Agenda Item 3.3	Species Action Plan Conservation Plan for the Harbour Porpoises Population in the Western Baltic, the Belt Sea and the Kattegat (WBBK Plan)
Information Document 3.3b	Progress Report on the Conservation Plan for the Harbour Porpoises in the North Sea (North Sea Plan) 2023
Action Requested	Take note
Submitted by	North Sea HP Coordinator

ASCOBANS

Note: Delegates are kindly reminded to bring their own document copies to the meeting, if needed.

PROGRESS REPORT

on

THE CONSERVATION PLAN FOR THE HARBOUR PORPOISE

IN THE NORTH SEA

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September 2023

CONTENTS

The views and recommendations expressed in this report are the authors' own. This report builds upon previous ones to show trends and attempts to present the most recent information that was available to the coordinators.

PROGRESS REPORT ON
THE CONSERVATION PLAN FOR THE HARBOUR PORPOISE IN THE NORTH SEA

Background and History

The 5th International Conference for the Protection of the North Sea (Bergen, Norway, 20-21 March 2002) called for a recovery plan for harbour porpoises in the North Sea to be developed and adopted (Paragraph 30, Bergen Declaration). Germany volunteered in 2003 to draft a recovery plan within the framework of ASCOBANS, and in association with Range State Norway.

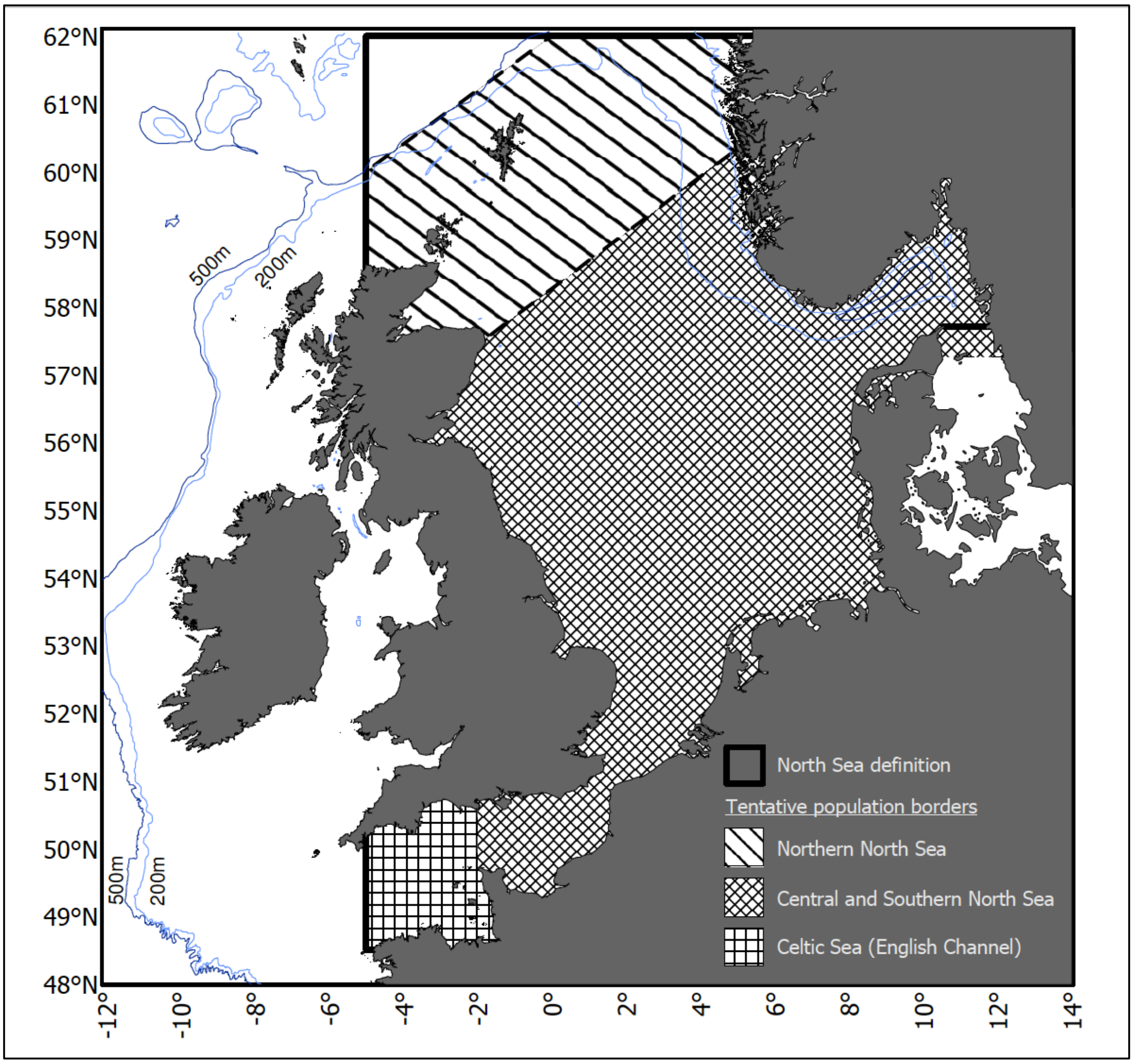


Figure 1. Area covered by the North Sea Conservation Plan (as defined at the 5th International Conference on the Protection of the North Sea in Bergen, Norway, 20 – 21 March 2002) showing the tentative harbour porpoise population borders (Source: ASCOBANS, 2009a)

A recovery plan for the harbour porpoise in the North Sea was developed and submitted to the 13th Advisory Committee meeting of ASCOBANS in Tampere, Finland in April 2006 (ASCOBANS, 2006) along with a background document on the porpoise population structure, distribution, abundance and threats in the region, prepared by Eisfeld and Koch (2006). From this, a conservation plan was drafted and presented at the 16th Advisory Committee meeting of ASCOBANS in Brugge, Belgium in April 2009 (ASCOBANS, 2009a). The change in name from a recovery plan to a conservation plan resulted from the fact that wide-scale surveys of the region in July 1994 and July 2005 indicated little change in overall population size for the species in the North Sea. The area under consideration included all of the North Sea, the Skagerrak, and the English Channel, with some tentative population borders set (Figure 1). The conservation plan was formally adopted at the 6th Meeting of the Parties in Bonn, Germany in September 2009 (ASCOBANS, 2009b).

During the 17th Advisory Committee meeting of ASCOBANS in Bonn, Germany in October 2010, terms of reference for a Steering Group were developed (ASCOBANS, 2010b, 2011a). The first meeting of the Steering Group took place in Bonn, Germany, in May 2011 (ASCOBANS, 2012a). Since then, meetings of the Steering Group were held annually prior to each Advisory Committee meeting between 2012 and 2015 (ASCOBANS, 2013, 2014, 2015a, 2016). There was no Advisory Committee meeting between September 2015 and September 2017, so the 6th meeting of the North Sea Group was held intersessionally at Wilhelmshaven, Germany in June 2017.

Between 2009 and 2010, two part-time consultants were contracted for the initial coordination of the conservation plan (Leaper & Papastavrou, 2009, 2010). In 2011, a new part-time coordinator was appointed, and continued in this role until 2014 (Desportes, 2012, 2013a, b, 2014).

The North Sea Conservation Plan initially proposed 12 actions (ASCOBANS, 2009a). Action 1 was the implementation of the plan through establishment of a co-ordinator and a Steering Committee. Seven of the remaining eleven actions were rated as high priority, centred around the most pressing conservation issue, that of bycatch (Actions 2-6), but including also monitoring trends in distribution and abundance (Action 7), and reviewing stock structure (Action 8). Actions proposed as of medium priority included the collection of incidental data on porpoises through stranding networks (Action 9), investigation of the health, nutritional status and diet of porpoises in the region (Action 10), investigation of the effects of anthropogenic sounds (Action 11), and collection and archiving of data on anthropogenic activities within a GIS (Action 12).

Since 2011, the North Sea Group has focused on the eight priority actions, whilst also briefly reviewing progress on the remaining four actions in the form of an Implementation Table. In 2021, it was proposed that Actions 9-11 should be considered as high priority. Action 12 is an ongoing action and outputs both national and international are presented when available. Once the updated Conservation Plan has been completed and reviewed, the proposal will be to include reporting on all recommended high priority actions.

ACTION 1. Implementation of the Plan through establishment of a Coordinator and a Steering Committee

A Steering Group was established in 2011 and has been maintained ever since. Its work has been undertaken mainly through annual meetings but there has also been exchanges by e-mail intersessionally. At each meeting, one or more representative of each range state usually attends, along with interested parties from NGO groups or other marine stakeholders. Between ten and twenty-one persons have participated in each of the meetings. Peter Evans (Sea Watch Foundation) has chaired the group since 2014.

After a gap of three years, funding was agreed upon for a part-time coordinator (to cover all three conservation plans) at the 23rd Advisory Committee meeting of ASCOBANS in Le Conquet, France in

September 2017. It was agreed that the Sea Watch Foundation (UK) would take on the coordination of the three action plans for 2018. In January 2019, ASCOBANS again asked for Expressions of Interest to fill the role as Coordinator of the ASCOBANS harbour porpoise action plans, and Coalition Clean Baltic received the contract for the task in March 2019. Since 2020, coordination of the action plans was divided between Coalition Clean Baltic and the Sea Watch Foundation with the Jastarnia Plan coordinated by Coalition Clean Baltic and the North Sea Plan by Sea Watch Foundation.

ACTION 2. Implementation of existing regulations on bycatch of cetaceans

For many years, the main regulation on bycatch affecting harbour porpoise in the North Sea has been Council Regulation (EC) 812/2004) which required at-sea observer schemes to monitor bycatch rates for vessels 15 m or over and mitigation using acoustic deterrent devices ‘pingers’ for vessels exceeding 12 m, for specific fisheries (see Action 5 for further details). EU Member States were required to submit a report to the European Commission annually, documenting how they had implemented this regulation.

Regulation (EU) 2019/1241 of the European Parliament and of the Council on the conservation of fisheries resources and the protection of marine ecosystems through technical measures (Technical Conservation Measures Regulation) came into force in June 2019, repealing Regulation 812/2004. The main elements of the Regulation are regionalised management with obligations to monitor, manage and mitigate bycatches of sensitive marine species; minimising and where possible eliminating incidental catches of those species and other negative environmental impact of fishing on marine habitats and to put in place management measures for the purposes of complying with the Habitats, Birds, Water Framework and Marine Strategy Framework Directives. The new technical measures should contribute to ensuring that bycatches of marine mammals, marine reptiles, seabirds, and other non-commercially exploited species do not exceed levels in Union legislation and international agreements. Specific provisions existing in Regulation 812/2004 concerning vessel sizes, areas and fishing gears where pingers are required or where monitoring of bycatches of cetaceans is mandatory are retained but are complemented with general and more wide-ranging obligations concerning incidental catches of all sensitive species in all areas. The technical specification of the pingers to be used has been carried over in Commission Implementing Regulation 2020/967. Triennial reports for presentation to Parliament and Council are now made from 2020 onwards. Table 1 summarises the extent of compliance from 2019-2022 in terms of report submissions from countries with EEZs within the North Sea region under consideration (ICES WGBYC, 2022). When compared with the corresponding table for 2017-20, reporting has improved greatly.

Table 1. Summary table of countries providing data submissions to ICES WGBYC with data on fishing effort, observer effort (either days at sea or other measurement, e.g. effort per haul or set), and bycatch records. Green = Data submission received, Pale Green = data received, but no records, White = no data received (Source: ICES WGBYC, 2023).

	Fishing Effort				Monitoring Effort				Bycatch Events			
Country	**2019**	**2020**	**2021**	**2022**	**2019**	**2020**	**2021**	**2022**	**2019**	**2020**	**2021**	**2022**
Belgium (BE)												
Denmark (DK)												
France (FR)												
Germany (DE)												
Netherlands (NL)												
Norway (NO)												
Sweden (SE)												
United Kingdom (GB)												

In advance of the latest ICES WGBYC meeting (26-30 September 2022), an ICES dedicated data call was made to countries for fishing and sampling effort, and bycatch observations for the year 2021 with some data already submitted for 2022 (ICES WGBYC, 2022). All countries surrounding the Greater North Sea responded.

As noted previously by ICES WGBYC (2022), the quality and scope of the information provided in the annual reports continues to be variable, but is improving. In the Greater North Sea ecoregion, monitored days in 2021 included bottom trawls (1,333), pelagic trawls (153), nets (1,383), surrounding nets (40), traps (14), and longlines (10). Bycatch was recorded from each of these métiers and monitoring methods were a mix of at-sea observers, logbooks and vessel crew observers. In addition, 14 fishing days for rods and lines, 34 fishing days for seines, and 3 fishing days for dredges were observed, all by at-sea observers, but no bycatch was recorded for these métiers. Thirty harbour porpoises were recorded by-caught in nets, twenty of which were from five incidents.

ICES WGBYC has long stated that significant gaps remain in data collection efforts and in data resolution, that limits the Working Group’s ability to provide useful assessments of the likely impacts of fishing activity across a wide range of protected species and areas. WGBYC note that broad-scale low level monitoring programmes may be insufficient to highlight very rare bycatch occurrences for populations at low abundance and/or low susceptibility to by-catch, but which could have significant population levels impacts.

Most countries rely on the Data Collection Framework (DCF) sampling programme to monitor marine mammal and other protected species bycatch; however, the UK has a dedicated protected species bycatch monitoring programme (PSBMP). Relying only on observations carried out under the DCF may lead to under estimation of bycatch events as some bycatches may be missed by the observers who focus mostly on other tasks (e.g. fish sampling). This is a concern for protected species data collection under the EU-MAP that has been expressed repeatedly (ICES WGBYC 2019, 2020, 2021) following the repeal of the Reg. 812/2004 which has been replaced by Regulation EU 2019/1241 (hereafter the “technical measures regulation”) on 14 August 2019. It is worth noting that of the thirty harbour porpoises recorded bycaught in the Greater North Sea in 2021, twenty-five of these were from electronic monitoring under the Danish programme.

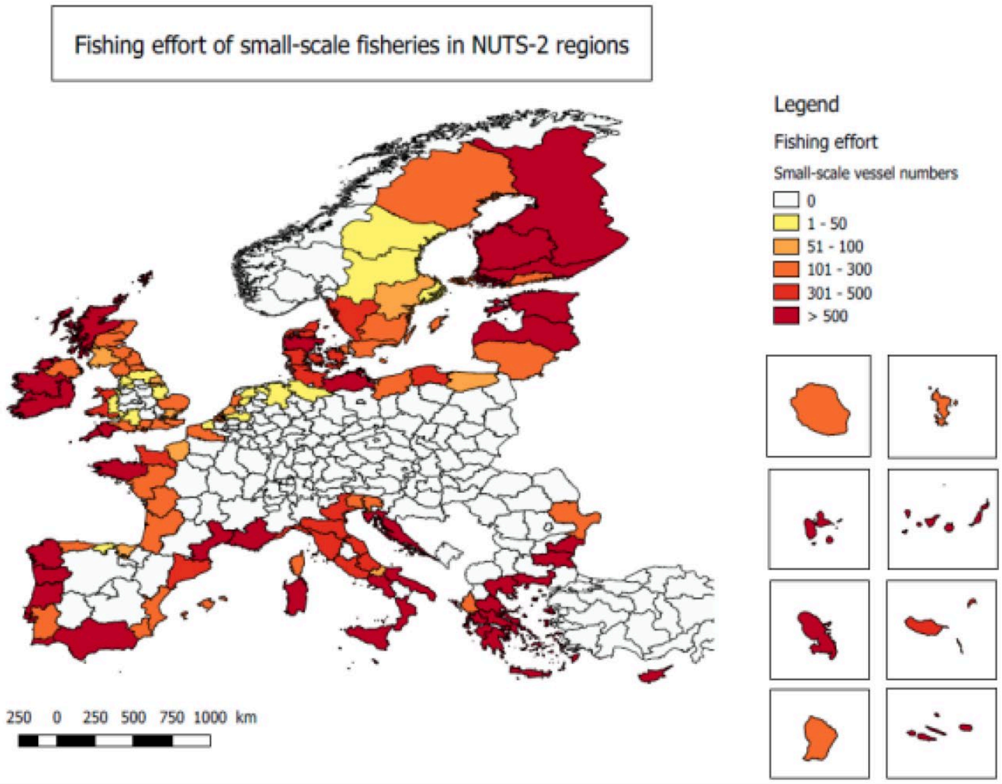
EU Member States also have obligations under Article 12 of the EU Habitats Directive: “Member States shall establish a system to monitor the incidental capture and killing of the animal species listed in Annex IV (a). In the light of the information gathered, Member States shall take further research or conservation measures as required to ensure that incidental capture and killing does not have a significant negative impact on the species concerned.”

Within the EU, there are initiatives currently to improve synergies in general monitoring and reporting (see, for example, ICES 2018, ICES WKDIVAGG 2018).

Key Conclusions and Recommendations *All North Sea Range States (within and outside of the EU) are now submitting annual reports to ICES on fishing and sampling effort, and bycatch observations. For EU member states, these are undertaken within the DCF sampling programme under the EU-MAP, where the emphasis inevitably is upon fish bycatch. Although attempts are being made to pay particular attention to protected species bycatch, concerns remain that the methods used and the experience of observers may be insufficient to adequately monitor bycatch of species such as harbour porpoise. This is reflected in the reported bycatch for 2021 where >80% of porpoises bycaught were documented through the Danish scientific programme of electronic monitoring, which other countries have yet to adopt for this purpose in this ecoregion. Furthermore, sampling effort may not* *target the high-risk areas and fisheries required to monitor cetacean bycatch in a robust manner, and greater attention is needed to monitoring fishing effort and bycatch from small vessels (<12 m length) that currently are not adequately covered. North Sea Range States have obligations both nationally and internationally to protect species such as the harbour porpoise through commitments to OSPAR, ASCOBANS, and EU directives such as the Marine Strategy Framework Directive and the Habitats Directive. The resolutions adopted by Parties to ASCOBANS should be fully implemented.*

ACTION 3. Establishment of bycatch observation programmes on small vessel (<15m) and recreational fisheries

Reviews of the status of small-scale fisheries (largely deploying small vessels) in Europe have been published recently in Stodderup *et al*. (2017) and Pascual-Fernández *et al.* (2020). The scale of fishing effort by region is depicted in Figure 2. They show that up to 300 vessels operate inshore in several parts of the North Sea including the coasts of Belgium, north Holland, northern France, north-eastern UK, East Anglia, and the south coast of England. However, there is little information available on bycatch from either small vessels or recreational ones.



Source: CFR 2016

Figure 2. Fishing effort of small-scale fisheries in Europe (from Stodderup *et al*., 2017)

Small vessels

Establishing bycatch observation programmes on small vessels is important to gain a more complete picture of the scale of the problem, especially given that harbour porpoise bycatch occurs mostly in gillnets, which are usually deployed from smaller vessels. However, scaling up bycatch rate estimates to fleet level estimates requires information on fisheries effort. Most countries do not have detailed fisheries effort data for vessels below 10 m, although this segment represents a non-negligible segment of the fleet. As an example, **Germany** has no effort data for vessels <=10m, which are not required to keep a logbook and have to record their catches only in monthly landing declarations (DE, AR 812/2004 2013) and part-time fishermen do not have to report effort at all. The German gillnet fleet in the North Sea was composed in 2008 of 30 vessels <7.5 m, 20 vessels between 7.5-15m, and only a single one >15 m (Kock, 2010). In 2019, the German North Sea fishing fleet comprised more than 200 vessels, of which 175 were small (12-24 m length) beam trawlers (targeting brown shrimp) (ICES, 2022).

The same is true for **Denmark**, where vessels <=10 m and part-time fishers do not have to report fishing effort. In 2012, the Danish fleet was estimated to amount to 2,743 vessels, of which 78% (2,150) were 10 m or less in length (Masters, 2014). By 2019, this had reduced to 1,560 vessels, with 717 vessels operating in the North Sea (ICES, 2022). There were around 600 operations by smaller vessels (<12 m), mainly gillnetting, supplemented by pot and trap operations. Observer data on incidental catches from Danish gillnets have been collected under the Data Collection Framework (DCF) sampling programme. In 2016, monitoring was carried out on vessels <15 m in area 27.3.a (5 fishing days; 2.0% coverage; two bycaught harbour porpoises), and vessels <15 m in area 27.4 (4 days; 2.2% coverage; zero porpoise bycatch) (ICES WGBYC, 2019). By comparison, with REM deployed, a bycatch of around 30 porpoises was recorded, highlighting the failings of a reliance upon a DCF scheme for monitoring porpoise bycatch. In 2017, monitoring was carried out on vessels <15 m in area 27.3.a (15 days at sea; 0.8% coverage; one bycaught harbour porpoise), vessels <15 m in area 27.4 (4 days at sea; 0.8% coverage; zero porpoise bycatch), and vessels >15 m in area 27.4 (15 days at sea; 0.5% coverage; zero porpoise bycatch). In 2018, video monitoring was undertaken on eight gillnet vessels, all <15 m length (ICES WGBYC, 2020).

In **Sweden,** the fleet was estimated to total 1,394 vessels in 2012, of which 70% (975) were 10 m or less in length (Masters, 2014). However, the fleet size overall has declined by about 20% in the ten years since 2009 (ICES, 2022). A pilot project with on-board observers dedicated to observing bycatch of marine mammals in gillnet fisheries has been carried out in the south of Sweden. Altogether, there was 36 observed DaS and two harbour porpoises recorded as bycaught in Area 23 in large meshed gillnets. Due to the low monitored effort, no total bycatch numbers can be estimated. Total effort for all Swedish gillnet fisheries (i.e. including the Baltic Sea) was 19,471 DaS in 2017.

The **Norwegian** North Sea fleet is composed of about 1,500 vessels, of which over 75% are small vessels ((<11 m; up from about 60% in 2009, corresponding to an increase of 445 vessels in this segment). These operate near the Norwegian coast and are known to cause significant porpoise bycatch (Bjørge et al., 2013).

In the **UK**, only vessels greater than 10 m are obliged to fill out logbooks. Some smaller vessels fill in logbooks on a voluntary basis, and port officials the record the number of days at sea by these boats. In 2010, of the 622 registered UK fishing vessels using gillnets in areas VIIefghj, only 22 of these were over 12 m (S. Northridge in Desportes, 2014). And in 2014, of 6,406 fishing vessels, 79% (5,032) were 10 m or less in length (Masters, 2014). In 2016, there were 6,191 fishing vessels recorded active with the same percentage, 79% (4,876) 10 m or less in length (Marine Management Organisation, 2017). By the end of 2021, the number of registered vessels was 5,783, a decline of 11% since 2010 (Marine Management Organisation, 2022). 4,568 vessels (79%) are 10 m or under in length, 2,255 vessels of which operate in England.

A fleet of around 882 vessels <10 m length operates in the eastern Channel and coastal North Sea, catching a diversity of fish and shellfish species. Around 25 of these vessels target pelagic fish. Vessels of 10–15 m length numbered 190 in 2019, 23 less than in 2014, with over 95% taking shellfish, and around 16 vessels targeting finfish (ICES, 2022).

In **France,** of 7,143 vessels in 2012, 73% (73% (5,196) were 10 m or less in length whereas **Belgium**'s small fleet of 212 vessels were all above 10 m, and mainly above 15 m length (Masters, 2014). In 2019, ICES (2021) reported 65 Belgian vessels active in the Greater North Sea, with few vessels smaller than 12 m length. However, most small-scale fishing vessels in Belgium are designated as part of the recreational fleet (Verlé et al., 2020).

In the **Netherlands**, of 850 vessels in 2012, 36% (308) were 10 m or less in length (Masters, 2014). By 2019, the fleet had reduced to c. 500 vessels (ICES, 2022). In the Netherlands, an REM project ran from 1 June 2013 to 31 March 2017, including 14 vessels (Scheidat *et al*., 2018). In total, 8133 fishing days of bottom-set gillnet fishing were analysed, with a total of 13 harbour porpoises recorded bycaught in this time. The bycatch rate was calculated to 0.004 animals/net length km for trammel nets and 0.0006 for single-walled gillnets. The bycatch rate for all net types combined (0.0011) was applied to calculate bycatch numbers, resulting in an estimate of 88 animals for the complete study period (95% C.I. 6–170; C.V. 14.54) and an annual average of 23 animals (95% C.I. 2-44). Other bycatch sources, such as recreational gillnet fishery or non-Dutch gillnet vessels were not included. The scale of the average annual mortality for the Dutch porpoise population was assessed to be between 0.05 and 0.07% (for the study period).

For many national fishing fleets, the majority of vessels are below 10m length. Although the number of vessels and overall fishing effort have declined in the last ten years, these numbers remain substantial, as indicated country by country, above. In the case of the **UK**, data from Masters (2014) indicated that the effort by vessels 10 m and below constituted 53% of the total drift and fixed net effort, while the value of their landings represented 40%. This has declined since then, however. In 2021, 75% of fish caught by UK vessels were landed by vessels over 24 m length; these vessels constituted just 4% of the UK fleet by number (MMO, 2022). Landings of pelagic species by vessels over 24 m length formed 97% of the annual pelagic landings for the whole UK fleet. 71 per cent of all landings of demersal species by the UK fleet were by vessels over 24 m length. In contrast, landings of shellfish were more evenly distributed across the fleet, with vessels of 10 m or less in length accounting for 22% of the total quantity of shellfish landings (MMO, 2022). It would be useful to have statistics from other countries for comparison, so that the nature of small vessel fisheries could be better assessed, and thus whether they constitute an important bycatch threat

Only a few countries, for example the UK and Denmark, undertake bycatch monitoring (the latter by REM), and most small vessels have been excluded from those observer programmes.

Recreational fishing

Recreational fishing is defined by ICES as "the capture or attempted capture of living aquatic resources mainly for leisure and/or human consumption. This covers active fishing methods including line, spear and hand-gathering, and passive fishing methods including nets, traps, pots, and set-lines". A study on recreational fishing in Europe for the EU PECH Committee (Hyder *et al*., 2018) calculated that 9 million people (1.6% of the total population) are engaged in the activity in Europe with a total economic impact of 10.5 billion EUR, and that it supports almost 100,000 jobs. Despite its socio-economic importance, countries have given little attention to their recreational fisheries, in term of bycatch monitoring and mitigation, although bycatch is known to occur in several countries (e.g., Denmark, Belgium, Netherlands). In all EU Member States in the North Sea area, except Germany, fishing with static nets is allowed with some restriction in terms of platform or length of nets, but good spatial estimates of recreational effort are lacking (Hyder *et al*., 2018), whilst in the UK, there have been some regional estimates of catches by sea anglers from a 2-year study (Hyder *et al*., 2020).

The **Danish** AgriFish Agency launched in 2012 an initiative for assessing bycatch of harbour porpoise in recreational fisheries (AgriFish 2012, 2013). Fisheries inspectors checking the legality of the used equipment must report the bycatch if any and a mandatory field has been included for this purpose in their reporting scheme. A total of 1,840 checks of recreational fishing gear was conducted in 2012 but no harbour porpoise was reported bycaught (AgriFish 2013). However, the report does not indicate the inspection strategy.

In 2013, the **Netherlands** conducted an impact assessment of the effects of set net fisheries on the conservation of harbour porpoises in the Natura 2000 area Noordzeekustzone. For this assessment, existing data on bycatch in set nets, both commercial and recreational were analysed (AC21/Inf.12.1.g). The report of the study is in Dutch and the results on recreational fisheries were not communicated further. The 2018 Dutch National Report to ASCOBANS (the latest to cover bycatch issues) does not indicate whether the programme for collecting effort and bycatch data in recreational fisheries has been implemented.

Belgium is the only EU country annually reporting bycatch in recreational fisheries. Although Member States have not formally reported any initiatives towards the mitigation of harbour porpoise bycatch in recreational fisheries since the adoption of the Harbour Porpoise Conservation Plan, Belgium twice implemented mitigation methods in recreational fisheries. In 2001, Belgium banned recreational fishing with gill nets below the low water line as a measure to protect marine mammals and particularly porpoises. Further measures were taken in 2006, limiting the kind of nets, their height and length (ASCOBANS AC14/Doc.19pp). Historical circumstances have likely led to the unique situation of c. 100 beam and otter trawlers being included in the recreational fleet, although 87% of the Belgian recreational fleet consists of anglers (Verlé *et al*., 2020).

Key Conclusions and Recommendations

EU Member States are required to establish pilot/scientific studies of the <15 m sector of their fleet but, for the most part, this has not been done. Furthermore, there is overall limited compliance to the EU Habitats Directive requirements amongst Member States with regards to monitoring and assessment of the impact of bycatch on harbour porpoise populations. The initiative in the UK (England & Wales) proposing to make iVMS mandatory for collecting data on fishing effort from vessels below 12 m length is to be welcomed, and should be considered by other range states.

Small vessel (<15 m) and recreational net fisheries are known to cause porpoise bycatch in and around the North Sea (see, for example, Bjørge & Moan, 2016), and yet are inadequately monitored (Desportes 2014). Although there are challenges in terms of placing observers aboard these small vessels, remote electronic monitoring has proven successful in Denmark (Kindt-Larsen et al., 2016; Larsen et al., 2021; Glemarec et al., 2022) and the Netherlands (Scheidat et al., 2018). Attention needs to be paid across the region to more effective bycatch monitoring of these fisheries

ACTION 4. Regular evaluation of all fisheries with respect to extent of harbour porpoise bycatch

The section below is largely a summary of the latest published ICES fisheries overview for the Greater North Sea (ICES 2022). ICES data on fishing effort comes from VMS (Vessel Monitoring System). A separate section has been included below analysing in further detail the fishing effort by ASCOBANS Parties using AIS data, along with a comparison of the two approaches.

ICES Summaries of Fishing Effort by Country from VMS

Fishing effort in the North Sea has varied a great deal over the last 50 years, with total landings peaking in the early 1970s and declining thereafter. ICES (2022) estimate that, currently, around 6,600 fishing vessels from nine nations are active in the Greater North Sea (see Figure 3, for map of defined area) with an annual landing of about two million tonnes of fish compared with twice that amount in the early 1970s (see Figure 4). Largest numbers of vessels come from the UK, Norway, Denmark, the Netherlands, and France.

Since 2003, total fishing effort has declined (Figure 5). However, profitability of many of the commercial fleets has actually increased in recent years due to the improved status of many fish stocks, reduced fleet sizes, lower fuel prices, and more efficient fishing gears (ICES 2020). Since 2015, fishing effort for most countries operating in the North Sea has varied relatively little, with only France showing an increase (Figure 6). Confidentiality rules were introduced by STECF in relation to landings and effort tables by country resulting in ICES being unable to show these statistics since 2017.

Denmark, Norway and the United Kingdom account for a high proportion of landings (Figure 4) although fishing effort is highest in the UK fleet (Figure 5). Herring and mackerel, caught using pelagic trawls and seines, account for the largest portion of the pelagic landings, while sandeel and haddock, caught using otter trawls/seines, account for the largest fraction of the demersal landings. Overall landings have increased slightly from 2011 after a rise in herring landings and again, most recently (since 2015), from increased catches of anchovy, sardine, and hake (ICES, 2021).

In order to provide a better understanding of the current nature of each country's fishing fleets in the North Sea, how they are comprised by vessel size, fishing gear and target species, the following descriptions have been summarised largely from ICES (2021) and ICES (2022).

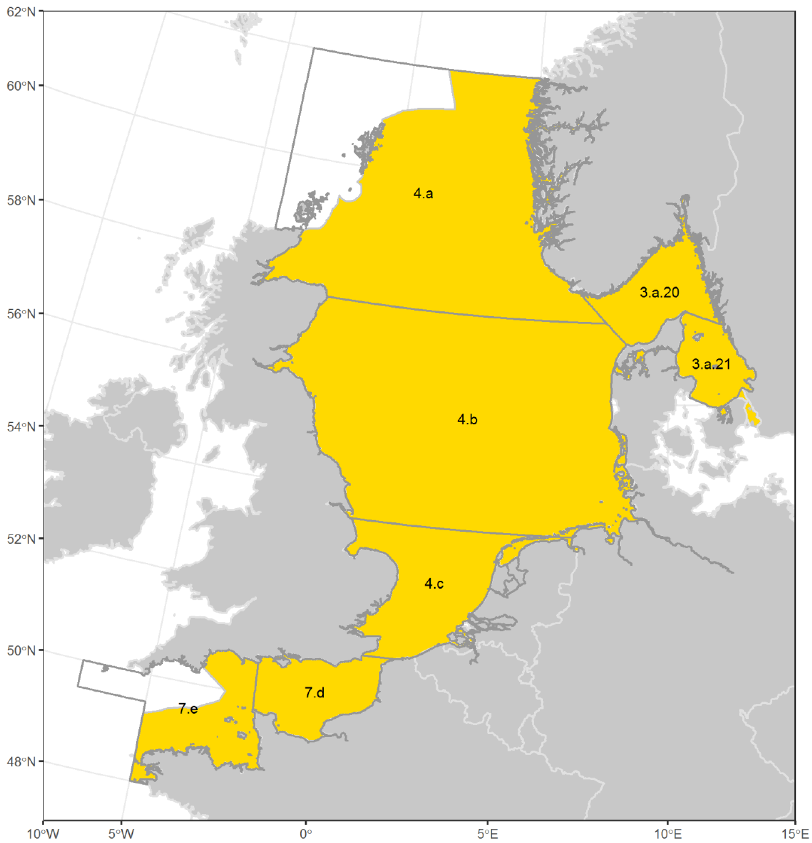


Figure 3. The Greater North Sea ecoregion (in yellow) as defined by ICES. The relevant ICES statistical areas are shown (Source: ICES 2018b)

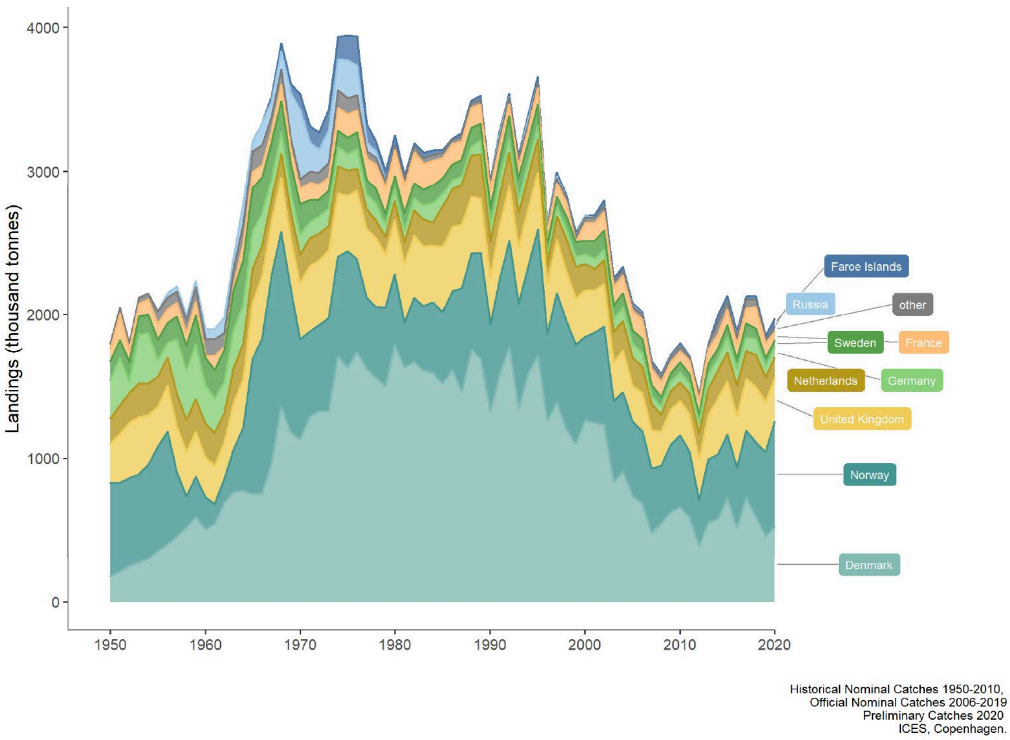


Figure 4. Landings (thousand tonnes) from the Greater North Sea in 1950–2020, by country. The nine countries having the highest landings are displayed separately and the remaining countries are aggregated and displayed as "other" (Source: ICES 2022)

In 2019 (the latest year reviewed by ICES, 2022), the **English** fleet in the Greater North Sea had 1,133 vessels, a reduction of 33 from the previous year and part of a general declining trend since 2009, particularly affecting small vessels of less than 10 m. A fleet of around 882 vessels <10 m length operates in the eastern Channel and coastal North Sea, catching a diversity of fish and shellfish species. Around 25 of these vessels target pelagic fish. Vessels of 10–15 m length numbered 190 in 2019, 23 less than in 2014, with over 95% taking shellfish, and around 16 vessels targeting finfish. Seventy vessels of 15–40 m length targets mainly cockles and edible crabs, with only around 12 vessels targeting demersal finfish. There were 12 English vessels over 40 m operating in the North Sea in 2019, and this number has been virtually unchanged for ten years. Those vessels target finfish, mostly demersal but some pelagic. These include mackerel, herring, and horse mackerel.

