Review of harbour porpoise bycatch in UK waters and recommendations for management

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EXECUTIVE SUMMARY AND RECOMMENDATIONS

Harbour porpoise bycatch in gillnets is a major welfare and conservation problem in the UK. Where harbour porpoise presence and gillnet use overlap, bycatch appears to be inevitable. Deriving accurate harbour porpoise bycatch estimates is problematic, due to lack of monitoring of some sectors and limitations of UK fisheries effort and landing data, especially for vessels under 10m in length. Northridge et al. (2018) estimate UK porpoise bycatch in 2017 to be between 587 and 2615 individuals with a best estimate of 1098, assuming all fishing vessels used pingers as required. The estimate for the Celtic Sea ecoregion has a 95% confidence interval of 620 to 1390 (ICES, 2018), which is estimated to represent between 1.1 and 2.4% of the population estimate for ICES subarea 7 (ICES, 2018), exceeding ASCOBANS reference points and suggesting considerable conservation concern. This bycatch occurs in a small proportion of the spatial area of the assessment unit creating a high risk of localised depletion. Localised depletion is also a risk off SE England with high rates of strandings along southern North Sea coasts in recent years but very limited data on bycatch rates.

To bring about substantial harbour porpoise bycatch reduction there are a number of actions that need to be taken in addition to current measures. The main fisheries legislation governing cetacean bycatch, EU Regulation (812/2004), obliging Member States to monitor, mitigate and report on bycatch has widely-recognised limitations with respect to both mitigation and monitoring. In the UK less than 1% of fishing days at sea using static nets are monitored by dedicated schemes, with almost no monitoring of under 12m vessels. Under Regulation 812/2004, the main tool for bycatch mitigation is the use of pingers, the only method which has been shown to consistently work with gillnets, producing significant reductions in bycatch with little evidence of habituation in porpoises. However in the UK in 2017, of 1256 vessels using static nets, only 24 vessels were obliged to deploy pingers by EU requirements (Northridge et al. 2018). Furthermore, their effectiveness relies on high levels of enforcement and compliance, there are concerns over displacement from suitable habitat, and they are most effective when used in combination with other mitigation methods such as time/area closures.

There is now a need to focus on changes in fisheries practices and management which seek to limit gillnet use rather than continuing to attempt to mitigate gillnet bycatch with technologies such as pingers. It is also necessary to increase the proportion of fishing effort which is monitored, especially in high-risk fisheries. Neither of these aims is unrealistic. Gillnet catch value amounts to just 2.4% of the UK total, and the areas of highest harbour porpoise bycatch risk are spatially concentrated (SE England, SW England and NW of Shetland, although data are lacking, especially in Shetland), making both improved monitoring levels and changes to fisheries a viable proposition. Improved monitoring can be achieved through the wider implementation of camera-based electronic monitoring systems, whilst at least some gillnet fisheries could be suitable candidates for shifts to alternative gear, primarily hooks (long and hand lines), but also potentially pots/traps and light trawls.

The UK’s newly-designated Sites of Community Importance (SCI) for harbour porpoise (which will become Special Areas of Conservation (SAC)), have relatively little overlap with current gillnet fisheries but provide an opportunity through management measures to minimise disturbance and other non-lethal threats such that harbour porpoise populations can maximise their use of optimal habitat. Measures to address lethal impacts such as bycatch need to be taken across the range of the population and will then contribute to the objectives of the SACs by maintaining local population numbers.

If the UK is to look towards more sustainable, ecosystem-based management of fisheries, a key improvement and indicator of success will be the reduction of cetacean and other marine wildlife bycatch. The following recommendations are suggested as a way to achieve this:

i) **All UK gillnet fisheries should be assessed for potential to use alternative gears**

Both gillnet fishery effort and porpoise distribution can be dynamic with substantial changes between years (Northridge and Hammond, 1999; Hammond et al., 2013; Wilson, 2016). Any overlap between porpoises and gillnets will create a bycatch problem; even gillnet fisheries that currently appear to have low bycatch (notwithstanding the low levels of monitoring or reporting) may pose a risk if porpoise distribution and/or fishing effort changes. Therefore there is value in investigating all gillnet fisheries for possible lower risk alternatives regardless of current reported bycatch.

Fishing methods using hooks (e.g. hand lines and/or long lines) are already used for catching some species which are currently also caught using gillnets, for example in southwest England (particularly for pollack), southeast England (particularly thornback ray), and Shetland (cod and hake). These fisheries should be examined more closely to see how techniques could be more widely applied to replace gillnets in other areas/other target species. Methods used elsewhere such as fish traps/pots and light trawls should be further investigated.

ii) **Concurrent monitoring and mitigation**

For fisheries which are currently not monitored but which use gillnets, and therefore have a high level of risk, it makes most sense to implement mitigation and monitoring at the same time. Much of the same work (e.g. working with stakeholders) is required for both monitoring and mitigation efforts. Moving to mitigation without adequate monitoring can be problematic. However, putting off mitigation until monitoring trials have been completed is also undesirable; monitoring trials can take many years and may use available budget such that there is then no further action even if monitoring results indicate substantial bycatch. In economic terms, the balance between commencing/continuing monitoring compared to moving straight to mitigation needs to be assessed. Moving straight to concurrent monitoring and mitigation could be appropriate in situations where the ‘mitigation’ was using alternative gears, in particular from small vessels.

iii) **Comprehensive at sea monitoring**

Advances in camera technology and decreasing costs of electronic monitoring systems are creating new possibilities for fisheries to demonstrate responsible practices and contribute to the UK’s commitment to an ecosystem-based approach to fisheries management. This applies both to monitoring catches and bycatch. It is now feasible to recommend installing REM systems across the whole UK fishing fleet. Comprehensive coverage would avoid many of the issues associated with sampling bias, including which vessels are chosen to be fitted with cameras, and any changes in fishing activity related to having cameras on board. The sampling design could be based on the data collected and need not increase analysis costs if only the required proportion of vessels was analysed to fulfil the monitoring objectives. For example, analysis would focus on a higher proportion of video in higher-risk fisheries and for vessels using mitigation methods (such as pingers). Efforts should continue towards developing cheaper, more robust, more portable EM systems with a particular focus on use in small scale coastal fisheries which have been difficult to monitor.

iv) Address specific data gaps in high risk areas

The deep water gillnet fisheries to the west of the British Isles and especially northwest of Shetland are poorly documented from a fisheries perspective and may well have a significant harbour porpoise bycatch. These are a priority for monitoring using observer programmes or adoption of EM camera systems and to ensure pingers are being used effectively as required by Regulation 812/2004.

v) Import regulations in the USA

An analysis should be undertaken of where EU (and any future UK) legislation needs to be strengthened to be comparable to the MMPA with respect to bycatch. This will identify where legislative measures should be developed to address bycatch in order to fully comply with US requirements regarding imports of fisheries products.

vi) Improved clarity in management objectives with respect to bycatch

Any new fisheries legislation should contain specific objectives to minimise bycatch of protected species. There needs to be a coordinated effort to include explicit objectives to reduce bycatch towards zero as agreed by ASCOBANS[1]. The implications of any discussion of bycatch limits or reference points will be highly dependent on the conservation objectives and most specifically the probability for which these are expected to be achieved. The interim ASCOBANS conservation objective of maintaining populations at 80% of K is often referred to, but it should be noted that the ultimate aim of ASCOBANS is 'to restore and/or maintain biological management stocks of small cetaceans at a level they would reach when there is the lowest possible anthropogenic influence'[2] (i.e. effectively at natural carrying capacity) whereas restoring and/or maintaining populations at 80% or more of the carrying capacity is a less ambitious interim objective leading towards this. It would therefore be expected that the interim objective should be achieved with a high probability (e.g. 95%) and further work on reference points should take this into account.

vii) UK as world-leader in bycatch best practice

The UK Government has stated an aspiration for the UK to be a world leader in environmentally responsible fisheries[3]. The UK also has a responsibility as a well-resourced country to demonstrate good bycatch mitigation practice, and develop strategies which can be applied elsewhere, particularly in artisanal fisheries in other countries, where gillnet use is widespread and resources are limited. Research into the potential for alternative gears in fisheries is a more viable proposition in the UK where more research and development resources are available. For example, attempts to develop alternative gear in Mexico in a race against vaquita extinction have been prohibitively difficult for political, social and economic reasons (Rojas-Bracho and Reeves 2013). If alternative gear had already been developed, ready for implementation, the situation in Mexico might have been different. When

[1] https://www.ascobans.org/sites/default/files/document/MOP8_2016-5_Bycatch.pdf

[2] https://www.ascobans.org/sites/default/files/document/MOP8_2016-5_Bycatch.pdf

[3] https://www.gov.uk/government/consultations/fisheries-white-paper-sustainable-fisheries-for-future-generations/sustainable-fisheries-for-future-generations-consultation-document

developing bycatch strategies in the UK and Europe, the focus should be on methods which could also be applicable for small cetacean bycatch problems in areas of the world where technologies such as pingers are not a viable mitigation tool due to their prohibitive cost and need for consistent deployment and monitoring.

1. INTRODUCTION

Of the impacts of fishing on the marine environment, cetacean bycatch has proved to be one of the more intractable, no more so than with the bycatch of small cetaceans, particularly porpoises, in gillnets. Despite many years of research there is still no adequate means of mitigating gillnet bycatch[4]. Attempts have been made to mitigate gillnet bycatch with technology such as pingers but changes in fisheries practices and management which have reduced gillnet use have resulted in the most substantial bycatch reductions. Adapting fisheries management to minimise bycatch in gillnets should be seen as an achievable aim within the UK; in 2017 gillnet catch value amounted to just 2.4% of the UK total (1.6% of the live weight of catch), and some fisheries in the UK which currently use gillnets have potential to shift to other fishing methods.

In UK waters, the harbour porpoise (*Phocoena phocoena*) is the most widely-distributed and common cetacean. Almost all UK shelf waters provide suitable habitat for harbour porpoise, so all areas should be considered important porpoise habitat. Of the threats to harbour porpoises throughout their range, including in UK waters, fisheries bycatch is the most obvious, in particular through entanglement in gillnets. Wherever there is spatial overlap between gillnet fisheries and harbour porpoise distribution, bycatch at some level will occur. Whilst the UK has for several years implemented monitoring and mitigation measures in response to porpoise bycatch in gillnets, the problem has persisted[5]. Northridge et al. (2018) estimate UK porpoise bycatch in 2017 would be between 718 and 2402 (best estimate 1282) without any mitigation, but that this has likely been reduced by around 180 individuals a year through the use of pingers to a best estimate of 1098 if all over 12 m boats used pingers in relevant areas. The estimate for the Celtic Sea ecoregion alone has a 95% confidence interval of 620 to 1390 (ICES, 2018). This estimate is lower than the annual estimate for the Celtic Sea (Irish and UK gillnet fisheries combined) between 1992 and 1994 of 2200 (95% CI 900-3500) by Tregenza et al. (1997). However much of this reduction has been due to a decrease in gillnet fisheries effort because of fish stock collapses (e.g. Northern hake in the early 2000s) rather than management measures related to bycatch. There is still a role for currently implemented and improved monitoring and mitigation measures, but there is also a strong imperative for alternative approaches.

2. BACKGROUND

2.1 Overview of UK Fisheries

Data on UK fishing effort and activities are often patchy and incomplete. However, Seafish[6], uses interviews with UK vessel owners, skippers and fishing business owners who contribute their vessel

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[4] FAO. 2018. Report of the expert workshop on means and methods for reducing marine mammal mortality in fishing and aquaculture operations. http://www.fao.org/3/I9993EN/i9993en.pdf

[5] ICES. 2018. Report from the Working Group on Bycatch of Protected Species (WGBYC). http://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/acom/2018/WGBYC/wgbyc_2018.pdf

[6] A Non-Departmental Public Body (NDPB) set up by the Fisheries Act 1981 to improve efficiency and raise standards across the seafood industry. Seafish is funded by a levy on the first sale of seafood products in the

accounts, complete questionnaires and participate in interviews, plus input from UK government fisheries departments and the Marine Management Organisation, to compile reports on the current status of the UK fishing industry.

The most recent of these publications (Seafish 2017) reported 4,607 active fishing vessels in 2016 of which 1,709 had a fishing income of less than £10,000. A further 1,769 vessels were inactive (mostly vessels under 10m). Vessels 10m long or under comprised 55% of the number of active vessels in 2015, but this figure excludes those with an income of less than £10,000 per year. The largest segment was the under 10m pots and traps fleet, which comprised over 1,000 vessels (35% of active vessels excluding those with an income of less than £10,000 per year). The remaining segments ranged from eight vessels in the North Sea beam trawl under 300kW segment to 223 vessels in the scallop dredge under 15m segment. Most UK active vessels are under 10m. However, whilst vessels over 10m represent 27% of active vessels, they account for 43% of the total fishing days at sea, due to the inactivity of many of the under 10m vessels. Vessels over 24m registered in England or Scotland accounted for the largest share in the weight of landings in 2016 for vessels registered in each of their respective countries, and the largest share in fishing income for vessels registered in England, Scotland and Wales. In 2016, there were increases in the number of vessels in the fleet under 10m, North Sea beam trawls under 300kW, West of Scotland nephrops and pots and traps 10-12m. Segments with fewer vessels in 2016 included North Sea and West of Scotland demersal vessels, West of Scotland nephrops under 250 kW and scallop dredgers under 15m (Seafish 2017).

Table 1a. Total numbers of licenced vessels in UK fleet by country of administration (November 2018)

Country of administration	Total number of <10m vessels	Total number of >10m vessels
England	2206	484
Northern Ireland	187	119
Scotland	1450	523
Wales	375	27
Total	**4218**	**1153**

Table 1b. Total numbers of licenced vessels in UK fleet by length class (November 2018)

Length class (m)	Total licenced vessels
<6	1390
6-8	1452
8-10	1385
10-12	353
12-15	255
15-18	150
18-24	219
>24	291

Data from MMO vessel lists[7]

There is a high level of diversity in the UK fishing fleet, both in terms of the type of vessels, gear types, where they fish, and the target species. There is also considerable variation in the number of vessels in each fleet segment. With several different types of vessel operating in the same area, conflicts can occur, especially between large/small vessels and static/mobile gear, the solution to

UK, including imported seafood in accordance with the 1982 Fisheries Act. Seafish operates at arm's length from their joint sponsors, the four Fisheries Administrations.

7 https://www.gov.uk/government/collections/uk-vessel-lists

which is seen as more regulation by some, and less regulation by others. Such conflicts are often mediated in inshore waters by inshore fisheries groups. Environmental impacts, including bycatch, could be considered when management action is taken to resolve such conflicts. For example, preferential access to an area could be granted to activities which pose lower bycatch risk.

In 2016, total fishing income for UK vessels was around £920 million (Seafish 2017). There have been fluctuations in fishing income over recent years, driven largely by changing global demand for pelagic species such as mackerel. Whilst in recent years the price of cod and haddock has dropped, scallops and monkfish have risen in value; in UK fishing, changes in revenues are largely driven by fish prices or fishing opportunities and stock size. The most important non-TAC managed species by value are scallops, crabs, lobsters, whelks and cuttlefish, which in 2016 represented 20% of the total value landed by the UK fleet. Fishing income in 2016 was higher than that of 2015 (£775 million) due to an increase in the average price of all species types, particularly shellfish. In general, shellfish and demersal species are the most valuable per tonne, reaching average prices approximately three times higher than those of pelagic species (Seafish 2017).

There is also considerable variation in fishing expenditure per day at sea between segments. For example, operating costs, expressed as a percentage of total income, ranged from 104% of total income for North Sea beam trawl vessels over 300kW to 65% of total income for pots and traps vessels 10-12m in 2015. Annual operating costs differ largely between fleet segments as a result of varying vessel size, power and level of activity, among other factors. Average annual operating costs in 2015 ranged from approximately £36,000 for under 10m vessels to £1.9million for North Sea beam trawlers over 300kW. Average operating profit per vessel is also highly variable. All segments except two (North Sea beam trawlers over and under 300kW) made an operating profit in 2015, though some individual vessels may have made a loss. For the remaining segments the average profit per vessel ranged between £9,200 for North Sea nephrops vessels under 300kW and £250,000 for North Sea and West of Scotland demersal seiners (Seafish 2017).

In 2016, of the 4067 active vessels in the UK fleet, there were 30 large gillnet vessels in the UK fleet catching a variety of species (see section 3.2). On average these vessels landed 1.53 tonnes per day, with an income of £3423 per day. There were a further 217 vessels under 10m which fished with drift or fixed nets, which landed an average of 0.22 tonnes per day, with an income of £504 per day. In addition, it is likely that of the 1709 vessels with annual income under £10,000 where no fishing method is specified, there are also polyvalent vessels which fish with gillnets all or some of the time (Seafish 2017).

While the UK over 15m fleet has had some dedicated observer programmes to estimate bycatch (see section 2.4), data on the inshore fisheries are more limited both with respect to effort and bycatch.

2.1.1 UK Inshore Fisheries

The total UK inshore fleet of vessels of 10m or under ('under tens'), generally classed as Small-scale Coastal Fisheries (SSCF) comprises nearly 80% of all registered vessels (Davies et al. 2018). In the North Sea, the UK has a higher proportion of under tens than the other main countries fishing in the North Sea (Denmark, Norway, Germany and The Netherlands). However, the UK inshore fleet, which also provides around 65% of the direct employment in fishing in England (Davies et al. 2018) is likely not adequately represented in discussions of Marine Spatial Planning (Jentoft and Knol 2014). Cardwell (2012) also notes that because of the way that UK quotas have been allocated, under tens currently have a much smaller proportion of the UK catch than boats longer than 10m. In 2011, the under tens had around 1.2% of the UK catch quota in the North Sea and about 7% in the English Channel, Western approaches, Celtic sea and Irish sea (Cardwell 2012). EU lobby group Low Impact

Fishers of Europe[8] recently reported that 97% of English quotas are owned by just a few fish producer organisations (POs). 40 % of the Scottish catch by value, and 65% by tonnage, was landed by 19 super-trawlers in 2016, and one super-trawler, British-flagged but Dutch-owned, has 94% of the English herring quota in the Atlantic and North Sea[9]. Small-scale coastal fishermen, who operate 80% of Scottish boats, have have only 1% of quotas[10].

The UK's inshore fisheries groups have the potential to improve the management of fisheries to reduce bycatch. The aim of inshore fisheries groups is to involve commercial and recreational fishermen and other local interests in the management of fisheries within 6nm of the shore, enforce national and European fisheries legislation, ensure representation in decision-making and mediating in fisheries disputes such as conflicts between mobile and static gear fishermen. Part of this is the formulation and implementation of Fisheries Management Plans. In England there are ten Inshore Fisheries and Conservation Authorities (IFCAs); in Scotland there are five Regional Inshore Fisheries Groups (IFGs). Northern Irish inshore fisheries are managed by the Inshore and Environmental Branch. In Wales, three informal Inshore Fisheries Groups provide advice to the Welsh Marine Fisheries Advisory Group. Whereas IFGs (in Scotland) can only advance management recommendations to Marine Scotland, the English IFCAs are statutory bodies which have the power to set local by-laws and have enforcement powers (such as criminal prosecution or financial penalties for non-compliance). Pieraccini and Cardwell (2016) suggest that the three key elements of co-management they identified (empowerment, inclusiveness of membership, and procedures allowing self-nomination) are more developed in England than they are in Scotland. This will influence how IFGs or IFCAs may be encouraged to address the issue of cetacean bycatch.

