WORKING GROUP ON MARINE MAMMAL ECOLOGY (WGMME)

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Contents

i Executive summary

The Working Group on Marine Mammal Ecology (WGMME) meeting 2020 was chaired remotely by Anita Gilles (Germany) and Anders Galatius (Denmark) and on-site chairs Matthieu Authier (France) and Ross Culloch (Scotland, UK).

Two terms of references were standing ToRs; under the first of these, ToR A, new and updated information on seal and cetacean population abundance, population/stock structure, management frameworks as well as anthropogenic threats to individual health and population status were reviewed. The latest abundance data on harbour, grey and ringed seals are also reviewed under this ToR along with findings on threats to marine mammals such as bycatch, pollution, marine debris and noise.

ToR B arose to facilitate the work of WGBIOIV's ToR A; "Investigate mechanisms linking trophic guilds under contrasting levels of pressure and/or primary production in case study areas". The initial focus of work should be on harbour porpoise, grey seal and harbour seal in the North Sea as a case study and, therefore, a number of recent studies addressing diet, foraging distribution and trophic interactions were reviewed. Additionally, an overview of published and unpublished data on diet and distribution of marine mammals in the North Sea was synthesized.

ToR C was implemented to review aspects of marine mammal-fishery interactions not covered by ICES WGBYC. In 2020, WGMME focused its efforts on i) reviewing conservation objectives with respect to maximum mortality since the lack of conservation targets was identified as hindering the ability to address marine mammal-fisheries interactions, ii) assessing the use of stranding records as a source of information to identify abnormal mortality and possible relations to fisheries. A country-by-country review of current stranding network activities was included.

ToR D, updating the database for seals, is the second standing term of reference. The database format generated in 2019 was updated with the most recent data on seal abundance.

ii Expert group information

Expert group name	Working Group on Marine Mammal Ecology (WGMME)
Expert group cycle	Annual
Year cycle started	2020
Reporting year in cycle	1/1
Chairs	Anita Gilles, Germany
	Anders Galatius, Denmark
Meeting venue and dates	10–14 February 2020, Barcelona, Spain (32 participants)

1 ToR A. Review and report on any new information on seal and cetacean population abundance, population/stock structure, management frameworks (including indicators and targets for MSFD assessments), and anthropogenic threats to individual health and population status

New information on seal and cetacean abundance, including distribution, and population/stock structure, as well as management frameworks and anthropogenic threats is reviewed and reported in this section. New information on fisheries bycatch is included under ToR C.

1.1 New abundance and distribution information

1.1.1 Seal abundance and distribution

In many ICES areas, seal populations are surveyed regularly, providing for a comprehensive long-term monitoring of these pinnipeds. Here abundances of harbour, grey and ringed seals in the North Atlantic and Baltic are described based on available data. Trends of harp and hooded seals are described in the WGHARP reports (ICES, 2019).

Table 1, Table 2 and Table 3 summarise the most recent available seal survey data, analogous to what WGMME has presented in former years. In the following, assessments of population status and developments are presented individually for the different countries/management units and species, including trajectories of (available) counts.

Unless it is stated that a figure refers to a population abundance estimate, numbers of seals reported are those counted on haul outs, which do not include seals at sea during surveys.

Table 1. Recent harbour seal survey data.

Country		Survey Year(s)	Adults (moult)	Pups	References
Norway					Nilssen and Bjørge, 2018
	North of 62N	2015	3872		
	South of 62N	2016–2018	1054		Nilssen and Bjørge, 2019
	Finnmark	2012–2013	981		
	Skagerrak	2016–2018	880		
Iceland		2016	7652		Thorbjörnsson *et al.*, 2017
Wadden Sea		2019	27 763	9683	Galatius *et al.*, 2019
Dutch Delta Area		2017/2018	969 (2017)	119 (2018)	Arts *et al.*, 2019
France		2019	1124	224	Poncet, 2019 (unpublished data)
UK					
	Scotland	2014–2018	26 864		SCOS, 2019
	England and	2014–2018	5095		SCOS, 2019
	Northern Ireland	2018	1012		SCOS, 2019
Ireland		2017–2018	4007		Morris and Duck, 2019
USA		2012	75 834		Waring *et al.*, 2015
Canada					NAMMCO
	south of Labrador	1970s	12 700		
	Estuary and Gulf of St Lawrence	1994–2000	4000–5000		
Sweden and Denmark					
	Skagerrak east coast	2019	7310		Swedish Museum of Nat. Hist.
	Kattegat/ Danish Straits	2019	9916	2112 (only counted in Danish area)	Swedish Museum of Nat. Hist., Aarhus University
	southern Baltic	2019	1130		Aarhus University
	Limfjord	2019	1048	521	Aarhus University
	Kalmarsund	2019	1778		Swedish Museum of Nat. Hist.

Table 2. Recent grey seal survey data.

Country		Recent Survey Year(s)	Adults (moult)	Pups	References
Norway	Troms and Finnmark	2015–2016		271	Nilssen and Bjørge, 2017a and b
	Norway north of 62N	2014–2018		349	Nilssen and Bjørge, 2019
	Norway south of 62N	2017		40	Nilssen and Bjørge, 2017a and b
Iceland		2017	6269	1452	Granquist, S.M. and Hauksson, E. 2019
Wadden Sea		2019	6538	1684	Cremer et al. 2019
Dutch Delta Area		2018	1269		Arts *et al.*, 2019
France		2019	750	72	Poncet, S. 2019 (unpublished data)
UK	Inner Hebrides	2016		4541	SCOS, 2018
	Outer Hebrides	2016		15 732	SCOS, 2018
	NW Scotland	2016		706	SCOS, 2018
	Scottish North Sea	2016, 2004*		33 177	SCOS, 2018; * Shetland
	English North Sea	2018		9884	National Trust, Lincolnshire Wildlife Trust, Natural England, Friends of Horsey Seals
	SW England and Wales	2016, 2005^		2000	SCOS, 2018; ^Wales
Republic of Ireland		2012		2100	Ó Cadhla *et al.*, 2013
Canada	Sable Island	2016		83 594	den Heyer *et al.*, 2017
	Gulf of St Lawrence + eastern shore Canada	2016		15 090	den Heyer, *et al.*, 2017; Hammill *et al.*, 2017
USA	USA east coast	2019		6253	Wood *et al.*, 2019
Baltic	Baltic	2019	38 000		HELCOM

Table 3. Recent ringed seal survey data.

Country		Survey Year(s)	Adults (moult)	Pups	References
Sweden, Finland	Bothnian Bay	2018	9919		HELCOM (normal ice conditions)
	Bothnian Bay	2019 2015	12 615 19 936		HELCOM (unusual ice conditions)
Estonia, Finland, Russia	Gulf of Finland	2018	95 + 13		M. Verevkin, 2018 (Russian side: 95, average taken of range, Finnish side: 13, all animals observed in complete survey, Estonia: remaining ice was observed, but no seals were observed)
Estonia, Latvia	Gulf of Riga	2018	1152		I. Jüssi, 2018
Finland	Finnish Archipelago Sea	2018	122 observed, population estimate 200–300		M. Kunnasranta, 2018

1.1.1.1 Abundance, Iceland

Harbour seals

Icelandic harbour seal (*Phoca vitulina*) and grey seal (*Halichoerus grypus*) populations are currently in decline. The harbour seal population has decreased from 33 000 animals in the first census in 1980 to 7700 animals in 2016 (Figure 1). The largest observed decline, however, occurred between 1980 and 1989, when a bounty system was in effect, but the declining trend continues, and the current estimated population size is the smallest that has ever been observed (Thorbjörnsson *et al.*, 2017).

Grey seals

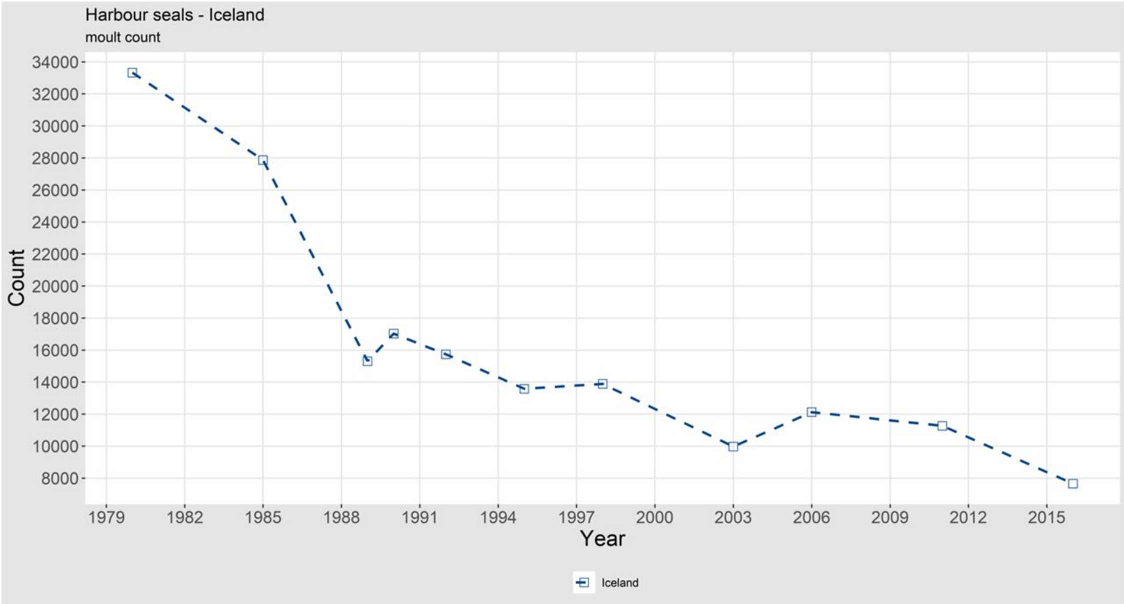


Figure 1. The trend of survey results of harbour seals in Iceland.

The Icelandic grey seal population has been surveyed at irregular intervals since 1982 when the population abundance was estimated at 9000 animals. The latest estimate from 2017 indicated a population abundance of 6269 animals, based on a pup survey yielding 1452 pups (Figure 2; Granquist and Hauksson, 2019).

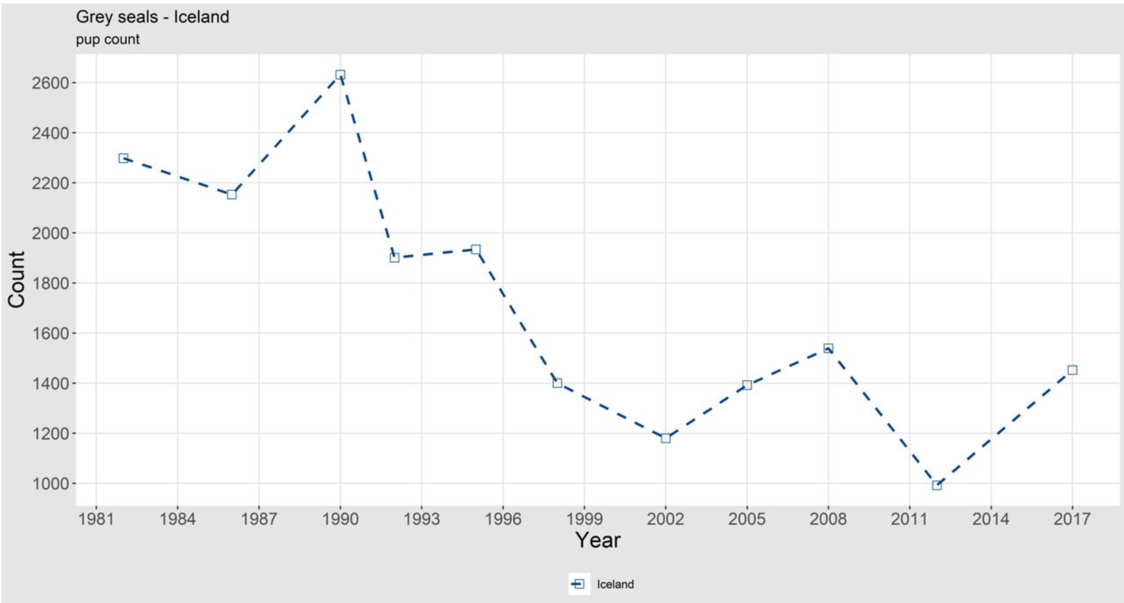


Figure 2. The trend of counted grey seal pups in Iceland.

Annual marine mammal bycatch in the lumpsucker fishery based on observations from 2014–2018 was estimated at 3223 (1225–5221) animals, comprising 1389 (903–1875) harbour seals, 989 (405–1573) grey seals, 240 (82–398) harp seals, 49 (1–98) ringed seals and 28 (10–46) bearded seals. These estimates are per year and are stratified by management area (Bonanom *et al.*, 2019). There is some discussion within NAMMCO on the accuracy of the estimated bycatch of this specific fishery, there might be reason for concern that fisheries mortality is affecting the Icelandic harbour and grey seal populations, especially as other fisheries also occur in the area. In addition to this threat, growing tourism including seal watching could affect the seals in the area (Granquist and Sigurjonsdottir, 2014).

1.1.1.2 Abundance, Baltic Sea

Ringed seals

Ringed seal (*Pusa hispida* ssp. *botnica*) breeding and moulting distribution is connected to sea ice in winter and spring. Their breeding success is highly dependent on sufficient ice-cover and overlaying snow layer through the breeding and nursing season. After breeding, ringed seals haul out scattered on ice during their annual moult, during which they have traditionally been surveyed using line-transect methodology. Favourable ice-conditions usually occur to some extent every year in the Bothnian Bay, where the surveys have been carried out since 1988. The number of hauled out individuals during the surveys in largely normal ice-conditions has increased from the level of around 2000 in the first survey years to 9919 in 2018 (Figure 3), corresponding to an annual average population increase of 4.7% per year. The increase rate has been slightly higher in the latter half of the period (2004–2018: 5.6% per year). Both increase rates are clearly below the intrinsic natural rate in a situation without limiting factors. Anomalous survey results in 2013, 2014, 2015, 2017 and 2019 are considered to be a result of early ice-breakup. These datapoints have been excluded from the trend analysis, as they are not comparable to previous data. The phenomenon behind the anomalous results and the role of early ice-breakup are not fully understood, and besides their deviation from results from 'normal' ice years, there is a large amount of variation in counts among 'anomalous' ice years. The situation was discussed in the WGMME 2018 report (ICES, 2018).

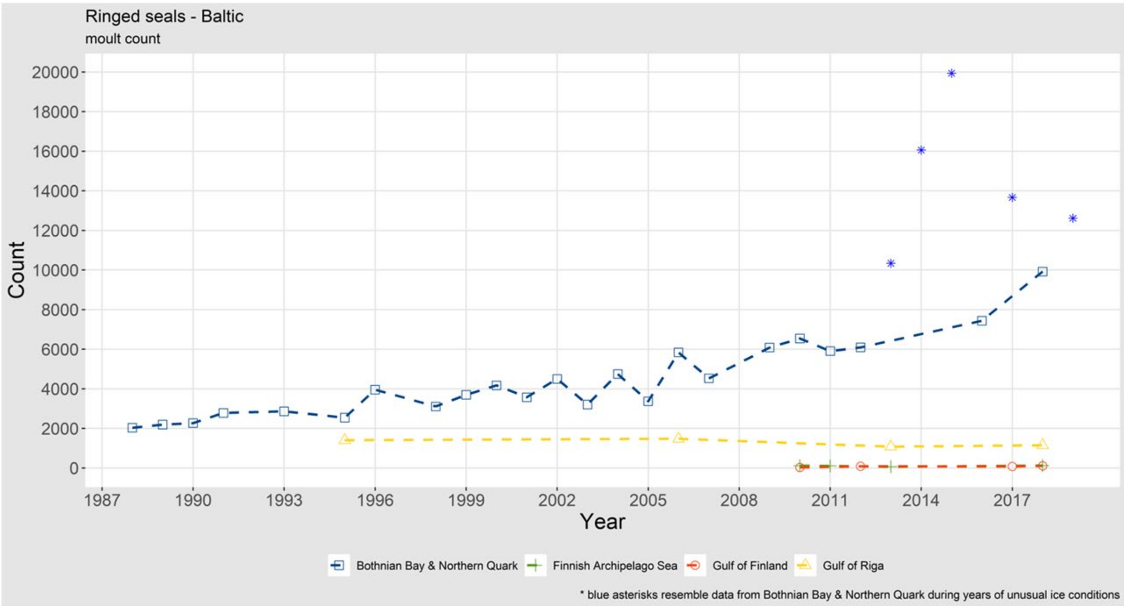


Figure 3. Trends of estimated numbers of ringed seals hauled out on sea ice during moult surveys in the Baltic.

The ringed seal subpopulation in the Bothnian Bay is the largest in the Baltic. It has recovered from the hunting-derived population decline during the 20th century and subsequent reproductive problems caused by environmental contaminants. However, recently raised hunting quotas together with deteriorating ice-conditions increase the pressures on this subpopulation. It is concerning that the deteriorating ice conditions affecting breeding success are also compromising monitoring data, making impacts on abundance trends difficult to assess.

Southern ringed seal populations in the Baltic Sea: As a result of population decline during the 20th century, the current Baltic ringed seal population is divided into four geographical subpopulations.

In addition to the largest subpopulation in the Bothnian Bay, Baltic ringed seal subpopulations can be found in the Gulf of Riga, the Finnish Archipelago Sea and the Gulf of Finland. The three southern subpopulations are threatened with extinction, largely as a result of reduced breeding success caused by reduced extent and duration of sea ice with less snow compared to historically average winters. This was covered in more detail in the WGMME 2018 report (ICES, 2018).

While the warmer winters have recently challenged population monitoring of ringed seals in the Bothnian Bay, traditional surveys have been impossible in the areas occupied by the southern subpopulations in most years. The lack of continuous monitoring data provides a severely fragmented view of population development, although the few survey results indicate stable or decreasing trends. The status of the southern ringed seals as well as the roles of climate warming and other factors on them was discussed in more detail in the WGMME 2018 report (ICES, 2018).

In 2019, no aerial surveys were carried out in the southern areas of ringed seal distribution due to lack of ice. Instead, almost all known land haul outs in Väinämeri area in western Estonia were surveyed from land or boat (I. Jüssi, personal communication). The result, a count of 884 ringed seals, is in line with the recent results, a sea ice count (2013: 1077 ± 449, 2018: 1152) as well as a two counts in ice-free conditions (2008: 1055, 2014: 1010, 2016: 834; Figure 3).

If ice conditions continue to deteriorate, alternative monitoring techniques need to be developed for all the areas to survey the species in the near future.

Harbour seals

Harbour seals in the Baltic (HELCOM) area (Denmark and Sweden) are surveyed annually using replicate annual aerial surveys during the moulting period in August (

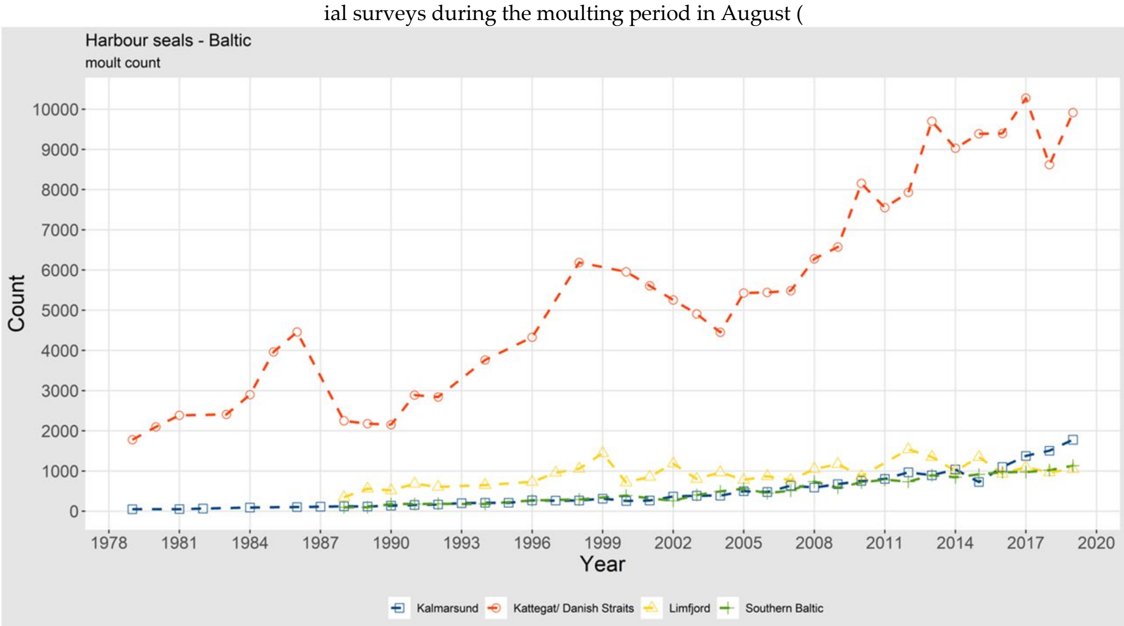


Figure 4). They are split into the four management units: Limfjord, Kattegat and the Danish Belt Sea, Southwestern Baltic and Baltic Proper (Kalmarsund).

LIMFJORD: The number of counted seals of the Limfjord harbour seal population has been fluctuating around 1000 individuals since the early 1990s and appears to have reached its carrying capacity. Genetic analyses indicate that the seals in the fjord originate in two different populations, (1) the population originally inhabiting the fjord, before a storm opened the passage to the North Sea in 1825, and (2) seals from the Wadden Sea (Olsen *et al.*, 2014). It is not known to what extent the seals from the Wadden Sea use the fjord for other purposes than hauling out and to which extent they interbreed with the native seal population. A proper assessment of the Limfjord harbour seals is contingent on clarification of these issues. In 2019, 1048 seals were counted in the fjord (Aarhus University).

KATTEGAT and the DANISH BELT SEA: The harbour seal population in Kattegat and the northern Danish Belt Sea experienced two dramatic mass mortality events due to PDV when more than 50% of the population died in 1988 and about 30% in 2002 (Härkönen *et al.*, 2006). Unusually large numbers also died in 2007, but the reason for this mortality remains unclear (Härkönen *et al.*, 2007). In spring and summer of 2014, some seals appearing to show signs of pneumonia were found in Sweden and Denmark. Avian influenza H10N7 were isolated from a number of these seals (Zohari *et al.*, 2014; Krog *et al.*, 2015; Bodewes *et al.*, 2016). The rate of increase between the two PDV epidemics was close to 12% per year, as in the adjacent North Sea populations. The annual population growth rate in Kattegat and the Danish Belt Sea remained close to 12% per year until 2010, but data suggest that it is levelling off, even if the increased mortality in 2014 is taken into account. This is likely to be caused by density-dependence, indicating that the population is approaching carrying capacity. Hauled-out population estimate was 9900 in 2019 (Aarhus University, Swedish Museum of Natural History).

SOUTHWESTERN BALTIC: Southwestern Baltic harbour seals were also hit hard by the PDV epidemics of 1988 and 2002. 1130 seals were counted in the area in 2019 (Galatius *et al.*, 2019). Since 2002 and until 2011, the population grew with an average annual rate of 13%. From 2012 to 2019, this rate has been reduced to 6%. This reduced growth may be the result of the population approaching carrying capacity of the area or may stem from competition with the increasing number of grey seals in the area.

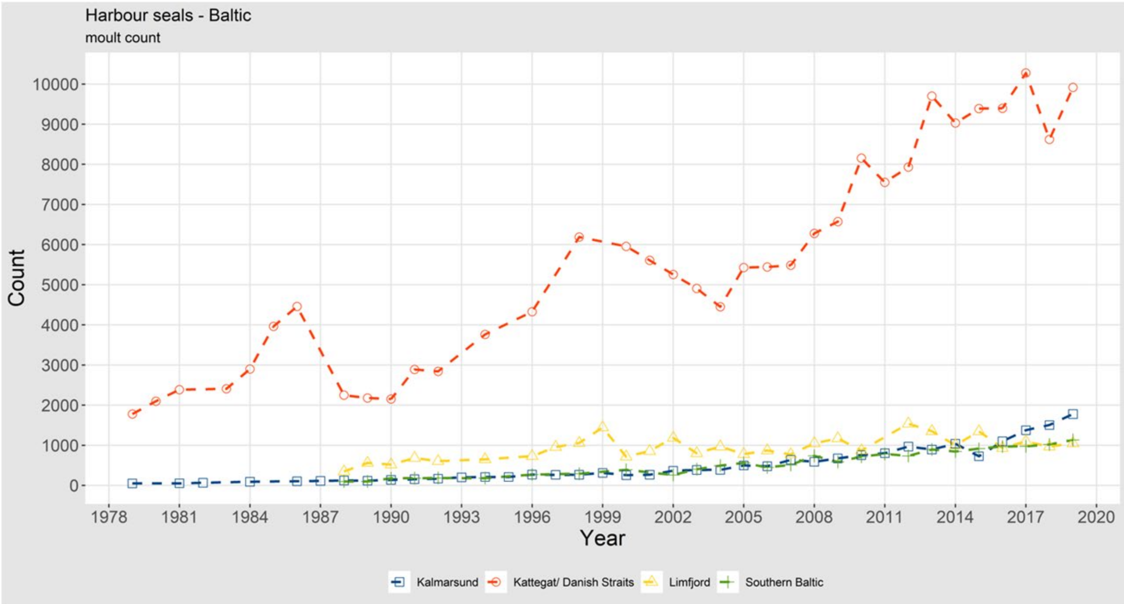


Figure 4. Trends of moult counts of harbour seals in the Kattegat and the Danish Belt Sea, Southwestern Baltic, Limfjord and Kalmarsund.

