REPORT OF THE ICES WORKING GROUP ON MARINE MAMMAL ECOLOGY (WGMME)

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Contents

i Executive summary

Five terms of reference (ToRs) were addressed at the working group.

The first three terms of reference were standing ones. Under ToR A, new information on cetacean and seal population abundance, distribution, and population/stock structure, was reviewed, including information on vagrancy in cetacean and pinniped species.

For cetaceans, coverage from the latest SCANS-IV survey (summer 2022) was presented as well as the results of recent regional/national surveys, particularly those in the Bay of Biscay and around the Iberian Peninsula. Updates on population estimates and distribution were provided for particular species studies, such as some coastal bottlenose dolphin populations. For seals, latest monitoring results were given for harbour, grey, and Baltic and Saimaa ringed seals. In addition, where possible, local long-term trends were illustrated for those species, based on earlier efforts by WGMME to assemble these data into a seal database. For both species' groups, recent records of vagrant species were summarised.

Under ToR B, cetacean and seal management frameworks in the North Atlantic were discussed, with an overview of the EU Maritime Spatial Planning Directive, and examples from the United Kingdom, Spain and the Faroe Islands of national management frameworks regarding marine mammals.

ToR C provided an overview of new published information with regards to anthropogenic threats to marine mammal populations following on from the review by WGMME in 2015 (ICES, 2015) and subsequent updates. These were considered under the following headings: cumulative effects, fishery interactions, chemical pollution including marine debris, underwater noise, ship strikes and other physical trauma, tourism disturbance, climate change, and new pathogens (including avian influenza).

ToR D focused upon bycatch. In support of WGBYC, this ToR aimed to contribute to the Roadmap for ICES PETS bycatch advice.

ToR E involved liaison with other WGs. The Chairs of the newly-formed WGJCDP introduced to WGMME members, the Joint Cetacean Database Programme, which is to be hosted by the ICES Data Centre. The scope to collect information on other marine species besides cetaceans was discussed. A meeting with another newly formed ICES working group, on Marine Protected Areas, was planned but was deferred at the request of that group.

On behalf of the working group, the Chairs would like to thank The Swedish Museum of Natural History for hosting the meeting.

ii Expert group information

Expert group name	Working Group on Marine Mammal Ecology (WGMME)
Expert group cycle	Annual
Year cycle started	2023
Reporting year in cycle	1/1
Chair(s)	Sophie Brasseur, The Netherlands
	Peter Evans, United Kingdom
Meeting venue(s) and dates	30 January – 2 February, Stockholm, Sweden (16 on site, 10 remote)

1 ToR A: New information on seal and cetacean population abundance, distribution, population/stock structure

Review and report on any new information on seal and cetacean population abundance, distribution, population/stock structure in the NE Atlantic (including North Sea and Baltic Sea), including information on rare or vagrant species of marine mammals in the area of interest and updating the seal database with abundance estimates and new data points.

1.1 Abundance and distribution of cetaceans

1.1.1 International / European initiatives: cetaceans

SCANS-IV is the fourth SCANS survey (1994, 2005/2007, 2016), covering shelf and offshore waters of the European Atlantic with the main objective to provide unbiased abundance estimates and trend assessments of the regularly occurring cetacean species by population-wide surveys. SCANS-IV took place in summer 2022, six years after SCANS-III, and covered European Atlantic coastal waters from southern Norway to the Strait of Gibraltar in a study area of approximately 1.8 million km^2, extending into offshore waters of the Bay of Biscay. Irish waters were independently covered by the ObSERVE-2 programme. Aerial surveys involved eight small aircraft carrying experienced observers, from the end of June to the middle of August 2022, with a Spanish aerial survey in coastal waters in September and October 2022. In addition, waters farther offshore such as the Bay of Biscay were surveyed from a ship. Data were collected by aerial survey (> 70 000 km) using the circle-back method for eight teams, and by a ship survey (> 4 500 km) in offshore waters of the Bay of Biscay using the two-team tracker method to account for animals missed on the transect line. Very good coverage could be achieved in central areas (southern North Sea, English Channel, Irish Sea and parts of the Celtic Sea) and along the coasts. In the north, the only gaps were north-west of the Hebrides and in the centre of the northern North Sea. Coverage offshore was lower off north-west Spain (Figure 1-1). The Portuguese offshore waters could be covered for the first time. In total, more than 5 000 sightings of 17 cetacean species were recorded during SCANS-IV, as well as observations of seals at sea, turtles, seabirds (including 800 flocks of dead seabirds during the bird flu epidemic), large fish, ships and floating marine debris.

The SCANS-IV project will also include work on a governance framework to ensure long-term implementation of the SCANS cetacean abundance monitoring programme, delivering timely estimates for European Union Member States that need to report every 6 years under both the Marine Strategy Framework Directive (Article 8) and the Habitats Directive (Article 17) as well as for indicator assessments under OSPAR and HELCOM.