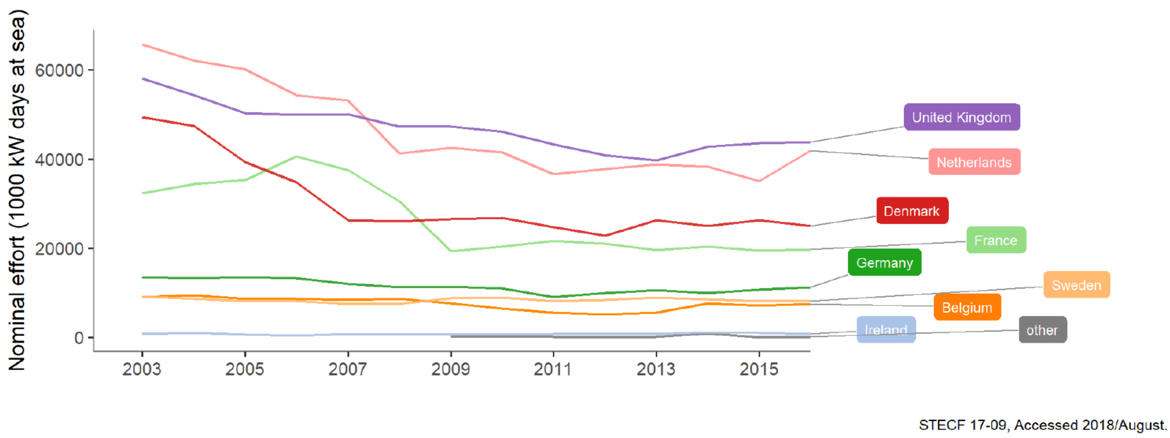


Figure 5. Greater North Sea fishing effort (thousand kW days at sea) in 2003–2017, by EU nation. STECF data are not available after 2016. (Source: ICES 2020)

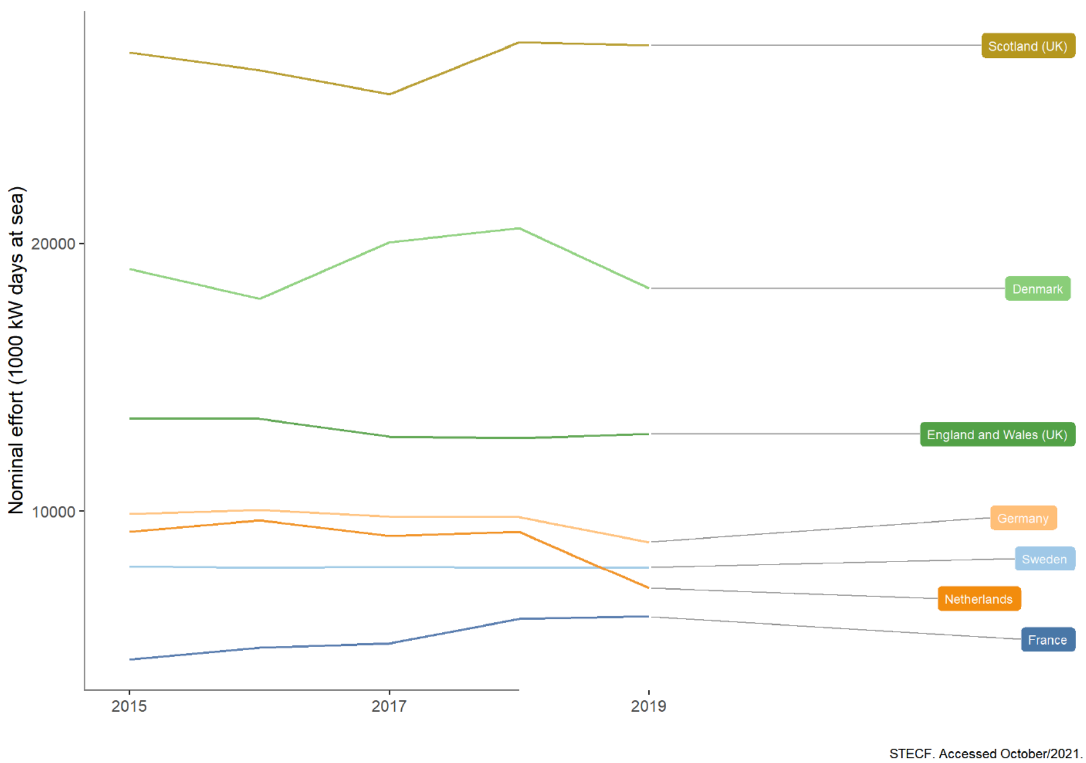


Figure 6. Greater North Sea fishing effort (thousand kW days at sea), 2015–2019, by EU nation. Confidential values are reported by Belgium, Lithuania, Poland and Portugal (Source: ICES 2021)

The **Scottish** North Sea fleet comprises around 1,000 vessels. More than 120 demersal trawlers (almost all >10 m) fish for mixed gadoids (cod, haddock, whiting, saithe, and hake,) and for groundfish such as anglerfish and megrim. A fleet of 139 trawlers fish mainly for Norway lobster in the North Sea: 48 of these vessels (<10 m) operate on the inshore grounds, while 91 (>10 m) operate over various offshore grounds. Pot or creel fishing is prosecuted by over 650 vessels (mostly <10 m) targeting lobsters and various crab species on harder inshore grounds. Scallop fishing is carried out by around 80 dredgers (mostly >10 m). Limited amounts of longlining and gill netting are also conducted by Scottish vessels. Significant catches of pelagic species are harvested by 18 large vessels, primarily using pelagic trawls.

The **French** fleet in the North Sea is composed of more than 600 vessels. The demersal fisheries operate mainly in the eastern English Channel and southern North Sea and catch a variety of finfish and shellfish species. Up until 2016, the largest fleet segments were gill- and trammel netters (10–18 m) targeting sole, followed by demersal trawlers (12–24 m) catching a great diversity of fish and cephalopod species, and dredgers catching scallops. Since 2016, the activity of gill- and trammel netters has decreased substantially, with part of the fleet converting to pot fishery targeting whelks and crustaceans, or stopping their activity altogether because of difficulty in catching sole in the north-eastern part of Division 7.d and the southern part of Division 4.c. Smaller boats operate different gears throughout the year and target different species assemblages. There is also a fleet of six large demersal trawlers (>40 m) that target saithe in the northern North Sea and to the west of Scotland. The pelagic fishery comprises three active vessels catching herring, mackerel, and horse-mackerel.

The **Belgian** fishing fleet is composed of 65 active vessels, primarily beam trawlers both above and below 24 m in length. Few vessels are smaller than 12 m. Most of the catch is demersal species; sole being the dominant species in value, and plaice the dominant species in volume. Other important species include Norway lobster, anglerfish, turbot, shrimp, lemon sole, common cuttlefish, squid, rays, and cod.

The **Dutch** fleet in the Greater North Sea consists of about 500 vessels. The main demersal fleet is the beam-trawl fleet (275 vessels, of which 85 are >24 m and 190 are < 24 m) that operates in the southern and central North Sea, targeting sole (dominant in value) and plaice (dominant in volume) as well as other flatfish species. Until the recent EU-wide ban on pulse trawling most of the >24m beam trawlers have used pulse trawls. Most of the smaller beam trawlers ("Eurocutters") seasonally target shrimp or flatfish. Pelagic freezer trawlers (7 vessels, >60 m) target pelagic species, mainly herring, mackerel, and horse mackerel.

The **German** North Sea fishing fleet comprises more than 200 vessels. Small beam trawlers of 12–24 m length constitute the largest fleet component (around 175 vessels in 2019) almost exclusively targeting brown shrimp in the southern North Sea. In addition, some medium- and large-sized beam trawlers (8 vessels, 24–40 m length; 3 vessels > 40 m length) target sole and plaice, and farm and harvest mussels. Several otter trawlers (c. 9 vessels, 18–24 m length) target Norway lobster and plaice in the North Sea. Medium-sized demersal trawlers (14 vessels, 24–40 m length) mainly target saithe in the northern North Sea, but also catch plaice, cod, hake, and haddock. A restructuring took place in this latter fleet segment with the building of two new trawlers and the decommissioning of some older vessels. Large pelagic trawlers (five vessels >40 m length in 2019) operate in the North Sea pelagic and industrial fisheries that primarily target herring, but also catch horse mackerel, mackerel, sprat, and sandeel. Overall, a reduction in the number of vessels was recorded by the German North Sea fishing fleet during the last ten years, with the number of smaller beam trawlers (12-18m length) being reduced by 25% with 35 fewer vessels, and the demersal otter trawlers (18-24m length) reduced by 50% with 14 fewer vessels. The number of large pelagic trawlers remained stable at five vessels.

The **Danish** fleet comprises 1,560 vessels, of which 717 vessels operate in the Greater North Sea. As has been the case for other countries, the size of the fleet has been declining over the last decade, from 968 vessels operating in 2010 (out of a total of 2,220 vessels). Many vessels carry more than one gear type, and to distinguish these, a vessel-gear type operation is referred to as an operation. There were around 600 operations by smaller vessels (<12 m) in 2019 compared to around 800 in 2010. This mainly consists of gillnetting operations supplemented by pot and trap operations for the smaller vessels and demersal operations for the larger vessels within this group. For the medium-sized vessels of 12–40 m in length there were around 281 operations in 2019 mainly represented by demersal trawling. In 2010, 439 operations were recorded. For the largest vessels above 40 m in length the 54 fishing operations in 2019 were split approximately 50% between demersal trawlers and pelagic trawlers. This is also a substantial reduction from the level in 2010 where 75 operations were recorded. Despite these reductions in fishing effort, the total value of the Danish fishery from the Greater North Sea has been relatively constant over the period 2010 to 2019, with demersal trawlers having around six times the value of gillnetters. The most important demersal fisheries target cod, plaice, saithe, northern shrimp, and Nephrops, using predominantly bottom trawls with some seine activity. The most important pelagic fisheries target herring and mackerel for human consumption, and sandeel, sprat, and Norway pout for fish meal and oils.

The **Swedish** fleet in the Greater North Sea comprises more than 400 vessels. Most vessels operate in Skagerrak and Kattegat, but around 25 of the vessels also fish in the North Sea. In total, around 130 vessels are involved in demersal trawl fisheries, catching several species in the Kattegat and Skagerrak; mainly Norway lobster, northern shrimp, cod, witch, flounder, and saithe. Around 15 of the demersal vessels also fish in the North Sea where they mainly target cod, saithe, haddock, and northern shrimp. The fleets using mainly passive gears consists of around 270 vessels, of which most are using pots to target Norway lobster, lobster, and edible crab, but also gillnets and lines targeting both demersal and pelagic species. The Swedish passive gear fisheries are almost exclusively located in the Skagerrak and Kattegat. The pelagic fleet fishing with active gears consists of just over ten vessels that mainly target herring and sprat in the Skagerrak and Kattegat, but also fish for mackerel, herring, and sandeel in the North Sea. The Swedish fleet (both using active and passive gears) has decreased by around 20% since 2009, largely in the Skagerrak and Kattegat.

The **Norwegian** North Sea fleet comprises about 1500 vessels. 94% of these catch demersal species, including fish, crustaceans, and elasmobranchs, while 33% catch pelagic species, including herring, blue whiting, mackerel, and sprat. In 2009, catches of pelagic species were much higher and demersal species lower, mostly driven by a sharp increase in small vessels (< 11 m) catching demersal species only. Sandeel (by weight) makes up a significant part of the Norwegian fishery here. Over 75% of the fleet are small vessels (< 11 m), corresponding to an increase of +445 vessels. These operate near the Norwegian coast and mostly use traps, pots, shrimp trawls and gillnets, catching mackerel, shrimp, crabs, Norway lobster, cleaner wrasses, and several other fish species.

Medium-sized vessels (11–24 m) mainly target Norway lobster and crabs using pots and traps; shrimp using trawls; mackerel, horse mackerel, and sprat with purse seines; and cod, saithe, and other demersal fish using gillnets or trawls. The number of vessels in this segment has dropped by over 35% over the last ten years. Larger vessels represent about 15% of the fleet (6% 24–40 m; 9% >40 m) and target mostly pelagic fish, such as mackerel, Norway pout, and herring, as well as saithe. Ten years ago, larger vessels accounted for over 20% of the fleet (9% 24–40 m; 13% >40m). The largest vessels among them (>40 m) are mostly pelagic trawlers and purse seiners that operate offshore and account for more than 80% of the total landings (up from 75% in ten years; +40% in absolute landing tonnage).

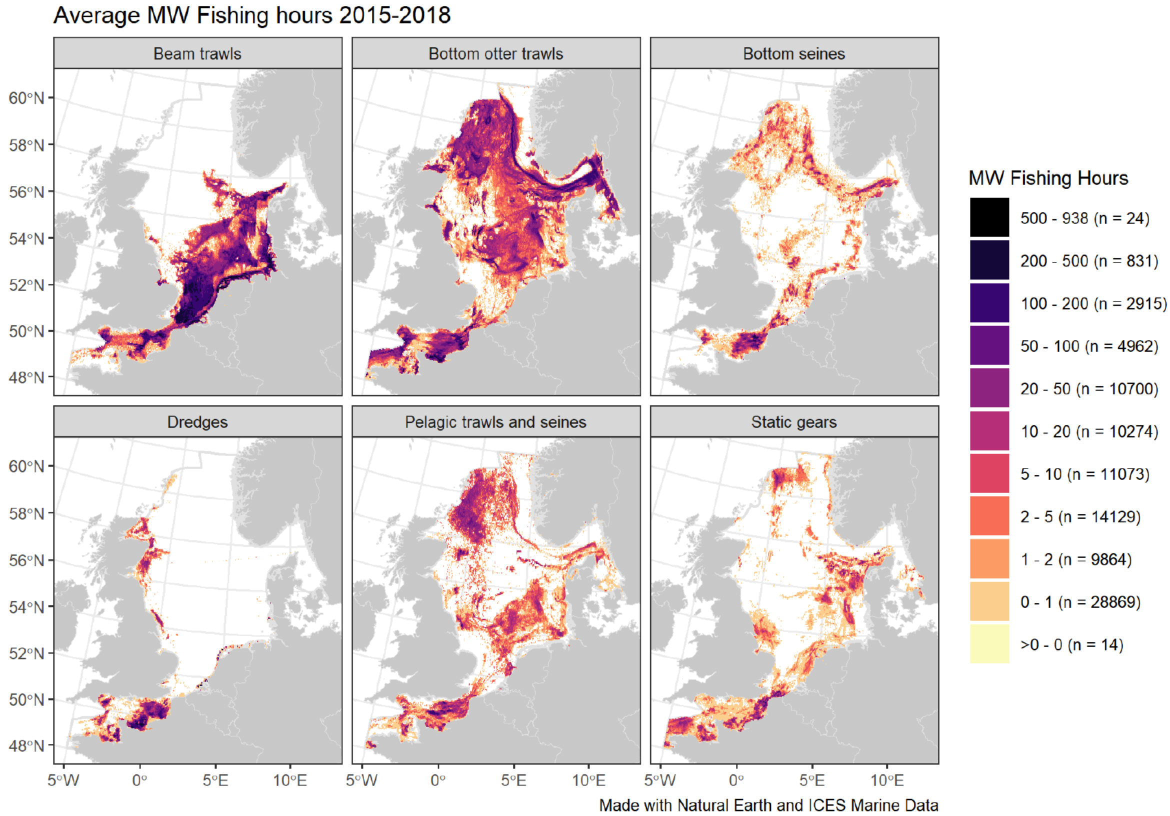
The **Faroe Islands** also fish in the Greater North Sea, but ICES is lacking information on this fleet.

The spatial distribution of different fishing gear from vessels (>12m length) using VMS, varies (Figure 6). Static gear is used most frequently in shallower areas of the southern North Sea, the eastern English Channel, in the Skagerrak, and in the waters east of Shetland. Bottom trawls are used throughout the North Sea, with lower use in the southern North Sea where beam trawls are most commonly used. Pelagic trawls and seines are used throughout most parts of the North Sea, except in the eastern portion of the central North Sea. The small-meshed (<32 mm codend) pelagic trawl fishery targets sandeel, Norway pout, sprat, and blue whiting for reduction purposes. The pelagic trawl fishery for human consumption is operated by refrigerated seawater trawlers (>40 m) and freezer trawlers (>60 m) and targets herring, mackerel, and horse mackerel. Some blue whiting is taken by these vessels in the northern North Sea.

A comparison between fishing effort (measured by VMS) for the period 2015-18 (ICES, 2019) with the latest period available, 2018-2021 (ICES, 2022) shows broadly the same areas used by the different fisheries but with an overall reduction in effort across most gear types, in some areas particularly for static gears, bottom otter trawls and bottom seines (Figure 7).

Static gears such as set gillnets are widely recognised to be the gear type posing the highest risk of bycatch to porpoises in the region. Total fishing effort using static gear in the North Sea appears to have remained rather constant for the latest years (2015-20) for which data have been published (Figure 8). Small and medium-sized boats using static gear target flatfish and demersal fish, depending on the gear used. Only otter trawls and seines have shown an increase in fishing effort over the same period.

a)



b)

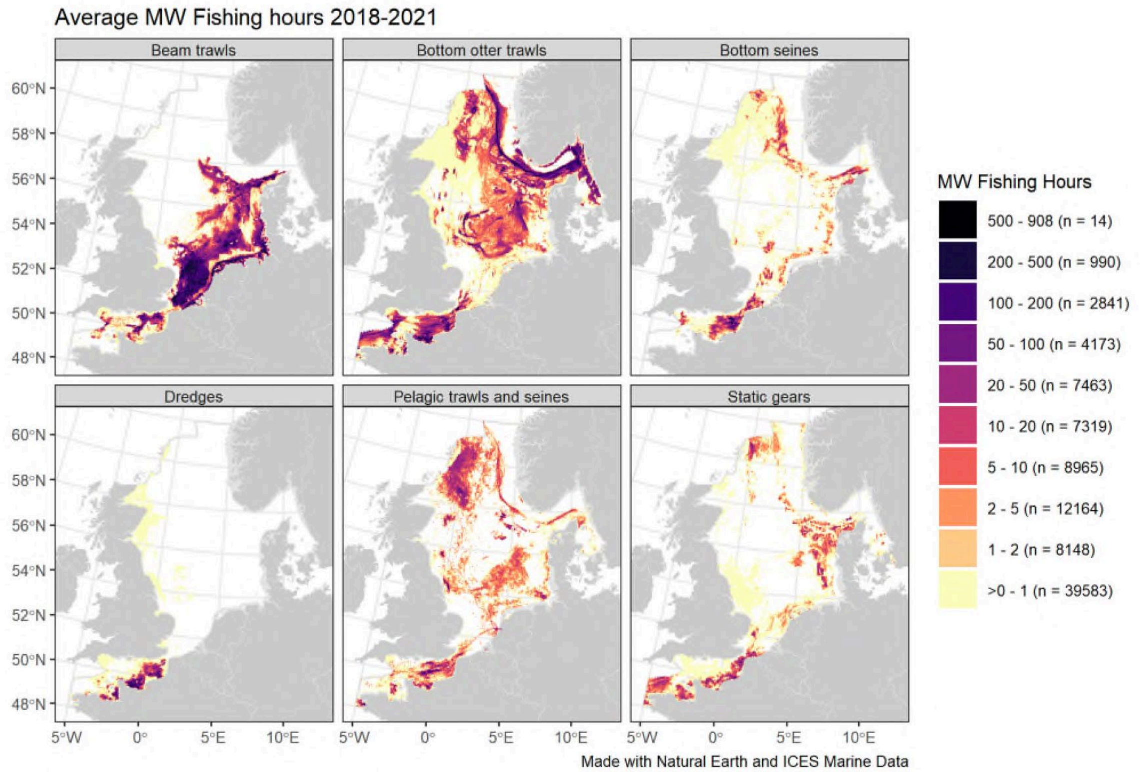


Figure 7. Spatial distribution of average annual fishing effort (MW fishing hours) in the Greater North Sea during a) 2015–18 and b) 2018-21, by gear type. Fishing effort data are only shown for vessels >12 m having vessel monitoring systems (VMS) (Source: ICES 2022)

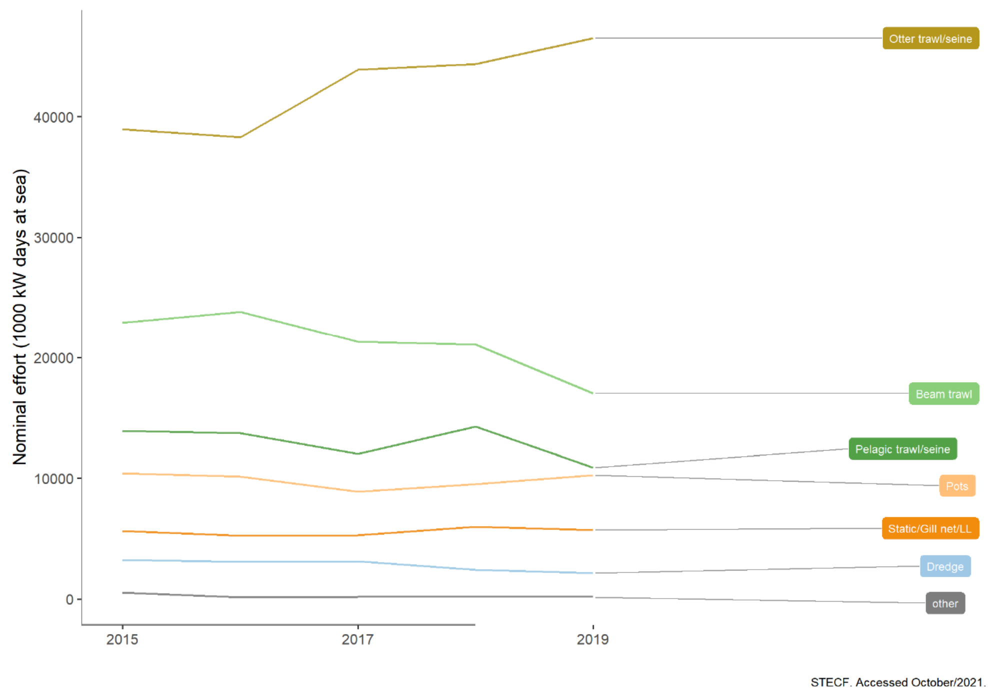


Figure 8. Greater North Sea fishing effort (thousand kW hours at sea) in 2015–2019, by gear type (LL = longlines). Confidential values are reported by Belgium, Lithuania, Poland, and Portugal (Source: ICES, 2021)

Recreational fisheries also occur in the North Sea targeting a wide range of species, but few of these fisheries are monitored or evaluated.

Fishing vessels less than 12 m length are not required to carry VMS, making monitoring of their effort not possible. As fishing fleets increasingly move to smaller vessels, this has resulted in a significant portion of some fleets being unmonitored. In the UK, recently, iVMS (inshore VMS) has been trialled successfully on segments of the inshore English fishing fleet and will be mandatory throughout England & Wales by 2024. Non-UK vessels under 12 m length fishing in English or Welsh waters will also be required to carry iVMS.

In the same way as with normal VMS, iVMS records the location, speed and heading of a vessel using a secure, tamper-resistant system on board. Using a secure line, in England it sends this information to the Marine Management Organisation's UK VMS Hub, using GPRS mobile telephone technology. When a device is located outside GPRS range, the device will continue to store the positional information and submit the data once GPRS coverage next becomes available. This is different to the VMS devices used by larger vessels, which transmit data via satellite and can become expensive.

Once the iVMS device is fitted, it works automatically when powered, meaning that fishers do not have to spend time turning it on and setting it up each time they put to sea. Two device types have been approved – Fulcrum NEMO and Succorfish SC2. EMFF funding support for fishers In England is available until 30 November 2023, to secure a suitable I-VMS device; the device is available for free to Welsh fishers.

Further Analysis of Fishing Effort Using AIS

Fishing vessels over 12 metres overall length within the European Union are legally required to carry a vessel monitoring system (VMS), a form of satellite tracking which transmits the vessel's identity, position, course and speed at least every two hours. There are reciprocal agreements with non-EU countries, such as Norway and Faroes as well as Regional Fisheries Management Organisations. When linked to the vessel's log book, these provide important information not only on fishing effort but also the gear used and catches. During transmission, the VMS information is encrypted so that confidentiality is maintained with data transfer certified. Flag states control and protect the data, deciding when and with whom to share it.

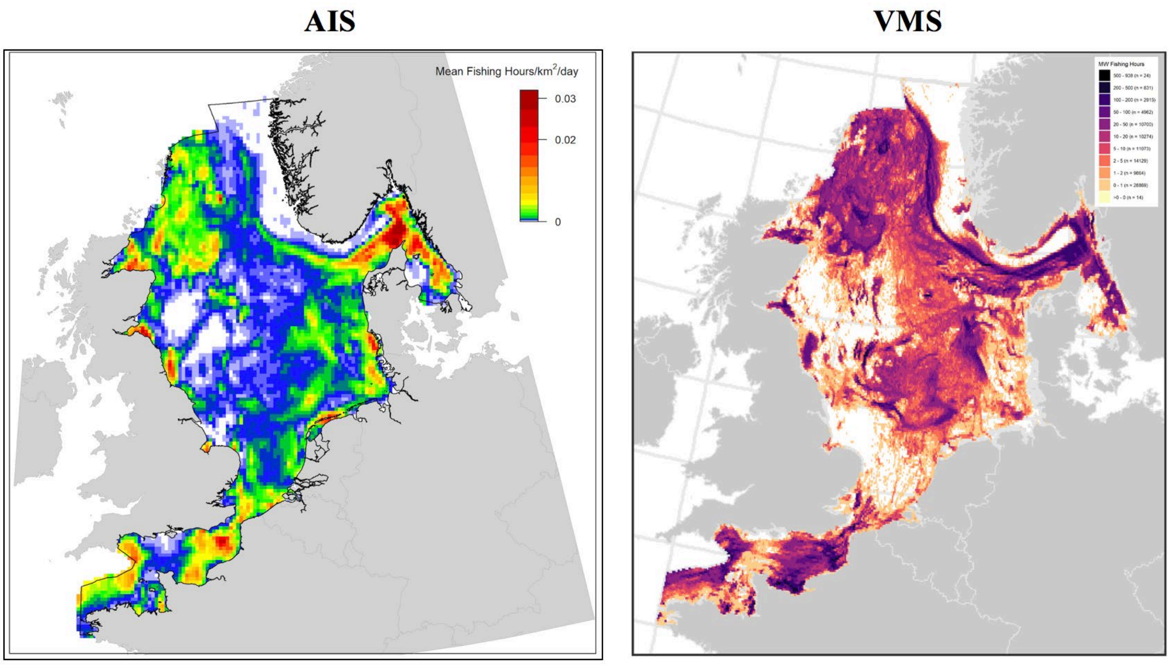
Automatic Identification Systems (AIS), another form of vessel tracking, was introduced by the International Maritime Organisation (IMO) to improve maritime safety and avoid ship collisions in the 1990s. AIS is a very high frequency (VHF) radio-based tool which automatically transfers information about the ship to other ships and coastal authorities. More recently, it has been identified as a useful tool to contribute to fisheries research and enforcement efforts since the data are publicly available. In 2014, all fishing vessels above 15 metres overall length within the European Union were required to carry AIS. In addition, an increasing number of fishing vessels (including those of 10-15m length) use AIS voluntarily as an aid to navigation, and as an operational and safety tool.

AIS was initially designed to communicate with vessels in line of sight which therefore limited coverage from land-based receivers. Since 2018, however, AIS receivers have been placed on low-earth orbit satellites. This has greatly increased coverage and means that AIS signals can be detected from vessels operating beyond the 40nm range of land-based AIS receivers. Global Fishing Watch have used two core machine learning algorithms, one to identify vessels and the other to determine fishing activity.

Using AIS data provided by Global Fishing Watch, maps were prepared of fishing effort for ten gear type groupings (pelagic trawls, pelagic seines, demersal trawls, demersal seines, driftnets, static gillnets, trammel nets, set longlines, drifting longlines, pots & traps) for the Atlantic area from southern Norway to Portugal including all of the Greater North Sea covering the years 2015 to 2018 (Evans *et al.,* 2021). A comparison with VMS maps produced by ICES, was made for the same period for the Greater North Sea), and shows good correspondence in terms of relative levels of fishing effort (Figure 9). AIS maps of fishing effort by gear type were then prepared by season, by year (2015-18), and by country. Full details are provided in Evans *et al.* (2021).