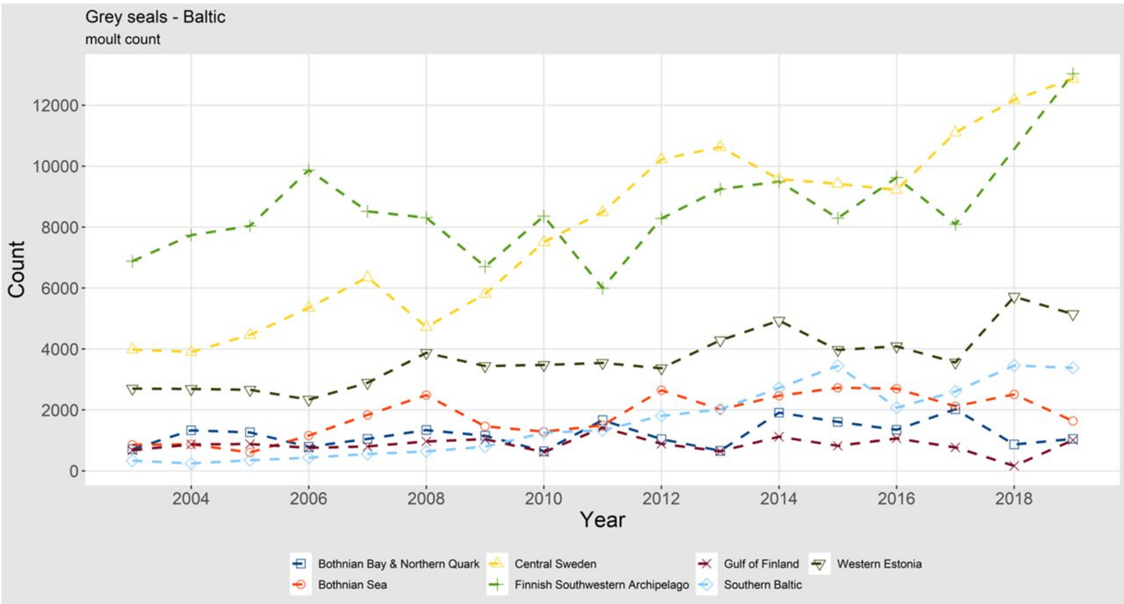


Figure 5. Trends for results of moult counts of grey seals in subareas of the Baltic Sea.

BALTIC PROPER/KALMARSUND: The harbour seal population in Kalmarsund is genetically divergent from adjacent harbour seal populations (Goodman *et al.*, 1998) and experienced a severe bottleneck in the 1970s when only some 30 seals were counted. Long-term isolation and small numbers have resulted in low genetic variation in this population (Härkönen *et al.*, 2006). The population has increased annually by ca. 9% since 1975 and counted numbers amounted to nearly 1800 seals in 2019 (Swedish Museum of Natural History).

Grey seals

Monitoring of the grey seal population in the Baltic Sea (*Halichoerus grypus* ssp. *grypus*) is based on internationally coordinated censuses during the moulting season, covering the entire Baltic moulting distribution of the species. The maximum number (not corrected for individuals in water) counted during 2–3 replicate surveys in each sea area is used for assessing abundance and trends. The grey seal population in the Baltic has been growing throughout the span of the coordinated surveys (starting in 2003) with the most pronounced growth in the southern and western parts of the moulting distribution (Figure 5). During recent years, however, the growth has shown signs of stabilising around 30 000 counted seals. Several factors alter the dynamics of the grey seal population. Hunting pressure (Kauhala *et al*., 2016) and bycatch (Vanhatalo *et al*., 2014) may have their roles in increased mortality, but decreasing birth rate and blubber thickness linked to decreasing food quality (Kauhala *et al*., 2016; 2017; 2019) can be signs of the population approaching the carrying capacity of the current Baltic Sea environment. However, in 2019, around 38 000 seals were counted, indicating that the population is still growing (HELCOM EG MAMA). Of the hauled-out population, around 80% were found in the core moulting area in the central Baltic proper (archipelagos of central Sweden, southwestern Finland and western Estonia). Outside the breeding and moulting seasons, grey seals travel and forage in other areas too. As the abundance of the population has increased, its range has expanded to also include the southern Baltic, where grey seals have been breeding regularly, although in small numbers, since 2003 (Galatius *et al.*, 2019). In recent years, pups are now also observed annually in Kattegat. (Galatius *et al*., 2019). This expansion has brought Baltic grey seals in contact with the Atlantic subspecies, and there are strong indications for hybridisation between the two groups based on microsatellite data from the southern Baltic (Fietz *et al.*, 2016). The annual numbers of grey seals observed during moult surveys in different subareas of the Baltic are shown in Figure 4.

1.1.1.3 Abundance, Atlantic Scandinavia

Harbour seals

The Skagerrak harbour seal population collapsed by roughly 50% during both mass mortality events due to PDV, in parallel with the Kattegat population, in 1988 and 2002. Before the two collapses, the population increased at high rates, indicating no factors retarding the growth. After the latter collapse, the rate of increase has been lower, which may indicate the population approaching carrying capacity. The counted number of harbour seals along the eastern coast of Skagerrak (starting from the eastern half of the Oslo Fjord in the north) was at the level of 7300 in 2019 (not corrected for seals at sea during the surveys; Figure 6).

Along the northern coast of Skagerrak (west of the Oslo Fjord), the harbour seal abundance (animals counted during moult) has decreased from 680 in 2008–2015 to 543 in 2016–2018. South of 62° N the harbour seal abundance has increased from 860 in 2011–2015 to 1054 in 2018 (Nilssen, and Bjørge, 2019). Counts in the northern Norwegian areas will be finished in 2021.

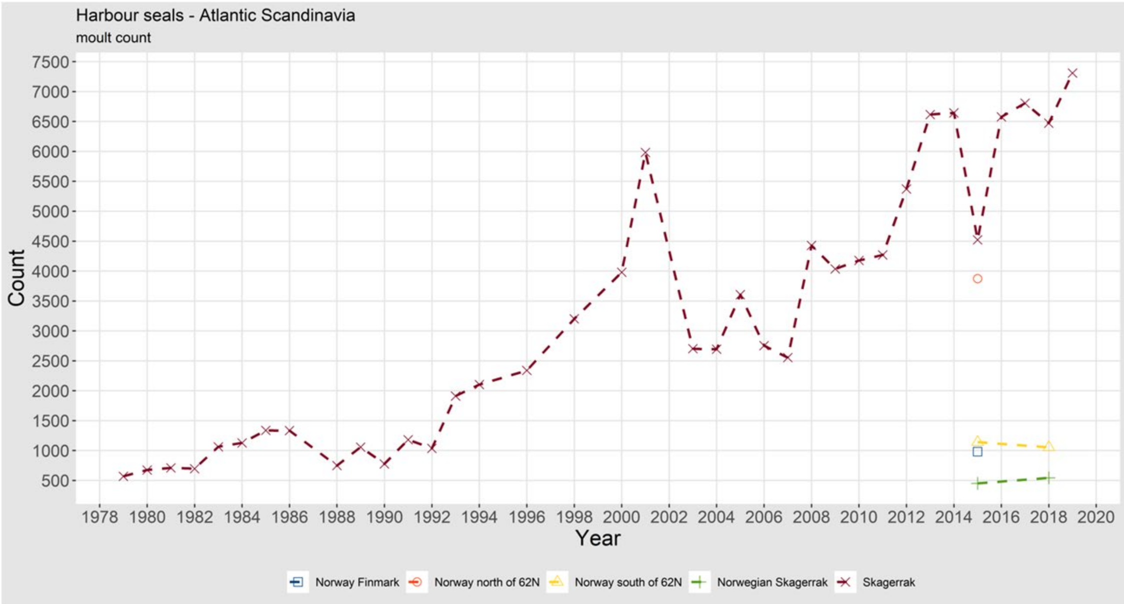


Figure 6. Trends of moult counts of harbour seals in the Skagerrak and Norwegian coast.

Grey seals

Since the early 1960s to 2010, the numbers of grey seals have increased in Norway and, based on pup production estimates from 2006 to 2008, a total population (including pups) of 8740 (95% CI: 7320–10 170) animals in 2011 was estimated by modelling (Øigård *et al*., 2012). However, a significant reduction in pup production has been observed between 62°N and 68°N in Trøndelag and Nordland counties (mid-Norway) in 2014–2018 (Nilssen and Bjørge, 2017), while in other areas along the coast pup production has been stable (Figure 7). A new survey was carried out in mid-Norway in 2018, which confirmed that pup production was low. The significant reduction in pup production in mid-Norway suggests a dramatic decline in the Norwegian grey seal abundance to a total population of 3850 (95% CI: 3504–4196) individuals, when scaling pup production using a multiplier of 5.7 (Nilssen *et al*., 2019). The most probable reason behind the reduced pup production is high bycatches of grey seals in gillnet fisheries for mainly monkfish, but also in cod gillnets.

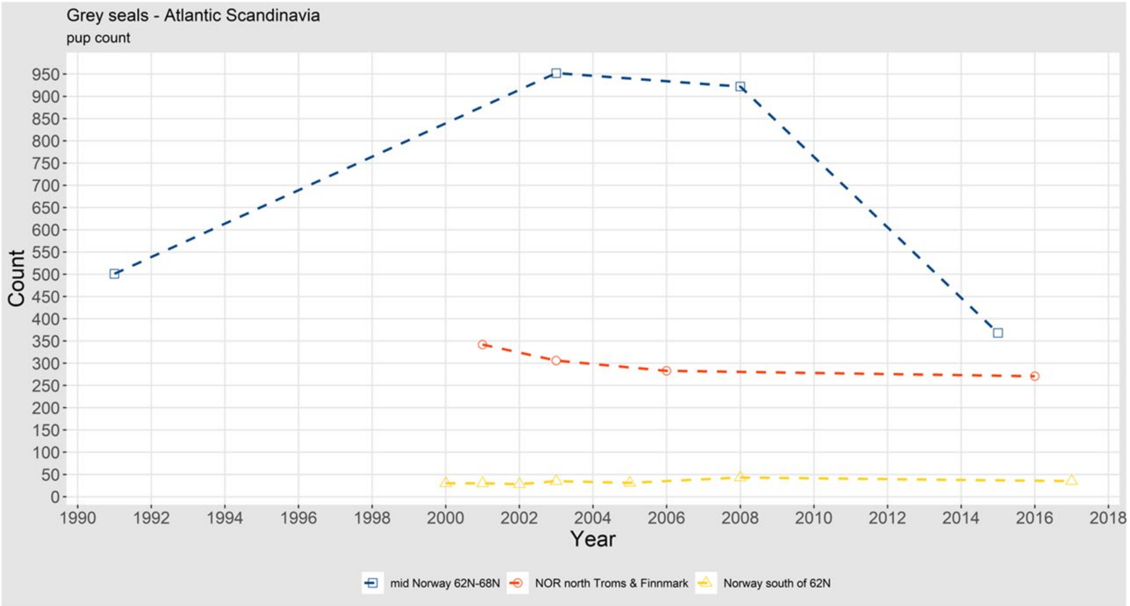


Figure 7. Trends of counts of grey seal pups in Norway.

1.1.1.4 Abundance, Continental coast, Wadden Sea to France

Harbour seals

WADDEN SEA (Denmark, Germany, the Netherlands): Harbour seal surveys in the Wadden Sea are coordinated among Danish, German and Dutch scientists. Brasseur *et al.* (2018) investigated a 40-year time-series (1974–2014) of counts of harbour seals in the Wadden Sea to study underlying processes of recovery and demonstrated the influence of historical regional differences in management regimes on the recovery of this population. Mortality rates were close to 50% during both PDV epidemics in 1988 and 2002, and between and after the epidemics, population growth rate has been close to the maximum intrinsic exponential growth rate of harbour seals at 12–13%. In 2019, a hauled-out population of almost 27 800 harbour seals was counted (Galatius *et al.*, 2019).

Since 2013, the trend has abruptly changed and growth in moult counts has levelled off, although pup counts continue to increase (Figure 8). Compared to the total counts, pup production based on counts represents almost 40% of the moult counts, almost 10 000 pups. The absence of subsequent growth in moult counts is still to be explained. Either mortality in this population is equivalent to the pup production or a substantial change in haul out behaviour has occurred which could affect the survey results. Either way, there is a clear indication of a recent change in the population.

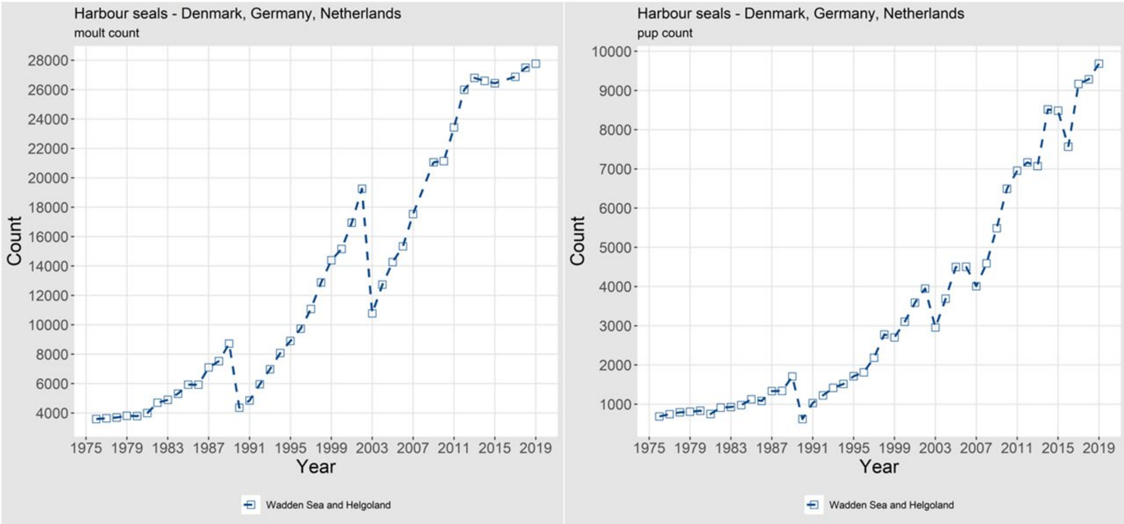


Figure 8. Trends of counts of moulting harbour seals (left) and harbour seal pups (right) in the Wadden Sea.

Results from Brasseur *et al.* (2018) indicate interesting exchanges between the different regions of the Wadden Sea with most important pup production in the German states, while after the breeding period seals redistribute throughout the area. As the entire Wadden Sea area is monitored synchronously, lack of growth is unlikely to be due to a redistribution of the animals.

SOUTHERN NETHERLANDS, BELGIUM and FRANCE. The growing harbour seal colony in the Dutch Delta area in the southern Netherlands is thought to be a colony of the Wadden Sea population as there are not enough local births (119 pups in 2018) to explain its growth (Figure 9). Moreover, although systematic stranding data lack, an average of 80 dead harbour seals are reported annually in the area. Telemetry data show regular exchange between this area and the Wadden Sea. Over 950 animals were counted in the Dutch Delta area in 2017 (Arts *et al.*, 2019), and numbers have been growing at almost 15% annually since 2002. A similar exchange might occur with the French colonies, although in France local births and exchange with southern English colonies might also play a role in the growth. In 2019, seal counts amounted to 1124 harbour seals in the colonies on the French coast from Normandy to the Belgian border (data compiled by Poncet S.; data owners: Office Français de la Biodiversité, SYMEL CDL, ADN, GDEAM-62, GMN, Bretagne Vivante, Picardie Nature, Réserve naturelle nationale du Domaine de Beauguillot (PNRMCB), Syndicat Mixte Baie du Mont-Saint-Michel, Maison de l'estuaire, CMNF, RNN des Sept-Iles / LPO).

In Belgium, there are no true seal colonies, however tens of animals strand annually along the coasts (48 in 2019, dead and dying, and excluding seals that were taken to a rehabilitation facility). The number of harbour seals observed hauling out in Belgium, especially in the port of Nieuwpoort, is rising and seals are seen daily. In 2018, 15 harbour seals were observed hauled out (exceeding previously recorded numbers). These are frequently joined by one or two juvenile grey seals. As in previous years, multiple animals were injured by fishing gear including hooks and rope (RBINS unpubl.; Haelters *et al.*, 2019).

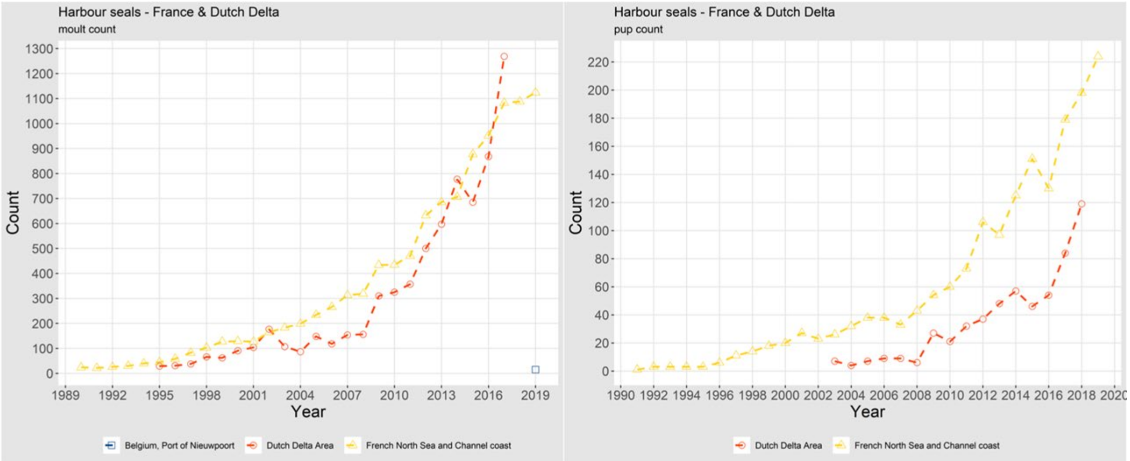


Figure 9. Trends of counts of moulting harbour seals and harbour seal pups in the Dutch Delta and French Coast.

Grey seals

After centuries of practical absence, grey seals have shown a remarkable recovery in the Wadden Sea area, where more than 6500 were counted during the moult in 2019. In the same area, 1684 pups were counted in the winter of 2018/2019 (Cremer *et al*., 2019; Figure 10). Partially fuelled by immigration from the UK (Brasseur *et al.*, 2015), colonies started in Germany and the Netherlands in the 1970s and have since expanded to Denmark. Up until now the majority of the grey seals are counted in the Netherlands (>70%), while recently counts in the German Wadden Sea (especially Helgoland and the Kachelotplate) have grown in importance (>20%), as have the numbers in Denmark (>5%). During the breeding season, the proportion of pups born in Germany is proportionally more important (almost 40%) compared to the moult counts.

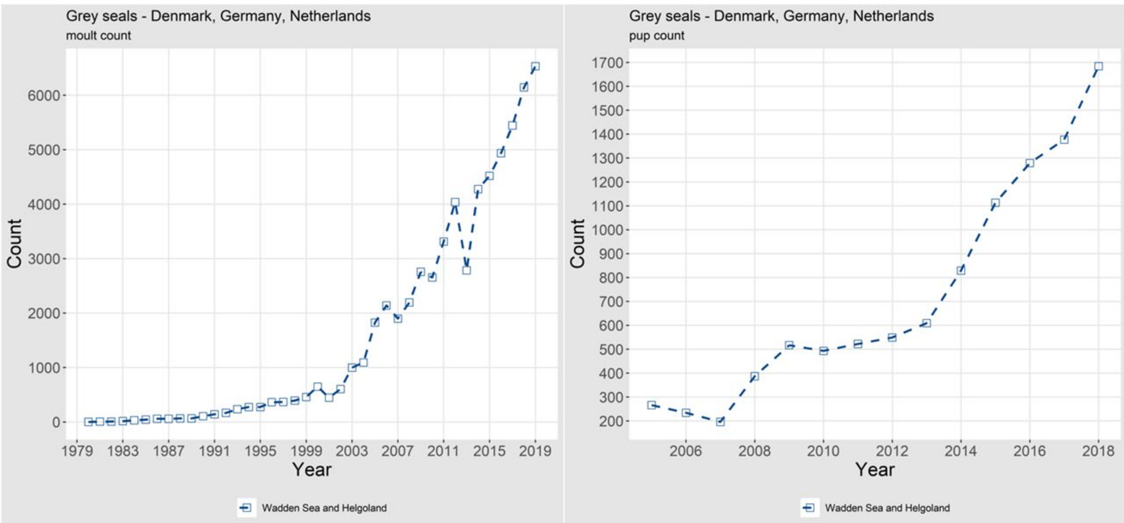


Figure 10. Trends of moulting grey seals and grey seal pups in the Wadden Sea.

The difference in relative distribution might be indicative of the importance of the exchange with the UK population. Possibly seals from the UK use the Dutch area more than other parts of the Wadden Sea.

As with harbour seals, grey seal numbers have been growing in the Dutch Delta area, despite the complete lack of births, reported dead grey seals amounted to ~40 animals per year. This suggests a continuous exchange between this area, the Wadden Sea and the UK, where numbers are growing. In 2018, a maximum count of 1269 grey seals in the Delta area was reported (Arts *et al.*, 2019, Figure 11). In France, there are also breeding colonies, and numerous exchanges with the UK and the Wadden Sea have also been recorded using telemetry. Occasionally few grey seals (2) are seen to haul out on the Belgian coasts. The maximum count along the French coasts amounted to 750 in 2019, and on the breeding sites, 72 pups were observed (Figure 11). (data compiled by Poncet S.; data owners: Office Français de la Biodiversité, SYMEL CDL, ADN, GDEAM-62, GMN, Bretagne Vivante, Picardie Nature, Réserve naturelle nationale du Domaine de Beauguillot (PNRMCB), Syndicat Mixte Baie du Mont-Saint-Michel, Maison de l'estuaire, CMNF, RNN des Sept-Iles / LPO).

Harbour seal

Harbour seals in the UK are counted annually during the moult period, although not all haul outs are surveyed annually. Therefore, data are collated for multiyear survey periods during which all large haul outs are surveyed, with only the most recent count for each haul out included.

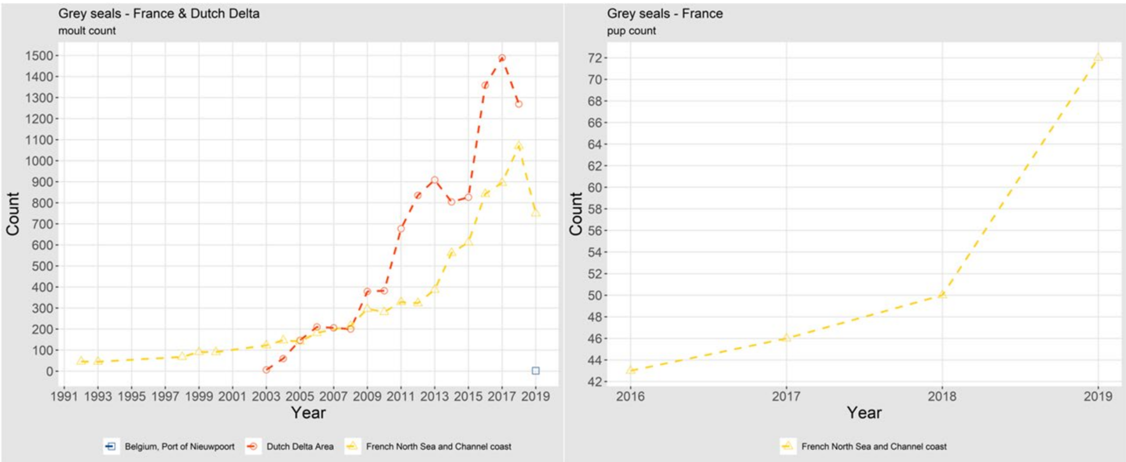


Figure 11. Trends of moult counts of grey seals (left) and grey seal pups (right) in the Dutch Delta Area and France.

1.1.1.5 Abundance, UK

The most recent August (moult) counts of harbour seals at haul out sites in the UK are presented for each country in Table 4. These data show an increasing trend for harbour seal counts within England and Wales, and a stable trend for Northern Ireland. There has been a generally decreasing trend for Scotland until the most recent survey period, where the data show a marked increase in harbour seal counts in 2014–2018. Overall, the UK total counts have increased since the last survey period.

