Agenda Item 4.3	Species Action Plan Conservation Plan for Harbour Porpoises in the North Sea (North Sea Plan)
Document 4.3	Progress Report on the Conservation Plan for the Harbour Porpoise in the North Sea
Action Requested	Take note Provide feedback
Submitted by	Harbour Porpoise Coordinator

UNEP 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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Sea Watch Foundation and Coalition Clean Baltic

CONTENTS

The views and recommendations expressed in this report are the authors' own

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.

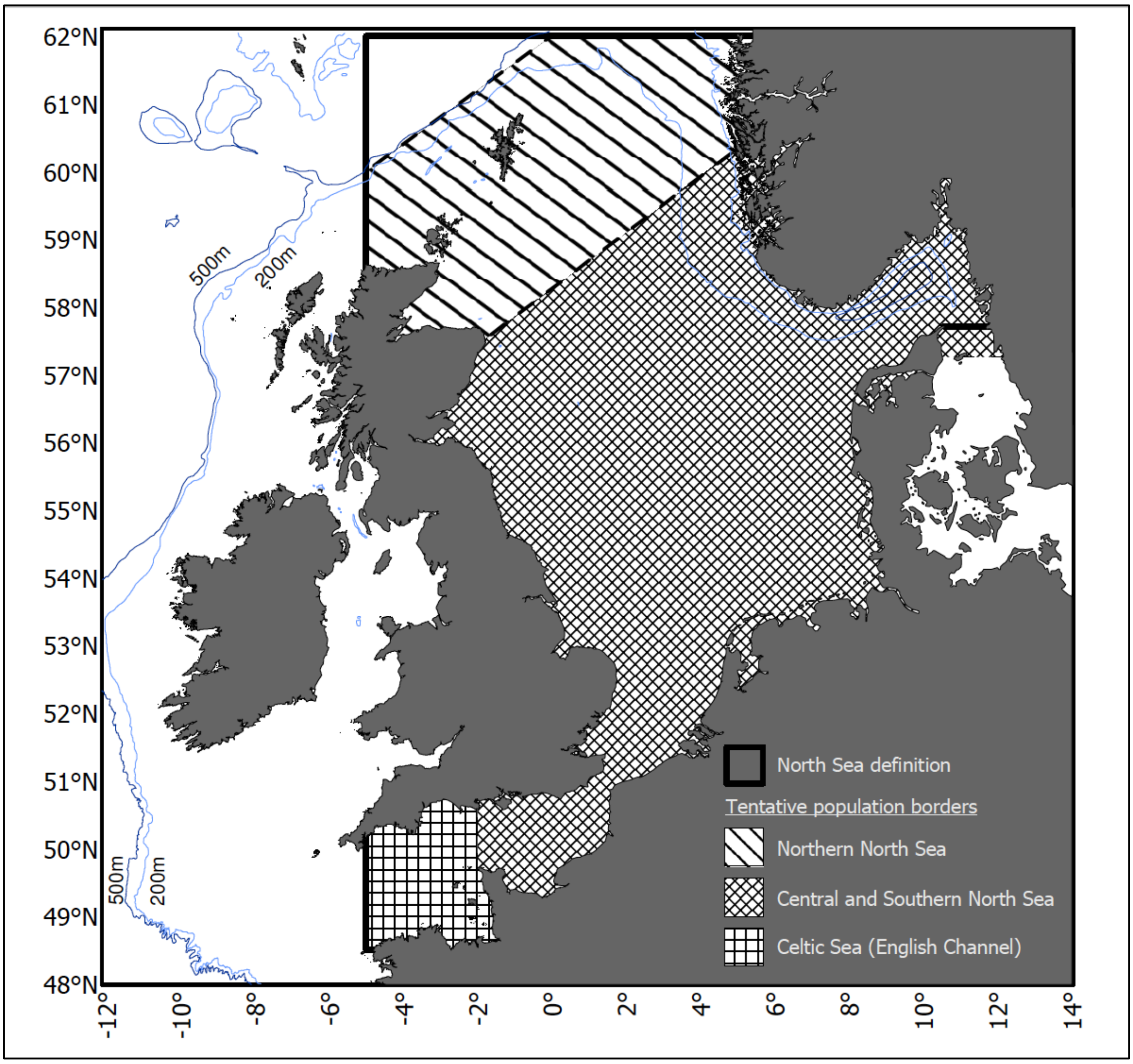


Figure 1. Area covered by the North Sea Conservation Plan (as defined at the 5th International Conference on the Protection of the North Sea in Bergen, Norway, 20 – 21 March 2002) showing the tentative harbour porpoise population borders (Source: ASCOBANS, 2009a)

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 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). The three other actions rated as 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 other actions in the form of an Implementation Table.

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 and has been re-elected at the 6th Meeting of the North Sea Group.

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.

ACTION 2 Implementation of existing regulations on bycatch of cetaceans

The main regulation on bycatch affecting harbour porpoise in the North Sea to date has been Council Regulation (EC) 812/2004 (hereafter Reg. 812/2004) which required at-sea observer schemes to monitor bycatch rates for vessels 15m or over and mitigation using acoustic deterrent devices 'pingers' for vessels exceeding 12m, 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. Table 1 summarises the extent of compliance from 2006-2017 in terms of report submissions from countries with EEZs within the North Sea region under consideration.

Table 1. Summary table of coastal EU Member States (MS) regarding the status of Reg. 812/2004 report submissions to the European Commission (Green = Yes for report with data on observer effort (either days at sea or other measurement, e.g. effort per haul or set); Pale grey = Yes for report with no data on observer effort (either days at sea or other measurement); Darker grey = As for pale grey but report only received in 2019; Orange = no report submitted; *** No Reg.812/2004 report but reports on cetacean bycatch observations made under DCF sent to the Commission. Some of this information was made available at the meeting; **** Data made available at the WGBYC meeting in 2019; (Source: ICES WGBYC 2019).

Coastal Member State of the EU	Monitoring (Art. 4-5)	Report Reg 812/2004 & effort data provided											
	Fishing in areas affected	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Germany DE	Yes									***			
France FR	Yes								****				
Ireland IE	Yes												
Netherlands NL	Yes											****	
United Kingdom UK	Yes												
Belgium BE	Yes												
Denmark DK	Yes												
Sweden SE	Yes								****	****		****	****

Generally, range states submit national reports to the European Commission on the implementation of reg. 812/2004 in June, summarising data collected in the previous year (Jan-Dec). The reports are available on request to the ICES WGBYC meeting in the following year; hence the 2019 WGBYC meeting reviewed reports summarising 2017 data. In some cases, (e.g. Sweden), the report had been made available to the ICES WGBYC meeting but not yet formally submitted to the EC. As noted by ICES WGBYC (2019), the quality and scope of the information provided in the annual reports continues to be variable, with some member states simply repeating the information provided in previous years.

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) for the purposes of meeting the requirements of Reg. 812/2004 and the EU Habitats Directive. 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 moving forward to protected species data collection under the EU-MAP (ICES WGBYC 2019) following the repeal of the Reg. 812/2004 which is replaced by Regulation EU 2019/1241 (hereafter the "technical measures regulation") on 14 August 2019.

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 *Although most EU Member States are submitting annual reports in relation to Reg. 812/2004, there is often a time delay and the content does not fulfil the objectives of providing reliable estimates of bycatch and instigating adequate mitigation measures to reduce bycatch. National reports should be consistent across countries with a comparable level of detail, and sufficient information on vessel numbers of all sizes actively operating different gears, and fully monitored vessels; the reports should be of easier access to the wider community which would allow greater scrutiny and should ultimately lead to improvements. Member States should ensure that the monitoring under the EU-MAP fulfils the requirements of environmental legislation such as the Marine Strategy Framework Directive and the Habitats Directive. Member States should also observe fully their obligations under these directives, and the resolutions adopted by Parties to ASCOBANS should be fully implemented.*

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

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 fisheries effort data for vessels below 10m, 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 2012, the German fleet (across all gear types and all areas fished) was estimated to total 1,551 vessels, of which 74% (1,150) were 10 m or less length (Masters, 2014).

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). Observer data on incidental catches from Danish gillnets have been collected under the Data Collection Regulation scheme (DCR). 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), however the REM monitoring data collected from 9 vessels in 2017 are currently being analysed.

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). 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 the country. All together there was 36 observed DaS and two harbour porpoises were 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.

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).

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 the **Netherlands**, of 850 vessels in 2012, 36% (308) were 10 m or less in length (Masters, 2014). In the Netherlands, an REM project has been running 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).

Clearly, overall, the great majority of the fleet is composed of vessels below 10m length and their fishing effort may be substantial. In the case of the **UK**, data from Masters (2014) indicate that the effort by vessels 10 m and below constitutes 53% of the total drift and fixed net effort, while the value of their landings represents 40% (Masters, 2014). There is monitoring of small vessels by some countries, for example the UK and Denmark (the latter by REM), and this should be extended to others.

Recreational fishing

Member States 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 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 (Desportes 2013). Good estimates of recreational effort are not available for any Member State in the North Sea (Desportes, 2014).

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 does not indicate whether the programme for collecting effort and bycatch data in recreational fisheries has been implemented.

Belgium is the only country annually reporting bycatch in recreational fisheries (and as such, known to the EU). Although Member States have not formally reported any initiatives towards the mitigation of harbour porpoise bycatch in recreational fisheries since the adoption of the Conservation Plan (Desportes, 2014), 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).

Reg. 812/2004 requires Member States to establish pilot/scientific studies of the <15 m sector of their fleet but this is largely ignored. Furthermore, as noted earlier, 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.

Key Conclusions and Recommendations *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) and the Netherlands (Scheidat et al. 2018). Attention needs to be paid across the region to more effective bycatch monitoring of these fisheries that, although required under Reg. 812/2004, is rarely implemented.*

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

Fishing effort in the North Sea has varied a great deal over the last 50 years. ICES (2018) estimate that, currently, around 6,600 fishing vessels from nine nations are active in the Greater North Sea (see Figure 2, for map of defined area) with an annual landing of about two million tonnes of fish compared with twice that amount in the 1970s (see Figure 3).

Since 2003, total fishing effort has declined (Figure 4). 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, 2018).

Denmark, Norway and the United Kingdom account for a high proportion of landings (Figure 3) although fishing effort is highest in the UK fleet (Figure 4). 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. 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 from ICES (2018).

The **English** fleet in the Greater North Sea has more than 1,120 vessels. Medium-size demersal trawlers (80 vessels, 18–24 m and 24–40 m) primarily target *Nephrops*, cod, and whiting. The small vessel (< 10 m) fleet (around 1,000 active vessels) operates in the eastern English Channel and coastal North Sea and catches a diversity of fish and shellfish species. Medium and large beam trawlers (about 40 vessels) account for the major share of the plaice landings. Three vessels (>50 m) operate in the pelagic fishery targeting mackerel, herring, and horse mackerel.

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 116 trawlers fish mainly for *Nephrops* in the North Sea: 37 of these vessels (<10 m) operate on the inshore grounds, while 79 (>10 m) operate over various offshore grounds. Pot or creel fishing is prosecuted by over 500 vessels (mostly <10 m) targeting lobsters and various crab species on harder inshore grounds. Scallop fishing is carried out by around 70 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 20 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. The largest fleet segments are gill- and trammel netters (10–18 m) targeting sole, demersal trawlers (12–24 m) catching a great diversity of fish and cephalopod species, and dredgers catching scallops. 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 is prosecuted by three active vessels catching herring, mackerel, and horse-mackerel.

The **Belgian** fishing fleet is composed of about 75 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 is the dominant species in value, and plaice the dominant species in volume. Other important species include lemon sole, turbot, anglerfish, rays, cod, shrimp, and scallops.

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. Many of these beam trawlers now use 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. Beam trawlers constitute the largest fleet component (around 180 vessels, 12–24 m) and target brown shrimp in the southern North Sea. Six large demersal trawlers (>40 m) target saithe in the northern North Sea (and in waters to the north of the North Sea). Several mid-sized otter trawlers and beam trawlers (24-40 m) target saithe, cod, sole, and plaice. Less than 10 vessels (mainly >40 m) operate in the North Sea pelagic and industrial fisheries that primarily target herring, but also catch horse mackerel, mackerel, sprat, and sandeel.