Figure 10 presents maps of overall mean fishing effort by country, bearing in mind that for the most part this includes vessels exceeding 15 metres length and small vessels will be greatly under-represented. Summarising the results, they indicate most fishing effort from **Swedish** vessels is restricted to the Skagerrak but there is some effort particularly pelagic seining in the central North Sea. **Denmark** also fishes heavily in the Skagerrak but with a lot of trawling and some gillnetting in the North Sea west of Denmark. Gillnetting by **German** vessels is concentrated relatively close to the coast not only in German waters but also NW of Denmark. Demersal trawling is widespread in the North Sea whilst pelagic trawling is mainly in the northern North Sea. **Dutch** demersal trawling and seining occur all along the southern North Sea coasts and in the Channel. Pelagic trawling is concentrated in the Channel and the northern North Sea. There is very little gillnetting by Dutch vessels of >15 m length. The **Belgian** fleet involves mainly demersal trawling and seining in the Channel but with some effort also in the central North Sea. Demersal trawling and seining by **French** vessels occurs in French, English and Belgian waters of the Channel**,** with gillnetting in coastal areas of France and Belgium. Both trawling and seining by **UK** vessels are concentrated particularly in the north-western North Sea although there is some demersal trawling and seining in the central North Sea and the Channel. Gillnetting is concentrated around the coasts of southern and South-east England.

a) Bottom Otter trawls



b) Demersal Seines

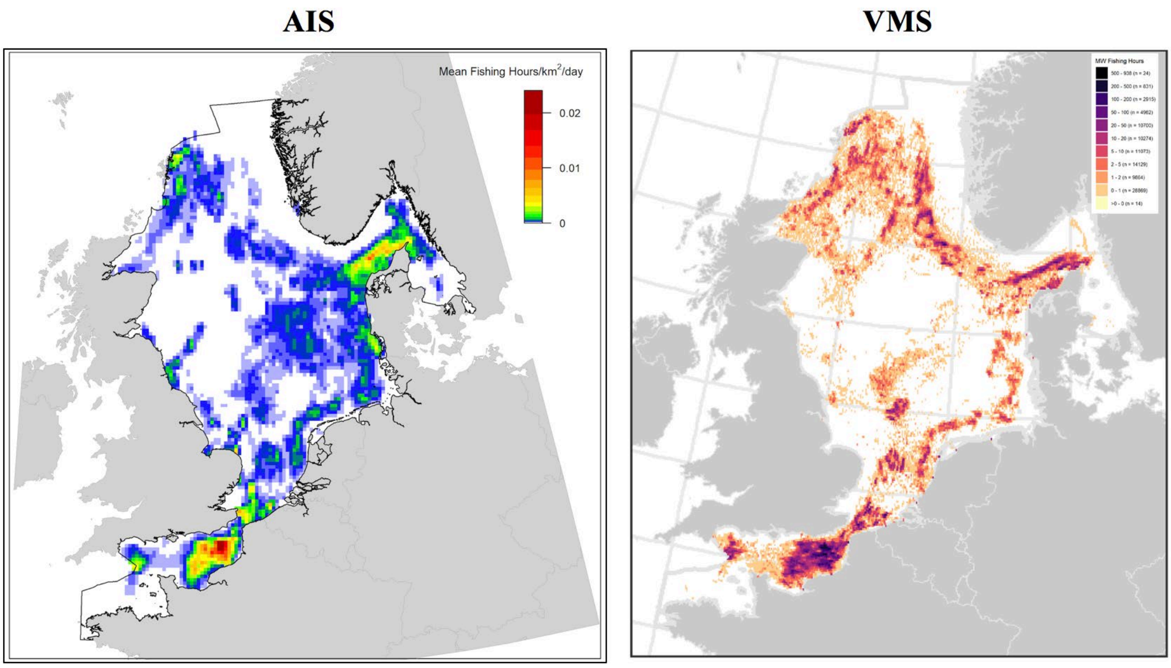
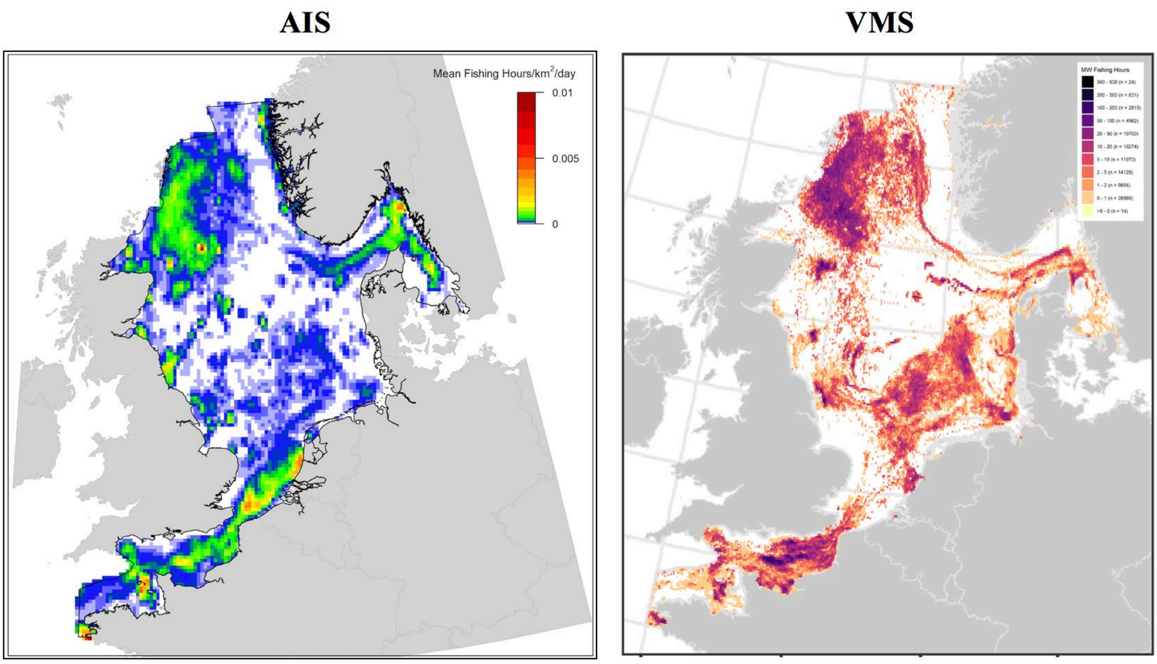


Figure 9. Comparison of Fishing Effort determined by AIS vs VMS
(mean fishing hours, 2015-18)

c) Pelagic Trawls & Seines



d) Static Gear

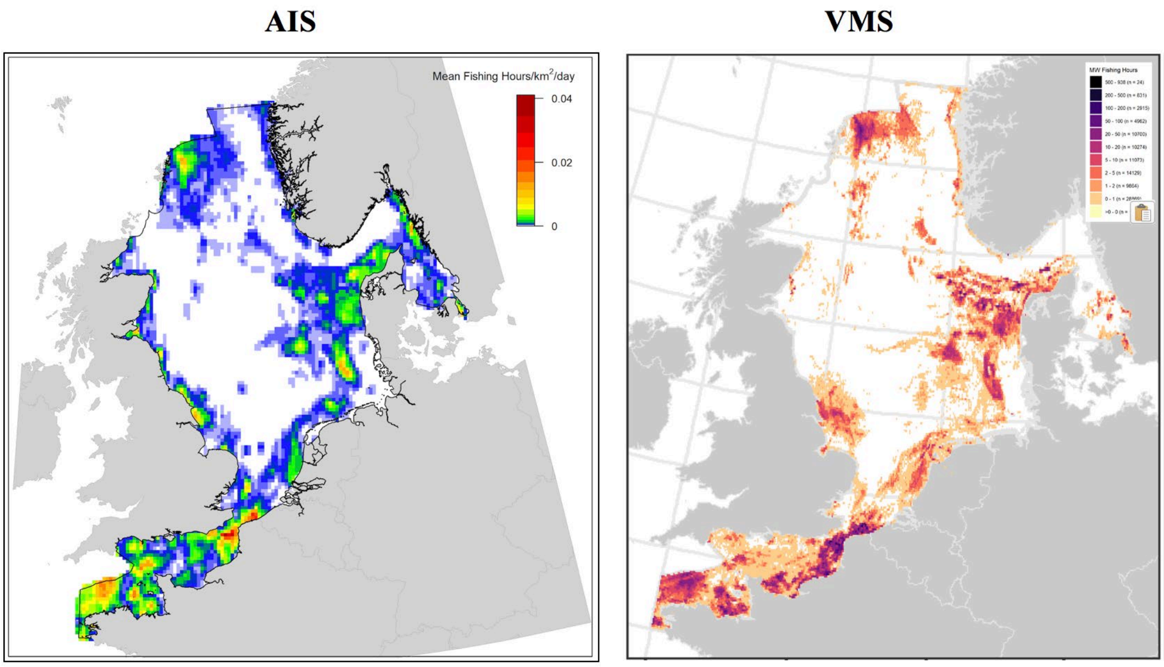
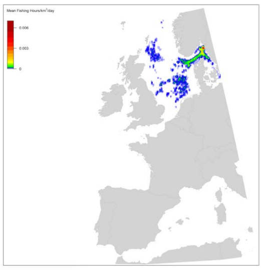


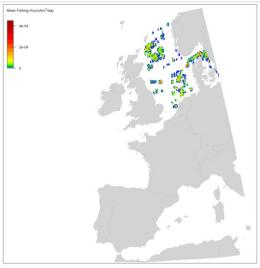
Figure 8 (cont.). Comparison of Fishing Effort determined by AIS vs VMS (mean fishing hours, 2015-18)

a) Sweden

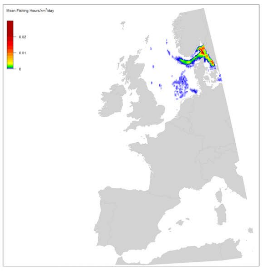
Pelagic Trawl



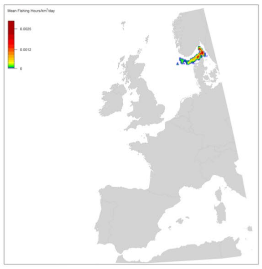
Pelagic Seine



Demersal Trawl

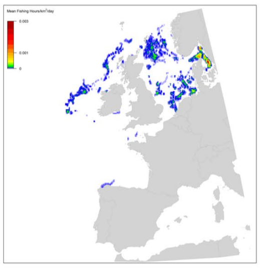


Demersal Seine

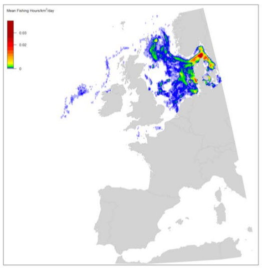


b) Denmark

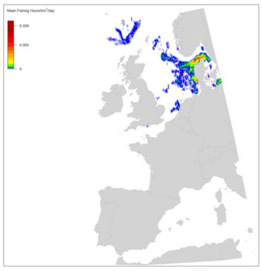
Pelagic Trawls



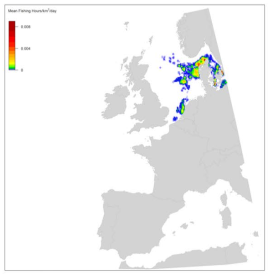
Demersal Trawls



Demersal Seines

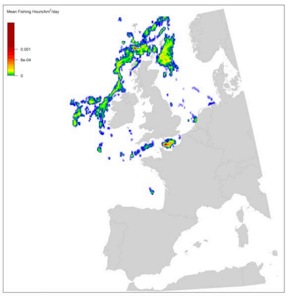


Set Gillnets

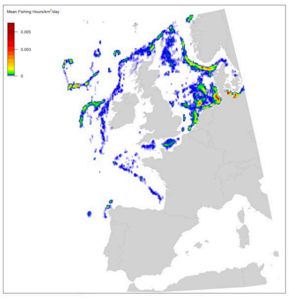


c) Germany

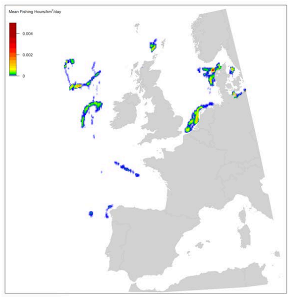
Pelagic Trawls



Demersal Trawls

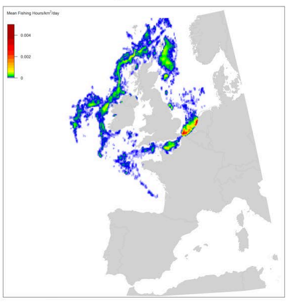


Set Gillnets

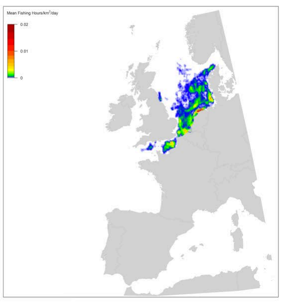


d) The Netherlands

Pelagic Trawls



Demersal Trawls



Demersal Seines

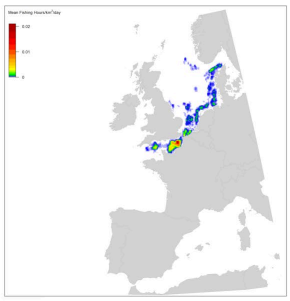
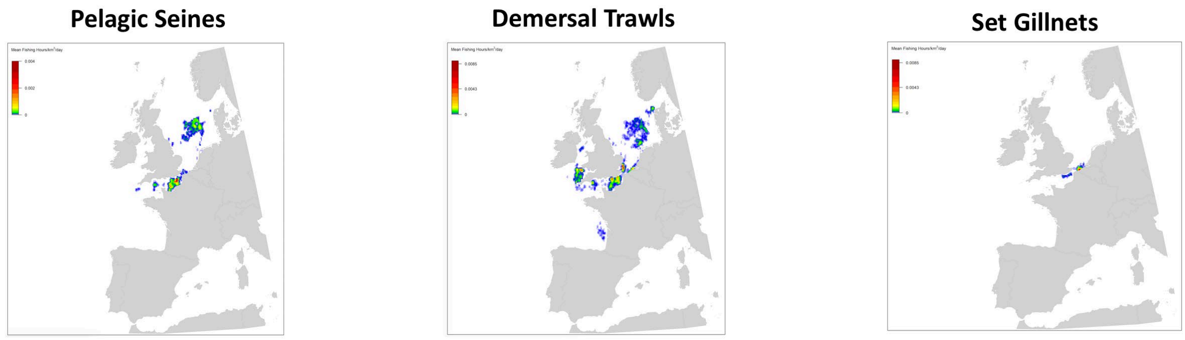
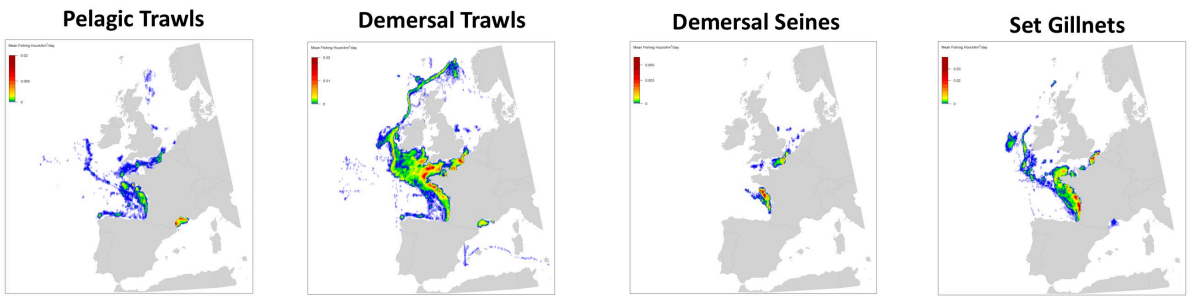


Figure 10. Fishing Effort (mean fishing hours/km2/day)
by Gear Type and by Country, 2015-18

e) Belgium



f) France



g) UK

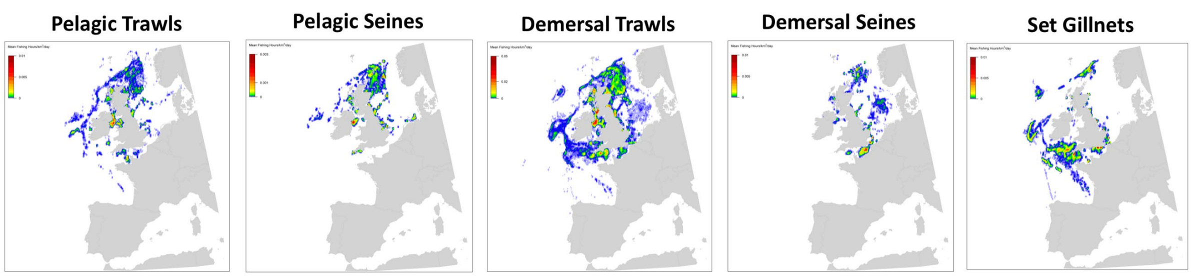


Figure 10 (cont.). Fishing Effort (mean fishing hours/km2/day) by Gear Type and by Country, 2015-18

Harbour Porpoise Bycatch Assessment

In the past, a detailed review of the implementation of Reg. 812/2004, and assessment of the bycatch issue has been undertaken annually by the ICES Working Group on Bycatch of Protected Species (see, for example, ICES WGBYC 2016, 2017, 2018, 2019). With the repeal of Reg 812/2004, this is now undertaken by ICES WGBYC within the Data Collection Framework (DCF).

Within the annual ICES data calls, WGBYC last made an overall bycatch estimate for the Greater North Sea of between 1,175 and 2,126 porpoises for the year 2017 (ICES WGBYC, 2019).

In September 2021, an ICES workshop took place by correspondence to estimate mortality of marine mammals due to bycatch (ICES WKMOMA, 2021). Data from 2015-2020 were examined (although no data were provided from Norway). As shown previously, gillnets generally had the highest bycatch rates of harbour porpoises, with the highest frequencies being recorded in large vessels using GNS in the Greater North Sea (ICES areas 27.3 and 27.4). However, there was non-random sampling with one country selecting several large vessels with high bycatch rates to participate in an REM trial, and this formed a very high proportion of the observed effort. Without that country, the rates were much lower for ICES Subarea 27.4. Small vessels using GNS also had relatively high rates in subareas 27.4 and in 27.3.

The average number of porpoises/bycatch event over 2015-2020 was generally between 1 and 1.5 individuals in most métiers and areas, apart from large vessels using GNS in ICES Subarea 27.4 where 2.5 individuals were observed on average per bycatch event if the non-random sampling observer effort is included. Removing the non-random sampling lowers that estimate down to 1.33 individuals/bycatch event.

In the North Sea, two estimates were presented, one higher estimate including submitted data from all countries (except Norway), but heavily skewed due to very frequent bycatch observations from a few targeted large vessels, and one estimate where the monitoring effort data from this country was removed. The two estimates for the North Sea were 5,929 (95% CI 3,176-10,739) porpoises and 1,627 (95% CI 922-3,325; not including the unrepresentative data) porpoises. The majority of the by-catch was estimated to be from GNS/GND in both cases (1,306/5,327 individuals), followed by GTR (198/479 individuals) and to lesser extent from OTB/OTT (123/123 individuals).

The assessments were subject to various potential biases: 1) they did not include data from all fleets fishing within the Greater North Sea, with data from vessels <12m length almost certainly under-represented, and fishing effort from Norway and the Faroes not included; 2) fishing effort was only poorly represented by the metric, days at sea, information on area swept for trawls and soak time and net length for gillnets being lacking; and 3) sampling of vessels for bycatch monitoring was non-representative (of both fishing effort across metiers and the density distribution of the porpoise population), and where monitoring does take place, it is usually DCF monitoring which has already been shown to under-record cetacean bycatch. The extent of bias from these sources is unknown.

Since then, OSPAR's Marine Mammal Expert Group has estimated harbour porpoise annual bycatch levels in the Greater North Sea for 2020 at 5,974 porpoises (OSPAR, 2023).

Below is a summary of monitoring effort by country, unless otherwise stated, taken from ICES WGBYC (2022) since national reports are no longer submitted to WGBYC on an annual basis. It is hoped that that individual countries will update the relevant sections with new national information.

United Kingdom has a dedicated protected species bycatch monitoring programme (PSBMP), originally established for the purposes of meeting requirements of Reg. 812/2004 and the EU Habitats Directive.

In 2018, 172 dedicated bycatch monitoring days were conducted during 150 trips on board static net vessels and 129 dedicated bycatch monitoring days during 36 trips on pelagic trawlers. A further 25 dedicated bycatch monitoring days were achieved in longline fisheries and 13 dedicated days in ring net fisheries. Over 100 days of non-dedicated sampling in static net fisheries was also conducted under other English, Welsh and Northern Irish fishery monitoring programmes, and roughly 600 days of non-dedicated sampling was undertaken under those same programmes mainly in a variety of demersal trawl fisheries. Observations of cetacean bycatch from all sampling (dedicated & non-dedicated) included one harbour porpoise reported from the southern North Sea (Division 4c), reported during dedicated monitoring in static net gears (large mesh tangle net) (Northridge *et al*., 2019).

In 2019, 173 dedicated bycatch monitoring days were conducted during 116 trips on board static net vessels and 5 dedicated bycatch monitoring days during 5 trips on pelagic trawlers. A further 23 dedicated bycatch monitoring days were achieved in longline fisheries and 14 dedicated days in ring net fisheries (Kingston et al., 2021). However, there was little monitoring in the North Sea, with only two days at sea on gillnetters, all in SubArea 4c, two days at sea on longliners in SubArea 4a, and one day at sea on longliners in SubArea 4c. No porpoises were recorded bycaught. (Kingston *et al*., 2021).

To estimate total bycatch in the UK static net fleet, key assumptions were made in the treatment of the underlying fishing effort and observed monitoring data. Therefore, bycatch estimates are likely biased, and may underestimate bycatch for larger offshore vessels and overestimate for smaller inshore vessels. However, with this caveat in mind, the “best” estimate of harbour porpoise bycatch for 2018 in all UK gillnet fisheries in the absence of pingers was between 845 and 1,633 animals (best estimate 1,150; CV=0.087), and if all over 12 m boats used pingers in relevant areas, the estimate was between 660 and 1,464 animals (best estimate 948 CV=0.108) (Northridge et al., 2019). The equivalent figures in 2017 in the absence of pingers was 1,282 animals (range:718 - 2402; CV=0.08), and if all over 12 m boats used pingers in relevant areas the estimate was 1,098 animals (range: 587-2615; CV=0.10) (Northridge et al., 2018).

The point estimate for harbour porpoise bycatch in 2019, assuming full compliance by the over 12m fleet with the ADD requirements of Regulations 812/2004 and 2019/1241 (both of which applied during 2019), was 833 (95% CL range 502-1560), and the point estimate assuming no ADD use is 1061 (95% CL range 599-1922) (Kingston et al., 2021). This suggests that full ADD compliance in 2019 would have reduced total mortality in UK net fisheries by in the region of 228 harbour porpoises. The largest metier specific reduction (185 to 25 porpoises per year) associated with ADD use is seen in the Gill Hake metier which mostly involves vessels over 12m operating in areas where ADDs are required. The potential reduction associated with fully compliant ADD use under the regulations applying in 2019 was 22% of total estimated mortality.

The collaborative Cetacean Strandings Investigation Programme (CSIP) in the United Kingdom is a consortium of partner organizations (Zoological Society of London, Scottish Rural University College (Inverness), the London Natural History Museum and Marine Environmental Monitoring in Wales) funded by Defra and the UK Devolved Governments of Scotland and Wales. The CSIP is collectively tasked with recording information on all cetaceans, marine turtles and basking sharks that strand around UK shores each year and with the routine investigation of causes of mortality through necropsy of suitable strandings. Harbour porpoises are the most commonly discovered species, as stranding levels were close to 400 carcasses both in 2019 and 2020. A few dozen animals were examined, and the proportion of bycaught porpoises was below 7%. Unfortunately, the numbers stranding or % bycaught in the Greater North Sea have not been differentiated from the rest of the UK.

In **France,** the programme OBSMER manages all the observations at sea as required by various fishery regulations. During 2017, a total of 701 fishing trips and 855 days at sea were monitored by observers. A total of 197 trips and 158 days at sea were dedicated to set nets in areas requiring pingers under the Regulation (Subareas 4 and 7). A total of eight harbour porpoises were recorded bycaught in 2017, however none within the North Sea region: three in towed gears in Divisions 27.8b, 27.7g and 27.8a, and five in trammel nets in 27.8a and b. The low coverage of metiers (1.5% for towed gears and <1% for static gears) by at sea observers did not allow production of estimates of total cetacean bycatch (ICES WGBYC 2019). During 2018, a total of 867 fishing trips and 1,991 days at sea were monitored by observers. For towed gears in subareas 7 and 8 and in the Mediterranean**,** the sampling covered 206 fishing trips (115 in the Mediterranean and 91 in subareas 7 and 8), representing 254 days at sea. For passive gear in ICES subarea 8, the sampling covered 274 fishing trips, representing 321 days at sea. In addition, for set nets, there were 176 fishing trips, representing 180 days at sea, in the areas covered by pingers (subareas 4 and 7**).** Incidental catches of cetaceans across all the samples taken at sea during 2018 totalled two harbour porpoises. Since then, there has been improved monitoring effort in the Bay of Biscay mainly to investigate common dolphin bycatch. However, dedicated bycatch monitoring of French vessels in the Greater North Sea (i.e. the Channel) has not been undertaken, and no porpoise bycatch has been reported. OBSCAMe is a French scientific programme based on REM observations, coordinated by the French biodiversity agency (OFB) in partnership with others. The first experimental phase involving five voluntary gillnetting vessels (10-18m length) started from January to May 2021 and recorded a single harbour porpoise bycatch, with the second phase involving twenty voluntary vessels (7-25m length) from October 2021 to July 2022, with a further 13 porpoises recorded bycaught up to April 2022 (866 trips involving 7,000 fishing hours hauling). However, the focus was again for vessels operating in the Bay of Biscay.

The French stranding network is co-ordinated by the Joint Service Unit *Observatoire Pelagis*, UMS 3462 University of La Rochelle/CNRS, dedicated to monitoring marine mammal and seabird populations, and funded by the Ministry in charge of the environment and the French Agency for Biodiversity. It consists of around 400 trained volunteers distributed along the French coast who collect data according to a standardised observation and dissection protocol. More than one thousand small cetaceans were recorded along the French coasts in 2018 (mostly common dolphins in the Bay of Biscay). 1,142 strandings were collected in 2019, and 1,289 in 2020 (ICES WGBYC, 2021). Between 64 and 72% of examined dolphins were attributed a cause of death as bycatch. Harbour porpoises were the second most frequent species found stranded (279 in 2019, 215 in 2020 and 244 in 2021); in 2021, bycatch evidence was detected on more than half of examined porpoises (70/138) in the Bay of Biscay and the Channel (ICES WGBYC, 2022).

Along the French coasts the use of a drift prediction model has allowed an estimate of the proportion of dead cetaceans at sea that sink or that would never get stranded according to the dominating winds and tides (Peltier et al., 2016). This has highlighted that the strandings recovered are probably only a fraction of dead cetaceans at sea.

In **Belgium,** no observer scheme was in place in 2018-2020 to monitor bycatch of marine mammals. Fishing trips were only observed on board vessels with towed gear to fulfil other monitoring requirements. No bycatch of marine mammals was observed during fishing operations. Due to the small number of vessels affected, Belgium states that commercial fishing practices in the country have a limited impact on the marine mammal populations.

Along the coast, a stranding network is organised and centralised by the Royal Belgian Institute of Natural Sciences (RBINS), maintaining, in cooperation with the University of Liège, a single database which can partly be consulted online. 89 strandings of harbour porpoises were recorded in 2018, and 10% of examined carcasses presented evidence of death in fishing gears. This compares with 93 stranded harbour porpoises (ICES area 4.c) in 2017 (ICES WGBYC 2019). Of 34 animals examined, 9 were found to have been caught incidentally in fishing operations (26.5%), although it is not possible to be sure in what type of fishing gear. In 2019, 2020 & 2021 respectively, 52, 67, and 79 harbour porpoises were recorded stranded along Belgian coasts. 14% of examined carcasses presented evidence of death in fishing gears in 2019 (Haelters *et al.,* 2020), and 7% (2/30) in 2021 (ICES WGBYC, 2022) .

In the **Netherlands**, EU Council Regulation 2019/1241 requires observer coverage in ICES areas 6, 7 and 8 in pelagic trawling fisheries for the period of 1 December – 31 March (fleet segment NLD003) and outside this area in all areas year round (fleet segment NLD004). The Netherlands reported for 2018 that, during 11 fishing trips, 63 days and 170 hauls were observed in fleet segment NLD003, and 121 days and 304 hauls were observed in fleet segment NLD004. With a total number of fleet days of 456 in fleet segment NLD003 and 922 in fleet segment NLD004, the coverage was 13.8% and 13.1%, respectively. Thus, the target of the Pilot Monitoring Scheme (PMS) of 10% for NLD003 and 5% for NLD004 was fulfilled. In addition to these trips, one observer trip was carried out on board a foreign flagged trawler which makes the total number of monitored trips by the Netherlands twelve. The observer effort onboard the foreign trawler consisted of 12 days (46 hauls), covering approximately 6.5% of the total Dutch monitoring effort. The observed bycatch rate of 0.00 dolphins per day in the pelagic fishery in 2018 is in line with the findings in 2006 -2017 when the observed bycatch rate was 0.00-0.01 dolphins per day. In 2021, 10 observer trips were carried on demersal fisheries and 12 observer trips on pelagic fisheries.

The Dutch strandings network consists of a consortium of a large number of organisations and volunteers. The observation effort is unequal along Dutch coasts (approaching 100% in western coasts, but very low in uninhabited Frisian islands and Wadden Sea). Post-mortem research has been carried out on a selection of strandings (approximately 10-20% of all stranded individuals) since 2008 at the Faculty of Veterinary Medicine of Utrecht University. A total of 476 harbour porpoise carcasses were detected along Dutch coasts in 2018 rising to 713 in 2021 (ICES WGBYC, 2021, 2022); these are the highest numbers registered for any country along the coasts of the North Sea. According to the decomposition status of carcasses, necropsies were performed on 12% of them in 2018 and 8% of them in 2021. The proportion of porpoises with bycatch evidence related to the number of examinations reached a maximum of 12% in the North Sea in the Netherlands. In 2019, 2020, and 2021, 429, 508 and 713 harbour porpoises respectively were recovered, with the percentage of carcasses examined considered bycaught rising from 2% to 13% (ICES WGBYC, 2021, 2022).

Germany monitored bycatch under the DCF observer programme for the 2018 reporting period. Fishing effort was only recorded for vessels >10 m in overall length (North Sea), since data on the fishing gear and mesh sizes used are unavailable for smaller vessels. The sampling intensity required under the Regulation 2019/1241 was not possible in some fleet segments for technical reasons or owing to a lack of capacity in the sampling programme tailored to the requirements of the EU fisheries data collection programme. Sampling effort in pelagic trawls in subareas 6, 7 and 8 was 22 out of a total fishing effort of 237 days (9.3%). There was no sampling in static nets ≥80 mm in divisions 6a, 7a,b, 8a,b,c and 9a (total fishing effort 189 days). No bycatches of marine mammals were observed during sampling. Information for 2020 and 2021 was not available to ICES (ICES WGBYC, 2021, 2022).

National Park Rangers patrol the coastline regularly throughout the year, ensuring a constant observation effort. Marine mammal carcasses that can be retrieved are collected and submitted for investigations at the University of Veterinary Medicine in Hannover and are usually kept in a deep-freeze storage until necropsies can be carried out by official veterinarians. The advanced decomposed status of strandings recovered along the eastern coasts of the North Sea (according to prevailing winds) reduces the possible necropsies and examinations, and therefore the determination of cause of death. For the year 2018, 116 strandings of harbour porpoises were recorded. Only one out of 25 porpoises examined presented evidence of bycatch. In 2019 and 2020, only around forty carcasses were examined whereas more than 200 porpoises were recovered. In 2021, 89 porpoises were recorded stranding in Schleswig-Holstein and 50 in Lower Saxony (where only opportunistic reporting occurs). Very few individuals in 2019-21 presented bycatch evidence, with none in 2021 (ICES WGBYC, 2020, 2021, 2022).

Denmark reported no specific monitoring programs for incidental bycatch of marine mammals during 2018 in the Danish pelagic trawl fishery (ICES WGBYC 2020). The reason for not continuing previous monitoring programmes from 2006-2008 was that the observer schemes, with a coverage of up to 7%, had no records of incidental bycatch of cetaceans. A much higher coverage would be needed to detect any bycaught cetaceans and other marine mammals in the Danish pelagic trawl fishery but this was also considered to be a very expensive task compared to the likely outcome. Also, no dedicated monitoring according to the Regulation No. 812/2004 took place in the Danish gillnet fishery. Instead, observer data on incidental catches of marine mammal in gillnets was collected under the national Data Collection Regulation scheme (DCR). As the DCR programme's main purpose is to monitor discards of fish, the observer coverage of gillnet vessels was in general very low, except in Subarea 27.4. Gillnetters usually have a low discard and therefore observer hours to monitor these fisheries have not been prioritised. However, video monitoring on-board gillnet vessels was continued in 2018 by DTU Aqua (Technical University of Denmark) on board 8 vessels, all less than 15 metres length. The data from 2018 have not yet been fully analysed. DTU Aqua undertook a consolidated analysis of all REM data from 2010-19, and this was published in 2021 (Larsen et al., 2021).

The stranding network is run by the Danish Nature Agency in collaboration with the Fisheries and Maritime Museum and the Zoological Museum, Natural History Museum of Denmark. Post mortems on stranded marine mammals are conducted by the National Veterinary Institute. Twenty-five harbour porpoises were recorded stranded dead along the coasts of Denmark (all Danish seas) in 2018. Examinations were performed on two individuals, and one of them presented evidence of bycatch. The increasing number of carcass examinations by the Danish network suggested that in 2019 and 2020, 21% of examined carcasses died in fishing gears. In 2021, 33 of 268 strandings were examined, of which 55% (18/33) had evidence of bycatch (ICES WGBYC, 2022). The number of strandings was much higher than in previous years due largely to increased effort. Note that the figures include both North Sea and Inner Danish waters; the two areas have not been differentiated.

Sweden has no dedicated national marine mammal at-sea observer schemes focusing on the bycatch of marine mammals. The monitoring effort conducted and provided by Sweden is part of the EU Data Collection Framework where on-board observer data are mainly from bottom otter trawl fisheries and also pot fisheries for crayfish. In addition, in 2017, Sweden started a pilot project monitoring bycatch of marine mammals and birds in gillnet and trammel net fisheries targeting cod and lumpfish in the south of Sweden with dedicated onboard observers. The project continued in 2018. This survey was part of a pilot project with the aim of collecting information on bycatch in fisheries for DCMAP. In the report, Sweden has included data from this survey along with monitored effort which is part of the standard EU Data Collection Framework. In 2018, a total of 32 trips/DaS were carried out with onboard observers. However, when summarizing the total number of trips/DaS per métier, it adds up to 43 observed trips. This is due to the fact that data are presented per métier and since fishermen can fish with two different gears on the same trip, the number of observed trips/observed DaS can exceed the total number of observed trips/DaS. The dedicated observer scheme along the Swedish coast gave valuable information regarding bycatches of harbour porpoises in gillnet fisheries; two harbour porpoises have been reported bycaught. No harbour porpoises were reported bycaught in bottom otter trawls or pot fisheries reported through the EU Data Collection Framework.

Reports of observations of both live and dead harbour porpoises are collected through a web-based system by the Swedish Museum of Natural History (SMNH), funded by the Swedish Agency for Marine and Water Management (SwAM). A limited number of carcasses are collected for necropsy and sampling (sine 2020, approximately 30 per year) by SMNH in collaboration with the National Veterinary Institute, funded by SwAM. Neimane *et al*. (2020) compiled data from necropsies of 89 stranded and 11 bycaught (handed over by fishermen) harbour porpoises, collected from 2006 to 2019. In addition, during this period, a total of 460 encountered dead harbour porpoises were reported by the public. This can be regarded as a minimum number of strandings as Sweden has a long coastline with archipelagos, and the reporting system is voluntary and opportunistic. Of all reported dead animals, 27% were from the summer management range of the North Sea population (as defined by Sveegaard *et al*. 2015), 69% from the summer management range of the Belt Sea population (as defined by Sveegaard *et al.* 2015), 3% from the area west of this in the southern Baltic Sea, and none within the summer management area of the Baltic Proper population (as defined by Carlén *et al.* 2018). The collected carcasses were examined for health status, reproductive status, cause of death etc. Bycatch and likely bycatch were the most common causes of death (36%) for the collected stranded animals for which cause of death could be determined (n=61). From 2006-2020, 140 porpoises were examined. Twelve of these were found entangled in fishing gear (known by-catch). The remaining 128 animals had stranded. Of the stranded animals, 13 (10%) were determined to have died in a fishery interaction and an additional 20 (16%) were diagnosed as probable bycatch.

In 2022, 41 porpoises were examined by necropsy (15 from Skagerrak, 6 from Kattegat, 14 from The Sound, and 6 from the Baltic Sea). Of those 41, 22 were found stranded (3 of which were diagnosed as by-caught) and 19 were submitted by fishers as by-caught between March and May, and July and October (K. Owen, SMNH, pers. comm.).

Bycatch Risk Mapping

For bycatch risk mapping, maps of porpoise density distributions were first prepared by season using a modelling approach that incorporated environmental variables applying to a northern oceanographic domain from southern Scandinavia to NW France based upon 1.25 million kilometres of dedicated survey effort, provided by 44 research groups, with surveys undertaken across the period 2005 to 2020. The number of research groups surveying in the North Sea is much smaller, however.

To create maps of relative risk of bycatch, standardised AIS effort rasters and animal density rasters were multiplied to create new rasters of relative bycatch risk. Values approaching 1 would indicate that the highest densities of animals correspond with the highest density of fishing pressure, representing the greatest risk; those approaching 0 would indicate that the lowest densities of animals correspond with the lowest density of fishing pressure, representing the lowest risk. Intermediate scores could represent high densities but low effort or the converse. Overlap for every species-gear type combination was mapped separately for northern and southern domains on a seasonal basis, and with overlays of protected areas. Pelagic trawls and seines were combined, as were set gillnets, trammel nets and drift nets; this was because of uncertainties revealed in the fishing effort data as to whether they had been correctly ascribed across the entire region, due largely to the polyvalent nature of fishing gear registered in some areas. Static gear is well known to be a particular cause of bycatch for porpoises. Seasonal bycatch risk maps for gillnetting indicate potential hotspots occurring in the southwest Skagerrak, just west of the Sylt Outer Reef in the German Bight, and in Dutch and Belgian waters including the Dover Strait (Figure 11). Seasonally, bycatch risk in most parts appears to be greatest between April and September.