A key difficulty with the part played by SSCF in harbour porpoise bycatch is the lack of reporting requirements for smaller inshore vessels, and therefore the data deficit regarding the inshore fleet's fishing activities (see also Section 2.2). There have been a number of schemes to increase the information available on inshore fishing activities such as The European Fisheries Fund (EFF) 'Evidence Gathering In Support of Sustainable Scottish Inshore Fisheries' research projects which focused on the future of the inshore fishing industry and took place over 12 months, concluding in Autumn 2015, including projects such as equipping some vessels with AIS, and training fishermen to collect data used for stock assessment through self-sampling/reporting[11,12]. Currently the Scottish Inshore Fisheries Integrated Data System is in development. Funded by European Maritime and Fisheries Fund (EMFF), the 30-month project started in 2016, with a team at the University of St Andrews developing an integrated system for collecting and analysing data from the Scottish inshore fishing fleet. The objective is to use technology and novel processes to involve the fishing industry more directly in data gathering in order to inform fisheries management and planning. The project aims to make use of the increased availability of low-cost, open source mobile technology and communications (such as the development of a data-input app for smart phones) which make it much more realistic to gather data from large numbers of small vessels, often operating in remote areas[13,14]. These types of schemes using cheaper, more accessible technologies to address data deficits in inshore fisheries may assist by providing a means for reporting cetacean bycatch data, and

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[8] http://lifeplatform.eu/wp-content/uploads/2017/12/Fishy-Business-in-the-EU.pdf
[9] https://www.theguardian.com/commentisfree/2018/jun/11/brexit-uk-fishermen-fishing-industry-quotas-uk-government
[10] http://lifeplatform.eu/wp-content/uploads/2017/12/Fishy-Business-in-the-EU.pdf
[11] http://www.ifgs.org.uk/files/2814/2122/6328/IFG-Newsletter-Winter-2014-15.pdf
[12] http://www.ifgs.org.uk/files/4614/7150/7318/IFG_newsletter_2016.pdf
[13] http://www.ifgs.org.uk/files/8414/8672/3454/rifg_newsletter_spring_2017.pdf
[14] http://www.ifgs.org.uk/files/3315/2293/2006/rifg-newsletter-spring-2018.pdf

therefore improving monitoring. The Marine Management Organisation (MMO) are currently (November 2018) consulting on the introduction of catch recording for the under 10m fleet[15].

2.2 UK Fisheries Data Reporting Requirements

UK fisheries are controlled and monitored under EU legislation (chiefly Council Regulation (EU) No. 1380/2013 and No. 1224/2009), under which the reporting requirements are set out[16]. In the UK, these activities are Devolved and managed separately, but all with common standards to ensure the UK as a whole is in compliance with EU legislation. UK fisheries administrations (Marine Management Organisation (MMO), Marine Scotland, Department of Agriculture and Rural Development Northern Ireland (DARD), Welsh Government etc.) provide guidance notes for fishermen on what their reporting obligations are, and collect and process fisheries data from which statistics are collected. The UK Government Guidance on fishing data collection notes that the master, owner or charterer of a licensed fishing vessel can also be required to provide information under the Sea Fisheries (Conservation) Act 1967 and the Sea Fish (Conservation) Act 1992.

Vessels over 10m in length are legally required to complete fishing logbooks to record data on the vessel's fishing activity by trip, and each day of activity within a trip. Data recorded on catch include species, and quantity, the fishing gear used and the area where the fish were caught (to the resolution of ICES rectangle). This system aims to achieve full coverage of activity. In the UK, vessels need to submit their data to UK authorities within 48 hours of landing. Landing declarations must also be submitted on the species, weight etc. of landed fish. First sales of fish also require sales notes[17]. Vessels 12m and over in length are expected to submit these data electronically (via the electronic reporting systems (ERS), or 'e-logbook'), as are buyers and sellers with an annual turnover of first sale fish of more than €400,000. The reliability of the data collected is dependent on the information provided by fishermen, and a proportion of fishing activity is not adequately reported[18]. The mixture of UK manual and automatic checks on the information provided by vessel operators include cross-checking logbooks, sales notes and observed landings in addition to the use of satellite position reports, and aerial and at-sea inspections and surveillance. Vessel Monitoring System (VMS), a satellite based control system, has also been mandatory for EU vessels with a length of 12m or more since 1 January 2012 (prior to which is was over 15m), which provides data on the position, heading and speed of vessels.

Vessels of 10m and under are currently not required to declare their catches but this may change in 2019[19]. Until 2005, any information collected was done so voluntarily in co-operation with the fishing industry and comprised log sheets, landing declarations, sales notes and landing information from port officials and market sources. In 2005, the Registration of Buyers and Sellers of First-Sale Fish Scheme was introduced, requiring registered buyers to provide sales notes for commercially sold fish. Information such as gear and fishing area are not recorded on the sales note but this detail can be added by coastal staff based on their knowledge and observations.

The annual statistical publication from the MMO UK Sea Fisheries Statistics, is produced in September every year. Also see Section 3.1.

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[15] https://marinedevelopments.blog.gov.uk/2018/11/29/catch-recording-app-fishing/
[16] Information is this section is from https://www.gov.uk/guidance/fishing-activity-and-landings-data-collection-and-processing
[17] https://www.gov.uk/government/publications/buyers-and-sellers-of-first-sale-fish-and-submission-of-sales-notes/sales-notes-completion-and-submission#what-are-electronic-logbooks
[18] https://www.gov.uk/guidance/fishing-activity-and-landings-data-collection-and-processing
[19] https://marinedevelopments.blog.gov.uk/2018/11/29/catch-recording-app-fishing/

2.3 Obligations under EU legislation for monitoring and mitigation of bycatch

UK fisheries are currently managed by the European Common Fisheries Policy (CFP) Regulation including a specific bycatch-related Regulation. There are additional European legal requirements with respect to implications for protected species such as cetaceans under the Habitats Directive and Marine Strategy Framework Directive, which have been transposed into UK legislation.

2.3.1 Habitats Directive (92/43/EEC)

The primary objective of the Habitats Directive is the maintenance or restoration, at Favourable Conservation Status, of the natural habitats and species of wild fauna and flora of Community Interest. Terms such as 'Favourable Conservation Status' are not precisely defined but the Directorate-General for Environment of the European Commission (DG Environment) issued guidance in 2007 regarding the implementation of the Directive[20]. This guidance notes that Favourable Conservation Status could be described as a situation where a habitat type or species is doing sufficiently well in terms of quality and quantity and has good prospects of continuing to do so in future. Member States are also required to establish a system to monitor the incidental capture and killing of all cetaceans, and to take measures to ensure that incidental capture and killing does not have a significant negative impact on the species concerned.

The provisions requiring the designation of Special Areas of Conservation (SACs) for species listed on Annex II which includes the harbour porpoise are described in section 2.6.

2.3.2 Marine Strategy Framework Directive (MSFD)

Directive 25 2008/56/EC of the European Parliament and Council (2008) established a framework for community action in the field of marine environmental policy: the Marine Strategy Framework Directive (2008). This is the mechanism by which EU Member States should take the necessary measures to achieve or maintain Good Environmental Status (GES) in the marine environment by the year 2020, through developing and implementing strategies to protect the marine environment and maintain biodiversity. The Directive recognises the importance of MPAs in achieving these aims, including those designated under the Habitats Directive. Whereas the Habitats Directive established the principle and basis for habitat and species protection, the Marine Strategy Framework Directive sets out the measures required by Member States to achieve GES which are subject to review and must be carried out within given timeframes. Bycatch mortality in relation to population status is covered by the Biological Diversity (species and habitats maintained) descriptor and the Elements of Marine Food Webs descriptor.

2.3.3 Regulation 812/2004

Current measures for addressing harbour porpoise (and other cetacean) bycatch in the UK are primarily those set out in Council Regulation (EC) No 812/2004[21]. This European legislation has been in place since 2004, but is currently in the process of being reviewed and potentially replaced. Its requirements, to which the UK currently adheres, comprise use of pingers (Articles 1-3), bycatch monitoring (Articles 4-5), and bycatch reporting. The monitoring component includes the requirement for at-sea observer schemes to monitor cetacean bycatch from a proportion of vessels of 15m or over in length in 'at risk' fisheries. The stated aim is for sufficient observer coverage to achieve a bycatch estimate of the most commonly caught cetacean species with a CV of less than 0.3, but the Regulation does not specify a proportion of effort which must be monitored. For vessels of under 15m in length, data are collected by means of studies or pilot projects. In the UK, the monitoring scheme, which has been in place since 2005 and is funded by DEFRA and Marine

[20] http://ec.europa.eu/environment/nature/conservation/species/guidance/pdf/guidance_en.pdf

[21] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32004R0812

Scotland, is managed by SMRU, in partnership with CEFAS and AFBINI and concentrates effort in the Celtic Sea, English Channel and Irish and Scottish waters. The UK conducts at-sea observations of a range of UK fisheries which are known or suspected to incur cetacean bycatch, and also monitors effort of some vessels under 15m. In 2017, 217 dedicated protected species bycatch monitoring days were conducted during 157 trips on board static net vessels (Northridge et al. 2018).

Regulation 812/2004 also mandates for the use of pingers on fishing vessels of 12m and over in length which fish using specified types of gillnets and entangling nets 'in areas and fisheries with known or foreseeable high levels of by-catch of small cetaceans', which in the UK means bottom-set gillnets or entangling nets in the North Sea and southwest England (ICES Divisions 7 d,e,f,g,h and j), bottom-set gillnets or entangling nets with mesh sizes 220mm or more operating in Subarea 4 or Division 3a, and bottom set gillnets or entangling nets the total length of which does not exceed 400m during the months of August, September or October in Subarea 4 or Division 3a.

The legislation also requires EU Member States to report annually on monitoring effort, fisheries effort, bycatch estimates and summaries of the observers' reports and pinger use. An annual review of these reports is carried out by the ICES Working Group on Bycatch of Protected Species (WGBYC) – see below.

Regulation 812/2004 has had its problems. Read et al. (2017) provide a review of its shortcomings and of levels of implementation by Member States. Briefly, Regulation 812/2004's problems fall into two categories:

i) insufficient scope of its monitoring, mitigation and reporting requirements in terms of spatial area, vessel and gear type;
ii) the inadequacy of compliance and implementation of these requirements.

Successive reviews of the legislation by the EC, ICES and ASCOBANS have all highlighted the lack of implementation, uncertainty in the data and inadequate mitigation (Read et al. 2017). Read et al. (2017) consider each EU Member State's compliance with its obligations under Regulation 812/2004. According to the authors, on the whole, Member States are not complying fully with their obligations. However, because even basic statistics of the fishing fleet are unclear, there is uncertainty as to how many vessels from each Member State require monitoring and mitigation under the Regulation, and therefore the degree to which they are in compliance. The UK is considered to be generally compliant with the requirements of Regulation 812/2004. Read et al. (2017) judge the UK to have achieved 'Good' compliance with the Reporting, Monitoring and Mitigation requirements of the Regulation over the period 2006 to 2014. It is the only EU nation to be judged to have good compliance in all categories.

However, how effective the measures are in reducing UK harbour porpoise bycatch is a separate issue. The scope of the at-sea monitoring scheme has not been sufficient to fully assess cetacean bycatch. Northridge et al. (2017) report that in 2016, 315 dedicated bycatch monitoring days were conducted during 177 trips on board static net vessels. In 2017, there were 217 dedicated monitoring days during 157 trips on board static net vessels (Northridge et al. 2018). In 2016 there were 33790 days of fishing recorded with gillnets, with 31475 in 2017 (Northridge et al. 2017, Northridge et al. 2018). Thus less than 1% of the days at sea were monitored by dedicated schemes, with almost no monitoring of smaller vessels.

For pinger use, although compliance with the pinger deployment obligation by UK vessels is considered to be good, based on the inspections that have been undertaken (Northridge et al. 2017, Read et al. 2017, Northridge et al. 2018), the majority of UK vessels which fish using gillnets are under 12m in length, and therefore not required to use pingers. For example, Northridge et al. (2017) report that during 2016, there were 1153 UK registered vessels using static nets. Of that number, only 23 were required to use pingers (that is, they were 12m or longer and fishing in the areas and using the type of gear that required them to do so). In English and Welsh waters, 13 inspections of over 12 metre gillnet vessels were carried out at sea and in port during 2016, all in ICES Subarea 7. Two infringements were detected.

In 2017, of 1256 vessels using static nets, 24 vessels required pingers. There were 21 inspections, all in ICES Subarea 7, of over 12 m gillnet vessels carried out at sea and in port during 2017. Two infringements were detected (Northridge et al. 2018). Static net vessels over 12m comprised 2% of the UK static net fleet in 2016 and 2017 (although were responsible for 45% of the total landings by the netting sector). In their 2017 report on 2016 Regulation 812/2004 implementation, Northridge et al. (2017) state that for 2016, the best estimate of porpoise bycatch in all UK gillnet fisheries was 1482 in the absence of pingers, 1250 if all over 12m boats used pingers in relevant areas. For 2017, the best estimate for bycatch in the absence of pingers was 1282, but 1098 if the vessels which were required to use pingers all did so (Northridge et al. 2018). The estimate of around 180 porpoises 'saved' annually assuming full compliance with the pinger requirements of 812/2004 has been similar since the estimate was first produced in 2013.

2.4 Cetacean Bycatch Monitoring

Onboard fisheries observers are considered to be the best way of obtaining bycatch estimates (IWC 2018). Results from observer monitoring schemes are reviewed annually by ICES Working Group on Bycatch of Protected Species (WGBYC). However, fisheries observer schemes are expensive, and consequently their coverage is often insufficient to generate estimates of bycatch (Mangi et al. 2015, Mortensen et al. 2017).

Moves under the Common Fisheries Policy towards a discard ban and Fully Documented Fisheries have involved the development of technologies which can provide more comprehensive coverage than observers, but retain an acceptable level of accuracy (Mangi et al. 2015, Needle et al. 2015, Mortensen et al. 2017, Plet-Hansen et al. 2017). Some of these technologies and changes in practice are also being used to improve cetacean bycatch monitoring. The most obvious of this is remote electronic monitoring (REM) techniques which provide video surveillance of fishing activities - handling for species identification and monitor retained and discarded catch, but can also be used for bycatch monitoring[22]. WWF reports on REM in fisheries management (WWF-UK 2015, WWF-UK 2017) provide detailed breakdowns of what REM can deliver, including the costs and the advantages in fisheries. REM combines video cameras with gear sensors and position data and records all fishing activity for later analysis. The resulting video data can either be used in their entirety (sometimes viewed greatly speeded up), or more usually samples of the data can be reviewed and compared with self-reported data. REM can be used as a substitute for or additional to fisheries observers to provide total catch data, for monitoring protected species, to provide spatial data on fisheries by using REM in conjunction with VMS data, and to check logbook reports from fishing vessels to verify participatory monitoring programs, and also to document cetacean bycatch (Mangi et al. 2015, Mortensen et al. 2017). REM systems have been trialled and are in use globally in a range of fisheries, areas and with a variety of target species (Mangi et al. 2015). However the uptake of REM in European fisheries has been limited and generally has not achieved the levels required to accurately monitor bycatch.

Amongst the challenges with REM, Mangi et al. (2015) report that skippers and crew are often not in favour of their fishing activities being recorded on video for reasons of privacy, although Plet-Hansen

[22] https://www.ascobans.org/sites/default/files/document/ASCOBANS_WS_REM_2015_Report.pdf

et al. (2017) note antipathy towards REM being higher amongst fishermen who had no experience of REM than amongst those who had. Technical problems (some of which are applicable to using REM for cetacean bycatch) include limitations of systems in large volume or mixed fisheries where the species present are not easy to distinguish from each other, problems with camera and image quality, camera orientation, and shortcomings with the analysis process (Mangi et al. 2015, Needle et al. 2015, Mortensen et al. 2017). The expense of the equipment, monitoring, maintenance, in addition to training, analysis and crossing-checking/validating the data are significant but when compared to monitoring using observers, can be cost effective (WWF, 2017). For example Kindt-Larsen et al. (2011) estimate the costs per vessel of installation and annual maintenance of the system, as well as the costs of analysing the data collected in their Danish trial as €10 200 and €4100, respectively (based on 300 days at sea and 500 hauls per year, and price data for 2009). They compare these costs to those on onboard observers: the annual cost of a Danish observer onboard for 300 days is approximately €200 000. Kindt-Larsen et al. (2011) note that the REM system delivers much the same data for 10% of the cost, providing continuous monitoring of all trips and hauls. Recent estimates for the UK fleet are around £4000 per vessel per year for hardware and analysis costs. These costs have reduced due to advancements in technology and review procedures[23].

A 2015 ASCOBANS workshop on REM[24] concluded that 'from a technical perspective REM could be used successfully to monitor small cetacean bycatch, but decisions whether REM was the best and most cost effective option would depend on the specific situation' and that consideration would need to be given to the type of monitoring, type of fishing fleet and variation in technical and personnel costs. For example, although the costs of REM compare favourably with observers, on small coastal vessels which may be the fleet that most requires monitoring for harbour porpoise bycatch, such systems can be logistically difficult to install and operate. However advances in the technology are resulting in new equipment being developed which, for example, overcomes some of the need to provide power from the vessel. The ASCOBANS report notes that there might be difficulties using REM on very small vessels without a wheelhouse or a hard structure for mounting or adequate power supplied, and alternative systems might have to be developed that were more suitable, or adjustments made to the vessels themselves.

REM systems in the Netherlands were used from September 2013 to March 2017 to estimate harbour porpoise bycatch and evaluate the practical feasibility of the system. Observations were compared between fishermen, an initial team monitoring the REM video (watching it at high speed) and a second inspection of the REM video (watched a slower speed, but higher than normal speed). Out of a total of six bycaught porpoises observed by all methods combined, one individual was missed by the fishermen and detected by the REM, one individual was detected by the fishermen and missed by the REM, and one was missed by both and detected on the second inspection of the video. The study also led to a number of recommendations to improve REM systems including making them more portable and easy to switch between vessels (Scheidat et al. in prep).

It is possible that porpoises dropping out of the net before coming on board would be missed by all observation methods including onboard observers. Kindt-Larsen (2012) noted that REM was more likely to detect bycatch which dropped out of the net before coming onboard than fishermens' logbooks, because in many cases fishermen were too busy working to observe bycatch which did not come through the hauler. However, the trials in the Netherlands also showed that an animal which dropped out of the net was missed by observers watching the REM video (Scheidat et al. in prep). Onboard observers who are aware of the dropout issue and not involved in other tasks would be most likely to detect dropouts. Tregenza et al. (1997) found that of 43 porpoises observed as

[23] https://greeneruk.org/sites/default/files/download/2018-11/The_importance_of_Remote_Electronic_Monitoring_1.pdf
[24] https://www.ascobans.org/sites/default/files/document/ASCOBANS_WS_REM_2015_Report.pdf

bycatch, 16 were seen to drop out of the net spontaneously and four others were first seen floating within 20m of the boat during or soon after hauling. Thus only around 50% of the bycaught animals were brought on deck. However, camera systems could be deployed to monitor nets as they emerge from the water which may improve the detection of drop outs.

2.5 Cetacean Bycatch Mitigation

Leaper and Calderan (2017) review mitigation methods which have been researched and implemented for all cetaceans including harbour porpoise. In the UK, the most widely used of these are pingers. The UK is generally considered to be compliant with the requirements for pinger use in Regulation 812/2004 (see Section 2.3.3). Regulation 812/2004 requires quite a narrow specification for pingers in terms of sound output. In 2012 the UK Government authorised the use of DDD-03L pingers and notified the European Commission accordingly (Northridge et al. 2017). The derogation was extended until 2018. Based on UK observer data, the bycatch rate of porpoises in nets properly equipped with pingers since 2008 has been 83% lower than the overall observed rate in nets without pingers and in 2017, it was estimated that UK porpoise bycatch was reduced by around 180 due to the use of pingers (Northridge et al. 2018). However, as discussed, only a small proportion of UK vessels fishing with gillnets are currently required to use them, chiefly because the vessels are under 12m in length (static net vessels over 12 m account for just 2% of the UK static net fleet in terms of vessel numbers (Northridge et al. 2018)). The overall effect on bycatch reduction has therefore been limited, as highlighted by successive ICES WGBYC reports.