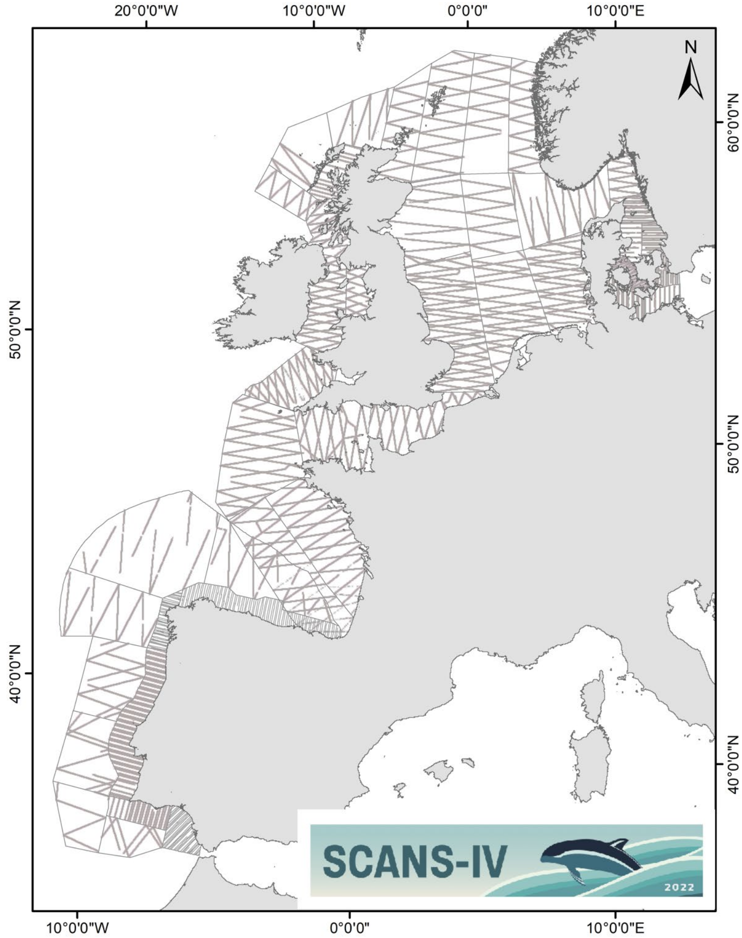


Figure 1-1. Realised effort along line-transects during the SCANS-IV aerial and ship surveys in summer 2022.

1.1.2 Belgium

In 2022, the Royal Belgian Institute of Natural Sciences performed two aerial marine mammal surveys covering Belgian waters. Estimated harbour porpoise abundances and densities were >1 1000 individuals at a density of 3.3 (95% CI: 2.3-4.9) animals per km² surveyed in March, and 2 000 individuals at a density of 0.8 (0.5-1.1) animals per km² surveyed in October. The area covered was equivalent to the area occupied by Belgian waters and largely overlapped the latter.

1.1.3 France

In winter 2021, the second cycle of the SAMM programme (Aerial Survey for Marine Megafauna) was initiated. The SAMM programme is part of the monitoring program implemented within the framework of the Marine Stategy Framework Directive (MSFD). The aim is to produce an inventory of the distribution and abundance of marine megafauna (mammals, seabirds, turtles and other species of large pelagic fauna) and marine litter, in summer and winter, in French waters. The first cycle took place in 2011-2012.

Conventional Distance Sampling estimates, uncorrected for availability bias (g(0)), for the winter of 2021 are now available for the Atlantic (221 565km²) and Channel (86 826 km²) areas (Laran *et al.*, 2022a; *Table 1-1*).

Table 1-1. Conventional Distance Sampling estimates of cetacean abundance in waters adjacent to mainland France in winter 2021. Lower and upper refers to the bounds of a 95% confidence interval. Estimates are not corrected for availability bias.

Species	No of sightings	Abundance (MCDS Estimates*)					
		Bay of Biscay			Channel		
		Lower	Mean	Upper	Lower	Mean	Upper
Common or striped dolphins (incl. Unidentified)*	356	134 000	186 700	260 700	4 800	8 900	16 500
Common dolphin*	302	80 900	127 400	201 500	1 800	3 600	7 100
Harbour porpoise*	198	2 200	3 400	5 500	9 700	12 700	16 600
Bottlenose dolphin*	60	3 200	8 500	22 500	2 200	4 300	8 400
Risso's dolphin	32	1 000	2 800	8 700	160	640	2 600
Minke whale	12	160	370	880	30	90	310
Large whales (incl. Fin whales)	12	10	40	190	5	20	100
Sperm whales	2	10	40	180	0	0	0
Beaked whales	2	380	950	2 530	0	0	0

*To estimate the detection function, sightings data from previous surveys were pooled to increase sample size. * MCDS, other species in CDS following minimum AIC. Numbers were rounded*.

On a smaller scale, the SPEE survey, which 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', was completed (Laran *et al.*, 2022b). Since winter 2019, 13 sessions of the SPEE survey have been carried out, with one session per season (4 sessions in winter, and 3 in each of the other seasons).

One salient result from the SPEE survey is the observed seasonal variation in small delphinids (common or striped dolphins, although within the area, common dolphins are sighted almost exclusively): winter density of small delphinids has increased in the study area since 2019 (Figure 1-2).