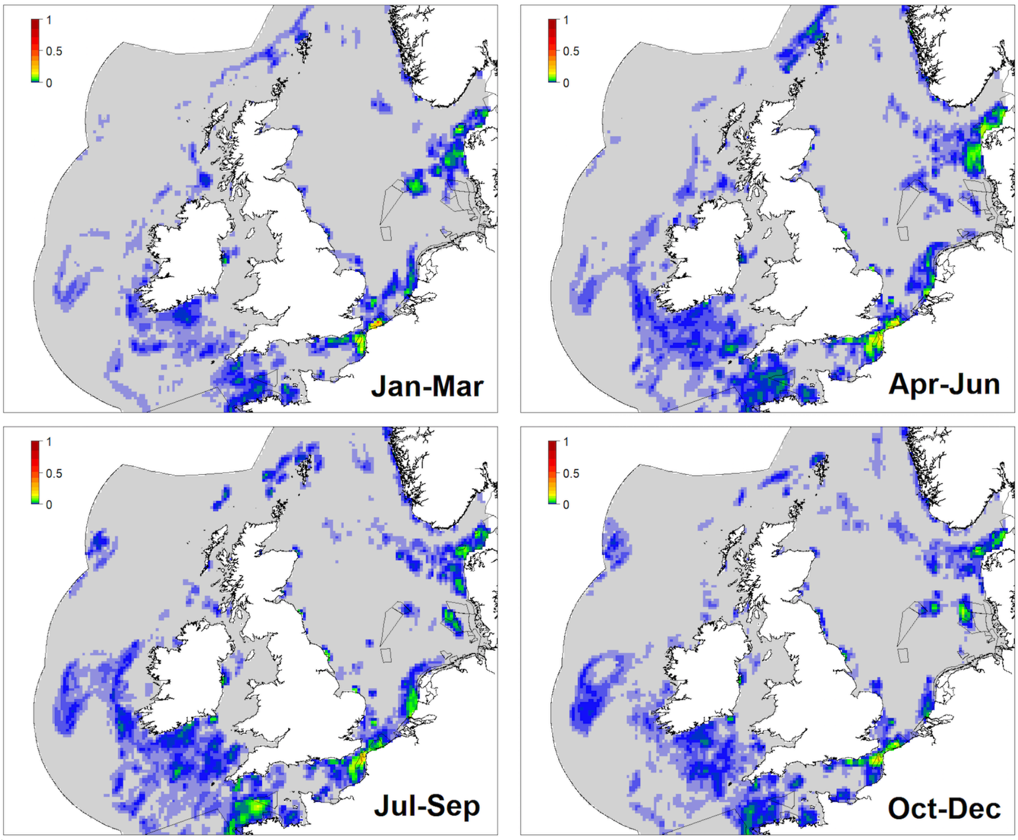


Figure 11. Harbour Porpoise Seasonal Bycatch Risk Maps for Static Gillnetting (Evans et al., 2021)

Key Conclusions and Recommendations *The conclusions and recommendations from the previous Progress Report remain relevant a year later. Bycatch rates continue to be derived from sampling of a small number of vessels and even smaller number of trips (mainly by visual observers but in a few cases experimentally also by remote electronic monitoring) and then extrapolation to entire fleets according to gear type. Often, those bycatch rate estimates are carried over to subsequent years with the estimates altered simply on the basis of changes in fishing effort. This takes no account of spatiotemporal changes in risk of bycatch due to varying overlap in porpoise occurrence and numbers and the presence and number of fishing vessels. Furthermore, the traditional metric for fishing effort, mandatory for vessels over 15 m length, is days at sea which is a poor representation of actual fishing effort. Fishing effort in the form of hours fished can also be derived from VMS data and is available for fishing vessels over 12 m, whilst vessels >10m record effort in their logbooks in terms of days fished. These different measures are not easily equated with one another, as was demonstrated for static nets and midwater trawls by ICES WGBYC (2018).*

Obtaining estimates that reflect the true amount of fishing effort by gear type is fundamental to the assessment of bycatch. We are currently far from obtaining spatiotemporal measures of net length and soak time for static gear but this should be a target to aim for. The other part of the equation is a sampling procedure that adequately reflects the actual number of porpoises bycaught per unit effort across all vessels causing bycatch. Currently, this is far from being met by any country.

Countries should take full-account of the necessary sampling protocols for cetaceans and other protected, endangered and threatened species, and carry out bycatch monitoring in the relevant métiers with sufficient observer coverage, at least 5-10% of total fleet effort for those fisheries representing a moderate or high risk of bycatch. Given that both porpoises and fishing activity vary in *space and time, this should be taken into account for more targeted monitoring   We urge parties to ensure there is a significant improvement in the consistency of bycatch data at a regional scale through the EU-MAP.*

ACTION 5. Review of current pingers, development of alternative pingers and gear modifications

Despite the repeal of Reg. 812/2004, acoustic deterrent devices such as pingers remain a required mitigation measure under the new Technical Conservation Measures Regulation (2019/1241) for vessels of 12 m length or more operating relevant gillnet fisheries in any part of the North Sea (Table 2, Figure 11).

Area	Gear	Period
ICES sub area IV and division IIIa	Any bottom-set gillnet or entangling net, or combination of these nets, the total length of which does not exceed 400 meters	1 August – 31 October
ICES sub area IV and division IIIa	Any bottom-set gillnet or entangling net with mesh sizes ≥ 220 mm	All year
ICES divisions VIId and VIIe	Any bottom-set gillnet or entangling net	All year

Table 2. Requirement for pinger use established under Council Regulation (EC) 812/2004 in the North Sea

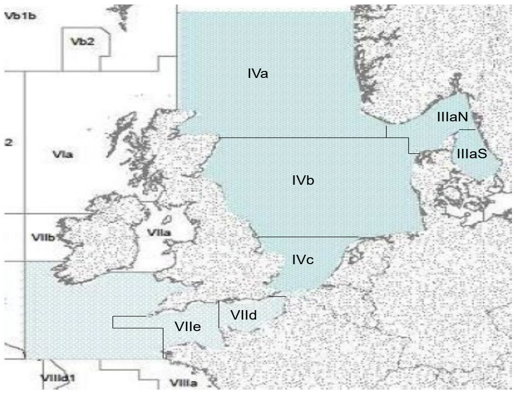


Figure 11. Pinger use - areas and gears regulated under CR (EC) 812/2004 in the North Sea, Skagerrak and Kattegat, and the Channel and Celtic Sea (ICES WGBYC, 2011), and maintained through CR (EC) 2019/1241

Below is a summary of each country's progress in usage of pingers within their fleets. Unless stated otherwise, it has been compiled from the latest reports of the ICES Working Group on Bycatch (ICES WGBYC 2021, 2022).

In 2018, of 26 **United Kingdom** registered vessels of ≥12 m using nets, 22 fished in Divisions 7defghj and thus required pingers (ICES WGBYC, 2020). Three vessels fished in subarea 4 and are assumed to have been required to use pingers (as all reported using meshes >220mm). One of these vessels fished in both Subareas 4 and 7, while two of the 26 over 12m vessels did not fish in any areas requiring the use of pingers under Reg. 812/2004. Overall, it was concluded that during 2018, 24 ≥12 m UK registered vessels fished in areas and with gears that require the use of pingers. In 2018, there were no records of vessels over 12 m using encircling gillnets (Northridge *et al*., 2019).

During 2018, eight trips where pingers were used were monitored, amounting to 77 observed hauls. Porpoise bycatch rates overall remain substantially (83%) lower when pingers are used according to the UK Government guidelines compared with when pingers are not being used, and there is no evidence of any change in pinger efficacy over time. The guidelines on pinger use which were produced in 2012 and agreed with industry, state that DDD pingers should be placed no more than 4 km apart, either to the buoy ropes at each end of a net fleet, or if net fleets more than 4 km are used, pingers should be attached to the floatline and/or buoy ropes so that no part of the net fleet is more than 2 km from an active pinger (Northridge *et al*., 2019).

In 2019, 18 UK registered vessels ≥12m worked in areas where use of ADDs is required. Sixteen of these vessels worked in relevant Divisions within Subarea 7 and four vessels worked in Subarea 4. Two vessels worked in both areas. Thirty-three days monitoring were carried out in fisheries where ADD use is mandatory, and a further 26 days were carried out on an over 12 m netter in ICES Division 7c (Porcupine Bank) where ADDs are not mandatory, but it was not clear when the observer joined at the start of the trip in what exact area the boat would operate. In those 33 sampled days on relevant vessels (≥12 m) in areas where ADDs are mandatory, 74 out of 78 (95%) monitored hauls had ADDs attached, although on a few hauls with ADDs (n=7) the spacing was not optimal. One harbour porpoise was caught in the 74 hauls with ADDs. No cetacean bycatch was recorded in 4 monitored hauls without ADDs (Kingston *et al*., 2021).

Fishing vessel compliance with the ADD requirements of Regulation 812/2004 and 2019/1241 are carried out by the Marine Management Organisation (MMO) in English and Welsh waters and by Marine Scotland (MS) in Scottish waters.

The MMO carried out 30 shore-side inspections of over 12 m netting vessels. All vessels were UK registered. No mention of ADDs was provided in the port inspection reports. Eight at-sea inspections were carried on over 12 m netting vessels involving one UK registered vessel, six French vessels and one German vessel. Three of the eight inspections involved assessment of ADD compliance. One French vessel received a verbal warning for insufficient number of ADDs onboard. ADDs were tested and found to be charged and working in an inspection of a second French vessel. ADDs were tested and found to be working in an inspection of a UK vessel (Kingston *et al*., 2021). In Scottish waters, Marine Scotland's Marine Protection Vessels (MPVs) completed five at-sea inspections on five different gill netters in ICES Division 4a (northern North Sea) during 2019 (Kingston *et al*., 2019).

No infringements were detected during these inspections. Pingers were specifically noted to be in use during one inspection and were recorded as STM DD03C type. The other four inspections refer to pingers being compliant but do not specify the type in use. Marine Scotland received no intelligence regarding lack of pinger use during 2019 (Kingston *et al*., 2019).

There were no reports of any cetaceans being bycaught during the inspections, which included periods aboard the fishing vessels while nets were being hauled.

The main concentration of netting effort in Scottish waters continues to be along the continental shelf edge west of the Shetland Islands, with increasing netting activity taking place on the continental shelf and up to the 6-mile limit west of Shetland. Compliance operational priorities during 2019 did not focus on this sector and Marine Scotland will continue to base at-sea inspection activities on a risk assessed basis.

In **Belgium**, the two vessels operating set nets do not meet the basic conditions, namely the length of the ship, to have this obligation imposed. As in recent years, there has therefore been no scientific monitoring of the use of pingers on vessels.

In **France**, a total of nine netters (GNS-GTR) fishing in Subarea 7 were equipped with STM DDD03L pingers in 2018 in accordance with Reg. 812/2004 (and then CR (EC) 2019/1241). No infringements were found in 2018 during the checks conducted in the areas and on the vessels covered by Regulation (EC) No 812/2004.The decree of 15 April 2014 permits the use of STM DDD03L acoustic deterrent devices by French fishing vessels. The LICADO Project has been running since 2019 until 2022, comparing the efficiency of DDD and Cetasaver (updated with a new acoustic signal) pingers on 4 pairs of midwater trawlers in the Bay of Biscay (ICES WGBYC, 2022). These have been primarily to address common dolphin bycatch. No significant difference in efficacy was found between the two pinger types.

The **Netherlands** reports that according to Reg. 2019/1241, the Dutch fishery does not include fleet segments in which pingers are mandatory. The use of pingers is obligatory in ICES subarea 4 for vessels larger than 12m for the period 1 August until 31 October, using nets that do not exceed 400m length (the regulation intends to cover set nets fishery at wrecks, where relatively short net lengths are being used). Most of the Dutch set gillnet fleet fishing in this period for sole use much longer nets. Thereby, no acoustic deterrents are in use by Dutch gillnet fishers.

In recent years, **Germany** has had fisheries operating in some of the areas listed in Annex I to Reg. 2019/1241 where the use of pingers is mandatory. Fishing vessels use analogue and digital pingers commercially available. No data are available on the number of vessels equipped with pingers. Compliance monitoring was done by competent authorities using Pinger Detector Amplifiers (Etec PD1102) when nets were in place. Due to masking of pinger signals by the inspection vessel noise, the relevant equipment is difficult to use. The relevant provision of Regulation (EC) No 2019/1241 merely requires pingers to be operational when setting the gear. Thus, no penalties could be imposed for any infringements found using the current procedure. The legal framework for the detection and prosecution of infringements needs to be further improved. In 2018, federal fishing protection vessels inspected a total of three fishing vessels obliged to use pingers. No violations were found.

Since 2017, fishers in Germany have been using PALs (“Porpoise ALerting” devices) in set net fisheries in Schleswig Holstein (Baltic Sea) following a project called “STELLA” (Development of alternative management approaches and fishing techniques to minimise conflicts between conservation objectives and gillnet fisheries), and now in its second phase (STELLA 2, Nov 2021-Oct 2024). The overall aim of this project is to minimize bycatch of harbour porpoises. The project comprised the following: 1) estimating fishing effort of the local gillnet fisheries and identifying behaviour patterns of different fisherman groups, 2) development of gillnet modifications to minimize bycatch of marine mammals and seabirds, 3) development of alternative fishing gears, 4) analyse motives of fishermen and identify incentives that may lead to enhanced acceptance of mitigation methods. Thünen Institute of Baltic Sea Fisheries had found PALs to be effective at reducing porpoise bycatch. However, it is not clear yet whether those effects persist over a longer period of time or if porpoises become habituated to the warning signal. A new project “PAL-CE” (Nov 2021-Nov 2024) has started comparing the reaction of naïve porpoises inhabiting the Danish Belt Sea with the behaviour and reactions to PALs of porpoises in Schleswig Holstein that already know the warning signal (ICES WGBYC, 2022).

Field experiments to determine reaction of porpoise to pearl nets have also been started. Pearl nets were tested in the turbot fishery in the Black Sea (Turkey) with promising, but not yet statistically significant results (in 10 hauls 5 individuals were bycaught in the standard net, 2 in pearl nets). The pearl net has also been tested in the Swedish lumpsucker fishery with F-PODs attached to both ends of the string in order to examine the porpoise echolocation behaviour around the nets.

In a systematic study, the acoustic reflectivity of a variety of objects in different shapes, sizes and bulk characteristics (e.g. Young’s Modulus, density) were simulated and experimentally verified in a water tank. First simulation results indicated that commercially available acrylic glass spheres of less than 10mm diameter exhibited promising characteristics with up to -42dB target strength at 130 kHz (the peak frequency used by harbour porpoise). Echograms taken with the sonar of FRV “Clupea” revealed that the net with spheres was highly visible at 120 kHz compared to a standard gillnet.

In **Denmark**, a total of 17 Danish vessels (57% of the total number of vessels) engaged in fishing activities in ICES areas 3a and 4 in fleet segments FPN, GN, GNS, and GTR with mesh sizes above 220 mm, were obliged to use pingers.

The pinger type “AQUAmark100” has previously been used in the Danish gillnet fisheries, where the use of pingers is mandatory. However, this pinger model is no longer available in Denmark, so other types are now being used. The Danish Fishermen’s Association report that a 10 kHz pinger is now the most widely used pinger in Danish commercial fisheries because batteries can easily be changed. The 10 kHz pinger, however, does not have the same effectiveness as the AquaMark 100, so the distance between these is mandated to be 200 m. The latest derogation applies not only to the AQUAmark100, but to also other acoustic deterrent devices, which scientifically are proven to be as effective.

Monitoring of pingers is a mandatory part of the general inspection of gillnet vessels in Denmark. When a gear inspection is conducted, the fisheries inspector registers whether there is a requirement for use of pingers on the gear. If there is a requirement, the activity and distance between pingers is checked. In 2018, the Danish fisheries inspection did not conduct any inspections on vessels with an overall length of 12 metres or above, due to a large organizational change and transfer of responsibility to another ministry (formerly the Ministry of Food and Agriculture, now the Ministry of Foreign Affairs). Similarly, no inspections were carried out for foreign vessels in 2018. It was expected that the Danish Fisheries Agency would conduct inspections again from 2019 onwards. This has yet to be officially confirmed.

Denmark is continuing trials of both pingers and lights as a means to mitigate bycatch of harbour porpoises and seabirds, as well as conducting research on the behaviour of porpoises around pingers. It is also continuing the development and testing of small-scale Danish seines and baited pots as alternatives to gillnets primarily for catching cod and flatfish. From studies by DTU Aqua, pinger trials have shown that adopting a spacing of 200m between pingers is more effective than a 500m spacing.

Sweden remains unsure whether pingers have been implemented on boats and in fisheries where they are mandatory. Back in 2007, fishermen conducting fisheries in areas where pingers were mandatory, were given pingers. Pingers have a lifetime of two years so one must assume that those pingers are not working anymore. There is limited enforcement to control the use of pingers, and no equipment to be able to see if the pingers are functioning. However, there has been increased pinger use in southern Swedish waters and along the west coast.

In 2018, 13 fishermen voluntarily used pingers (Banana Fish tech and Future Oceans) in the lumpfish and cod fisheries in subdivisions 21 and 23 (Kattegat and Belt Seas). Pingers are lent to the fishermen from year to year. Seven fishermen were using pingers in the lumpfish fishery and three fishermen in the cod gillnet fishery. Fishermen reported their fishing effort and use of pingers to the Swedish University of Agriculture Science. In the area where pingers have been used in the commercial lumpfish fisheries in southern Sweden, a study investigating the distribution of harbour porpoises in relation to a commercial fishery with pingers has been taking place in recent years. Results showed that harbour porpoise detections in the area were low when fisheries with pingers were deployed. However, when the fishery ceased, harbour porpoise detections increased and were at the same levels as areas where no fishing with pingers had been carried out. The study continued through to 2020. There has also been a project implementing cod pots as an alternative to gillnet fisheries for cod, and a small-scale seine net for coastal fisheries has been developed as an alternative to gillnet fisheries.

Key Conclusions and Recommendations *Pingers are mandatory in certain gillnet fisheries in the North Sea for EU Member States. However, their use is not implemented by all countries, and the level of enforcement varies greatly between countries. More research is needed to find mitigation measures that are both practical and effective. Pingers have the potential to temporarily deter porpoises from foraging areas and recent trials for ways to improve their effectiveness in particular gears have been promising. However, more effort is needed to develop alternative gears which may be the most desirable long-term solution to porpoise bycatch. Other approaches also need further* *investigation, such as move-on procedures when groups of animals are seen at the start of active fishing.*

ACTION 6. Finalise a management procedure approach for determining maximum allowable bycatch limits in the region

Whereas the ultimate goal should be for zero bycatch, the intermediate conservation objective under ASCOBANS has remained 'to restore and/or maintain stocks/populations to 80% or more of their carrying capacity'. The ASCOBANS Meeting of the Parties in 2000 (MOP3) had concluded that a total anthropogenic removal rate of more than 1.7% of the population had to be considered unacceptable, and an interim measure should be to ensure that overall mortality is reduced to a level that will allow recovery of populations. Several different criteria have been proposed as limits to anthropogenic mortality that may still allow conservation objectives to be met. These criteria include simple percentages of the best population abundance estimate and more complex procedures that account for uncertainty and other information about the population. Scheidat *et al*. (2013) reported new estimates of abundance for porpoises in **Dutch** waters, and applied several methods to calculate maximum anthropogenic mortality limits from these estimates. They considered whether these mortality limits would meet the objective of the ASCOBANS agreement and other international obligations, and how these limits might be applied at a national level rather than the biological population level. They recommended the use of management procedures for setting mortality limits that take into account available data including associated uncertainties and biases, and whose performance has been extensively tested through simulation.

In July 2015, an ASCOBANS workshop (ASCOBANS, 2015b) was held in London to consider further development of management procedures for defining the threshold of 'unacceptable Interactions'. From a societal perspective, environmental limits and triggers for action were considered as 1) intermediate steps to help drive progress towards achieving the ASCOBANS aim of zero bycatch; 2) they should be based on clearly defined conservation objectives which reflect broad societal views and have been developed and agreed with managers, scientists and stakeholders; 3) they should be used as a tool to help make decisions on the conservation and sustainable use of the marine environment and balance competing priorities; 4) they should be developed to take into account total anthropogenic removals; 5) they should be used to indicate a 'critical' or 'unacceptable' point in the environment that should not be exceeded without endorsing that any removals are 'acceptable'; 6) they should be used to 'trigger' more urgent and stronger management action where levels of bycatch have been identified as being of a high level of concern (e.g. likely to lead to population extinction or failing to meet conservation objectives); 7) they should be used to prioritise the targeting of effective management measures, ensuring the investment of effort/financial resources into reducing, or quantifying more precisely, bycatch levels is proportionate to the scale of the problem i.e. different management responses may be appropriate for fisheries with close to zero bycatch, with levels close to but below the environmental limit/trigger, and for those above; 8) they should be 'tuned' to help managers determine whether conservation objectives are being achieved and to target management measures effectively; and 9) they should be accompanied by a clear guidance on how they should be applied and interpreted, including clarity on the nature of appropriate management action.

Since then, the **UK** developed a Removals Limit Algorithm (RLA) to set limits to anthropogenic mortality of small cetaceans to meet specific conservation objectives, with an example implementation for bycatch of harbour porpoise in the North Sea (Hammond *et al*., 2019). This RLA was developed to set limits to anthropogenic mortality of small cetaceans that allow specified conservation objectives to be met, picking up from previous work of a similar nature presented to the IWC in 2005-2009 as part of the SCANS-II project. The RLA is very similar in concept to the Catch Limit

Algorithm (CLA) of the IWC's Revised Management Procedure. The RLA comprises a simple one-line population model which is fitted to a time series of estimates of abundance to estimate population growth rate and depletion, which are then used in a removals calculation. The RLA is tuned through computer simulation of a more complex population model that is assumed to represent reality to set limits to anthropogenic mortality that allow the specified conservation objects to be met. The robustness of the RLA is determined by assessing its performance in a range of computer simulation tests describing uncertainty in our knowledge of population dynamics, the data, and the wider environment.

As an example, the RLA was applied to bycatch of harbour porpoise in the North Sea using abundance estimates from SCANS surveys (1994, 2005, 2016) and a time series of bycatch estimates constructed by making a number of strong assumptions about effort for most fleets and appropriate bycatch rates. Using a particular tuning level that reflects a conservation approach and which is appropriate if maximum net productivity is 2%, the removal limit was 1,856 animals per year for a six-year period until a new survey estimate becomes available after the 2022 SCANS-IV survey. The analysis indicated that there was little support for the population of harbour porpoises in the North Sea being heavily depleted or for the current carrying capacity to be less than 350,000 animals. Using a tuning level that led to slightly less robust results and that is appropriate if a maximum net productivity is 4%, the removal limit was 4,641. However, the RLA developed was dependent on how the conservation objectives are defined (Hammond *et al*. 2019).

A joint NAMMCO/IMR harbour porpoise workshop that took place in Tromsø, Norway, in December 2018 assessed the North Sea harbour porpoise population through a population dynamic production model (NAMMCO & IMR 2019). This model used as input data estimated time series of bycatch levels and population size, and hence did not specifically estimate maximum allowable bycatch limits for the region. The model estimated that the population of harbour porpoise in the North Sea has been stable (increasing very slowly) since around 2005 (Figure 13), whilst subject to an average annual by-catch of around 4,500 animals (range 2,500-6,700) during this period.

In September 2019, an OSPAR-HELCOM workshop was held in Copenhagen to examine possibilities for developing indicators for bycatch of birds and mammals (OSPAR-HELCOM 2019). The following conservation objective was proposed: "Minimise and where possible eliminate incidental catches of all marine mammal and bird species such that they do not represent a threat to the conservation status of these species". An interim management objective was that "The mortality rate from incidental catches should be below levels which threaten any protected species, such that their long-term viability is ensured." However, this still needed to be expressed quantitatively for harbour porpoise. The RLA exercise undertaken by Hammond *et al*. (2019) set this at 80% of carrying capacity within a 100-year period. In simulation tests, this equates to the median population level being at 80% of carrying capacity for 50% of cases. The IWC in applying CLA to manage whale stocks proposed a threshold of 72% of carrying capacity within a 100-year period.

Both RLA and CLA fit a population dynamics model to a time series of abundance estimates and removals data. They assume a population with density-dependent growth and subject to anthropogenic removals. Model simulations are used to tune the parameters of the RLA until the conservation objectives are met, at which point the limit to removals can be determined. This method is data demanding as it requires regular estimates of population size, total bycatch, and other sources of mortality. None of these are known very well even for a well-studied species such as the harbour porpoise in the North Sea. PBR estimates are less data demanding. In the US, a threshold of 50% of carrying capacity (K) reached for 95% of cases over a 100-year period has been adopted whereas the ASCOBANS conservation objective has a higher ambition (due to the long history of intensive human pressures around Europe) of 80% of carrying capacity but has not yet agreed the timescale over which this should be considered.

ASCOBANS has not explicitly set a probability or a time frame as a goal for achieving 80% of K. Recently, the OSPAR Marine Mammal Expert Group (OMMEG) used RLA on the harbour porpoise population in the Greater North Sea to set limits to anthropogenic mortality that allow specified conservation objectives to be met (OSPAR, 2023). They followed Hammond *et al*. (2019) in setting the conservation objective as “a population should [be able to] recover to or be maintained at 80% of carrying capacity, with 80% probability, within a 100-year period”, as a quantitative interpretation of the ASCOBANS short-term practical sub-objective. To set the anthropogenic mortality limit, tuning the RLA to the conservation objective with probability 0.8 corresponds to using the $55th$ quantile of the posterior distribution of the quantity, the Equation ($\text{Anthropogenic mortality limit} / \widehat{N} = r \times \max(0, depletion - \text{IPL})$) is applied where $\widehat{N}$ is the best available abundance estimate and IPL is the internal protection level set to 0.54 (i.e. 54% of carrying capacity K); if the estimated depletion level of the population is below the IPL, then the bycatch limit is set to 0 (ICES WKMOMA, 2021). When applied to the harbour porpoise in the Greater North Sea assessment unit, this corresponds, on average across simulations, to 1,622 porpoises or 0.47% of the best available abundance estimate (345,000) (OSPAR, 2023). For comparison, the ASCOBANS unacceptable interactions threshold of 1.7% of the best available abundance estimate is equivalent to 5,865 porpoises whilst an intermediate precautionary objective of 1% of the best available abundance estimate is equivalent to 3,450 porpoises, both values well above the RLA-derived threshold.

In April and May 2023, two workshops were held by ASCOBANS to review the current conservation objectives and try to reach agreement on how best to quantify these objectives. It was concluded that the fixed percentages (1.7% and 1% of overall population size) were inappropriate and not sufficiently precautionary. Currently, there is disagreement whether within a time horizon of 100 years, there should be the ambition in the short-term to achieve population size that is 80% of carrying capacity within 20 years as some consider this to be unrealistic, and similarly there is a difference of opinion whether one should set the probability values at 95% or 80%. We hope these issues will be resolved in the near future.

Key Conclusions and Recommendations *There has been a long-standing debate as to what society should set as quantitative conservation objectives. The RLA approach developed within the UK and then extended by OMMEG sets some numerical parameters to establish an environmental limit and potential trigger for action for harbour porpoises experiencing bycatch in the North Sea. A number of assumptions have had to be made including the accuracy of the annual bycatch estimate, the overall population size, demographic trend and structure, reproductive and mortality rates, carrying capacity, and the impact levels of other anthropogenic activities. If one accepts the OMMEG estimate of harbour porpoise annual bycatch in the North Sea to be 5,974 animals, then this clearly exceeds the RLA-derived threshold, as well as both of the original ASCOBANS thresholds of 1.7% and 1% of best available abundance estimate for this population. On the other hand, the North Sea population has not shown a decline over recent times.*

There is still more discussion to be had amongst ASCOBANS Parties to agree a consistent and well-defined conservation objective across the region, and to set environmental limits and triggers over a practical time scale. There needs to be further consideration of the utility of the RLA approach vs alternatives such as PBR and PVA, bearing in mind the various uncertainties that exist. This discussion is crucial for answering the questions on levels for Good Environmental Status (GES) under the EU Marine Strategy Framework Directive.

ACTION 7. Monitoring trends in distribution and abundance of harbour porpoises in the region

Coordinated efforts to monitor harbour porpoise abundance in the North Sea in recent times have involved 1) SCANS III where the entire region was surveyed by a combination of aerial and vessel surveys in July 2016 (Hammond *et al*. 2017; see Figure 12); 2) SCANS III undertaken in a similar manner in July-September 2022; and 3) aerial surveys undertaken seasonally in the southern North Sea across the EEZs of Belgium, the Netherlands, Germany, and Denmark (Gilles *et al*. 2016, Peschko *et al*. 2016; Nachtsheim *et al*., 2020).

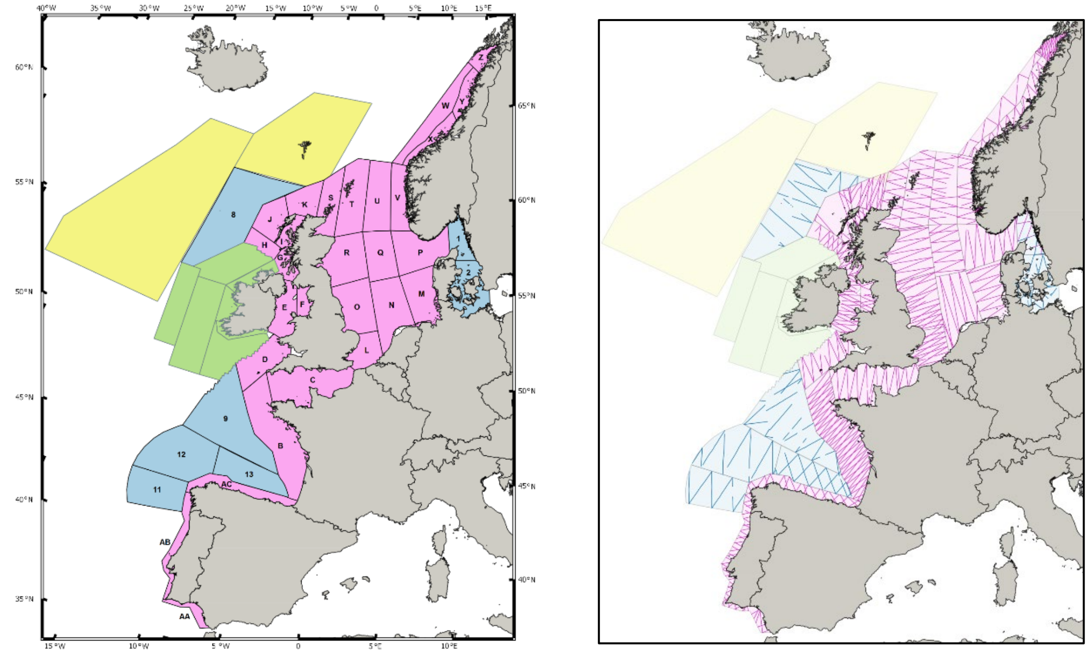


Figure 12. Area covered by SCANS-III and adjacent surveys. SCANS-III: pink lettered blocks were surveyed by air; blue numbered blocks were surveyed by ship. Blocks coloured green to the south and west of Ireland were surveyed by the Irish ObSERVE project. Blocks coloured yellow were surveyed by the Faroe Islands as part of the North Atlantic Sightings Survey in 2015 (Source: Hammond *et al*. 2017)

The SCANS III survey in July 2016 yielded an abundance estimate of 345,373 porpoises (CV=0.18; 95%CI: 239,000-483,000) in the North Sea (Hammond *et al.,* 2017). The equivalent estimate for July 2005 was 355,408 (CV=0.22) (Hammond *et al.,* 2013) and for July 1994 was 289,150 (CV=0.14) (Hammond *et al.,* 2002). A trend analysis showed no significant change between 1994 and 2016 (Figure 13).

For the period 2005-2013, using aggregated visual survey data from the international SCANS II survey as well as more frequent small-scale national surveys, Gilles *et al.* (2016) produced model-based average estimates for porpoise numbers in all of the North Sea extending to the Dover Strait (but not further west), for three seasons, Spring (Mar-May), Summer (Jun-Aug), and Autumn (Sep-Nov). These were 372,167 (CV=0.18) (Spring), 361,146 (CV=0.20) (Summer), and 223,913 (CV=0.19) (Autumn).

The OSPAR intermediate assessment used data from large-scale visual surveys such as SCANS (Hammond *et al.* 2002), SCANS-II (Hammond *et al.* 2013), SCANS-III (Hammond *et al.* 2017, revised 2021), CODA (CODA 2009), NASS (www.nammco.no) and NILS (e.g. Solvang *et al.* 2015) to infer distribution of abundance of cetaceans, including harbour porpoise, in the OSPAR area. The assessment could not detect any trends in abundance of harbour porpoises, although the shift in distribution from northern to southern North Sea between SCANS (1994) and SCANS-II (2005) was clear, and has been confirmed by several small-scale national surveys showing increasing numbers of porpoises occurring in French, Belgian, Dutch and German waters (e.g. Gilles *et al.,* 2009, 2011, Haelters *et al.,* 2011, Scheidat *et al*., 2012; Peschko *et al.,* 2016). A new SCANS-IV survey took place in summer 2022 but the results are not yet available.

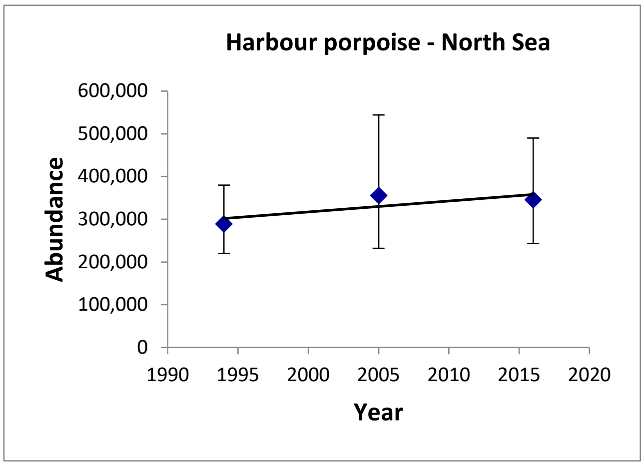


Figure 13. Estimates of abundance (error bars are log-normal 95% confidence intervals) for harbour porpoise in the North Sea Assessment Unit. Trend lines are fitted to time series of more than two abundance estimates (Source: Hammond *et al.* 2017)

Belgium, the **Netherlands**, **Germany** and **Denmark** have continued national monitoring with aerial surveys of the southern North Sea on an annual basis, although from 2020, the Netherlands switched to surveys every three years. Other Range States (**Norway, Sweden, France** and **UK)** have not been undertaking regular wide scale surveys of their waters, although **France** has conducted surveys in relation to marine renewable energy development, and repeated aerial surveys of the Channel (and Bay of Biscay in 2021 and 2022).