The **Danish** fleet comprises 1,400 vessels, of which 600 vessels operate in the Greater North Sea demersal fisheries. Smaller vessels (<12 m) constitute the greatest proportion of the fleet hence the importance for monitoring their potential bycatch impact upon harbour porpoise. The most important demersal fisheries target cod, plaice, saithe, northern shrimp, and Nephrops using bottom trawls and seines. The most important industrial and pelagic fisheries are prosecuted by around 30 large vessels (>40 m) and around 200 smaller (12–40 m) vessels; these fisheries target herring and mackerel for human consumption, and sandeel, sprat, and Norway pout for reduction purposes (i.e. fish meal and oils).

The **Swedish** fleet in the Greater North Sea comprises more than 500 vessels. The demersal fleet is highly diversified, catching several species in the Kattegat and Skagerrak, mainly *Nephrops*, northern shrimp, cod, witch, flounder, and saithe. The passive gear fleet is composed of around 400 vessels, of which 100 vessels (30 vessels of 10–18 m, 70 vessels <10 m) target *Nephrops*. The 16 vessels in the pelagic fleet target sprat, herring, and sandeel.

The **Norwegian** North Sea fleet is composed of about 1585 vessels. 85% of these catch demersal species, including fish, crustaceans, cephalopods, and elasmobranchs, and 30% catch pelagic species, including herring, blue whiting, mackerel, and sprat. Approximately 60% of the fleet targeting demersal species are small vessels (< 10 m) that operate near the Norwegian coast using traps, pots, and gillnets, catching crabs, squid, and several fish species. Medium-sized vessels (10–24 m) mainly target Nephrops and crabs using pots and traps, shrimp using trawls, and cod, saithe, ling, and monkfish using gillnets. The industrial fleet (5 vessels of 24–40 m; 25 vessels >40 m) target Norway pout and sandeel for reduction purposes. The offshore fleet (>40 m) is predominantly otter trawlers, but also includes seiners and longliners. Larger vessels (>24 m) account for most of the landings of saithe, ling, cod, tusk, hake, haddock, herring, blue whiting, mackerel, and sprat.

The **Faroe Islands** also fish in the Greater North Sea, but information is lacking on this fleet (ICES, 2018).

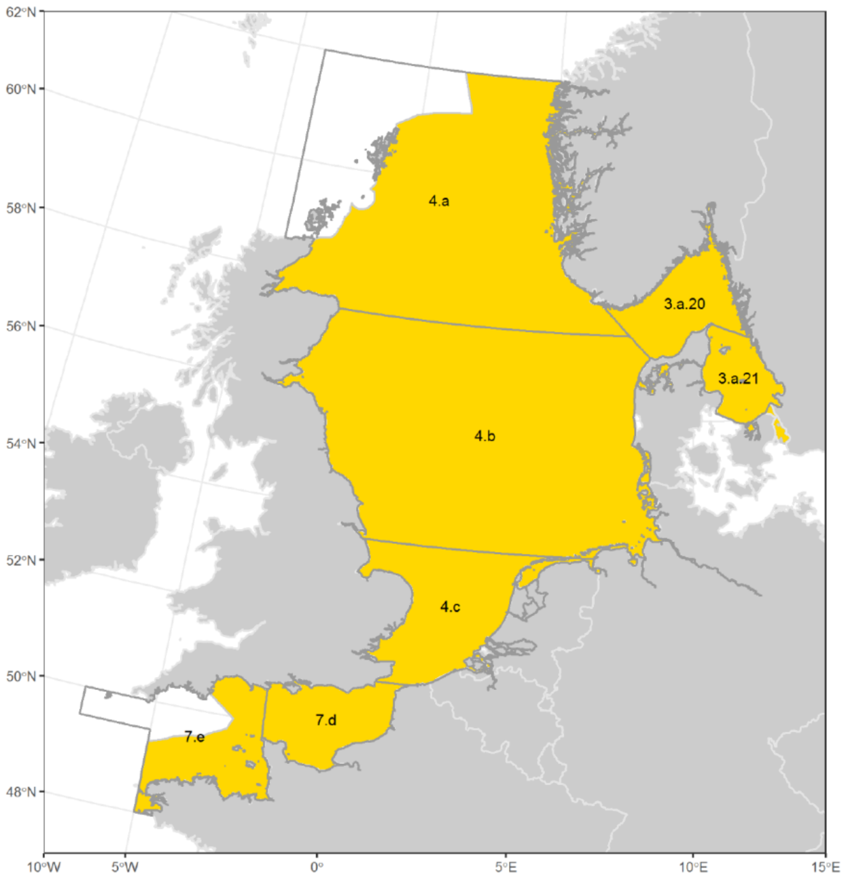


Figure 2. The Greater North Sea ecoregion (in yellow) as defined by ICES.
The relevant ICES statistical areas are shown (Source: ICES, 2018)

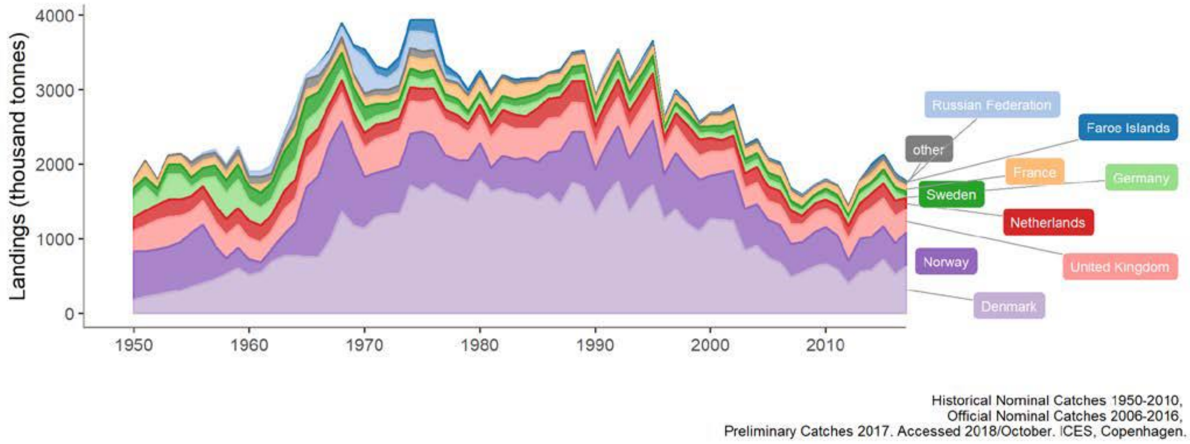


Figure 3. Landings (thousand tonnes) from the Greater North Sea in 1950–2017, by country. The nine countries having the highest landings are displayed separately and the remaining countries are aggregated and displayed as "other" (Source: ICES, 2018)

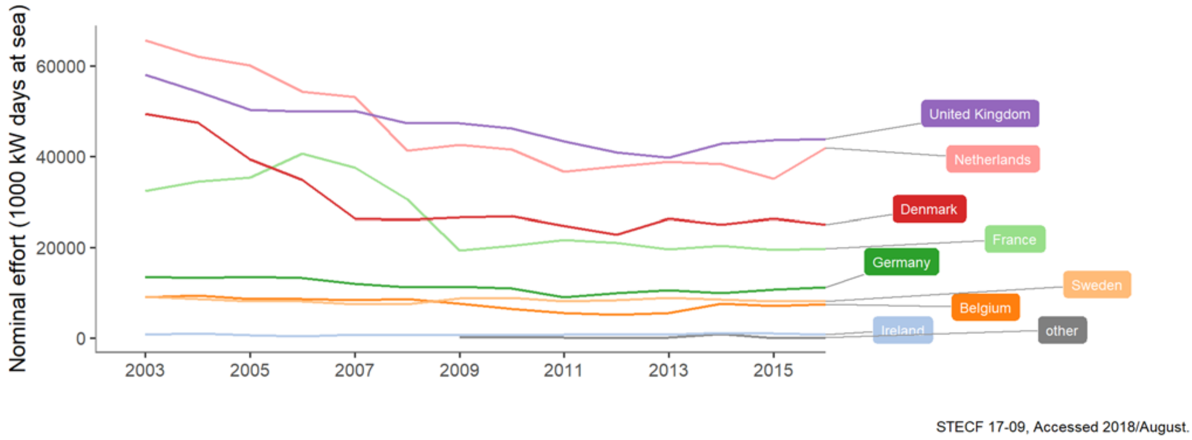


Figure 4. Greater North Sea fishing effort (thousand kW days at sea) in 2003–2017, by EU nation (Source: ICES, 2018)

The spatial distribution of fishing gear varies (Figure 5). Static gear is used most frequently in the English Channel, the eastern part of the Southern Bight, the Danish banks, and in the waters east of Shetland. Bottom trawls are used throughout the North Sea, with lower use in the shallower southern North Sea where beam trawls are most commonly used. Pelagic gears are used throughout the North Sea.

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. Landings from static gear in the North Sea have remained rather constant over the last ten years in contrast to pelagic trawling which has increased markedly recently (Figure 6). Small and medium-sized boats using static gear target flatfish and demersal fish.

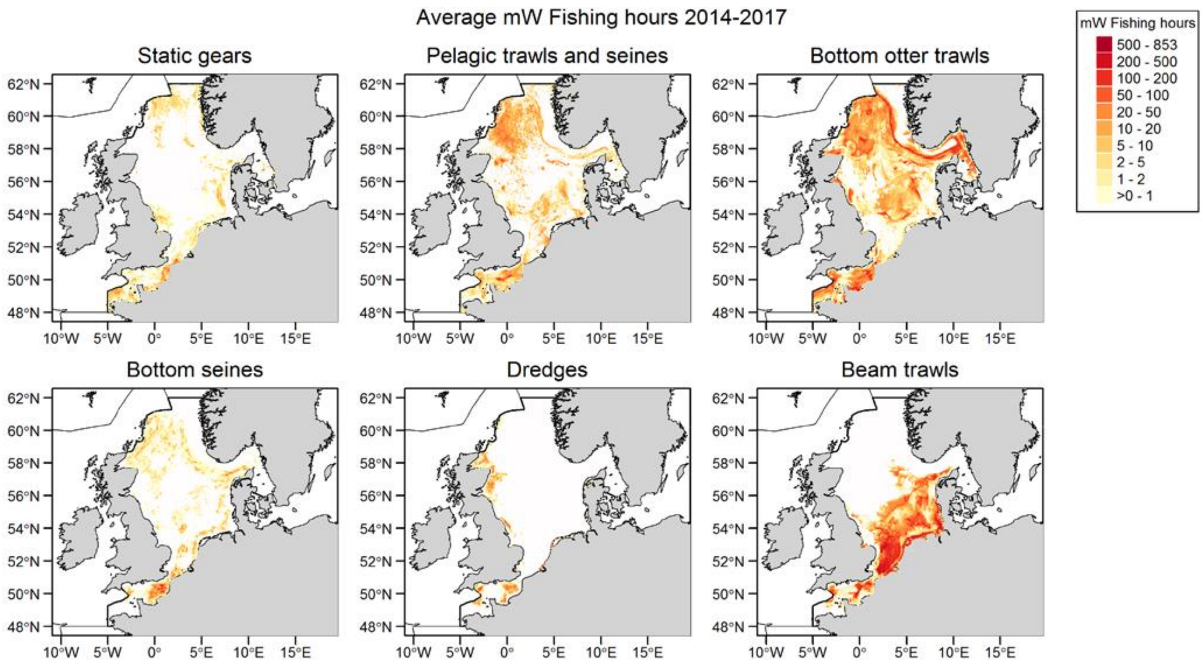


Figure 5. Spatial distribution of average annual fishing effort (mW fishing hours) in the Greater North Sea during 2014–2017, by gear type. Fishing effort data are only shown for vessels >12 m having vessel monitoring systems (VMS) (Source: ICES, 2018)