However, more widespread mandatory pinger use would not necessary be desirable or effective. Leaper and Calderan (2017) review the efficacy of pingers, and their limitations. With respect to harbour porpoises, most studies and experiments such as those reviewed by Dawson et al. (2013), show that they can produce substantial reductions in bycatch with no habituation. However, a key issue is enforcement and compliance levels, which need to be addressed when using pingers. Currently in the UK, compliance with pinger deployment is considered to be good (Read et al. 2017). However, it only needs to be checked and enforced amongst a very small number of vessels. Even in these circumstances, the practical implementation of mitigation and compliance have been impacted by pinger cost, reliability and failure rates (Kingston and Northridge 2011, Dawson et al. 2013). It is likely that a wider requirement for pinger use amongst smaller vessels in the inshore fleet would involve greater expense and logistics issues making it more difficult, both for the vessels themselves and also for monitoring and enforcement. As discussed by Leaper and Calderan (2017), if pingers are not deployed correctly (in terms of spacing, spatial coverage, deployment depth, maintenance and replacement of batteries), they can result in higher bycatch than nets with no pingers. Therefore any wider roll-out of pinger requirements would have to be properly funded and monitored with a robust regulatory and compliance structure suitable for small inshore fisheries.

There have been developments in pinger design, such as the alerting device, the Porpoise Alarm (PAL), developed by F3: Forschung. Fakten. Fantasie (Heikendorf), which generates synthetic harbour porpoise click trains based on recordings of aggressive interactions between captive animals at a frequency of 133 kHz (Culik et al. 2016). The aim is to stimulate harbour porpoise to increase their echolocation rate, rather than physically avoid the area (Culik et al. 2016). To test their effectiveness, from 2014 to 2016, PAL devices were deployed by the Thünen Institute of Baltic Sea Fisheries (Rostock) on a small number of German and Danish commercial gillnet vessels in the Baltic (50% of nets set with PALs, 50% without), and first results showed a bycatch reduction of 70%. Porpoises increased their echolocation activity but were not attracted to the devices[25]. However, PALs were trialled in Iceland in April 2018 in the cod gillnet fishery, and the results were not so encouraging; when the devices were tested in two cetacean bycatch hotspots in northern and

[25] http://lifeplatform.eu/wp-content/uploads/2017/06/Culik_DAGA_2017_ENG.pdf

southeastern Iceland, where nets were set 50% with PALs, 50% without, 23 porpoises were bycaught, twelve were caught in the sets with PALs, and eleven in the control sets. The study also noted that eleven of the twelve porpoises bycaught in the nets fitted with PALs were large adult males, and eight were found very close to a PAL device, suggesting that that adult males might have been investigating or attracted to the PALs. In the control sets, there were seven males and four females bycaught (ICES 2018). Notwithstanding this outcome of the Icelandic trials, in April 2017, 1700 PALs were issued to fishermen on the German Baltic coast (Schleswig-Holstein). This was a voluntary agreement to which 234 fishermen had signed up by mid-2018, and fishermen started to market their fish as 'harbour porpoise friendly'. This scheme did not initially involve any monitoring of the effectiveness of the PALs. However in April 2018 it was recommended to the German authorities that a long-term monitoring programme should be put in place[26].

Fishtek Marine has developed the 'banana pinger'. Whilst the device works like a standard pinger (a broadband signal with the aim deterring porpoises from nets), it is marketed as being cheaper, easier to deploy and more durable that standard pingers, and therefore more likely to be used consistently. Some studies have shown it to be similarly effective to other pinger models (ICES 2018). In Norway, a small pilot study with two types of pingers was conducted in 2017 to assist in the planning of a larger scale experiment in commercial fisheries from July 2018. The Future Oceans' porpoise pinger and the Fishtek's Banana pinger were used (ICES 2018). In the cod fishery, a total of 11 porpoises was observed caught (2 from 1723 net-weeks of nets with pingers, and 9 from 2535 net-weeks without pingers) suggesting a 70% reduction in bycatch in nets with pingers. There were only 3 porpoises observed caught in nets set for monkfish (1 from 3411 net-weeks with pingers and 2 from 7084 net-weeks without pingers). These small sample sizes were not sufficient to determine any differences in catch rates (ICES 2018). In Iceland, when banana pingers were tested in April 2017 in the cod gillnet fishery in west, north and southeast Iceland (with 50% of the nets fitted with pingers, and 50% not), eleven cetaceans (nine harbour porpoises and two white beaked dolphins) were caught. Six of those (five harbour porpoises and one white beaked dolphin) were caught in the sets equipped with banana pingers, while five animals (four harbour porpoises and one white beaked dolphin) were caught in the control sets. There was similar size and gender composition of the bycaught animals between the nets with pingers and the controls, neither was there a difference in catch or species composition of fish (ICES 2018).

The experience of programs such as the US National Marine Fisheries Service Harbor Porpoise Take Reduction Plan (HPTRP) where pinger use was mandated in combination with other mitigation measures such as time-area restrictions, other gear modification requirements, outreach, training and education, demonstrates that for the most effective bycatch reduction, pingers should not be used in isolation, but with other mitigation methodologies (Palka et al. 2008, Orphanides and Palka 2013, Read 2013). Simulation modelling also suggests that a combined approach of using time-area closures in conjunction with pingers could effect the most substantial porpoise bycatch reduction (van Beest et al. 2017). Changes and reduction in effort by the fisheries themselves also likely played some part in the bycatch reduction in the Gulf of Maine (Read 2013).

With harbour porpoise, habituation to pingers does not appear to be so much of a concern as with other species (Dawson et al. 2013). However Kindt-Larsen et al. (2018) recently found some evidence of habituation to one type of pinger and recommend specific further experimental trials to investigate response to pingers.

Habitat exclusion is also an issue with pingers, as are other environmental, welfare and behavioural impacts such as the introduction of noise into the marine environment. Harbour porpoise are particularly sensitive to underwater noise (Nabe-Nielsen et al. 2018), which may impact on their

[26] http://www.un.org/depts/los/general_assembly/contributions_2018/ASCOBANS.pdf

foraging success, with population-level impacts especially if used in high-quality porpoise foraging habitat. Van Beest et al. (2017) concluded that widespread deployment of pingers can have important indirect population-level consequences that challenge their usefulness as an independent bycatch mitigation measure. It has also been suggested that pingers result in reduced echolocation rate by porpoises (Culik et al. 2001). Given these issues, and the expense and long-term maintenance obligations of pingers, there are problems with considering them to be a long-term solution to gillnet bycatch.

In the EU, ICES WGBYC reports have noted that one of the weaknesses of Regulation 812/2004 is an over reliance on the use of acoustic deterrent devices to mitigate bycatch. Although they do reduce bycatch of harbour porpoise in gillnets, gillnets do not just catch harbour porpoises, and pingers can be less effective with other species of small cetaceans (ICES 2016). Gillnets' wide use is at least in part because as a fishing method they are relatively cheap and simple. In the UK in 2016, vessels under 10m fishing with drift and fixed nets had operating costs that were 74% of their income compared to 81% for those using demersal trawls or seines, and 79% for those using pots or traps (Seafish, 2017). Much of this is accounted for by fuel use, which is lower for drift and fixed (36 litres per day) than for demersal trawls or seines (66 litres per day) or pots and traps (47 litres per day).

However gillnets are not compatible with the welfare and conservation of small coastal cetaceans where their ranges overlap. As Taylor et al. (2016) note with reference to vaquita, 'Gillnet fisheries … pose serious extinction risks for vaquita and other coastal species of megafauna. Bycatch in gillnets remains the greatest threat to marine mammals (Reeves et al. 2013) with more than 600,000 killed each year (Read et al. 2006)…Stopping the cascade of extinctions that will deplete coastal waters of local species will take international support to develop alternative gear and to market the resulting seafood'. Whilst it is not straightforward to shift small coastal fisheries in the UK away from gillnets and towards either other fishing methods already in existence or towards developing alternative gears, neither is it straightforward to require all vessels to deploy and use pingers correctly and consistently. Although as discussed, fishing with gillnets is relatively low cost and simple, mandatory pinger use would largely remove these advantages. Under these circumstances, moving away from gillnets towards other fishing methods looks more viable. For example, UK fisheries data suggest that the cost of fishing with hooks is already lower than fishing with gillnets. For vessels under 10m fishing with hooks only 66% of their income was operating costs, using only 29 litres of fuel per day (Seafish 2017). As previously discussed (Leaper and Calderan 2017), whilst pingers are effective in certain areas and fisheries, better fisheries management including effort restrictions and change in gear are an important part of the solution, especially in small coastal fisheries.

An action of the ASCOBANS Conservation Plan for Harbour Porpoises in the North Sea is to review pinger use and gear modifications. The progress report in 2018 noted the need to find mitigation measures that are both practical and effective and that development of alternative gears may be the most desirable longterm solution to porpoise bycatch[27].

Other alternative gears such as hooks (long and hand lines), light trawls or cod pots, and gear modifications were reviewed by Leaper and Calderan (2017). Modifications to gillnets such as stiffened and acoustically reflective nets have generally proven ineffective at reducing bycatch. In the UK, hooks are in use in some fisheries which fish for the same target species as gillnets (see Section 5). Light trawls have been used in the Gulf of California as an alternative to gillnets for catching shrimp (Rojas-Bracho and Reeves, 2013) but would need development specific to UK fisheries. Cod pots have been used as an alternative to gillnets in Sweden (Königson et al. 2015) and

27 https://www.ascobans.org/sites/default/files/document/AC24_Doc._3.2.b_Progress%20Report%20on%20the%20Conservation_HP_NS_Plan.pdf

there is currently a project in Scotland assessing the use of pots or traps as a novel way to harvest commercial species of finfish[28].

2.6 SACs/SCIs relevant to harbour porpoise in UK and EU

Council Directive 92/43/EEC (EC Habitats Directive), which protects and conserves habitats and species, is transposed into UK law by the Conservation of Habitats and Species Regulations 2017 in England and Wales. In Scotland, the Habitats Directive is transposed through the Habitats Regulations 2010 (in relation to reserved matters) and the Conservation (Natural Habitats &c.) Regulations 1994. The Conservation (Natural Habitats, &c) Regulations (Northern Ireland) 1995 (as amended) transpose the Habitats Directive in relation to Northern Ireland.

Under the Regulations there is provision for the designation and protection of 'European sites', the protection of 'European protected species', and the adaptation of planning and other controls for the protection of European Sites. The Secretary of State of Member States must propose a list of sites which are important for either habitats or species (listed in Annexes I and II of the Habitats Directive respectively) to the European Commission. When agreed by the Commission, and EU Member States have agreed that the sites submitted are worthy of designation, they are identified as Sites of Community Importance (SCIs). Member States must then designate these sites as Special Areas of Conservation (SACs) within six years. The Regulations provide for the protection of European marine sites, requiring the country agencies to advise other authorities of the conservation objectives for a site, and also of the operations which may affect its integrity.

As part of their inclusion under Annexes II (Species of Community interest whose conservation requires the designation of Special Areas of Conservation) and IV (Species of Community interest in need of strict protection) of the Habitats Directive, harbour porpoise are afforded a certain amount of protection including through the provision of a network of Natura 2000 SACs. These have potential to be used as a tool for reducing threats to harbour porpoise, including fisheries bycatch, with measures within protected areas also potentially useful for minimising bycatch across wider populations.

When SACs are designated, the status of species present at each site is assessed in a number of ways, the primary parameter being an overall grade (from A to D) for the population based on the 'best expert judgement' of its size (where estimated) and density present on the site as a percentage of population present within the national territory, based on the progressive model: A: 100% >= p > 15%, B: 15% >=p> 2%, C: 2% >=p> 0% ,D: non-significant population[29].

Grades A and B relate to sites in which a species is a primary reason for site selection. Sites where the species is listed on the site details as a qualifying feature are graded C, and sites are graded D if a non-significant population is present. Designated SACs where the harbour porpoise is listed as a non-qualifying feature (graded 'D'), are not very helpful in conservation terms, as no specific measures are required for conservation of D-graded species – they do not feature in the site management scheme and are not taken into account in any subsequent decision-making process or protection required under Article 6 of the Habitats Directive (Evans and Prior 2012). Article 6 defines how SACs should be managed and protected: the designation of SACs requires the implementation of conservation measures which correspond to the ecological requirements of Annex I habitats and Annex II species present on the site (Article 6(1)). Article 6(2) requires that appropriate steps be taken to avoid the deterioration of habitats and significant disturbance to species for which the SAC

[28] https://www.fiscot.org/projects/projects/fis025-novel-approaches-to-fish-catching-and-surveying-using-traps/

[29] http://ec.europa.eu/environment/nature/legislation/habitatsdirective/docs/standarddataforms/notes_en.pdf

is designated. Article 6(3) states that any new plan or project should be assessed in terms of its implications for the site and to ensure that it does not have any negative implications for an SAC. The plan or project should not go ahead if it adversely affects the integrity of the site, unless there are no other options, or there is a strong imperative.

Within the EU as a whole, of the 277 Natura 2000 sites designated for harbour porpoise, with reference to population, 12 are graded A, 30 graded B, 105 graded C whilst 127 are graded D (for three sites the grading is not available)[30] – see Table 2.

Table 2. Natura 2000 sites SACs/SCIs designated/proposed for harbour porpoise (November 2018)

Member state	Sites graded A (population)	Sites graded B (population)	Sites graded C (population)	Sites graded D (population)	Grade not given	Total number of sites
Belgium	1	0	1	3	0	5
Bulgaria	1	7	6	0	0	14
Denmark	0	3	14	48	0	65
France	2	1	23	19	0	45
Germany	3	4	24	10	0	41
Greece	0	0	0	5	2	7
Ireland	0	0	3	1	0	4
Netherlands	0	2	6	0	0	8
Poland	1	3	0	0	0	4
Portugal	0	1	0	0	0	1
Romania	1	3	2	2	0	8
Spain	0	0	15	5	1	21
Sweden	1	3	9	0	0	13
UK	2	3	2	34	0	41
Total	12	30	105	127	3	277

In the UK, although a number of SACs have included harbour porpoise as a non-qualifying feature (grade D) for some years, a failure to submit any sites for the harbour porpoise to the European Commission for which the species is a primary reason for site selection was a matter of discussion and concern, leading to the EU issuing legal infraction proceedings against the UK Government for failing to adhere to the Habitats Directive[31]. This resulted in a data analysis and consultation process which led to the proposal of six new sites (see Figure 12):

- Inner Hebrides and the Minches (Grade A)[32]
- Southern North Sea (Grade A)[33]
- West Wales Marine / Gorllewin Cymru Forol (Grade B)[34]
- North Anglesey Marine / Gogledd Môn Forol (Grade B)[35]
- Bristol Channel Approaches / Dynesfeydd Môr Hafren (Grade B)[36]

[30] https://eunis.eea.europa.eu/
[31] http://europa.eu/rapid/press-release_IP-16-3128_en.htm
[32] https://eunis.eea.europa.eu/sites/UK0030393
[33] https://eunis.eea.europa.eu/sites/UK0030395
[34] https://eunis.eea.europa.eu/sites/UK0030397
[35] https://eunis.eea.europa.eu/sites/UK0030398
[36] https://eunis.eea.europa.eu/sites/UK0030396

- North Channel (Grade C)[37]

In the six new sites (currently at SCI stage of designation), unusually there are no habitats or other species listed as part of the designation – they are harbour porpoise sites only. There is also a seventh site, Skerries and Causeway in Northern Ireland, which was designated as an SCI in 2013 and an SAC 2017, and includes harbour porpoise with a grade C listing[38] for population. These new designations mean the UK now has 41 Natura 2000 SACs or SCIs which include harbour porpoise in their designation of which (2 grade A, 3 grade B, 2 grade C , 34 are grade D (for harbour porpoise population)).

Other European countries have been more timely in their designations of SACs for which the harbour porpoise is a primary reason for site selection. In total there are now twelve which list porpoises with an A grading (including the two new UK sites). However, within those sites, although most list commercial fishing activities such as netting and benthic or demersal trawling as identified pressures/threats, it is not clear that any has defined or enacted specific fisheries bycatch related actions to be taken to protect harbour porpoises within the SAC (notwithstanding general fishing regulations that exist throughout a nation's territorial waters)[39]. At a European level, SACs have not yet been used as a tool to leverage protection for porpoise from bycatch, even when porpoises are a primary reason for site selection. In 2016, Germany initiated a consultation process for fisheries management under Article 11 and Article 18 of Regulation (EU) No 1380/2013 of the European Parliament and of the Council of 11 December 2013 on the CFP in the Natura 2000 sites within the German EEZ in four MPAs in the North Sea (Sylt Outer Reef, Eastern German Bight, Borkum Reef Ground, Dogger Bank). The proposals included habitat protection through the exclusion of bottom-contacting fishing gear, and limitations/bans on gillnet fishing and use of REM in certain areas to reduce and monitor harbour porpoise bycatch. However, objections were raised to the proposals by France, the UK, the Netherlands and Denmark about the proportionality of the measures, a lack of evidence of impacts, concerns about CCTV, lack of bycatch data and displacement of fishing effort; the management measures have yet to be put in place[40]. At the time of writing, it appears that only one SAC where harbour porpoise is a Grade A feature, the Rapotamo SAC in Bulgaria, had any agreed fisheries management measures designed to reduce bycatch, requiring the use of repellent devices on fixed fishing gear.[41]

A 2015 Scottish Government Business and Regulatory Impact Assessment relating to the introduction of new fisheries management measures for MPAs and SACs stated that Article 6(3) should be made to apply to changes in fisheries policy, and other fisheries management plans, meaning that all changes in fisheries policy or fisheries management plans (or the development of new management arrangements) would require to be tested against the provisions in Article 6(3) with additional management measures as necessary[42]. However, in both the Scottish SCI and the other five newly designated areas, there is little or no overlap between areas of high gillnet effort and the newly-listed SCIs (see Section 3.3.) In Scotland, the Inshore Fishing (Monofilament Gillnets) (Scotland) Order 1996 already prohibits fishing for sea fish with a monofilament gillnet in Scottish inshore waters (6 nautical miles) with a mesh size of less than 250mm.

[37] https://eunis.eea.europa.eu/sites/UK0030399
[38] https://eunis.eea.europa.eu/sites/UK0030383
[39] https://eunis.eea.europa.eu/species/1510
[40] WWF internal correspondence
[41] https://eunis.eea.europa.eu/sites/BG0001001
[42] 'Introduction of new fisheries management measures for Marine Protected Areas (MPAs) and Special Areas of Conservation (SAC), Socio-Economic Analysis'

2.7 Harbour porpoise bycatch mitigation outside of UK

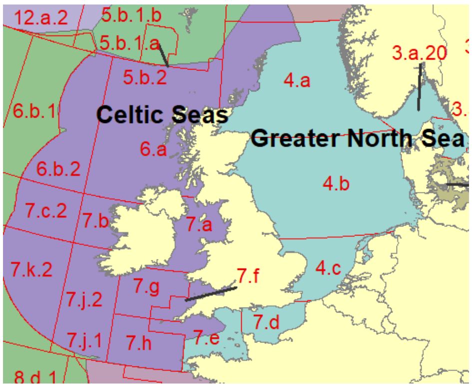


Figure 1. ICES Ecoregions and statistical areas around the UK[43]

The ICES Working Group on Bycatch of Protected Species (WGBYC) assesses EU Member States' actions under Regulation 812/2004, advising the ICES Advisory committee as to how these obligations are being met and how monitoring and mitigation can be improved[44]. Within the EU, the only Member State with a dedicated Protected Endangered and Threatened Species (PETS) observer programme is the UK. Other Member States use non-dedicated observers through the Data Collection Framework (DCF) ((EC) No 2017/1004), Data Collection Multi-Annual programme (DC-MAP) (Commission Decision 2016/1251/EU), or other national fisheries monitoring programmes. Member States' harbour porpoise bycatch mitigation and monitoring schemes generally do not go beyond their obligations under Regulation 812/2004, which they fulfil with varying levels of diligence. Read et al. (2017) review the levels of implementation of Regulation 812/2004 by Member States from 2006 to 2014. They assess each Member State individually for their fulfilment of monitoring, mitigation and reporting obligations. In the majority of cases, the authors assess Member States' implementation to be either partial or, in some cases poor. Only the UK was assessed as being in good compliance with 812/2004. However as noted earlier, compliance with 812/2004 does not necessarily mean that mitigation is effective given the small percentage of vessels to which it applies.