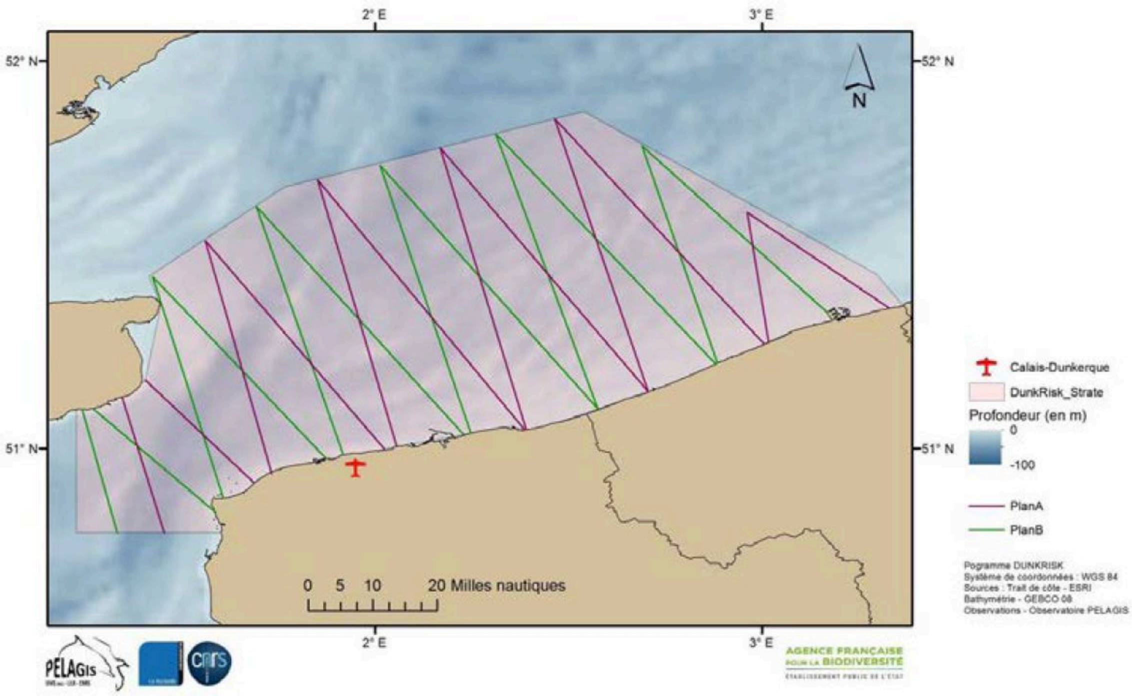


Figure 14. PELAGIS Project Aerial Surveys undertaken by France during 2017-2018
(Source: ICES WGMME, 2018)

During 2017–2018, a **French** survey was dedicated to estimate marine mammal and seabird relative abundance and distribution in the area of Dunkirk before construction of an offshore windfarm (Virgili et al., 2018; Figure 14). The survey effort covered 9400 km^2 distributed as follows: 37% in France, 37% in Belgium and 26% in UK. Observations were collected following a standardised aerial survey protocol (Laran et al., 2017). Four sessions were realised on 6–7 April (1526 km), 13–14 June (1534 km), 7–8 August (1532 km) and 4–5 December (1463 km). In 2018, two sessions were realised on 6–7 March (1256 km) and 4–5 May (1526 km).

The most sighted marine mammal species was the harbour porpoise and the number of observations reflected a high seasonality for this species (Table 3). Harbour porpoise distribution also differed between the sessions (Figure 15). The results showed the importance of the eastern part of the Channel for porpoises, although there were strong seasonal differences both in distribution and relative abundance (Figure 15, ICES WGMME, 2018).

Table 3. Number of sightings (on effort) of harbour porpoises during the aerial survey (Virgili *et al*. 2018)

	April 2017	**June 2017**	**Aug 2017**	**Dec 2017**	**Mar 2018**	**May 2018**
Harbour porpoise	315	100	35	202	147	321

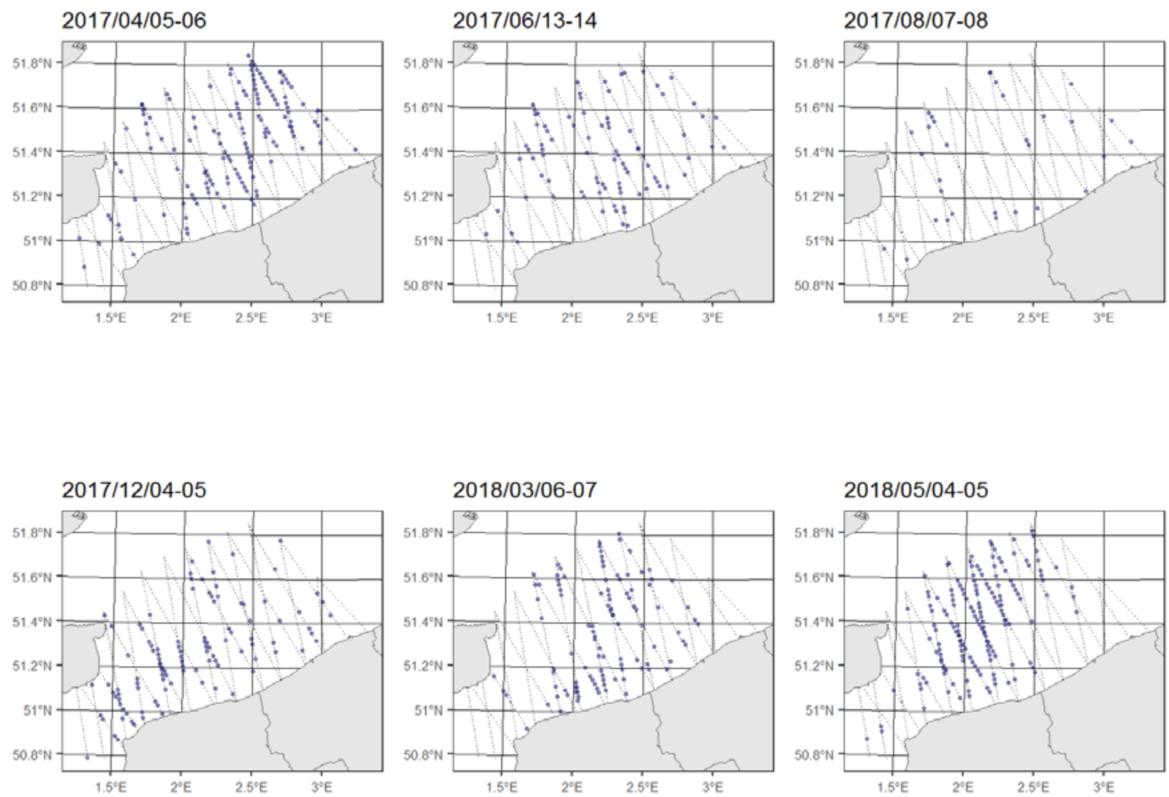


Figure 15. Observations of harbour porpoises from the PELAGIS Project Aerial Surveys undertaken by France in the eastern Channel during 2017–2018. Dotted lines are the transect lines, and blue dots are the detections of harbour porpoises. (Source: ICES WGMME 2019)

SAMM-II multi-target (cetaceans, seabirds, shark, fish, turtles, litter, shipping) aerial surveys were conducted from January to March 2021 across the Bay of Biscay, in the Channel, and western end of the southern North Sea (Figure 16). 20.000 km of effort was undertaken, of which about 30% were completed with an aircraft fitted with high definition cameras allowing the 200m wide band on each side of the track to be recorded. Pictures were used to confirm and refine species identification and group size estimates recorded by observers. Figure 17 shows the distribution of porpoise sightings. Analyses are on-going, and further surveys have been undertaken in 2022.

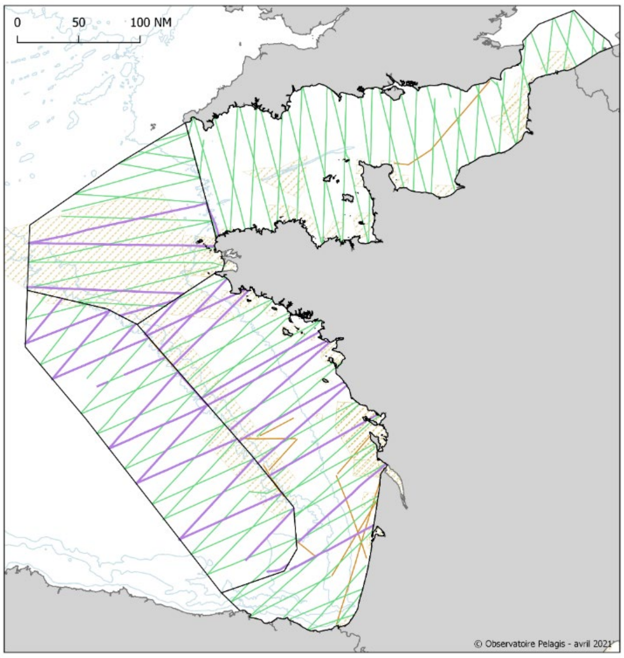


Figure 16. Effort of the SAMM-II survey conducted from January to March 2021; 20.000 km of effort, of which 30% conducted with high definition cameras fitted under the aircraft (STORMM protocol; purple lines). Orange lines are transit off-effort flights.

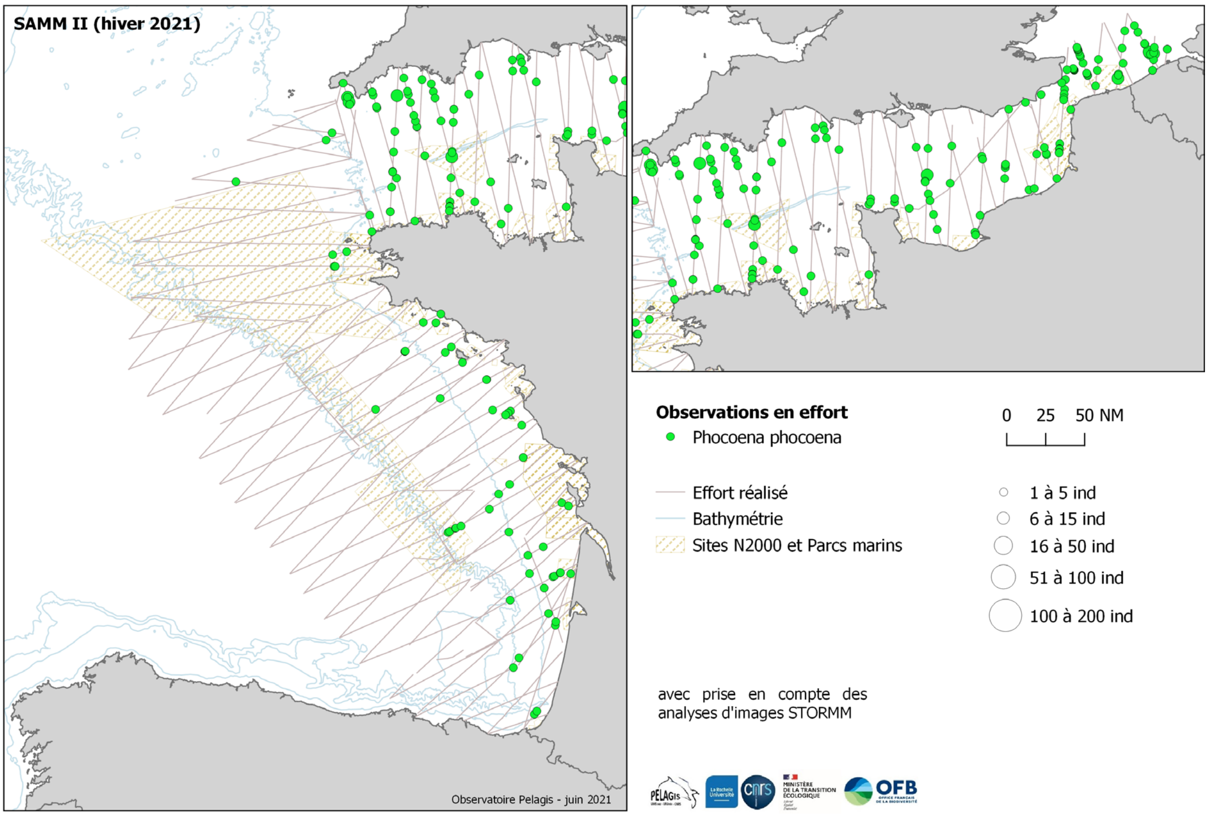


Figure 17: Distribution of harbour porpoise on-effort sightings during the SAMM-II winter survey conducted from January to March 2021.

In **Belgium**, the Royal Belgian institute for Natural Sciences (RBINS) have undertaken two to three aerial surveys annually within their EEZ (Figure 18). Three aerial surveys were completed in 2018. Densities in July and October were in line with previous surveys, with on average 0.7 and 0.6 animals/km² respectively. The survey in April yielded a remarkably high average density (5.7 animals/km² in the survey area) with 404 animals sighted during the survey that lasted 3h44' (on effort). The animals were not evenly distributed, with very high densities (over 15 animals/km²) between the Westhinder anchorage area and the Northinder Traffic Separation System, a zone that is proposed as an offshore windfarm area (to be confirmed in the new marine spatial plan 2020–2026) (ICES WGMME 2019). Two aerial surveys were completed in 2019 (Figure 19). Observed harbour porpoise densities in June and August were normal, with on average 0.72 and 0.62 animals/km² respectively (Haelters *et al.* 2020). Two aerial surveys were completed in 2020 (Figure 20), with 34 porpoises observed during June, yielding an average estimate of 0.56 (0.37–0.77) animals/km² in Belgian waters. During the survey on 1–2 September, 37 porpoises were observed, yielding a similar average density of 0.55 (0.36–0.78) animals/km² (Haelters *et al*., 2021). Surveys in 2021 have yet to be submitted.

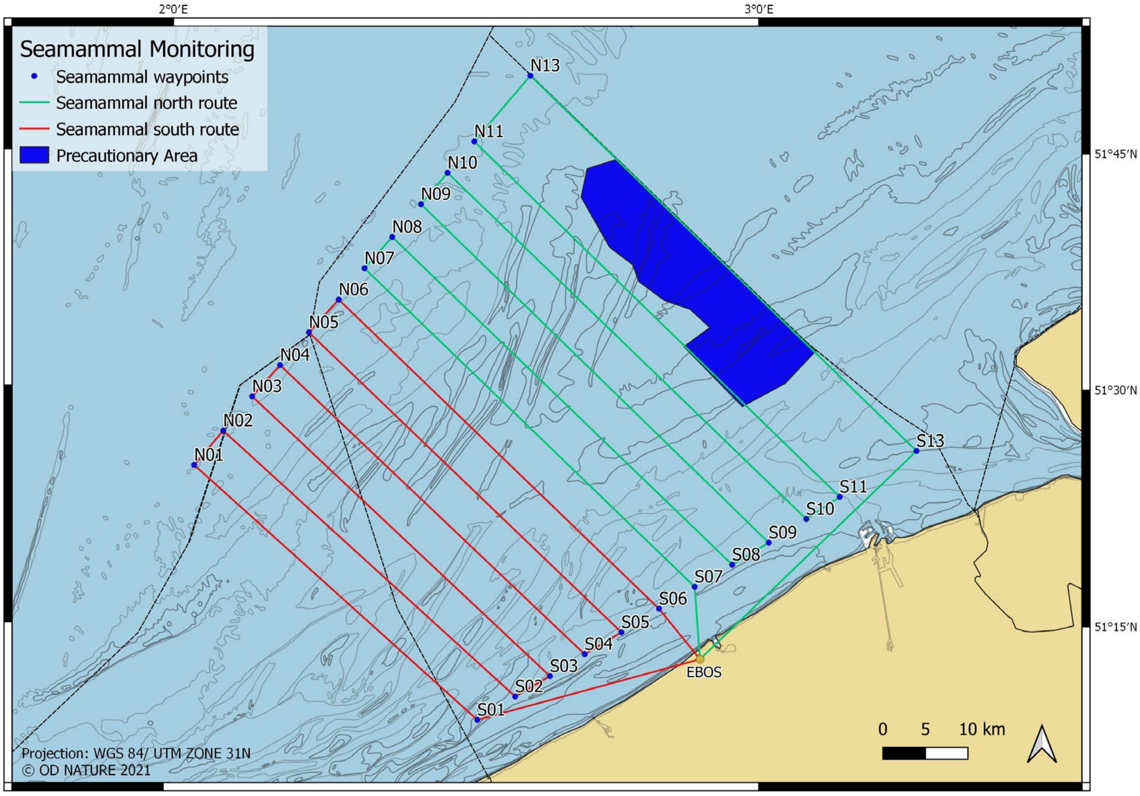


Figure 18. Aerial survey flight-lines are shown in red and green. The wind farm area (polygon) is shown in blue (RBINS data from Haelters *et al*., 2020)

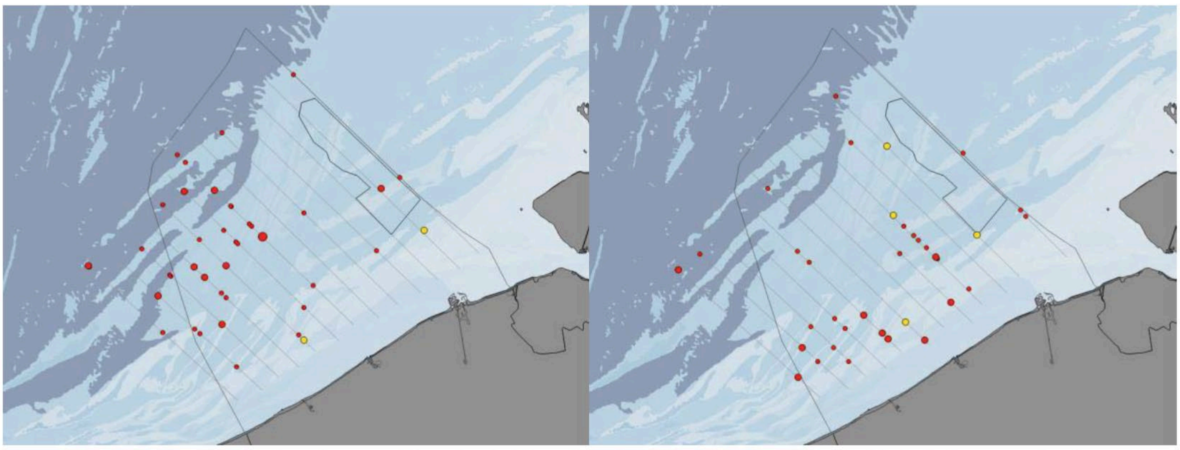


Figure 19. Observations during the survey in June (left) and August (right) 2019: porpoises (red) and seals (yellow); the flight lines and wind farm area (polygons) are shown in grey (RBINS data from Haelters *et al*., 2020)

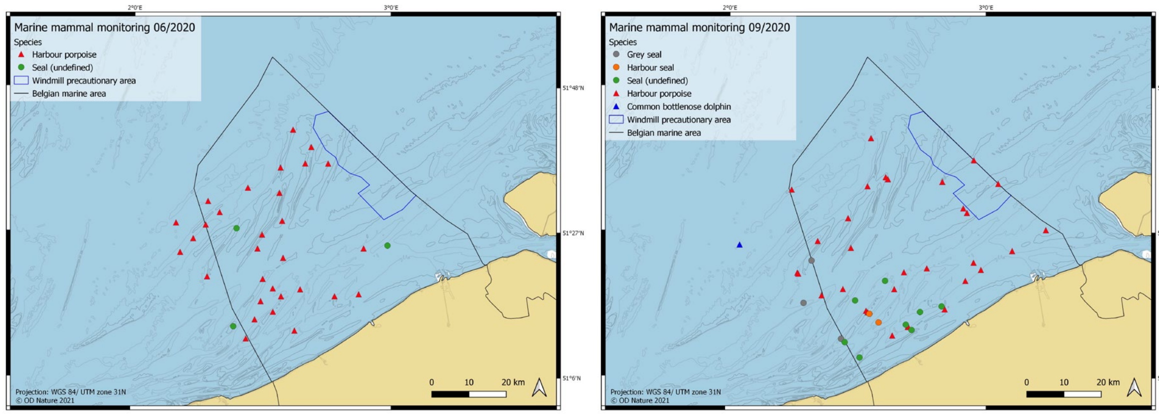


Figure 20. Observations during the survey in June (left) and August (right) 2020: porpoises (red) and seals (green); the flight lines and wind farm area (polygons) are shown in grey (RBINS data from Haelters *et al*., 2021)

In the **Netherlands**, Geelhoed & Scheidat (2018) analysed the results of their aerial surveys across the Dutch EEZ (Figure 21) for the years 2012-2017. Maps of porpoise distributions for each of those years are shown in Figure 22. Distribution patterns of porpoises differed between seasons and years, although a band of higher densities from the southern part of the Dutch Continental Shelf to the area north of the western Wadden Sea Islands was visible in all seasons (Geelhoed & Scheidat, 2017). Calves were only seen in July. The abundance estimates in spring (*n*=63,408-66,685) were in the same order of magnitude as summer (*n*=41,299-76,773). The total abundance estimates in spring and summer correspond to a maximum of 17-21% and 7-23% of the southern North Sea population respectively. The abundance estimates are not strictly comparable to those given above from SCANS surveys and the DEPONS Project as different Effective Strip Widths (ESWs) were used in the analysis. However, they do highlight the fact that, in recent years for at least part of the year, a substantial proportion of the porpoise population in the southern North Sea and the eastern Channel utilises the Dutch Continental Shelf.

Between 13–18 July 2018, and between 16 July-4 August 2019, the entire Dutch Continental Shelf was again surveyed along the same pre-determined track lines, resulting in a total distance of 5182.0 km (3039.8 km in 2018 and 2142.2 in 2019) of effort. The resulting total number of harbour porpoises on the Dutch Continental Shelf was estimated at 63 514 animals (CI = 34 276–119 734) and 38,911 individuals (CI = 20,791-76,822) respectively. Neither the DCS abundance estimates, nor the abundance estimates per subarea showed a trend (Geelhoed *et al*. 2020). The harbour porpoise distribution from this survey is shown in Figure 23. The next series of aerial surveys will be in 2023, following the decision to run surveys in spring and summer every three years (Ministry of Agriculture, Nature and Food Quality, 2020).

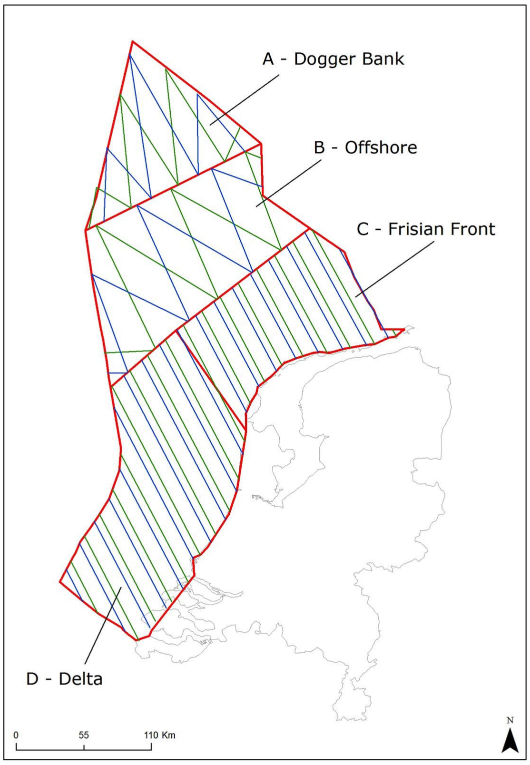


Figure 21. Map of the Dutch Continental Shelf with the planned track lines in study areas A – Dogger Bank, B – Offshore, C – Frisian Front and D – Delta. Colours indicate sets of track lines (Source: Geelhoed & Scheidat, 2018)

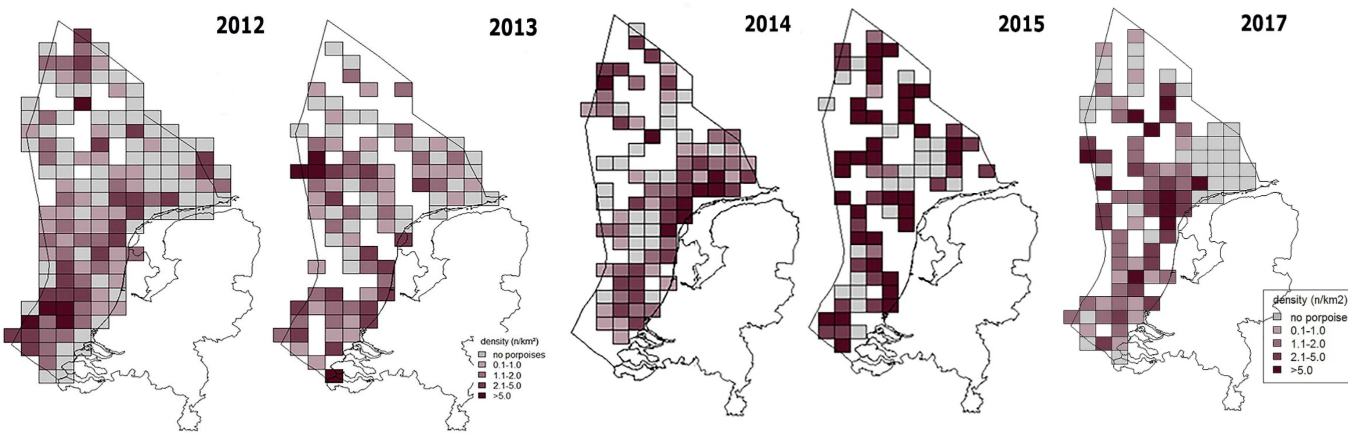
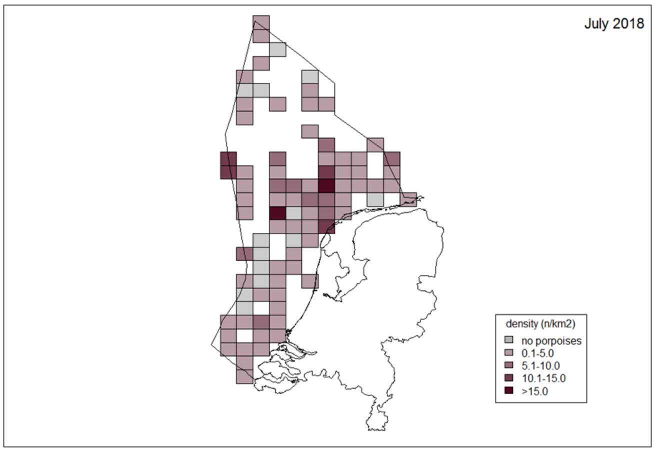


Figure 22. Density distribution of harbour porpoises (animals/km²) per 1/9 ICES grid cell, spring 2012 to 2017. Grid cells with low effort (<1 km^2) are omitted (Source: Geelhoed & Scheidat 2018)



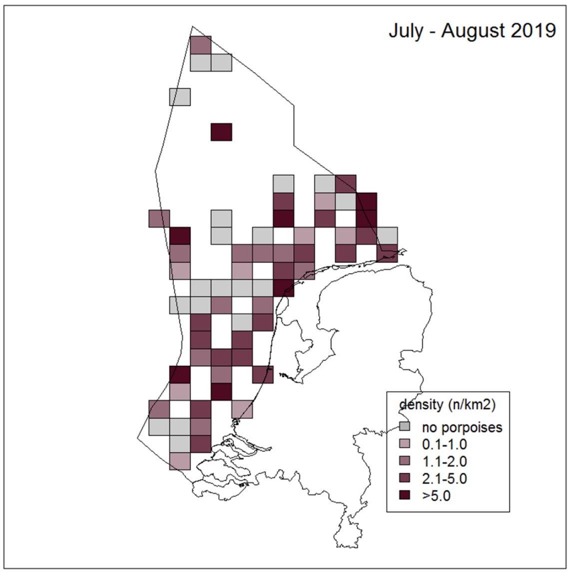


Figure 23. Density distribution of harbour porpoises (animals/km²) per 1/9 ICES grid cell, July 2018 and July-Aug 2019. Grid cells with low effort (<1 km^2) are omitted (Source: ICES WGMME 2019, Geelhoed *et al*. 2020)

In **Germany**, with funding from BfN (Federal Agency for Nature Conservation), aerial surveys are undertaken every year in spring and summer in the area of three Natura 2000 areas (Dogger Bank, Borkum, Sylt Outer Reef), whilst every two years, complete coverage of the German EEZ and 12 nm zone was made. In 2017, the strata and transect design for the visual monitoring of harbour porpoises was revised in an effort to harmonise the national monitoring efforts for cetaceans and seabirds and to provide a survey design for potential future digital surveys. This resulted in the design of new study areas for the aerial line transect surveys in the German North Sea and Baltic Sea (ICES WGMME 2019; Figure 24).

In spring 2017, one aerial line transect survey was conducted near Borkum Reef Ground and a total of 18 harbour porpoise groups (23 animals, incl. two calves) were sighted along 559 km of effort. Due to logistical reasons and bad weather, no surveys could be conducted in the North and Baltic Sea during summer 2017. In spring 2018, a total of 163 harbour porpoise groups (179 animals, no calves) were recorded along 1459 km of effort in three areas in the North Sea (Borkum Reef Ground, Weser-Elbe estuary and Dogger Bank. In summer 2018, a total of 166 groups (200 animals, incl. 14 calves) were observed under 2077 km of effort in four study areas in the North Sea (Weser-Elbe estuary, Sylt Outer

Reef West and East, and Dogger Bank. In spring 2019, a total of 145 harbour porpoise groups (172 animals, seven calves) were recorded along 1516 km of effort in three aerial survey strata in the North Sea. In summer 2019, a total of 245 harbour porpoise groups (318 animals, including 12 calves) were observed along 3694 km of effort in all eight study areas in the North Sea.

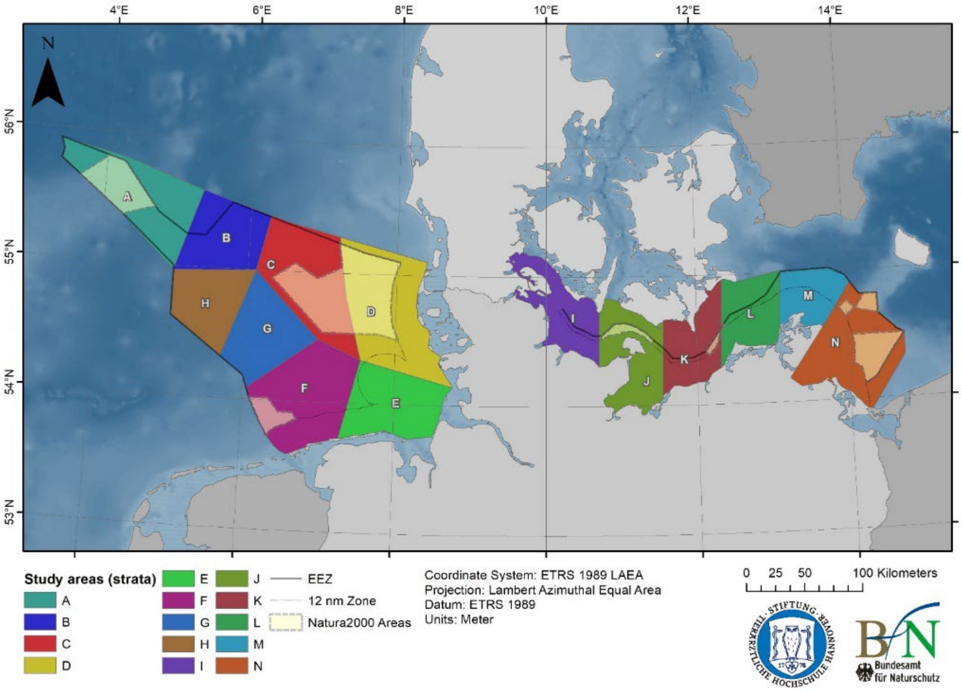


Figure 24. Newly designated study areas for the visual monitoring of harbour porpoises in the German North and Baltic Sea

Effort corrected density and abundance estimates were generated using a bootstrapping approach, also correcting for availability and perception bias. In spring 2017, the abundance for Borkum Reef Ground in the North Sea was estimated to be 2,862 (95%CI: 1175–4656) animals, at 0.44 (0.19–0.76) animals/km². In spring and summer 2018, and spring 2019, the German North Sea was not entirely covered, allowing abundance and density estimates only for the individual areas (ICES WGMME 2019, 2020; Figure 25). For spring 2019, abundance estimates by survey block were: 'Dogger Bank (A)' with 7,707 (95% CI: 4005–12 405), at 1.36 (0.71–2.20) animals/km²; 'Borkum Reef Ground (F)' with 3,315 (95% CI: 1605–6150) animals, at 0.54 (0.26–1.01) animals/km² and 'Weser-Elbe estuary (E)' with 887 (95% CI: 296–1981) animals, at 0.20 (0.05–0.45) animals/km² (ICES WGMME 2020).

In spring 2020, a total of 432 harbour porpoise groups (561 animals, 71 calves) were recorded along 2,641 km of effort in five areas in the North Sea (Dogger Bank, Area B, Sylt Outer Reef West, Sylt Outer Reef East, Weser-Elbe estuary, Figure 26a). In summer 2020, a total of 245 harbour porpoise groups (320 animals, incl. 25 calves) were observed under 2,237 km of effort in four areas in the North Sea (Sylt Outer Reef West, Sylt Outer Reef East, Weser-Elbe estuary, Borkum Reef Ground, Figure 26b). In spring 2020, the German North Sea was largely covered (areas A–E). The total abundance for these areas was estimated to be 44,554 (95%CI: 33 189–59 552) animals, at 1.66 (1.24–2.22) animals/km² (Table 3). In summer 2020, the German North Sea was covered in four of the eight areas (C–F). The total abundance for these areas was estimated of 25,480 (17 855–35 986) harbour porpoises and an average density of 1.09 (0.76–1.54) animals/km² (Table 4; ICES WGMME, 2021).