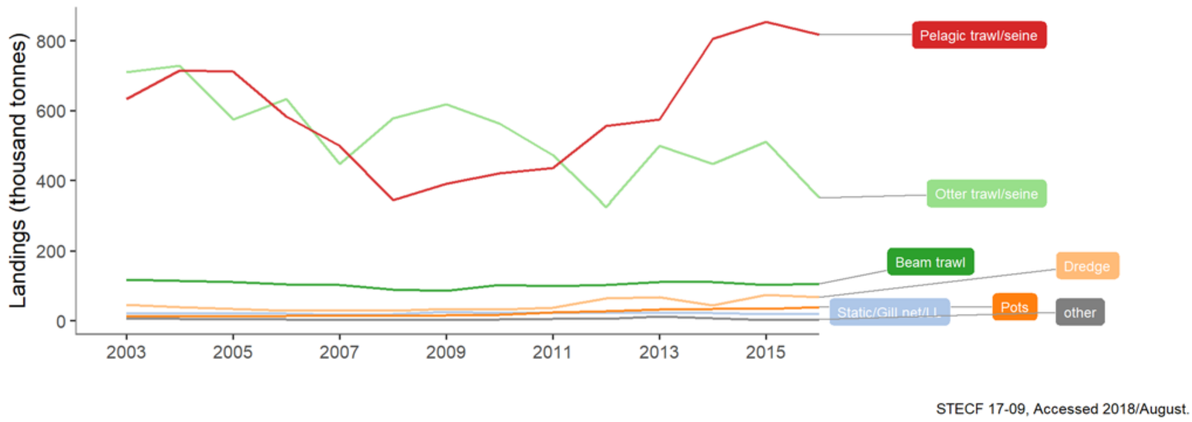


Figure 6. Commercial landings (thousand tonnes) from the Greater North Sea in 2003–2016, by gear type (LL = longline) (Source: ICES, 2018)

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

A detailed review of the implementation of Reg. 812/2004, and assessment of the bycatch issue is undertaken annually by the ICES Working Group on Bycatch of Protected Species (see, for example, ICES WGBYC, 2016, 2017, 2018, 2019). The last annual bycatch estimate, overall, for the Greater North Sea were between 1,175 and 2,126 porpoises in 2017 (ICES WGBYC, 2019). The summaries below are drawn from the latest ICES WGBYC report (2019).

United Kingdom has a dedicated protected species bycatch monitoring programme (PSBMP) for the purposes of meeting requirements of Reg. 812/2004 and the EU Habitats Directive. In 2017, the PSBMP conducted 217 dedicated bycatch monitoring days during 157 trips on board static net vessels. Five harbour porpoises were recorded bycaught, all in subarea 7. Additional monitoring data were also summarised from other fishery monitoring programmes, including 72 days in static net fisheries, with no cetacean bycatch recorded (ICES WGBYC 2019).

"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 will likely 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 2017 in all UK net fisheries in the absence of pingers is 1,282 animals (range:718 - 2402; CV=0.08), and if all over 12 m boats used pingers in relevant areas the estimate is 1,098 animals (range: 587-2615; CV=0.10) (ICES WGBYC 2019).

In **France,** the program OBSMER manages all the observations at sea as required by various fishery regulations. During 2017, a total of 701 trips and 855 fishing days 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).

*"In **Belgium,** no observer scheme was in place in 2017 to monitor bycatch of marine mammals. Fishing trips were only observed on board vessels with towed gear for the purposes of stock surveys and 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"* (ICES WGBYC 2019).

In 2017, 93 stranded harbour porpoises were recorded in Belgium (ICES area 4.c) - a much lower number than in 2016, but close to the 10-year average. The cause of death of the stranded animals was systematically established where possible. Of the 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 the **Netherlands**, the monitoring of all protected species bycatch is implemented in the new Data Collection Framework (DCF) since January 2017. During 10 fishing trips, 71 days and 210 hauls were observed in fleet segment NLD003 (pelagic fisheries in the period of 1 December till 31 March in ICES areas VI, VII and VIII), and 78 days and 192 hauls were observed in fleet segment NLD004 (Pelagic fishery in European waters during the year excluding the fishery in the period 1 December till 31 March in ICES areas IV, VII and VIII). With a total number of fleet days of 388 in fleet segment NLD003 and 776 in fleet segment NLD004, the coverage was 18.3% and 10.1% respectively. Thus, the target of the Pilot Monitoring Scheme (PMS) of 10% for NLD003 and 5% for NLD004 has been fulfilled. No porpoises were reported bycaught in the North Sea (ICES WGBYC 2019).

Ten percent of 53 porpoises necropsied in 2017 along the Dutch coast had cause of death attributed to bycatch (Netherlands 2017 National Report to ASCOBANS).

Germany monitored under the DCF observer programme, attempting to follow the requirements of Reg. 812/2004 as much as possible. No porpoises were reported as bycatch in the North Sea**.**

Denmark reported no specific monitoring programs for incidental bycatch of marine mammals during 2017 in the Danish pelagic trawl fishery, and neither was any specific monitoring according to the Regulation carried out in the Danish gillnet fishery. Instead, observer data on incidental catches of marine mammals from gillnets was collected under the Data Collection Regulation scheme (DCR). 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 addition, video monitoring continued in 2017 on board 9 different vessels fishing in areas 27.SD22-23 and 27.3a. The data have not yet been analysed.

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 trawl fisheries but also pot fisheries for crayfish. No cetacean bycatch was recorded in this monitoring programme.

A pilot project with on-board observers dedicated to observing bycatch of marine mammals in gillnet fisheries has been carried out in southern Sweden. In total, there were 36 observed DaS and two harbour porpoises were caught in Area 23 in large meshed gillnets. Total effort of gillnet fisheries were 19471 DaS. Due to the low monitored effort, no total by-catch numbers can be estimated (ICES WGBYC 2019).

In the Appendix, table A1 shows figures for the number of porpoises recorded bycaught in the North Sea from various observation schemes and table A2 shows data from stranding schemes for some countries bordering the North Sea.

Key Conclusions and Recommendations *Estimates of bycatch rates require extrapolation from sampling of a limited number of vessels (by visual observers or remote electronic monitoring) to entire fleets according to gear type. Besides issues of low sampling rate, there are problems over determining fishing effort in a way that will yield meaningful overall estimates. Days at sea have been the traditional metric for effort. For vessels above 15 m length, data on days at sea are mandatory; although not mandatory for vessels below this length, those data are often also available. Databases are also maintained by ICES and apply to all fishing vessels, with effort expressed in days at sea. 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 demonstrated clearly 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 spatio-temporal 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.

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. We sincerely hope that the consistency of bycatch data on the regional scale will be improved through the EU-MAP.

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

Acoustic deterrent devices such as pingers are a required mitigation measure for vessels of 12 m length or more operating relevant gillnet fisheries in any part of the North Sea (Table 2, Figure 7).

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

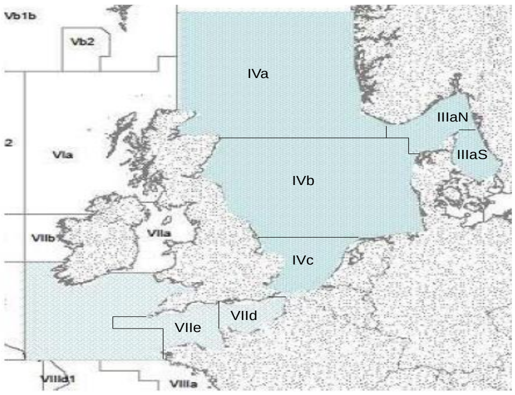


Table 2. Requirement for pinger use under Council Regulation (EC) 812/2004 in the North Sea
Figure 7. Pinger use - areas and gears regulated under CR (EC) 812/2004 in the North Sea, Skagerrak and Kattegat, and the Channel and Celtic Sea (ICES WGBYC, 2011)

Below is a summary of each country's progress in usage of pingers within their fleets. It has been compiled from the latest report of the ICES Working Group on Bycatch (ICES WGBYC, 2019).

In 2017, 24 **United Kingdom** registered vessels of ≥12m fished with gear types (bottom set-nets and entangling nets) and in areas specified as requiring acoustic deterrent devices under Reg. 812/2004. All relevant skippers are aware of the requirements of the Regulation. The 22 inspections carried out at sea by UK authorities in 2017, found a high level of compliance and only one warning was issued. These vessels represent just 2% of the UK's static net fleet in terms of vessel numbers, but were responsible for 13% of the total days at sea and 45% of landings by weight by the netting sector.

These vessels mainly use the DDD-03L pinger, authorized for use by the UK Government under derogation. Guidance for the correct deployment and use of these devices is provided by the UK's Marine Management Organisation, available at:
http://www.marinemanagement.org.uk/fisheries/monitoring/regulations_cetaceans.htm.
These pingers continue to be effective at reducing harbour porpoise bycatch; since 2008, observed bycatch rates in pingered nets are 83% lower than in unpingered nets. The effects of pingers, in terms of the number of porpoise deaths avoided by their use to comply with Reg. 812/2004, was explored: the current best estimate of porpoise bycatch in all UK gillnet fisheries ranges between 718 and 2,402 animals (best estimate 1,282; CV=0.08) in the absence of pingers, and between 587 and 2,615 animals (best estimate 1,098 CV=0.10) if all over 12 m boats used pingers in relevant areas. The effectiveness of these pingers for other cetacean species, such as common dolphin, is currently unknown due to low sample sizes precluding a statistically robust comparison (ICES WGBYC, 2019).

A project funded by Defra and undertaken by the Sea Mammal Research Unit has been investigating whether pingers and closed areas are useful tools to mitigate porpoise bycatch in Special Areas of Conservation (SACs). The aim is to better understand the impacts of pinger deployment within porpoise SACs and explore the value of closed areas as a measure to reduce harbour porpoise bycatch.

Rather than advocating the widespread use of pingers across the SACs, which could result in acoustic disturbance, this work aims to inform where the deployment of pingers would likely be of most benefit by evaluating the area of disturbance from pingers deployed under various scenarios within the SACs. Additionally, given that rates of bycatch are thought to be greater outside the SACs, the value of closed areas within the SACs will be evaluated in order to consider the implications of displacing fishing effort to areas of potentially higher bycatch. The outputs will be used by the Statutory Nature Conservation Bodies to inform fisheries management options for the SACs (UK 2018 National Report to ASCOBANS).

In **France** in 2017, 77 vessels operating in Subarea 7 were obliged to use pingers under Reg. 812/2004, but only 9 vessels operating with static gears (GNS-GTR) in subarea 7 deployed pingers (STM DDD03L). No studies were carried out in 2017 to evaluate the effect of pingers on cetacean bycatch.

The **Netherlands** reports that the use of pingers is obligatory in ICES Subarea 4 for vessels ≥12m in the period 1 August till 31 October, using nets that do not exceed 400 m length (the regulation intends to cover set nets worked on wrecks, where relatively short net lengths are being used). The vast majority of the Dutch set gillnet fleet fishes in this period for sole with much longer net fleets and meshes below 220mm. If some vessels are required to use pingers, this is not registered or known by government authorities, nor are the fishermen aware that they should use pingers. Most likely, no pingers are in use by Dutch gillnet fishers. However, the number of vessels larger that 12m fishing on wrecks, with nets that do not exceed 400m, is most likely very low, if not zero.

In 2017, **Germany** had fisheries operating in some of the areas listed in Annex I to Reg. 812/2004 where the use of pingers is mandatory. Fishing vessels use analog and digital pingers commercially available. In order to carry out compliance monitoring, the personnel of the competent federal and state authorities were equipped with Pinger Detector Amplifiers (Etec model PD1102) and trained accordingly. The detectors determine whether a pinger in the water actually emits its ultrasonic signals. The use of such detectors proves difficult in practice, since pinger signals can be masked by engine noise from control vessels. Also, the relevant legal norm (Article 2, paragraph 2, Reg. 812/2004) requires that the pingers only have to function at the time of deployment. It is therefore irrelevant to check nets already set, as possible violations could not be punished. The legal framework for the detection and prosecution of violations should therefore be further optimised.

The fishing gear listed in Annex I to Reg. 812/2004 was not used in the territories of the Länder of Lower Saxony and Bremen (North Sea) during the periods described in the Regulation and therefore no controls were carried out. During 2017, no activities of vessels requiring deterrent devices was seen in the coastal waters of Schleswig-Holstein in the North Sea (ICES WGBYC 2019).