Thompson *et al*. (2019) reviewed trends of harbour seal abundance in the UK and found that total current abundance was similar to estimates from the late 1990s at slightly more than 30 000 seals counted. Behind this overall result, there were large declines in some seal management units (SMUs) and increases in others. Populations in the southeast (southeast and northeast England SMUs) have shown continuous growth (except for the phocine distemper virus epidemics of 1988 and 2002), populations in the northwest (west Scotland, Western Isles and southwest Scotland SMUs) have been stable or increased, while populations in the northeast (East Scotland, Moray Firth, North Coast and Orkney, and Shetland SMUs) have seen large declines. Notably populations in the North Coast and Orkney and in East Scotland SMUs are continuing to decline and there is research underway in the UK to determine the cause(s). Continued declines are no longer evident in Shetland or the Moray Firth, however there is no indication of recovery. These regional trends are more visible in Figure 12.

Table 4. The most recent August counts of harbour seals at haul out sites in the UK by seal management unit, compared with three previous survey periods: 1996–1997, 2000–2006 and 2007–2009. Details of sources and dates of surveys used in each compiled regional total are given in SCOS (2019).

REGION / COUNTRY	HARBOUR SEAL COUNTS FOR EACH SURVEY PERIOD			
	2014–2018	2007–2009	2000–2006	1996–1997
Scotland Total	26 864	20 430	23 391	29 514
England and Wales Total	5095	4035	3051	3160
Northern Ireland Total	1012	1101	1176	*
UK Total	32 971	25 566	27 618	32 674*

*** No data available for Northern Ireland for 1996–1997.**

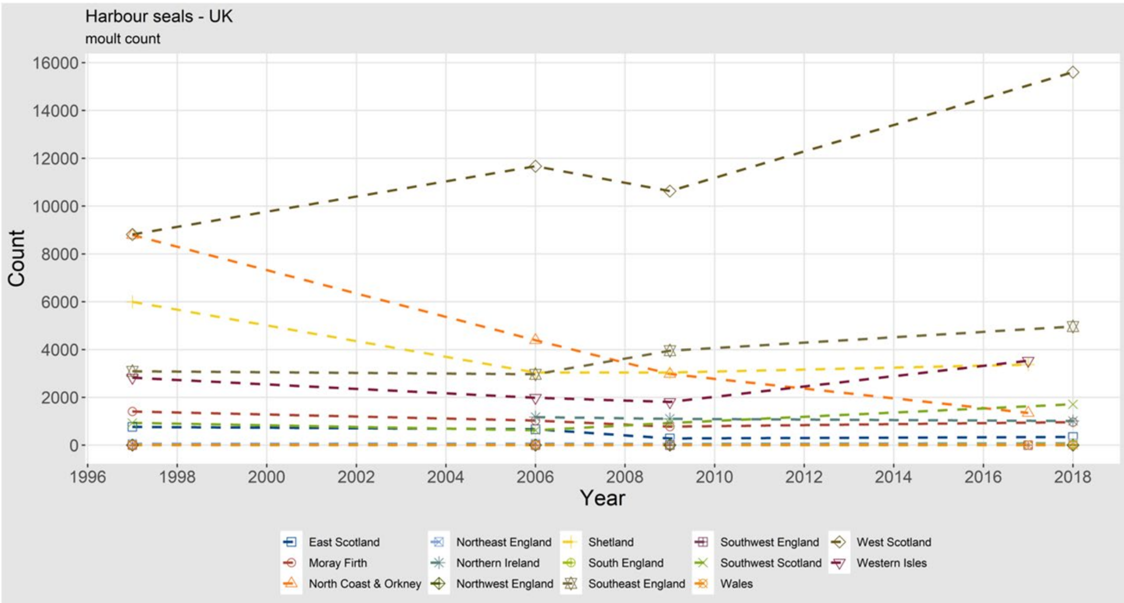


Figure 12. Trends of moulting harbour seals in the subareas of the UK.

Grey seal

In the UK, grey seal population trends are assessed from the counts of pups born during the autumn breeding season, when females congregate on land to give birth. The most recent aerial surveys of the principal Scottish grey seal breeding sites were conducted in 2016. Results from the most recent surveys from each subarea are presented in Table 2. A new pup production estimate including the latest counts from eastern England is not currently available. However, the results from the 2016 surveys together with the 2016 estimates from the annually ground counted sites in eastern England, and adding in an additional 6700 pups estimated to have been born at less frequently surveyed colonies in Shetland and Wales as well as other scattered locations throughout Scotland, Northern Ireland and South-west England, resulted in an estimate of 65 400 (95% CI 57 800–71 800) pups (SCOS, 2019). Trends of grey seal pup counts from subareas of the UK are shown in Figure 13. This figure highlights the continued increase in pup counts in most areas, most notably in the Western Isles and Southeast England. Note that this figure includes estimates for Southwest England, Northern Ireland and Wales.

Thomas *et al*. (2019) used a Bayesian state–space model to estimate UK grey seal abundance from 1984 to 2010, using pup production estimates and an independent count of hauled-out seals from

2008. Growth in the Inner and Outer Hebrides and Orkney began to slow in the 1990s and seemed to have reached carrying capacity in 2010, while the colonies in the North Sea were still growing exponentially in 2010. A total abundance of 116 100 (95% CI 98 400–138 600) seals aged one year or more was estimated for 2010. SCOS (2019) reported that the population model provided an estimate of 152 800 (95% CI 135 300–173 800) UK grey seals (1+ aged population) in 2017.

1.1.1.6 Abundance, North America

Harbour seals

In 2001, the harbour seal abundance in Maine was estimated at almost 100 000 individuals (Gilbert *et al.*, 2005). The growth of the harbour seal population along the US east coast is currently being reviewed, the results of this analysis should be available for the WGMME 2021 report.

Grey seals

Along the North American east coast, grey seal population trends are assessed from the counts of pups born during the breeding season. In 2016, the pup production on Sable Island accounted for 85% of the estimated total number of pups born in Canadian waters, with 11% in the Gulf of St Lawrence and 4% along the coast of Nova Scotia. The total population estimate in 2016 was lower than in 2014, after adjustment for the sex ratio in the population and other changes to the population model (Hammill *et al.*, 2014; 2017). The total estimated Canadian grey seal population in 2016 was 424 300 (95% CI=263 600–578 300), with a Sable Island and coastal Nova Scotia herd of 380 300 (95% CI=234 000–517 200), and 44 100 (95% CI=29 600–61 100) for Gulf of St Lawrence herd.

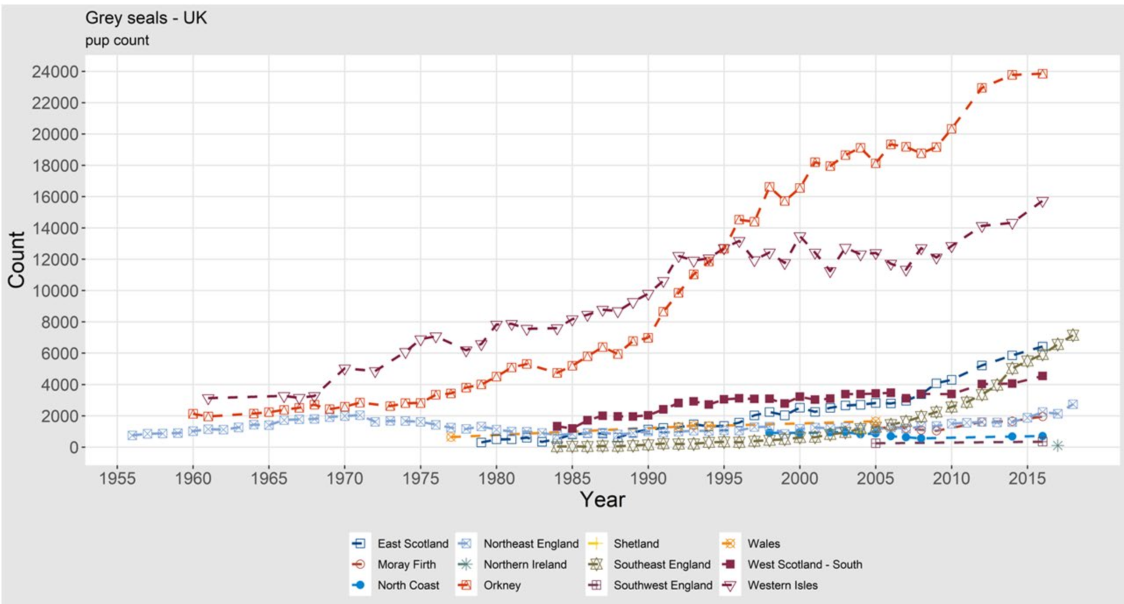


Figure 13. Trends of pup counts of grey seals in subareas of the UK.

A smaller, but growing number of grey seal pups are born along the US east coast in Maine and Massachusetts. The number of pups born at US breeding colonies can be used to approximate the total size (pups and adults) of the grey seal population in US waters, based on the ratio of total best population size to pups in Canadian waters (4.3:1). Using this approach, the population estimate in US waters is 27 131 (CV=0.19, 95% CI: 18 768–39 221) animals in 2016 (Hayes *et al.*, 2017). There is uncertainty regarding this abundance level in the US because life-history parameters that influence the ratio of pups to total abundance in this portion of the population are unknown. It also does not reflect seasonal changes in stock abundance in the northeast region for a transboundary stock. For example, roughly 24 000 seals were observed in southeastern Massachusetts alone in 2015 (Pace *et al.*, 2019), and 28 000–40 000 grey seals were estimated in southeastern Massachusetts in 2015, using correction factors applied to seal counts visible in Google Earth imagery (Moxley *et al.*, 2017). Observed counts of grey seal pups from the North American east coast are shown in Figure 14. The grey seal pup counts from the US coast in 2008–2014 do not include Seal Island, which is the 2nd largest breeding site, in theory a few hundred pups would have been missed. The most recent grey seal pup count for the US East Coast reported 6253 pups in 2018-2019 across Muskeget Island, Nomans Island, Green Island, Great Point, Monomoy Island, Matinicus Rock, Seal Island, Wooden Ball and Mt. Desert Rock (Wood *et al*., 2019).

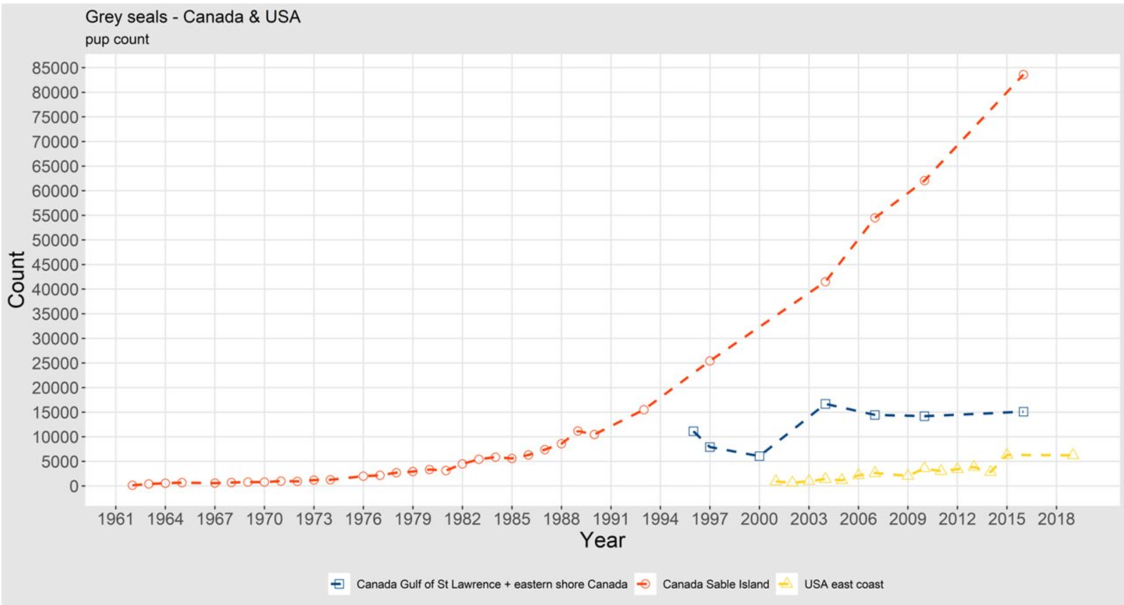


Figure 14. Trends of pup counts of grey seals along the east coast of North America.

1.1.1.7 New information on seal distribution

Russell *et al*. (2019) analysed time trends of grey seal pup production in UK colonies. Pup production has levelled off since around 2000 and was approaching an asymptote of around 40 000 born annually in 2010. However, behind this overall trend, colonies in the North Sea were still growing exponentially. Even in areas with stagnating growth, some colonies (often newer colonies) continued growing while other (often older colonies designated as Special Areas of Conservation; SACs) showed declines. Colonies on islands that have become available to the seals more recently may be more conducive to higher pup survival, resulting in higher site-specific growth in this philopatric species. This highlights the importance of monitoring extensively in contrast to limited monitoring of key sites (particularly SACs). Moreover, results demonstrate that newer colonies may be very important for the population dynamics of pinnipeds.

In the southern Baltic, grey seals were more likely to forage in deeper, colder and more saline waters, while active fishing gear also had a pronounced positive effect on foraging activity. This was demonstrated by Van Beest *et al*. (2019) using a hidden Markov model on dive data and GPS positions of tagged grey seals to investigate movement in relation to behaviour states.

Planque *et al*. (2020) compared horizontal and vertical approaches of identifying seal foraging areas in the Channel from GPS locations and dive data of eight grey seals and nine harbour seals.

The two approaches evidenced similar foraging hotspots at the population level when pooling all individuals of the same species, but there was also substantial variation between the two approaches at the individual level. Planque *et al.* (2020) highlighted how the comparison of foraging areas detected from horizontal and vertical approaches can reveal inter-individual differences in foraging strategies.

1.2 Cetacean abundance and distribution

1.2.1 Passive acoustic monitoring (PAM) of harbour porpoises in the Baltic Sea

WGMME has reported on passive acoustic monitoring (PAM) of harbour porpoises (*Phocoena phocoena*) using C-PODs in Denmark, Finland, Germany, Poland and Sweden in 2018–2019 (ICES, 2018; 2019). The following new information can be added:

DENMARK: The Ministry of Environment and Food are funding the national monitoring of harbour porpoises in Denmark and they have initiated a monitoring program for the Baltic harbour porpoises in the waters around Bornholm. The monitoring is carried out by Aarhus University. Ten C-POD stations, positioned on the original SAMBAH locations, were deployed for one year from June 2018. The plan is to repeat this monitoring again in 2022–2023 or during SAMBAH II. The waters around Bornholm are believed to be inhabited by a mix of the Belt Sea population and the Baltic Proper population. The results show that 1) all stations did at some point detect porpoises, 2) the stations further west had more detections, 3) the annual average of porpoise positive minutes for all stations combined were higher in 2018–2019 (0.07) compared to during SAMBAH (2011–2013) (0.03), and 4) we found more detections during summer in 2018–2019 compared to SAMBAH (Sveegaard *et al*., 2019; Sveegaard, 2020).

In the Belt Sea population area, harbour porpoise SACs are in turn monitored for one year using PAM. In 2017–2018, Kalundborg Fjord and the Great Belt were monitored. In comparison to previous monitoring periods (2012, 2014 and 2017–2018) a higher variation was found in porpoise detections between stations and seasons, but overall the seasonal variation was similar between the three monitoring periods. Furthermore, an overall increase in porpoise detections was found in the Great Belt from 2012 to 2018, whereas in Kalundborg Fjord the highest levels were found in 2014 compared to 2012 and 2017–2018 (Sveegaard *et al*., 2019).

FINLAND: The Ministry of Environment and the Åland Government has granted funding to Turku University of Applied Sciences to continue the monitoring at least until autumn 2020. New data show similar detection rates as in previous years, indicating that harbour porpoises are present on a regular and predictable basis in the monitored area, however in small numbers. An update on the status of harbour porpoise in the northern and eastern Baltic Sea is planned to be published in near future.

GERMANY: The long-term monitoring project TopMarine, where PAM in the Baltic Sea is conducted by the German Oceanographic Museum, was continued in 2019 and will end in May 2021. In 2020, C-PODs will be deployed at an additional ten stations (same positions as in 2018). At a subset of these, SoundTraps will also be deployed. The acoustic data will be compared to visual data collected by aerial surveys using digital systems and observers, collected in the same area and during the same period. In 2018, only one sighting during aerial survey was made, therefore it was not possible to compare visual and acoustic data. The project is funded by the Federal Agency for Nature Conservation.

POLAND: No PAM for porpoises was carried out in 2019.

SWEDEN: The monitoring carried out by the Swedish Museum of Natural History (SMNH), funded by the Swedish Agency for Marine and Water Management, will continue at least until autumn 2020. In the Baltic Sea, 11 previous SAMBAH stations and one previous BIAS station (www.bias-project.eu) are monitored. In 2019, the national monitoring programme was extended to also include 14 stations in five Natura 2000 sites in the Kattegat Sea. In addition to this, SMNH are also processing data collected by Blekinge County Administrative Board at up to 15 stations located in coastal waters in southeast Sweden since 2016. Data on detection rates are uploaded on an annual basis to a publicly accessible database, Sharkweb, hosted by the Swedish Meteorological and Hydrological Institute (https://sharkweb.smhi.se/). In 2020, an analysis of the detection rates at the previous SAMBAH stations will be carried out to investigate a possible change from 2011–2013 (SAMBAH data) to 2017–2019.

In June 2019, a concept note for a SAMBAH II project was submitted to the EU LIFE programme. The application included partners in all EU Member States around the Baltic Sea and HELCOM as project coordinator, and the application process was led by the SMNH. The concept note was approved by the Commission in October 2019, and the project consortium was invited to submit a full application in February 2020. However, due to problems with securing the national co-financing in some countries, the application had to be withdrawn. The countries are currently investigating the options for the national co-financing, which need to be secured before a new concept note may be submitted in June 2020.

1.2.1.1 Visual monitoring and strandings

BELGIUM: Royal Belgian Institute for Natural Sciences (RBINS) completed two aerial surveys in 2019. Observed harbour porpoise densities in June and August were normal, with on average 0.7 and 0.6 animals/km² respectively.

As in 2018, bottlenose dolphins (*Tursiops truncatus*) were regularly observed in Belgian waters. In October, a group comprising 20+ animals, including several calves, was observed. Most other observations concerned solitary animals, often very sociable towards humans, and staying in small areas for months. On November 10th, a minke whale (*Balaenoptera acutorostrata*) was filmed in the Norther wind farm.

The number of stranded harbour porpoises in 2019 (n = 53) was quite low (Figure 15) with most of the stranded animals in an advanced state of decomposition (63%). Porpoise strandings were lower than average throughout the year, except for September, which showed a marked peak in strandings.

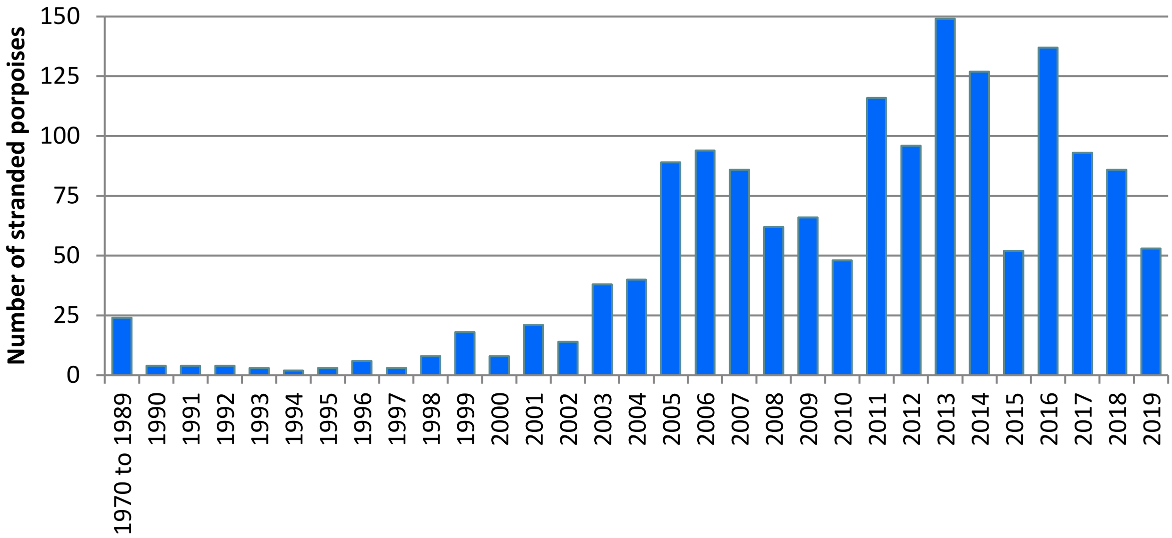


Figure 15. Strandings of harbour porpoises in Belgium recorded annually from 1990 to 2019 (plus total for 1970–1989). Data from Haelters *et al.*, (2019) and RBINS (unpubl.).

DENMARK: A new population abundance survey (MiniSCANS-II, aerial survey only) for the Belt Sea porpoise population will be conducted in June–July 2020, in collaboration with Germany and Sweden. Results from monitored SACs in 2018 show that for the North Sea, the number of porpoises within the southern North Sea (abundance: 2013 animals (95% CI: 954–3186), density: 0.38 animals /km^2 (95% CI: 0.18–0.60) were similar to 2017 (abundance: 1918 (95% CI: 976–2947)), but overall from 2011 until today, a decreasing trend was found. In Skagerrak, the abundance estimate was 5323 porpoises (95% CI: 2415–9232), density: 0.44 animals /km^2 (95% CI: 0.20–0.76) which is approximately half the abundance estimated in 2017 (the only year with comparable data).

Denmark is not collecting a sufficient amount of stranded and bycaught animals to monitor blubber thickness (as an indicator of health) or to determine thresholds for blubber thickness per species, sex, age and regions.

GERMANY: In spring 2019, a total of 145 harbour porpoise groups (172 animals, seven calves) were recorded along 1516 km of effort in three aerial survey strata in the North Sea (Figure 16). In summer 2019, a total of 245 harbour porpoise groups (318 animals, including 12 calves) were observed along 3694 km of effort in all eight study areas in the North Sea (Figure 16). Two single minke whales were observed in May near the Dogger Bank.

The Baltic Sea was surveyed in four aerial survey strata (Mecklenburg Bay West and East, Kiel Bight, and Fehmarn) in summer 2019 and a total of 79 harbour porpoise groups (102 animals, whereof seven calves) were sighted along 2476 km of effort (Figure 16).

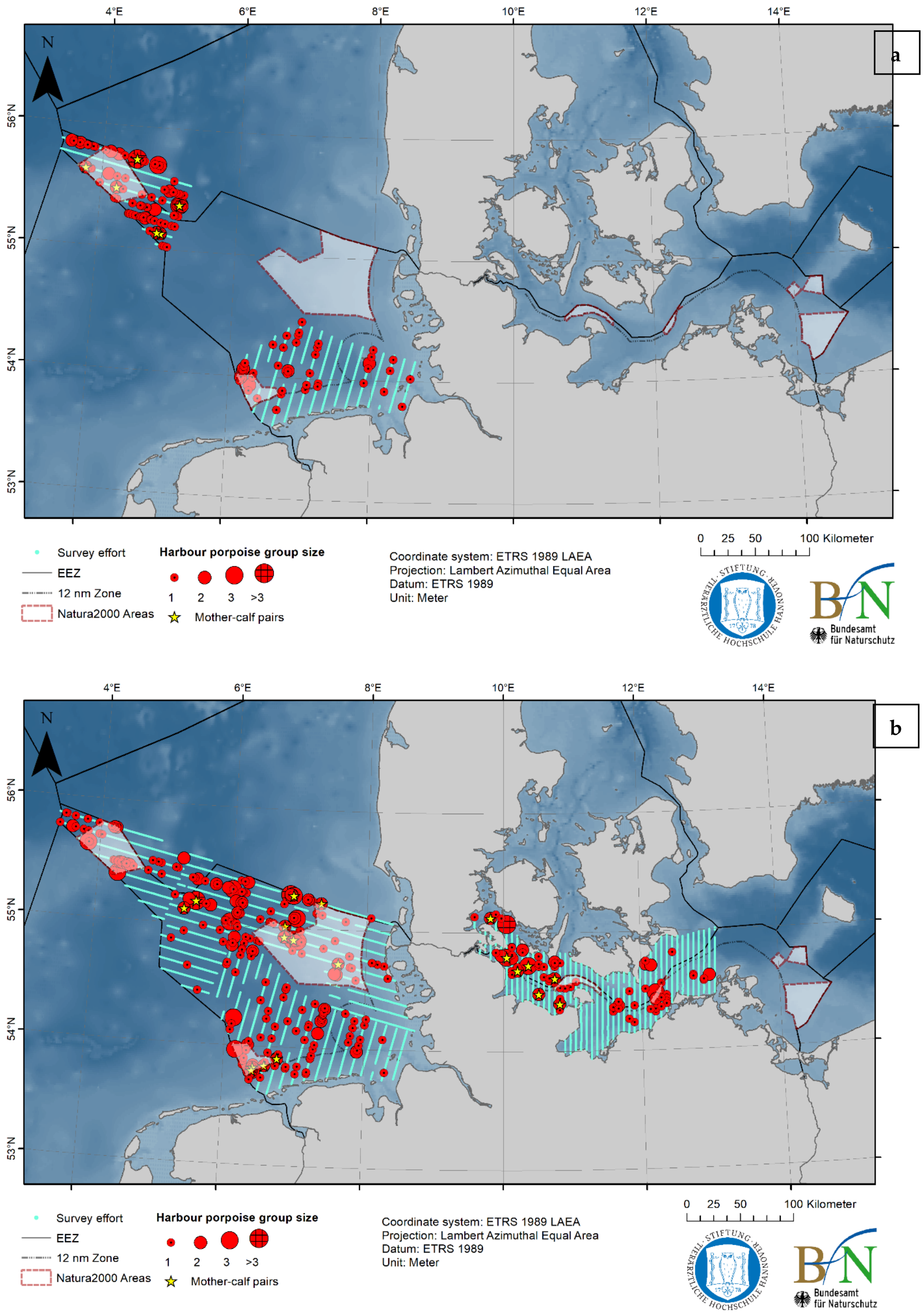


Figure 16. Survey effort and harbour porpoise sightings during aerial surveys in the German North and Baltic Sea during a) spring 2019 and b) summer 2019. Harbour porpoise group sizes are indicated using group size dependent red circles; yellow stars mark mother-calf pairs; blue lines indicate covered transect lines (i.e. survey effort).