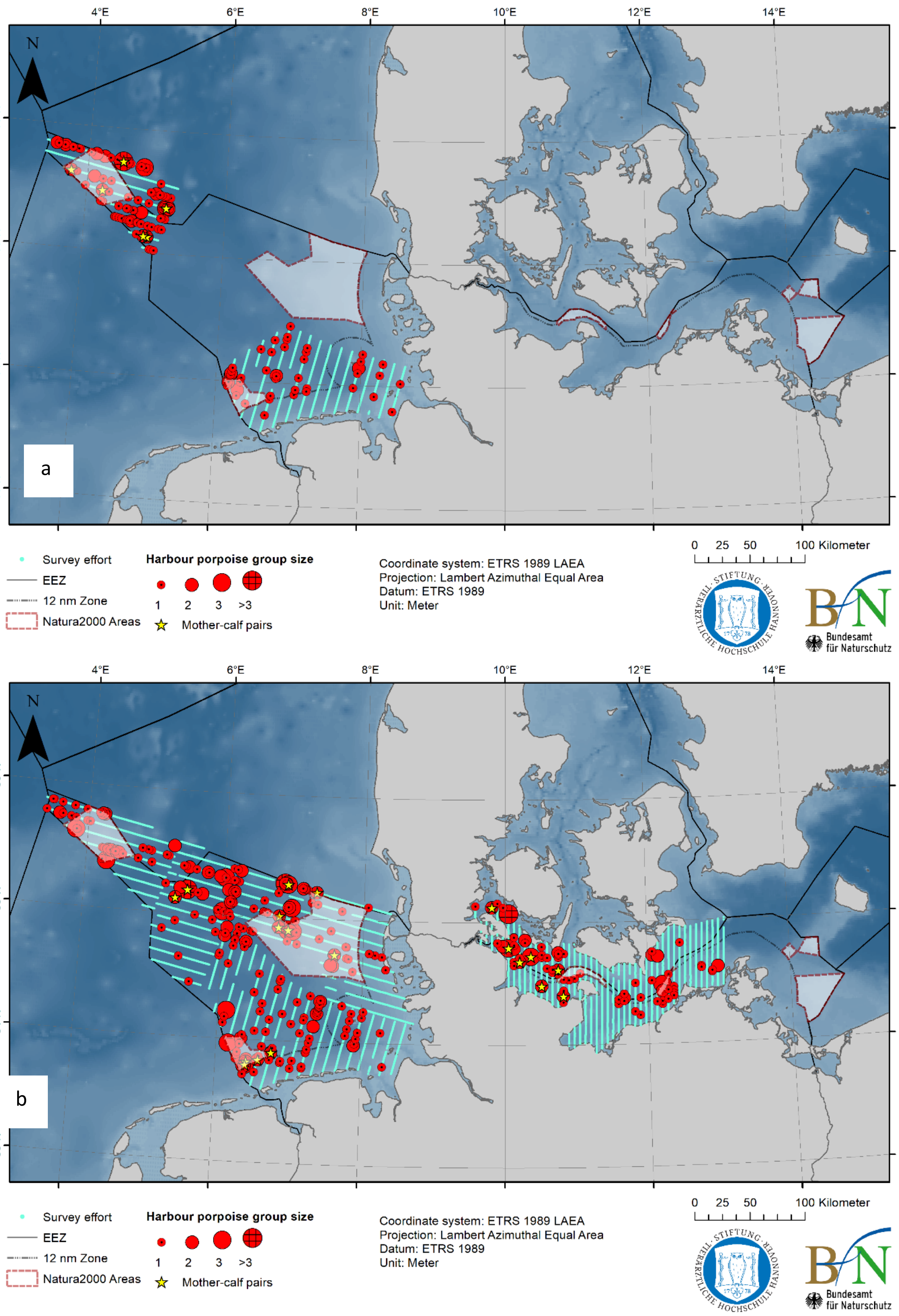


Figure 25. Survey effort and harbour porpoise sightings during aerial surveys in the German North and Baltic Sea during a) spring 2019 and b) summer 2019. Harbour porpoise group sizes are indicated using group size dependent red circles; yellow stars indicate mother-calf pairs; blue lines indicate covered transect lines (i.e. survey effort). (Source: ICES WGMME 2020)

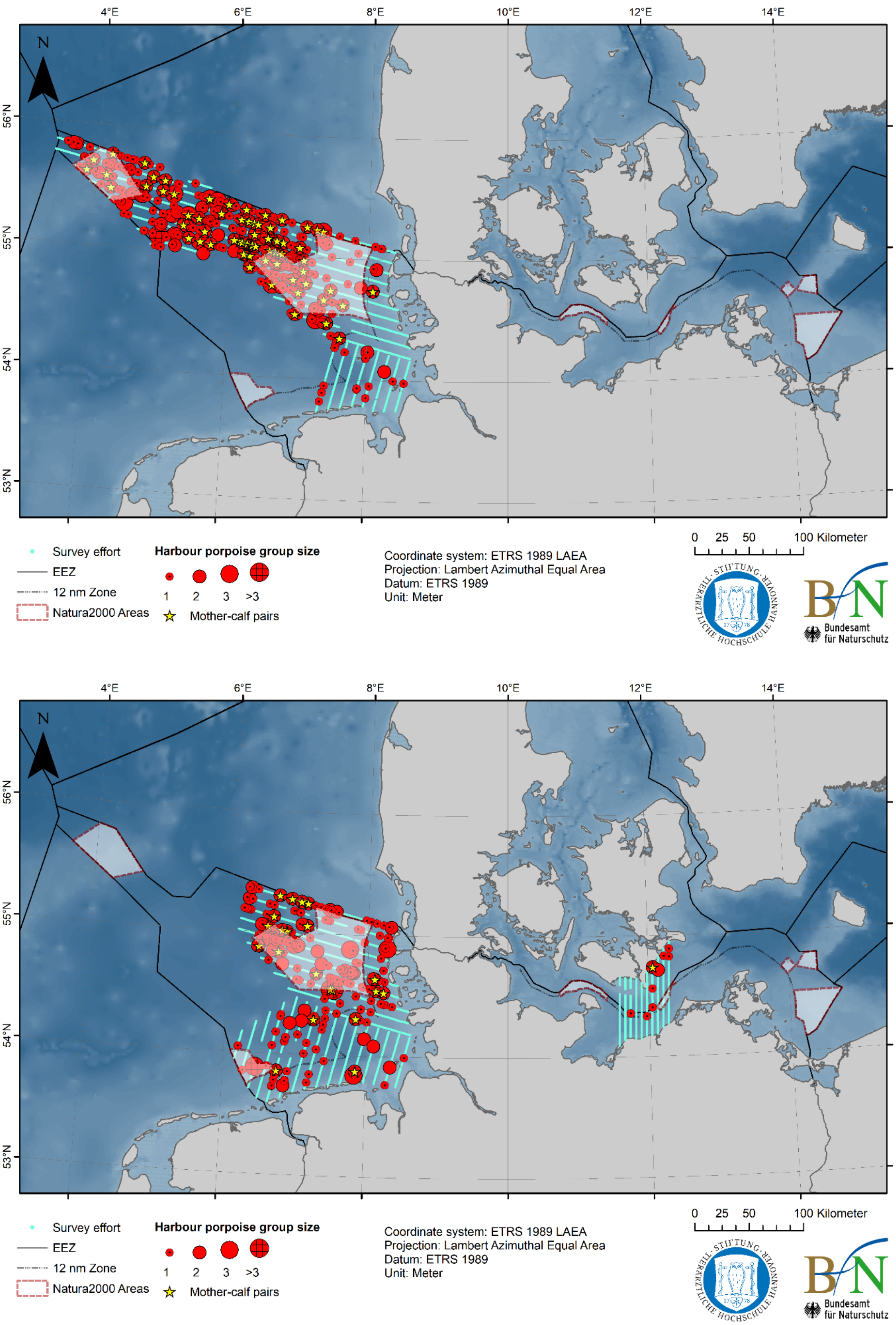


Figure 26. Survey effort and harbour porpoise sightings during aerial surveys in the German North and Baltic Sea during a) spring 2020 and b) summer 2020. Harbour porpoise group sizes are indicated using group size dependent red circles; yellow stars indicate mother-calf pairs; blue lines indicate covered transect lines (i.e. survey effort). (Source: ICES WGMME, 2021)

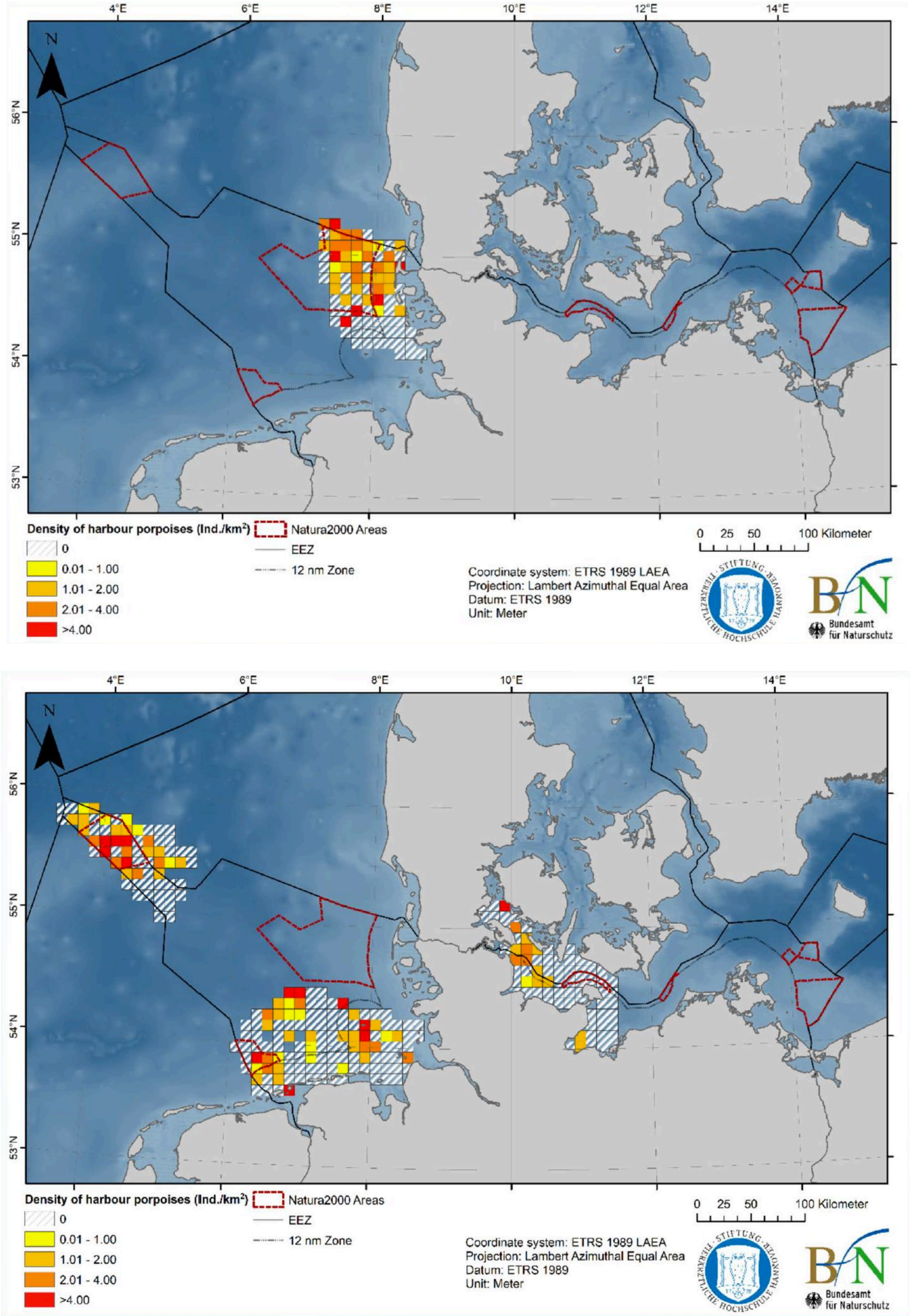


Figure 27. Survey effort and harbour porpoise sightings during aerial surveys in the German North and Baltic Sea during a) spring 2021 and b) summer 2021. Harbour porpoise group sizes are indicated using group size dependent red circles; yellow stars indicate mother-calf pairs; blue lines indicate covered transect lines (i.e. survey effort). (Source: ITAW/BfN, courtesy of P. Brtnik)

Table 4. Summary of effort corrected, bootstrapped density and abundance estimates for spring 2020 and summer 2020 in the German EEZ of the North Sea. N = estimated abundance of harbour porpoises; $N_{95\%CI}$ = 95% confidence interval around N; D = density estimate of harbour porpoises in indiv./km²; $D_{95\%CI}$=95% CI around D; s = average group size (Source: ICES WGMME, 2021)

Area	Season	N	$N_{95\% CI}$	D	$D_{95\% CI}$	$\hat{s}$
Dogger Bank (A)	spring 2020	11 425	8011–16 093	2.02	1.42–2.85	1.25
(B)	spring 2020	9209	6149–13 075	2.33	1.56–3.31	1.40
Sylt Outer Reef West (C)	spring 2020	18 677	12 139–27 808	3.12	2.03–4.64	1.34
Sylt Outer Reef East (D)	spring 2020	3318	1819–5111	0.48	0.26–0.74	1.31
Weser-Elbe estuary (E)	spring 2020	1925	916–3298	0.44	0.21–0.75	1.10
North Sea Areas: Dogger Bank (A) (B) Sylt Outer Reef West (C) Sylt Outer Reef East (D) Weser-Elbe estuary (E)	spring 2020	44 554	33 189–59 552	1.66	1.24–2.22	1.31
Sylt Outer Reef West (C)	summer 2020	9929	6249–14 850	1.66	1.04–2.48	1.29
Sylt Outer Reef East (D)	summer 2020	9991	5806–15 550	1.45	0.84–2.25	1.30
Weser-Elbe estuary (E)	summer 2020	1467	279–3785	0.34	0.06–0.86	1.60
Borkum Reef Ground (F)	summer 2020	4092	2657–5914	0.67	0.44–0.97	1.28
North Sea Areas: Sylt Outer Reef West (C) Sylt Outer Reef East (D) Weser-Elbe estuary (E) Borkum Reef Ground (F)	summer 2020	25 480	17 855–35 986	1.09	0.76–1.54	1.31

In spring 2021, just one area (Sylt Outer Reef East) was covered in the North Sea (Figure 27a), whereas in summer 2021, three areas (Dogger Bank, Weser-Elbe estuary, and Borkum Reef Ground) (Figure 27b). The total abundance for Sylt Outer Reef East in spring 2021 was estimated to be 7,836 (95%CI: 4,144–12,838) porpoises, at an average density of 1.14 (0.6–1.86) animals/km² (Table 5). In summer 2021, the total abundance was estimated at 5,305 (95%CI: 2,142-9,401) for Dogger Bank at an average density of 0.94 (95%CI: 0.38-1.66), for Weser-Elbe estuary it was estimated at 4,571 (95%CI: 1,391–10,152) porpoises at an average density of 1.04 (0.32-2.32) animals/km² (Table 5), and for Borkum Reef Ground, it was estimated at 3,986 (95%CI: 1,438-7,465) porpoises and an average density of 0.65 (0.24–1.23) animals/km² (Table 5).

Table 5. Summary of effort corrected, bootstrapped density and abundance estimates for spring 2021 and summer 2021 in the German EEZ of the North Sea and Baltic Sea. N = estimated abundance of harbour porpoises; $N_{95\%CI}$ = 95% confidence interval around N; D = density estimate of harbour porpoises in indiv./km²; $D_{95\%CI}$=95% CI around D; s = average group size (Source: ITAW/BfN, courtesy of P. Brtnik)

Area	Area size [km²]	Abundance (95% CI)	Density (95% CI)
D	6,897	7,836 (4,144 – 12,838)	1.14 (0.6 - 1.86)
Σ Surveyed North Sea areas spring	*6,897*	*7,836 (4,144 – 12,838)*	*1.14 (0.6 - 1.86)*
A	5,647	5,305 (2,142 – 9,401)	0.94 (0.38 - 1.66)
E	4,377	4,571 (1,391 – 10,152)	1.04 (0.32 - 2.32)
F	6,092	3,986 (1,438 – 7,465)	0.65 (0.24 - 1.23)
Σ Surveyed North Sea areas summer	*16,116*	*13,862 (7,338 – 22,037)*	*0.86 (0.46 - 1.37)*
I	3,116	2,063 (645 – 3,458)	0.66 (0.21 – 1.11)
J	3,575	*145 (0 - 496)*	*0.04 (0 - 0.14)*
Σ Surveyed Baltic Sea areas summer	*6,691*	*2,209 (773 – 3,653)*	*0.33 (0.12 - 0.55)*

Nachtsheim *et al.* (2020) analysed harbour porpoise trends in abundance within the German North Sea, and particularly within three Natura 2000 sites (Sylt Outer Reef, Borkum Reef, and Dogger Bank) from aerial surveys undertaken between 2002 and 2019. Trends were estimated for each SAC and two seasons (spring and summer) as well as the complete area of the German North Sea. For the trend analysis, a Bayesian framework was applied to a series of replicated visual surveys, in order to address spatio-temporal heterogeneity and other sources of uncertainty in the surveys. In general, harbour porpoise abundance decreased in northern areas and increased in the south, such as in the SAC Borkum Reef Ground. A particularly strong decline with a high probability (94.9%) was detected in the core area and main reproduction site in summer, the SAC Sylt Outer Reef (-3.79% per year) (Figure 28). The overall trend for the German North Sea revealed a decrease in harbour porpoise abundance over the whole study period (-1.79% per year) with high probability (95.1%).

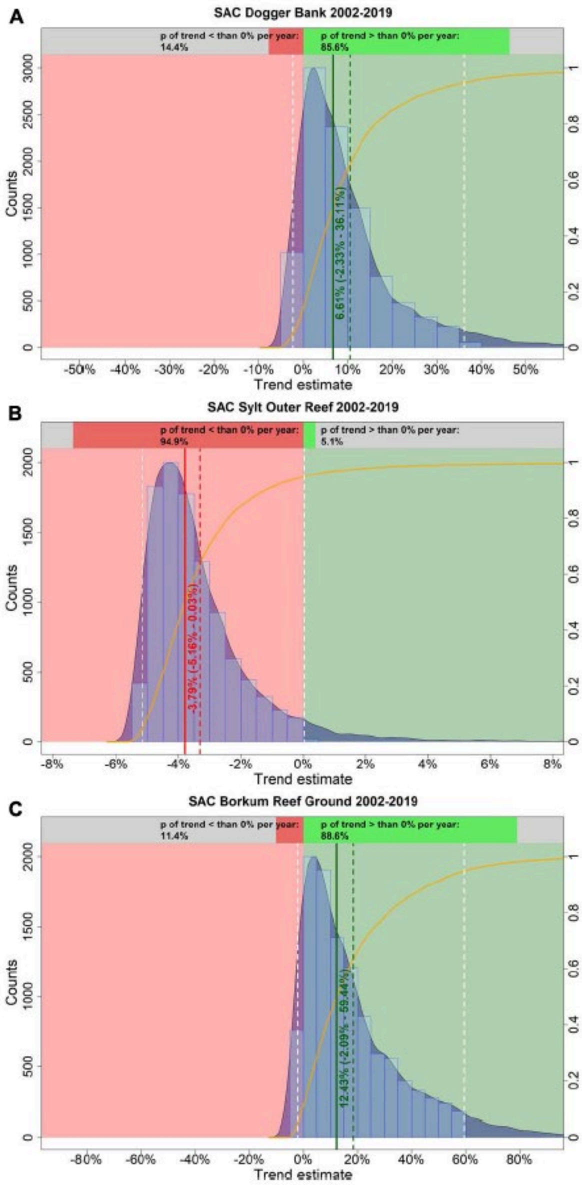


Figure 28. Estimated trends in harbour porpoise abundance in the three SACs Dogger Bank (A), Sylt Outer Reef (B), and Borkum Reef Ground (C) in summer, between 2002 and 2019. The light blue histogram and the blue shaded density curve show the distribution of the trend estimates (relative change in abundance) between 2002 and 2019 (x-axis); the median is indicated by the solid red vertical line. The mean is shown by the vertical red dashed line, while the white dashed lines represent the upper and lower 95% credibility intervals of the trend estimate. The red coloured area corresponds to an area with a negative trend, whereas the green coloured area represents a positive trend. The orange solid line illustrates the empirical cumulative distribution function of the trend estimates, giving the probability of a trend estimate at a specified value (e.g. 0%). The upper bar chart hence indicates how likely it is that the trend is either negative (i.e., p < 0%; red) or positive (i.e., p > 0%; green). (Source: Nachtsheim *et al*., 2020)

In **Denmark**, monitoring of harbour porpoises is carried out through the national monitoring programme NOVANA. Every year in July/August aerial surveys are conducted in the southern Danish North Sea and Skagerrak, covering the five Natura 2000 areas for harbour porpoises in this region. In the Skagerrak area in 2019 (Figure 29a), a total of 47 porpoises were observed in groups of up to 4 individuals. The average group size was 1.5. In the North Sea area (Figure 29b) 41 porpoises were observed, with an average group size of 1.08. Calves were observed in both survey areas. In 2020, a total of 22 porpoises were observed in groups of up to two individuals. The average group size was 1.22.

In the Skagerrak, the total abundance in 2018 was estimated to be 5,323 individuals (95% CI: 2,415-9,233). 40% of the observations were within the large Natura 2000 site 'Skagens Gren og Skagerrak' (Figure 29a). The Skagerrak area was previously monitored using a slightly different method and comparable estimates are thus not possible prior to 2017. The abundance estimate in 2018 is lower than in 2017, whilst in 2019, the total abundance in the Danish Skagerrak was estimated to 2,674 individuals (95% CI: 1,513-4,216). This is lower than any previous surveys and indicates a generally declining trend (Hansen & Høgslund 2021; Figure 32).

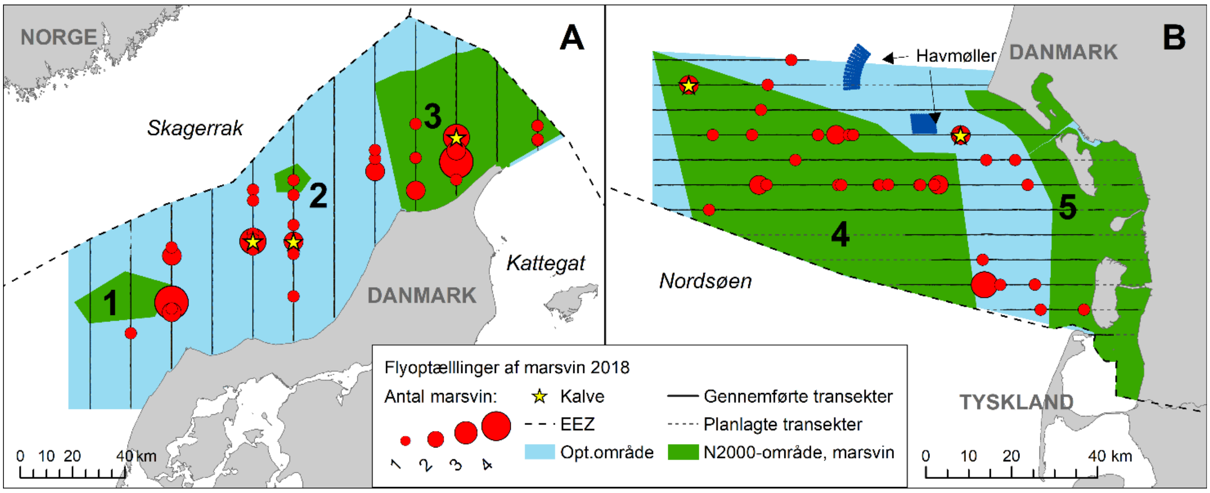


Figure 29. Aerial surveys of harbour porpoises in A) Skagerrak on 29 July 2018 and B) the North Sea on 2 August 2018. The green areas indicate Natura 2000 areas 1) Gule Rev, 2) Store Rev, 3) Skagens Gren and Skagerrak, 4) Sydlige Nordsø and 5) The Wadden Sea with Ribe Å, Tved Å and Varde Å west of Varde. No. of porpoises observed shown by the size of red dots and yellow stars indicate that calves were seen. Blue areas indicate offshore windfarms.

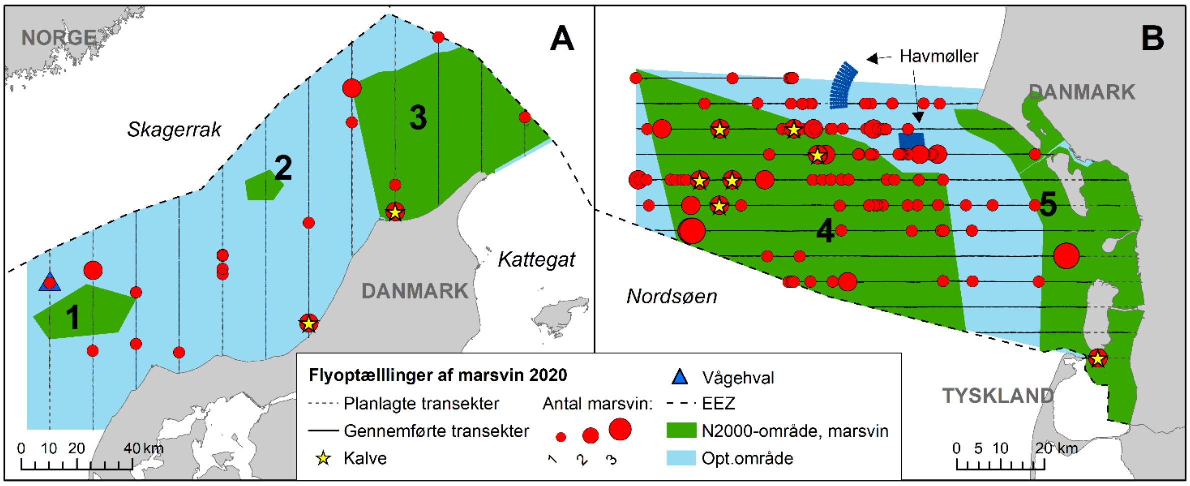


Figure 30. Aerial surveys of harbour porpoises in A) Skagerrak on 10 July 2020 and B) the North Sea on 7. August 2020. The green areas indicate Natura 2000 sites: 1) Gule Rev, 2) Store Rev, 3) Skagens Gren og Skagerrak, 4) Sydlige Nordsø og 5) Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde. No. of porpoises observed shown by the size of red dots and yellow stars indicate that calves were seen. Dark blue areas indicate offshore windfarms and light blue areas indicate the survey area. Blue triangle indicates a minke whale observation. (Source: Hansen & Høgslund, 2021)

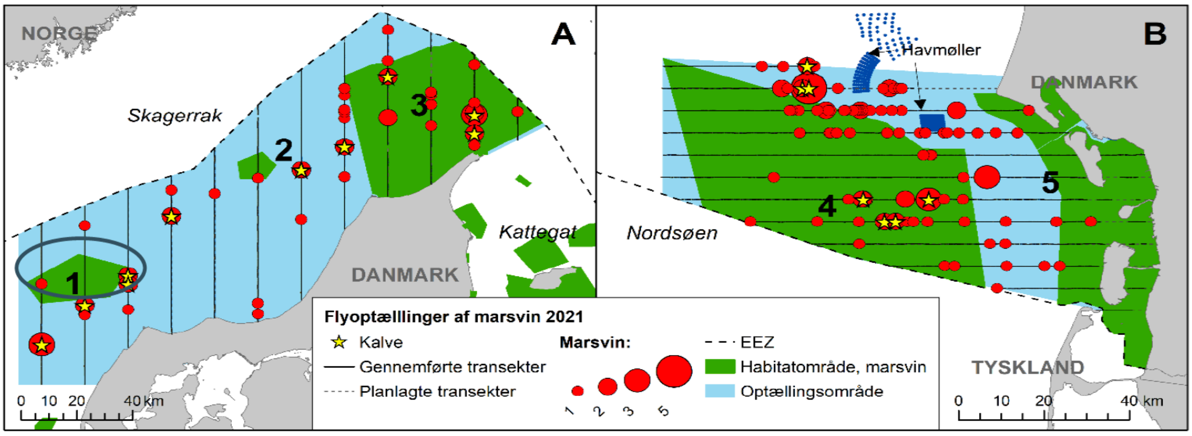


Figure 31. Aerial surveys of harbour porpoises in A) Skagerrak in July 2021 and B) the North Sea in August 2021. The green areas indicate Natura 2000 sites: 1) Gule Rev, 2) Store Rev, 3) Skagens Gren og Skagerrak, 4) Sydlige Nordsø og 5) Vadehavet med Ribe Å, Tved Å and Varde Å vest for Varde. No. of porpoises observed shown by the size of red dots and yellow stars indicate that calves were seen. Dark blue areas indicate offshore windfarms and light blue areas indicate the survey area. (courtesy of S. Sveegaard).

The total abundance in the North Sea survey area in 2018 was estimated to be 2,013 individuals (95% CI: 954-3,186). In the North Sea area during surveys in 2019 (Figure 29b), 147 porpoises were observed, with an average group size of 1.20. In the southern North Sea, the total abundance was estimated to 5,929 individuals (95% CI: 3,895-8,310). Most observations were again detected in or near the large Natura 2000 site “Sydlige Nordsø”, with rather few observed within the Wadden Sea. A similar distribution was observed during surveys in 2020 (Figure 30) and 2021 (Figure 31).

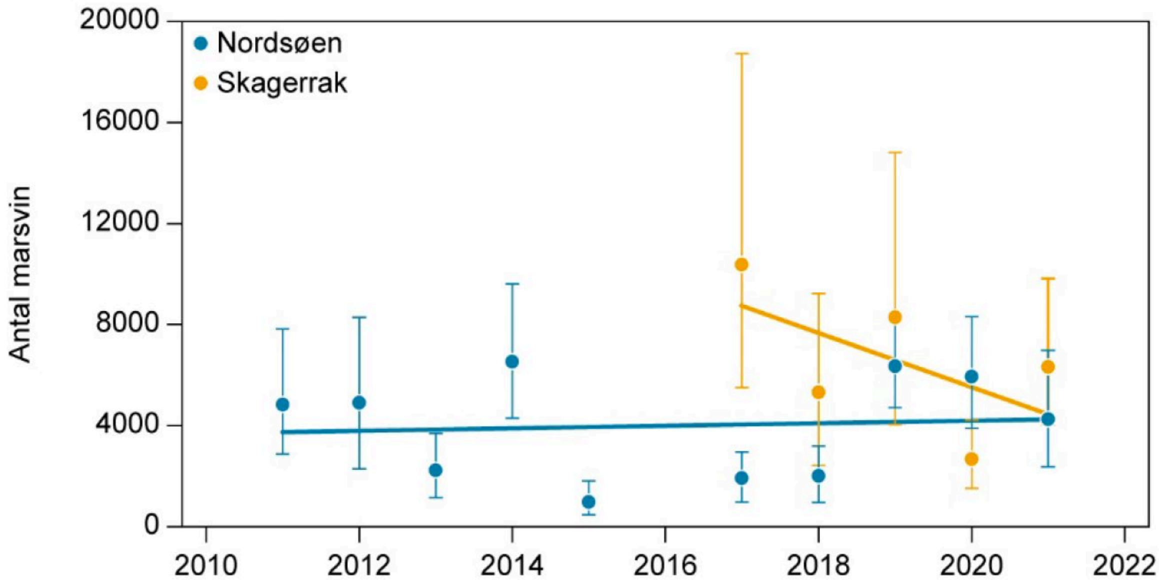


Figure 32. Estimated abundance of harbour porpoises in the Danish North Sea (2011-2020) and Skagerrak (2017-2020), respectively. Vertical lines indicate the 95% confidence interval. Dashed lines indicate the trend for the North Sea population (Source: Hansen & Høgslund, 2021, S. Sveegaard, pers. comm.)

There are relatively large variations in abundance estimates between years, which may reflect actual differences in abundance (a possible decline in Skagerrak), but may also be a result of the method, which only gives a snapshot of the distribution and abundance. Furthermore, annual differences in temperature, currents, timing of prey migrations and so on will influence the annual estimates. Consequently, long time series are essential to monitor the long-term trend within an area.

Eastern Channel Ferry Surveys

Bouveroux *et al.* (2020) analysed effort-based sightings of harbour porpoise from ferry routes in the eastern English Channel (Dunkirk – Dover), collected between 2012 and 2014. Data were collected by volunteers of OCEAMM, a non-government organisation based in France. Generalised linear models (GLM) were used to investigate spatiotemporal patterns in occurrence (presence of animals) and aggregation size (number of animals when present) in the region. It was not possible to estimate densities as distance sampling was not performed. Statistical analyses were divided into two processes: a descriptive model describing temporal patterns and an explanatory model investigating possible drivers of temporal patterns. The first analysis showed an increase in occurrence and aggregation size in winter months; both also showed general increases across the study period, being highest in 2014 and lowest in 2012. The second analysis showed that animal occupancy peaked in the coolest months, although increases across the study period could not be explained sufficiently by temperature. Aggregations were larger in faster offshore waters than slower coastal waters across seasons. Encounter rates peaked in slower coastal waters in summer months, but in faster offshore waters in winter months, suggesting some seasonality in harbour porpoise habitat-use.

East Scottish Aerial Surveys

In the **UK**, digital aerial surveys commissioned by the Scottish Government were conducted monthly between February 2020 and March 2021 by APEM Ltd in offshore waters of the North Sea east of Scotland between the Shetland Isles and the Firth of Forth. Flights were made at a height of 2,000 feet (610 m) and a ground speed of 120 knots (222 km per hour). Using these data, distribution models were developed for marine mammal and bird species occurring regularly in the area, along with seasonal abundance estimates. The number of harbour porpoises in the region was estimated at c. 55,000 animals in July 2020 with broadly similar numbers year-round but a peak of c. 120,000 between April and June, based upon an estimate of instantaneous availability of 0.123 (Paxton *et al*., 2022). Greatest numbers occurred east of the Moray Firth. Point estimates of porpoise densities over the region varied from 0 to 5 animals/km^2, with progressively higher densities in the south of the survey area. Estimates of abundance and density for July 2020 were similar to those from the July 2016 SCANS survey although it is difficult to draw direct comparisons because the boundaries of the study areas differed somewhat.

Modelled seasonal density distributions of Harbour Porpoise

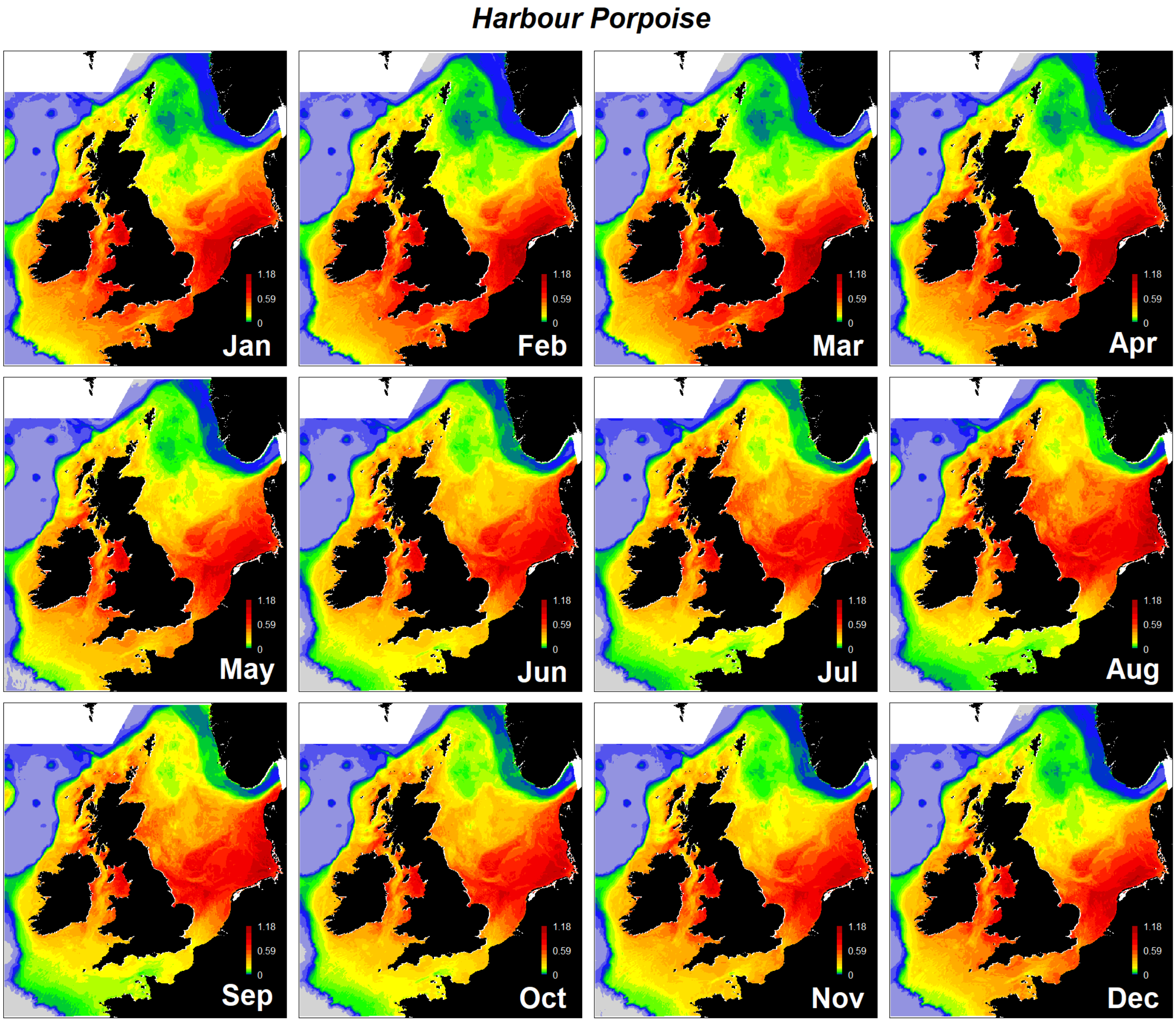


Figure 33. Monthly modelled density distributions of harbour porpoise averaged over the period 2005-2018 (Source: Waggitt *et al.,* Marine Ecosystems Research Programme)

Since 2014, the joint NERC-Defra funded Marine Ecosystems Research Programme has been collating dedicated survey data and undertaking modelling to derive abundance estimates and distribution patterns for all cetacean and seabird species occurring regularly in NW European seas. The project has collated around three million km of cetacean survey effort from more than fifty research groups in Northwest European seas covering the period 1978–2018 (Waggitt *et al*., 2020). Collectively, these surveys are being used to test ecological questions/hypotheses using a variety of modelling approaches, and to generate potentially useful data products. Using hurdle models that incorporate a range of environmental parameters believed to influence prey distributions and prey capture availability for different cetacean species, integrating the probability of encountering the species and its abundance, density maps of the 12 most common species have been produced at monthly temporal and 10 km spatial resolution across the past three decades. Monthly summaries of harbour porpoise distribution are shown in Figure 33. These highlight the importance of the North Sea for harbour porpoise in the context of NW European shelf seas. Further analyses suggest that there has been a distributional shift westwards in the southern North Sea, with the Dogger Bank area increasing in relative importance and the Outer Sylt Reef decreasing in importance.