In addition to the “regular” type of pingers, a new type of acoustic deterrent device (Porpoise Alert, PAL), has been developed and tested by the Thünen Institute of Baltic Sea Fisheries (Rostock) and F³:Forschung.Fakten.Fantasie (Kiel) since 2012. PALs operate by replicating the sounds of porpoises (synthesising aggressive click trains at 133 kHz) and were designed to serve as an alerting device rather than as a deterrent, by increasing the rate of echolocation in porpoises nearby (Culik et al., 2015a, b). To test their effectiveness, PAL devices were deployed on a small number of German and Danish commercial gillnet vessels while carrying out their normal fishing activities in the Baltic Sea. Trials in a Danish fishery using REM to monitor bycatch rates had indicated a 70% reduction when PALs were deployed (Culik et al., 2017), although the size of the effect was much less than with pingers. The device has also been tested in a Danish North Sea fishery but was found to have no positive effect there. Trials with PALs were also carried out in the Icelandic cod gillnet fishery in April 2018 (ICES WGBYC 2018). In a total of 98 sets hauled over one week, a total of 23 porpoises were caught. 12 of those in nets with PALs and 11 in the control nets, indicating no significant difference between the PAL sets and the controls. Interestingly, almost all the bycaught porpoises in the PAL sets (eleven out of twelve) were large adult males, while the gender ratio in the control sets was seven males and four females. Also, eight of the twelve porpoises caught in the PAL sets were found right by the PAL device, suggesting possible attraction of adult males towards the PAL devices. Reasons for the different results are unclear but it should be investigated further before deploying PALs in fisheries on a large scale. To date, there is no clear evidence that PAL operates as an alerting device. However, since spring 2017, 1,680 PALs have been deployed in gillnet fisheries in the German Baltic Sea (Schleswig-Holstein), but no monitoring is being carried out of this effort, to assess results and effects. A project is being planned in Germany, to start in 2021, to further investigate the signal used by the PALs and its effects on harbour porpoises.

In the whale sanctuary within the National Park Schleswig-Holstein Wadden Sea all kinds of gillnet fishery are prohibited within the 3nm zone (according to the "Landesverordnung zur Änderung der Landesverordnung über die Ausübung der Fischerei in den Küstengewässern vom 4. Dezember 2013"). Beyond the 3nm zone gillnet fishery in the whale sanctuary with nets exceeding a special height and mesh size (nets with a stretched span between bottomline and floatline higher than 1.30 m and a mesh size above 150 mm) is prohibited for German fishermen. It is envisaged that within the Wadden Sea sanctuary, there will be a total exclusion of set gillnet and trammel net fisheries within the 12 nm zone that shall be applied to all EU fishing vessels with access to waters under German sovereignty or jurisdiction (Germany 2017 National Report to ASCOBANS).

Currently, the STELLA project at the Thünen-Institute for Baltic Sea Fisheries, funded by the Federal Agency for Nature Conservation (BfN), is developing a holistic approach to minimize conflict between gillnet fisheries and nature conservation goals. One of the actions involves developing modified gillnets reducing bycatch of harbour porpoises (and birds). A simulation study determining the "ideal" object to enhance the acoustic reflectivity of gillnets has been carried out, and small acrylic glass spheres have been identified to create a rather strong echo is due to resonance effects at 130kHz. This has been confirmed in an experiment in a large acoustic tank. A prototype gillnet was equipped with the spheres (distance between spheres = 30cm) and echogram images were taken at 38 kHz and 120kHz of both the modified and a standard net. In the 120 kHz echogram the rows of spheres are clearly visible, while the standard netting is not visible at all. Floatline and leadline are visible for both nets. The next steps include a behavioural study of porpoises around the modified nets as well as a commercial trial of the modified gillnets (ICES WGBYC 2019).

In **Denmark**, a total of 22 Danish vessels were obliged to use pingers in 2017. In 3.d.24/3.c.22 only a few vessels are required to use pingers (2%), compared to 63% of the vessels operating in 3.a & 4. The pinger type "AQUAmark100" has generally been used in the Danish gill net fisheries. However, this pinger model is no longer available in Denmark, and the Danish Fishermen Association has informed that a 10 kHz pinger is the most widely used in Danish fisheries due to the option of changing the batteries. The 10 kHz pinger, however, does not have the same effect as the AquaMark 100, so the distance between these has to be 100 m. More studies on new devices are planned in collaboration with DTU Aqua and the fisheries organisations.

Monitoring of pingers is a mandatory part of the general inspection of gillnet vessels in Denmark. However, in 2017, the Danish fisheries inspection did not conduct any inspections. This is primarily due to a large organizational change and transfer of responsibility to another ministry (formerly the Ministry of Food, Agriculture and Fisheries, now the Ministry of Foreign Affairs). It is expected, that the Danish Fisheries Inspection Agency will conduct inspections again in 2019 at the same level as previous years. It is unclear if the European Commission has followed up on infringements of mandatory pinger use by vessels from other Member States, that have been reported by Denmark in previous years. It is noted that there is a need for trilateral communication with the Member States in question, that the Commission should lead on. The Commission should also ensure that any infringements are prosecuted.

Denmark has conducted two trials of mitigation measures since May 2018. One tested whether 3 kHz pingers from Future Oceans could reduce the depredation by cormorants on fish caught in pound nets. Preliminary results show that the mean dive time of cormorants inside the pound net was significantly shorter (79 s vs. 114 s) when pingers were deployed than in the control period. Further analyses are needed to determine if the shorter dive time results in reduced depredation. The second trial was a continuation of a controlled experiment conducted in early 2018, which tested if light (Fishtek NetLight prototype) or pingers (Future Oceans, 3 kHz) could reduce the amount of seabird bycatch in the cod gillnet fishery. The preliminary analyses showed no significant effects of lights or pingers on bycatch of seabirds. Development and testing of fishing gear as alternatives to gillnets for catching cod is also continuing. This includes both small-scale Danish seines, baited pots and Pontoon traps (ICES WGBYC 2019).

Sweden reported that the use of pingers as required under Reg. 812/2004 most likely is not being implemented in regulated fisheries in Sweden. However, in 2015 a project started with the purpose of implementing pingers on a voluntary basis. After discussions with fishermen, Banana pingers were chosen for the project. The fishermen feel the Banana pinger is easy to use and that the bycatch of harbour porpoises has decreased. The voluntarily pinger use has continued, and in 2017 nine fishermen used pingers voluntarily. Seven fishermen are using pingers in the lumpsucker gillnet fishery and three fishermen are using pingers in the cod gillnet fishery, all in ICES Divisions 3.21 and 3.23. The fishermen report their fishing effort and use of pingers to the Swedish University of Agriculture Science.

In the Swedish small-scale coastal fisheries, alternative fishing gear is still being developed. Examples of alternative gears under development are cod pots, fyke nets for cod, seine nets for flatfish, vendace and cod and trap-nets for cod. In 2017 to 2018 there has been an implementation project with the purpose of fulfilling the use of cod pots in the South Baltic Sea. Two fishermen are now fishing commercially with cod pots as an alternative to gillnets. (ICES WGBYC 2019).

Key Conclusions and Recommendations *Pingers are mandatory in certain gillnet fisheries in the North Sea for EU Member States. However, pinger use is not implemented in all countries, and the level of enforcement is very variable 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 whilst alternatives like PAL systems as developed in Germany need further investigation to establish their effectiveness in different situations. Development of alternative gears may be the most desirable long-term solution to porpoise bycatch.

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 recommend 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** has been working on developing 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. This development picks up from previous work of a similar nature presented to the IWC in 2005-2009 as part of the SCANS-II project that became stalled until recently. 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 is assumed to become available in 2022. 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 is entirely dependent on the conservation objectives; further work would be needed if the conservation objectives were different from those assumed (Hammond et al. 2019)

Other countries have not yet developed a similar management procedure approach for determining maximum allowable bycatch limits in the region. **Denmark** has focused upon implementing monitoring to show whether there was a bycatch problem. They consider environmental limits as important steps towards achieving zero bycatch, but they had to be understandable and achievable within a realistic time frame to help managers implement appropriate bycatch mitigation measures. They believe that the need for improved population estimates and better bycatch data are priorities, along with a consideration for whether marine protected areas were the best approach to protecting highly mobile species like the porpoise.

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.

Key Conclusions and Recommendations *There remains a debate as to what society should set as conservation objectives. The RLA approach developed within the UK 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 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. Bearing in mind those caveats, it is believed that current levels of bycatch in the North Sea are not causing serious depletion of the harbour porpoise population.*

A continuing discussion should take place amongst Member States to attempt to arrive at consistent and well-defined conservation objectives across the region, and the setting of environmental limits and triggers over a practical time scale, with further consideration of the utility of the RLA approach bearing in mind a number of uncertainties. This discussion is crucial for answering the questions on levels for Good environmental status (GES) under the EU Marine Strategy Framework Directive, as well as Favourable Conservation Values under the EU Habitats 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 8), and 2) the DEPONS Project where aerial surveys were undertaken annually in spring, summer and autumn in the southern North Sea across the EEZs of Belgium, the Netherlands, Germany, and Denmark (Gilles *et al*., 2016; Peschko *et al*., 2016).

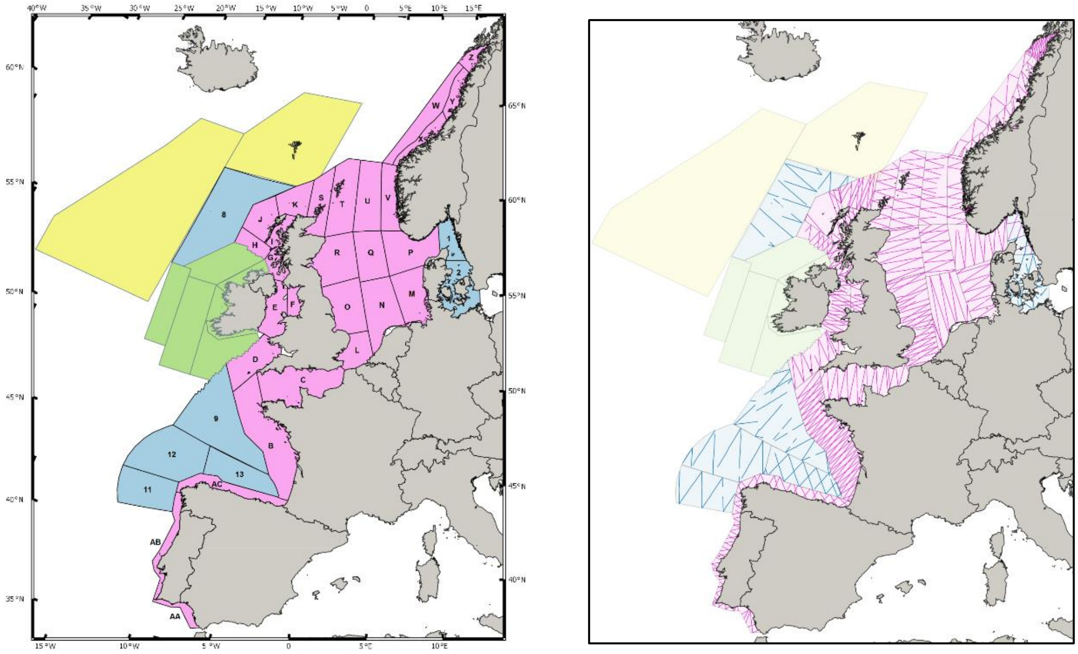


Figure 8. Area covered by SCANS-III and adjacent surveys. SCANS-III: pink lettered blocks were surveyed by air; blue numbered blocks were surveyed by ship. Blocks coloured green to the south and west of Ireland were surveyed by the Irish ObSERVE project. Blocks coloured yellow were surveyed by the Faroe Islands as part of the North Atlantic Sightings Survey in 2015 (Source: Hammond *et al*., 2017)

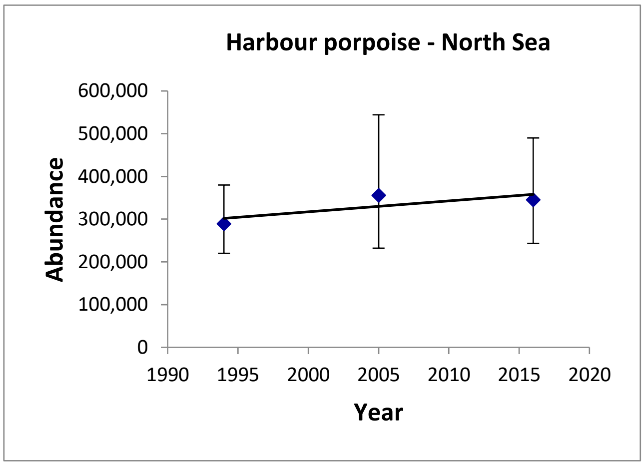


Figure 9. Estimates of abundance (error bars are log-normal 95% confidence intervals) for harbour porpoise in the North Sea Assessment Unit. Trend lines are fitted to time series of more than two abundance estimates (Source: Hammond *et al.*, 2017)

The SCANS III survey in July 2016 yielded an abundance estimate of 345,373 porpoises (CV=0.18) 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 9).