Effort corrected density and abundance estimates were generated using a bootstrapping approach, also correcting for availability and perception bias. In spring 2019, the German North Sea was not entirely covered, allowing abundance and density estimates for individual areas only; survey block 'Dogger Bank (A)' with 7707 (95% CI: 4005–12 405), at 1.36 (0.71–2.20) animals/km²; 'Borkum Reef Ground (F)' with 3315 (95% CI: 1605–6150) animals, at 0.54 (0.26–1.01) animals/km² and 'Weser-Elbe estuary (E)' with 887 (95% CI: 296–1981) animals, at 0.20 (0.05–0.45) animals/km².

In summer 2019, the German North Sea was entirely covered, the total abundance was estimated at 27 752 (95% CI: 20 151–39 690; CV=0.17) harbour porpoises and an average density of 0.68 (95% CI: 0.50–0.98) animals/km² (Table 5). The Baltic Sea study area (areas I-L), was largely covered, leading to a total abundance estimate of 3749 (95% CI: 2549–5225; CV=0.18) harbour porpoises and an average density of 0.29 (95% CI: 0.2–0.4) animals/km² for summer 2019 (Table 5).

Table 5. Summary of effort corrected, bootstrapped density and abundance estimates for summer 2019 in the German North and Baltic Sea. N = estimated abundance of harbour porpoises; $N_{95\%CI}$ = 95% confidence interval around N; D = density estimate of harbour porpoises in ind./km²; $D_{95\%CI}$=95% CI around D; s = average group size.

area	season	N	$N_{95\% CI}$	D	$D_{95\% CI}$	$\hat{s}$
Dogger Bank (A)	summer 2019	4597	2219 – 7439	0.81	0.39 - 1.32	1.26
Offshore I (B)	summer 2019	4809	2807 – 7974	1.22	0.71 - 1.79	1.44
Sylt Outer Reef West (C)	summer 2019	5879	3002 – 11594	0.98	0.50 - 1.93	1.54
Sylt Outer Reef East (D)	summer 2019	2465	926 – 4707	0.36	0.13 - 0.68	1.20
Weser-Elbe estuary (E)	summer 2019	1122	191 – 2473	0.26	0.04 - 0.57	1.08
Borkum Reef Ground (F)	summer 2019	5992	3432 – 9953	0.98	0.56 - 1.63	1.23
OWF (G)	summer 2019	2337	1098 – 3653	0.57	0.27 – 0.90	1.19
Offshore II (H)	summer 2019	551	203 – 1068	0.16	0.06 – 0.31	1.00
All North Sea areas	summer 2019	27752	20151 - 39690	0.69	0.50 – 0.98	1.30
Kiel Bight (I)	summer 2019	1649	1043 - 2471	0.53	0.33 – 0.79	1.41
Fehmarn (J)	summer 2019	564	84 – 1232	0.16	0.02 - 0.34	1.21
Mecklenburger Bay West (K)	summer 2019	1164	660 – 1778	0.37	0.21 – 0.57	1.26
Mecklenburger Bay East (L)	summer 2019	372	134 – 687	0.12	0.04 - 0.23	1.10
All Baltic Sea areas:	summer 2019	3749	2549 - 5225	0.29	0.20 – 0.41	1.29

FRANCE: Two small-scale aerial surveys are currently being carried out in France: CAPECET and SPEE. Both surveys cover the Bay of Biscay (Figure 17). CAPECET aims to investigate patterns of distribution of small delphinids during the winter months. In particular, CAPECET surveys are carried out when large numbers of strandings are occurring on the Atlantic seaboard. SPEE is a smaller survey that aims to document seasonal patterns of marine mammal abundance and distribution within a recently designated MPA, the 'Parc Natural Marin de l'Estuaire de la Gironde et de la mer des Pertuis'. Since 2019, four SPEE surveys have been carried out, with one survey per season.

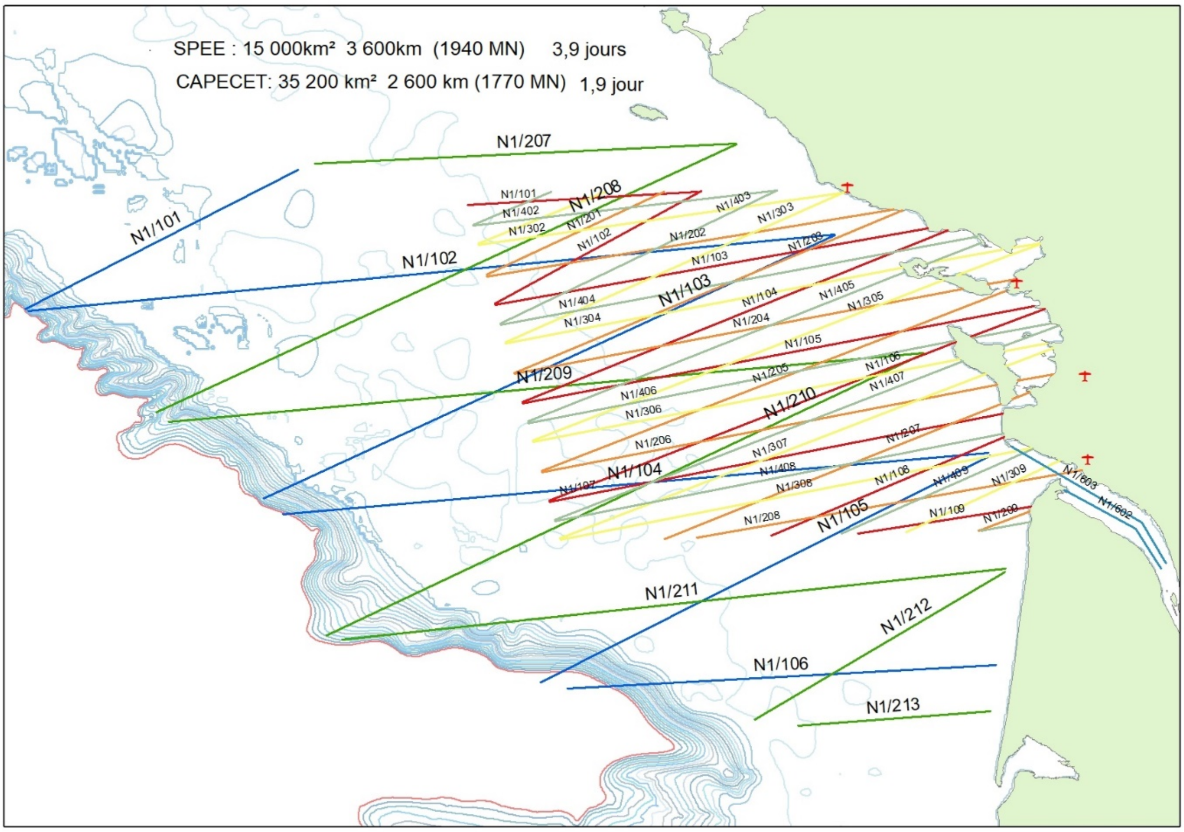


Figure 17. Design of the SPEE and CAPECET surveys.

Lambert *et al*. (2019) reported on the impact of recording seabird sightings during aerial surveys on the estimation of cetacean abundance in the Bay of Biscay and the Channel. A double-platform experiment was carried out in the Bay of Biscay and English Channel during the SCANS-III survey in 2016. Two observation platforms using different protocols were operating on board a single aircraft: the reference platform (SCANS), targeting cetaceans, and the 'Megafauna' platform, recording all the marine fauna visible at the sea surface. The data collected were analysed to assess whether observers who were instructed to record seabirds (using strip-transect methodology) would collect data of lower quality on cetaceans. A decreased perception of cetaceans after seabird observation within 30 sec prior to a cetacean sighting was found. This small-scale effect had no effect on the density estimates, which were similar for the two protocols. There was no evidence of lower performance regarding small cetacean population monitoring for the multi-target protocol in the study area, characterized by moderate cetacean densities and small spatial overlap of cetaceans and seabirds, any extrapolation to other areas or time period requires caution.

Peltier *et al*. (2019) examined stranding data, including photography and necropsy reports, collected between 1972 and 2017 in mainland France to provide a comprehensive review of confirmed collision records of large whales. A total of 51 ship-strike incidents were identified: with an increase from seven between 1972 and 1982, to 22 between 2005 and 2017.

Between 1 February and 31 March 2017, 793 stranded cetaceans (84% of which were common dolphins) were found along the French Atlantic seaboard. Most common dolphins showed evidence of entanglement in fishing gear. See ToR C for further information.

NETHERLANDS: In July 2019, aerial surveys to estimate the abundance of harbour porpoises on the Dutch Continental Shelf were conducted (Geelhoed *et al*., 2020). These surveys followed predetermined track lines in four areas: A - Dogger Bank, B - Offshore, C - Frisian Front and D - Delta. Between 16 July and 4 August, the entire Dutch Continental Shelf (DCS) was surveyed, resulting in a total distance of 2142.2 km surveyed on effort. Of this distance, 76.5% was surveyed with good or moderate conditions on at least one side of the plane.

Harbour porpoises were assessed using line transect distance sampling methods. Density and abundance estimates were calculated. Porpoise densities varied between 0.46 and 0.71 animals/km² in the areas A–D. The lowest density (0.46 animals/km²) was recorded in area A – Dogger Bank. The densities in the other areas were in the same order of magnitude, ranging between 0.68–0.71 animals/km² (Table 6). The total number of harbour porpoises on the Dutch Continental Shelf (areas A-D) was estimated at 38 911 individuals (95%CI = 20 791–76 822, CV=0.35), corresponding to an overall density of 0.66 animals/km². This estimate falls within the range of abundance estimates since 2010, with a minimum of 25 998 (95%CI = 13 988–53 623 in 2010) and a maximum of 76 773 (95%CI = 43 414–154 265 in 2014) individuals. The confidence intervals of the abundance estimates overlap, indicating no statistically significant differences between the years. The time-series, however, is relatively short for estimating trends.

Apart from harbour porpoises, three solitary minke whales were seen (feeding) in area A – Dogger Bank and B – Offshore, with another one sighted off effort in the same area. One sighting of a pair of white-beaked dolphins *Lagenorhynchus albirostris* was made in area B – Offshore.

Table 6. Density and abundance estimates of harbour porpoises on the Dutch Continental Shelf in July-August 2019 per study area/survey block.

	Density (animals/km²)	95% CI	Abundance	95% CI	CV
Area A – Dogger Bank	0.46	0.11–1.05	4380	1017–10 056	0.51
Area B – Offshore	0.68	0.29–1.39	11 557	4825–23 437	0.38
Area C – Frisian Front	0.69	0.40–1.34	8262	4780–16 093	0.32
Area D – Delta	0.71	0.24–1.64	14 713	4987–34 130	0.48

In 2019, 514 stranded cetaceans divided over four species were recorded (www.walvisstrandingen.nl) by Naturalis Biodiversity Center. As usual, harbour porpoise was the most abundant species (n =504, Table 7). The number of stranded harbour porpoises in 2019 is among the lowest of the last decade but well above the average of the previous years (Figure 7). Since 2016, ca. 50 fresh harbour porpoises are collected annually for post mortem examinations by the Faculteit Diergeneeskunde, University of Utrecht. One of the main objectives of the research is to quantify human-induced causes of death (IJsseldijk *et al.,* 2018). The results for 2019 are not available yet.

Table 7. Stranded cetaceans recorded in the Netherlands in 2019. Source: www.walvisstrandingen.nl Naturalis Biodiversity Center.

Species	N
Harbour porpoise	504
Minke whale	2
Fin whale	2
White-beaked dolphin	1
unidentified dolphin	5
	514

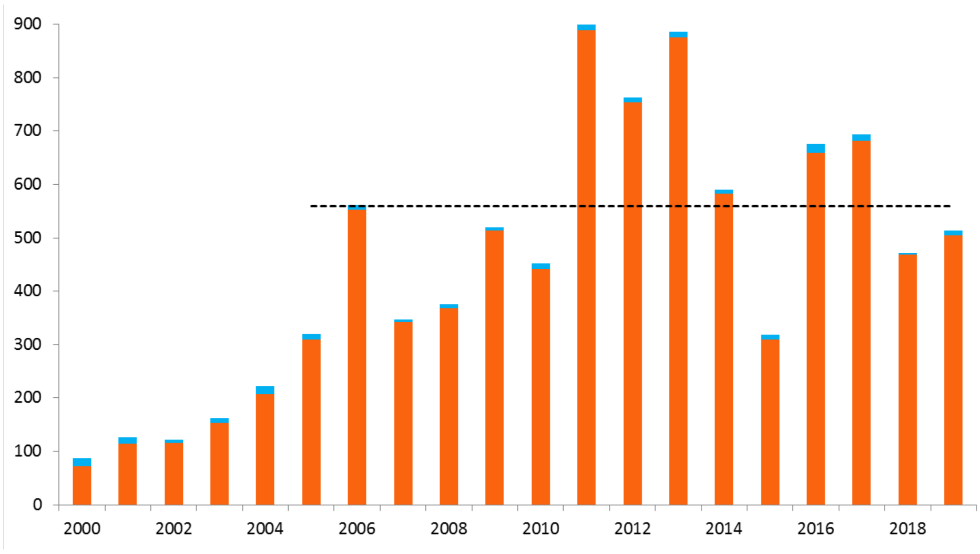


Figure 18. Strandings of harbour porpoises (orange) and other cetaceans (blue) in the Netherlands recorded annually from 2000 to 2019. The dotted line is the average since 2005. Source: www.walvisstrandingen.nl Naturalis Biodiversity Center.

PORTUGAL: WGMME 2019 (ICES, 2019) described the planned pilot surveys for MISTIC SEAS II in Macaronesia: Madeira (study area 1.907 km$^{2;}$ 2017–2018), the Canary Islands (study area 32 804 km^2, 2017) and the Azores (study area 36 613 km^2, 2018; Pipa *et al.*, 2019). Systematic shipboard surveys were conducted as pilot monitoring programmes and obtained abundance estimates for some species (Table 8).

Coastal bottlenose dolphins were sampled by a pilot photo-ID survey to estimate the abundance within bottlenose dolphin management units in the Azores, Madeira and Canary Islands. Although the main goal of the Pilot Monitoring Project was to test the methodology, estimates obtained can be used in the assessment of coastal bottlenose dolphins in the Azores to compare with baseline estimates. Data from Madeira may be used in future assessments after dealing with bias caused by excess of transient individuals. For the Canary Islands, data were insufficient to produce reliable estimates.

Table 8. Design-based and model-based abundance estimates obtained during ship-based surveys in the Azores, the Canary Islands and Madeira. Abundance estimates and CVs that may be reported for MSFD are in bold. Sf = Atlantic spotted dolphin *Stenella frontalis*, Tt = bottlenose dolphin *Tursiops truncatus*, Dd = common dolphin, Zc = Cuvier's beaked whale *Ziphius cavirostris*, Mb = Sowerby's beaked whale *Mesoplodon bidens*, Ha northern bottlenose whale *Hyperoodon ampullatus*, Gg = Risso's dolphin *Grampus griseus*, Gm = short-finned pilot whale *Globicephala macrorhynchus*, Pm = sperm whale *Physeter macrocephalus*, Be = Bryde's whale *Balaenoptera edeni*, Bp = fin whale *Balaenoptera physalus* and Bb = sei whale *Balaenoptera borealis*.

Management Units proposed in MSI						
Archipelago	*Species*	Design-based		Model-based		*Monitoring requirements MSI*
		N	%CV	N	%CV	
Azores	*Cc*	**5,187**	**46**			Line transect
	Sf	2,328	20	**2,324**	**15**	Line transect
	Tt	**431**	**41**			Line transect
	Gg	**299**	**44**			Photo-id
	Pm	129	22	**156**	**18**	Photo-id
Canary Islands	*Cc*	2,151	45	**2,701**	**40**	Line-transect
	Sf	41,120	32	**34,851**	**18**	Line-transect
	Tt	2,726	39	**2,808**	**27**	Photo-id
	Gm	2,854	28	**2,344**	**24**	Photo-id
	Zc	**64**	**56**			Photo-id
Madeira	*Cc*	149	40	**107**	**35**	Line-transect
	Sf	853	40	**728**	**41**	Line-transect
	Tt	226	36	**197**	**33**	Line-transect
	Gm	95	24	**104**	**21**	Line-transect
	Be	37	26	**30**	**28**	Photo-id
Other species						
Archipelago	*Species*	Design-based		Model-based		
		N	%CV	N	%CV	
Azores	*Dd*	**205**	**60**			
	Sc	467	28	**423**	**22**	
	Gm	**150**	**723**			
	Ziphiidae	829	23	**820**	**19**	
	Mb	337	27	**333**	**20**	
	Zc	**53**	**38**			
	Ha	**127**	**72**			
	Mesoplodon	**367**	**27**			
	Baleen	88	25	**76**	**19**	
	Bb	**42**	**35**			
Canary Islands	*Sb*	**1,575**	**63**			
	Gg	**595**	**40**			
Madeira	*Pm*	6	38	**3**	**56**	
	Ziphiidae	4	77	**3**	**32**	

SWEDEN: From 2006 to 2019, the Swedish Natural Museum of History collected a total of 109 stranded or bycaught harbour porpoises that have been necropsied in collaboration with the Swedish Veterinary Institute, all financed by the Swedish Agency for Marine and Water Management. An overview of the examinations carried out and the resulting findings on these porpoises have now been compiled (Neimane *et al*., 2020). Bycatch or probable bycatch was the most common cause of death (24.5%), followed by infectious diseases (16.5%), such as pneumonia. A few cases of probable grey seal predation were found. Bycaught harbour porpoises had a higher nutritional status than those who had died of infectious diseases. The compilation will serve as a basis for the discussions on the development of health and reproductive indicators on harbour porpoises.

UK: East coast Scotland bottlenose dolphin population: Photo-identification data from 2009 to 2015 were analysed using mark–recapture models to investigate the proportion of the population that uses St Andrews Bay and the Tay Estuary (Arso Civil *et al.*, 2019). Habitat models were fitted to bottlenose dolphin presence–absence data to identify areas of high use. The estimated number of dolphins using St Andrews Bay and the Tay Estuary during the summer increased from 91 (95% CI: 78–106) in 2009 to 114 (95% CI: 95–137) in 2015, representing, on average, 52.5% of the total estimated east coast population for that period. Spatial mixing of individuals during the summer between St Andrews Bay and the Tay Estuary and the Moray Firth SAC was estimated to be a minimum of ~6% per year and ~30% over the study period. The entrance to the Firth of Tay and waters around Montrose were identified as areas of consistent high use.

Southwest UK bottlenose dolphin population: a photo-ID based abundance estimate of the bottlenose dolphin population in the Southwest UK was made by collation of photos of bottlenose dolphins from citizen scientists, whale-watching organisations and other local organisations (such as the Cornwall Seal Group) in 2017. This was carried out as part of the Southwest Bottlenose Dolphin Consortium (with Cornwall Wildlife Trust), analysis carried out by a University of Plymouth masters (MRes) student to estimate a population of only 28 dolphins, showing this to be a highly vulnerable population.

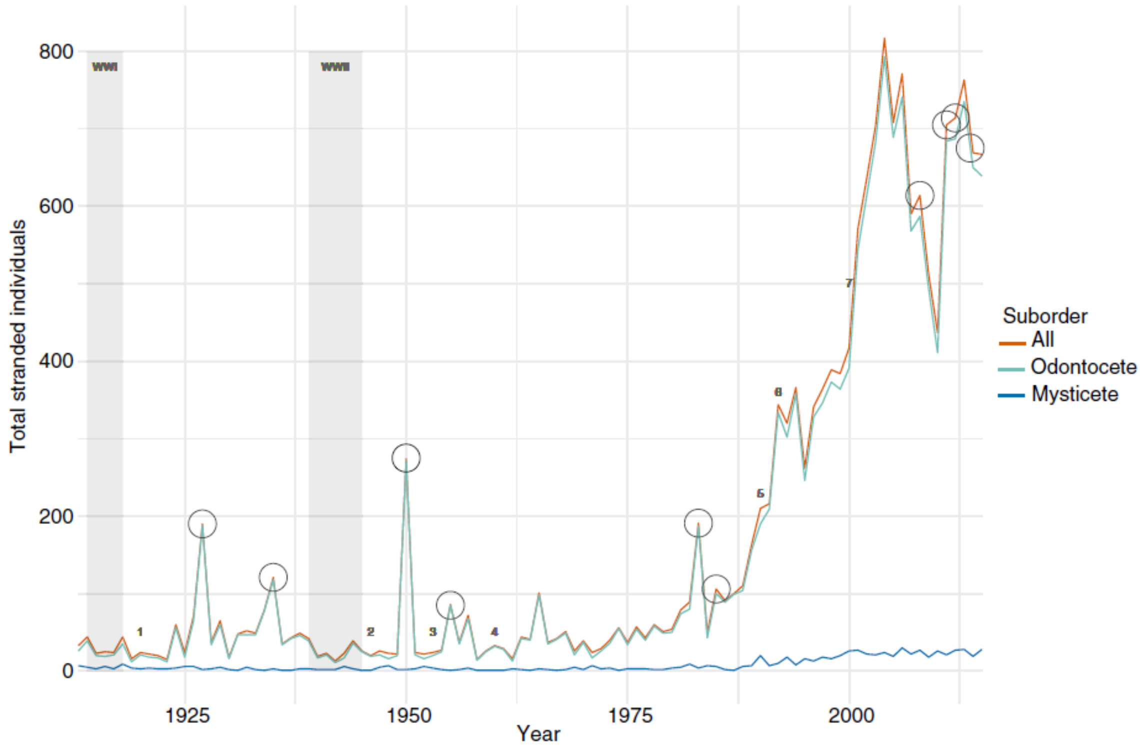
Cardigan Bay Wales bottlenose dolphin: Since 2001, the Sea Watch Foundation has been monitoring the bottlenose dolphin population inhabiting coastal waters of Cardigan Bay, with annual summer abundance estimates, mainly using photo-ID capture–mark–recapture approaches, but also some line-transect distance sampling (Lohrengel *et al.*, 2017). This monitoring effort has focused upon two Natura 2000 sites for the species, Cardigan Bay Special Area of Conservation in the south of the bay, and Pen Llyn a'r Sarnau Special Area of Conservation in the north of the bay. The former area has been surveyed on an annual basis whereas the latter has not been surveyed every year. Funding for the monitoring has come largely from Natural Resources Wales.

The latest estimates (summer 2019) were 138 (CV= 0.42; 95% CI=63–303) for the Cardigan Bay SAC, compared with 121 (95% CI 99–185) in 2018 using closed population models. The equivalent estimates using robust design population models were 141 (CV=0.39; 95% CI 67–295) in 2019, compared with 119 (95% CI 93–187) in 2018.

Over the 19-year period, population size has fluctuated both within Cardigan Bay SAC and the wider Cardigan Bay (Lohrengel *et al*., 2017), with evidence of movements between Cardigan Bay and areas to the north (North Wales, Liverpool Bay, and the Isle of Man), with females significantly more likely to spend the summer in the Bay when giving birth. Bottlenose dolphin responses to marine recreational activities in Cardigan Bay were investigated by Koroza (2018) and Vergara Peña (2019), and spatio-temporal trends in skin lesions within the population by Stylos (2019).