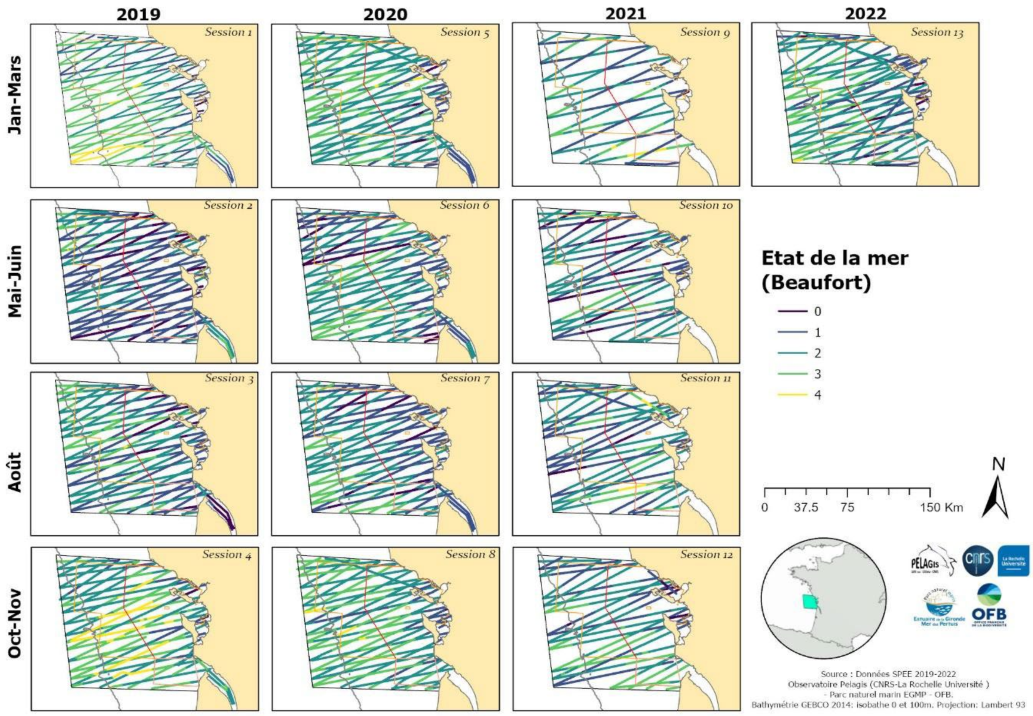


Figure 1-2. Survey effort (colour coded by Beaufort sea state) during the 13 sessions of the SPEE surveys.

1.1.4 Spain

Table 1-2. Ship surveys details carried out in the Bay of Biscay and the Iberian Coast and Western Mediterranean Sea ecoregion by IEO-CSIC and AZTI in 2022.

Survey	Organization	Dates (2022)	Area
MEGS0322	AZTI	13/03-31/03	Continental shelf and slope of French waters in the Bay of Biscay
PELACUS0422	IEO-CSIC	02/04-30/04	Continental shelf of Northern Spain
BIOMAN0522	AZTI	06/05-26/05	Continental shelf and slope of Bay of Biscay
MEDIAS0722	IEO-CSIC	08/07-10/08	Continental shelf of Spanish Mediterranean
JUVENA0922	AZTI	05/09-26/09	Continental shelf and slope of Bay of Biscay
IBERAS0921	IEO-CSIC	27/09-08/10	Continental shelf of Galicia and Portugal
ECOCADIZ-RECLUTAS1022	IEO-CSIC	12/10-26/10	Continental shelf of Gulf of Cadiz

During 2022, the Spanish Institute of Oceanography (IEO-CSIC) and AZTI completed their annual ship surveys (PELACUS, BIOMAN, IBERAS and JUVENA) to collect data on top predators in the Bay of Biscay and the Iberian Coast ecoregion. AZTI also carried out the MEGS survey that takes place every 3 years and covers the French continental shelf of Bay of Biscay. In 2022, the PECAN survey was not included in the IEO-CSIC ship survey schedule but it is included in the 2023 schedule, so the plan is to resume the historical series in 2023. The marine mammal group of the IEO-CSIC also participated for the first time in the ECOCADIZ-RECLUTAS survey carried out in the Gulf of Cadiz, and in the MEDIAS survey, which covered the Spanish Mediterranean continental shelf. Table 1-2 shows details of the surveys carried out in the different ecoregions.

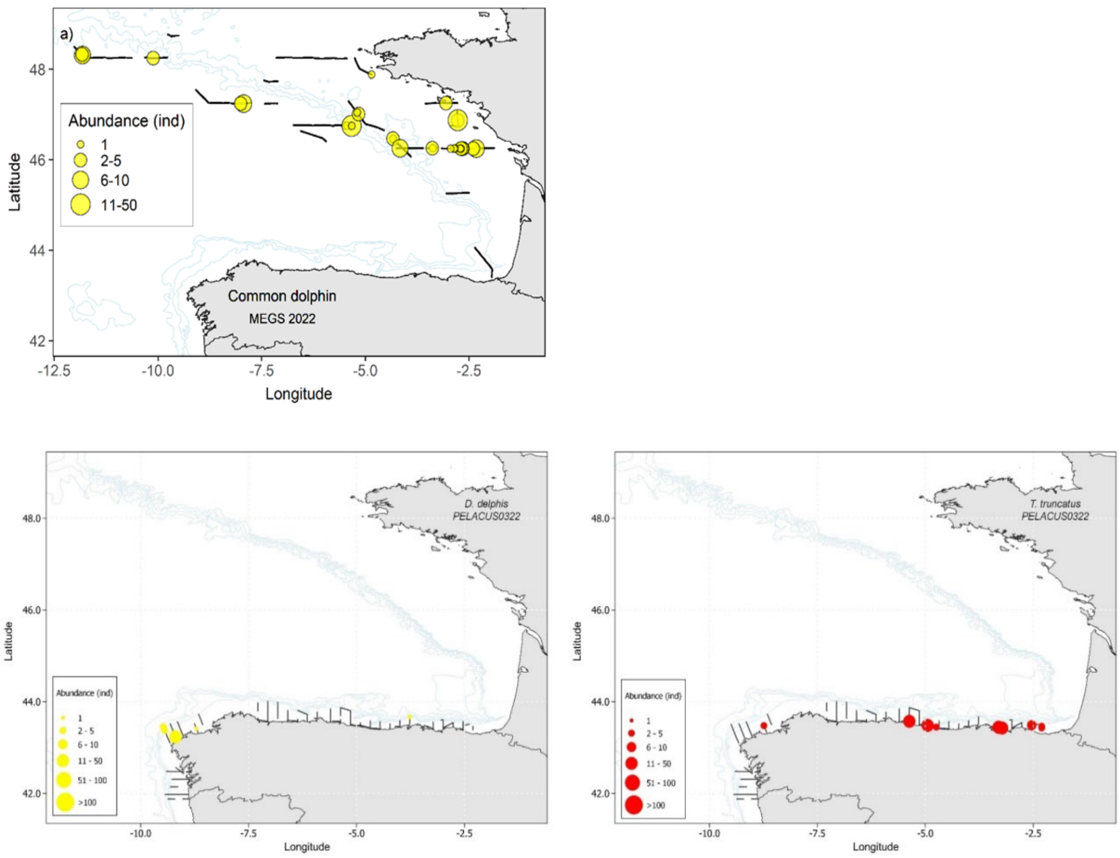
Table 1-3. Number of cetacean sightings recorded during each ship survey in 2022 (the month of the survey is indicated in parentheses).

