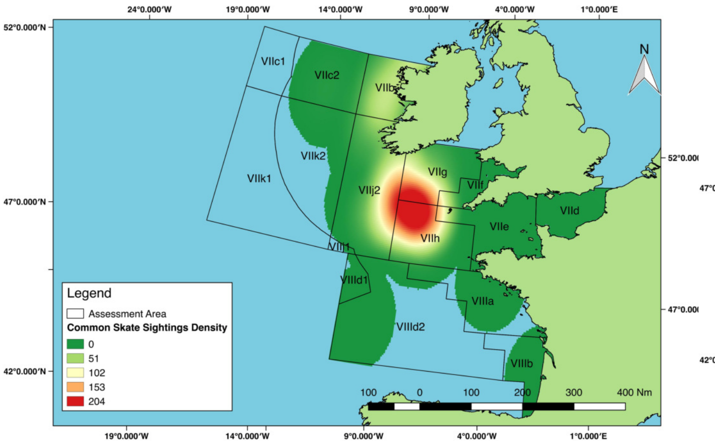


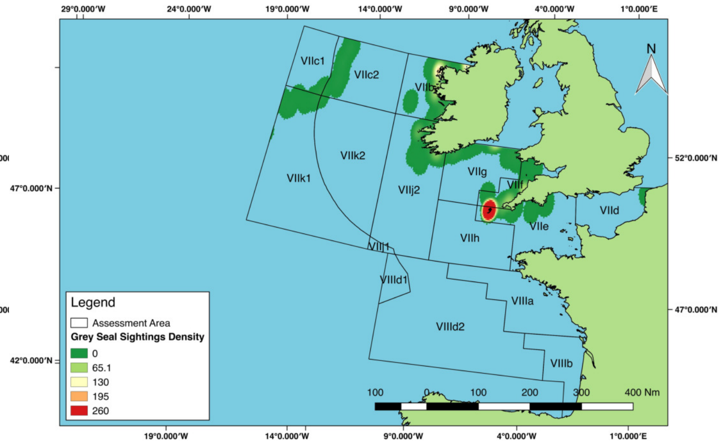


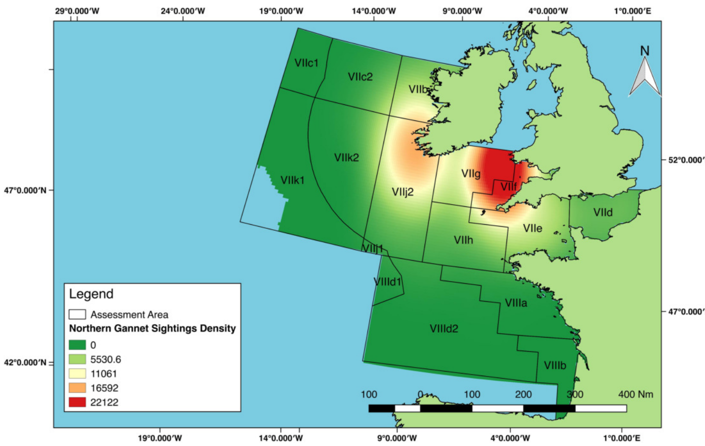


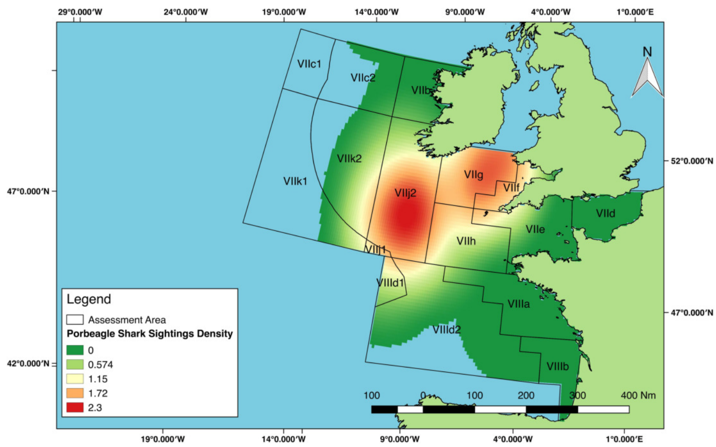


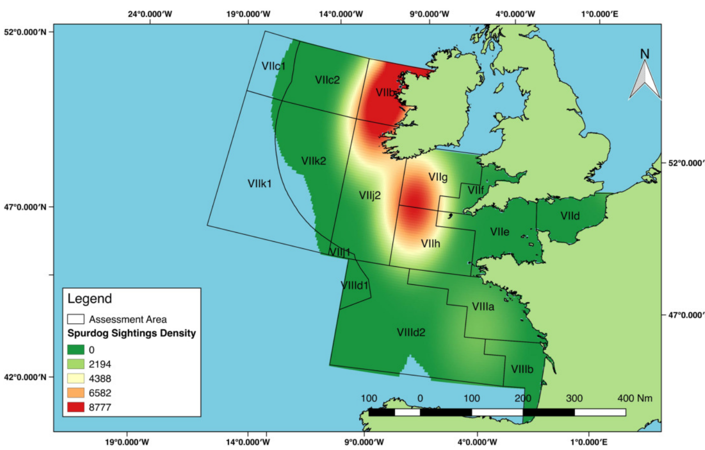


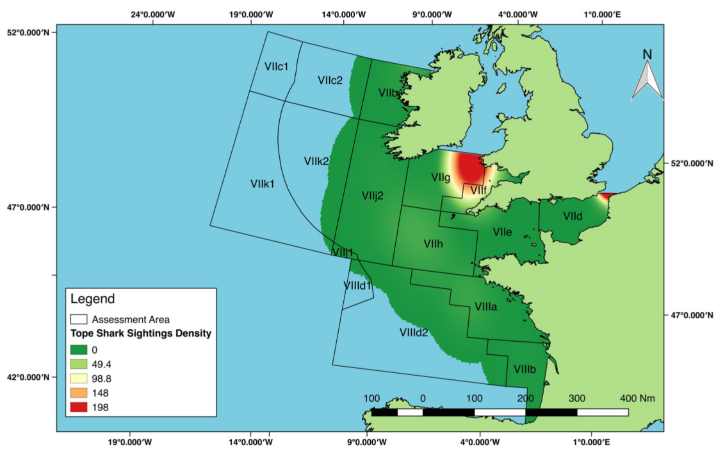

Legend
Assessment Area
Common Skate Sightings Density
0
51
102