Actions taken by Member States on harbour porpoise bycatch reported under 812/2004 obligations are collated annually by the ICES WGBYC. The themes drawn from the reports from year-to-year by the Working Group vary little, covering issues from the requirements of Regulation 812/2004 to its implementation by Member States. These include the short-comings of Regulation 812/2004 (chiefly that it does not cover fishing activity with the highest bycatch), insufficient monitored effort (of both areas and fishing methods) to make assessments of bycatch impact, variable quality and scope of the submissions, the likely underestimation of bycatch events in data recorded by non-dedicated observers whose main focus is other tasks, lack of compliance by Member States in pinger deployment and reporting. The reports note that without an accurate estimate of total fishing effort from relevant EU waters, with considerable uncertainty about how representative the effort reported under Regulation 812/2004 by Member States is, the scope for evaluating the magnitude of bycatch mortality is greatly limited (ICES 2015, ICES 2016, ICES 2017, ICES 2018). Of the coastal Member States which fish in areas with harbour porpoise distribution and which are covered by Regulation 812/2004, the majority (but not all) generally report on their implementation of Regulation 812/2004 (either via the EC or directly to the WGBYC). Member States provide

[43] www.ices.dk
[44] http://www.ices.dk/community/groups/Pages/WGBYC.aspx

information on the monitoring which they have undertaken, their fulfilment of pinger deployment requirements, and any other information on research or activities (for example some Member States report data from their strandings schemes) (ICES 2017, ICES 2018). In relation to Members' actions specifically regarding harbour porpoise and gillnet/set net bycatch monitoring, most either have no observer schemes for monitoring marine mammal bycatch in set nets (e.g. in most years Belgium, Sweden, Slovenia, Lithuania), or collect data under the Data Collection Regulation scheme (DCR), DCF schemes, or other national fisheries schemes (e.g. in most years Denmark, Latvia, Estonia, Germany, France, Spain, Poland, Portugal and the Netherlands). The EU Data DCF is generally not considered to be an appropriate system for monitoring small cetacean bycatch, as sampling effort is mainly targeted at demersal trawls, which are not in general high cetacean bycatch fisheries, and sampling protocols were not designed to quantify the bycatch of cetaceans which sometimes fall out of nets and are not brought onboard with target species[45].

Of the Member States required to use pingers in their fisheries, levels of implementation are also variable (apart from the UK, which is in compliance). In the 2018 WGBYC report on activity of Member States, some nations reported deployment of pingers, but it was often voluntary, with the levels of compliance variable or unknown and ambiguity as to whether the devices were working (e.g. France, Germany, Denmark, the Netherlands, Poland, Portugal, Sweden, Latvia). Some Member States also reported carrying out mitigation and pinger trials and experiments. Mitigation research has included development of a porpoise alarm in German waters, research on pinger effectiveness in Danish and UK waters, and the development of alternative fishing gears in Swedish waters (ICES 2015, ICES 2018).

Outwith the EU, a few nations have addressed harbour porpoise (or other small coastal cetacean) bycatch through pingers, time-area restrictions, other gear modifications outreach, training and education, or a combination of these (Leaper and Calderan 2017). These include the Harbor Porpoise Take Reduction Plan in the northeast US, measures to protect Hector's dolphins in New Zealand, and to protect vaquita in Mexico. The US plan integrates several mitigation approaches, whilst in New Zealand and Mexico, closed areas and fishing restrictions have been the approach taken. Area-based management has the potential to be effective if the area is in the right place, is large enough, effectively manages threats, if no new threats are added, and if the threats are not simply moved elsewhere to outside the protected area (Slooten 2013). Compliance and enforcement are also of key importance, most clearly demonstrated in the case of vaquita, where several refuges and gillnet bans have been established, but have failed through lack of enforcement (Taylor et al. 2016).

3. BASELINE UK ANALYSIS OF BYCATCH RISK FOR HARBOUR PORPOISE

3.1 Information on current seasonal distribution and density of harbour porpoise in UK waters

The use of predictive models combining a range of sources of input data has the potential to inform risk analyses and mitigation strategies. The challenge is obtaining data at an appropriate spatial and temporal scale relevant to management actions that may be taken within a fishery. The well-documented changes in porpoise distribution in the North Sea (Hammond et al. 2013) highlight this challenge with respect to any spatial measures related to fishing. In order to estimate total bycatch risk there is a need for analyses based on historic distribution, and any spatial management needs to also take into account future risk within a realistic time scale for the implementation and duration of management measures.

The main sources of recent data on porpoise density covering almost all UK waters are the SCANS III survey (2016) and the Joint Cetacean Protocol (JCP Phase III). SCANS III data have not yet been fully

[45] https://www.ascobans.org/sites/default/files/document/ASCOBANS_WS_REM_2015_Report.pdf

analysed, and finer scale predictive models have not been finalised, so the data currently available are densities at the scale of the SCANS blocks. The JCP provides model-based predictions of harbour porpoise densities for 2010. There are limited data about seasonal distribution patterns for UK waters as a whole (e.g. the SCANS surveys are summer only) but where there have been year round surveys (e.g. for EIAs of offshore windfarms) these have been used within models of seasonal distribution patterns. Gilles et al. (2016) provide seasonal estimates of porpoise density for the North Sea and these have been used for risk analyses related to noise exposure (Merchant et al. 2018). Other recent modelling work includes a component of the Marine Ecosystems Research Programme (MERP) on mapping cetacean distributions in NW European Seas[46]. MERP examined data from over 2 million km of cetacean surveys between 1979 and 2017. The modelling framework included environmental data on coarse scale processes (e.g. depth, primary productivity, sea surface temperature, stratification) and fine scale processes likely to influence prey (e.g. tides, currents, eddies and seabed characteristics). Preliminary outputs include monthly maps of expected harbour porpoise distribution and overlap with gillnet fisheries.

For the North Sea the three main porpoise distribution modelling studies are Heinänen and Skov (2015) using JCP data, Gilles et al. (2016) using some of the same data but also more recent surveys from Belgium, Netherlands and Germany, and MERP (still unpublished but reported to ASCOBANS in 2018). Heinänen and Skov (2015) include predictions up to 2009 whereas Gilles et al. (2016) include data up to 2013. Heinänen and Skov (2015) and MERP cover all of UK waters and MERP also included an analysis of gillnet risk. The persistent high density areas identified by Heinänen and Skov (2015) with more than three years of survey effort are shown in Figure 2 and are:

- Three coastal areas off west Wales (Pembrokeshire and Cardigan Bay), and northwest Wales (Anglesey, Lleyn Peninsula), and part of the Bristol Channel (Camarthen Bay)
- Smaller areas north of Isle of Man (winter) and on the Northern Irish coast near Strangford Lough
- Western Channel off Start Point (summer)
- Northwestern edge of Dogger Bank (summer)
- Inner Silver Pit (North Sea)
- Offshore area east of Norfolk and east of outer Thames estuary (winter)
- Smith Bank, Outer Moray Firth (summer)
- Coastal areas off north- west Scotland, including the Minches and eastern parts of the Sea of Hebrides.

46 https://www.ascobans.org/sites/default/files/document/2.4.1%20Mapping%20cetacean%20distributions_Evans.pdf

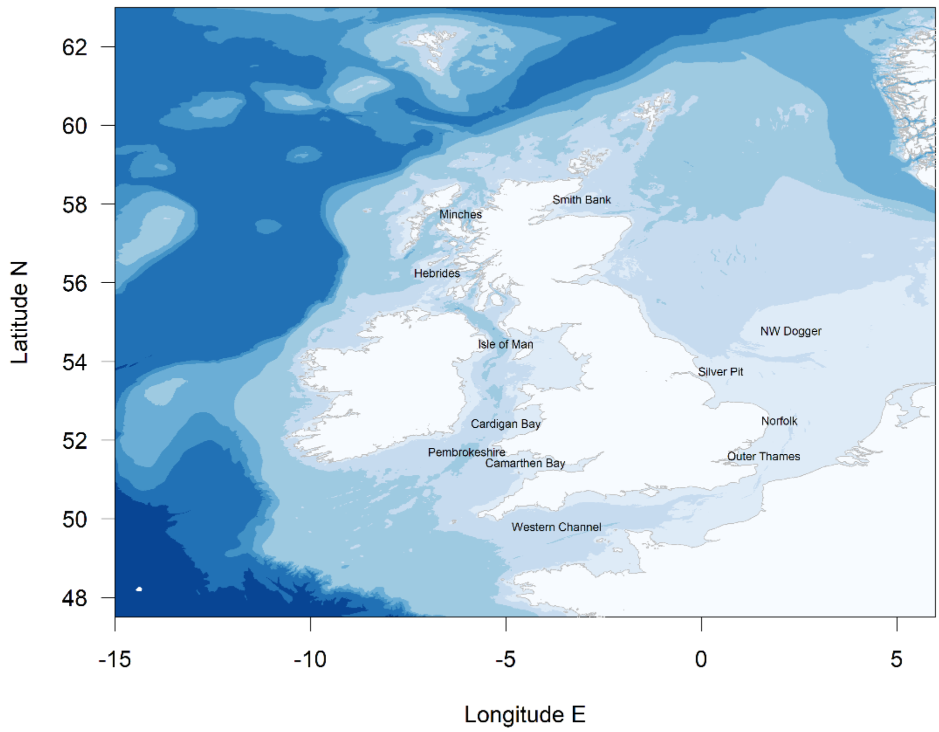


Figure 2. Persistent high density areas identified by Heinänen and Skov (2015)

Other areas identified in the same study, but with fewer than three years of surveys were:

- Parts of high density zone between western edge of Dogger Bank and Norfolk coast, including both the Inner and Outer Silver Pit areas
- Offshore area north of Shetland
- Edge of the Norwegian Trench
- Shelf edge off southwest Cornwall.

3.2 Information on gillnet effort in UK waters

There are a number of sources of data on UK fishing effort using nets that may pose a risk to harbour porpoise. These include the annual reports to the EU on UK activities under Regulation 812/2004, the annual UK fleet landings by ICES rectangle (available from MMO UK Sea Fisheries Statistics[47]) and a number of other data sources. Breen et al. (2015) use observational data mainly from fisheries protection vessels to estimate days at sea in inshore fisheries. VMS and AIS data are also used, but require processing to detect activity and there can be substantial data gaps in AIS (Shepperson et al. 2018).

Fishing and reporting regulations differ with the length of the vessel, with basic categories of 10m and under, 10-12m, 12-15m and over 15m. Within the UK the under 10m vessels are generally considered as small-scale coastal fisheries but different definitions are used in other neighbouring countries (Davies et al. 2018). There are three key sources of data for the UK fleet landings in the UK IFISH repository: the logbook of activity while at sea, the landing declaration recording the accurate weight of fish when landed, and sales notes created when the fish are first sold after landing. The

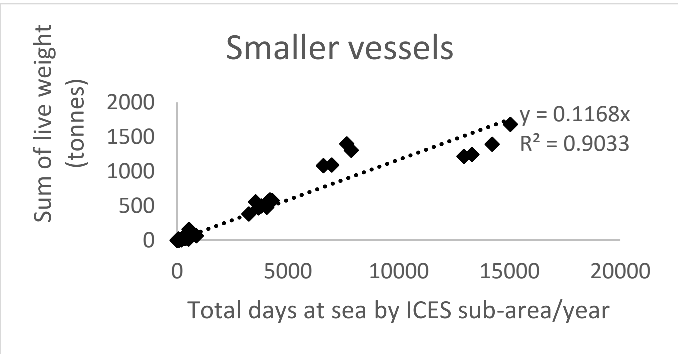
[47] https://www.gov.uk/government/statistics/uk-sea-fisheries-annual-statistics-report-2017

first two of these are required from all fishermen operating vessels over 10m overall length, the sales notes information is required for sales by all licensed vessels irrespective of length. The data includes the species, weight and value of fish landed along with details of the vessel involved, where the fish was caught, and with what gear (see Section 2.2).

The best measurement of effort in relation to bycatch risk appears to be length of net multiplied by soak time (i.e. km hours). This was the measure used by (Tregenza et al. 1997) in estimates of porpoise bycatch on the Celtic Shelf. OSPAR (2017[48]) also recommend the use of 'Net meter per day' to provide a more accurate record of fishing effort than 'days at sea' especially in the case of set nets. Kindt-Larsen et al. (2016) compared estimates of porpoise density based on satellite tracking and fishing effort with bycatch rates. They found that the best model for bycatch rate was the most intuitive net soak time multiplied by porpoise density. However, neither total net length or soak time are available in the logbook and landings data of the UK gillnet fleet.

In most cases, there are limited data available and fisheries statistics are generally limited to days at sea, landed weight of catch or landed value. The UK fisheries statistics[49] are most readily available as landed weight and landed value which are disaggregated by catch species, length of vessel (over 10m or under 10m). For the purpose of bycatch monitoring, days at sea were used in the UK reports on implementation of Regulation 812/2004 and other bycatch estimates (e.g. ASCOBANS AC24). These are normally separated into <15m and >15m vessels in order to meet the monitoring requirements of Regulation 812/2004.

In order to compare different metrics, we used ICES sub-areas and years as sampling units to compare the total days at sea reported with static nets from UK annual Regulation 812/2004 reports with the reported landings using 'Drift and fixed nets' category. Figure 3a shows the data for 'smaller vessels' with total days at sea from the <15m fleet and total live weight from the <10m fleet for an ICES sub-area in any one year (2013-2016). Figure 3b is for 'larger vessels' which are >15m and >10m in the respective data sets.



48 https://oap-cloudfront.ospar.org/media/filer_public/f3/43/f343edf0-55e0-4ec0-bc92-428f9d9b1745/harbour_porpoise_bycatch_m6.pdf
49 https://www.gov.uk/government/statistics/uk-sea-fisheries-annual-statistics-report-2017

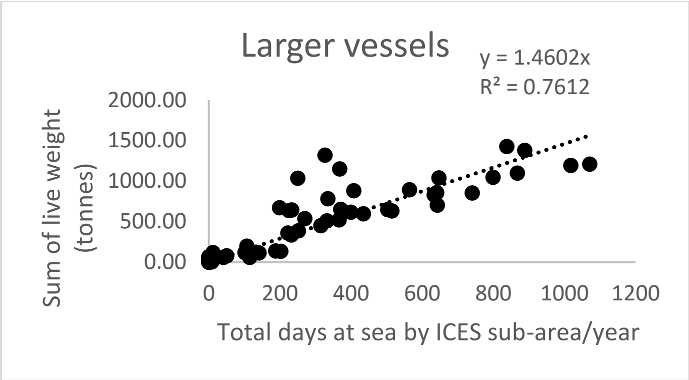


Figure 3 (a and b). Plot of reported live weight for 'Drift and fixed nets' (UK sea fisheries annual statistics) against reported total days at sea (from UK annual Regulation 812/2004 reports) for each year and ICES sub-area.

In both cases there was a strong correlation between landings and days at sea with a stronger relationship for smaller vessels ($R^2 = 0.90$) than for larger vessels ($R^2 = 0.76$). In both cases the correlation was considered sufficiently high that for the purposes of this study, days at sea or live weight could be considered as equivalently valid measures of effort provided vessels were divided into two size classes. Further analyses were all performed using live weight by ICES statistical rectangle (Figures 5, 6, 7) as a measure of effort. The aim is to include more information from the under 10m sector, which is required to report sales, but is often not included in assessments of days at sea such as by ICES. Live weight corresponds very closely to landed weight ($R^2 = 0.99$ across ICES rectangles) but may be a better representation of effort where there was an operational or commercial reason for a lower landing weight.

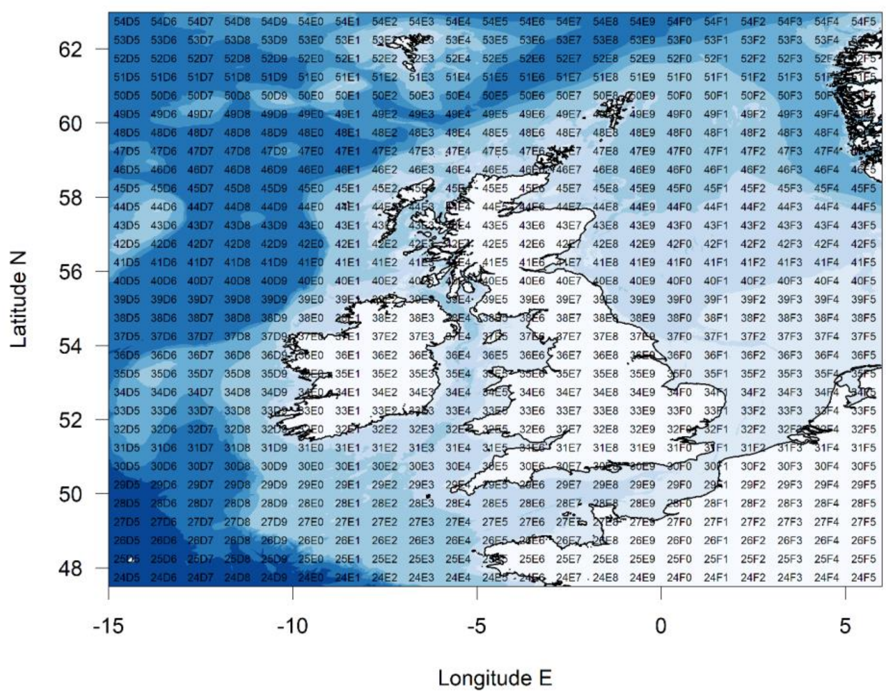


Figure 4. Four digit codes of ICES statistical rectangles (30' of latitude by 1° of longitude)

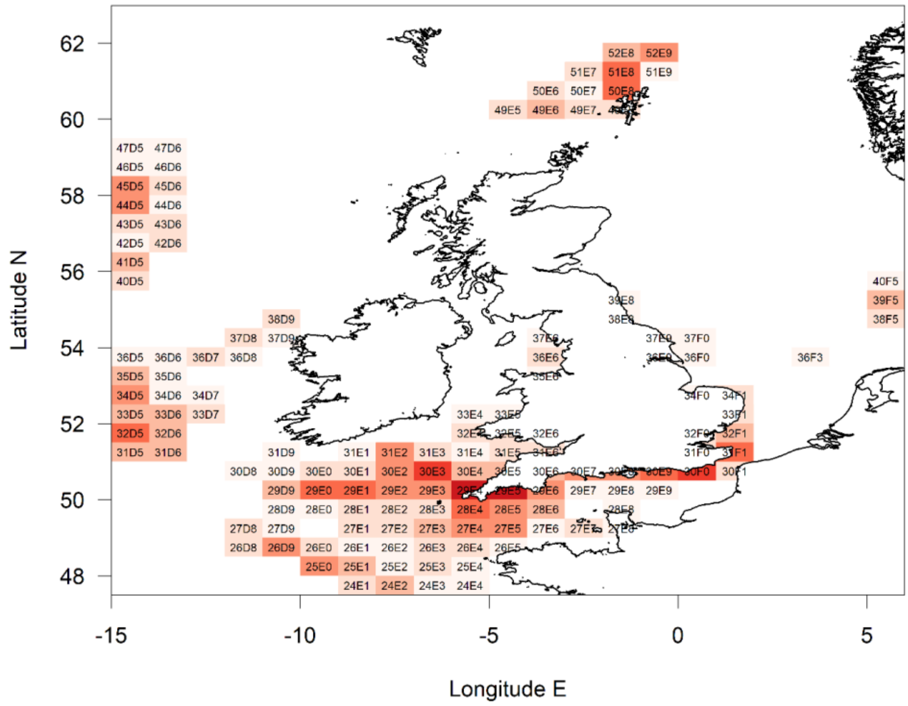


Figure 5. Drift and set net effort for 2017 estimated by reported live weight (UK sea fisheries annual statistics – all vessels). Labels are ICES statistical rectangles. See Figure 7 for scale.