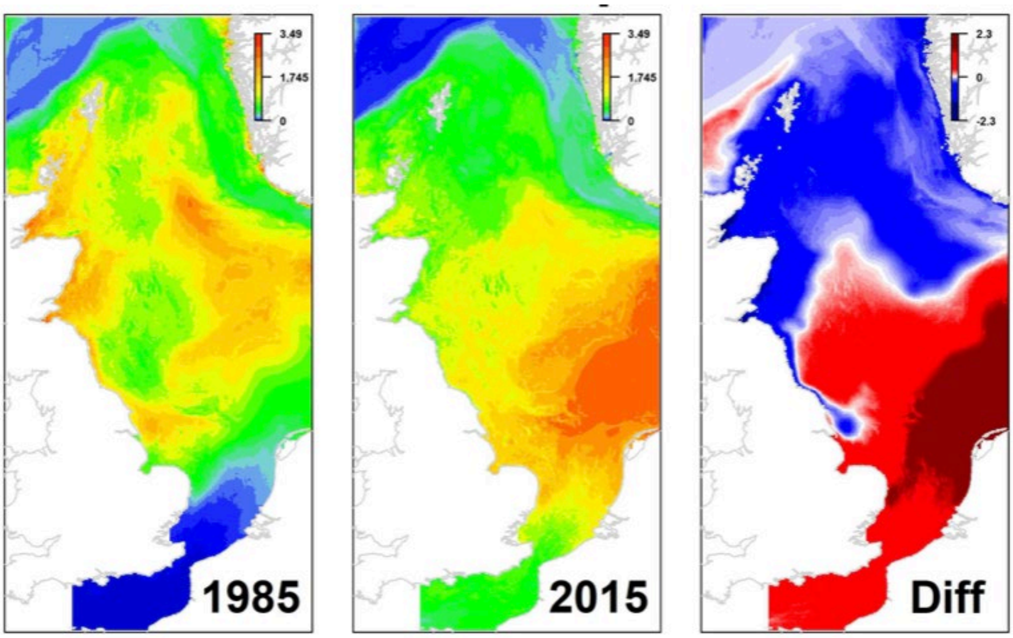


Figure 34. Long-term changes in modelled density distributions of harbour porpoise between 1985 and 2015. Red = increase in density; blue = decrease in density (Source: Waggitt & Evans, Marine Ecosystems Research Programme)

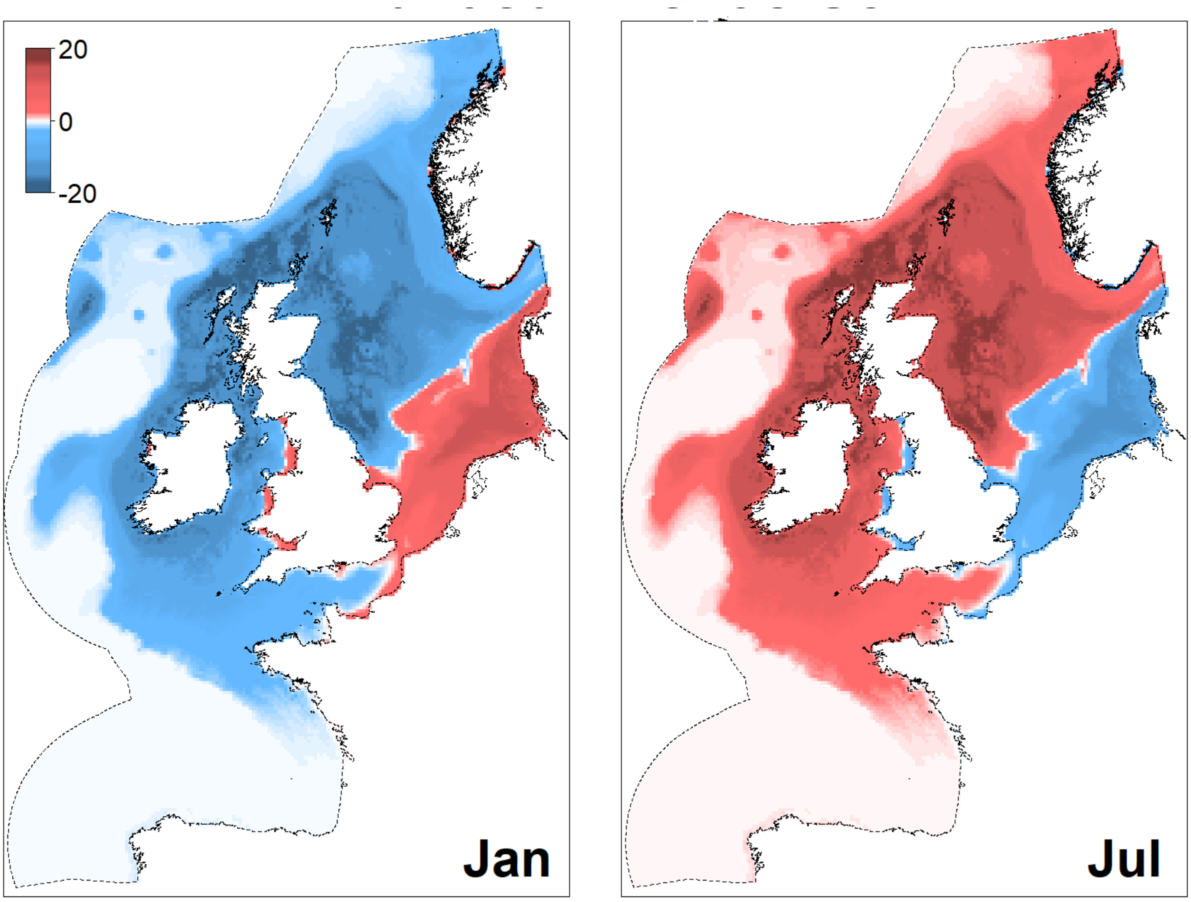


Figure 35. Seasonal change in modelled density distributions of harbour porpoise in the North Sea, 2005-2016 (Source: Waggitt & Evans, Marine Ecosystems Research Programme)

Figure 34 shows clearly the general southward shift in density distributions away from the northern North Sea since the 1990s, already established from earlier studies (Camphuysen, 1994, 2004; Evans *et al*. 2003*;* Kiszka *et al*., 2004, 2007; Hammond *et al.,* 2013).

Modelled density distributions for porpoises in the North Sea for January and July indicate greater densities in the southernmost parts in winter (Figure 35). Further work is needed to establish whether any potential seasonal trends have been sustained over the long-term or have changed more recently.

In addition to visual surveys, acoustic monitoring (largely using C PODs) continues to be undertaken at a number of coastal locations in the **UK**, **the Netherlands**, **Germany** and **Denmark**, often in association with marine renewable energy developments. These have led to a series of publications in recent years (UK: Williamson *et al*., 2016, 2017; Germany: Dähne *et al*., 2017; Denmark: Nabe-Nielsen *et al.,* 2018).

Key Conclusions & Recommendations

The harbour porpoise population within the North Sea (including the eastern half of the English Channel) in 2016 was estimated in the region of 250,000-350,000 animals. There has been no significant change in abundance since the mid 1990s. However, there is some evidence for a decline in abundance in the eastern North Sea and a corresponding increase in the south-west. Abundance estimates from the SCANS-IV survey undertaken in summer 2022 have yet to be released.

Regular visual monitoring by aerial survey is now being undertaken on a seasonal and annual basis in the southern North Sea involving a number of countries. Winter months remain less well covered, and areas in the central and northern North Sea have been monitored largely by decadal wide-scale surveys and some local windfarm-related visual and/or acoustic monitoring. It is recommended that these gaps are filled and that every ASCOBANS Party has a regular programme of monitoring across its entire EEZ.

ACTION 8. Review of the stock structure of harbour porpoises in the region

Currently, within ICES, harbour porpoises in the North Sea are considered within a single assessment unit equivalent to ICES Areas 4.a, 4.b, 4.c, 7.d, and 3.a.20 (ICES WGMME 2013; Figure 36). This encompasses all of the Skagerrak, the North Sea up to a line parallel with the Faroe Islands, and the eastern half of the English Channel. A recent joint NAMMCO & IMR workshop on the status of harbour porpoises in the North Atlantic (NAMMCO & IMR 2019) discussed assessment units of harbour porpoises in the North Atlantic, and decided to keep most of the borders for the North Sea assessment unit from ICES WGMME 2013 intact, with the exception that the border between the Belt Sea and North Sea assessment units was moved south into the Kattegat Sea, in accordance with Sveegaard *et al.* 2015 (Figure 37, detail in Figure 38).

Earlier, the ASCOBANS Population Structure workshop when reviewing multiple lines of evidence had proposed two management units within the North Sea divided by an arbitrary line separating the northern and eastern sector from the southern and western sector (Evans and Teilmann, 2009). The lines of evidence suggesting sub-structuring within the North Sea included skeletal and tooth ultrastructure variation (Kinze, 1985, 1990; Lockyer, 1999; De Luna *et al*., 2012), genetic analyses (Walton, 1997; Tolley *et al*., 1999; Andersen *et al*., 2001; De Luna *et al*., 2012), dietary studies (Aarefjord *et al*., 1995; Bjørge, 2003), stable isotope studies (Das *et al.* 2003), contaminant loads (Das *et al*., 2004, Lahaye *et al*., 2007), and telemetry studies (Teilmann *et al*., 2008; Sveegaard *et al*., 2011). Details of their findings are given in Desportes (2014).

A number of authors allude to differences in ecology between animals from the north-eastern and southern/western North Sea, particularly with respect to feeding. There are obvious differences in the bathymetry and oceanography of these two regions, being much deeper in the north-east than in the southernmost North Sea. If porpoises in the north-eastern North Sea are feeding mainly upon pelagic prey (for which skull characteristics, particularly of the buccal cavity, have developed – see De Luna *et al.,* 2012) whilst those in the southernmost North Sea are taking fish primarily off the bottom (with equivalent changes to the size of the buccal cavity), then these may represent separate management units with a potential boundary following bathymetric and oceanographic changes. Recent tagging studies of porpoises in the Wadden Sea area of the south-eastern North Sea indicate that porpoises in this region may be sedentary (Vrooman *et al.*, 2022; J. Vrooman, *pers. comm.*), and may therefore represent a separate population to those in the western North Sea.

De Luna *et al*. (2012) and Andersen *et al.* (2001) found significant differences between porpoises from the British North Sea and those from the Danish North Sea, as well as differences between porpoises from Norway and both the Danish North Sea and the British North Sea. Wiemann *et al.* (2010) also showed significant sub-structuring between the Danish North Sea and Norway. Thus, the presence of three Management Units might also be considered (Desportes, 2014).

Sveegaard *et al*. (2015) reviewed harbour porpoise management areas in the Baltic, Belt Seas and Kattegat combining information from genetics, morphology, acoustics and satellite tracking. They concluded that porpoises in the Western Baltic, Belt Seas and Kattegat represented a separate management unit to those in the Baltic Proper and recommended a northern boundary halfway down into the Kattegat (along an east-west line drawn at 56.95°N) (see Figure 38). It was therefore agreed that from 2021 this should form the south-eastern boundary for the North Sea Porpoise Conservation Plan.

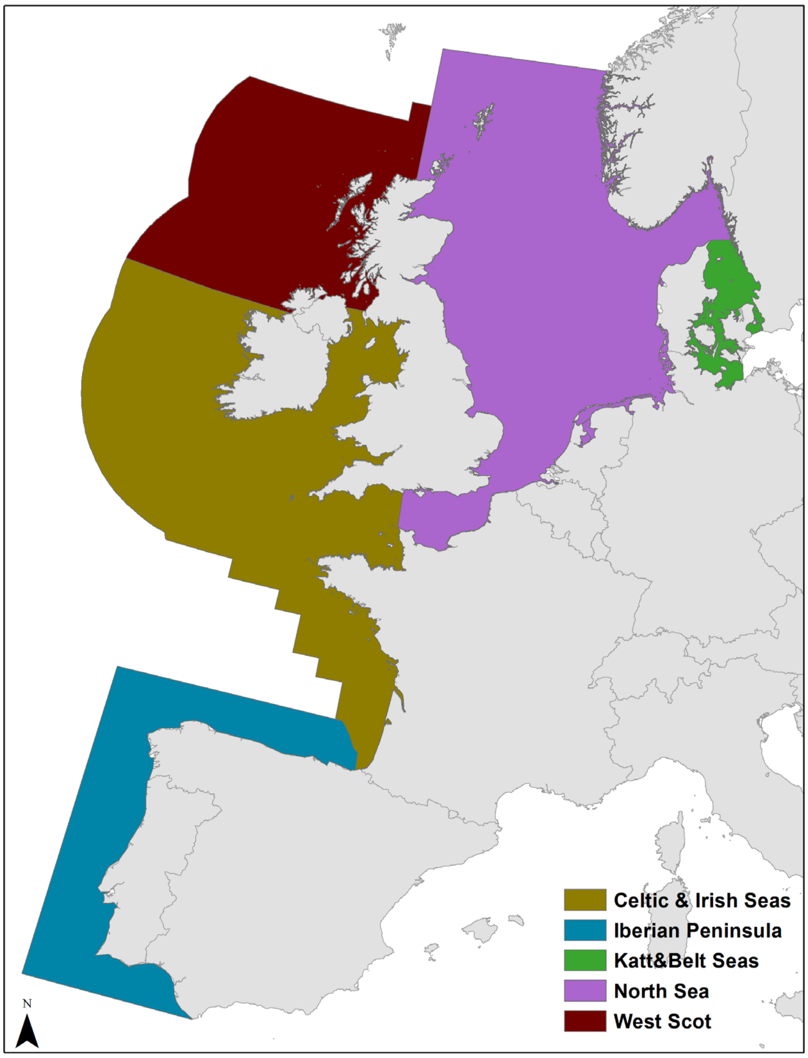


Figure 36. Assessment Units for the Harbour Porpoise as proposed by ICES WGMME (2013)

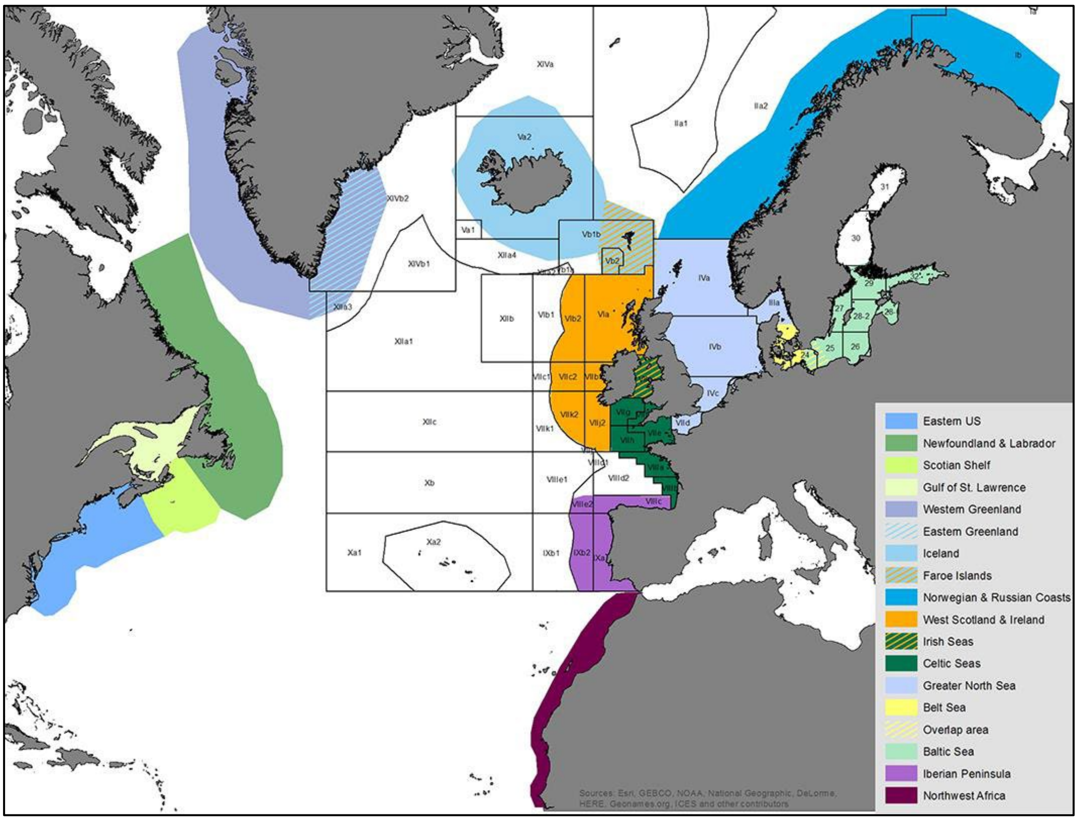


Figure 37. Assessment units for harbour porpoise in the North Atlantic as proposed and used during the joint NAMMCO/IMR workshop, with the ICES fishing areas superimposed. (Source: NAMMCO & IMR 2019).

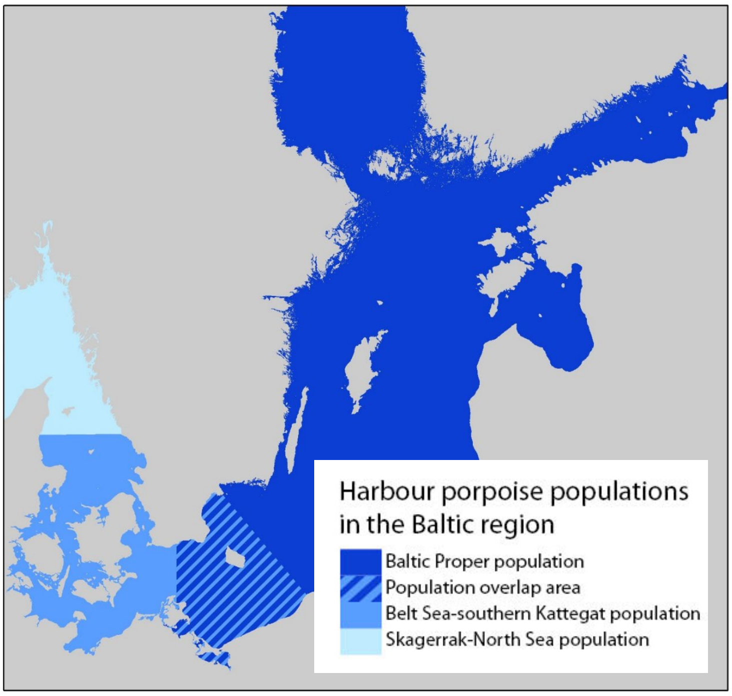


Figure 38. Harbour porpoise populations in the Baltic region. Blue shading indicates the borders proposed for the management unit of the Belt Sea population by Sveegaard *et al.* (2015) and for the Baltic Proper population by Carlén *et al*. (2018). All borders are for the summer half-year only.

At the south-western end of the ICES WGMME North Sea assessment unit area, Fontaine *et al* (2017) analysed the fine-scale genetic and morphological variation in harbour porpoises around the UK by genotyping 591 stranded animals at nine microsatellite loci. The data were integrated with a prior study to map at high resolution the contact zone between two previously identified ecotypes meeting in the northern Bay of Biscay. Clustering and spatial analyses revealed that UK porpoises are derived from two genetic pools with porpoises from the southwestern UK being genetically differentiated, and having larger body sizes compared to those from other UK areas.

South-western UK porpoises showed admixed ancestry between southern and northern ecotypes with a contact zone extending from the northern Bay of Biscay to the Celtic Sea and Channel (Fontaine *et al*. 2017). Around the UK, ancestry blends from one genetic group to the other along a southwest–northeast axis, correlating with body size variation, consistent with previously reported morphological differences between the two ecotypes. They also detected isolation by distance among juveniles but not in adults, suggesting that stranded juveniles display reduced intergenerational dispersal. This would be expected if adults show some philopatry and faithfulness to particular breeding areas, as suggested in harbour porpoises, especially in females (mtDNA and satellite tagging studies both indicate greater philopatry for females than males), and then disperse again the rest of the year (e.g. for foraging). Identifying where a boundary might exist in the English Channel between porpoises from a southwestern ecotype and those from the North Sea is difficult given the distribution of samples from along the south coast of England and lack of knowledge of their exact origins (due to passive drift). For the time being, there seems no reason to recommend a change to the western boundary to the North Sea assessment unit proposed by ICES WGMME (2013).

The challenge in determining where management boundaries should lie is that different authors have used different sampling divisions, there are geographical gaps in sampling, sample sizes in these have varied a lot, and the precise origins of the samples are rarely known. Some of the key areas of potential management unit boundaries that have been poorly sampled include the north-eastern North Sea south and west of Norway and the central English Channel.

Key Conclusions & Recommendations *There is still some uncertainty over the extent to which there is sub-structuring of harbour porpoise populations in the North Sea, with one, two, or three areas suggested as Management Units. It would be useful to obtain further samples for some of the boundary areas – Danish vs Norwegian Skagerrak, northern Kattegat, southern vs western Norway, Shetland vs Orkney/Scottish mainland, for analysis using a range of approaches (skull morphology, genetics, etc).*

The possibility of further sub-structuring should be explored in the central North Sea from the Danish and north German coasts across to eastern Britain since there are signals of differentiation on an east-west as well as north-south axis. Analyses are best conducted on samples where the precise original location is known. This is obviously not possible with most stranded animals sampled, but even with individuals that have been bycaught, care needs to be taken to ensure that the precise location of that bycaught animal is recorded.

Summary of Progress in Implementation of the Plan

Table 6 provides a qualitative assessment of progress by each of the Member States on the various actions identified as high and medium priorities. Progress has been variable since the adoption of the plan in 2009. Some aspects (e.g. the monitoring of distribution and abundance, at least in the southern North Sea) have received a lot of attention, whereas others (e.g. adequate monitoring to derive robust bycatch estimates particularly of vessels less than 15 m length, and the implementation of effective mitigation measures to reduce bycatch) have made less progress.

Draft criteria for assessment of progress in implementation actions under the harbour porpoise conservation plan are proposed below.

Draft Status Assessment Criteria for Progress of the Implementation of the Actions of the North Sea Conservation Plan

1. **Implementation of the CP: co-ordinator and Steering Committee**
   Yes/No

2. **Implementation of existing regulations on bycatch of cetaceans**

   Enforcement of Technical Conservation Regulations (or national equivalent)
   N.A. – Not applicable
   0 – No activity
   1 – Some enforcement of high-risk fisheries
   2 – Full enforcement of some high-risk fisheries
   3 – Full enforcement of all high-risk fisheries

   Protected Species Observer Programmes
   N.A. – Not applicable
   0 – No activity
   1 – Data Collection Framework (DCF) Sampling Programme only
   2 – Research or Pilot project to improve bycatch estimates from monitoring (under Reg. 2019/1241 or equivalent) with <10% of high-risk fisheries covered
   3 – Regular Dedicated Bycatch monitoring of >10% of high-risk fisheries (under Reg. 2019/1241 or equivalent) resulting in a robust estimate of bycatch rates

   Regulating fishing activities in Marine Protected Areas (including Natura 2000 sites)
   N.A. – Not applicable
   0 – No regulation of fishing
   1 – Some regulation of high-risk fisheries within MPAs
   2 – High-risk fisheries not permitted within MPAs
   3 – No fishing allowed

3. **Establishment of bycatch observation programmes on vessels smaller than 12 m length, including both professional and recreational fisheries**
   N.A. – Not applicable
   0 – No activity
   1 – Research project on bycatch monitoring of vessels <12 m length in high-risk fisheries
   2 – Bycatch monitoring of part of high-risk fisheries resulting in a robust estimate of bycatch rates

3 – Bycatch monitoring in all high-risk fisheries resulting in a robust estimate of bycatch rates fishing gear

4. **Regular evaluation of relevant fisheries, extent of harbour porpoise bycatch**

   N.A. – Not applicable
   0 – No estimates available
   1 – Estimate of bycatch available from research project, for part of the fisheries
   2 – Estimate of bycatch available for >50% of relevant fisheries resulting in a robust estimate of bycatch rates
   3 – Estimate of bycatch available for all relevant fisheries resulting in a robust estimate of bycatch rates

5. **Bycatch mitigation measures: ADDs (pingers etc) in use, development of alternative ADDs, gear modifications, fisheries closures/effort reduction, ghost netting removal**

   Deployment of working ADDs (regularly checked for compliance)
   N.A. – Not applicable
   0 – No mitigation measures in place
   1 – Research projects ongoing using ADDs
   2 – Working ADDs deployed routinely on high-risk fisheries in accordance with delegated acts, i.e. a risk management procedure is in place but noting that no bycatch at all may not be achieved

   Development of alternative ADDs (tested in active fisheries)
   N.A. – Not applicable
   0 – No activity
   1 – Research projects on developing & testing alternative ADDs
   2 – Fully field-tested alternative ADDs deployed on appropriate fisheries, i.e. a risk management procedure is in place but noting that no bycatch at all may not be achieved

   Modification of fishing gear (e.g. acoustically reflective nets, other less damaging gears)
   N.A. – Not applicable
   0 – No activity
   1 – Research projects ongoing on alternative gear
   2 – Fully field-tested gear modification deployed on appropriate fisheries, i.e. a risk management procedure is in place but noting that no bycatch at all may not be achieved

   Fisheries effort reduction or closures
   N.A. – Not applicable
   0 – No activity
   1 – Research projects ongoing on fisheries closures, effort reduction
   2 – Fisheries effort reduction/closures where appropriate in high-risk areas and/or MPAs, i.e. a risk management procedure is in place but noting that no bycatch at all may not be achieved

   Removal of ghost netting
   N.A. – Not applicable
   0 – No activity

1 – Ghost net removal carried out in some parts of the country's EEZ within the Greater North Sea
2 – Ghost net removal carried out throughout the country's EEZ within the Greater North Sea, i.e. a risk management procedure is in place but noting that no bycatch at all may not be achieved

6. Review of management procedure approach for determining maximum allowable bycatch limits

N.A. – Not applicable
0 – No activity
1 – Some research into developing a management procedure approach for national application
2 – Maximum allowable bycatch limits established and applied nationally

7. Monitoring trends in distribution and abundance of harbour porpoise in the North Sea

Large-scale
N.A. – Not applicable
0 – No activity
1 – Surveys carried out every 10-12 years, results with CVs for abundance estimates of above 0.4
2 – Surveys carried out every 10-12 years, with CVs for abundance estimates of between 0.2 and 0.4, maps of harbour porpoise density
3 – Surveys carried out every 6 years, with CVs for abundance estimates of 0.2 or less, maps of harbour porpoise density

Regional/surveys
N.A. – Not applicable
0 – No activity
1 – Some monitoring at local/national scale, not continuously
2 – Seasonal (at least 2 seasons) monitoring for at least two years every six years
3 – Seasonal (at least 2 seasons) monitoring annually

Regional/modelling
N.A. – Not applicable
0 – No activity
1 – Some density modelling at local/national scale, not continuously
2 – Seasonal (at least 2 seasons) density modelling for at least two years every six years
3 – Seasonal (at least 2 seasons) density modelling annually

8. Review of the stock structure of harbour porpoise in the North Sea

N.A. – Not applicable
0 – No activity
1 – Samples collected from some carcasses found within the Greater North Sea, but no analysis in last year
2 – Samples collected from some carcasses found within the Greater North Sea, some analysis completed relevant to stock structure (genetics, morphometrics etc.) in the last year

3 – Samples collected from over 75% of carcasses (in suitable condition) found within the Greater North Sea, and all possible analyses completed relevant to stock structure (genetics, morphometrics, etc.) in the last year

9. Collection of incidental harbour porpoise data through stranding networks

Life history parameters
N.A. – Not applicable
0 – No activity, no plan or guidance on how to act in case of a stranding
1 – At least ten samples suitable for life history determination collected from some carcasses from within the Greater North Sea, no analysis carried out within last year
2 – Some analysis and assessments completed on appropriate material for at least 20 carcasses within last 3 years
3 – Analysis and assessments completed on appropriate material for at least 30 carcasses within last 3 years

Contaminant Levels
N.A. – Not applicable
0 – No activity, no plan or guidance on how to act in case of a stranding
1 – Samples suitable for contaminants analysis (PCBs, PAHs, Cd, Hg, Pb) collected from some carcasses from within the Greater North Sea, no analysis carried out
2 – Some analysis and assessments completed on appropriate material
3 – Analysis and assessments completed on appropriate material for at least 30 carcasses within last 3 years

10. Investigation of the cause of death, health/nutritional status and diet of harbour porpoise in the North Sea

Cause of Death
N.A. – Not applicable
0 – No activity, no plan or guidance on how to act in case of a stranding
1 – Samples collected from some carcasses from within the Greater North Sea, no analysis carried out
2 – Some analysis and assessments completed on appropriate material
3 – Full necropsies (according to ASCOBANS protocol) conducted for at least 30 carcasses in good enough condition, and samples analysed within last 3 years for cause of death. Regular (at least every 6 years) assessments of results

Health/Nutritional Status
N.A. – Not applicable
0 – No activity, no plan or guidance on how to act in case of a stranding
1 – Samples collected from some carcasses from within the Greater North Sea, no analysis carried out
2 – Some analysis and assessments completed on appropriate material
3 – Full examination conducted for at least 30 carcasses in good enough condition, and samples analysed within last 3 years, for health/nutritional status. Regular (at least every 6 years) assessments of results

Diet
N.A. – Not applicable
0 – No activity, no plan or guidance on how to act in case of a stranding

1 – Samples collected from some carcasses from within the Greater North Sea, no analysis carried out
2 – Some analysis and assessments completed on appropriate material
3 –Full examination conducted for at least 30 carcasses in good enough condition, and samples analysed within last 3 years, for diet. Regular (at least every 6 years) assessments of results

11. Investigation of the effects of anthropogenic sounds on harbour porpoise

Monitoring Levels and Impacts of continuous noise (shipping)
N.A. – Not applicable
0 – No activity
1 – Research projects in place to improve knowledge
2 – Modelling of continuous underwater noise levels & potential impacts across country's EEZ within Greater North Sea
3 – Direct annual measurements of continuous underwater noise & potential impacts at sampling sites with good coverage across country's EEZ within Greater North Sea

Monitoring Levels and Impacts of Impulsive noise (seismic, sonar, explosions, piling)
N.A. – Not applicable
0 – No activity
1 – Research projects in place to improve knowledge
2 – Direct measurements of some sources of impulsive underwater noise & potential impacts across country's EEZ within Greater North Sea
3 – Direct measurements of all sources of impulsive underwater noise & potential impacts across country's EEZ within Greater North Sea

Mitigating effects of continuous noise (shipping)
N.A. – Not applicable
0 – No activity
1 – Mitigation measures (quieting technologies, speed restrictions, re-routing vessels) under development or being tested
2 – Mitigation measures (quieting technologies, speed restrictions, re-routing vessels) in place to some extent, to reduce continuous noise
3 – Mitigation measures (quieting technologies, speed restrictions, re-routing vessels) routinely in place to reduce continuous noise, i.e. that a risk management procedure is in place, noting that the potential impact of continuous noise cannot be completely addressed

Mitigating effects of impulsive noise (seismic, sonar, explosions, piling)
N.A. – Not applicable
0 – No activity
1 – Mitigation measures (soft starts, bubble curtains, insulation casings) under development or being tested, available mitigation methods used to some extent
2 – Mitigation measures (soft starts, bubble curtains, insulation casings) in place to some extent, to reduce impulsive noise
3 – Mitigation measures (soft starts, bubble curtains, insulation casings) routinely in place, to reduce impulsive noise, i.e. a risk management procedure is in place, noting that the potential impact of all impulsive noise cannot be completely addressed

12. Collection and archiving of data on anthropogenic activities and development of GIS

N.A. – Not applicable
0 – No activity
1 – Some collection of data on some anthropogenic activities potentially impacting porpoises
2 – Regular collection of data on all anthropogenic activities potentially impacting porpoises
3 – Development of an integrated cumulative effects mapping framework

Table 5. Qualitative Assessment of Progress in the Implementation of the ASCOBANS North Sea Conservation Plan for the Harbour Porpoise (undertaken December 2021)

	Actions from the North Sea Conservation Plan for HP	Priority		SE	DK	DE	NL	BE	FR	UK
2	Implementation of existing regulations on bycatch of cetaceans - e.g. EC 2019/1241 & Habitats Directive (HD)	High	Enforcement policy	2	3	0	na	na	3	3
			Protected Species observer programme	2	2	0	1	1	2	2
			Regulating fisheries in N2K sites	2	2	1	1	1	2	2
3	Establishment of BYC observation programmes on vessel smaller than 12m long, professional and recreational fisheries	High	Professional	1	1	0	1	na	1	1
			Recreational	na	1	na	0	na	0	na
4	Regular evaluation of relevant fisheries, extent of HP BYC:	High	Overall assessment	1	1	0	1	na	1	1
	Gillnet fisheries =>15m vessels, dedicated, % DaS observed			?	1*	?	na	na	?	?
	Gillnet fisheries <15m vessels, dedicated, % DaS observed			5-10	?	0	1	na	?	?
	Cetacean scheme appended to DCF / DCR schemes			yes	yes	yes	yes	no	yes	yes
	DCF observations in NS, % DAS observed			yes	yes	?	10-15	na	?	?
5	Bycatch Mitigation Measures	High	Deployment of working ADDs	1	2	1*	1*	na	1?	2
			Development of alternative ADDs	1	1	1	na	na	1	1?
			Modification of Fishing Gear	1	1	1	0	0	1	1
			Fisheries effort reduction/closures	1	1	2	1	1	1	1
			Removal of Ghost Netting	1	1*	1*	1*	1**	0	1*
6	Review of management procedure approach for determining maximum allowable byctch limits	High		Progress ICES WGBYC, OSPAR (MSFD), ASCOBAN						
				1	1	1	1	1	1	1
7	Monitoring trends in distribution and abundance of HP in NS	High	Large scale	SCANS IV undertaken in 2022						
			Reg/survey	0	2	3	2	3	2	1
			Reg/modelling	0	2	3	2	3	2	1
8	Review of the stock structure of HP in NS	High		1	1	1	1	1	1	1
9	Collection of incidental porpoise data through stranding networks	Medium	Life History	3	2	2	2	2	2	3
			Contaminants	2	2	3	3	2	2	3
10	Investigation of the health, nutritional status and diet of HP in NS	High	Cause of death	3	2	2	3	3	3	3
			Health/Nutritional Status	3	2	2	3	3	3	3
			Diet	2?	3	3	3	3	2	1
11	Investigation of the effects of anthropogenic sounds on HP	High	Monitoring continuous noise	2	3	2	2	2	2	2
			Monitoring impulsive noise	2	2	2	2	2	1	2
			Mitigation of continuous noise	1	1	1	0	0	0	2
			Mitigation of impulsive noise	2	3	3	3	2	1	2
12	Collection and archiving of data on anthropogenic activities and development of a GIS	Medium		1	1	1	1	1	1	1

Priority Recommendations

1) Improve quality and availability of fishing effort data for the region, by gear type, vessel size category, season, and country
2) Investigate options for more cost-effective bycatch monitoring, particularly to include vessels less than 15 metres length
3) Investigate gear specific solutions to mitigate bycatch, including alternative fishing methods to static gillnetting
4) Improve in a timely manner the more detailed information provided by countries relevant to the Conservation Plan

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APPENDIX I

Table A1. Bycatch for harbour porpoise in the North Sea, as reported by Parties, from various observation schemes

Country	**Year**	**ICES area/ subarea**	**Metier (level 3)**	**Type of monitoring**	**Days at sea monitored**	**% fleet monitored**	**Species bycaught**	**Number of specimen**	**Bycatch rate (No of specimens/ monitored DaS**
UK	2017	7	GNS/GTR	Dedicated	217		Harbour porpoise	5	0.023
DK		27.3.a	GNS	DCF	15	0.8	Harbour porpoise	1	0.067
SE		3.a.23	GNS	Dedicated	36	0.18	Harbour porpoise	2	0.056
NL	2013-2017		GNS/GTR	REM	8133		Harbour porpoise	13	0.0016

Notes: Data have been taken from the WGBYC Report (2019) and show monitored metiers where bycatch was observed in the North Sea during 2017 (the latest year of reporting).