Coombs *et al*. (2019) presented an overview of cetacean strandings for the UK and Irish coastline covering the period 1913–2015. A total of 17 491 strandings comprising 21 species was recorded. The dataset contains 786 mysticete records from five species, and 16 705 odontocete records from 16 species. The most frequently stranded species were harbour porpoise (n = 8265; 47% of all stranding records), common dolphin (n = 3,110; 18%) and long-finned pilot whale (n = 1606; 9%). Temporal patterns in strandings varied across and within species.

Figure 19. Temporal stranding patterns of each cetacean species stranding in the UK and Ireland from 1913 to 2015. The y-axis shows total stranding count per year, the x-axis shows the year. (From Coombs *et al*., 2019)



1. 1920s: Sonar use in French and UK waters
2. 1946: NATO military testing in European waters: submarine, sonar, and torpedo testing increase
3. 1950s: Increase in post–war fishing and whaling effort
4. 1960s: Increase in use of polychlorinated biphenyls (PCBs) and other chemical pollutants
5. 1985/86 season: Moratorium on whaling comes into effect
6. 1990: The CSIP and IWDG programmes start
7. 2000s: Increase in pile–driving for offshore wind turbines

Figure 20. Temporal variation in cetacean strandings records for all species, odontocetes (toothed whales), and mysticetes (baleen whales) in the waters around the UK and Ireland from 1913 to 2015. Key anthropogenic events are labeled with numbers, with the corresponding text below the plot. Key periods are shaded in light grey. WWI is World War I, WWII is World War II, CSIP is the Cetacean Stranding Investigation Programme, IWDG is the Irish Whale and Dolphin Group. The circles highlight years with mass strandings of >20 individuals. (from Coombs *et al.*, 2019).

Generally, stranding records of all odontocetes increased throughout the 1990s to the present. Mysticete strandings showed an overall decline throughout the century until the 1980s. The data showed an increase in mysticete strandings after 1987 and throughout the 1990s to the present (Figure 20). Minke whales accounted for 79% of all mysticete strandings and also accounted for the majority of the rise in mysticete strandings after 1990. The CSIP and IWDG programs began in 1990, after which there was an increase in stranding records for both mysticetes and odontocetes. The analyis could not, in a satisfactory way, account for sampling effort. Therefore, it cannot take into account social and attitudinal changes over the 103 yr period that are likely to have had a significant impact on reporting effort.

Coombs *et al.* (2019) showed no correlation between the numbers of annually stranded cetaceans and several potential environmental and anthropogenic predictors: storms, geomagnetic activity, North Atlantic Oscillations, sea-surface temperature, and fisheries catch. This may be caused by the scale of change in the variables being too coarse to detect any potential correlations. It may also highlight the idiosyncratic nature of species' responses to external pressures, and further the need to investigate other potential correlates of strandings, such as bycatch and military sonar.

NORTHWEST EUROPEAN SEAS: WGMME 2019 (ICES, 2019) reported on the preliminary results from the five-year Marine Ecosystems Research Programme (MERP), funded by the UK Natural Environment Research Council and Department of Food, Environment and Rural Affairs, Sea Watch Foundation and Bangor University. As part of the Marine Ecosystems Research Programme (MERP), an analysis of cetacean and seabird survey data from the Northeast Atlantic to predict monthly density surface maps for several species of seabird and cetacean, using nearly 40 years of data (1980–2018), was recently published by Waggitt *et al*. (2020).

During the shared session with WGBIODIV, species distribution models were discussed and the applicability of the recent and species-wise extensive study by Waggitt *et al*. (2020) received particular attention.

WGMME discussed standardisation of the data sources, the modelling methodology and the applicability of model results (main issues briefly outlined below). WGMME recognised the breadth of the work in the MERP project but was only able to review the primary output available, *i.e.* Waggitt *et al*. (2020).

The MERP database used in Waggitt *et al*. (2020) comprises a large number of data sources, from systematic purpose-designed line transect surveys to non-systematic opportunistic surveys. WGMME acknowledges the desire to maximise the use of available data to inform conservation and management. However, combining a wide range of data sources, particularly incorporating non-systematic surveys, is extremely challenging for a number of reasons. A similar study confronted by the same challenges was conducted by Paxton *et al*. (2016) in which several strong assumptions were made in order to standardise the data. Paxton *et al*. (2016) concluded that "if these assumptions are incorrect then the conclusions will not be valid".

A critical issue when combining any survey data sources is that correction factors to account for differences in detection probability (i.e. esw and g(0)) are survey-specific. Estimating correction factors across groupings of data sources assumes that the covariates used to explain variability in the data can accurately reflect inter-survey differences. This is particularly important when incorporating non-systematic surveys, which are conducted in a wide range of different ways. Because non-systematic surveys typically do not use the full suite of methods necessary to meet the assumptions of line transect sampling, incorporating them effectively leads to coarsening of the systematic survey data included in the model. For further validation, it would be useful to investigate how the processing necessary to include the non-systematic (including European Seabirds at Sea ESAS) datasets influenced the final dataset that was modelled.

Also, combining such data sources may result in a spatial and temporal imbalance in effort and coverage. In Waggitt *et al*. (2020) this variability is confounded with survey type in some cases, but it is unclear what the effects of this are on the results.

Besides these potential issues, the study uses models that differed from conventional species distribution models (SDM). For some species, there is broad agreement of the output of the distribution models with previous studies, but for others, particularly the harbour porpoise, there are differences in the location of highest densities to previous modelling of data from systematic surveys (Gilles *et al*., 2016) and non-systematic surveys (Paxton *et al*., 2016). Further work should explore the reasons for these differences.

Waggitt *et al*. (2020) acknowledge that "these distribution maps still need careful interpretation" and that "outputs should not be used as a representation of absolute densities and fine-scale distributions at the present time". Instead, it is recommended that "outputs be used as a general illustration of relative densities and broad-scale distribution over several decades", but also stated that "while some caution is needed, these distribution maps have widespread and immediate applications". End users should be aware of the mentioned caveats and limitations in the interpretation of these density maps. WGMME encourages further work to use model outputs in a complementary manner, e.g. by applying ensemble model techniques.

1.3 Management frameworks (including indicators and targets for MSFD assessments)

1.3.1 Seal management frameworks

OSPAR Convention

Under the OSPAR Convention, there are currently two biodiversity indicators for seals: M3 (harbour and grey) seal abundance and distribution, and M5 grey seal pup production. Assessments of seal abundance and distribution aim to determine if populations are in a healthy state, with no long-term decrease in population size, beyond natural variability. Assessments of pup production examine trends in the number of grey seal pups born at long-established breeding sites. Future changes in distribution or declines in abundance or pup production would signal that populations are no longer in a healthy state, needing further studies to establish the cause of these changes and to determine whether management measures are required.

These two OSPAR seal indicators are common across Region II, Greater North Sea. These indicators also contribute to regionally coordinated assessments of the state of marine mammals and assessments of Good Environmental Status under Marine Strategy Framework Directive (MSFD) criteria: D1C2 – Primary (Abundance) and D1C4 – Primary (Distribution) for M3 and D1C3 – Secondary (demographic characteristics) for M5.

Seal abundance and grey seal pup production were assessed in the OSPAR Quality Status Report (QSR) 2010 by means of an OSPAR Ecological Quality Objective (EcoQO) in the Greater North Sea. The most recent seal indicator assessments were produced for the OSPAR Intermediate Assessment in 2017 (IA2017), and the next round of assessments will be produced for the QSR2023. WGMME has previously provided advice to OSPAR on the EcoQOs (ICES, 2010) and reviewing the IA2017 assessments (ICES, 2016).

HELCOM

In the Baltic Sea area HELCOM uses core indicators Population trends and abundance of seals and Distribution of Baltic seals. The evaluation of the indicators is based on the data from the standardized aerial monitoring during the moult and on more scattered information on breeding and foraging distributions. The Population trends and abundance of seals evaluates the state of the seal populations in each management unit.

For the grey seal population there is one management unit covering the whole Baltic population, excluding Kattegat. The harbour seal is evaluated in three management units: Kalmarsund, Southern Baltic and Kattegat. Evaluation for the ringed seal is separate for the Bothnian Bay and the Southern management unit (consisting of three sub-populations). Good status is achieved when the abundance is exceeding the limit reference level (LRL) of 10 000 animals and is growing with a natural rate when under carrying capacity or not decreasing more than 10% over a 10-year period when close to carrying capacity. The core indicator Distribution of Baltic seals reaches good status when the distribution of seals is close to pristine conditions considering haul out sites, breeding sites and foraging areas. The core indicators are evaluated in six-year assessment periods. The most recent indicator reports were published for the period 2011–2016 (HELCOM, 2018a, b).

1.3.2 Cetacean Management frameworks (including indicators and targets for MSFD assessments)

WGMME has reported in previous years on the development of common indicators and targets for the Marine Strategy Framework Directive (MSFD) primarily associated with the Marine Atlantic region (e.g. ICES, 2012, 2013, 2014, 2015, 2016, 2017, 2018 and 2019).

HARBOUR PORPOISE ABUNDANCE and DISTRIBUTION INDICATORS: In HELCOM, core indicators on harbour porpoise abundance (D1C2) and distribution (D1C4) within the HELCOM agreement area are being developed. The indicators build on data from continuous or recurring national monitoring programmes, and large-scale surveys such as SAMBAH carried out about once every decade. National monitoring data can be used for detecting local changes in porpoise occurrence and can be used for early warnings of changes, while large-scale surveys are needed for estimation of abundance and changes in distribution patterns on the level of the whole population.

MSFD-INDICATORS MACARONESIA: The MISTIC SEAS II pilot monitoring programmes in Macaronesia obtained abundance estimates for some species in 2017–2018 (Table 8). Of these, a selection was chosen as MSFD indicator species for the Macaronesian subregion: small, toothed cetaceans (Atlantic spotted dolphin, bottlenose dolphin and common dolphin), deep-diving, toothed cetaceans (Cuvier's beaked whale, Risso’s dolphin, short-finned pilot whale and sperm whale) and baleen whales (Bryde’s whale and fin whale (Table 9)). No formal assessment has yet been carried out to validate the adequacy and efficiency of the sampling strategy. However, the results make it clear that, for at least some species/management units, more search effort is needed (over a wider sampling period within each year and over multiple years) to reduce the CVs of the abundance estimates and increase the power to detect trends to the levels needed for MSFD assessment.

Table 9. Species proposed for monitoring MSFD descriptor 1 in the Macaronesian archipelagos of Azores, Madeira and Canary Islands. D1C1 = Mortality rate, D1C2 = Abundance and D1C3 Demographic characteristics Survival rate.

Species	Azores	Madeira	Canary Islands
Atlantic spotted dolphin	D1C1/D1C2	D1C2	D1C2
Bottlenose dolphin	D1C1/D1C2/D1C3	D1C1/D1C3	D1C2/D1C3
Common dolphin		D1C2	
Bryde's whale		D1C2	D1C2
Fin whale	D1C1/D1C2		
Cuvier's beaked whale			D1C2/D1C3
Risso's dolphin	D1C1/D1C2/D1C3		
Short-finned pilot whale		D1C2/D1C3	D1C2/D1C3
Sperm whale	D1C1/D1C2/D1C3	D1C1	D1C1/D1C2/D1C3
Monk seal		D1C1/D1C2/D1C3	

PCB INDICATOR: A report from the joint ASCCOBAMS/ASCOBANS working group on MSFD has highlighted the lack of pressure-related indicators for cetaceans within the OSPAR region, which are needed to help interpret changes in population status, and to successfully implement a programme of measures to achieve GES (Murphy, 2019). The ICES WGMME in 2013 proposed a mammal blubber PCB toxicity threshold indicator for inclusion as a biodiversity common indicator (ICES, 2013), which was further developed by the OSPAR Marine Mammal Expert Group (OMMEG), and the proposed pollutant indicator was reviewed by OSPAR's BDC and HASEC committees in 2019. Monitoring PCBs in cetaceans is considered a key aspect in assessing GES (according to MSFD). Within both OSPAR's BDC and HASEC committees, Contracting Parties expressed support for continued evaluation of a marine mammal contaminants-effects based indicator. It was also recommended to broaden the indicator to trends and status of persistent chemicals in marine mammals. As a result, continued research is required to identify other potential chemicals that could be included within the indicator (Murphy, 2019).

1.4 New information on anthropogenic threats

1.4.1 Update on cumulative effects

A modelling tool to quantitatively assess cumulative impacts of pile driving for offshore wind farm (OWF) construction on harbour porpoise was tested within the Strategic Environmental Assessment North Sea Energy as an aid for Maritime Spatial Planning (SEANSE) project. The SEANSE project was co-funded by the EU's European Maritime and Fisheries Fund. It started in early 2018 and was finalized in the beginning of 2020. The cumulative effects of impulsive underwater sound from OWF developments in the North Sea on the harbour porpoise population were assessed by applying the procedure that was developed by a Dutch expert group (Heinis *et al*., 2015; 2019).

Sound propagation by pile driving was calculated using the Aquarius 4 model that was developed by TNO in the context of the Offshore Wind Energy Programme (Wozep) (see de Jong *et al*., 2019a). Output from the iPCoD (Interim Population Consequences of Disturbance) model is presented as probability of impacts on the population. The probability of a population reduction due to the scenarios modelled, is quantified by the 5%, 10% and 50%-percentiles of the difference in size between the disturbed and undisturbed populations. The results for a scenario taking into account windfarm developments up to 2038 under current mitigation regimes show a 5% probability of a population reduction by 13% in 2038, and a 50% probability of a population reduction by 2% in that year (de Jong *et al*., 2019b).

However, any results should be interpreted with caution as the authors identified uncertainties and/or knowledge gaps relating to quantification of sound source and propagation, threshold values for disturbance/changes in behaviour, quantification of the number of disturbed animals, vulnerable subpopulation, extrapolation of animal disturbance to effects on vital rates, assumptions in Interim PCoD model about population development and demographic parameters, and scenario definition.

1.4.2 Foodweb

In many areas seal populations have been recovering and understanding their possible role in the ecosystem has become a growing important issue. ToR B provides a review and updates information on the ecological role of marine mammals. To avoid repetition, information can be found under that ToR.

1.4.3 Fishery bycatch

For information on bycatch we refer to ToR C.

1.4.4 Pollution

There are a number of studies currently ongoing in western European waters into contaminants and chemical pollutants including, inter alia, Persistent Organic Pollutants (POPs); these include studies from the UK, Ireland, France and Sweden.

IRELAND: A study examining legacy pollutants such as polychlorinated biphenyls, organochlorine pesticides, brominated flame retardants and heavy metals in a range of cetacean species is currently being carried out by researchers at the Galway-Mayo Institute of Technology. Previously, the Marine Institute analysed blubber tissue samples on an *ad hoc* basis for organochlorines and a range of other pollutants.

Hernandez-Milian *et al.* (2019) investigated incidence and distribution of microplastics along the intestines of 13 grey seals that were bycaught in trammelnets targeting monkfish and rays off the south coast of Ireland between 2012 and 2015. All seal intestines contained microplastics. A total of 363 particles were identified, 85% of which were fibers, 14% fragments and 1% films. Acantocephala parasites (n = 1543) were found in 12 seals, with an average of 74.5 ± 67.7 parasites per seal. Distribution of microplastics varied between seals, although microplastics tended to accumulate in areas where more parasites were aggregated. Aggregations of helminth parasites may decrease the intestinal lumen and increase the contact surface within the intestinal lumen, therefore microplastics may have more chances to be retained in these areas. Most of the Acantocephala parasites in seal intestines tend to aggregate between the 9th and the 15th section. Although no statistical relationship with such aggregations was found in this study, microplastics were found to be more abundant before the 14th section of the intestine.

FRANCE: Work was recently been undertaken to assess POPs in blubber and mercury (THg) in the skin of free-ranging bottlenose dolphins from the Normanno-Breton Gulf. Among the POPs analysed, the ΣNDL-PCBs (non-dioxin-like PCBs) were the most abundant compounds found in the blubber, with mean concentrations greater for males than females (Zanuttini *et al.*, 2019), while among the DLPCBs, the hexachlorobiphenyls (PCB 153 and PCB 138) were the major compounds (ranging from 64 to 80%). Within the study, the majority of bottlenose dolphins exceeded the higher 41 mg/kg threshold. Analysis of temporal trends of organic contaminants in harbour porpoises in French waters is currently being undertaken. Samples from 67 male porpoises (sampled between 2001 and 2017) have been processed. 69.7% of porpoises showed PCB concentrations above Kannan's toxicity threshold of 17 μg/g lipid weight for total PCBs (as Aroclor 1254[1]) (Paula Mendez Fernandez unpublished data, in Murphy, 2019).

DENMARK: Sonne *et al*. (2019) investigated the human exposure to polychlorinated biphenyls, perfluorinated compounds and mercury through ingestion of harbour seal meat from the southern Baltic. Consumption should not exceed around 50 g to be within tolerable weekly intake of mercury and perfluorinated compounds.

SWEDEN: Sweden is participating in a baseline study to assess the impact of hazardous substances on the health of harbour porpoises in the OSPAR region. It is anticipated that results will

[1] The 17 mg/kg lipid PCB toxicity threshold for the onset of earliest physiological (reproductive and immunological) endpoints in marine mammals was based on observed effects in experimental studies on seals, otters and mink (Kannan *et al*., 2000). This was calculated to be equivalent to 9.0 mg/kg, as sum Σ25CBs (individual chlorobiphenyl congeners) lipid) (Jepson *et al*., 2016).

be included in an assessment or description of the health status of harbour porpoise in OSPAR's Quality Status Report in 2023 (Murphy, 2019).

UK: The largescale ChemPop project, involving partners from the Centre for Ecology and Hydrology, the Institute of Zoology London, University of Hull and Brunel University London, runs until 2022 and is funded by NERC. The project is investigating trends in a number of POPs and the risks they pose to cetaceans in UK waters, including harbour porpoise, bottlenose dolphins, and killer whales. A second project, funded by the UK Department of the Environment, Food and Rural Affairs is undertaking analysis of PCBs in UK-stranded species; including the common dolphin, striped dolphin, Atlantic white-sided dolphin, white-beaked dolphin, Risso's dolphin, long-finned pilot whale, harbour porpoise and killer whale. Analyses from this project will also assess blubber and muscle samples in harbour porpoises, to investigate the potential impact of lipid mobilisation.

Williams *et al*. (2019) showed that mean blubber PCB concentrations in tissue samples of UK-stranded harbour porpoises collected between 1990 and 2017 (n = 814), have fallen below the thresholds for toxic effects (9 µg/g lipid; Kannan et al., 2000). Blubber PCB concentrations appeared to be in decline at the beginning of the study period (1990–1998), this appeared to stop around 1998, after which concentrations were stable until 2006. In the most recent years of the study, PCB blubber concentrations have begun to decline again and, in 2007, fell below the aforementioned threshold. Despite finding that blubber PCB concentrations for the UK have fallen below the most widely used toxicity threshold, there are still individuals that are above this threshold. Levels in West England and Wales were declining slower than in the rest of the U.K. and may still be above the toxicity threshold.

Robinson *et al*. (2019) investigated changes in the concentrations of persistent organic pollutants (POPs) in blubber from weaned grey seal pups from the Isle of May (Scotland) between 2002 and 2015–2017. Polychlorinated biphenyls decreased to ca 75% of the 2002 values while DDT and its metabolites did not decrease detectably. These small or absent changes may mean that grey seal pups in this area are still at risk from adverse effects on endocrine status and immune function from these legacy contaminants and highlight the need for continued investigations. Also using blubber biopsies of grey seal pups from the Isle of May, it was established that POPs affected the metabolic characteristics of the adipose tissue, potentially affecting the energy balance regulation of the seals (Robinson *et al*., 2018).

Nelms *et al.* (2019) described a new methodology to examine the feasibility of assessing prey composition in detail, and detecting microplastics in the scats, concurrently. They demonstrated the efficacy of using DNA metabarcoding combined simultaneously with a microplastic extraction process to investigate the relationship between specific prey types and the abundance of microplastics detected in scats from seals.

USA: Hudak and Sette (2019) investigated fecal samples from Massachussets haul outs from 2016–2017 from grey and harbour seals for anthropogenic micro debris. Debris >500 µm was found in two of 32 harbour seal scats and 2/129 grey seal scats. The debris was identified as cellophane, alkyd resin and EPDM rubber.

1.4.5 Underwater noise

Given a global rise in anthropogenic underwater noise and the vital importance of underwater sound for marine mammals, research on the potential effects underwater noise are increasing. In their review on the effects of ship noise on marine mammals, Erbe *et al.* (2019) conclude that the majority of studies have been patchy in terms of their coverage of species, habitats, vessel types, and types of impact investigated. They state that there is an urgent need for standards on study design, data analysis and reporting so that results (mostly obtained for more easily accessible species) are comparable (across space and time). This can also effect that these data can be synthesized to address the major questions on the consequences of chronic exposures, as well as the role of context in determining the response to shipping noise.

BELGIUM: Norro (2019) studied the effectiveness of underwater sound mitigation measures used during pile driving for the Norther offshore wind farm at the Belgian coast. Underwater sound mitigation measures are required to lower the sound pressure generated during pile driving to reduce impacts on harbour porpoises. The sound mitigation system (insertion loss) applied in this project was a Single Big Bubble Curtain (BBC). In addition, for five monopiles, experiments were conducted using the AdBm Noise Mitigation System, a stationary resonator system, either alone or together with the BBC. In this study, the underwater sound generated was recorded during five full pile driving events, including during three of the stationary resonator experiments. The diameter of the monopiles ranged from 7.2 to 7.8 m. The hammer used during this project was capable of a maximal energy of 3500 kJ. In situ measured zero to peak sound levels (Lz-p) showed values ranging from 188 to 200 dB re 1 µPa (normalised to a distance of 750 m from the source) respectively. The higher values were recorded when no sound mitigation measures were deployed at all, and with the lower sound levels when the AdBm and BBC noise mitigation systems were both active. Based on these measurements, the sound mitigation achieved by the BBC was in the single digit range, and double-digit reduction was only achieved when both mitigation systems were working concurrently, achieving an 11 dB re 1 µPa (Lz-p) reduction. As previously observed, there was a lower-than-expected performance of the sound mitigation measures, which is likely to be due to local hydrodynamic conditions and or sub-optimal use of the devices.

In May 2019, a permanent acoustic recording station was installed in the Belgian part of the North Sea by the Royal Belgian Institute of Natural Sciences in the framework of the project 'Joint Monitoring Programme for Ambient Noise North Sea' (JOMOPANS). The new equipment is part of a network of 14 monitoring stations and will help in understanding how underwater noise is distributed over the North Sea (Merchant *et al.*, 2018).

DENMARK: Hermannsen *et al*. (2019) studied the noise contribution of vessels with and without AIS (non-AIS) in a shallow coastal area within the Inner Danish waters. They showed that motorised non-AIS vessels (primarily recreational vessels) contribute significant noise in the study area, with elevations in ambient noise in third-octave bands at 0.125, 2 and 16 kHz of up to 55, 47 and 51 dB, respectively. Furthermore, due to their high prevalence (83% of all vessels) and proximity to the coast, recreational vessels dominated the soundscape in all three frequency bands. They concluded that AIS data would therefore poorly predict vessel noise pollution and its impacts in many shallow, coastal habitats with protected marine life. This is largely due to the movement patterns of these vessel types, with large AIS vessels mainly travelling in offshore shipping lanes, while recreational boating occurs primarily along the coast. They suggest improving vessel noise models and impact assessments by requiring that faster and more powerful recreational vessels carry AIS transmitters. In addition, their results suggested that that the current European MSFD bands at 63 and 125 Hz are poor proxies for vessel noise loads at mid-to-high frequencies in shallow water environments, and therefore of little use in assessing acoustic habitat quality for small marine mammals in shallow waters. A TOL (third-octave level) centred at 2 kHz, as proposed by the BIAS project (Nikolopoulos *et al*., 2016), would be a better predictor of vessel noise at higher frequencies.

Sarnocinska *et al.* (2020) investigated the effects of a 3D seismic survey on harbour porpoise echolocation activity in the Danish sector of the North Sea. This was achieved by deploying porpoise click detectors (C-PODs) and sound recorders (SM2M and SM3M) both inside and adjacent to the seismic survey area, before, during and after the survey over a total duration of nine months. Decreases in echolocation signals were detected up to 8–12 km from the active airguns, which may indicate temporary displacement of porpoises or a change in porpoise echolocation behaviour. However, no general displacement of harbour porpoises away from the seismic survey area could be detected when comparing to reference stations 15 km away from any seismic activity.

Stöber and Thomsen (2019) compared three established exposure criteria frameworks from Germany, Denmark, and the US to analyse the effect of impact pile driving at a location in the Baltic Sea on harbour porpoise and harbour seal hearing. The acoustic modelling using MIKE showed that an unmitigated scenario would lead to auditory injury under all three criteria. Despite readily apparent variances in impact ranges among the applied approaches, it was also evident that noise mitigation measures could reduce underwater sound to levels where auditory injuries would be unlikely in most cases. It was concluded that each of the frameworks has its own advantages and disadvantages. Single noise exposure criteria follow the precautionary principle and can be enforced relatively easily. Criteria that consider hearing capabilities and animal response movement can improve the accuracy of an assessment, if data are available.