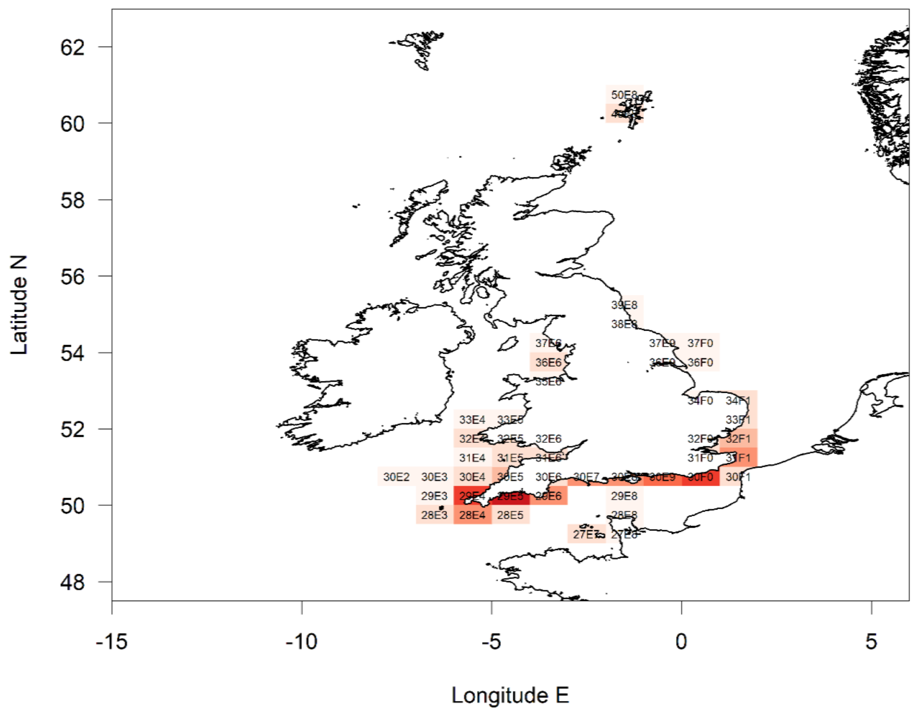


Figure 6. Drift and set net effort for 2017 estimated by reported live weight (UK sea fisheries annual statistics). Vessels less than 10m length. Labels are ICES statistical rectangles. See Figure 7 for scale.

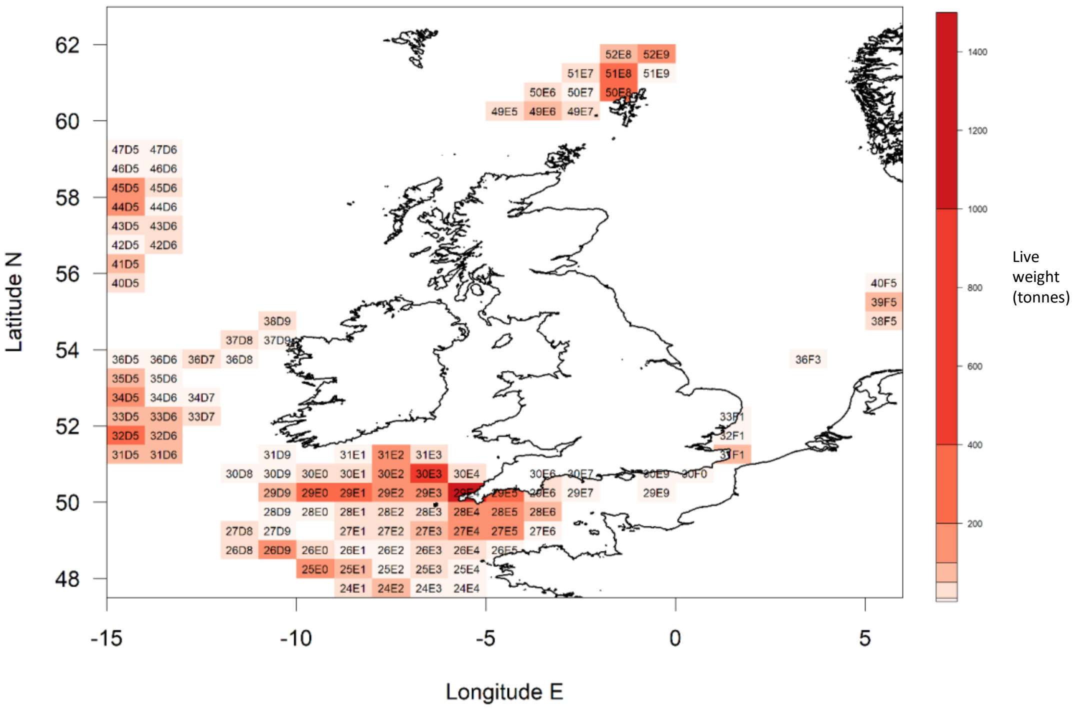


Figure 7. Drift and set net effort for 2017 estimated by reported live weight (UK sea fisheries annual statistics). Vessels more than 10m length. Labels are ICES statistical rectangles.

Of the areas identified by Heinänen and Skov (2015) as having persistent high densities of porpoises there is significant overlap with gillnet fishing effort in the following areas:

- Western Channel south of Start Point
- East coast of Norfolk and outer Thames estuary
- Areas of Bristol Channel and SW Wales
- North of Shetland
- Shelf edge off southwest Cornwall

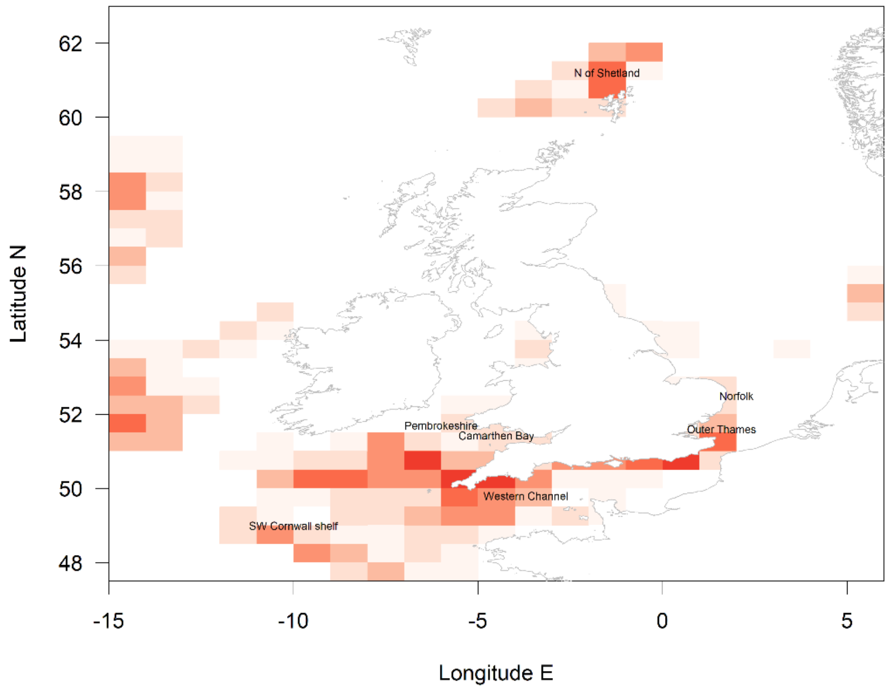


Figure 8. Areas identified by Heinänen and Skov (2015) as having persistent high densities of porpoises with overlap with gillnet fishing effort

Of these, there are parts of the Bristol Channel and southwest Wales that overlap with the SCIs (Bristol Channel Approaches and West Wales Marine) and a limited area of the Southern North Sea SCI. However, all gillnet effort in UK shelf waters in Figure 4 overlaps with known porpoise distribution to some extent. Gillnet effort by under 10m vessels is concentrated in southern England and particularly along the south coast (Figure 6).

The total value of all UK drift and set nets is fairly constant throughout the year (Figure 9) but there are seasonal patterns in some areas. The total value also declined slightly across years (Figure 10) but with some changes by area. In order to examine the most recent changes we looked at the 2017 value as a fraction of the five year total. The rectangles with landed value > £100,000 with the most substantial increases in 2017 are shown in Table 3 and highlighted by shading in Figure 9.

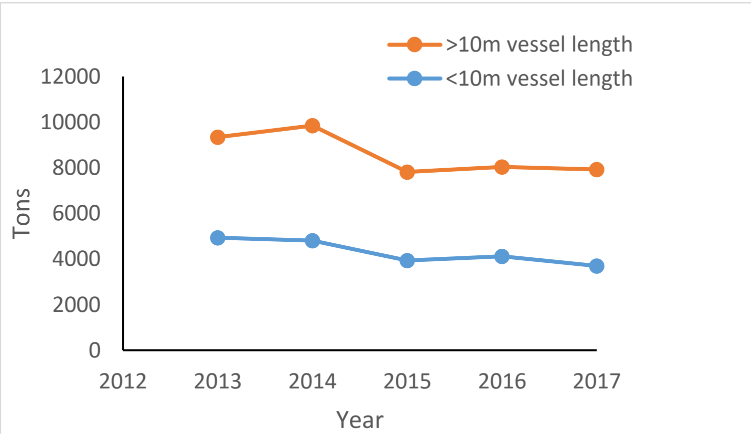


Figure 9. Total catch by drift and fixed nets by year (UK sea fisheries annual statistics)

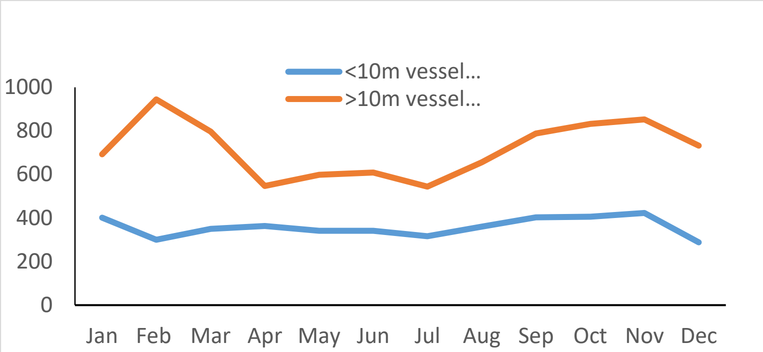


Figure 10. Total average catch (2013-2017) by drift and fixed nets by month (UK sea fisheries annual statistics)

Table 3. Total landed value of catches using drift and fixed nets over the period 2013-2017 with the total proportion in 2017.

ICES rectangle	Landed value £ (Limited to > £100,000)	2017 as a fraction of total value (2013-2017)
30E5	366096	0.65
39F5	134577	0.59
34D5	384808	0.49
30E3	2706411	0.48
45D5	706142	0.47
29E0	1603486	0.40
40D4	199139	0.36
28E6	426245	0.34
30E6	618361	0.31
30E7	2148613	0.31
38F5	179395	0.30
40D5	415333	0.27
26D8	516085	0.27
27E5	1127633	0.27
28E5	1305679	0.25

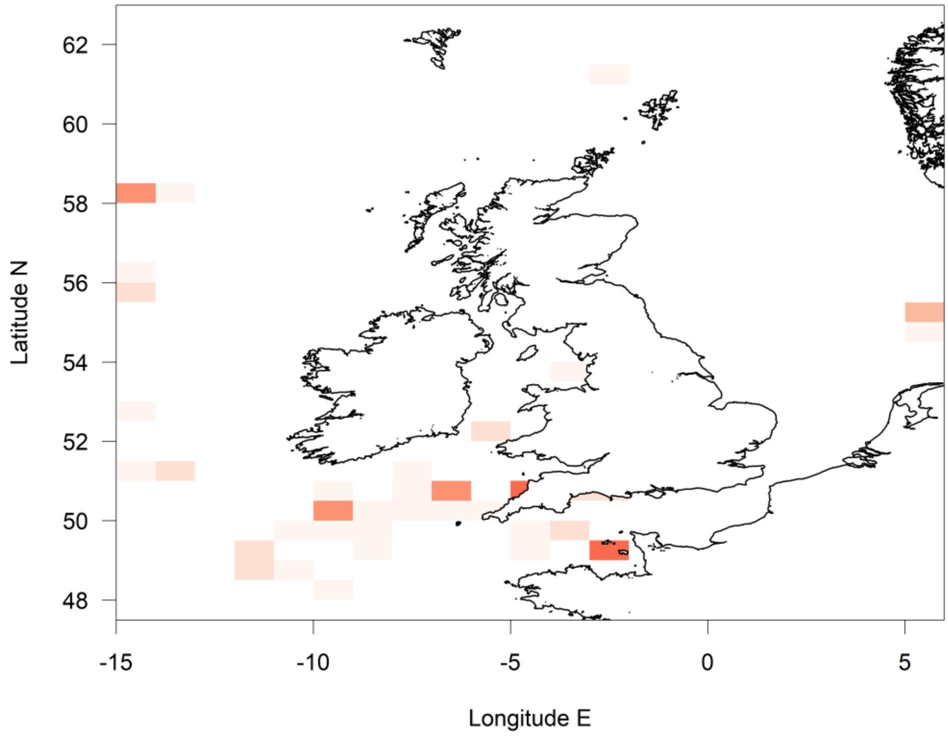


Figure 11. ICES rectangles showing a substantial increase in landed value from drift and fixed nets in 2017 compared to 2013-2016, shaded by total value (UK sea fisheries annual statistics).

These show an increase in gillnetting activity in 2017 in some areas of the Channel and SW approaches. There was generally no increase in the North Sea. One of the areas to show the largest increase was around the Channel Islands of Guernsey and Jersey. Here the main species targeted with gillnets is pollack. There is still more caught with hooks than gillnets, but gillnet use has increased substantially. It is not clear whether this trend will continue, but areas with increases in gillnet catches merit further investigation in order to try to understand what is driving these changes.

3.2.1 Summary by ICES rectangle of areas with reported gillnet effort (2017 data)

In order to gain a better understanding of the fisheries in ICES rectangles with high gillnet effort we examined the main species that were caught and any seasonal or inter-annual trends. These results are summarised in Table 5. The main intention of this is to guide further localised investigations of specific coastal fisheries where there may be possibilities to investigate use of alternative fishing methods.

Table 4. Summary of main catch species by drift and fixed nets by ICES rectangles

ICES rectangle	Area	Total reported live catch from drift and fixed nets by weight (tonnes)	Description
27E7	Jersey and Guernsey	20	All <10m dominated by pollack (54%), but net catch of pollack slightly lower than catch using hooks.
28E5	Offshore S Devon	146	Dominated by > 10m boats (92% of 146t in 2017). Mainly pollack, 78% of live net weight. No obvious trend over years.
29E1	Celtic Shelf	277	>10m targeting hake, 70-80% of reported live weight
29E2	Celtic Shelf	186	>10m targeting hake, 70-80% of reported live weight

29E3	Celtic Shelf	187	>10m targeting hake, 70-80% of reported live weight
29E4	N. Cornwall	1911	In 2017, 490 tonnes for under 10m vessels dominated by monks/anglers (20%) and pollack (20%). Over 10m 1420 tonnes of which 94% pilchards, believed to be ring netting and unlikely to cause porpoise bycatch.
29E5	SW Devon	1382	62% pilchards out of a total of 1382t in 2017 down from a peak of 2819t live weight in 2012. 75% 10m and under. Need to find out how pilchard fishery operates. Pilchards are mainly winter with little between Apr-August. pollack also important.
29E6	SE Devon	189	95% 10m and under. 19% pollack out of 392t in nets in 2017. 20% sole and plaice. Pollack is a winter fishery mainly Jan-Apr.
30E4	N. Cornwall offshore	67	In 2017, 67 tonnes, dominated by turbot (27%) and hake (21%). Only 20 tonnes from under 10m vessels.
30E5	N. Devon	77	In 2017, 77 tonnes all from under 10m vessels, 46% pollack.
30E7	Dorset	148	35% sole and plaice out of 165t in nets in 2017.
30E8	Hampshire	187	31% sole and plaice out of 203t in nets in 2017. 99% 10m and under. Mullet quite important. General lack of porpoises in this area along UK coast (e.g. Laran et al. 2017) but this does not rule out presence in the future.
30E9	Sussex	331	Net gear only 10% of total live weight (20% for under 10m). 99% of net live weight 10m and under.
30F0	Kent and East Sussex (Brighton to Dungeness)	465	All (99.7%) 10m and under vessels net effort. Net gear only 10% of total live weight (24% for under 10m). Net live weight peaked at 830t in 2014 before dropping to 465t in 2017. 47% of live weight sole and plaice. Bass had been important but almost none by 2017. Peaks in live weight April and October/November, lowest in Jan/feb.
31E5		11	In 2017, 11 tonnes, around 50% thornback ray.
31F1	Coast of Kent from Thames Estuary south	229	10m and under vessels. Drift and fixed nets account for 23% of total live weight. Other fishing activity mainly pots and traps (60%). Not much variation in live weight by month. Substantial decline in net catches in 2016 and 2017 compared to previous years (around 320 tonnes 2013-2015 dropping to 156t in 2017). Sole is 22% of catch but 43% of value. Overall live weight peaks in April and then again in October. Over 10m vessels. Only 73t of live weight in 2017 (32% of net live weight). 93% was thornback ray. So in summary net effort is dominated by 10m and under vessels.
32E4	SW Wales, Pembrokeshire	10	All by vessels less than 10m. In 2017, 10.5 tonnes of which 62% was thornback ray
32E5		24	In 2017, 24 tonnes, 32% bass, 29% thornback ray
32F1	Essex and northern Thames Estuary	98	Just 4% of total live weight from nets. Steady decline since 2013 from 156t to 98t in 2017. Was dominated by bass but in 2017 sole was largest (32% of weight). 96 % of live weight in nets from under 10m vessels.
33E4	West Wales, NW Pembrokeshire	9	All by vessels less than 10m. In 2017, 9.3 tonnes of which 97% was pollack.
33E5	West Wales, Cardigan Bay	3	All by vessels less than 10m. In 2017, 2.5 tonnes of which 83% was spider crab.
33F1	Suffolk	46	68% of live weight herring mainly <10m but some <10m vessels.
34F1	Norfolk	17	85% of live weight herring out of 17t in nets in 2017.
36F0	E. Yorkshire	2	Less than 2 tonnes in 2017, all by under 10m vessels, mainly cod.
37F0	N. Yorkshire	1	1 tonne total in 2017, all by under 10m vessels, mainly sea trout.
49E5	West Shetland	22	99% monks and anglers, all larger than 10m vessels
49E6	West Shetland	60	99% monks and anglers, all larger than 10m vessels
49E7	West Shetland	16	99% monks and anglers, all larger than 10m vessels
49E8	Coastal Shetland	16	16 tonnes, 87% cod, all under 10m vessels
50E6	NW Shetland	15	97% monks and anglers, 99% > than 10m vessels
50E7	NW Shetland	4	97% monks and anglers, 99% > than 10m vessels
50E8	NW Shetland	390	97% monks and anglers, 99% > than 10m vessels
51E7	N Shetland	25	95% monks or anglers, all > 10m vessels
51E8	N Shetland	381	95% monks or anglers, all > 10m vessels
51E9	N Shetland	4	95% monks or anglers, all > 10m vessels

52E8	N Shetland offshore	61	93% monks or anglers, all > 10m vessels
52E9	N Shetland offshore	197	93% monks or anglers, all > 10m vessels

3.3 Spatial overlap between porpoise distribution and gillnet effort for UK harbour porpoise SCIs

The overlap between the UK SCIs and gillnet fishing effort is shown in Figure 12 and further described in Table 5 by each individual SCI. We describe the qualitative estimates of modelled harbour porpoise density for each SCI and the amount of fishing with drift and fixed nets together with any other more specific information on fishing locations (Breen et al. 2015) The intention is to assess the amount of current gillnet fishing within the SCI and the likely bycatch risk compared to adjacent areas. In particular, we try to summarise the potential implications of restricting gillnet use within the SCI. There is limited scope for reducing porpoise bycatch by measures to reduce the risk from gillnets within the SCIs, and in some cases a need for caution if effort might be displaced to other areas of possibly higher density. However, through management plans and stakeholder involvement, SACs may facilitate trials with alternative gear that could then be encouraged elsewhere. There may also be possibilities from stakeholder contacts made during the SAC consultations to encourage such work in areas adjacent to the SAC.