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 in 2017 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), 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) is clear, and is confirmed by 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).

Belgium, the **Netherlands**, **Germany** and **Denmark** have continued national monitoring with aerial surveys of the southern North Sea on an annual basis, but 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.

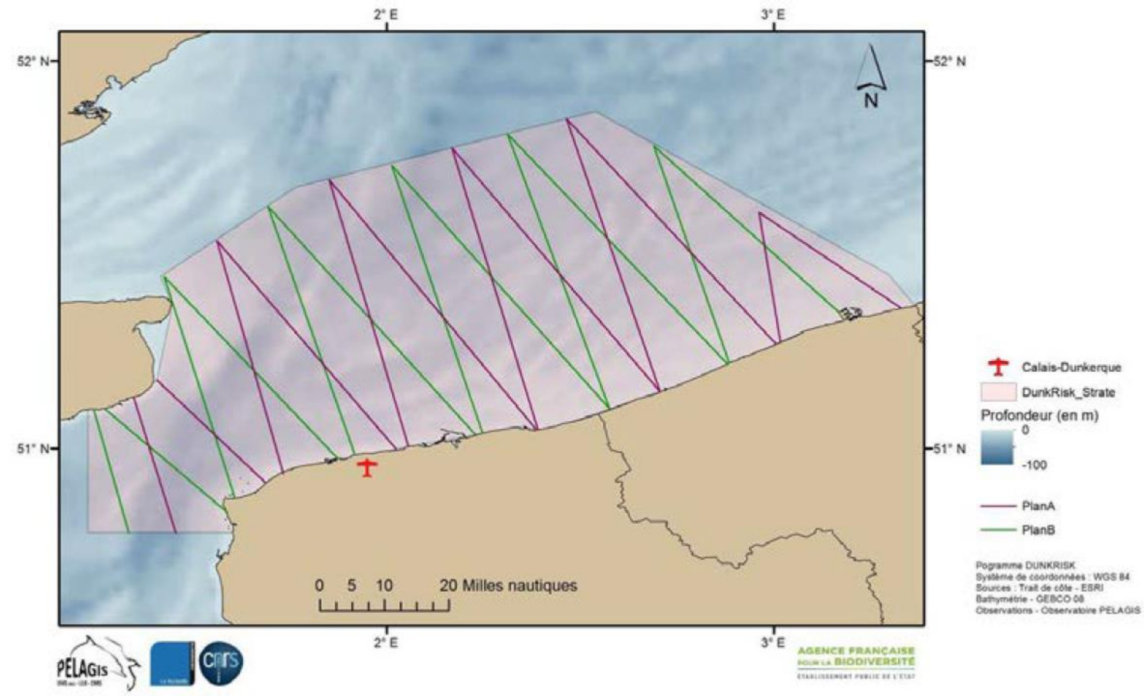


Figure 10. PELAGIS Project Aerial Surveys undertaken by France during 2017-2018
(Source: ICES WGMME, 2018)

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). 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 10). The results show the importance of the eastern part of the Channel for porpoises, although there were strong seasonal differences both in distribution and relative abundance (Figure 11, 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**	**August 2017**	**December 2017**	**March 2018**	**May 2018**
Harbour porpoise	315	100	35	202	147	321

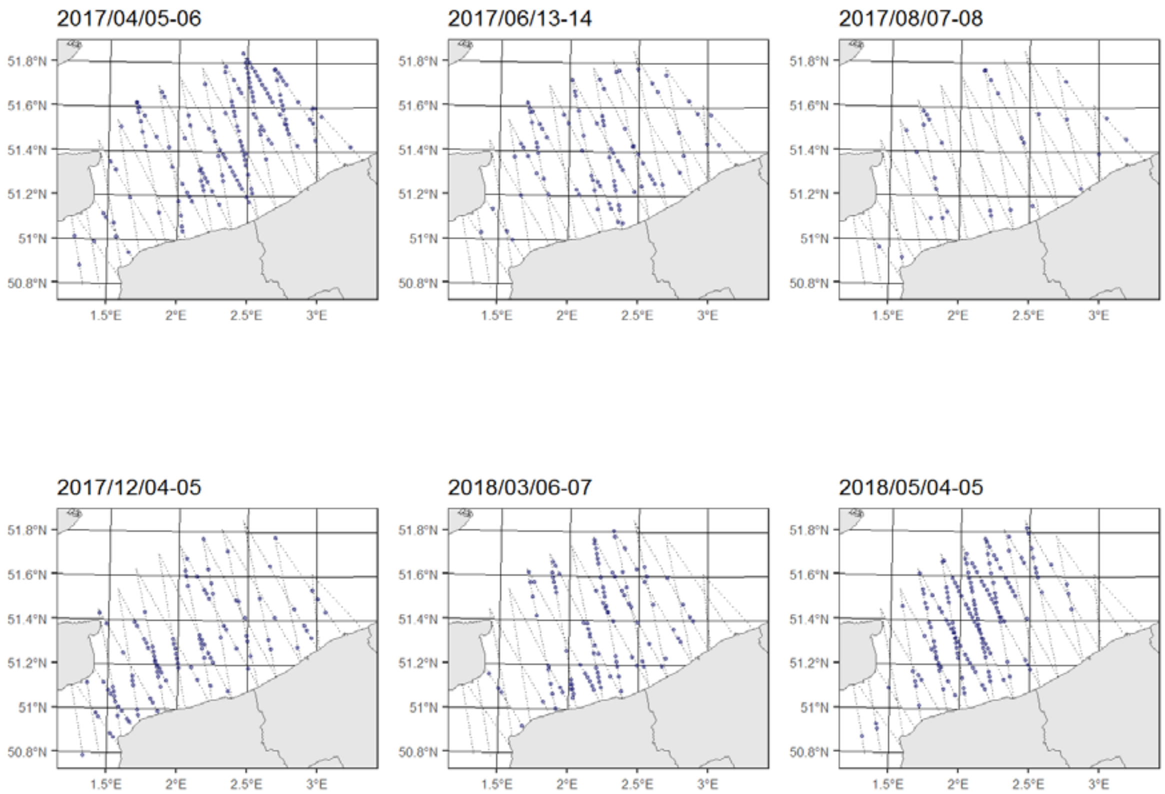


Figure 11. Observations of harbour porpoises from the PELAGIS Project Aerial Surveys undertaken by France in the eastern Channel during 2017–2018. Dotted lines are the transect lines, and blue dots are the detections of harbour porpoises. (Source: ICES WGMME 2019)

In the **Netherlands**, Geelhoed & Scheidat (2018) analysed the results of their aerial surveys across the Dutch EEZ (Figure 12) for the years 2012-2017. Maps of porpoise distributions for each of those years are shown in Figure 13. 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 Isles 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 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, the entire Dutch Continental Shelf was again surveyed along the same pre-determined track lines, resulting in a total distance of 3039.8 km 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) Neither the DCS abundance estimate, nor the abundance estimates per subarea show a trend (ICES WGMME 2019). The harbour porpoise distribution from this survey is shown in Figure 14.

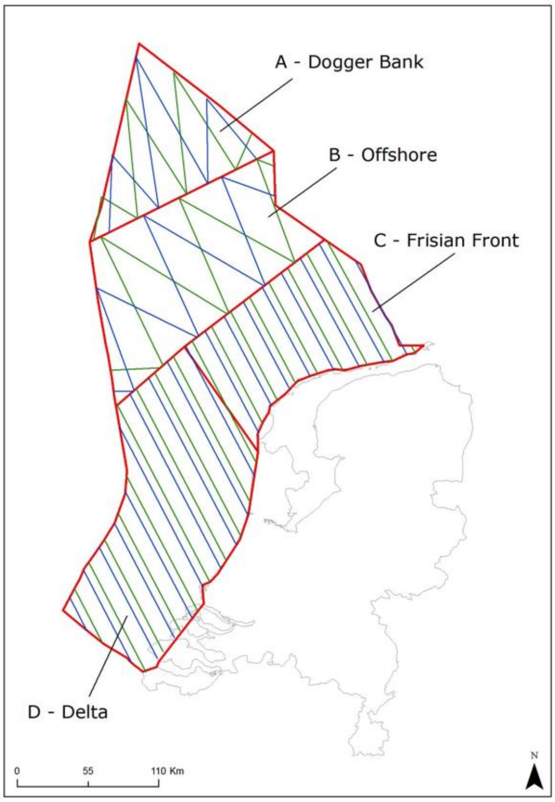


Figure 12. Map of the Dutch Continental Shelf with the planned track lines in study areas A – Dogger Bank, B – Offshore, C – Frisian Front and D – Delta. Colours indicate sets of track lines (Source: Geelhoed & Scheidat, 2018)

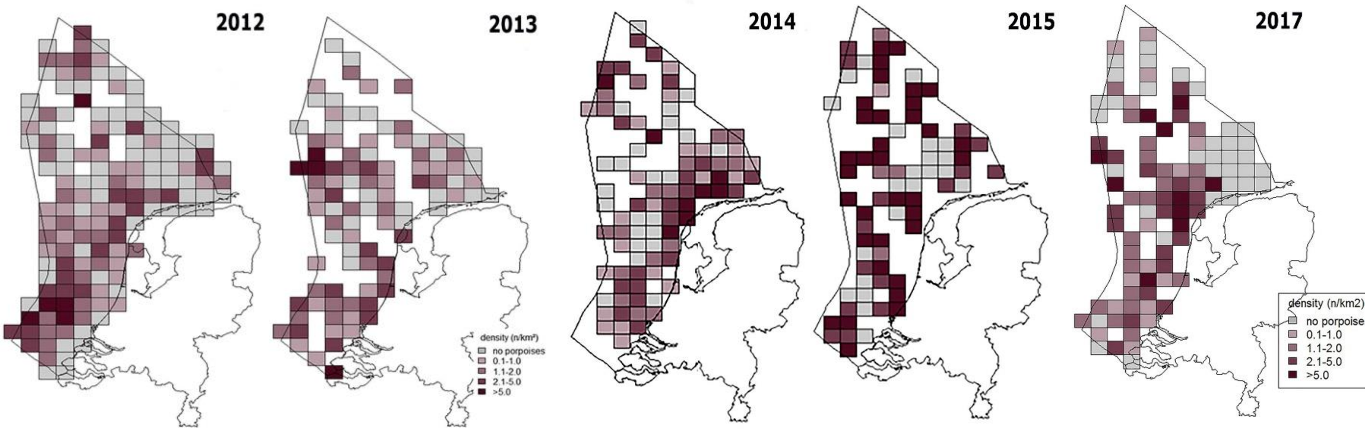


Figure 13. Density distribution of harbour porpoises (animals/km²) per 1/9 ICES grid cell, spring 2012 to 2017. Grid cells with low effort (<1 km^2) are omitted (Source: Geelhoed & Scheidat 2018)

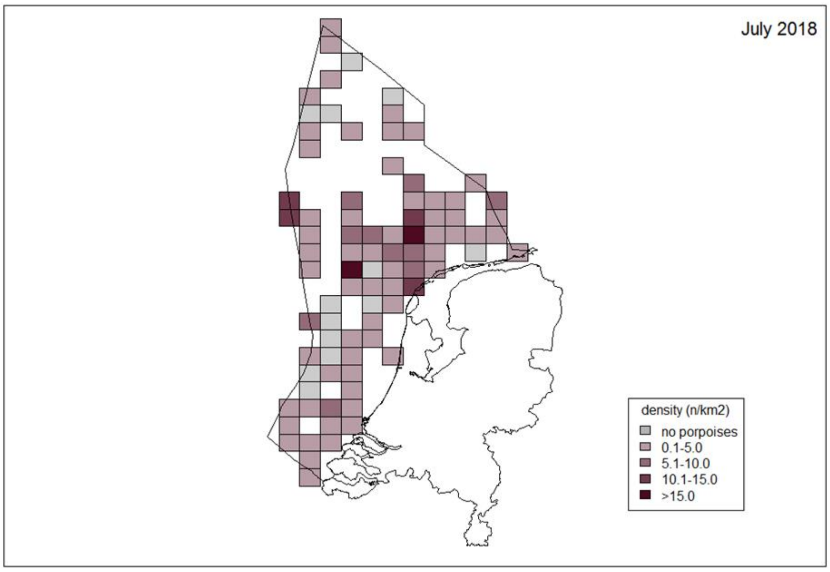


Figure 14. Density distribution of harbour porpoises (animals/km²) per 1/9 ICES grid cell, July 2018. Grid cells with low effort (<1 km^2) are omitted (Source: ICES WGMME 2019)

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 (Figure 15, ICES WGMME 2019).