GERMANY: Schaffeld *et al.* (2020) evaluated the effects of multiple exposures to pile driving noise on harbour porpoise hearing during simulated flights. They determined that the deterrence prior to pile-driving events is particularly important and has to be monitored to give harbour porpoises sufficient time to leave hazardous areas at moderate speeds. Based on their simulation approach, only the combination of restricting the maximum SELSS to 160 dB re 1 lPa2 s at a distance of 750 m (German pile driving threshold), a previous deterrence and a soft start with reduced energy and longer pulse intervals allow harbour porpoises to avoid a TTS from multiple exposures. However, the authors note that uncertainty remains about deterrence efficiency and possible effects of deterrence devices.

Acoustic deterrent devices (ADDs) are mainly used to deter seals from aquaculture sites but exposure of harbour porpoises occurs as a side effect. At construction sites, by contrast, ADDs are frequently used to deter harbour porpoises from the zone in which pile driving noise can induce temporary threshold shifts (TTSs). However, ADDs emit such high sound pressure levels that there is concern that ADDs themselves may induce a TTS. In a study by Schaffeld *et al.* (2019) a harbour porpoise in human care was exposed to an artificial ADD signal with a peak frequency of 14 kHz. A significant TTS was found, measured by auditory evoked potentials, with an onset of 142 dB re 1 lPa2s at 20 kHz and 147 dB re 1 lPa2s at 28 kHz. They therefore strongly recommended to gradually increase and down-regulate source levels of ADDs to conform to the desired deterrence range.

The Gescha 2 study (Rose *et al.*, 2019) analysed the impact of the construction of eleven offshore wind farms (OWFs) and offshore converter platforms (OSS) built in the German North Sea and adjacent Dutch waters in the period 2014–2016 on harbour porpoises. The dataset combines porpoise monitoring data from passive acoustic monitoring using Porpoise Detectors (CPODs) and digital aerial survey data with measured data on noise levels in 750 m and 1500 m distance from the piling location as well as other piling characteristics. The effect range regarding porpoise detection rates based on all hourly CPOD data during mitigated pile driving from all projects within Gescha 2 was at 17 km (std. error range: 15–19 km). The effect duration at close range lasted from 28 hours (lower SE not available; upper SE 22 hours) before until 48 hours (lower SE 35 hours; upper SE not available) after stop of pile driving. These values were similar to those obtained for pile driving activities without noise mitigation (Gescha 1 – Brandt *et al*., 2016). The authors highlight five possible explanatory approaches which might be relevant alone or in combination: stereotypical escape distance, increasing relative importance of the displacement ef-fect of seal scarers, either construction-related noise, cumulative effects due to tight piling sequence and habitat characteristics at different OWF areas.

IRELAND: Kavanagh *et al.* (2019) modelled over 8000 hours of cetacean survey data across a large marine ecosystem covering >880 000 km² off the west coast of Ireland to investigate the effect of seismic surveys on baleen and toothed whales. They observed an 88% (82–92%) decrease in sightings of baleen whales, and a 53% (41–63%) decrease in sightings of toothed whales during active seismic surveys when compared to control surveys. Significantly fewer sightings of toothed whales also occurred during active versus inactive airgun periods of seismic surveys, although some species-specific response to noise was observed. This study provides strong evidence of multispecies impacts from seismic survey noise on cetaceans.

Todd *et* al. (2020) used nine years of passive acoustic monitoring data paired with environmental covariates to study the spatio-temporal dynamics of harbour porpoise and dolphin species in a protected marine area in northwest Ireland (Broadhaven Bay) using generalised estimating equations-generalised linear models (GEE-GLMs). Construction activity had a significant negative effect on the presence of porpoises, but not dolphins. However, no subsequent long-term decrease in detection rates of porpoise was recorded.

LITHUANIA: On the seabed of the Lithuanian Baltic Sea area as in other Baltic Sea areas, unexploded ordnances remain, which are progressively eliminated. Removal of this unexploded ordnance usually radiates very high levels of sound energy into the marine environment. These high acoustic energy levels can injure or negatively affect marine animals. Bagočius and Narščius (2019) predicted and validated the resulting sound exposure spectra for variable charge weights by scaling laws using models derived from empirical data. They then applied mammal auditory weighting functions to determine mammal-specific sound exposure levels, which can be used for the environmental impact assessments and evaluation of environmental state.

NETHERLANDS: Broadband impulsive sounds generated by pile driving may disturb and distract marine mammals such as harbour porpoises; their concentration may be reduced, affecting the skills they need for foraging or reduce their ability to catch prey and, thus, their foraging efficiency. Kastelein *et al*. (2019a) studied the effects of impulsive pile-driving playback sounds on the ability of two captive harbour porpoises to catch fish. Their results suggest that high-amplitude pile driving sounds are likely to negatively affect foraging in some harbour porpoises by decreasing their success rate and increasing the termination rate of their fish-catching attempts; the severity of the effects is likely to increase with increasing pile driving SELss. However, individual differences in responses to sound, termination rates, and fish-catching success (even in ambient conditions) may complicate the quantification of the impacts of pile driving sounds on harbour porpoises. In order to understand the effects of reduced foraging efficiency, Kastelein *et al*. (2019b) quantified the body mass and blubber thickness of two captive porpoises while they were kept under ambient temperature conditions similar to those experienced by wild conspecifics in the North Sea, while they were near-fasting (i.e., almost fasting) for 24 hours (consuming 3 to 10% of the average daily food intake of their normal ration in each period). A linear mixed-effects model showed that mass loss was greatest overall in autumn, lowest in summer, and intermediate in winter and spring. Harbour porpoises, therefore, appear to be most vulnerable to the effects of fasting due to disturbance in autumn, perhaps because their blubber layer must increase in autumn to cope with the decreasing water temperature.

TTS was induced in two captive harbour seals after 60 min exposures to a 6.5 KHz tone at 123–159 dB re 1 μPa. Both seals showed similar results. The greater the exposure, the higher was the TTS induced at frequencies above the eliciting sound's center frequency (Kastelein *et al*., 2019c). TTS was also induced in two captive harbour seals by playback of pile driving sounds, but only after 360 min exposure at 151 dB re 1 μPa at 2760 strikes per hour. TTSs were small and hearing recovered after 60 minutes (Kastelein *et al*., 2018).

Hearing thresholds of harbour seals for Helicopter Long Range Active Sonar (HELRAS) were estimated by Kastelein *et al.* (2019d), allowing distances of detection by harbour seals to be calculated. It was concluded that harbour seals detect HELRAS at greater distances than harbour porpoises.

NORWAY: To understand the consequences of underwater noise exposure for cetaceans, there is a need for assessments of behavioural responses over increased spatial and temporal scales. Bottom-moored acoustic recorders and satellite tags provide such long-term and large spatial coverage of behaviour compared to short-duration acoustic-recording tags. However, these tools result in a decreased resolution of data from which an animal response can be inferred, and no direct recording of the sound received at the animal. Von Benda-Beckmann *et al*. (2019) discussed the consequence of the decreased resolution of data from satellite tags and fixed acoustic recorders on the acoustic dose estimated by propagation modelling and presented a method for estimating the range of sound levels that animals observed with these methods have received. This problem was illustrated using experimental results obtained during controlled exposures of northern bottlenose whales exposed to naval sonar, carried out near Jan Mayen, Norway. It was shown that variability and uncertainties in the sound field, resulting from limited sampling of the acoustic environment, as well as decreased resolution in animal locations, can lead to quantifiable uncertainties in the estimated acoustic dose associated with the behavioural response (in this case avoidance and cessation of foraging). The same experiment showed that northern bottlenose whales in a pristine environment responded strongly to both proximate and distant navy sonar signals (Wensveen *et al*., 2019). There was no indication that the source distances tested in the experiments modulated the behavioural effects of sonar, as has been suggested for locations where whales are frequently exposed to sonar.

UNITED KINGDOM: Estimating impacts of offshore windfarm construction on marine mammals requires data on displacement in relation to different noise levels and sources. Using echolocation detectors and noise recorders, Graham *et al*. (2019) investigated harbour porpoise behavioural responses to pile driving noise during the 10-month foundation installation of the Beatrice Offshore Windfarm off the east coast of Scotland. In contrast to current UK guidance, which assumes total displacement within 26 km of pile driving, they recorded a 50% probability of response within 7.4 km (95% CI = 5.7–9.4) at the first location of pile driving, decreasing to 1.3 km (95% CI = 0.2–2.8) by the final location; representing 28% (95% CI = 21–35) and 18% (95% CI = 13–23) displacement of individuals within 26 km. Distance proved as good a predictor of responses as audiogram-weighted received levels, presenting a more practicable variable for environmental assessments. Critically, acoustic deterrent device (ADD) use and vessel activity increased response levels. Policy and management to minimize impacts of renewables on cetaceans have concentrated on pile driving noise. These results highlight the need to consider trade-offs between efforts to reduce far-field behavioural disturbance and near-field injury through ADD use.

Verfuss *et al*. (2019) conducted a review of noise abatement systems (NAS) for offshore wind farm construction noise, and the potential for their application in Scottish waters identifying significant uncertainties and knowledge gaps regarding the deployment and efficiency of NAS in reducing the impact on marine animals in waters deeper than 45 m. Only two kinds of NAS have so far been applied in water depths found in potential future Scottish OWF-sites and are commercially available: Big Bubble Curtains (BBC) and Vibrohammers (VH). Although the application of BBCs in waters deeper than 45 m was found to be challenging due to the need for an increasing number of compressors to form a suitable bubble curtain at higher hydrostatic pressures, and to counteract against the drift of the bubbles on their path to the water surface, especially in locations with strong currents. Vibrohammers on the other hand are currently mostly used in connection with a conventional piling hammer and emit a different kind of noise that may need further assessment to ensure that this method indeed reduces the impact on marine mammals. The use of resonators may also be a potential solution for use in Scottish waters, but field experience is lacking in waters deeper than 45 m.

GPS-tagged harbour seals showed avoidance behaviour to playback of tidal turbine noise with localized reduction of area usage between 11% and 41%. This behaviour is likely to reduce risk of collision with such structures for seals (Hastie *et al*., 2018). A study of harbour seal behaviour around an actual tidal turbine in Scotland showed that it did not present a barrier to seal movement, but transits were reduced and more transits occurred at slack water than when the current was running and thus driving the turbine (Sparling *et al*., 2018).

Gordon *et al*. (2019) used a controlled exposure experiment to test the reactions of GPS/UHF tagged harbour seals to acoustic deterrent devices (ADD) and killer whale calls. The reactions to killer whale calls were highly variable, but it was suggested that signals similar to those of the Lofitech ADD could be used to reduce risks of TTS and PTS to harbour seals from intense underwater sound exposures like pile driving and explosions.

USA: A permanent hearing threshold shift (PTS) of at least 8 dB at 5.8 KHz was detected in a captive harbour seal exposed to a 60 s tone of 181 dB re 1 μPa, following an unexpectedly large temporary threshold (TTS) shift of >47 dB (Reichmuth *et al*., 2019). This is the only reported case of permanent threshold shift in a marine mammal from a known acoustic exposure.

1.4.6 Disturbance

UNITED KINGDOM: Paterson *et al*., 2019 investigated the effects of disturbance on harbour seals on a haul out in western Scotland. Seals were approached with a boat until all hauled-out seals had entered the water. Counts of seals returned to 52% of pre-disturbance levels after 30 minutes, but only returned to 94% after 4 hours. Telemetry tagged seals were not induced to move to a different haul out after disturbance. Tagged seals were not deterred from hauling out within the same low tide cycle following disturbance.

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2 ToR B. Review foraging areas and estimate consumption by relevant seal and cetacean species in case study areas

This ToR arose to facilitate the work under the Working Group on Biodiversity Science's (WGBIODIV) ToR A: "Investigate mechanisms linking trophic guilds under contrasting levels of pressure and/or primary production in case study areas". Under this ToR, WGBIODIV aims to:

i. use diet/trait information and predator and prey abundance to estimate potential impact on prey due to consumption by predators;
ii. contrast risk due to natural mortality (consumption) with risk due to fishing pressure;
iii. project change in risk for prey groups due to increase in predator abundance or shifts in community composition as predator communities recover;
iv. clearly define roles of top–down control and bottom–up limitation at different trophic levels.

To help achieve (i), WGMME is in a position to source and collate available information on the diet, foraging distribution and abundance of marine mammal species, and to use this information to estimate consumption by these species.

WGMME held a joint meeting with WGBIODIV in February 2020 to discuss how this collaborative work could progress. This discussion was facilitated by a number of presentations.

Thompson described work to assess change in functionally distinct feeding "guilds", a focus that has been widely advocated to support environmental status assessment, but has not yet been incorporated into MSFD indicator frameworks for biodiversity and foodwebs. Changes in the biomass distribution, interactions and energy flux of feeding guilds (i.e. predator groupings based on diet composition, e.g. planktivores, benthivores and top predators) and their underlying drivers have been investigated for the North Sea fish assemblage using a database of feeding interactions that covers the Northeast Atlantic (Thompson *et al.*, in press). Seven distinct guilds were evident, with spatial structure in their biomass distribution, and change relating to changes in resource availability, temperature, fishing, and the biomass of other guilds. A systematic method for defining feeding guilds was presented that is applicable across systems, while enabling new data from e.g. mammals and seabirds, to be added efficiently. Findings will support biodiversity and foodweb status assessments and Ecosystem Based Management.

Ransijn described two areas of recent work: (a) generation of spatially referenced estimates of the energy represented by harbour porpoise prey; and (b) development of multispecies functional response models to estimate consumption of prey by harbour porpoise (*Phocoena phocoena*).

A recent study (Ransijn *et al.*, 2019) generated maps of the energy represented by different species of harbour porpoise prey (Atlantic cod, whiting, European sprat, Atlantic herring and sandeels) for 2005 and 2016, the years in which the most recent North Sea-wide cetacean surveys (SCANS-II and SCANS-III) were carried out (Hammond *et al.*, 2017). Overall, results show high amounts of energy potentially available in the North Sea mostly contributed by whiting and sandeels. Mean estimates of total energy ranged between 21 610 and 30 764 megajoule (MJ) per km^2 (winter and summer, respectively) in 2005 and between 34 661 and 76 938 MJ per km^2 (winter and summer, respectively) in 2016. Ongoing work is exploring the uncertainty of these estimates. These maps and uncertainty estimates will be included as candidate explanatory covariates in the development of spatial models to explore the relationship between harbour porpoise distribution and prey availability. Results should be finalised and published in the summer of 2020 (Ransijn *et al.*, in prep a).

Ransijn *et al*. (in prep b) modelled a multispecies functional response to describe the relationship between consumption by harbour porpoises and the availability of multiple prey species in the southern North Sea. Harbour porpoise prey consumption was estimated from stomach contents data from the Netherlands collected between 2006 and 2014 (Leopold, 2015). Prey availability was estimated based on the spatial overlap between prey distributions, estimated from fish survey data, and porpoise foraging range in the days prior to stranding, predicted from telemetry data (Sveegaard *et al*., 2011, 2012; Teilmann *et al*., 2007). The shape of the functional response leads to different implications for system function (Smout *et al*., 2010) and the coexistence of species (Vincent *et al*., 1996). Results indicated a Type III functional response indicative of prey switching (i.e. a change in prey preference with changes in prey abundance). The consumption of sandeels remained high, even when other prey species were relatively abundant, indicating that porpoises in this area seemed to have a strong preference for sandeels. Future work will broaden this approach to develop multispecies functional response models for grey and harbour seals.

Brasseur described the results of a study to estimate the impact of harbour seal predation on the fish community in the Wadden Sea and nearby coastal waters (Aarts *et al*., 2019). The harbour seal population in the Wadden Sea grew exponentially following a ban on seal hunting in 1960s, and the current estimate of ~38 000 is close to the historic population size. Fish remains in faecal samples and published estimates on the seal's daily energy requirement were used to estimate prey selection and the magnitude of seal consumption. Estimates on prey abundance were derived from demersal fish surveys, and fish growth was estimated using a Dynamic Energy Budget model. GPS tracking provided information on where seals most likely caught their prey. Harbour seals hauling-out in the Dutch Wadden Sea fed predominantly on demersal fish, including flatfish (flounder, sole, plaice, dab), cod, whiting and sandeel. Although harbour seals acquire the majority of prey further offshore in the adjacent North Sea, and only spend 14% of their diving time in the Wadden Sea, seal predation was still estimated to cause an average annual mortality of 43% of the remaining fish in the Wadden Sea and 60% in the nearby shallow coastal waters (<20 m). There were, however, large sources of uncertainty in the estimated impact of seals on fish, including the migration of fish between the North Sea and Wadden Sea, and catchability estimates of the fish survey sampling gear, particularly for sandeel and other pelagic fish species. The estimated predation mortality suggested a considerable top–down pressure by harbour seals on demersal fish. However, predation by seals may also alleviate density-dependent competition between the remaining fish, allowing for increased fish growth, and partly compensating for the reduction in fish numbers. This study shows that recovering coastal marine mammal populations could become an important component in the functioning of shallow coastal ecosystems.

Hammond described ongoing work to model the distribution of cetaceans in the European Atlantic based on data from large-scale surveys conducted in 2005/07 (SCANS-II, CODA) and in 2016 (SCANS-III and ObSERVE) (Hammond *et al*., 2013, 2017; Rogan *et al*., 2018). The aim is to investigate changes in the distribution of the main species and guilds of cetacean, and in species diversity, in the area over this period. The survey data were analysed to estimate detection probability, including correcting for animals missed on the transect line using mark-recapture distance sampling methods for ship survey data and circle-back (racetrack) analysis for aerial survey data. Generalised Additive Models were used to fit smooth relationships between density and a suite of candidate environmental variables for each species for each survey. Overall, the main variables influencing distribution were found to be geographic and physiographic (depth, especially, and also seabed slope); dynamic oceanographic variables had relatively little influence. The deep-diving species (sperm, beaked and pilot whales) were distributed primarily along the shelf edge and predicted distribution changed rather little between 2005/2007 and 2016. The distribution of the baleen whales also changed little over this period (minke whale primarily in northern shelf waters and fin whale primarily in the Bay of Biscay). Of the smaller cetaceans, harbour porpoise, white-beaked dolphin and striped dolphin also showed relatively little change, but changes were evident in the distribution of common dolphin and bottlenose dolphin to the west of Britain and Ireland and in the northern Bay of Biscay. Maps of species diversity showed relatively low diversity in the northern part of the area, but high diversity in the Bay of Biscay. The Celtic Sea appeared less diverse in 2016 than in 2005/2007.

Following discussion of these presentations, it was agreed that, in the first instance, the focus of joint work of WGMME and WGBIODIV should be on harbour porpoise, grey seal and harbour seal in the North Sea. This was a suitable case study area because the information available for these species in this area is more comprehensive than for other species/areas.

As a first step Table 10 was created, which lists the available datasets and information that could be used in this activity, focusing on the North Sea and the three focal species, but also including other species and other areas. This table is intended to be refined as the work under this ToR progresses and could be enlarged.

Some additional new information related to the topic of this ToR was also received.

Grey seal diet and prey consumption in Norway

To obtain knowledge of feeding habits and prey consumption of grey seals, data were sampled in selected areas along the Norwegian coast. Prey were recovered from 182 grey seal gastrointestinal tracts and 199 scat samples, collected during 1999–2010 in Finnmark, Nordland and Rogaland counties. The most important prey were saithe *Pollachius virens*, cod *Gadus morhua* and wolffish *Anarchichus* spp. Wolffish was mainly eaten by seals ≥ five years old. Otherwise, the data did not suggest important temporal or spatial variations between the main prey items in the grey seal diet. However, capelin *Mallotus villosus* was eaten during spring in Finnmark suggesting that seasonally abundant pelagic fish species could be regionally important. Assuming that the observed grey seal diet composition in the sampling areas was representative for the diet along the Norwegian coast, the mean total annual consumption by 3850 grey seals was estimated to be 8084 tons in Norwegian waters; saithe (3059 tons), cod (2598 tons,) and wolffish (1364 tons) were consumed in highest quantities. The estimated total grey seal consumption of cod, 2598 tons (95% CI: 1311–3164), is assumed to include both coastal cod and Northeast Arctic cod. Norwegian annual fishery catches of coastal cod and Northeast Arctic cod were 35 000–39 000 tons and 192 000–378 000 tons, respectively, in the period 2003–2015. The leisure and tourist catch of coastal cod was estimated to be 13 000 tons in 2015 (Nilssen *et al.*, 2019).

Harbour seal diet in the Norwegian Skagerrak

Harbour seal diet was explored in four areas along the Norwegian Skagerrak coast. The overall seal diet included 20 different fish species/groups. Gadoids and flatfish (families Pleuronectidae and Bothidae) comprised approximately 90% of the species. The most important prey in terms of relative numerical frequency were gadoids of genus *Trisopterus*, i.e. Norway pout, poor cod and bib (27.3%), long rough dab/witch (13.7%), whiting (12.7%), and haddock/pollack/saithe (9.5%). Cod constituted about 1% of the overall diet. Species richness and diet composition varied between seasons and locations. Harbour seals generally preferred small fish below the minimum allowed landing size. The estimated total annual amount of fish consumed by harbour seals was four times lower than the total annual landings by local fisheries (all species pooled). Estimated consumption of cod was only 3% of the annual cod landings, suggesting that competition between local fisheries and harbour seals is limited (Sørlie *et al.,* submitted).

Grey seal birth rates in Finnish waters

Baltic grey seal reproductive rate was shown to correlate with changes in the foodweb, particularly the sizes of herring and sprat. Larger sizes of prey species led to increased birth rates of grey seals in Finland (Kauhala *et al*., 2019).