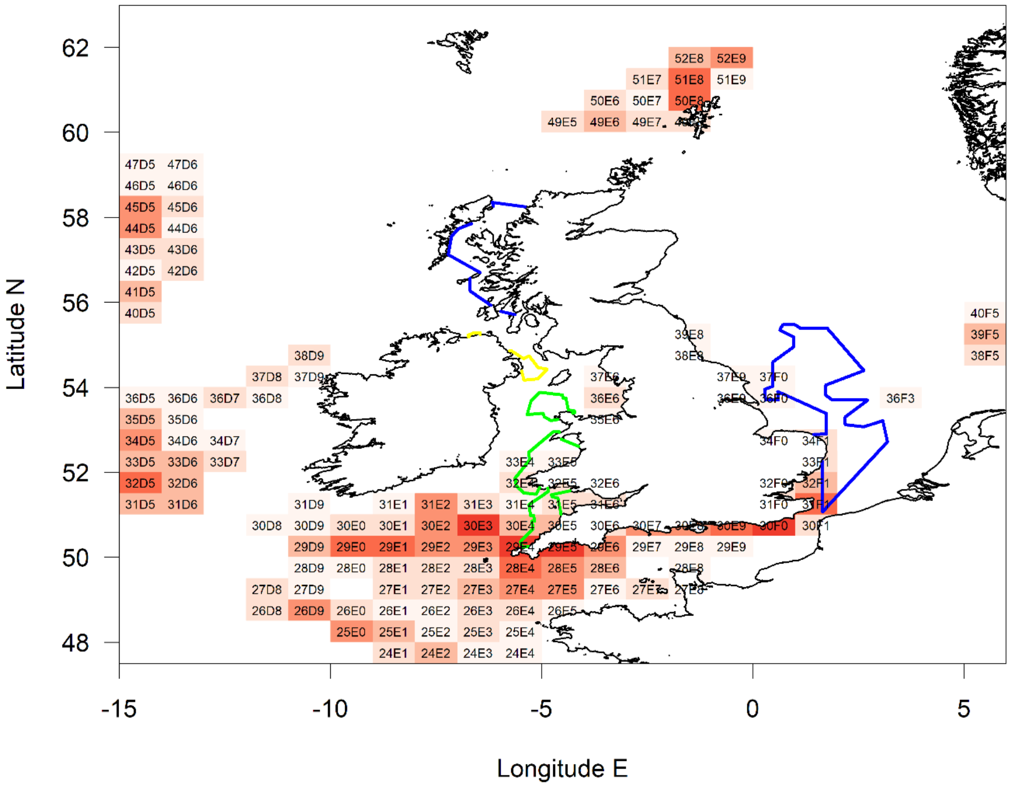
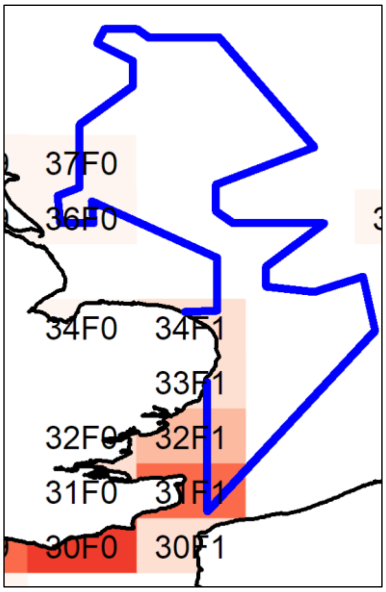
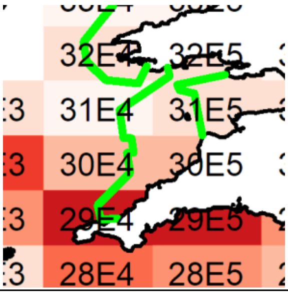


Figure 12. Overlap of SCIs with ICES Rectangles. Shading in rectangles indicates total gillnet catch for 2017 excluding pilchards which are caught in ring nets unlikely to cause bycatch (UK sea fisheries annual statistics). Blue = A, Green = B, Yellow = C for population grading of SCI

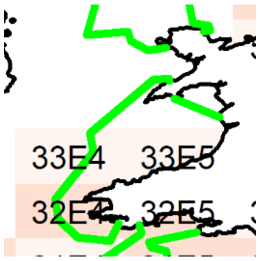
Table 5. Summary of information on fishing activity and porpoise distribution for each of the UK SCIs

Southern North Sea	
JNCC 2016 assessment	UK registered vessels >12m: Negligible effort of Vessel Monitoring System (VMS) registered vessels using static net gears within the site UK registered vessels <12m: current exposure is unknown. EU registered vessels: higher effort of static net setting than UK vessels with two concentrated areas. Effort in the south east appears to have increased between 2009 and 2013. One option for management could be to extend the pinger requirement to further vessels.
Overlap with ICES rectangles with drift and set net effort	31F1, 32F1, 33F1, 34F1, 36F0, 37F0 Breen et al. (2015) found that almost all the net effort in the Thames Estuary and off Kent coast in 31F1 and 32F1 would be west of the SCI. Similarly, effort in 37F0 will be to the west but there may be a small amount of overlap in 36F0. Limited effort in 33F1 and 34F1 would be within the SCI.
Overlap with SCANS III block(s). SCANS III densities (individuals km^{-2})	L (0.607),O (0.888)
Description of modelled porpoise density from Gilles et al 2016 in SCI	Includes high density spring, summer and autumn areas in the north of the SCI west of Dogger Bank. Generally low densities predicted off the Norfolk coast. High densities predicted in spring for the southern tip of SCI but also concentrations further south and west into Thames Estuary and Dover Strait.
Description of modelled porpoise density from MERP (ASCOBANS 24) in SCI	Includes year round areas of high density in the north of the SCI. Also predicts concentrations around the Norfolk coast. Does not predict high densities to the south and west.
Overlap of predicted porpoise density and gillnet effort	The highest gillnet effort is in 31F1 (156t in 2017) but had been much higher in earlier years. Most of this appears to be west of the SCI. Dedicated surveys (Laran et al. 2017) also reported high numbers of sightings in summer that overlap with the southern tip

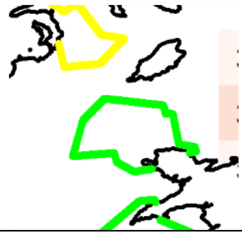
	of the SCI but also to the south and west. Hence there appears a substantial bycatch risk but mainly to the west of the SCI. Catches using nets in 33F1 and 34F1 are relatively small (less than 20 tonnes in 2017, mainly of herring) so unlikely to be a significant bycatch issue. Catches in 36F0 were very small (< 2tonnes) in 2017.
Potential implications of restricting gillnet use within the SCI	The bycatch within the SCI is expected to be low due to low fishing effort and will be lower than adjacent areas particularly to the west in the Thames Estuary and Dover Strait where fishing effort is higher. In these areas the model predictions for porpoise densities are rather different and so it is not clear if displacing effort from the SCI would increase or decrease risk, but either way the changes would be small.

Bristol Channel Approaches / Dynesfeydd Môr Hafren	
JNCC 2016 assessment	UK registered vessels >12m: negligible activity within most of the site. Higher effort in the western offshore area of the site. Welsh Vessels <12m (majority of Welsh small scale commercial fleet) that include static nets have minor effort and negligible to no bycatch. English vessels <12m: static net effort in the site is currently unknown. Monitoring data show harbour porpoise bycatch to be of greatest concern in UK waters in the South Western Approaches (ICES VIId-g) (Northridge et al. 2014). Recreational netting also occurs at a low level of effort along the coast (at least in Wales) with negligible to no bycatch EU registered vessels: little evidence from Vessel Monitoring Systems (VMS) of >12m non-UK vessels currently using static net gears within the site. One option for management could be to extend the pinger requirement to further vessels.
Overlap with ICES rectangles with drift and set net effort	29E4, 30E4, 30E5, 31E4, 31E5, 32E5 Some effort in 30E4 is likley to be coastal (Breen et al. 2015) and hence will be within the SCI, whereas for 31E5 most effort will be outside.
Overlap with SCANS III block(s). SCANS III densities (individuals km^{-2})	D (0.118)
Description of modelled porpoise density from Heinänen and Skov (2015).	Includes high density areas in winter with much lower densities in summer. The SCI is on the eastern edge of the main predicted offshore winter concentration. Year round concentrations predicted close to the Welsh coast.
Description of modelled porpoise density from	Relatively low densities predicted year round, but lowest in winter.

MERP (ASCOBANS 24) in SCI	
Overlap of predicted porpoise density and gillnet effort	Highest overlap will be in 29E4 with the <10m vessels which reported around 490 tonnes in 2017. Over 10m vessels are almost exclusively catching pilchards with purse seine or ring nets unlikley to cause proposie bycatch. Under 10m vessels in 30E4 caught 20 tonnes and 79 tonnes in 30E5. All of this is likley to be wihin the SCI. Much of the catch (24 tonnes in 2017) in 32E5 will be within the SCI.
Potential implications of restricting gillnet use within the SCI	Any displacement of Cornish coastal gillnet effort to the west could bring it into higher density areas. Vessels might also switch to fishing on the south coast which Heinänen and Skov (2015) predict as having some persistent high density areas. Along the Welsh coast, the area to the west falls within the West Wales Marine SCI. To the east of the area, further up the Bristol Channel, gillnet effort is very low (11 tonnes in 31E5).

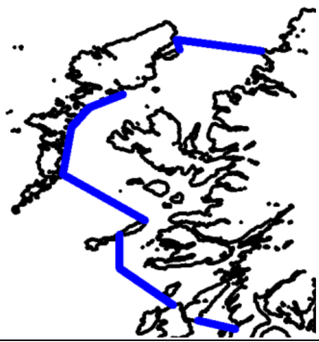
West Wales Marine / Gorllewin Cymru Forol	
JNCC 2016 assessment	UK registered vessels >12m: Negligible effort of Vessel Monitoring System (VMS) registered vessels using static net gears within the site. Vessels <10m (majority of Welsh small scale commercial fleet) include static nets: Minor to moderate effort and negligible to no bycatch. Recreational netting also occurs at a low level of effort along the coast with negligible to no bycatch. EU registered vessels: likely lower effort of static net setting in the site than UK vessels. It is currently considered unlikely that further measures will be required.
Overlap with ICES rectangles with drift and set net effort	32E4, 33E4, 33E5
Overlap with SCANS III block(s). SCANS III densities (individuals km^{-2})	E (0.239)
Description of modelled porpoise density from Heinänen and Skov (2015).	Persistent high density areas in summer across most of the SCI but also some localised all year round coastal high density in SW Cardigan Bay.
Description of modelled porpoise density from MERP (ASCOBANS 24) in SCI	Relatively low densities, year round.
Overlap of predicted porpoise density and gillnet effort	Highest gillnet effort in 32E4 likley to be close to the coast within the SCI but still very low effort (10.5 tonnes in 2017). Small amount of effort (<10 tonnes) in 33E4 and 33E5.

Potential implications of restricting gillnet use within the SCI	Currently low gillnet effort. No immediately adjacent areas of high porpoise density. Displacing effort unlikely to be an issue.

North Anglesey Marine/Gogledd Môn Forol	
JNCC 2016 assessment	UK registered vessels>12m: Evidence of low levels of static gears crossing over a small portion of the northwest corner of the site boundary. Vessels <12m (majority of Welsh small scale commercial fleet) include static nets: Minor to moderate effort and negligible to no bycatch. Recreational netting also occurs at a low level of effort along the coast with negligible / no bycatch.EU registered vessels: Evidence in Vessel Monitoring System (VMS) data of low levels of static gears (>12m vessels) crossing over the northwest of the site boundary. It is currently considered unlikely that further measures will be required.
Overlap with ICES rectangles with drift and set net effort	Currently negligible reported (< 1 ton).
Overlap with SCANS III block(s). SCANS III densities (individuals km^{-2})	E (0.239)
Description of modelled porpoise density from Heinänen and Skov (2015).	Persistent high density in summer.
Description of modelled porpoise density from MERP (ASCOBANS 24) in SCI	Relatively low densities, year round.
Overlap of predicted porpoise density and gillnet effort	Currently very little.
Potential implications of restricting gillnet use within the SCI	Currently would have little impact but not clear that the SCI has particularly higher porpoise densities than adjacent areas.

North Channel MPA	

JNCC 2016 assessment	UK registered vessels >12m: No effort of Vessel Monitoring Systems (VMS) registered vessels using static net gears within the site. UK registered vessels <12m: current exposure is unknown EU registered >12mvessels: VMS data show low levels of dispersed effort in Northern Ireland waters. It is currently considered unlikely that further measures will be required.
Overlap with ICES rectangles with drift and set net effort	Currently negligible reported (< 1 ton).
Overlap with SCANS III block(s). SCANS III densities (individuals km^{-2})	E (0.239)
Description of modelled porpoise density from Heinänen and Skov (2015).	Localised winter areas of persistent high density.
Description of modelled porpoise density from MERP (ASCOBANS 24) in SCI	Moderate density, peaking in autumn.
Overlap of predicted porpoise density and gillnet effort	Currently very little.
Potential implications of restricting gillnet use within the SCI	Currently would have little impact but not clear that the SCI has particularly higher porpoise densities than adjacent areas.

Inner Hebrides and the Minches	
JNCC 2016 assessment	SNH recommend the continued exclusion of drift nets and nets set on the sea bed (tangle, trammel, gill) to avoid the risk of entanglement/bycatch within the SCI
Overlap with ICES rectangles with drift and set net effort	Currently none reported.
Overlap with SCANS III block(s). SCANS III densities (individuals km^{-2})	I (0.397)
Description of modelled porpoise density from Heinänen and Skov (2015).	Persistent moderate densities across whole area in summer.

Description of modelled porpoise density from MERP (ASCOBANS 24) in SCI	Moderate densities across area, mainly July to October.
Overlap of predicted porpoise density and gillnet effort	Currently very little.
Potential implications of restricting gillnet use within the SCI	Currently gillnet use is restricted.

3.4 Estimates of harbour porpoise bycatch in UK waters

Estimates of total bycatch for populations are often compared to the population estimate and the ASCOBANS reference points of 1% or 1.7% of best population estimate[50]. More recent work taking uncertainty into account has shown that these reference points are likely too high to meet ASCOBANS objectives (Scheidat et al. 2013). This has been an ongoing issue of debate within ASCOBANS (e.g ASCOBANS 2015: Workshop on Further Development of Management Procedures for Defining the Threshold of 'Unacceptable Interactions'[51]). Hammond et al. (2018) describe the development of a 'Removals Limit Algorithm' to set maximum mortality limits to meet certain conservation objectives (e.g. the interim ASCOBANS objective of maintaining populations at 80% of K). They give an example for bycatch of the harbour porpoise in the North Sea. This example is based on a 50% probability that the objective will be achieved (i.e. it will fail to be achieved half the time) which may be considered rather low for achieving the interim objective since the ultimate aim of ASCOBANS is to restore and/or maintain biological management stocks of small cetaceans at a level they would reach when there is the lowest possible anthropogenic influence.

Recent estimates of bycatch in UK waters have come from the work of the ICES WGBYC based on annual reports from the UK on implementation of Regulation 812/2004 (e.g. Northridge et al 2018 and earlier years). In 2015 ICES WGBYC conducted a bycatch risk assessment for harbour porpoise in sub regions of the North Atlantic (ICES, 2015) followed by the Celtic Sea ecoregion in 2018 (ICES, 2018). For the North Sea ecoregion the 95% CI for estimated porpoise bycatch in 2013 was 1235–1990 (ICES, 2015). The bycatch risk assessment for the Celtic Sea ecoregion indicated a 95% CI for porpoise bycatch of 620-1391. This level of bycatch is 1.1-2.4% of the abundance estimate of 57,491 from 2016 for ICES subarea 7, based on data from the SCANS III survey (ICES, 2018). This indicates bycatch levels that suggest a considerable conservation concern. A large proportion of the Celtic Sea bycatch would be expected from UK fisheries in ICES area 7 whereas the UK proportion for the North Sea would be rather smaller. In addition, much of the bycatch will occur over a very limited spatial area of overlap with gillnet fisheries and so the risk of localised depletion is even higher than that for the population as a whole.

ICES note some important caveats with these estimates:

- The data on fishing effort (in number of days at sea) are likely to be underestimated because effort from smaller commercial vessels (particularly <10 m in length), from recreational vessels, and from fisheries from the beach is not represented. This would lead to underestimates in bycatch;

[50] https://oap-cloudfront.ospar.org/media/filer_public/f3/43/f343edf0-55e0-4ec0-bc92-428f9d9b1745/harbour_porpoise_bycatch_m6.pdf

[51] https://www.ascobans.org/sites/default/files/document/ASCOBANS_WS_UnacceptableInteractions_I_2015_Report.pdf

- The bycatch rates may be overestimated because the majority of bycatch records were collected by observers on large vessels (>15 m) that use more gear than smaller vessels and may have higher likelihood of catching cetaceans;
- The data on fishing effort and the bycatch records from observers on vessels cover a wide range of vessel types and fishing gear types (i.e. trammel nets, set gillnets, driftnets). No account was taken of any spatial heterogeneity (i.e. patchiness) or of any differences in mesh size, net length or other important gear characteristics. ICES point out 'there is an implicit assumption that the summarized observations are representative of the nature and diversity of the gillnet fisheries within each assessment region, and this is not likely to be true'.

3.4.1 Estimates from monitoring programmes

Following the agreed ICES approach, more specific estimates are available for UK fisheries based on the dedicated UK monitoring programmes using observers. The most recent data are available for 2017 but continue a long series of annual reports which have contributed to the ICES bycatch risk assessments. In 2017, 217 dedicated protected species bycatch monitoring days were conducted during 157 trips on board static net vessels >12m which comprise 2% of the UK static net fishing fleet in terms of vessel numbers, but account for 13% of the total days at sea and 45% of landings by weight by the netting sector. Most observer effort was focused in ICES Divisions 7ef (158 days), with 36 days in the offshore Divisions 7ghj, 21 days in the Eastern Channel (7d) and Southern North Sea (4c) and just 1 day in the Irish Sea (7a). Five harbour porpoise were observed bycaught, all in static nets in subarea 7 resulting in a total estimate of between 718 and 2402 animals (best estimate 1282) for all UK gillnet fisheries in the absence of pingers (Northridge et al. 2018).

Based on observer data gathered between 2010 and 2017, Northridge et al. (2018) were able to estimate bycatch rates per haul for different metiers (Drift demersal, Drift pelagic, Gill, Gill hake, Gill light, Gill flatfish, Tangle/Trammel). These indicated that gillnets set for hake had the highest bycatch rates per haul followed by tangle/trammel nets which had a rate around three times higher than the unspecified gillnet category. This is consistent with other studies that have suggested a higher risk from tangle and trammel nets (e.g. Scheidat et al. in prep.). This results in estimates of around 45% of UK harbour porpoise bycatch in trammel/tangle nets making them the largest contributor from the different net metiers.

The estimates for the UK fleet come with the similar caveats as noted by ICES for the population level estimates. In particular, there are no specific bycatch rate estimates for under 10m vessels and no direct reports of days at sea for these vessels because they are not required to submit log books. We have used the reported landings (which they are required to submit) as a way of getting a better picture of bycatch risk across the whole UK fleet, but these data do not allow estimates of bycatch numbers. Hence we have not been able to add to the estimates that have already been discussed in detail by the ICES working group WGBYC.