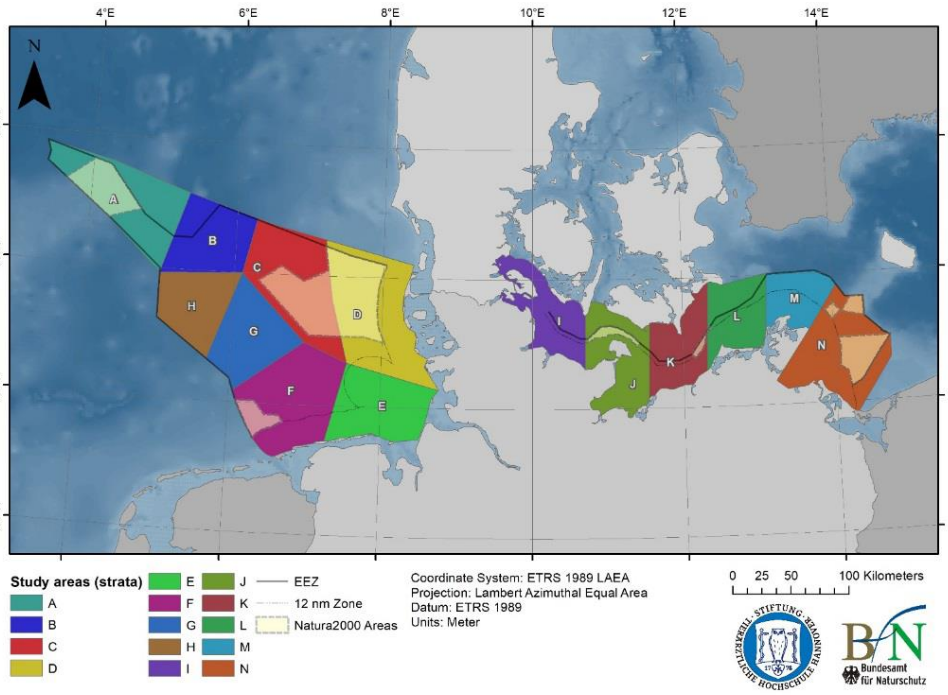
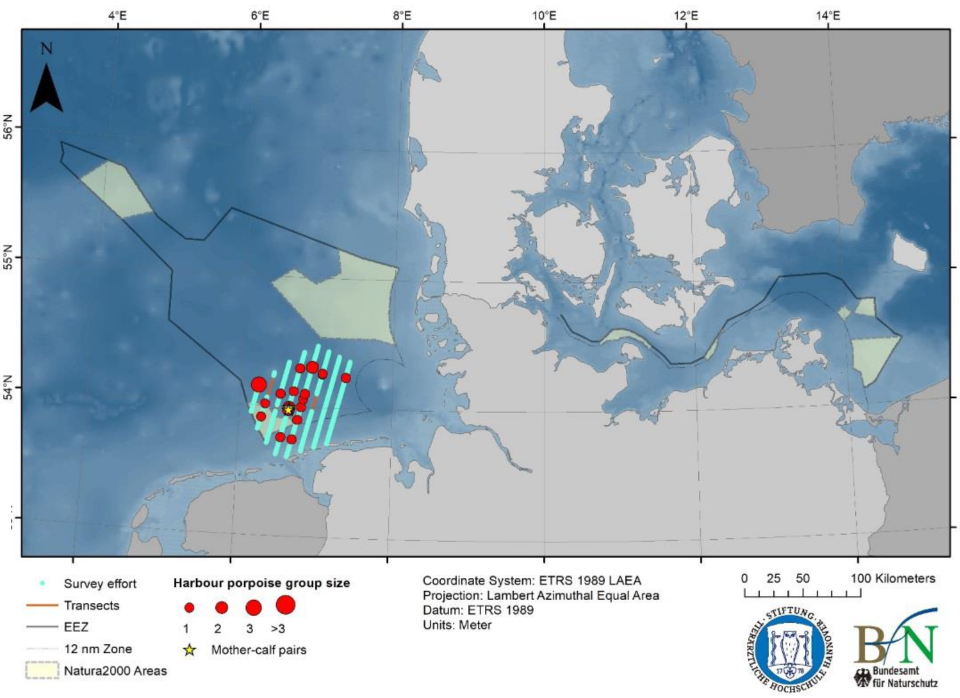
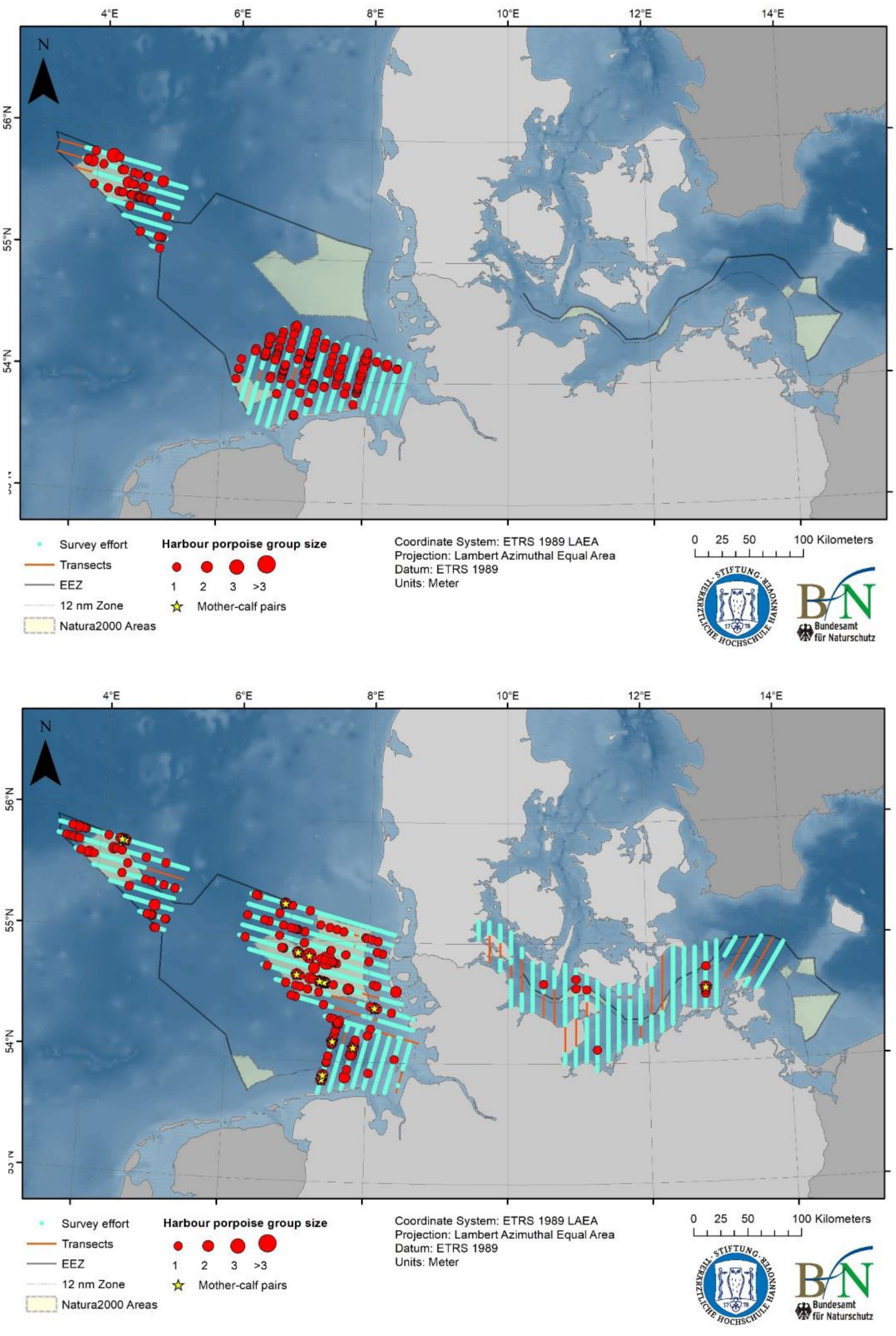


Figure 15. Newly designated study areas for the visual monitoring of harbour porpoises in the German North and Baltic Sea.

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 (Figure 15a). 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, Figure 15b). 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, Figure 15c).

a





b

c.

Figure 14. Survey effort and harbour porpoise sightings during aerial surveys in the German North and Baltic Sea during a) spring 2017, b) spring 2018 and c) summer 2018. Harbour porpoise group sizes are indicated using group size dependent red circles; yellow stars mark mother-calf pairs; red lines indicate transect lines that were not covered though planned; blue lines indicate covered transect lines (i.e. survey effort). (Source: ICES WGMME, 2019)

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 2862 (95%CI: 1175–4656) animals, at 0.44 (0.19–0.76) animals/km². In spring and summer 2018, the German North Sea was not entirely covered, allowing abundance and density estimates only for the individual areas (Table 6, ICES WGMME 2019).

In **Belgium**, the RBINS project completed three aerial surveys 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 time). The animals were not evenly distributed, with very high densities (over 15 animals/km²) between the Westhinder anchorage area and the Norhthinder 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).

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 2017 the survey was carried out in August. In the Skagerrak area (Figure 15a) a total of 67 porpoises were observed in groups of up to 6 individuals. The average group size was 2.1 which is larger than the previous years when group size has been around 1.3. In the North Sea area (Figure 15b) 39 porpoises were observed, with an average group size of 1.08. In this area three calves were observed.

In 2015 and 2017 densities in the North Sea area (Figure 16a) are significantly lower than previous years, while densities in the Skagerrak area (Figure 16b) are roughly the same.