Cetacean Species	MEGS (03)	PELACUS (04)	BIOMAN (05)	MEDIAS (07)	JUVENA (09)	IBERAS (09)	ECOCADIZ RECLUTAS (10)
Harbour porpoise		1				1	
Bottlenose dolphin		18	5	12	13	6	6
Common dolphin	35	11	103		94	48	12
Striped dolphin	1		5		2		
Common/Striped dolphin					1		
Atlantic spotted dolphin							
Unidentified dolphin	4		3		1		
Short-finned pilot whale							
Long-finned pilot whale	2				14		
Risso´s dolphin					4		
Cuvier's beaked whale					1		
Unidentified beaked whale			1		1		
Sperm whale							
Minke whale		1					
Bryde's whale							
Fin whale				1	30		
Blue whale							
Unidentified whale					1		

Table 1-3 shows the number of sighting of the cetacean species detected in each survey. The most frequently sighted species in the Bay of Biscay and Iberian Coast ecoregion was the common dolphin with 303 sightings, followed by the bottlenose dolphin (48 sightings) and the long-finned pilot whale (16 sightings). In the Western Mediterranean Sea ecoregion, the most frequently sighted species was the bottlenose dolphin with 12 sightings. Because the spatial coverage of the effort is different in each survey, it is difficult to identify clear temporal distribution patterns in either of the two most abundant species. Considering the continental shelf of the Cantabrian Sea, common dolphin presence during the PELACUS survey (April) was minimal (11 sightings); during BIOMAN (May) they were seen mostly near the slope (103 sightings), whilst during JUVENA (September) they were seen more often near the coast (94 sightings). In the case of the bottlenose dolphin, the lower number of sightings makes determination of trends even more difficult but this species was sighted (18 sightings) during the PELACUS survey, specifically in the eastern half of the Cantabrian Sea.

Figure 1-3 and Figure 1-4 show the spatial distribution of the most commonly sighted species in the Bay of Biscay and Iberian Coast ecoregion (common and bottlenose dolphins) and the Spanish Mediterranean continental shelf (bottlenose dolphins), respectively, based on the 2022 surveys. The data collected during these ship surveys are being used by OSPAR and for the CETAMBICION project, together with other data sets collected by France and Portugal, to obtain abundance estimates in the Bay of Biscay and the Iberian Coast sub-region for MSFD reporting.

Diaz Lopez *et al.*, (2021) carried out 43 days of at-sea observation during January to October 2020, covering a total distance of 4 500 km in shelf waters along the southern Galician coast. Among 493 sightings of groups of 8 species of cetaceans, 20% were groups of fin whales. The high number of fin whale sightings, as well as sightings of 30 blue whales.