Table 10. Information on diet (a), abundance and distribution (b) of harbour porpoise, grey seal and harbour seal in the North Sea.

a) Diet:

country	species	timeline	area	availability	published	contact
Netherlands	Harbour porpoise	1990–present	Dutch coastline	Yes		Mardik Leopold
	Grey seal	1990–present		Not yet; not all sample have been analysed. Specific study and budget would speed up the process.		Sophie Brasseur
	Harbour seal	1980–present			Aarts *et al*., 2019	Sophie Brasseur
	Others			Yes		Mardik Leopold
United Kingdom [Scotland, England]	Harbour porpoise		UK coastline	Not yet, but currently both datasets are being finalised		Graham Pierce, Simon Northridge
	Grey seal	1985, 2002, 2010–2011	UK coastline	Yes		Philip Hammond
		1992	Eastern Scotland	Yes		Paul Thompson
	Harbour seal	2010–2012	UK coastline	Yes		Philip Hammond; Lindsey Wilson
	others		Scottish coastline	Maybe		Stranding's network
Belgium	Harbour porpoise	1997–2019	Belgian coastline	Yes, but currently still in process finalised in 2020	No	Jan Haelters
	Grey seal			Yes, historical data. More recent data still needs to be processed. Roughly 100 samples.		
	Harbour seal					

country	species	timeline	area	availability	published	contact
	seabirds					Erik Stienen
Germany	Harbour porpoise	1990–1994	German North and Baltic coastline	Yes, historical data; More recent data still needs to be processed.	Lick 1991; Benke *et al.*, 1998	Anita Gilles, Ursula Siebert (Schleswig-Holstein);
		1994–2006	German North and Baltic Sea		Gilles *et al.*, 2008; Gilles 2009	Harald Benke, Michael Dähne (Mecklenburg-Western Pomerania)
		1980–2011	Western Baltic		Andreasen *et al.*, 2017	
	Grey seal	1994–2006	German North and Baltic Sea		Gilles *et al.*, 2008	
	Harbour seal	1994–2006				
		1981–1984	Wadden Sea, Schleswig-Holstein		Sievers, 1989	
		2012–2014			de la Vega *et al.*, 2016; de la Vega *et al.*, 2018	
Denmark	Harbour porpoise	1980–2011	Western Baltic	no	Sveegaard *et al.*, 2012; Andreasen *et al*, 2017	Signe Sveegaard
	Grey seal	2010–2019	Western Baltic	no	Scharff-Olsen *et al.*, 2018	Anders Galatius, Morten Tange Olsen, Finn Larsen
	Harbour seal	2005–2019	Limfjord, Kattegat, Western Baltic	no	Andersen *et al.*, 2007; Scharff-Olsen *et al*,. 2018	Anders Galatius, Morten Tange Olsen
	others					
France	Harbour porpoise	1990–present	Channel / Bay of Biscay	Partially; many samples need to be analysed	Mahfouz *et al.*, 2017	Jérôme Spitz
	Grey seal				Ridoux *et al.*, 2007	
	Harbour seal				Spitz *et al.*, 2010; Spitz *et al.*, 2015	
	Others (Common dolphin, Striped dolphin, Bottlenose dolphin,				Meynier *et al.*, 2008; Spitz *et al.*, 2006a; Spitz *et al.*, 2006b;	

country	species	timeline	area	availability	published	contact
	Other cetaceans)				Louis *et al.*, 2014; Spitz *et al.*, 2011	
Sweden	Harbour porpoise	2007–2020 1989–1996	Kattegat, Skagerrak and the Baltic Kattegat & Skagerrak	Not yet Yes	No Yes	Anna Roos (also some DNA samples are being processed) Patrik Börjesson
	Grey seal	2011–2012	ICES SDs 27, 29, 30 and 32 of the Baltic Sea	Blubber, muscle, liver (n = 108 for each) and gut samples	Tverin *et al.*, 2019	Karl Lundström
	Harbour seal					
	others					
Norway	Harbour porpoise	2016–2017	Norwegian coastal waters and fjords	Publishing the results in 2020. Data will be available after this.		Ulf Lindstrom, Camille Saint-André
	Grey seal					
	Harbour seal					
	Others (minke whales, harp & hooded seals)	1992–2002 1990–2000s				Ulf Lindstrom, Kjell T. Nilssen

b) Distribution and abundance:

country	species	timeline	area/type	Availability	published	contact
Netherlands	Harbour porpoise	2010–present [summer since 2010 & 2014, 2011 & 2013 spring, autumn more recently]	Aerial survey EEZ	Yes	Yes	Steve Geelhoed
	Grey seal	1980–present (Wadden Sea) 2003–present (Delta)	Aerial survey, Wadden Sea survey includes the Dutch, German and Danish waters		Yes, annual national reports and international Wadden sea counts via CWSS; Brasseur *et al.*, 2015	Sophie Brasseur
	Harbour seal	1976–present (Wadden Sea) 1995–present (Delta)			Yes, annual national rapports and international Wadden sea counts via CWSS; Brasseur *et al.*, 2018	
	Others					
United Kingdom [Scotland, England]	Harbour porpoise and other cetaceans	1994, 2005, 2016 [summer]	SCANS I, II, & III, entire North Sea	Yes, 2016 still being finalised should be ready summer 2020	Yes	Philip Hammond
	Grey seal	Varied by area but roughly 1996–2017	Aerial counts, entire UK	Yes	Yes; also UK SCOS reports	Debbie Russell
	Harbour seal					
Belgium	Harbour porpoise					Jan Haelters
	Grey seal					
	Harbour seal					
	others					
Germany	Harbour porpoise	1995 & 1996 2002–present	Aerial survey, North Sea and Baltic Sea (EEZ and N2K areas)	Yes	Siebert *et al.*, 2006; Scheidat *et al.*, 2008, Gilles *et al.*, 2009, 2011, 2016;	Anita Gilles

country	species	timeline	area/type	Availability	published	contact
					Peschko *et al.* 2016; & national reports	
		2002–present	PAM in Mecklenburg-Western Pomerania		Gallus *et al.*, 2012; Benke *et al.*, 2014 & national reports	Anja Gallus
	Grey seal	1980–present (German Wadden Sea)	Aerial survey, Wadden Sea (coordinated within Trilateral Seal Expert Group); daily land counts Helgoland since 2016	yes	Yes, annual national reports and international Wadden sea counts via CWSS	Armin Jeß, Ursula Siebert. Abbo van Neer
	Harbour seal	1976–present (German Wadden Sea) 2016–present (Helgoland)			Yes, in reports; Brasseur *et al.*, 2018	
Denmark	Harbour porpoise	Abundance surveys by ship: 1994, 2005, 2016 (SCANS), 2012 (MiniSCANS) PAM of some MPAs (2011–present); Annual aerial surveys (Southern North Sea, Skagerrak, 2011–present); Satellite tagging studies (1997–present)	Aerial and ship surveys; Passive acoustic monitoring (PAM); Satellite tracking	yes	Yes, annual national reports and international Wadden sea counts via CWSS	J. Teilmann & Signe Sveegaard
	Grey seal	1980–present (Wadden Sea)	Aerial survey, Wadden Sea survey includes the Dutch, German and Danish waters	yes	Yes, in reports	Anders Galatius
	Harbour seal	1976–present (Wadden Sea)		yes	Yes, in reports; Brasseur *et al.*, 2018	Anders Galatius
France	Harbour porpoise		Aerial survey			
	Grey seal	1992–present				
	Harbour seal	1990–present				
	others					

country	species	timeline	area/type	Availability	published	contact
Sweden	Harbour porpoise	2011–2013 (SAMBAH project, Baltic Sea) 2019–present (Kattegat) 2017–present (Baltic Sea)	Static acoustic monitoring	SAMBAH project: partially national monitoring data: yes	SAMBAH project: partially National monitoring: no	J. Carlström
	Grey seal					
	Harbour seal					
	others					
Norway	Harbour porpoise					
	Grey seal					
	Harbour seal					
	Others (minke whales, harp & hooded seals)					

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3 ToRC. Review selected aspects of marine mammal-fishery interactions. Details of this ToR to be agreed with WGBYC

ToR C reflects common interests between WGMME and WGBYC, recognising that some aspects of marine mammal ecology and marine mammal interactions with fisheries (specifically bycatch) may otherwise not be covered by either group.

In principle, WGMME aims to assemble data and qualitative information available from other sources not covered by WGBYC. The future approach/roadmap regarding the workflow is currently discussed intersessionally between the ICES WGs.

3.1 Conservation objectives and targets with respect to maximum mortality

A critical gap hindering the ability of both WGs, WGMME and WGBYC, to properly address marine mammal interactions with fisheries (specifically bycatch) is the lack of conservation objectives for marine mammals and targets with regards to bycatch mortality. ICES (2010; 2012) has detailed the need for management targets to be determined in the context of explicit conservation objectives. Furthermore, following WGMME's (ICES, 2010) recommendation to "move […] towards the explicit definition and justification of target population sizes and management objectives", ICES (2010) advice to the European Commission (EC) (Section 1.5.1.2) stressed the need for these explicit conservation and management objectives for marine mammal populations. However, the advice to the EC was not acted upon (see ICES, 2013, page 35–37 for further discussion; see also ToR E, this report, Section 5).

Lacking explicit conservation objectives, the simplest, but also the crudest, approach for assessing the impact of bycatch on the marine mammal population is to consider a fixed percentage of total abundance as a threshold. This approach has been recommended for small cetaceans (e.g. ASCOBANS, 2006) and used in practice based on the best available estimates of abundance and bycatch levels (e.g. ICES, 2015, page 2; ICES, 2017, page 17; ICES, 2018, page 62; ICES, 2019a, page iii). Specifically, by ASCOBANS (2000) proposed for harbour porpoise, to define "unacceptable interactions" as being, "in the short term, a total anthropogenic removal above 1.7% of the best available estimate of abundance". In particular, a number of MS used this approach in their assessment of marine mammal bycatch in relation to criterion D1.C1 (*Mortality rate due to bycatch*) following the MSFD (2008/56/EC) requirements (ICES, 2019b). The European Commission accepted the ICES (2010) advice to use this approach (Anon., 2010), although without endorsing any of the technical elements within the advice - such as using a fixed percentage of abundance - as policy.

Next to the method based on *Percentage of abundance* as depicted above, two other methods to evaluate the impact of fisheries bycatch on marine mammals were reviewed in ICES, 2019b, (Section 3.5, pages 83–85): *Potential Biological Removal (PBR)* and *Catch Limit Algorithm (CLA)*. These methodologies were used by the ICES Working Group on Harp and Hooded Seals (ICES, 2019d). The methods were also discussed in a recent joint HELCOM/OSPAR workshop (HELCOM/OSPAR, 2019). Here, the importance of clarity about the distinction between conservation objectives and management objectives/targets, and how such objectives inform the definition of thresholds, was stressed. This workshop recommended, *inter alia*, the following conservation objective: 'Minimise and where possible eliminate incidental catches of all marine mammal and bird species such that they do not represent a threat to the conservation status of these species'; and proposed as a management objective that '[t]he mortality rate from incidental catches should be below levels which threaten any protected species, such that their long-term viability is ensured'.

Another outcome of this HELCOM/OSPAR workshop was the proposition of a decision tree to help in choosing a methodology (assuming that clear objectives have been defined), given the available data. Using a fixed threshold (*Percentage of abundance*) was retained as a 'rule of thumb' approach for data-poor species, whereas other, more data hungry or computationally intensive, approaches were also retained for data-rich species[2]. An intermediate approach is the use of Potential Biological Removal (PBR; Wade, 1998), which requires a recent measure of minimum population size, typically provided as the lower 20th percentile of a recent estimate of abundance. PBR was developed as a tool to set an upper limit to human-caused mortality so as to minimise risk of depletion of a population. Specifically, it was designed to meet the conservation objective of the US Marine Mammal Protection Act (MMPA) to allow a marine mammal "stock" to recover to or be maintained as an Optimal Sustainable Population (OSP) with 95% probability. In the US MMPA, OSP is defined as a population at or above its Maximum Net Productivity Level, conservatively defined as occurring at 50% of carrying capacity (Taylor and DeMaster, 1993).

The PBR level is the product of the following factors:

- a minimum estimate of abundance that "provides reasonable assurance that the stock size is equal to or greater than the estimate" ($N_{\min}$);
- one half of the maximum theoretical or estimated net productivity rate of the stock at a small population size ($0.5 \times R_{\max}$); and
- a recovery factor, F_r, between 0.1 and 1.0 (Wade, 1998).

The PBR approach has been applied to harbour porpoises in the Baltic Sea (Berggren *et al.*, 2002; North Atlantic Marine Mammal Commission and the Norwegian Institute of Marine Research, 2019). In the absence of explicit conservation objectives (ICES, 2013, pages 35–37), PBR is also used in an illustrative way (that is, without endorsing its conservation objectives as laid out in the US MMPA) to address the 2019 EC special request concerning harbour porpoise in the Baltic Sea (see ToR E for further details). With regards to the 2019 EC special request concerning fishery emergency measures to address common dolphin bycatch in the Northeast Atlantic, the computation of a PBR was carried out using the latest SCANS-3 (Hammond *et al.*, 2017) and ObSERVE (Rogan *et al.*, 2018) estimates of absolute abundance. The best available evidence suggests a single stock (European Atlantic Management Unit; ICES Advice, 2014, page 5), and explicit conservation objectives and management targets lack for this stock. This PBR level was then used to help addressing ToR E.

3.2 New legislation at the European Union level

In 2019, regulation (EC) No 812/2004 was repealed (among others) with the introduction of Regulation (EU) 2019/1241 on the conservation of fisheries resources and the protection of marine ecosystems through technical measures (hereafter 'Technical Measures'). Article 3 sets the objectives, including *inter alia* to 'ensure that incidental catches of sensitive marine species, including

[2] Data-rich species are species for which (i) a time-series of abundance estimates (with their associated uncertainties), (ii) a time-series of bycaught individuals, and (iii) life-history parameters are available (HELCOM/OSPAR, 2019, page 29).

those listed under Directives 92/43/EEC and 2009/147/EC, that are a result of fishing, are minimised and where possible eliminated so that they do not represent a threat to the conservation status of these species'. Article 4 sets targets, including 'incidental catches of marine mammals, marine reptiles, seabirds and other non-commercially exploited species do not exceed levels provided for in Union legislation and international agreements that are binding on the Union.'

Article 11 of these Technical Measures states that '[t]he catching, retention on board, transhipment or landing of marine mammals or marine reptiles referred to in Annexes II and IV to Directive 92/43/EEC and of species of seabirds covered by Directive 2009/147/EC shall be prohibited.' Article 31 details review and reporting obligations: 'By 31 December 2020 and every third year thereafter, [...], the Commission shall submit a report to the European Parliament and to the Council on the implementation of this Regulation. That report shall assess the extent to which technical measures both at regional level and at Union level have contributed to achieving the objectives set out in Article 3 and reaching the targets set out in Article 4'. Annex XIII, whose Part A concerns cetaceans mitigation measures to reduce incidental catches of cetaceans. In particular, Member States shall (i) take the necessary steps to collect scientific data on incidental catches of sensitive species; and (ii) monitor and assess the effectiveness of the mitigation measures established under Annex XIII.

3.3 Stranding records of marine mammals

Strandings are an important source of information to assess pregnancy rates, health, and diet, but also to identify abnormal mortality and possible relations to human activities such as fisheries. As such, records of dead animals and analyses of possible causes of death are considered a first step in identifying possible bycatch issues and to gain baseline knowledge or recognize changes in this type of interaction. In many areas however, registration of stranding events and subsequent necropsies of at least a sample of the animals are not available, and it is therefore unlikely that bycatch issues could be recognised.

Stranding networks vary locally in how systematically strandings are reported, and whether necropsies are systematically carried out and, if so, whether this is done by trained veterinarians. Moreover, throughout the ICES regions, different species are treated differently. Recently, ACCOBAMS and ASCOBANS held a joint workshop dedicated to the harmonisation of the best practices for necropsy of cetaceans (ACCOBAMS-ASCOBANS, 2020). There is on the other hand, a general lack of similar coordination for pinnipeds. These differences between stranding networks were tentatively assessed by having representatives fill out a table on the national frameworks for reporting and necropsies of stranded marine mammals (Table 11).

Strandings have traditionally been used to provide minimum estimates of bycatch, since issues such as currents, weather, and accessibility influence the probability of a bycaught animals reaching the coast and, once stranded, being discovered. In this respect, drift models have been used to derive estimates of bycatch levels from stranded cetacean carcasses (Peltier *et al.*, 2016; see also ICES 2018, Section 5.2 pages 61–63 for caveats). This use of strandings to obtain large-scale statistics on bycatch with drift modelling is a relatively recent development. While estimating bycatch levels falls under the remits of ICES WGBYC (e.g. ICES, 2019a, pages 69–70), there are other aspects of marine mammal ecology (including interactions with fisheries) which are not covered by ICES WGBYC: WGBYC lists strandings that have been identified as bycaught, however, there seemed to be a caveat with respect to the regions and species monitored.

WGMME has therefore produced a first overview summarised in Table 11, indicating marine mammal strandings that may not be covered by ICES WGBYC[3] on a regional basis.

3.3.1 Country by country stranding information

BELGIUM*:* There is long standing network along the Belgian coast, collecting and registering all stranded marine mammals. The Belgian stranding network aims to record and collect all stranded marine mammals, and to autopsy all relatively fresh animals. In 2019, the Belgian stranding network recorded relatively few strandings (51) of harbour porpoises. Of the 14 animals with a known cause of death, four were diagnosed as probable bycatches, half of which could be attributed to an identified static gear fishing vessel. Since 2001, bottom setnets and tanglenets are forbidden in Belgian coastal waters (from 2015 also in the intertidal zone); this possibly influences the local porpoise mortality.

DENMARK*:* There is no formal stranding network in Denmark. Under the Danish Nature Agency, there is a contingency plan for dealing with stranded marine mammals which are reported to the authorities. It details that location, date, sex, size and condition are recorded for stranded harbour porpoises and that, for other species, the skeleton and samples are secured for science. Stranded seals are to be registered and determined to species. Furthermore, there is an aim to collect 25 (stranded) harbour porpoises, 25 harbour seals and five grey seals annually for necropsy to assess health condition.

IRELAND*:* The data collection phase of a marine mammal necropsy project which ran between 2017 and 2019 has come to an end. The scheme was funded by EMFF through the Marine Institute, and part of the programme involved assessing bycatch in stranded cetaceans. Necropsy work followed all UK Cetacean Strandings Investigation Programme necropsy protocols and was carried out by the Irish Regional Veterinary Laboratory, IWDG and GMIT, with all case history reporting as part of the project reviewed by the Institute of Zoology, London. Over 100 cetaceans were necropsied during the course of the programme, and case history reviews and final reporting are scheduled for completion in quarter two of 2020.

GERMANY*:* Stranding networks along the coastline of the German North and Baltic Sea have different qualities due to federalism. In the federal state of Lower Saxony (southern North Sea), stranded marine mammals are opportunistically reported by beach-goers to the National Park Administration; thus, there is no systematic monitoring nor necropsies and the impact of fisheries on marine mammals for those waters is unknown. In Hamburg (North Sea and estuary of the river Elbe) and Mecklenburg-Western Pomerania MWP (Baltic Sea), most marine mammals reported are collected and further investigated. In Schleswig-Holstein (SH; North Sea and south-western Baltic Sea), a dedicated stranding network was established following the first seal die-off in 1988/1989. Beaches have been patrolled twice a day by trained seal rangers since 1990 (Siebert *et al.*, 2001; 2006; Siebert *et al.*, submitted). All cetaceans (180–310 per year), grey seals (80–120 per year) and a selected number of harbour seals (500–800 per year) are transported to the responsible institute for further investigations. Only marine mammals that were handed over by fishermen and verified by necropsy as bycaught are classified as 'bycatch'; bycatches determined among strandings, based on pathological investigations following necropsies and histopathological investigations, are classified 'suspected bycatch'(or "bycatch cannot be ruled out"). Since fishermen continue to not directly handover bycatches, the total number of strandings is also taken as an indication whether bycatch is in- or decreasing. This is currently very important

[3] ICES WGBYC started tallying numbers of strandings identified as bycatch because some Member State reported this as a measure of minimum bycatch in their EC 812/2004 reports.

since there is no monitoring programme associated with the widely distributed and used Porpoise-Alert (PAL)-systems (ca. 1500–2000 devices) in the Baltic Sea of SH. Systematic pathological investigations on harbour porpoises conducted since 1990 revealed that bycaught individuals (i.e., handed over by fishermen) displayed all types and severity of lesions found in stranded animals (Siebert *et al*., 2001; Wünschmann *et al*., 2001). Therefore, if only healthy animals are suspected to be potentially bycaught (exclusion approach) the number of bycaught harbour porpoises will be, at least for the Baltic Sea, largely underestimated. Investigations on the ear complex (imaging technics, histology, immune cytochemistry and electron microscopy) showed that harbour porpoises bycaught in the Baltic Sea suffer from pathological changes with a higher frequency than expected.

FRANCE*:* There is long standing network along the French coasts, collecting and registering all stranded marine mammals. The French stranding network aims to record all stranded marine mammals via a network of trained volunteers (numbering approximately 400, including citizen, wildlife officers, researchers and veterinarians). A national law from 1989 mandates local authorities to report all marine mammals that may strand. Observatoire Pelagis (UMS 3462, CNRS-La Rochelle Université) is mandated by the French ministry in charge of the Environment to register all strandings, and plan for an examination of all animals. A hundred necropsies are realized each year (although hundreds of examinations are carried out each year), mostly on cetaceans. Each year, the French stranding network report statistics on strandings for the whole of French seaboards, including over-sea territories (reports available at https://www.observatoire-pelagis.cnrs.fr/publications/rapports/bilan-des-echouages/article/bilan-des-echouages). Reporting of stranded marine mammal is considered reliable and constant since 1990 (Authier *et al*., 2014).

Between 1 February and 31 March 2017, 793 stranded cetaceans (84% of which were common dolphins) were found along the French Atlantic seaboard. Most common dolphins had evidence of death in fishing gear. Peltier *et al*. (2020) aimed to identify the fisheries potentially involved from the spatial distributions of likely areas of mortality of bycaught dolphins, inferred from carcass drift modelling. Using VMS data, spatial and temporal overlap between two main mortality areas and various fisheries were investigated. A total of 3690 common dolphins (95% confidence interval: 2230–6900) were estimated to have died in fishing gear within the Bay of Biscay during this unusual stranding event. There was a positive correlation between the origin of stranded bycaught dolphins and the fishing effort distribution of French midwater pair trawlers, Spanish otter bottom trawlers and French Danish seiners. This co-occurrence highlighted candidate fisheries for further investigation (through observers or electronic-monitoring). These fisheries differed in their fishing gear, but two characteristics appear to be shared: they targeted predatory fishes (sea bass and hake) in winter and used high vertical opening gear.

Bouchard *et al*. (2020) used stranding data (from 1990 until 2012) to provide monthly forecasts over 2013–2018 of the maximum number of stranded small delphinids over a 3-day window along the coasts of France (harbour porpoises in the Channel, common dolphins in the Bay of Biscay, and striped dolphins in the North-Western Mediterranean). Using generalized extreme value modelling, Bouchard *et al*. (2020) evidenced an increasing trend since the 1990s in the intensity of at-sea mortality events of harbour porpoises in the Channel and common dolphins in the Bay of Biscay (Figure 21), which they interpreted as an increase in anthropogenic pressures on these species (*e.g.* bycatch).

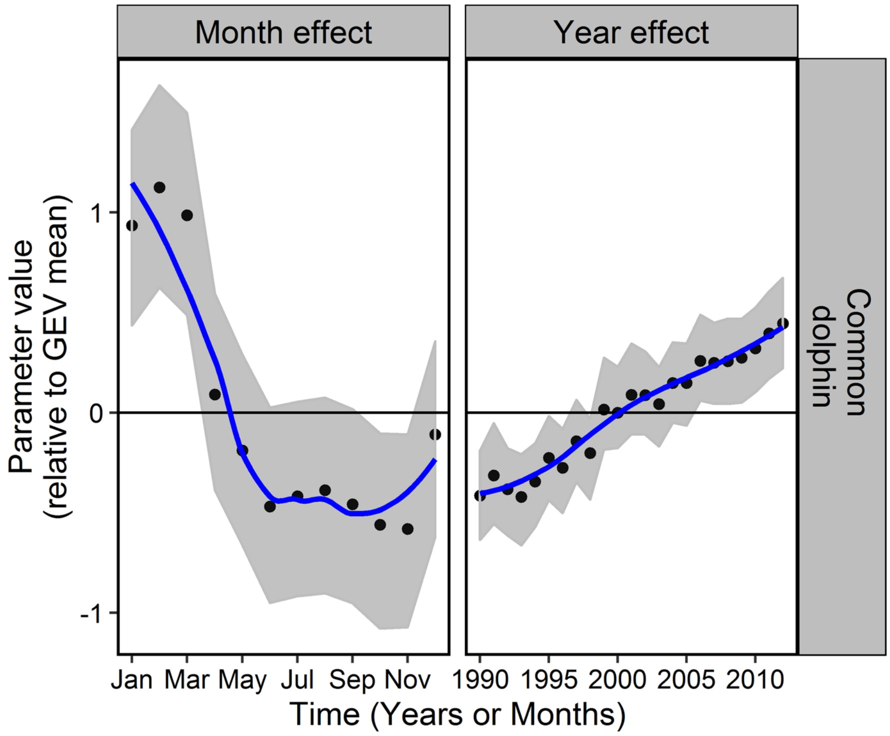

Figure 21. Month and year effects of the best Generalized Extreme Value (GEV) model estimating extreme mortality events in common dolphin in the Bay of Biscay. The blue curve corresponds a loess smoothing of the posterior means (black dots) and the grey area to the 95% Highest Probability Density intervals around posterior means. There is strong seasonal effect, and an increasing trend with year.

SPAIN: There is no nationally coordinated stranding network in Spain and the available networks which carry out their work regionally present wide differences in means, experience, capability and funds. One of the most experienced and with the longest available series has operated since the early 1990s in Galicia (NW Spain), run by an NGO, the Coordinadora para o Estudio dos Mamíferos Marinos (CEMMA) with funding from the regional government of Galicia. The number of stranded cetaceans ranges from 300 to 400 individuals annually but lack of funds limits the number of post mortem examinations that can be carried out. However, evidence (presence of net marks, missing tails, presence of remains of nets/ropes) suggests that bycatch is one of the main causes of death.

ICELAND: Estimated marine mammal bycatch in the lump sucker fishery based on observations from 2014–2018 was estimated at 3223 (1225–5221) animals, comprising 1389 (903–1875) harbour seals, 989 (405–1573) grey seals, 240 (82–398) harp seals, 49 (1–98) ringed seals and 28 (10–46) bearded seals. These estimates are per year and are stratified by management area (ICES, 2019a). Though there is some discussion within NAMMCO on the accuracy of the estimated bycatch of this specific fishery, there might be reason for concern whether fisheries mortality is affecting the harbour and grey seal population in this area, especially as other fisheries also occur in the area. Next to this, growing tourism including seal watching could affect the seals in the area (Granquist and Sigurjonsdottir, 2014).

NETHERLANDS*:* Cetaceans: There is long standing cetacean stranding network along the Dutch coast; collecting and registering all stranded cetaceans. Basic information on strandings is collected, validated and stored centrally by Naturalis Biodiversity Center (www.walvisstrandingen.nl). From 2000 onwards, harbour porpoise strandings are recorded in detail along the Dutch coasts and from 2006 at least 50 porpoises (irrespective of the state of the carcass) were annually necropsied (Leopold, 2015). Since 2016, ca. 50 only fresh harbour porpoises have been collected annually for post mortem examinations by the Faculteit Diergeneeskunde, University of Utrecht. One of the main objectives of the research is to quantify human-induced causes of death. Other stranded species are opportunistically necropsied. All rare cases of other cetacean species stranding are sampled or necropsied depending on the status of the carcass and the need for samples and data on the species.