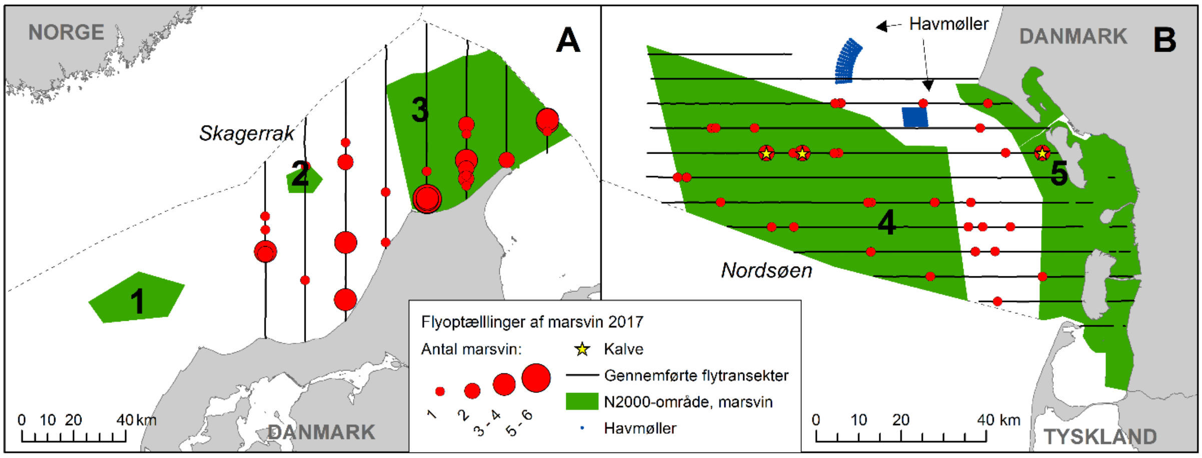


Figure 15. Aerial surveys of harbour porpoises in A) Skagerrak on 23 Aug 2017 and B) the North Sea on 26 Aug 2017. The green areas indicate Natura 2000 areas 1) Gule Rev, 2) Store Rev, 3) Skagens Gren og Skagerrak, 4) Sydlige Nordsø og 5) Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde. Number of porpoises observed are shown by the size of the red dots and yellow stars indicate that calves were seen. Blue areas indicate offshore windfarms.

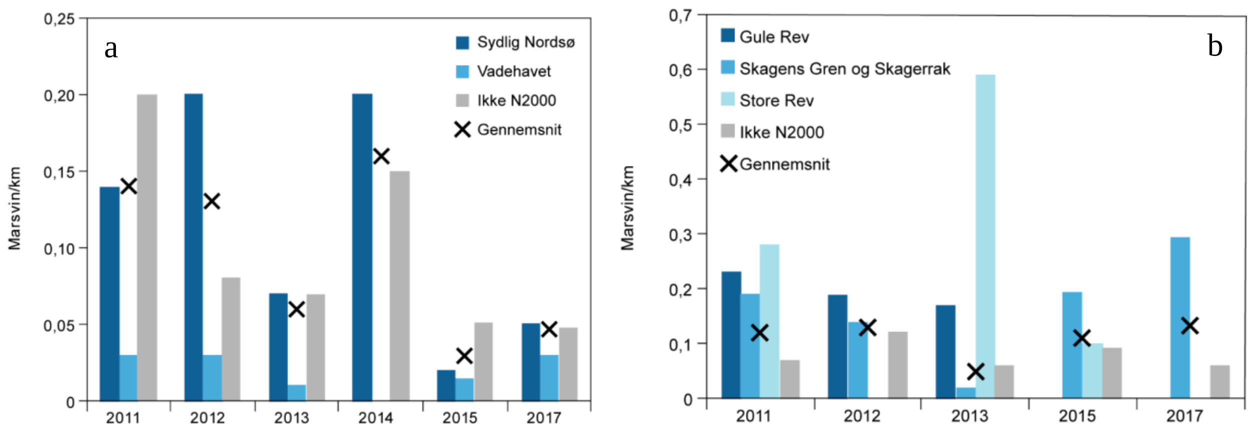


Figure 16. Density of harbour porpoises recorded within (blue shades) and outside (grey) Natura 2000 areas during aerial surveys in Danish waters in August 2017. Averages shown with black x.

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. 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. January and July summaries of harbour porpoise distribution are shown in Figure 17. These highlight the importance of the North Sea for harbour porpoise in the context of NW European shelf seas.

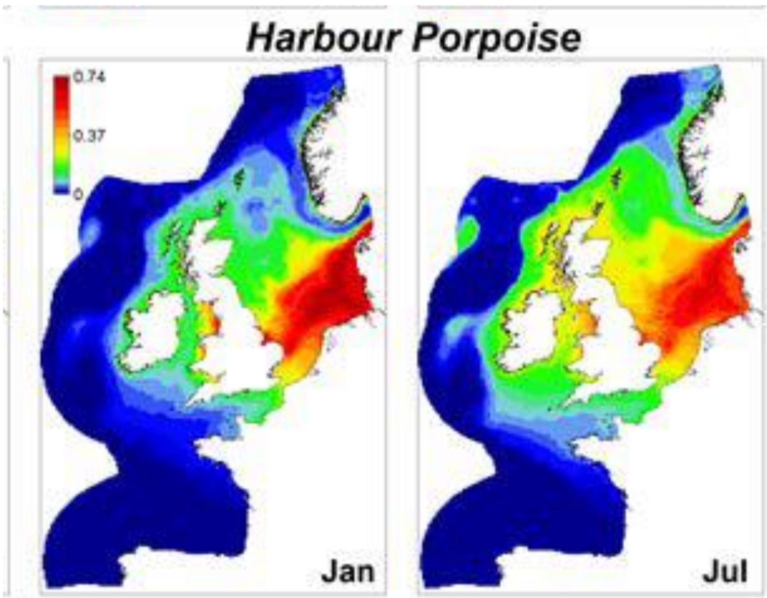


Figure 17. Predicted average January and July densities (animals per km2) for harbour porpoises (Source: Marine Ecosystems Research Programme)

Figure 18 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).

Model based abundance estimates for the North Sea indicated a general declining trend between the mid-1980s and mid-2000s but more widely varying values since then with no obvious trend (Figure 19). These results are preliminary and further refinements continue.

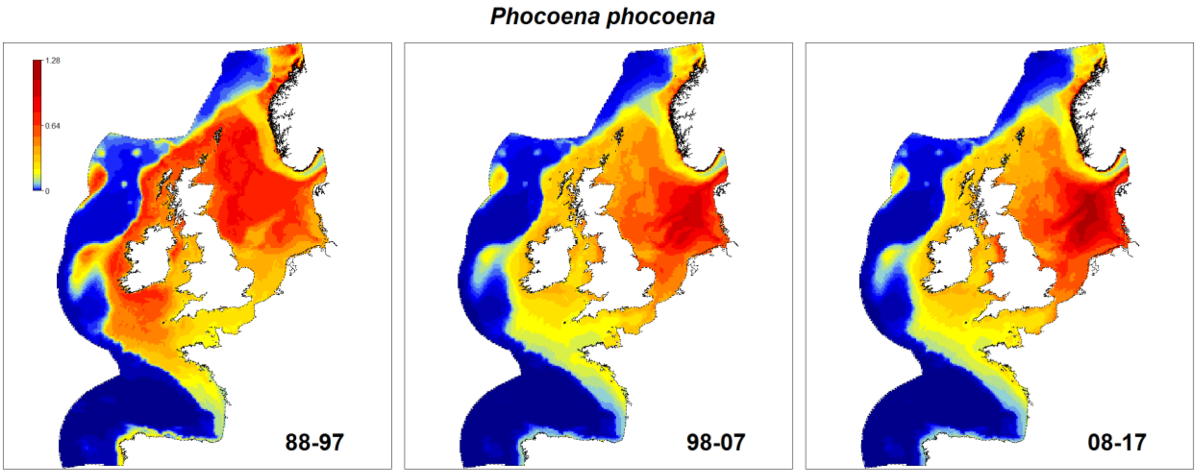


Figure 18. Modelled average density distributions of harbour porpoise by time period (Source: Marine Ecosystems Research Programme)

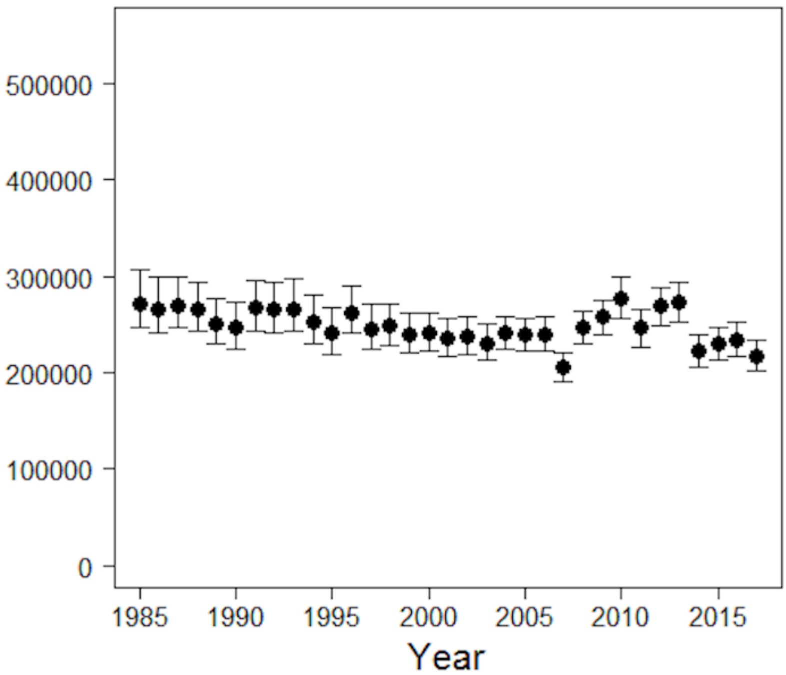


Figure 19. Estimated harbour porpoise population sizes in the North Sea, averaged across months, for each year from 1985-2017 (Source: Marine Ecosystems Research Programme)

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) is estimated in the region of 250,000-350,000 animals. There has been no significant change in abundance since the mid 1990s.*

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 are largely unmonitored except by decadal wide-scale surveys and some local windfarm-related visual and/or acoustic monitoring. The northernmost part of the North Sea is relatively poorly monitored. It is recommended that these gaps are filled and that every Member State 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 20). 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 21, detail in Figure 22).

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 Tiedemann, 2009). The lines of evidence suggesting substructuring 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.

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 substructuring 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 22).

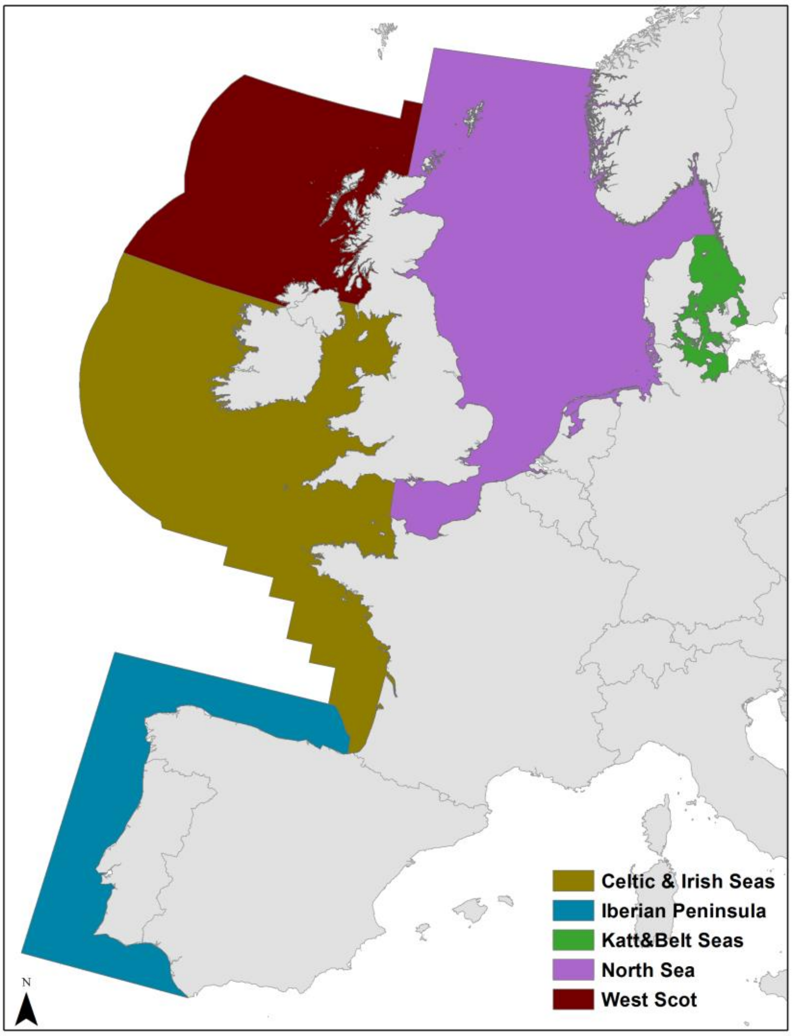


Figure 20. Assessment Units for the Harbour Porpoise
as proposed by ICES WGMME (2013)

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.