3.4.2. Estimates from strandings

There has been increasing attention paid in recent years to attempting to use stranding data in a more quantitative way to make inferences about bycatch, both in terms of total numbers and identifying where bycatch occurred. This has involved estimating the probability that a bycaught animal will strand, and drift modelling to try to reconstruct the trajectory of a carcass before it was washed up on the beach (Peltier et al. 2016). This approach has been applied to harbour porpoise strandings in the North Sea, English Channel and Bay of Biscay (Peltier et al. 2018). There are a number of challenges in making such inferences from strandings and these were considered by the IWC Scientific Committee in 2018. Parameters that create particular uncertainty are the estimation of immersion level, the probability of being buoyant, and the probability of stranding and being reported. Estimating the time of death from a stranded carcass is also important to be able to calculate the expected drift (IWC 2018). Estimates of harbour porpoise bycatch for the Bay of Biscay and Channel based on the strandings data were between 800–1800. For these areas, the annual proportion of stranded porpoises with evidence of bycatch could be estimated because many strandings were examined in detail (Peltier et al. 2018). These estimates are broadly consistent with those from observer programmes for the Celtic Sea ecoregion given the level of spatial overlap between the two studies. Peltier et al (2018) did not attempt to estimate bycatch mortality for the North Sea due to difficulties in comparing estimates of the proportion of strandings that were bycaught across a number of different stranding schemes. However, they did estimate a time series of total mortality (Figure 13).

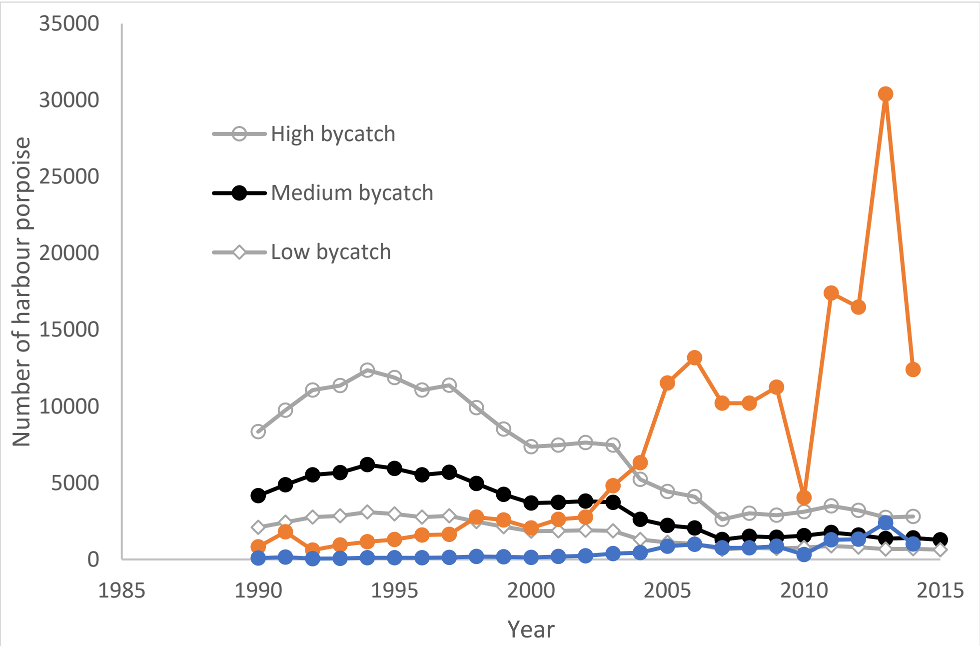


Figure 13. Time series of estimated porpoise bycatch in the North Sea based on days at sea using gillnets from Hammond et al (2018), showing high, medium and low bycatch rate assumptions. Blue line indicates total reported strandings in the eastern North Sea , orange line indicates estimated total mortality (all causes), from Peltier et al. (2018).

Prevailing winds will result in bycaught animals in the south western North Sea and eastern Channel being likely to strand on the coasts of northern France, Belgium and possibly also the Netherlands. This could also include a high proportion of bycatch from UK coastal fisheries. The predicted locations of death for many for many of the strandings modelled by Peltier et al. (2018) were off SE England, with particularly high numbers in 2011-2013.

Strandings from Belgium showed that of the 1364 stranded harbour porpoise specimens collected between 1995-2017, the cause of death could be identified in 640 cases. Of these animals, 36.5% (n=234) had (probably) been bycaught. In 2017, a total of 93 harbour porpoises washed ashore, a similar number to the average over the last ten years Where cause of death was established, 24% (n=8) were from incidental catch (Haelters et al. 2018). Strandings do show considerable interannual variability with 137 in 2016 up from 52 in 2015. The peak in 2016 was in April – May and 21 out of 54 (39%) examined were found to have been caught incidentally in fishing operations (ICES, WGBYC 2018). On the coasts of France strandings of 297 harbour porpoise were examined in 2016, of which 37% exhibited bycatch marks (Dars et al. 2017). In the Netherlands, an average of 7.5% of porpoise strandings with known cause of death between 2014 and 2016 was attributed to bycatch.

There is a strong negative correlation between the time series of estimates based on observer data and fishing effort of Hammond et al (2018), and the mortality predictions based on strandings of Peltier et al. (2018). Some of this can be explained by shifts in porpoise distribution into the southern North Sea after the 1990s but it does overall highlight that there may well be extensive bycatch in the southwest North Sea (some of which may occur in the Southern North Sea SCI) that is not being recorded by the observer programmes.

Prevailing winds make it more likely that bycaught animals off the southwest coasts of the UK will strand on UK coasts than those off the southeast, and the proportion of stranded animals showing evidence of bycatch on the coast of Cornwall appears to be the highest for any European coast. On the coast of Cornwall, of 142 stranded harbour porpoise subject to full veterinary necropsy between 1990 and 2006, 61% were determined to have died as a result of being bycaught in fisheries (Leeney et al. 2008).

In the UK as a whole, 17% of post mortem examinations of 1,692 porpoises stranded in the UK between 1991 and 2010 were attributed to bycatch (Deaville and Jepson 2011). In 2015, out of 53 harbour porpoises examined at post-mortem, 10 were bycaught (19%) with no consistent trends in any cause of death category for UK-stranded harbour porpoises between 2011 and 2015 (Deaville 2015). In Ireland, Lusher et al. (2018) found that 92 out of 608 (15%) harbour porpoise stranded between 1990 and 2015 were considered to have interacted with fisheries. However, any bycatch from the Irish fleet fishing on the Celtic Shelf would be more likely to strand on the UK coast than Ireland.

It should be noted that not all proportions are directly comparable, depending on the criteria used and whether it is the proportion of total strandings or the proportion where cause of death was clearly identified.

3.4.3 High risk areas in UK waters

The overlap of porpoise distribution and gillnet effort indicates three main areas of concern: NW of Shetland, SE England from Essex to Sussex, and SW England including the Celtic Shelf and SW Approaches. Of these, the SW areas have already received considerable attention, the SE is a recognised concern with large numbers of strandings showing evidence of bycatch but very limited observer data, and NW of Shetland where there is no information about bycatch and very limited data on the fisheries themselves. The ASCOBANS Conservation Plan For the Harbour Porpoise in the North Sea[52] which has been ongoing since 2009 also covers the area NW of Shetland and the English Channel east of 5° west.

3.4.3.1 Shetland

Around Shetland there is a small amount of coastal gillnet effort mainly fishing for cod (16 tonnes in 2017)[53], but the great majority of gillnet effort is in the monkfish and angler fishery in deeper waters (100-200m) to the north and west of Shetland. This fishery had some observer effort between 1996 and 1998 with 129 hauls observed with over 25,000 net km.hrs (Northridge and Hammond 1999). No bycaught porpoises were observed which the authors note was a surprising result given the amount of observed effort. They suggest that this might be due to the average depth of the sets (120m). More recent evidence shows that porpoises generally occur in deeper waters than had been previously thought and individuals tagged in Denmark did make use of the area west of Shetland

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52 https://www.ascobans.org/sites/default/files/document/AC24_Doc._3.2.b_Progress%20Report%20on%20the%20Conservation_HP_NS_Plan.pdf

53 https://www.gov.uk/government/statistics/uk-sea-fisheries-annual-statistics-report-2017

with depths up to 500m where most gillnetting occurs (Nielsen et al. 2018). Bycatch has also been observed in gillnets set for monkfish off the coast of Norway, although bycatch rates were lower than for gillnets set for cod (Bjørge and Moan 2016). Large mesh gillnets for cod and monkfish in the Norwegian coastal zone have an estimated annual bycatch of about 3000 harbour porpoises (Bjørge and Moan, 2016).

The deep gillnet fisheries that have operated west of the British Isles including Shetland since the mid-1990s with a fleet of up to 50 vessels, are poorly documented. Vessels participating in the fishery were reported to use up to 250km of gear, with the nets left fishing unattended and hauled every 3-10 days with trip lengths varying between 4–8 weeks. The total amount of nets constantly fishing at the same time by the fleet was estimated at between 5800 and 8700 km. The long soak times in these fisheries result in a high proportion of the catches being unfit for human consumption[54]. There continues to be sparse data on this fishery, although in recent years (2006–2016) around 17% of total landings of monkfish were from this fishery. A large proportion of the landings in the gillnet fishery are taken by Spanish owned, UK registered vessels. The fishery is not well understood and there is little information on catch composition or discards[55]. There has been considerable controversy regarding these UK-registered, Spanish-owned fishing vessels, with protests from local Shetland fishermen about their fishing activity[56].

The four UK vessels fishing in this area (ICES sub area 4.a) in 2017 reported mesh sizes >220mm and >15m vessel lengths. Thus they should be required to use pingers under Regulation 812/2004. According to Northridge et al (2018) there was one vessel inspection and pingers were noted to be in use. The authors note that 'Compliance operational priorities during 2017 did not focus on this sector and Marine Scotland will also continue to base the majority of their at sea inspection activities on a risk assessed basis'. There is no requirement for bycatch monitoring of bottom set gillnets in sub-area 4 under Regulation 812/2004. The UK has undertaken some monitoring elsewhere in sub-area 4 in the North Sea but the area west of Shetland has had very little attention.

3.4.3.2 Southeast England

Although the limited observer data available has not revealed substantial bycatch off southeast England, the combination of high gillnet effort (largely from vessels under 10m), and fairly recent increased harbour porpoise distribution in the area is indicative of a high level of risk. This is supported by the strandings rates along the coasts of northern France and Belgium, a high proportion of which show evidence of bycatch as the cause of death (see section 3.4.2). There is also considerable inter-annual variability both in the proportion of strandings showing evidence of bycatch and the total numbers. Small changes in spatial distribution by fisheries or porpoises may result in large changes in risk and thus bycatch within the area. The current data on porpoise distribution from predictive models is limited in its ability to predict at such small spatial scales although data from recent aerial surveys also provide some year round data on harbour porpoise distribution in the eastern Channel (Laran et al. 2017, ICES 2018) which could be included in finer scale habitat models. A report on the Current State of Drift net Fisheries in the UK notes that 'more research is needed to better define just how damaging these fisheries are in the UK - in terms of bycatch and discards' [57]. The same report notes considerable interest in drift net fisheries in SE England for bass and herring which has involved up to 250 boats.

Porpoise bycatch in the SE should be considered in the context of an estimated bycatch for the North Sea Assessment Unit from observer data that is 0.36-0.58% of the current best population

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[54] http://www.ices.dk/sites/pub/CM%20Doccuments/2005/N/N0705.pdf
[55] http://www.ices.dk/sites/pub/Publication%20Reports/Stock%20Annexes/2018/anf.27.3.a46_SA.pdf
[56] https://www.shetnews.co.uk/2015/06/08/local-boats-forced-off-fishing-grounds/
[57] https://www.seafish.org/media/1198217/sr673_finaldrift_nets.pdf

estimate[58]. Analysis of strandings also suggests high mortality in recent years with very different temporal trends to the predictions based on observer data and effort (Figure 13). These differences have yet to be resolved. However, the spatial concentration of bycatch suggests a high risk of localised depletion even if the implications for the North Sea population as a whole do not appear as serious as for the Celtic and Irish Seas.

3.4.3.3 Southwest England

The gillnet fisheries in the southwest of the UK and Celtic Sea have received most attention with respect to porpoise bycatch following estimates by Tregenza et al (1997) of an annual bycatch of over 2000 individuals from UK and Irish set net fisheries. The area has the highest levels of gillnet effort in UK waters and is also important porpoise habitat. Estimates of bycatch rates from observer programmes in 2017 continued to be high, particularly in areas 7.f and 7.g. Pingers are in use on a small number of vessels but much of the effort is from the under 10m fleet. The UK Cetacean Bycatch Focus Group led by DEFRA has agreed to start with SW England to trial further approaches for bycatch reduction. It is not clear yet what specific actions will be considered. Porpoise bycatch in the SW should be considered in the context of an estimated bycatch for the Celtic and Irish Seas Assessment Unit that is 1.1 – 2.4% of the current best population estimate (ICES, 2018). This level of bycatch which is in excess of ASCOBANS reference points is clearly of concern.

4. CHANGES TO CURRENT MANAGEMENT AND LEGISLATION: IMPLICATIONS

4.1 What next after Regulation 812/2004?

Regulation 812/2004 is unsatisfactory in that its requirements for the collection and submission of fisheries and bycatch data, and its monitoring and mitigation requirements (in terms of vessel length, gear type, operating areas and types of mitigation) are limited. In the 15 years since it came into force, some of the premises on which it is based have been superseded, especially in relation to mitigation.

Any review or repeal of Regulation 812/2004 could potentially allow the development of legislation which is more fit for the purpose and consistent with the changing consensus on effective bycatch monitoring and mitigation. There is the potential to improve the quality and quantity of cetacean bycatch mitigation measures, for example moving away from pinger use and towards reducing and replacing gillnet fisheries. However, it is currently unclear whether new legislation will offer any improvements or may be weaker with respect to cetacean bycatch. The problem of implementation of any new legislation will also have to be addressed.

Regulation 812/2004 will be succeeded by a proposed *Regulation on the conservation of fishery resources and the protection of marine ecosystems through technical measures (2016/0074)* (the *Technical Conservation Measures* (TCM) Regulation). The European Commission has produced a legislative proposal including measures for cetacean bycatch[59] which has been reviewed and amended and is now being examined by the European Parliament. Dolman et al. (2017) describe amendments which have been tabled by MEPs from the Committee on Fisheries (PECH). Some of these would weaken bycatch legislation. However some would make it stronger than current Regulation 812/2004 requirements, such as the consideration of the welfare impacts of fishing activities on sensitive species, an obligation to ensure bycatch of sensitive species is minimised and where possible eliminated, reporting of sensitive species bycatch, extension of bycatch measures to a more appropriate range of fishing gear types, support for the assessment of fisheries impacts in

[58] https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/biodiversity-status/marine-mammals/harbour-porpoise-bycatch/
[59] https://ec.europa.eu/transparency/regdoc/rep/1/2016/EN/1-2016-134-EN-F1-1.PDF

Natura 2000 sites, real-time closures for sensitive species, and a prohibition on the deployment of gears known to have a high risk of cetacean bycatch (e.g. bottom set gillnet, driftnet, entangling net or high vertical opening trawl) without the use of proven mitigation technology, in line with the recommendations made by ASCOBANS to the European Commission in 2016.

4.2 Role of US import restrictions under the MMPA

In 2016, the US enacted provisions under the Marine Mammal Protection Act (MMPA)[60] which will require countries exporting seafood to the US to demonstrate that their fisheries are not associated with any intentional killing of marine mammals, and/or that their marine mammal bycatch is at comparable levels with that of US fisheries (NOAA 2016, Williams et al. 2016). The regulation has been in effect since 1 January 2017, with a five-year exemption during which time exporting nations are expected to assess their bycatch issues, then enact regulatory programmes and mitigation strategies to address marine mammal bycatch which are analogous in efficacy to those of US fisheries.

Based on information compiled by the US on imported seafood products, and data supplied by exporting nations on the nature of their fisheries and bycatch mitigation regimes, fisheries will be classified as either ‘exempt’ (a seafood operation with very low bycatch (defined as (1) 10% or less of any marine mammal stock’s bycatch limit, or (2) more than 10% of any marine mammal stock’s bycatch limit, yet that fishery by itself removes 1% or less of that stock’s bycatch limit annually)), or ‘export’ (a seafood operation which exports commercial fish and fish products to the United States and has more than a remote likelihood of incidental mortality and serious injury of marine mammals in the course of its commercial fishing operations) (NOAA, 2016).

If the required information cannot be provided by nations, NOAA will attempt to do this themselves by drawing analogies with similar US fisheries and gear types interacting with similar marine mammal stocks. If this is not possible, the fishery will be classified as ‘export’ until more information is provided. Following these investigations, if a fishing operation is found to be consistent with the US in the level of injurious or fatal interactions with marine mammals (whether through analogous and similarly effective mitigation in the form of a regulatory programme for an export fishery, or through demonstrating the requisite low levels of interaction for an exempt fishery), then it will be issued with a Comparability Finding, which is required for a nation to export fish and fish products to the United States. By the end of the five-year exemption period and every four years thereafter, countries exporting to the US must have applied for and received a Comparability Finding for their fisheries to export fish and fish products to the United States.

The EU has proposed that the its current legislation framework comprises a regulatory framework analogous to the MMPA, and that EU fisheries exports to the US should therefore be classed as exempt under the MMPA assessment. Whilst an MMPA for the EU which is comparable to the US legislation would be a desirable goal, the Habitats Directive and MSFD do not fulfil such a role. The MMPA is specific to marine mammals rather than the much more general Habitats Directive of the EU which applies to both terrestrial and marine species and habitats. This allows requirements in the MMPA to be much more specific and hence make it much clearer to assess whether the regulations have been complied with. For example, there are specific monitoring and reporting requirements and a clear procedure with time lines for establishing take reduction plans if bycatch problems are identified. Take reduction plans have an immediate goal ‘to reduce, within 6 months of its implementation, the incidental mortality or serious injury of marine mammals incidentally taken in the course of commercial fishing operations to levels less than the potential biological removal (PBR) level’ and a long term goal to ‘reduce, within 5 years of its implementation, the incidental mortality

[60] https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-protection-act#download-the-full-pdf-version

or serious injury of marine mammals incidentally taken in the course of commercial fishing operations to insignificant levels approaching a zero mortality'. Within Europe there are no similar binding requirements. In addition to not having legal status, the ASCOBANS criteria that a total anthropogenic removal above 1.7% of the best available estimate of abundance is to be considered unacceptable in the case of the harbour porpoise (which was reaffirmed by Resolution 2016-5[61]) allows for a generally much higher take than PBR (Scheidat et al., 2013).

The current EU position appears to be that because the Common Fisheries Policy is a shared competence of the EU then it is the European Commission that negotiates with the US on this issue rather than individual Member States. However, if the US does not accept that EU legislation is a comparable regulatory structure to the MMPA, and therefore does not issue a comprehensive Comparability Finding for all EU seafood exports to the US, then it is unclear what will happen next. If there are fisheries within the EU which are considered to have bycatch levels in excess of PBR, the current position of the EU may result in all of that product from the EU, regardless of the EU country of origin, being classed as an 'export' fishery. As harbour porpoise bycatch is considered to be of concern and possibly in excess of PBR for some fisheries in some EU countries (Calderan and Leaper 2017), this may affect the UK's exports to the US, regardless of the UK bycatch levels (which also could be found to be in excess of PBR for some population assessment units such as the Celtic Sea ecoregion). In the event of the UK leaving the EU and no longer being subject to the CFP, it would still be subject to the MMPA export regulation, and required to demonstrate bycatch regulations analogous to the MMPA

4.3 Potential implications of BREXIT for UK fisheries management

A central uncertainty in future UK policy on bycatch is the fisheries legislation which will be introduced should the UK leave the EU in March 2019, and no longer be covered by the CFP. While the CFP will be brought across as part of the UK Withdrawal Bill, Brexit will change the context of fisheries management in the UK in terms of access to waters, sharing of fishing quotas, and tariff and non-tariff trade barriers. In October 2018, the Fisheries Bill was published[62], setting out the intended course of UK fisheries management outwith the EU. Whilst the Bill had been trailed as focusing on sustainability[63], and there had been hopes of more environmentally coherent management, there is little in the Bill to suggest this will be the case, apart from some high-level objectives. The Bill does require 'an ecosystem-based approach to fisheries management so as to ensure that negative impacts of fishing activities on the marine environment are minimised' but there is no specific mention of cetacean bycatch, so it is unclear what, if any bycatch monitoring, mitigation and reporting regimes will replace current EU legislation. Without specific measures addressing bycatch of protected species there is a risk that even if local byelaws require some measures, there will be no coordinated effort across UK waters.