Seals: historically, a relatively large number (of the order of several hundred per year) of (mostly) pups are taken into rescue centres (Brasseur, 2018). However, with some exceptions (see below), dead stranded seals are often discarded directly, and registration is on a voluntary basis, and therefore often incomplete or incorrect. Individual observers may enter observations in a public database. Though responsible rescue centres provide some data when available, information on size, sex and sometimes even species of seals found dead is not registered. Currently, there is no national systematic seal necropsy programme in the Netherlands.

NORWAY*:* Owing to the very long coastlines, there is no stranding network for seals or cetaceans.

SWEDEN*:* Cetaceans: The Swedish Museum of Natural History has a web-based reporting form for observations of both live and dead harbour porpoises. Observations of other cetacean species (alive and dead) can be reported to the website www.valar.se, run by the Gothenburg Natural History Museum. In addition, species observations can also be reported to the Species Observation System, although few cetacean observations are reported to this site. Since 2016, the Swedish Museum of Natural History has been funded by the Swedish Agency for Marine and Water Management to collect approximately 20 stranded or bycaught harbour porpoises per year for necropsies. Fresh carcasses are prioritized, although more decomposed carcasses are also collected or sampled from the Baltic Sea. The necropsies are carried out in collaboration with the Swedish Veterinary Institute and samples are stored at the Environmental Specimen Bank at the Swedish Museum of History. Rare cases of strandings of other cetacean species are sampled or necropsied depending on the status of the carcass and the need for samples and data on the species.

Seals: Members of the public report on stranded seals on a website (approximately 200–300 seals per year, ranging from fresh carcasses to skeletons). Some fresh carcasses are collected for necropsy by the Swedish Museum of Natural History, funded by the Swedish EPA. The funding is limited and focussed on seals from the Baltic and not the Skagerrak/Kattegat. This might be changed in the future, but it is still uncertain. The seal necropsy program is currently mostly using seals from the hunt to assess pregnancy rates, health, etc.

UK*:* The collaborative Cetacean Strandings Investigation Programme (CSIP) coordinates the investigation of all cetaceans, marine turtles and some shark species that strand around the UK coastline. Necropsies are carried out by veterinarians or under veterinarian authority. With respect to the investigation of seal mortality, since 1992, systematic reporting and routine necropsies are conducted in Scotland by the Scottish Marine Animal Strandings Scheme (SMASS), a veterinary pathology investigation team supported by a network of 200+ citizen scientists. SMASS aims to provide a systematic and coordinated approach to the surveillance of Scotland's marine species by collating, analysing and reporting data of all cetaceans and seals (but also marine turtles and basking sharks) that strand on the Scottish coastline. The network collects photographs, morphometrics and, in some cases, tissue samples for genetic and contaminant analyses. Seal carcases reporting in Scotland is more complex than cetaceans: paradoxically where seals are common, mortalities are seldom reported, possibly because the high mortality rate of juvenile grey seals (up to 50%) results in carcases not being considered an unusual sight. In addition, the vast majority of carcases reported to SMASS are incomplete or in an advanced state of decomposition, which precludes meaningful necropsy. 269 cetaceans and 491 seals were reported to SMASS in 2019, the latter comprising of 307 grey seals, 95 harbour seals, one hooded seal and 88 unidentified pinnipeds. Of these, 30 seals were samples for tissues, and 17 seals were recovered for necropsy. The actual number of seals (particularly harbour seals) that can be examined at post mortem appears to be lower than the target of 40–50 (Hall and Hanson, 2018). In Cornwall, the Cornwall Wildlife Trust Marine Strandings Network (CWTMSN) and University of Exeter (UoE) are conducted responsible for the investigation of seal mortality, systematic reporting and routine necropsies. Elsewhere in the UK, records of stranded seals are collected by the CSIP on an *ad hoc* basis, but only occasional necropsies are conducted.

3.4 Seal fisheries interactions

WGMME (ICES, 2019b) highlighted a historical data gap because ICES WGBYC focused primarily on cetacean bycatch, in particular collating and analysing information provided by Member States (MS) in response to the requirements of (now repealed) Regulation 812/2004. ICES WGBYC completed a Bycatch Risk Approach[4] (BRA) for grey seals in the Celtic Seas (CS) and Greater North Sea (NS) ecoregions (ICES, 2019a, Section 3). However, Regulation 812/2004 did not require monitoring for species other than small cetaceans and therefore seal bycatch reporting was only on a voluntary basis, using dedicated (marine mammal) observers deployed to record cetacean bycatch for area/gear combinations where such monitoring was mandated under 812/2004. Thus, the extent and magnitude of seal-fisheries interaction may have been underestimated, and in some cases have gone undetected.

Regulation EU 2019/1241 (hereafter referred to as Technical Measures) now mandates MS to report bycatch of all sensitive species listed on HD Annex II and Annex IV(a), including thus grey seals, harbour seals, harp seals, Baltic ringed seals, and Saimaa ringed seals. These new reporting requirements may allow for a better quantitative assessment of seal bycatch by ICES WGBYC, although they are no guarantee of an improved data collection in fisheries monitoring schemes. The operational change from the repealed Regulation 812/2004, wherein dedicated observers were required, to fisheries observers as required under Technical Measures may in fact impact adversely the quality of the collected data on marine mammal bycatch in general. An efficient and effective fisheries monitoring schemes would allow to be able to identify dead seals caught in gears, which would then preclude the need for training in veterinary pathology to realize necropsies on the fraction of bycaught animals that may wash ashore in order to assess the cause of death of said animals. There are, however, serious hurdles to overcome in order to implementing such a monitoring scheme: given the difficulties seen with the now repealed Regulation 812/2004, the direct reporting of dead seals caught in gears appears highly unlikely. This is turn stresses the importance of stranding networks, necropsies and trained veterinary pathologists to assess a minima bycatch.

Below, information on seal bycatches as currently recorded / available, are summarized on a country by country basis.

HELCOM: The HELCOM Workshop on Seal-Fisheries Interactions (https://portal.helcom.fi/meetings/sfi%20ws%201-2019-631/default.aspx) took place in Copenhagen on 27 June 2019. Its objective was to build on current knowledge and previous discussions on how to deal with seal fisheries interactions within HELCOM and to develop proposals for how the issue could be brought forward within the HELCOM context. Problems with seals destroying nets and taking the catch are common among coastal small-scale fishermen using setnets in the Baltic. Seal-fisheries interactions initially spread from the northern part of the Baltic Sea to most Baltic

[4] ICES (2019a) used the acronym BRA for "Bycatch Risk Assessment". Yet a risk assessment has a specific, technical meaning which is not met by BRA *sensu* ICES WGBYC. ICES WGBYC was consequently proposed BRA to stand for "Bycatch Risk Approach" (Kelly MacLeod, comm. pers.).

Sea coastal States now reporting problems, mainly with grey seals. Baltic grey seal populations started to recover in the 2000s after a heavy decline. However, grey seal population status can be very different depending on subregion within the Baltic Sea. HELCOM collects annual information on confirmed anthropogenic mortality of marine mammals, but these confirmed cases in all likelihood underestimate the magnitude of actual cases given the severity of the seal-fisheries conflict in the Baltic.

BELGIUM*:* In 2019, 47 seals washed ashore on the Belgian coast. Bycatch was diagnosed the probable cause of death for two grey seals and three harbour seals (out of 14 seals with a known cause of death). Note that these data for 2019 are not yet definitive.

DENMARK*:* no assessment of seal bycatch has been conducted.

IRELAND*:* New research by Luck *et al*. (2020) identified drivers of spatiotemporal variability in bycatch of grey seals in static net fisheries in Ireland. The study combined bycatch data collected during scientific observer programmes and by fishers from inshore fishing vessels off the west, southwest, and south coasts of Ireland. Thirteen vessels fishing with gillnets, tangle nets, trammel nets and spider nets, and comprising of over 3000 hauls, were included in the study. Data were modelled with environmental variables including, *inter alia*, season, distance to nearest seal colony, water depth, and turbidity. From these models, Luck *et al*. (2020) identified environmental variables that were correlated to regional and seasonal patterns in seal bycatch observed in the fishery. Distance to major seal colonies was identified as a significant predictor of spatial variation in seal bycatch, and water turbidity a major seasonal predictor, with fewer seals bycaught in less turbid waters. The results of this study aid our understanding of the risks of seals becoming entangled in nets and may provide a novel approach to technical mitigation. However, the difficulty in estimating fishing effort for the under 10 m fleet remains, hampering efforts to quantify the potential level of seal bycatch across the entire fishery.

GERMANY*:* So far, bycatch of seals has been a minor issue in comparison to harbour porpoises. In the German North Sea, bycatch of harbour and grey seals are rare and only reported as single cases in the coastal fisheries. This may be partly due to limited fisheries activities in the National Parks of the Wadden Sea and the Whale Sanctuary (i.e., along the coastline of the island of Sylt). In the Baltic Sea, however, bycatch has always existed, especially in Mecklenburg-Western Pomerania (MWP) and carcases are often handed over by fishermen. Since the recovery of the grey seal stocks, the conflict with fisheries is increasing, with fishermen complaining of economic impacts due to grey seals, and a suspected increase of incidental or even directed catches of grey seals is reported (Dähne *et al*., 2018). Thus, the need to identify seals which died in fishing gear is high, however, this requires a highly trained veterinary pathologist.

FRANCE*:* no assessment of seal bycatch has been conducted.

LATVIA: Seal bycatch is currently not being reported in fisheries logbooks. However, stranded carcasses of seals are reported each year by local municipalities: the Latvian coastline is mostly made of sandy beaches, and removing carcases have to be removed for public safety and aesthetic reasons. The majority of stranded carcasses of seals are assumed to result from interactions with fisheries. Interviews with fishermen conducted over the past two years suggest that bycatch as estimated from strandings may underestimate true levels of bycatch by approximatively 20%.

NETHERLANDS*:* In general, as monitoring of stranded seals is not carried out in the Netherlands, relatively little is known about causes of mortality and possible seal bycatch, still, some (historical) data are available. Fyknets are commonly used as a passive gear along the coasts and these were renoun to accidently catch seals attracted by the enclosed fish. Since the late 1980s however, it is compulsary in most coastal areas to provide these with a wide-meshed netting to prevent seals from entering the gear (Reijnders, 1985; Reijnders *et al*., 2005). Despite this precaution, and despite the lack of structural recording of strandings and necropsies there are indications that bycatch of seals migth be sevearly underestimeted in the Netherlands. For example, on its own initiative, the seal center of Pieterburen necropsied 286 harbour seals and 93 greyseals collected in the period of 1979 to 2008 (Osinga *et al*., 2012). For grey seals, the most common cause of death was bycatch (confirmed and inferred), while in harbour seals by catch was the most common (19%) after the PDV virus which had affected the population twice, in 1988 and 2002. A more recent study of the voluntary public raporting of stranded seals was published (Brasseur *et al*., 2018). Here, the only rapported occurences of dead seals were presented (up to 500 animals/year). Interestingly, the concentration of strandings of dead animals did not coincide with the known seal distribution. It was suggested to both setup a structured stranding monitoring system, including necropsies and to concentrate study efforts in areas where unusually high stranding rates seemed to occur.

UK*:* Ten grey seals were reported in 2018 as bycaught during dedicated bycatch sampling under 812/2004 regulation (Northridge *et al*., 2019). Six were reported from sandeel trawls in the central North Sea (4b), while four were reported in large mesh tangle nets set for monkfish or ray in divisions 7e and 7f.The Marine (Scotland) Act of 2010, under Part 6 Conservation of Seals, provides some protection for seals but also permits the killing of seals in closed seasons under certain circumstances, for example to prevent a seal from damaging a fishing net, fishing tackle or a fish caught in a net. Seal licensing takes into account the number of shootings applied for and uses a Potential Biological Removal (PBR) approach to ensure that seal populations remain in a Favourable Conservation Status. Only a small proportion of the seals (e.g. in 2015 approximately <10% of grey seals and <2% of harbour seals) taken under licence are retrieved and obtained by SMASS for post mortem examination (Hall and Hanson, 2018).

Table 11. Registration and necropsies of marine mammals in ICES and adjacent regions (Note that this is not yet an exclusive list since some regions are missing information).

			Seals		Cetaceans		
Ecoregion	**Country**	**Area**	**Registration**	**Necropsy**	**Registration**	**Necropsy**	**Comment**
Baltic Sea	Sweden	Southern Baltic	optional	no	yes	yes	All encountered dead cetaceans are to be reported by law, and all reports are registered, however the knowledge of the law is limited.
Baltic Sea	Denmark	Kattegat/ Danish Straits, Limfjord Southern Baltic	optional	yes	optional	yes	
Baltic Sea	Estonia	Gulf of Riga, Gulf of Finland	unknown	unknown	unknown	unknown	possibly no cetaceans present
Baltic Sea	Finland	Baltic	optional	no	yes	yes	few cetaceans found; hunted seals are collected and sampled/ measured
Baltic Sea	Germany	Southern Baltic	yes	yes	yes	yes	
Baltic Sea	Latvia	Gulf of Riga	yes	no	yes	no	no stranded cetaceans found during last 30 years (harbour porpoise was caught once during this time by coastal fishery near Riga) and delivered to Nature museum); stranded seals are registered by local municipalities, if seals are removed from beach
Baltic Sea	Latvia	Central Baltic	yes	no	yes	no	no stranded cetaceans found during last 30 years (harbour porpoise was caught once during this time by coastal fishery near Riga) and delivered to Nature museum); stranded seals are registered by local municipalities, if seals are removed from beach
Baltic Sea	Poland	Southern Baltic	yes	yes	yes	yes	
Baltic Sea	Russia	Gulf of Finland	no?	no?	unknown	yes/ n.a.	possibly no cetaceans
Baltic Sea	Sweden	Bothnian Bay	optional	fresh	yes	yes	cetaceans are extremely rare

			Seals		Cetaceans		
Ecoregion	**Country**	**Area**	**Registration**	**Necropsy**	**Registration**	**Necropsy**	**Comment**
Baltic Sea	Sweden	Central Sweden	optional	fresh	yes	yes	cetaceans: same as for Southern Baltic
Baltic Sea	Sweden	Kalmarsund	optional	fresh	yes	yes	cetaceans: same as for Southern Baltic
Norwegian Sea	Norway	Norway north of 62N	no	no	no	occasional	
Greater North Sea	Norway	Norway south of 62N	no	no	no	occasional	
Greater North Sea	Norway	Skagerrak	no	no	no	occasional	
Greater North Sea	Sweden	Skagerrak, Kattegat, the Sound	optional	no	yes	yes	≤ approximately 20/year
Greater North Sea	Belgium	Belgium	yes	yes	yes	yes	
Greater North Sea	Denmark	Wadden Sea	optional	yes	optional	yes	
Greater North Sea	France	Normandy, Brittany (N)	yes	yes	yes	yes	
Greater North Sea	Germany	Wadden Sea, Lower Saxony	no	no	no	occasional	
Greater North Sea	Germany	Wadden Sea, Schleswig-Holstein Hamburg	yes	yes	yes	yes	
Greater North Sea	Netherlands	Dutch Delta Area	optional	no	yes	yes	
Greater North Sea	Netherlands	Wadden Sea	optional	no	yes	yes	
Greater North Sea	United Kingdom	East England	no	no	yes	yes	cetaceans recorded by CSIP
Greater North Sea	United Kingdom	North Sea Scottish North Coast	yes	yes-some	yes	yes	records and necropsies by SMAS (Cetaceans recorded by CSIP); many samples available for analysis
Greater North Sea	United Kingdom	Scotland	yes	yes-some	yes	yes	records and necropsies by SMAS (Cetaceans recorded by CSIP) many samples available for analysis

			Seals		Cetaceans		
Ecoregion	**Country**	**Area**	**Registration**	**Necropsy**	**Registration**	**Necropsy**	**Comment**
Celtic Seas	Republic of Ireland	Republic of Ireland	no	occasional	yes	yes	recently less for seals, data collection for the cetacean programme finished in 2019
Celtic Seas	United Kingdom	Northern Ireland	yes	yes-some	yes	yes	records and necropsies by SMAS (Cetaceans recorded by CSIP, necropsy by DAERA); many samples available for analysis
Celtic Seas	United Kingdom	Scotland	yes	yes-some	yes	yes	records and necropsies by SMAS (Cetaceans recorded by CSIP, necropsy by DAERA); many samples available for analysis
Celtic Seas	United Kingdom	Wales	no (records)	no	yes	yes	Cetaceans recorded by CSIP (MEM), necropsy by CSIP; many samples available for analysis
Celtic Seas	United Kingdom	West England	no	no	yes	yes	cetaceans recorded by CSIP
Bay of Biscay	France	Bay of Biscay	yes	yes	yes	yes	
Bay of Biscay	Portugal	Portugal	yes	yes	yes	yes	very little seals
Bay of Biscay	Spain	Gallicia	yes	yes	yes	yes	regional differences
Bay of Biscay	Spain	not Gallicia	no	no	no	no	regional differences
Lake Ladoga	Russia	Russia	unknown	unknown	n.a.	n.a.	
Lake Saimaa	Finland	Finland	yes	yes	n.a.	yes?	
Western Mediterranean Sea	France	France	n.a.	n.a.	yes	yes	

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4 ToR D. Update the database for seals

4.1 The 'ICES/WGMME seal database'

It has previously been agreed that WGMME would maintain a central repository for data on harbour (common) seal, *Phoca vitulina*, and grey seal, *Halichoerus grypus* and in recent years, Baltic ringed seals (*Pusa hispida*) have been added to the database. In particular, numbers reported under national monitoring programmes are of interest. The idea was to collate information across ICES areas so that it was easier to access regional data incorporating seal numbers from several countries' coastlines. The scientific justification accounts for the fact that, as mobile marine predators, grey and harbour seals move across national borders. There is obvious merit in the WGMME knowing about trends in abundance of seals, where they co-occur and in documenting expansions and/or contractions in specific areas, especially at the outer extent of their range. The area of relevance was originally focused on the Northeast Atlantic and the North Sea, but has been expanded to encompass harbour and grey seals in the North Atlantic at large as well as Baltic ringed seals. Only data from Russia, the Faroe Islands and Svalbard are currently missing from the database.

At WGMME 2019, the database was restructured, rationalizing the area descriptions, updating the data with the most recent counts (where available), and attempting to extend the database with data from ICES regions that had not yet been incorporated (ICES, 2019). Table 1 gives an overview of the status of the data included for the different areas. At the moment, the ICES data and information collection are limited to grey and harbour seals throughout most of their range within the ICES area, as well as ringed seals in the Baltic region. For grey seals, different survey methods are used in different regions. Pup counts can be used as a basis for population estimate models. Moult counts are used in some cases, and these may, in conjunction with pup counts provide information on the transboundary behaviour of the animals. For the Baltic grey seals, moult counts are used as the abundance index, as a large part of the pups are spread out on sea ice, complicating traditional counts. In the Wadden Sea for grey seals, both pup counts and moult counts are conducted. Grey seals in this area represent a mix of animals breeding locally and animals breeding in the UK. For harbour seals, most surveys reported are conducted during the moult, in the Wadden Sea, and along the Dutch, French and Danish coasts, pup counts are collected as well. In the case of ringed seals, current climatic changes have caused concern with regard to the survey methods, as changing ice conditions can mean unpredictable variation of results. Moreover, ringed seals are currently included from only the Baltic area, although the species is distributed over a much larger part of the ICES area.

The database will continue to be held and maintained by the WGMME and updated at the annual WGMME meetings (either from publicly available sources online, or by direct contact with the data holders). A summary of seal population trajectories is, thus, easily accessible to WG members for the purposes of including up-to-date information in the annual report.

4.2 Other species and missing areas

The WG is aware that other seal species and some areas have been omitted from the former WGMME reports (Table 1). This includes the Arctic species such as the ringed, harp, hooded and bearded seals and the walrus notably, occurring in the more arctic zones of the ICES areas. The question is whether these all should be included in the WGMME report. WGMME is aware of the WGHARP biannual meetings and will explore if it may suffice to refer to that group's report for harp and hooded seals. For the other species and areas, either scientists working on these animals or areas could be invited to join the WGMME or reference could be made to results reported by other groups outside the ICES.

Table 1. Overview of data included in WGMME database per survey area. Years indicate coverage. Orange shading: possible data to include within the next WGMME reports. Grey shading: areas where data were merged over several years and could be included in more detail. In some areas, other seal species (ringed, harp, hooded and bearded seals and walrus) could be added in future WGMME reports; these are indicated by * in the far right column.

Survey areas			Grey seals		Harbour seals		Ringed seal
			Adults (Moult)	Pups	Adults (Moult)	Pups	Adults (Moult)
Baltic	Western Estonia / Gulf of Riga	Estonia	2003–				1995–2018
	SW Finnish archipelago	Finland	2003–				2010–
	Gulf of Finland	Finland, Estonia, Russia	2003–				2010–
	Gulf of Riga						
	Bothnian Bay and North Quark	Sweden, Finland	2003–	-			1988–
	Sea of Bothnia	Sweden, Finland	2003–				
	Central Sweden	Sweden	2003–				
	Southern Baltic	Sweden, Denmark, Germany, Poland	2003–		1988–-		
	Skagerrak	Sweden and Norway			1979–		
	Kattegat/ Danish Straits	Sweden and Denmark			1979–	1979	
	Limfjord	Denmark			1988–	1988	
	Kalmarsund	Sweden			1979–		
Norway	Svalbard						*
	North of 62N	1997		?	2015		
	South of 62N	2001		?	2015		
	Finnmark			?	2015		
	Skagerrak				1979–		
	Wadden Sea	Danish, German and	1980–	1980–	1976–	1976–	

Survey areas			Grey seals		Harbour seals		Ringed seal
			Adults (Moult)	Pups	Adults (Moult)	Pups	Adults (Moult)
Southern North Sea		Dutch Wadden Sea Area					
	Delta Area	Netherlands	2003–	-	1995–	1995–	
	Belgium		Occasional sightings				
	France		1992–	1990–	1990–	1990–	
UK	Northern Ireland	Northern Ireland	2000–2018	estimate only	2000–2018		
	Wales	Wales	2000–2018 (estimate)	1977, 1992–1994, 2005 (estimate)	1996–2018 (estimate)		
	England	Southwest England	2000–2017 (estimate)	2005, 2016 (estimate)	1996–2017 (estimate)		
		Northwest England	2000–2017 (estimate)	-	1996–2017 (estimate)		
		Northeast England	2000–2018	1959-2018	1996–2018		
		Southeast England	2000–2018	1984-2017	1996–2018		
		South England	2000–2018 (estimate)	-	1996–2018 (estimate)		
	Scotland	Southwest Scotland	1996–2018	-	1996–2018		
		W Scotland	1996–2018	1984-2008, 2010, 2012, 2014, 2016	1996–2018		
		Western Isles	1996–2017	1961-2016	1996–2017		
		North Coast	1996–2017	1998, 2000, 2002–2008, 2014, 2016	1996–2017		
		Orkney	1996–2017	1960–2010, 2012, 2014, 2016	1996–2017		
		Shetland	1996–2017	2004	1996–2017		
		E Scotland	1996–2018	1997–2010, 2012, 2014, 2016	1996–2018		

Survey areas			Grey seals		Harbour seals		Ringed seal	
			Adults (Moult)	Pups	Adults (Moult)	Pups	Adults (Moult)	
		Moray Firth	1996–2018	2005–2009, 2012, 2014, 2016	1996–2018			
	Ireland		2005–2012	2005, 2012	2003–2018			
	Iceland		1980–2016	1980–2016	1980–2016			
	Greenland							*
North America	USA			2001–2019				*
	Canada	Sable Island		1961–2016				*
		Eastern Canada & Gulf of St Lawrence		1996–2016				*
Russian Federation*								*

4.3 References

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5 ToR E. Address the special request from EU on emergency measures bycatch Northeast Atlantic by:

i. Evaluating current conservation population status and pressures and threats to harbour porpoises in the Baltic Sea and common dolphins in the Bay of Biscay.
ii. Evaluating whether the described conservation measures within the request are appropriate.

Documentation produced to address this ToR has been included in the report of the Workshop on fisheries Emergency Measures to minimize BYCatch of short-beaked common dolphins in the Bay of Biscay and harbour porpoise in the Baltic Sea (WKEMBYC 2020).

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Annex 2: Resolutions

ToRs 2020

Term of reference	Addressed in this report
a) Review and report on any new information on seal and cetacean population abundance, population/stock structure, management frameworks (including indicators and targets for MSFD assessments), and anthropogenic threats to individual health and population status;	Yes
b) Review foraging areas and estimate consumption by relevant seal and cetacean species in case study areas	Yes
c) Review selected aspects of marine mammal-fishery interactions. Details of this ToR to be agreed with WGBYC;	Yes
d) Update the database for seals.	Yes
e) Address the special request from EU on emergency measures bycatch NE Atlantic by: i) Evaluating current population status and pressures and threats to harbour porpoises in the Baltic Sea and common dolphins in the Bay of Biscay. ii) Evaluating whether the described conservation measures within the request are appropriate.	Yes