153
204
100 0 100 200 300 400 Nm

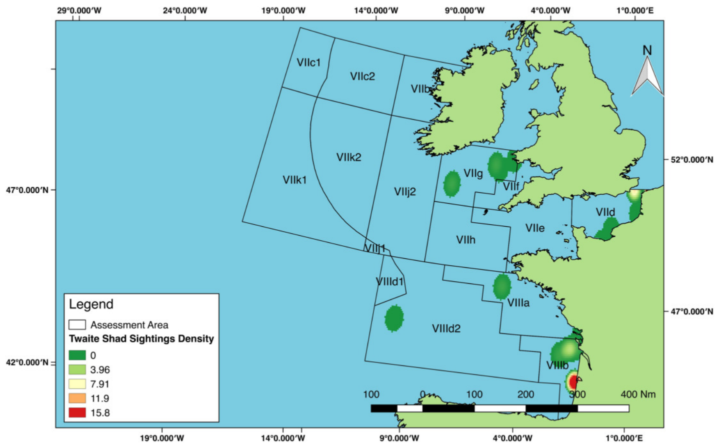

Legend
Assessment Area
Grey Seal Sightings Density
0
65.1
130
195
260
100 0 100 200 300 400 Nm

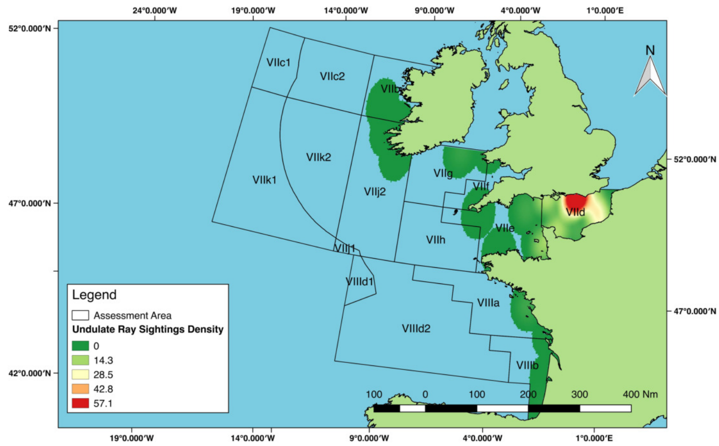

Legend
Assessment Area
Northern Gannet Sightings Density
0
5530.6
11061
16592
22122
100 0 100 200 300 400 Nm