5. ADDRESSING HARBOUR PORPOISE BYCATCH IN THE UK

There is a need to reinvigorate the ways in which the UK addresses harbour porpoise bycatch. At ASCOBANS AC 24 in September 2018, the bycatch working group's (AC24/2.1.2[64]) recommendations were to:

- Improve quality and availability of fishing effort data, by gear type, vessel size category, season, and country

[61] https://www.ascobans.org/sites/default/files/document/MOP8_2016-5_Bycatch.pdf
[62] https://services.parliament.uk/bills/2017-19/fisheries.html
[63] https://www.gov.uk/government/news/gove-launches-fisheries-bill-to-take-back-control-of-uk-waters
[64] https://www.ascobans.org/sites/default/files/document/2.1.2%202.1.8%20Bycatch%20WG.pdf

- Ensure adequate bycatch monitoring (improved observer programmes, consideration of REM) and investigate options to make this more cost -effective, particularly to include vessels less than 15 metres length
- Investigate gear specific solutions to mitigate bycatch, including alternative fishing methods
- Ensure that minimising cetacean bycatch is an objective when deciding on fisheries management strategies (e. g. quota or limiting effort)[65].

Of these recommendations, the measure that would make the most difference to UK harbour porpoise bycatch is reducing gillnet effort. This could be achieved through alternative fishing methods or limitations on effort. Effort limitation will inevitably have economic implications whereas alternative gears might potentially allow equally or more profitable fisheries but with reduced bycatch risk. Time/area closures to limit effort, particularly in SACs, would appear to offer opportunities, however the siting of SACs in relation to fishing effort suggests that there would be limited risk reduction achieved. Therefore the potential of alternative gear over as wide an area as possible should be further explored.

5.1 Potential for alternative gear

In many areas of the UK, different gear types are used to target the same catch species, which demonstrates the potential for some fisheries to shift from using gillnets to other fishing method(s). No fishing method is without its environmental impacts, and different gears will give rise to different environmental issues, including that of bycatch. Where there are a range of metiers operating in the same area, there are often also conflicts, particularly between mobile and static gears[66]. These factors need to be taken into account when considering changing fishing methods in an area.

Notwithstanding these caveats, there are some fisheries and areas where gear shifts should be investigated in order to reduce gillnet effort. Whilst developing new alternative gears may seem necessary, this can be difficult and costly (see Leaper and Calderan, 2017), and it may be that existing fishing methods may be appropriate in many situations. One possible switch is from gillnets to fishing using hooks amongst the under tens (see Table 6). Seafish (2017) reports that for the UK under 10m vessels as a whole in 2016, vessels using drift and fixed nets had a slightly higher catch per day (0.22 tonnes) than those using hooks (0.18 tonnes), but slightly lower daily income (£504 compared to £542) due to the difference in the quality of the fish caught. Operating costs as a proportion of income were also higher (74% compared to 66%) partly due to higher fuel consumption (107 compared to 88 litres per day). Table 6 shows data from the Marine Management Organisation UK Sea Fisheries Annual Statistics Report 2017[67] of fish species which are caught both by gillnet and by hooks, with highlighted rows indicating species which could be further investigated for gear switching in specific fisheries. For example, in UK fisheries the catch of hake in 2017 was dominated by gear using hooks, which was all by over 10m vessels mainly fishing west of Shetland (ICES rectangles 47-51, E3 – F0). A study by Santos et al. (2002) comparing gillnet and longline catches in a hake fishery found higher daily yields and higher quality fish for longlines than gillnets, using an 11.7 longline vessel, and so this could be applicable to smaller vessels in the UK fleet.

In cod fisheries, there was a similar amount caught with hooks as nets in 2017. 90% of the hook catches were by under tens in ICES rectangles 48E8 and 49E8 (southern Shetland). The mean value of the catch of £2305 per ton for hook caught in these areas was also greater than the value of the catch for netting of £1716 per ton[68], again reflecting the higher quality of a line caught fish 80% of

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[65] https://www.ascobans.org/en/meeting/AC24
[66] http://www.europarl.europa.eu/RegData/etudes/STUD/2014/529070/IPOL_STU(2014)529070_EN.pdf
[67] https://www.gov.uk/government/statistics/uk-sea-fisheries-annual-statistics-report-2017
[68] ibid

the catch of pollack with gear using hooks is off Cornwall and South Devon (155 tonnes), mainly using handlining[69]. Although the hook catch is only around 20% of the gillnet catch in this fishery, it is still sizeable and shows the potential for gear by these methods for this species. The mean value of the catch of £2960 per ton for hook caught pollack was also greater than for netting of £2500 per ton.

There is also a significant handline fishery for bass along the south coast of England (primarily Devon and Dorset). The south coast 10m and under fleet caught 195 tonnes of bass in 2017 with hooks. In 2018 bass was only allowed to be caught as bycatch in gillnet fisheries but vessels were allowed up to 5 tonnes of catch by hook and line[70].

Although the proportion of thornback ray caught by hooks is less than 10% of the coastal catches by under 10m vessels off Essex and Suffolk of 24 tonnes in 2017 show that gear switches may also be viable in this fishery. The mean value of the catch of £1700 per ton for hook caught was also greater than for netting of £1343 per ton.

Table 6. Total UK Catch weights by main species using drift and fixed nets and gear using hooks, in 2017. Highlighted rows indicate species which could be further investigated for gear switching from gillnets in specific fisheries

	Sum of Live Weight (tonnes)	
Catch species	Drift and fixed nets	Gears using hooks
Monks or Anglers	3332.3	1.9
Hake	1441.4	6652.5
Pollack	1053.2	216.6
Sole	387.5	4.4
Thornback Ray	352.6	30.8
Plaice	333.5	2.3
Turbot	217.4	0.3
Smoothhound	200.0	5.1
Crabs (C.P.Mixed Sexes)	185.0	7.8
Ling	183.0	1285.8
Cod	165.6	151.2
Blonde Ray	141.6	2.8
Herring	139.4	5.1
Haddock	128.5	3.1
Bass	111.0	255.9
Mackerel	105.5	1954.7

Globally, the use of longlines has been proposed in several situations as an alternative to gillnets, for example in New Zealand, where it has been investigated in detail in an effort to reduce bycatch of Māui dolphin (*Cephalorhynchus hectori maui*) (IWC 2017). Use of longlines has also been investigated for fisheries management reasons. Santos et al. (2002) compared longline and gillnet catches within the same area of southern Portugal in terms of catch composition, fishing yield, by-catch and discards, catch size frequency distribution and quality of the fished product. Hake discards were significantly lower for longlines (7%) compared to 42% for gillnets due to fish deterioration related to soaking time. Higher daily yields were obtained for longlines compared with those for gillnets. In Iceland, some monkfish are caught by longline, while all the monkfish around Shetland

[69] http://www.cornwallgoodseafoodguide.org.uk/fishing-methods/handlining.php, https://www.linecaught.org.uk/
[70] https://www.gov.uk/government/publications/bass-industry-guidance-2018/bass-fishing-guidance-2018

are currently caught in gillnets or demersal trawls/seines. 75% of the total UK monks or anglers catch in 2017 was by demersal trawls/seine[71].

5.2 Measures within SACs

The role of the UK SACs in addressing harbour porpoise bycatch will require further consideration. The first issue is whether they are in fact in areas of consistently high density of harbour porpoise which are likely to remain over the time taken to establish management measures within the SAC. As the various studies of porpoise distribution demonstrate, it is difficult to find clear areas of consistently high density and distribution can change substantially over time. Wilson (2016) points out that SACs are likely to be designated following a period of high use of an area and so changes in distribution are more likely to result in a decline within the SAC than an increase. The second issue is whether the SACs include the areas of highest bycatch risk in terms of overlap between gillnet fisheries and porpoises. This is clearly not the case, and the UK SACs include very little current gillnet effort. Nevertheless, measures to address bycatch outside of the spatial extent of the SAC will contribute to the objectives of the SAC in terms of maintaining the numbers in the population unit that uses the SAC. Thus the SAC can provide a basis for managing non-lethal threats within the designated area to allow maximum benefit to be derived from optimum habitat, combined with addressing lethal threats outside of the area, since if individuals which use a SAC are killed it does not matter where that happens in terms of the impact on the SAC objectives.

Furthermore, Pieraccini and Cardwell (2016) show that even conservation measures that do not impose changes on the behaviour of resource users may be vigorously contested as the case of the Barra SAC designation demonstrated. This was resisted by the residents of Barra for thirteen years, from first proposal in 2000 to eventual designation in 2013. Pieraccini and Cardwell (2016) attributed this resistance to historic negative perceptions and experiences of protected areas, and the case highlights the challenges and considerations of implementing restrictions to address bycatch.

However, although gear restrictions within SACs may not directly contribute to reduced porpoise bycatch, there may be some scope to use SACs to encourage testing and use of alternative gears.

5.3 Market incentives and eco-labels

Caveen et al. (2017) describe the UK Sea Fish Industry Authority risk assessment tool known as the Risk Assessment for Sourcing Seafood (RASS[72]) which includes an assessment scale related to bycatch of endangered, threatened, and protected (ETP) species. RASS was developed to help UK commercial seafood buyers make judgements on the environmental risks associated with catches. In relation to bycatch, risk is classed as ‘very low’ if bycatch of ETP species is considered very unlikely, but the ‘low’ risk category can also include bycatch in excess of PBR if the population status is considered to be healthy. If bycatch is likely and population status is unknown or declining then risk is classed as ‘moderate’. It has been suggested that the bycatch scoring guidance will be reviewed, and refined if necessary (ASCOBANS AC 24/2.1.7). It is surprising that bycatch in excess of PBR would ever be classified as a ‘low’ risk and this is something that should be reviewed. For example a fishery might be classified as low risk by RASS but still not be considered as acceptable to export to the US under the new MMPA regulations.

Table 7. RASS risk categories for bycatch of Endangered, threatened, and protected (ETP) species from Caveen et al (2017).

Very Low	Capture of ETP species over the course of a fishing season is very unlikely.
Low	Capture of ETP species is likely. Population status of ETP species is healthy **OR** removal is less than PBR

[71] https://www.gov.uk/government/statistics/uk-sea-fisheries-annual-statistics-report-2017
[72] www.seafish.org/rass

Moderate	Capture of ETP species is likely and population status is unknown or declining. However, mitigation in fishery is likely to significantly reduce impact.
High	Capture of ETP species is likely. Impact on the population may be significant because; Population status of ETP species is declining **OR** removal > PBR **AND** Effect of any mitigation is questionable or not well documented.
Very High	Capture of ETP species is likely and population status is critical. Removals very likely to be having a significant impact on the population.

While RASS is a business-to-business commercial seafood buyer's tool, the certification system by the Marine Stewardship Council (MSC) is aimed at consumers. The MSC Fisheries Standard is used to assess if a fishery is well-managed and environmentally sustainable in terms of meeting three core principles. One of these, that 'fishing operations must be managed to maintain the structure, productivity, function and diversity of the ecosystem' is relevant to bycatch but does not necessarily mean that a fishery with a high cetacean bycatch would not be certified depending on the interpretation.

6. CONCLUSIONS

Despite the UK's compliance with its obligations under EU regulations in relation to harbour porpoise bycatch in gillnets, annual estimates of bycaught animals remain high. The estimate of porpoise bycatch for 2017 is between 587 and 2615 animals (Northridge et al. 2018); with current data deficiencies, especially in fisheries effort and landings records, it is difficult to improve on this estimate without further data. The high risk areas of harbour porpoise bycatch in the UK appear to be quite localised in southwest England, southeast England and northwest Shetland, although data on bycatch in northwest Shetland are particularly sparse.

EU monitoring and mitigation requirements as they currently stand are insufficient to provide either the necessary observer coverage or the type and level of mitigation needed to effect a substantial reduction in porpoise bycatch. A change of approach is therefore required both in monitoring and mitigation, towards addressing cetacean bycatch as part of sustainable, ecosystem-based fisheries management. The need for improved levels of monitoring can at least in part be achieved by a requirement for camera-based electronic monitoring across the UK fleet, a technology which is improving rapidly and becoming more cost-effective. Mitigation should move away from technological modifications to gillnets such as pingers, towards more systemic changes in fisheries practices such as using alternatives to gillnets, such as hooks.

Successful bycatch strategies will often be area and target species-specific. On-site fact-finding and data-gathering studies to assess the nature of particular fisheries and their bycatch problems are preferable to attempts to impose global regulations across a fleet which may be quite diverse, and where local changes may be more appropriate. For example, in some areas (such as Shetland), pingers may in fact continue to be the most sensible mitigation strategy, if their use is properly monitored and enforced. In some areas where high bycatch risk has been identified, and where alternative fishing gears are suggested as the most appropriate means of tackling the problem, it may be preferable to move straight to concurrent monitoring and mitigation, rather than delaying a change in fishing methods until an extended period of monitoring has been conducted.

With the recent designation of six new SCIs (future SACs) for harbour porpoise in the UK, there is improved potential for bycatch reduction in UK waters. There is limited overlap of gillnet activity/bycatch risk with the SACs, and therefore action solely within the SAC boundaries in relation to tackling bycatch will be limited in its effects. However, measures to address lethal impacts such as bycatch need to be taken across the range of the population and will then contribute to the objectives of the SAC by maintaining local population numbers. SACs provide an opportunity through management measures to minimise disturbance and other non-lethal threats such that harbour porpoise populations can maximise their use of optimal habitat.

This report is confined to addressing bycatch of harbour porpoises in gillnets, and has not considered common dolphin bycatch in mobile gears. This is largely because many of the issues and possible mitigation strategies are different to those of harbour porpoise bycatch in gillnets, and so are beyond the scope of this study. The focus on harbour porpoise should not detract from efforts to address common dolphin bycatch. Any policies that resulted in a shift in gillnet effort rather than a reduction would need to take risks to other species into account.

7. RECOMMENDATIONS

i) All UK gillnet fisheries should be assessed for potential to use alternative gears

Both gillnet fishery effort and porpoise distribution can be dynamic with substantial changes between years (Northridge and Hammond, 1999; Hammond et al., 2013; Wilson, 2016). Any overlap between porpoises and gillnets will create a bycatch problem; even gillnet fisheries that currently appear to have low bycatch (notwithstanding the low levels of monitoring or reporting) may pose a risk if porpoise distribution and/or fishing effort changes. Therefore there is value in investigating all gillnet fisheries for possible lower risk alternatives regardless of current reported bycatch.

Fishing methods using hooks (e.g. hand lines and/or long lines) are already used for catching some species which are currently also caught using gillnets, for example in southwest England (particularly for pollack), southeast England (particularly thornback ray), and Shetland (cod and hake). These fisheries should be examined more closely to see how techniques could be more widely applied to replace gillnets in other areas/other target species. Methods used elsewhere such as fish traps/pots and light trawls should be further investigated.

ii) Concurrent monitoring and mitigation

For fisheries which are currently not monitored but which use gillnets, and therefore have a high level of risk, it makes most sense to implement mitigation and monitoring at the same time. Much of the same work (e.g. working with stakeholders) is required for both monitoring and mitigation efforts. Moving to mitigation without adequate monitoring can be problematic. However, putting off mitigation until monitoring trials have been completed is also undesirable; monitoring trials can take many years and may use available budget such that there is then no further action even if monitoring results indicate substantial bycatch. In economic terms, the balance between commencing/continuing monitoring compared to moving straight to mitigation needs to be assessed. Moving straight to concurrent monitoring and mitigation could be appropriate in situations where the 'mitigation' was using alternative gears, in particular from small vessels.

iii) **Comprehensive at sea monitoring**

Advances in camera technology and decreasing costs of electronic monitoring systems are creating new possibilities for fisheries to demonstrate responsible practices and contribute to the UK's commitment to an ecosystem-based approach to fisheries management. This applies both to monitoring catches and bycatch. It is now feasible to recommend installing REM systems across the whole UK fishing fleet. Comprehensive coverage would avoid many of the issues associated with sampling bias, including which vessels are chosen to be fitted with cameras, and any changes in fishing activity related to having cameras on board. The sampling design could be based on the data collected and need not increase analysis costs if only the required proportion of vessels was analysed to fulfil the monitoring objectives. For example, analysis would focus on a higher proportion of video in higher-risk fisheries and for vessels using mitigation methods (such as pingers). Efforts should continue towards developing cheaper, more robust, more portable EM systems with a particular focus on use in small scale coastal fisheries which have been difficult to monitor.

iv) Address specific data gaps in high risk areas

The deep water gillnet fisheries to the west of the British Isles and especially northwest of Shetland are poorly documented from a fisheries perspective and may well have a significant harbour porpoise bycatch. These are a priority for monitoring using observer programmes or adoption of EM camera systems and to ensure pingers are being used effectively as required by Regulation 812/2004.

v) Import regulations in the USA

An analysis should be undertaken of where EU (and any future UK) legislation needs to be strengthened to be comparable to the MMPA with respect to bycatch. This will identify where legislative measures should be developed to address bycatch in order to fully comply with US requirements regarding imports of fisheries products.

vi) Improved clarity in management objectives with respect to bycatch

Any new fisheries legislation should contain specific objectives to minimise bycatch of protected species. There needs to be a coordinated effort to include explicit objectives to reduce bycatch towards zero as agreed by ASCOBANS[73]. The implications of any discussion of bycatch limits or reference points will be highly dependent on the conservation objectives and most specifically the probability for which these are expected to be achieved. The interim ASCOBANS conservation objective of maintaining populations at 80% of K is often referred to, but it should be noted that the ultimate aim of ASCOBANS is 'to restore and/or maintain biological management stocks of small cetaceans at a level they would reach when there is the lowest possible anthropogenic influence'[74] (i.e. effectively at natural carrying capacity) whereas restoring and/or maintaining populations at 80% or more of the carrying capacity is a less ambitious interim objective leading towards this. It would therefore be expected that the interim objective should be achieved with a high probability (e.g. 95%) and further work on reference points should take this into account.

vii) UK as world-leader in bycatch best practice

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73 https://www.ascobans.org/sites/default/files/document/MOP8_2016-5_Bycatch.pdf

74 https://www.ascobans.org/sites/default/files/document/MOP8_2016-5_Bycatch.pdf

The UK Government has stated an aspiration for the UK to be a world leader in environmentally responsible fisheries[75]. The UK also has a responsibility as a well-resourced country to demonstrate good bycatch mitigation practice, and develop strategies which can be applied elsewhere, particularly in artisanal fisheries in other countries, where gillnet use is widespread and resources are limited. Research into the potential for alternative gears in fisheries is a more viable proposition in the UK where more research and development resources are available. For example, attempts to develop alternative gear in Mexico in a race against vaquita extinction have been prohibitively difficult for political, social and economic reasons (Rojas-Bracho and Reeves 2013). If alternative gear had already been developed, ready for implementation, the situation in Mexico might have been different. When developing bycatch strategies in the UK and Europe, the focus should be on methods which could also be applicable for small cetacean bycatch problems in areas of the world where technologies such as pingers are not a viable mitigation tool due to their prohibitive cost and need for consistent deployment and monitoring.

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