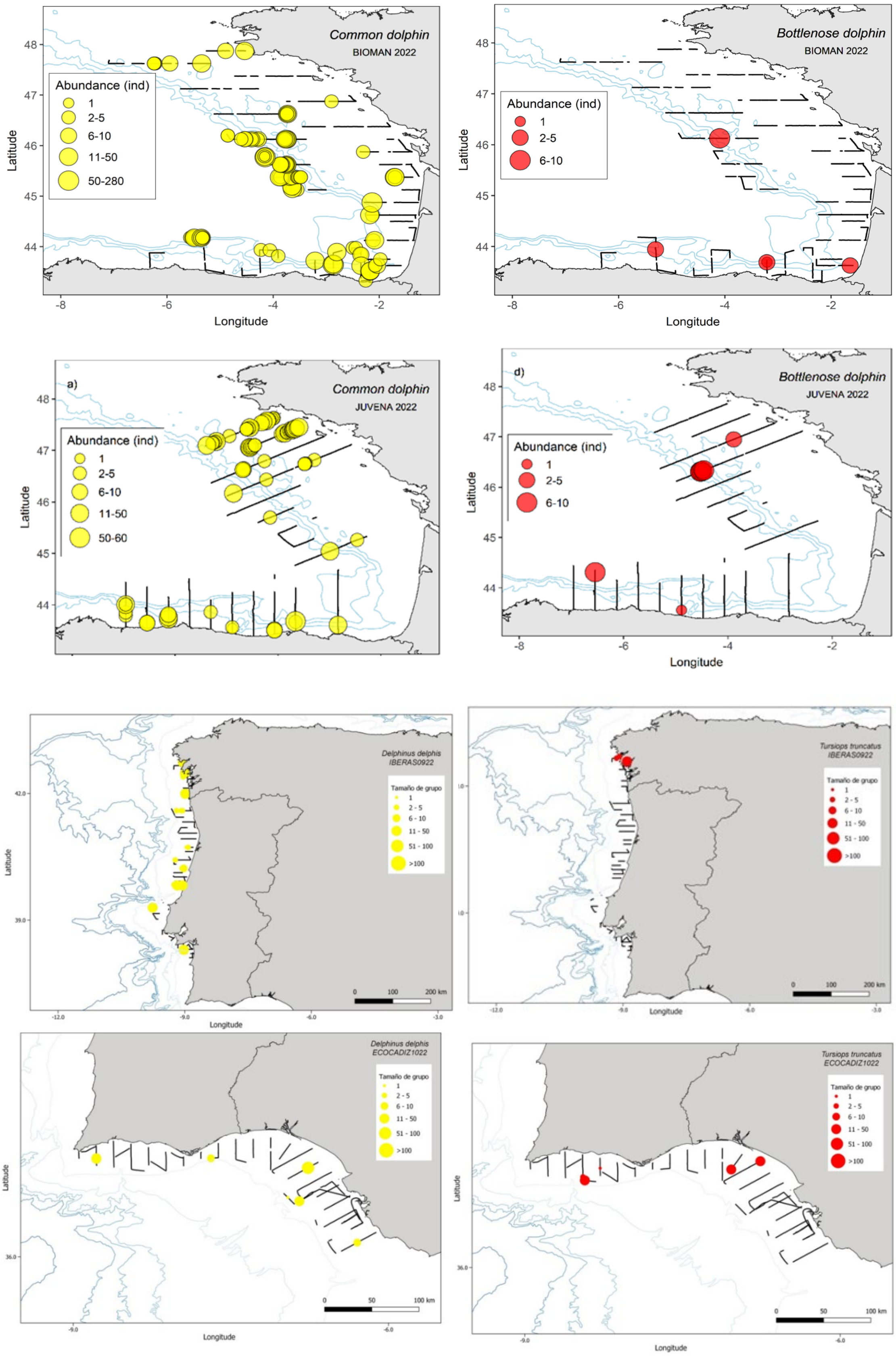


Figure 1-3. Spatial distribution of common and bottlenose dolphins in the Bay of Biscay and Iberian Coast ecoregion based on (from North to South) the MEGS, PELACUS, BIOMAN, JUVENA, IBERUS and ECOCADIZ surveys in 2022.

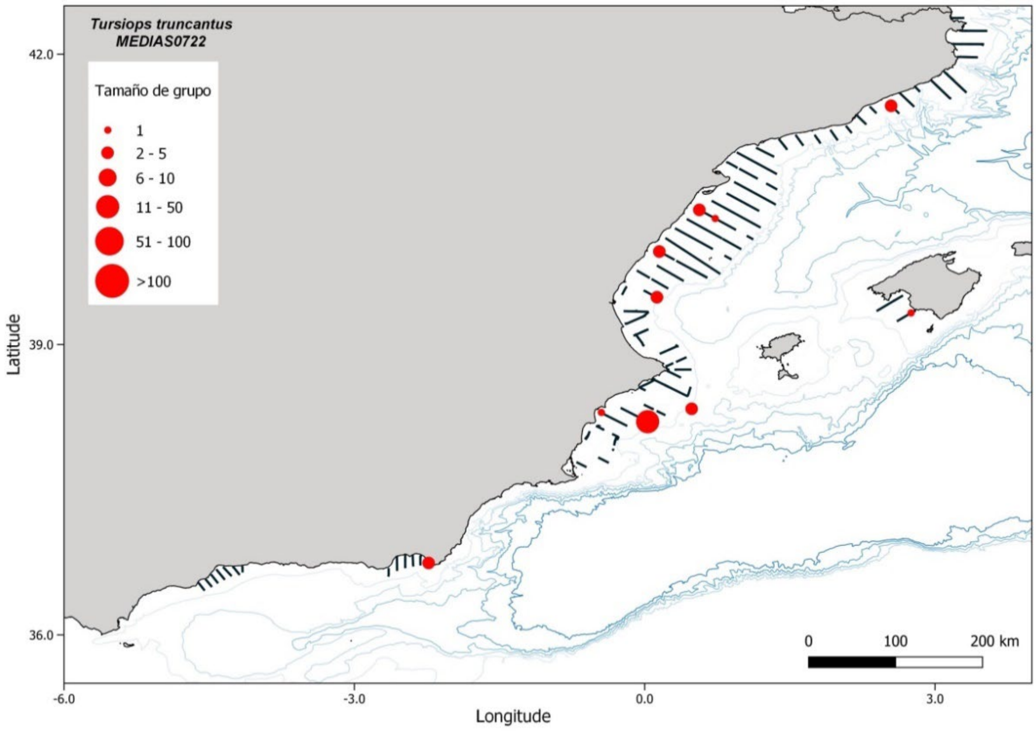


Figure 1-4. Spatial distribution of bottlenose dolphins in the Western Mediterranean Sea ecoregion, from the MEDIAS survey in 2022

1.1.5 United Kingdom

Scotland: Mark-recapture methods have been used to monitor coastal bottlenose dolphins in the Moray Firth (East Scotland) since 1990. Using citizen-science photo-identification data, the Citizen Fins project investigates the potential observed range expansion in the Moray Firth. Individuals originally associated with the Moray Firth population have been matched to sightings of individuals further south towards St Andrews Bay and the Tay estuary (Arso Civil *et al.*, 2019). At present, it is unclear whether this range shift reflects a shift in the distribution, a southerly expansion of range, and/or seasonal variations (Gutierrez-Muñoz *et al.*, 2021). In a similar trend, tens of known individuals of the Moray Firth resident population have been matched using photo-identification to individuals sighted along the northeast coast of England (Aynsley, 2017; Arso Civil *et al.*, 2019; Ellis, 2022). Further research is needed to better understand whether the observations indicate a shift in the range, or an expansion towards more southerly areas. However, bottlenose dolphins are now reported year-round in eastern England, with matches to the Moray Firth population (Hackett, 2022). Two decades previously, bottlenose dolphins extended their range southwards out of the Moray Firth along the coast of Aberdeenshire (Stockin *et al.*, 2006).