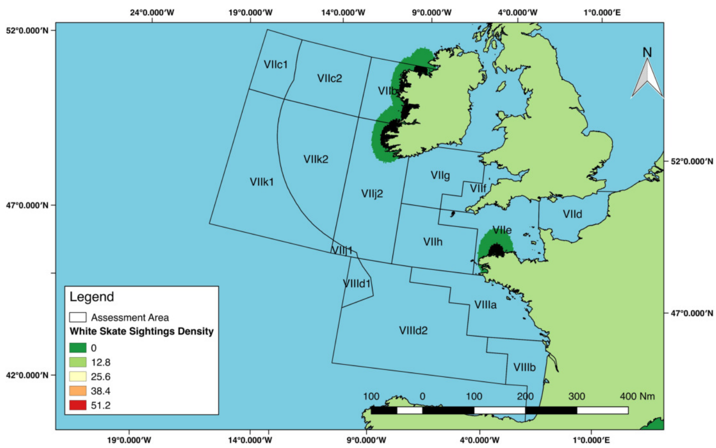

Legend
Assessment Area
Porbeagle Shark Sightings Density
0
0.574
1.15
1.72
2.3
100 0 100 200 300 400 Nm


Legend
Assessment Area
Spurdog Sightings Density
0
2194
4388
6582
8777
100 0 100 200 300 400 Nm


Legend
Assessment Area
Tope Shark Sightings Density
0
49.4
98.8
148
198
100 0 100 200 300 400 Nm


Legend
Assessment Area
Twaite Shad Sightings Density
0
3.96
7.91
11.9
15.8
VIIc1
VIIc2
VIIb
VIIk2
VIIk1
VIIj2
VIIg
VIIf
VIIh
VIIe
VIId
VIIj1
VIIId1
VIIId2
VIIIa
VIIIb
100 0 100 200 300 400 Nm


Legend
Assessment Area
Undulate Ray Sightings Density
0
14.3
28.5
42.8
57.1
VIIc1
VIIc2
VIIb
VIIk2
VIIk1
VIIj2
VIIg
VIIf
VIIh
VIIe
VIId
VIIj1
VIIId1
VIIId2
VIIIa
VIIIb
100 0 100 200 300 400 Nm


Legend
Assessment Area
White Skate Sightings Density
0
12.8
25.6
38.4
51.2
VIIc1
VIIc2
VIIk2
VIIk1
VIIj2
VIIg
VIIf
VIIh
VIIe
VIId
VIIj1
VIIId1
VIIId2
VIIIa
VIIIb
100 0 100 200 300 400 Nm

27. Appendix F Cefas Observer Data Statistical Anova Summary

	Beam Trawl				Demersal Trawl				Gill & Trammel Nets			
	Year	Quarter	ICES Rectangle	Vessel Length	Year	Quarter	ICES Rectangle	Vessel Length	Year	Quarter	ICES Rectangle	Vessel Length
Basking Shark	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	●	-	-	-
Common Seal	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	●	-	-	-
Common Skate	●	-	●	●	-	-	●	-	●	●	●	●
European Eel	-	-	-	●	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Harbour Porpoise	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	●	-	-	-
Northern Gannet	●	-	-	-	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Porbeagle Shark	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	●	-	-	-
Spurdog	●	-	-	-	●	-	-	-	●	-	-	●
Tope Shark	●	-	●	-	●	-	-	-	●	●	●	-
Twaite Shad	●	-	-	-	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Undulate Ray	●	●	●	-	●	-	●	●	●	-	●	-

TABLE 41 SIGNIFICANT FACTORS UPON ETP SPECIES OF DIFFERENT GEAR TYPES

The table shows the ETP species captured by the fishery and whether or not the year, quarter, ICES Rectangle or vessel length was a significant factor on catch rates of the species with a particular gear type.

● = P<0.05 - = P>0.05 n/a = species not recorded as bycatch in gear type model used = glm(log(CPUE+0.1)~0+Y+Q+ICESRectangle+L)