Dedicated = at sea Protected Species Observer Scheme
DCF = Data Collection Framework
REM = Remote Electronic Monitoring
GNS = Static Gillnet
GTR = Trammel Net

*Only the northern part of ICES Subarea 3a is in the North Sea Plan area. However, the resolution of the fisheries and monitoring data currently do not enable allocation of the effort to a particular part of 3a.

Table A2. Overview of harbour porpoise strandings, necropsies, and bycatch determination for the North Sea (input provided by France, Belgium, The Netherlands, Germany, Sweden, and the United Kingdom, source ICES WGMME 2019, 2020; ICES WGBYC, 2020)

country	year	Area: ICES MU	Area: Sea	number of recorded strandings*	all stranded porpoises necropsied**	number of necropsied porpoises with: known cause of death	unknown cause of death	cause of death bycatch	% of strandings necropsied	% bycatch of: all stranded animals necropsied	all animals necropsied with known cause of death
FR	2013	NS	NS	313	1	1^	0	0	**0.3**	0	**0**
FR	2014	NS	NS	181	10	3^	7	3	**5.5**	30	**30**
FR	2015	NS	NS	131	6	5^	1	3	**4.6**	50	**60**
FR	2016	NS	NS	262	2	2^	0	1	**0.8**	50	**50**
FR	2017	NS	NS	168	1	1^	0	1	**0.6**	100	**100**
FR	2018	NS	NS	182	73	73	0	26	**40.1**	36	**36**
BE	2016	NS	NS	137	116˜	33^	83	21	**84.7**	18.1	**63.6**
BE	2017	NS	NS	94	85˜	25^	60	9	**90.4**	10.6	**36.0**
BE	2018	NS	NS	89	30	30	0	3	**33.7**	10	**10**
NL	2014	NS	NS	582	57	24	33	2***	**9.8**	3.5	**8.3**
NL	2015	NS	NS	309	32	28	4	1***	**10.4**	3.1	**3.6**
NL	2016	NS	NS	661	68	54	14	2***	**10.3**	2.9	**3.7**
NL	2018	NS	NS	476	57	57	0	7	**12.0**	12.3	**12.3**
DE	2015	NS	NS	109	109	-	-	3****	**100******	2.8	**2.8**
DE	2016	NS	NS	126	126	-	-	2****	**100******	1.6	**1.6**
DE	2017	NS	NS	91	91	-	-	5****	**100******	5.5	**5.5**
DE	2018	NS	NS	116	25	24	0	1	**21.6**	4.0	**4.0**
SE	2016	NS	NS	19	4	3	1	1	**21.1**	na	**na**
SE	2017	NS	NS	19	20	6	1	1	**30.0**	na	**na**
SE	2018	NS	NS							na	**na**
UK	2016	NS	NS	248	39	39	0	1	**15.7**	2.6	**2.6**
UK	2017	NS	NS	185	33	33	0	1	**17.8**	3.0	**3.0**
UK	2018	NS	NS	183	20	20	0	2	**10.9**	10.0	**10.0**

*some databases include live strandings that don't survive, partial finds of porpoises, and/or bones.
**where known, animals that were bycaught and brought in by fishermen were not included in the stranded data
*** cause of death code used: hpr - high probability of bycatch, pr - probable bycatch; animals considered possible bycatch not included
**** all strandings undergo a post mortem examination but not necessarily a full necropsy
^database includes animals with known cause of death that were not necropsied. These animals are not included here
^^Numbers not final
˜This includes animals where the cause of death was determined without a necropsy
na not applicable (as sample size too low to give a representative %)

Remarks (from data contributors):

- The percentage of animals stranded that are necropsied varies greatly between countries. The highest percentage is for Germany where all strandings undergo post mortem examination but may not receive a full necropsy, and Sweden where relatively few strandings are recorded. For the remainder, it is between 10 and 20%.
- Bycatch rates are similar for the UK and the NL. However, they are much higher for Belgium (and Sweden). These differences need explaining. The sample sizes for Sweden are too small to draw many conclusions.
- The ICES MU to which the data apply has been included but in the case of the UK, needs checking.
- The difference in numbers of recorded porpoise strandings between the UK and the Netherlands is striking, with many more in the NL despite its much shorter length of coastline.

APPENDIX II

Life history parameters of the harbour porpoise

Here, life history parameters of harbour porpoises in the North Sea and the greater north Atlantic has been summarised, largely based on reviews by Graham Pierce (presentation to the ASCOBANS North Sea group in 2018), Fiona Read (2016) and Sinead Murphy and others at the NAMMCO & IMR harbour porpoise workshop (2019).

In general, female harbour porpoises grow to be larger than males, and some differences in size seem to occur between areas/subpopulations, most notably porpoises off the Iberian Peninsula are larger than their conspecifics further north. Sexual maturity generally occurs between 2-5 years of age, but differs between sub-populations with ASM being lower in northern areas (for example Iceland and Greenland) than in the southern North Sea.

Harbour porpoises reproduce seasonally, with calving taking place during summer, in general between May and August but often with a peak in June or July, and conception soon after that, supporting the gestation period of between 10-11 months. The female lactates for 7-12 months, and can be simultaneously pregnant and lactating, sometimes giving birth to one calf each year. However, the pregnancy rate varies between areas, from around 0.4 in the northern North Sea and around Ireland to almost 1 in eastern Canada and Iceland. The seasonality of calving and lactation means that special attention should be paid to important areas for harbour porpoises during summer, when calving and mating takes place, as well as during autumn and winter when young calves are entirely dependent on their mothers for survival. During these times populations are likely extra sensitive to any disturbances which may influence the interaction between male and female during mating, and possibly even more important, the interaction between mother and calf during lactation.

Harbour porpoises have a rather short lifespan compared to many other cetacean species. They can live to be over 20 years old, but many do not live past the age of 12 (Lockyer and Kinze, 2003). In the German North Sea, females reach sexual maturity at around 4.95 years of age, and it is estimated that only approximately 55% of females live long enough to participate in reproduction (Kesselring et al., 2018, 2017). Given that the fertility of female harbour porpoises seem to be negatively impacted by PCBs (Murphy *et al*., 2015) and females often do not give birth to one calf each year, the overall reproduction rate may be cause for concern.

Concerning annual adult mortality, which has recently been discussed in relation to the MSFD bycatch indicator under D1, there are a few relevant studies available. For UK waters, Lockyer (1995) found the annual adult mortality to be 0.20 for males and 0.18 for females. Kinze (1990) estimated total annual adult mortality to 0.13 in Danish waters. Hammond *et al*. (2019) estimated annual natural mortality to 0.15 for age 0, 0.13 for age 1 and 0.09 for age 2+ years, based on Winship (2009).

In summary, we see a need for continued collection of samples and analysis of life history parameters in harbour porpoises in European waters, to increase sample sizes and follow any changes occurring. Also, assessments of life history parameters in relation to pollutant levels should be undertaken, for example, it should be investigated if the lower pregnancy rates found in some areas may partly be due to higher contaminant loads in those areas.

Table A3a. Variation in life history parameters for harbour porpoise across its North Atlantic range, males.

Area (years)	**Maximum length (cm)**	**Mean adult length (cm)**	**Mean adult weight (kg)**	**Maximum age (years)**	**Length at sexual maturity (cm)**	**Age at sexual maturity (years)**	**Length at physical maturity (cm)**	**Asymptotic length at physical maturity ± SE/SD (cm)***	**Asymptotic weight at physical maturity ± SE/SD (cm)***	**Age at physical maturity (years)**	**Males**
NWIP	189 (N=136)			19 (N=77)	151 (154-171) (N=47)	3.8 (N=47)	162 (N=47)			10 (N=47)	Read (2016)
Galicia, NW Spain	176 (N=27)			9	155	5					Lens (1997), Lopez (2003)
Portugal (1981-1994)	175 (N=15)										Sequeira (1996)
Scotland, northern North Sea (1992-2004)	170 (N=252)			20 (N=138)	132.2 (N=145)	5.0 (N=64)	151 (147-155)	147.2		~5	Learmonth et al. (2014)
Northern North Sea (2001-2003)	160			12	130-138	3.5-6					Pierce et al. (2005)
UK (1985-1994)	163 (N=114)	145		24 (N=114)	130-135 (N=114)	>3 (N=114)	145	145	50		Lockyer (1995; 2003)
Ireland (2001-2003)	157 (N=19)				4-8	131-146					Pierce et al. (2005)
Denmark (1938-1998)	167	145	50	23	130-135.5 (N=96)	3-4	145				Lockyer & Kinze (2003)
Kattegat/ Skagerrak (1988-1991)	163	141.6						142 (n=201)			Hedlund (2008)
Belt Sea								>130			Karstad et al. (1993)
The Netherlands	147 (N=5)			12.5 (N=2)							Pierce et al. (2005)
France (2001-2003)	165 (N=17)			14 (N=12)							Pierce et al. (2005)

Area (years)	**Maximum length (cm)**	**Mean adult length (cm)**	**Mean adult weight (kg)**	**Maximum age (years)**	**Length at sexual maturity (cm)**	**Age at sexual maturity (years)**	**Length at physical maturity (cm)**	**Asymptotic length at physical maturity ± SE/SD (cm)***	**Asymptotic weight at physical maturity ± SE/SD (cm)***	**Age at physical maturity (years)**	**Males**
West Greenland (1988-1989, 1995)	158 (N=91)	141.5		17 (N=91)	127 (123-130)(N=91)	2-2.45 (N=94)	141.5 ± 1.4	141.5 ± 1.4	51.177 ± 1.824		Lockyer et al. (2003)
Greenland				17? (sex not mentioned)		2.7 (1995, SE=0.03) 3.1 (2009, SE=0.08)					NAMMCO (2013)
Iceland (1991-1997)	165 (N=794)			16 (N=615)	135.6/135	1.9/2.6 /2.9	150	149.6	51.7		Ólafsdóttir et al. (2003)
Gulf of Maine (1989-93)	157			15*		>3 (3-4) (N=31)	143 ± 1.25			~5*	Read & Hohn (1995)
Canada, Bay of Fundy				17				144			Read & Hohn (1995), Read & Gaskin (1990)
Canada, eastern Newfoundland (1990-1991)	155.5				135.1 (SE=0.02)	3		142.9 (SE=1.2)			Richardson et al. (2003)
Southern North Sea (1955-~1975)	151					~5		~130-135			Van Utrecht (1978)
Faroe Islands				>10		5					NAMMCO & IMR (2019)

Table A3b. Variation in life history parameters for harbour porpoise across its North Atlantic range, females.

Area	Maximum length (cm)	Mean adult length (cm)	Mean adult weight (kg)	Maximum age (years)	Length at sexual maturity (cm)	Age at sexual maturity (years)	Length at physical maturity (cm)	Asymptotic length at physical maturity ± SE/SD (cm)*	Asymptotic weight at physical maturity ± SE/SD (cm)*	Age at physical maturity (years)	Females
NWIP	202 (n = 127)			18 (n = 71)	169 (161-202) (n = 60)	5.5 (n = 60)	185 (n = 60)			10 (n = 60)	Read (2016)
Galicia, NW Spain	202 (n = 38)			9	166 (n = 35)	3					Lopez (2003)
Portugal (1981-1994)	208 (n = 22)										Sequeira (1996)
Scotland, northern North Sea (1992-2004)	173 (n = 227)			20 (n = 132)	138.8 (n = 190)	4.35 (n = 111)	164 (157-171)	158.4		~5	Learmonth et al. (2014)
Northern North Sea (2001-2003)					>140	4.5 (CL ± 0.2886)					Pierce et al. (2005)
UK (1985-1994)	189 (n = 96)	160		22 (n = 96)	140-145	3	160	160	55		Lockyer (1995; 2003)
UK (1990-2012)						4.92					Murphy et al. (2015)
Ireland (2001-2003)	175 (N=27)			11 (N=21)	>140/>150	3.67 (CL±0.33) (Irish Sea)					Pierce et al. (2005)
Denmark (1938-1998)	189	160	65	23	143 (136-151) (n = 59)	3.5 (n=25)	160				Lockyer & Kinze (2003)
Kattegat/ Skagerrak (1988-1991)	171 (n = 232)	156.7				4.32 (3.76-4.87)		156 (n=201)			Hedlund (2008)
German North Sea and German Baltic Sea				19		4.95 (±0.6)					Kesselring et al (2017)
Belt Sea							153	152.4 (±5.5)			Karstad et al. (1993)
The Netherlands	160 (N=19)			12 (N=14)							Pierce et al. (2005)
France (2001-2003)	192 (N=14)			24 (N=9)							Pierce et al. (2005)

Area	Maximum length (cm)	Mean adult length (cm)	Mean adult weight (kg)	Maximum age (years)	Length at sexual maturity (cm)	Age at sexual maturity (years)	Length at physical maturity (cm)	Asymptotic length at physical maturity ± SE/SD (cm)*	Asymptotic weight at physical maturity ± SE/SD (cm)*	Age at physical maturity (years)	**Females**
West Greenland (1988-1989, 1995)	166 (n = 85)	154		12 (n = 85)	138-142 (n = 85)	2.95-3.63 (n = 84)	154 ± 2.6	154.0 ± 2.6	64.391 ± 1.960		Lockyer et al. (2001, 2003)
Greenland				17? (sex not mentioned)		3.7 (1995, SE=0.03) 3.5 (2009, SE=0.03					NAMMCO (2013)
Iceland (1991-1997)	174 (n = 474)			20 (n = 354)	138/147.6 /146	2.1/2.8/ 3.2/4.4	160	160.1	77.5 (including pregnant)		Ólafsdóttir et al. (2003)
Gulf of Maine (1989-93)	168			17*		3.36/3.15/3.27 (n=99)	158 ± 1.56			~7	Read & Hohn (1995)
Canada, Bay of Fundy				17		3.15-3.44		155			Read & Hohn (1995), Read & Gaskin (1990)
Canada, eastern Newfoundland	162				146.4 (SE=0.03)	3.1 (SE=0.07		156.3 (SE=2.9)			Richardson et al. (2003)
Southern North Sea (1955-~1975)	186					~6			~150		Van Utrecht (1978)
Southern North Sea (2001-2003)					>130	~5					Pierce et al. (2005)
Faroe Islands				>9		3					NAMMCO & IMR workshop (2019)

Table A3c. Variation in life history parameters for harbour porpoise across its North Atlantic range, calving and seasonality

Area	Annual Pregnancy rate	Ovulation rate/year	Gestation period (months)	Lactation period	Calving interval (years)	Calving season	Mean birth date	Mating season – Activity of mature males	Mating season – Ovulation/ conception period in females	Mean conception date in females	Newborn weight (kg)	Newborn length (cm)	Sex ratio in foetuses males: females	Calving and season-ality
NWIP	0.54 (n = 13)				1.89	May-Aug						85 (84.5-90)		Read (2016)
Scotland, northern North Sea (1992-2005)	0.34-0.4 0.42 (n = 33)		10-11 months	June-Nov			end May - end June	Apr-Jul		end July - early August	6.84	76.4		Learmonth et al. (2014)
UK (1985-1994)						June (May-Aug)					~5kg	65-70		Lockyer (1995; 2003)
UK (1990-2012)	0.50													Murphy et al. (2015)
Ireland (2001-2003)	0.4													Pierce et al. (2005)
Denmark (1938-1998)		0.61	10 months	>8 months	1.5	June (Mar-Aug)		June (May-Aug)/July -Sept		August	4.5-6.7	65-75 cm	1.1:1	Lockyer & Kinze (2003), Lockyer (2003)
Kattegat/ Skagerrak (1988-1991)	0.57	0.91 (0.65-1.18)												Hedlund (2008)
Belt Sea			10-11 months											Karstad et al. (1993)
West Greenland (1988-1989, 1995)		0.73/0.76 -1.38				late summer		Aug	Aug			70?		Lockyer et al. (2003)
Greenland					1 year									NAMMCO (2013)

Area	Annual Pregnancy rate	Ovulation rate/year	Gestation period (months)	Lactation period	Calving interval (years)	Calving season	Mean birth date	Mating season – Activity of mature males	Mating season – Ovulation/ conception period in females	Mean conception date in females	Newborn weight (kg)	Newborn length (cm)	Sex ratio in foetuses males: females	Calving and season-ality
Iceland (1991-1997)	0.98	0.98		≤7 months	1 year	June (May-July)	Mid June	Summer	June-Aug?	June-Aug?		75-80	1.2:1	Ólafsdóttir et al. (2003)
Gulf of Maine (1989-93)	0.93		10.6 months	8-12 months	~1 year	June-July		late June - early July	late June - early July			108 (SE=1.4)	0.93 (n = 14)	Read & Hohn (1995)
Canada, Bay of Fundy						May		late June						Read (1989)
Canada, eastern Newfoundland	0.83		10.8 months			Early June	Early June	July	Early July	July				Richardson et al. (2003) + unpublished data
Southern North Sea						May-Aug						74.3		Lockyer (2003)/Addink et al. (1995)/Pierce et al. (2005)
Northern North Sea (2001-2003)						June-July				July-Aug				Pierce et al. (2005)
German North Sea (1990-2000)							27 June (6 June - 16 July)							Hasselmeier et al (2004)
Southern North Sea (1955-~1975)			~11 months			peak in June							67-90 (n = 10)	Van Utrecht (1978)

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APPENDIX III

Diet of the harbour porpoise

The harbour porpoise in the North Atlantic feeds mainly on small shoaling fish from pelagic and demersal habitats, and in general it seems porpoises in any one area tend to feed on two-four main species of prey. There seems to have been a shift from clupeid fish species to sandeels and gadoids in some areas, which may be related to a decline in herring stocks during the 1960s (Santos and Pierce, 2003). While herring and sprat are rather high in energy, gadoids are less so, and such shifts in diet may influence the time that individuals have to spend foraging. Based on analyses of $\delta^{13}C$ and $\delta^{15}N$, Das and colleagues (Das *et al*., 2003) found that harbour porpoise in the southern North Sea has a slightly lower trophic position than harbour seal, grey seal, white beaked dolphin and cod, reflecting a higher proportion of zoo-planktivorous fishes in their diet compared to that of other top predators.

The table below summarises diet studies of harbour porpoises, mainly from the northeast Atlantic, but with some examples from other areas. Frequency of occurrence of prey species are ranked from 1-5 where 1 is the most important prey species in the respective study. In the northern North Sea (Scotland), the main prey species are whiting, sandeel, clupeids such as herring and sprat, as well as cephalopods. *Trisopterus* spp. and other gadoids also occur quite frequently, as well as mackerel in some cases. In the UK and southern North Sea, gobids are generally the most frequently occurring prey, together with sandeel and gadoids. Clupeids and cephalopods are also rather frequent.

In contrast, harbour porpoises further north, such as the Norwegian coast, Iceland and Greenland, have a rather large proportion of capelin in their diet, while porpoises in the Black Sea feed on gobids but also on flatfish such as flounder and dab, as well as whiting. Off the northwest Iberian Peninsula, gadiods such as *Trisopterus* spp, silvery pout and blue whiting seem to make up most of the prey together with gobids and sardines.

Table A4. Summary of diet studies for harbour porpoises. Frequency of occurrence of prey species are ranked from 1-5 where 1 is the most important prey species in the respective study

Area (sampling years)	**Sea area**	**n**	**Capelin** *Mallotus villosus*	*Clupeidae*	**Herring** *Clupea harrengus*	**Sprat** *Sprattus sprattus*	**Greater Argentine** *Argentina silus*	**Sardine** *Sardina pilchardus*	*Gadidae*	**Cod** *Gadus morhua*	**Whiting** *Merlangius merlangus*	**Haddock** *Melanogrammus*	**Blue whiting** *Micromesistius*	**Silver hake** *Merlucius bilinearis*	**Silvery pout** *Gadiculus argentus thori*	**Saithe**	**Scad** *Trachurus trachurus*	*Trisopterus spp.*	**Sandeel** *Ammodytidae sp.*	**Gobies** *Gobidae*	**Sand smelt** *Atherina presbyter*	**Sardines** *Sardina pilchardus*	**Hagfish** *Myxine glutinosa*	**Poorcod** *Trisopterus*	**Norway pout** *Trispoterus esmarkii*	**Pearlsides** *Maurolicus spp.*	**Sole** *Solea solea*	**Dab** *Limanda limanda*	**Flounder**	**Mackrel** *Scomber scumbrus*	**Redfish** *Sebastes*	**Atlantic horse mackerel** *Trachurus trachurus*	*Trachurus spp.*	**Snailfishes** *Liparidae*	*Zoarcidae*	*Urophysis spp.*	**Cephalopods**	**Reference**
Eastern Canada (1969-1972)	North Atlantic	81			1					3				4																2								Smith & Gaskin 1974
Bay of Fundy, Canada (1985-1987)	North Atlantic	127			1					3				2																								Recchia & Read 1989
Bay of Fundy, Gulf of Maine, Canada	North Atlantic				1									2												4										3		Gannon et al. 1998
Skjálfandi Bay, Iceland (2011-2012)	North Atlantic	28	1							2																								3				Koponen 2013
Iceland (1991-1997)	North Atlantic	1047	1		5				3										2												4							Víkingsson et al. 2003

Area (sampling years)	**Sea area**	**n**	**Capelin** *Mallotus villosus*	*Clupeidae*	**Herring** *Clupea harrengus*	**Sprat** *Sprattus sprattus*	**Greater Argentine** *Argentina silus*	**Sardine** *Sardina pilchardus*	*Gadidae*	**Cod** *Gadus morhua*	**Whiting** *Merlangius merlangus*	**Haddock** *Melanogrammus*	**Blue whiting** *Micromesistius*	**Silver hake** *Merlucius bilinearis*	**Silvery pout** *Gadiculus argentus thori*	**Saithe**	**Scad** *Trachurus trachurus*	*Trisopterus spp.*	**Sandeel** *Ammodytidae sp.*	**Gobies** *Gobidae*	**Sand smelt** *Atherina presbyter*	**Sardines** *Sardina pilchardus*	**Hagfish** *Myxine glutinosa*	**Poorcod** *Trisopterus*	**Norway pout** *Trispoterus esmarkii*	**Pearlsides** *Maurolicus spp.*	**Sole** *Solea solea*	**Dab** *Limanda limanda*	**Flounder**	**Mackrel** *Scomber scumbrus*	**Redfish** *Sebastes*	**Atlantic horse mackerel** *Trachurus trachurus*	*Trachurus spp.*	**Snailfishes** *Liparidae*	*Zoarcidae*	*Urophysis spp.*	**Cephalopods**	**Reference**
Norway (1985-1990)	North Sea/ North Atlantic	109	3		1		5									2								4														Aarefjord et al. 1995
Ireland (1992-2013)	Celtic Sea/ Atlantic			4							2							1																			3	data from Emer Rogan
Irish waters (1989-1994)	Celtic Sea/ Atlantic	26			2				1		1							1																				Rogan & Berrow 1996
Scotland (1959-1965)	North Sea/ North Atlantic	52			1	2				3	1																			3								Rae 1965
Scotland (1965-1971)	North Sea/ North Atlantic	41			2	4				4	1								3						4					5								Rae 1973
Scotland (1992-1996)	North Sea/ North Atlantic	72			2	4					1	4						3	1																		2	Santos 1998
Scotland (1992-2003)	North Sea/ North Atlantic	188							4		1							5	2																		3	Santos et al. 2004

Area (sampling years)	Netherlands (1989-1995)	Netherlands (2006-2014)	Netherlands (2005-2012)	German North Sea	UK	Scotland (1992-2010)
Sea area	North Sea	North Sea	North Sea	North Sea	North Sea	North Sea/ North Atlantic
n	62	829	74	34		
Capelin *Mallotus villosus*						
Clupeidae		4	2			
Herring *Clupea harrengus*						
Sprat *Sprattus sprattus*						
Greater Argentine *Argentina silus*						
Sardine *Sardina pilchardus*						
Gadidae		3	3		1	x
Cod *Gadus morhua*						x
Whiting *Merlangius merlangus*	1					1
Haddock *Melanogrammus*						x
Blue whiting *Micromesistius*						
Silver hake *Merlucius bilinearis*						
Silvery pout *Gadiculus argentus thori*						
Saithe						
Scad *Trachurus trachurus*						
Trisopterus spp.	5					
Sandeel *Ammodytidae sp.*	4	2	4	1	2	2
Gobies *Gobidae*	2	1	1		3	
Sand smelt *Atherina presbyter*						
Sardines *Sardina pilchardus*						
Hagfish *Myxine glutinosa*						
Poorcod *Trisopterus*						
Norway pout *Trispoterus esmarkii*						
Pearlsides *Maurolicus spp.*						
Sole *Solea solea*				2		
Dab *Limanda limanda*						
Flounder						
Mackrel *Scomber scumbrus*						
Redfish *Sebastes*						
Atlantic horse mackerel *Trachurus trachurus*						
Trachurus spp.						
Snailfishes *Liparidae*						
Zoarcidae						
Urophysis spp.						
Cephalopods	3	5				x
Reference	Santos 1998	Leopold 2015	Leopold et al. 2015	Benke et al. 1998	Martin 1996	Read et al. 2014

Area (sampling years)	Netherlands (2003-2014)	Belgium (1997-2011)	Southern North Sea (2010-2013)	France	Bay of Biscay, Channel, France (1988-2003)	Germany
Sea area	North Sea	North Sea	North Sea	North Sea	Channel/ Bay of Biscay	North Sea/ Baltic Sea
n	600	64	52	17	29	
Capelin *Mallotus villosus*						
Clupeidae	4	4				
Herring *Clupea harrengus*						
Sprat *Sprattus sprattus*			2			
Greater Argentine *Argentina silus*						
Sardine *Sardina pilchardus*						
Gadidae	3	3	5			3
Cod *Gadus morhua*						
Whiting *Merlangius merlangus*						
Haddock *Melanogrammus*						
Blue whiting *Micromesistius*				1	1	
Silver hake *Merlucius bilinearis*						
Silvery pout *Gadiculus argentus thori*						
Saithe						
Scad *Trachurus trachurus*				2		
Trisopterus spp.					2	
Sandeel *Ammodytidae sp.*	2	2	3			1
Gobies *Gobidae*	1	1	1		5	
Sand smelt *Atherina presbyter*			4			
Sardines *Sardina pilchardus*					3	
Hagfish *Myxine glutinosa*						
Poorcod *Trisopterus*						
Norway pout *Trispoterus esmarkii*						
Pearlsides *Maurolicus spp.*						
Sole *Solea solea*						2
Dab *Limanda limanda*						4
Flounder						
Mackrel *Scomber scumbrus*						
Redfish *Sebastes*						
Atlantic horse mackerel *Trachurus trachurus*					4	
Trachurus spp.						
Snailfishes *Liparidae*						
Zoarcidae						
Urophysis spp.						
Cephalopods					x	
Reference	Schelling et al. 2014	Haelters et al. 2012	Mahfouz et al. 2017	Desportes 1985	Spitz et al. 2006	Lick 1991 Lick 1993

Area (sampling years)	Kattegat/ Skagerrak (1989-1996)	Denmark/ Sweden (1985-1990)	Denmark	The Sound, Baltic Sea	Western Baltic (1980-2011)	German Baltic Sea
Sea area	Skagerrak/ Kattegat/	Skagerrak/ Kattegat/ Belt Sea	Skagerrak/ Kattegat/ Belt Sea	Kattegat/ Belt Sea	Western Baltic	Western Baltic
n	112	138		53	339	27
Capelin *Mallotus villosus*						
Clupeidae						
Herring *Clupea harrengus*	1 juv	1		2	4	2
Sprat *Sprattus sprattus*	juv	5		5	5	
Greater Argentine *Argentina silus*						
Sardine *Sardina pilchardus*						
Gadidae	x juv			4		
Cod *Gadus morhua*			1	1	1	3
Whiting *Merlangius merlangus*		2	1	5	2	
Haddock *Melanogrammus*						
Blue whiting *Micromesistius*						
Silver hake *Merlucius bilinearis*						
Silvery pout *Gadiculus argentus thori*						
Saithe						
Scad *Trachurus trachurus*						
Trisopterus spp.						
Sandeel *Ammodytidae sp.*	juv	4		5	5	
Gobies *Gobidae*	4 juv	3		3	3	1
Sand smelt *Atherina presbyter*						
Sardines *Sardina pilchardus*						
Hagfish *Myxine glutinosa*	2					
Poorcod *Trisopterus*						
Norway pout *Trispoterus esmarkii*	3					
Pearlsides *Maurolicus spp.*						
Sole *Solea solea*						
Dab *Limanda limanda*						
Flounder						
Mackrel *Scomber scumbrus*						
Redfish *Sebastes*						
Atlantic horse mackerel *Trachurus trachurus*						
Trachurus spp.						
Snailfishes *Liparidae*						
Zoarcidae						
Urophysis spp.						
Cephalopods						
Reference	Börjesson et al. 2003	Aarefjord et al. 1995	Källquist 1974	Sveegaard et al. 2012	Andreasen et al. 2017	Benke et al. 1998

Area (sampling years)	**Sea area**	**n**	**Capelin** *Mallotus villosus*	*Clupeidae*	**Herring** *Clupea harrengus*	**Sprat** *Sprattus sprattus*	**Greater Argentine** *Argentina silus*	**Sardine** *Sardina pilchardus*	*Gadidae*	**Cod** *Gadus morhua*	**Whiting** *Merlangius merlangus*	**Haddock** *Melanogrammus*	**Blue whiting** *Micromesistius*	**Silver hake** *Merlucius bilinearis*	**Silvery pout** *Gadiculus argentus thori*	**Saithe**	**Scad** *Trachurus trachurus*	*Trisopterus spp.*	**Sandeel** *Ammodytidae sp.*	**Gobies** *Gobidae*	**Sand smelt** *Atherina presbyter*	**Sardines** *Sardina pilchardus*	**Hagfish** *Myxine glutinosa*	**Poorcod** *Trisopterus*	**Norway pout** *Trispoterus esmarkii*	**Pearlsides** *Maurolicus spp.*	**Sole** *Solea solea*	**Dab** *Limanda limanda*	**Flounder**	**Mackrel** *Scomber scumbrus*	**Redfish** *Sebastes*	**Atlantic horse mackerel** *Trachurus trachurus*	*Trachurus spp.*	**Snailfishes** *Liparidae*	*Zoarcidae*	*Urophysis spp.*	**Cephalopods**	**Reference**
Western Baltic (2006-2008)	Western Baltic	75			4	5				1	3									2																		Ross et al. 2016
Baltic Proper (1960-1961)	Baltic Sea	50			2	1				3									5	4																		Lindroth 1962
Poland (1986-	Baltic Sea	27			1	2														3																		Malinga et al. 1997
Denmark (1989-1992)	North Sea/ Skagerrak/ Kattegat/ Belt Sea	58			3					5	1									4															2			Santos 1998
NWIP (1990-2010)	Bay of Biscay/ Iberian Peninsula								x				2				x	1		x													3					Read et al. 2014
Galicia (1991-1995)	Bay of Biscay/ Iberian Peninsula	6						2							2		1	3	3	3																		Santos 1998

Area (sampling years)	**Sea area**	**n**	**Capelin** *Mallotus villosus*	*Clupeidae*	**Herring** *Clupea harrengus*	**Sprat** *Sprattus sprattus*	**Greater Argentine** *Argentina silus*	**Sardine** *Sardina pilchardus*	*Gadidae*	**Cod** *Gadus morhua*	**Whiting** *Merlangius merlangus*	**Haddock** *Melanogrammus*	**Blue whiting** *Micromesistius*	**Silver hake** *Merlucius bilinearis*	**Silvery pout** *Gadiculus argentus thori*	**Saithe**	**Scad** *Trachurus trachurus*	*Trisopterus spp.*	**Sandeel** *Ammodytidae sp.*	**Gobies** *Gobidae*	**Sand smelt** *Atherina presbyter*	**Sardines** *Sardina pilchardus*	**Hagfish** *Myxine glutinosa*	**Poorcod** *Trisopterus*	**Norway pout** *Trispoterus esmarkii*	**Pearlsides** *Maurolicus spp.*	**Sole** *Solea solea*	**Dab** *Limanda limanda*	**Flounder**	**Mackrel** *Scomber scumbrus*	**Redfish** *Sebastes*	**Atlantic horse mackerel** *Trachurus trachurus*	*Trachurus spp.*	**Snailfishes** *Liparidae*	*Zoarcidae*	*Urophysis spp.*	**Cephalopods**	**Reference**
Black Sea	Black Sea	4000									4									1							3		2									Tsalkin, 1940, quoted from Tomilin 1957

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