Strategic acoustic monitoring of small cetaceans using broadband recorders and F-PODs continues in Scotland through the Scottish Passive Acoustic Network (SPAN), which integrates those locations and sampling methods covered by the UK ECOMMASS project.

Digital aerial surveys were commissioned by the Scottish Government between February 2020 and March 2021 in offshore waters of the North Sea east of Scotland between the Shetland Isles and the Firth of Forth. Using these data, distribution models were developed for marine mammal and bird species occurring regularly in the area, along with seasonal abundance estimates. The number of harbour porpoises in the region was estimated at c. 55 000 animals in July 2020 with broadly similar numbers year-round but a peak of c. 120 000 between April and June, based upon an estimate of instantaneous availability of 0.123 (Paxton *et al.*, 2022). Greatest numbers occurred east of the Moray Firth. Point estimates of porpoise densities over the region varied from 0 to 5 animals/km^2, with progressively higher densities in the south of the survey area. It should however be noted that this study acknowledges the present limitations of aerial digital surveys, particularly in relation to species identification. Estimates of abundance and density for cetacean species in this report are much larger than those generated from the SCANS surveys and may be partially due to corrections that were necessary for instantaneous availability bias in the study.

Wales: Mark-recapture methods have been used to monitor coastal bottlenose dolphins in Cardigan Bay (West Wales) since 2001. Mark-recapture analysis of bottlenose dolphins in west Wales from data captured in summer 2022 yielded population estimates, using a robust design model, of 121 individuals (95% CI: 50-291) for Cardigan Bay SAC and 169 individuals (95%CI: 95-188) for the wider Cardigan Bay (Lohrengel & Evans, 2023). Both population estimates indicate a declining trend in this region since 2008-2012.

Evans & Waggitt (2023) presented results from over 440 000 km of vessel survey effort conducted between 1990 and 2020 from the Irish Sea, Bristol Channel and the Celtic Deep South. Density distributions were modelled for harbour porpoise, bottlenose dolphin, common dolphin, Risso's dolphin, and minke whale. Sightings rates were calculated for these species and for several less common species: striped dolphin, white-beaked dolphin, Atlantic white-sided dolphin, killer whale, long-finned pilot whale, fin whale and humpback whale. For harbour porpoise, modelled distributions by decade suggest generally lower densities during the 1990s compared with the subsequent two decades. Distribution patterns varied both between seasons and months, with the third quarter, particularly May to September, having the highest densities, particularly in the central part of the Irish Sea. For bottlenose dolphins, Cardigan Bay has a resident population but the species has also been seen over much of the coastal parts of the eastern Irish Sea. In those locations, particularly in winter, groups rarely remain for extended periods in any one locality, instead ranging around and often occurring more offshore. Photo-ID matches have been obtained with individuals occupying Cardigan Bay in summer.

Southwest England: Bottlenose dolphins have regularly been sighted in the southwest of England since the 1990's. While there is no systematic survey effort in the region, historically, individuals from the population were considered to range seasonally as far east as Kent (Williams *et al.*, 1997; Williams & Browning, 1999). However, until recently, more up to date evidence of this has been absent. A newanalysis of available data from local citizen science networks shows a discrete interconnected population with an adult survival rate of 0.951 (0.017 ± SE) suggesting that the population was relatively stable between 2008 – 2017, with a population size of 40 animals (CV= 0.18, 95%, HPDI = 30-59). The data demonstrate that the core range of this population extends further than previously understood (IAMMWG, 2015), with sightings of known individuals through to East Sussex and North Cornwall (Dudley, 2017; Corr *et al.*, 2020). This expansion in range is reflected in a recently published review and update to the Management Unit boundaries for cetaceans in UK waters (IAMMWG, 2023).

1.1.6 Faroe Islands

Ongoing tagging of pilot whales is expected to reveal new information on distribution and stock structure of the species (B. Mikkelsen, *pers. comm.*, 2 February 2023).

1.1.7 Greenland

A winter survey focusing on belugas, walrus and bowhead whales was carried out in West Greenland in March and April 2022. An aerial survey for narwhals, with hunter participation, was carried out in East Greenland in May 2022. Further, a paper on how to estimate availability bias when studying abundance of narwhals, based on the proportion of time narwhals spend on the surface, was published (Heide-Jørgensen and Lage, 2022).

1.1.8 Iceland

Several papers were published on the distribution of cetaceans in Icelandic waters during 2022, investigating distribution and abundance of minke whales (Albrecht *et al.*, 2022), fin whales (García-Vernet *et al.*, 2022), North Atlantic killer whales (Mrusczok *et al.*, 2022a), and long finned pilot whales (Selbman *et al.*, 2022). Selbman *et al.* (2022) reported on occurrence of long-finned pilot whales and killer whales in Icelandic coastal waters and their interspecific interactions. Mrusczok *et al.* (2022b) described long-distance movements of North Atlantic killer whales from Iceland via Spain and Italy to Lebanon. Samarra *et al.* (2022) investigated occurrence of cetaceans in the waters of the volcanic island Surtsey between 2008 and 2021.

The results from the last two North Atlantic Sightings Surveys (NASS) (2007 and 2015) and abundance estimates from all NASS surveys have been previously published (Leonard and Øien, 2020a, b). The next NASS is at a planning stage and scheduled for the summer of 2024.

Tagging orcas with Dtags was conducted during the summer field season in 2022 as well as playback experiments of pilot whale sounds to killer whales to investigate their interspecific interactions. Land-based observations also allowed for broader monitoring of variations in the occurrence of killer whales and other cetaceans in the local marine ecosystem.