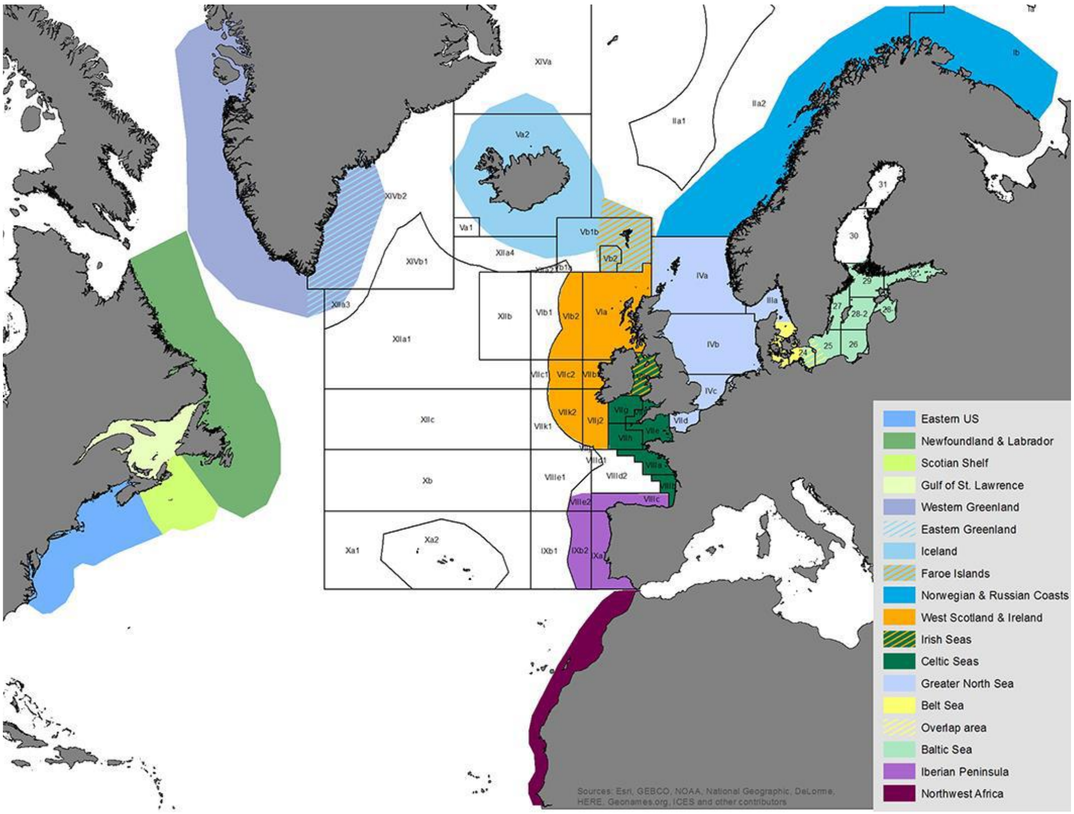


Figure 21. Assessment units for harbour porpoise in the North Atlantic as proposed and used during the joint NAMMCO/IMR workshop, with the ICES fishing areas super-imposed. (Source: NAMMCO & IMR 2019).

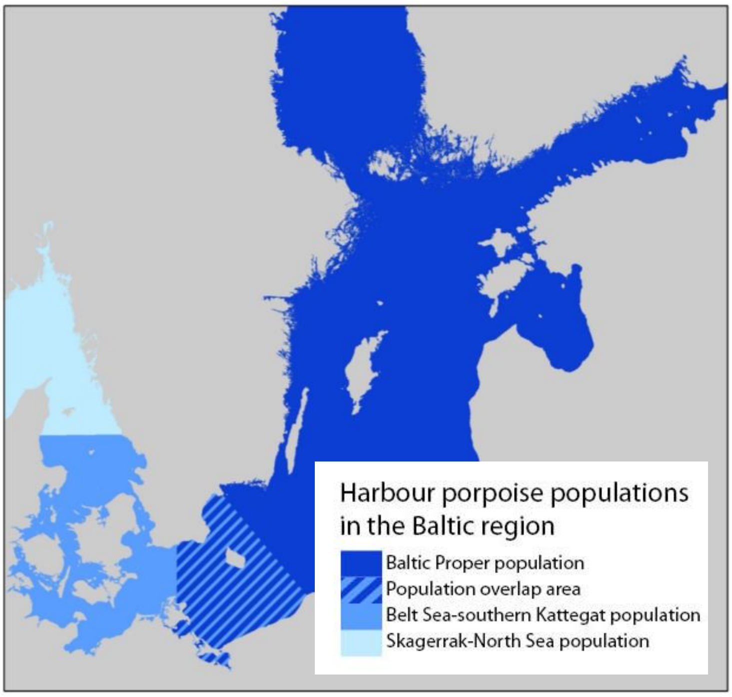


Figure 22. Harbour porpoise populations in the Baltic region. Blue shading indicates the borders proposed for the management unit of the Belt Sea population by Sveegaard *et al.* (2015) and for the Baltic Proper population by Carlén *et al*. (2018). All borders are for the summer half-year only.

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 substructuring 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 substructuring 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 3 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 recreational fisheries and vessels less than 15 m length, and the implementation of effective mitigation measures to reduce bycatch) have made less progress.

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 the information provided by countries relevant to the Conservation Plan

Table 3. Qualitative Assessment of Progress in the Implementation of the ASCOBANS North Sea Conservation Plan for the Harbour Porpoise

Qualitative Assessment of Progress in the implementation of the ASCOBANS North Sea Conservation Plan (CP) for HP (update Aug 2018)

Except for Action 2, ref. pinger use: na = non applicable; **-1**, situation is less good than at the adoption of the plan in 2009, **0** = no progress, **1** = small progress or at experimental level; **2**, steady progress; **3**, fully implemented.

	Actions form the North Sea Conservation Plan for HP	Priority		SE	DK	DE	NL	BE	FR	UK
1	**Implementation of the CP: co-ordinator and Steering Committee**	**High**		Coordinator currently in place						
2	**Implementation of existing regulations on bycatch of cetaceans - e.g. EC 812/2004 & Habitat Directive (HD)**	**High**	Vessels requiring pingers	?	14	yes	yes	0	90	6-8
			No. of vessels using pingers	?	?	?	0	na	9	6-8
			Enforcement policy	0	?	1	?	na	na	3
			Dedicated observer prog	0	0	0	0	0	(yes)	3
			Monitoring under HD	0	0	0	0	yes	yes	yes
3	**Establishment of BYC observation programmes on vessel smaller than 15m long, professional and recreational fisheries**	**High**	Professional	1	1	0	2	0	2	2
			Recreational	0	1	na	0	0	1?	na
4	**Regular evaluation of relevant fisheries, extent of HP BYC:**	**High**		0	0	0	0	0	0	1
	Gillnet fisheries =>15m vessels, dedicated, % DAS observed			0	0	0	0	0	14%	18%
	Gillnet fisheries <15m vessels, dedicated, % DAS observed			0	0.2	0	REM	0	0.7	0.33
	Cetacean scheme appended to DCF / DCR schemes			no	yes	yes	yes	no	yes	yes
	DCF observations in 2016 in NS, % DAS observed			0	0.76	0	0	0	na	9.4
5	**Review of current pingers, dev. of altern.pingers and gear modif.**	**High**		2	2	2	1	na	1	2
6	**Finalise a management procedure approach for determining maximum allowable byctch limits**	**High**		**General progress ICES WGMME, WGBYC, OSPAR (MSFD)**						
				0	0	0	1	0	0	2
7	**Monitoring trends in distribution and abundance of HP in NS**	**High**	Large scale	**SCANS III undertaken in 2016**						
			Reg/survey	1	2	2	2	2	1	1
			Reg/modelling	0	2	2	2	2	2	2
8	**Review of the stock structure of HP in NS**	**High**		1	1	1	1	1	1	1
9	**Collection of incidental HP data through stranding networks**	**Medium**		1	0	3	3	3	2	3
10	**Investigation of the health, nutritional status and diet of HP in NS**	**Medium**		1	2	2	2	1	1	2
11	**Investigation of the effects of anthropogenic sounds on HP**	**Medium**		0	2	2	2	2	1	2
12	**Collection and archiving of data on anthropogenic activities and development of a GIS**	**Medium**		1	2	2	2	1	1	2

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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		7	GNS/GTR	Dedicated	217		Harbour porpoise	5	0.023
DK	2017	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 Belgium, The Netherlands, Germany, Sweden, and the United Kingdom, source ICES WGMME 2019)

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**
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**
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**
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**
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**
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**

*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)
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)

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)

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, gadiods 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 zooplanctivorous fishes in their diet compared to that of other top predators.

The table below summarizes 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

Scotland (1992-2010)	Scotland (1992-2003)	Scotland (1992-1996)	Scotland (1965-1971)	Scotland (1959-1965)	Irish waters (1989-1994)	Ireland (1992-2013)	Norway (1985-1990)
North Sea/ North Atlantic	North Sea/ North Atlantic	North Sea/ North Atlantic	North Sea/ North Atlantic	North Sea/ North Atlantic	Celtic Sea/ Atlantic	Celtic Sea/ Atlantic	North Sea/ North Atlantic
	188	72	41	52	26		109
							3
						4	
		2	2	1	2		1
		4	4	2			
							5
x	4				1		
x			4	3			
1	1	1	1	1	1	2	
x		4					
							2
	5	3			1	1	
2	2	1	3				
							4
			4				
			5	3			
x	3	2				3	
Read et al. 2014	Santos et al. 2004	Santos 1998	Rae 1973	Rae 1965	Rogan & Berrow 1996	data from Emer Rogan	Aarefjord et al. 1995

Belgium (1997-2011)	Netherlands (2003-2014)	Netherlands (1989-1995)	Netherlands (2006-2014)	Netherlands (2005-2012)	German North Sea	UK
North Sea	North Sea	North Sea	North Sea	North Sea	North Sea	North Sea
64	600	62	829	74	34	
4	4		4	2		
3	3		3	3		1
		1				
		5				
2	2	4	2	4	1	2
1	1	2	1	1		3
					2	
		3	5			
Haelters et al. 2012	Schelling et al. 2014	Santos 1998	Leopold 2015	Leopold et al. 2015	Benke et al. 1998	Martin 1996

Denmark	Denmark/ Sweden (1985-1990)	Kattegat/ Skagerrak (1989-1996)	Germany	Bay of Biscay, Channel, France (1988-2003)	France	Southern North Sea (2010-2013)
Skagerrak/ Kattegat/ Belt Sea	Skagerrak/ Kattegat/ Belt Sea	Skagerrak/ Kattegat/	North Sea/ Baltic Sea	Channel/ Bay of Biscay	North Sea	North Sea
	138	112		29	17	52
	1	1 juv				
	5	juv				2
		x juv	3			5
1						
1	2					
				1	1	
					2	
				2		
	4	juv	1			3
	3	4 juv		5		1
						4
				3		
		2				
		3				
			2			
			4			
				4		
				x		
Källquist 1974	Aarefjord et al. 1995	Börjesson et al. 2003	Lick 1991 Lick 1993	Spitz et al. 2006	Desportes 1985	Mahfouz et al. 2017

	Denmark (1989-1992)	Poland (1986-	Baltic Proper (1960-1961)	Western Baltic (2006-2008)	German Baltic Sea	Western Baltic (1980-2011)	The Sound, Baltic Sea
	North Sea/ Skagerrak/ Kattegat/ Belt Sea	Baltic Sea	Baltic Sea	Western Baltic	Western Baltic	Western Baltic	Kattegat/ Belt Sea
	58	27	50	75	27	339	53
	3	1	2	4	2	4	2
		2	1	5		5	5
							4
	5		3	1	3	1	1
	1			3		2	5
			5			5	5
	4	3	4	2	1	3	3
	2						
	Santos 1998	Malinga et al. 1997	Lindroth 1962	Ross et al. 2016	Benke et al. 1998	Andreasen et al. 2017	Sveegaard et al. 2012

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
Black Sea	Black Sea	4000									4									1							3		2									Tsalkin, 1940, quoted from Tomilin 1957

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