Several photo-ID projects are ongoing in Iceland, where an attempt is made to use photos received from scientists and the public, to identify individuals of different cetacean species including fin whales, minke whales (Lechwar *et al.*, in press), blue whales, humpback whales, killer whales (Mrusczok, 2022a), long-finned pilot whales and white-beaked dolphins. These studies aim to increase knowledge on important population parameters relevant for management, such as abundance, behaviour, group composition, and migration, and can also aid in identifying critical cetacean habitats.

In relation to acoustic surveys, research on northern bottlenose whales continued in 2022, including deployments of mono and stereo acoustic recorders in deep waters off the east and northeast of Iceland to study acoustic occurrence and movement directions, and photographic analyses for understanding individual movement, group composition, and age-sex distributions. A study on the year-round occurrence of humpback whales in South Iceland, based on acoustic detections, as well as vocal behaviour in this region, was completed as a Master thesis (Chicco, 2022).

A total of 25 stranding events of cetaceans was recorded by the MFRI in 2022, including seven single strandings of sperm whales.

1.1.9 Canada

An updated population estimate is available for the North Atlantic right whale: 340 (+/- 7) individuals, slightly lower than the 2020 estimate of 348 (+/-5) individuals (https://www.narwc.org/report-cards.html).

The analysis of 25 acoustic recorders off eastern Canada deployed between May 2015 and November 2017, using a combination of automated detectors and manual validation to identify vocalizations showed that blue, fin, and humpback whales occurred off eastern Canada year-round (Delarue *et al.,* 2022). In addition, sei, minke, and North Atlantic right whale vocalizations also occurred in the data but were not adequately captured by the adopted methodology.

1.2 Distribution shifts and vagrants (cetaceans)

Extra-limital records of marine mammals outside of the expected range or season may relate to the individual or to unusual environmental conditions, and therefore may indicate changing conditions in the long-term or short-term.

Humpback whale: Humpback whales to date have been categorised as a vagrant species in UK waters (e.g. via Article 17 Habitats Directive Reporting). However, UK coastal sightings of humpback whales, particularly in Scotland and southwest England have been increasingly reported upon in the last ten years. Several UK-based citizen science initiatives have developed photo-identification catalogues, which are compared both between initiatives and with international partners. An analysis of images collected in UK and adjacent waters since the 1990s has been made by Harris (2022). There has been a clear increase in records over the last two decades, particularly in the last five years (Evans & Waggitt, 2020) but with the rise in social media usage, reporting has also increased. There is a need to review the evidence and consider whether the above status in the UK remains appropriate.

Grey whale: Grey whales are presently distributed in the North Pacific Ocean. The species was extirpated from the northeast Atlantic in the 15th century, and from the northwest Atlantic between the 17th and 18th centuries (Hurk, 2020). A combination of environmental and anthropogenic factors (i.e., whaling) may have been responsible for its disappearance from the North Atlantic (Alter *et al.,* 2015). In 2010, one vagrant individual, which may have migrated from the eastern North Pacific, was observed off the Mediterranean coasts of Israel and Spain (Scheinin *et al.,* 2011). Later in 2013, a second individual, which appears to have belonged to the western North Pacific population, was sighted in Namibian waters (Elwen and Gridley, 2013; Hoelzel *et al.,* 2021). In 2021, a third animal was first observed off the Atlantic coast of Morocco, before entering the Mediterranean and being seen off the coasts of Algeria, Italy, France, and Spain. Genetic analyses carried out on ancient bones indicate that grey whales made the passage between the Atlantic and Pacific at least several times during the last ~100 000 years (Alter *et al.,* 2015). In addition, archaeological bone remains dating from Roman and pre-Roman archaeological sites suggest that the species was once present in the Mediterranean (Rodrigues *et al.,* 2018), while medieval specimens from the Netherlands suggest the species might once actually have been abundant in the North Sea (Hurk *et al.,* 2020). With climate change and the consequent melting of sea ice, grey whale sightings in the Atlantic Ocean may continue in the future, as individuals from the North Pacific could wander into Atlantic waters via the Arctic. Current research efforts carried out under the EU project "Demise of the Atlantic Grey Whale" aiming to better understand what factors led to the disappearance of grey whales in the eastern Atlantic and whether the species might return to European waters in the future.

Blue whale: The current gross population estimate for blue whale in the south European Atlantic shelf waters is over a thousand individuals, out of a total North Atlantic abundance of around 4 000 – 5 000 animals, which may correspond to one third of their pre-exploitation abundance (Aguilar and Borrell, 2022). The moratorium on whaling and factors such as (amongst others) prey availability could potentially lead to an increase in blue whales venturing in Iberian waters. In comparison to fin whales, blue whales were apparently never abundant in Iberian waters, as suggested by whaling catch data, live sightings and strandings (Covelo *et al.*, 2017; Aguilar and Borrell, 2022). Catches in the region during whaling operations were thus relatively low compared to other species such as fin whales (61 blue whales were caught over a 55-year period from 1921-1985). At the end of the 1980s, the population size for the south European Atlantic shelf waters was estimated to be between ca. 337-497 individuals (Aguilar and Borrell 2022).

The five "Ballena" surveys for fin whales during 1981-1985 recorded only 13 blue whale sightings (Covelo *et al.*, 2017), including two on 6/8/1982 in offshore waters of Galicia (close to the Banco de Galicia) during Ballena 2 (Sanpera *et al.*, 1984), none during Ballena 3 (Sanpera *et al.*, 1985) and three at unspecified locations during Ballena 4 (Sanpera & Jover, 1986). There were no blue whale sightings during the large-scale NASS surveys in 1987 and 1989, SCANS II in 2005, and CODA in 2007. In 2016, there were two sightings, one around Cap Breton Canyon in the south of the Bay of Biscay and one during SCANS III west of Cap Finisterre. Between the 1980s and 2016, only one stranded blue whale was recorded on the Iberian Peninsula.

An increase in sightings of blue whales has been reported in Galician waters (NW Spain) during recent years (Diaz-Lopez *et al.*, 2021; Bland *et al.*, 2023) (Table 1-4). It was suggested that this may be an indication of a slow recovery of the population in Iberian waters (Diaz-Lopez *et al.*, 2021; Aguilar and Borrell, 2022).

Table 1-4 Number of sightings (and number of individuals sighted) of blue and fin whales off NW Spain by the Bottlenose Dolphin Research Institute 2017-2020 (Bland *et al.*, 2023).

Species	Number of sightings (and individuals sighted), by year				
	2017	2018	2019	2020	Total
Minke whale	5 (7)	10 (12)	5 (5)	6 (7)	26 (31)
Fin whale	22 (36)	12 (12)	12 (15)	33 (136)	79 (209)
Blue whale	5 (5)	4 (4)	2 (2)	16 (24)	27 (35)

1.3 Abundance and distribution of seals

In many ICES areas, seal populations are surveyed regularly, providing for a comprehensive long-term monitoring of these pinnipeds. This is mostly the case for the more temperate species including harbour, grey and ringed seals in the North Atlantic and Baltic Sea. The numbers of these species are described annually based on available data.

Tables 1-5, 1-6 and 1-7 summarise the most recent available harbour, grey and ringed seal survey data, analogous to what WGMME has presented in previous years. In the following, assessments of population status and developments are presented individually for the different countries or management units and different species, including trajectories of (available) counts. Unless it is stated otherwise, numbers of seals reported are those counted on haul-outs, which do not include seals at sea during surveys.

Trends in harp and hooded seals are described in the WGHARP reports (ICES, 2019a). The group discussed that in the future, other species, including arctic species should be reported to allow for observations of trends with respect to global changes. Therefore, vagrants observed are included in this report (1.4).

Table 1-5 Recent harbour seal survey data

Country		Recent Survey Year(s)	Moult (All seals)	Breeding (Pups)	References
NORWAY	Svalbarð	2009–2010	1 888		Merkel *et al.*, 2013
	North of 62N	2021	4 922		Nilssen *et al.*,2021
	South of 62N	2016–2018	1 054		Nilssen and Bjørge, 2019
	Finnmark	2016–2021	1 119		Nilssen and Bjørge, 2017
	Skagerrak	2016–2018	543		Nilssen and Bjørge, 2019
SWEDEN & DENMARK	Skagerrak east coast	2022	3 917		Swedish Mus. Of Nat. Hist.
	Kattegat/ Danish Straits	2022	8 315	1 897 (DK only – 2022)	Swedish Mus. Of Nat. Hist., Aarhus University
	Limfjord	2022	1 074	409	Aarhus University
	Southwestern Baltic	2022	1 232		Aarhus University
	Kalmarsund	2022	2 028		Swedish Mus. Of Nat. Hist.
WADDEN SEA	Denmark	2022	2 800	538	Galatius *et al.*, 2022a
	Schleswig-Holstein	2022	8 384	3 839	
	Helgoland	2022	98	1	
	Lower Saxony	2022	4 822	2 176	
	Netherlands	2022	7 550	1 960	
DUTCH DELTA AREA		2021	1 293	234 (pups in 2022)	Hoekstein *et al.*, 2022; 2023 in press
BELGIUM		2022	18	1	Haelters *et al.*, 2022
FRANCE	Mainland	2022	1 440	307	Poncet *et al.*, in press
UK	Scotland	2016–2019 2021*	26 846 690 261		SCOS, 2022 *Moray Firth *East Scotland
	England and Wales	2020-2021	3 659		SCOS, 2022
	Northern Ireland	2021	818		SCOS, 2022
REPUBLIC OF IRELAND		2017–2018	4 007		Morris and Duck, 2019
ICELAND		2020	10 319		Granquist, 2021
USA		2018	47 371 (estimate)		Sigourney *et al.*, 2021

CANADA	south of Labrador	1970s	12 700		NAMMCO
	Estuary and Gulf of St Lawrence	1994–2000	4 000–5 000		
FRANCE	Saint-Pierre et Miquelon (NW Atlantic)	2022	825	NA	DTAM; Vincent, C, unpublished data

Table 1-6 Recent grey seal survey data

Country		Recent Survey Year(s)	Moult (All seals)	Breeding (Pups)	References
NORWAY	Troms & Finnmark	2021–2022		275	Kjell Nilssen (unpublished data)
	Mid Norway 62N-68N	2014–2022		453	Kjell Nilssen (unpublished data)
	Norway south of 62N	2021–2022		34	Kjell Nilssen (unpublished data)
BALTIC	Baltic	2022	37 000		HELCOM
	Estonia	2022	5 587	2 049	HELCOM
	Sweden	2021		2 794	Swedish Mus. Of Nat. Hist.
WADDEN SEA		2022	8 948	1 927 (2020-2021)	Schop et al., 2022
DUTCH DELTA AREA		2022	2 738	33 (2021-2022)	Hoekstein et al., 2022; 2023 in press
BELGIUM		2022	3		Haelters et al., 2022
FRANCE	Mainland	2022	3 330	99	Poncet et al., in press
UK	Inner Hebrides	2019		4 455	SCOS, 2022
	Outer Hebrides	2019		16 083	SCOS, 2022
	NW Scotland	2019		609	SCOS, 2022
	Scottish North Sea	2019, 2004*		32 213	SCOS, 2022; * Shetland
	English North Sea	2019		10 725	Nat. Trust, Lincolnshire Wildlife Trust, Natural England, Friends of Horsey Seals
	SW England & Wales	2019		2 750	SCOS, 2022
	Northern Ireland	2019		250	SCOS (estimate?)
REPUBLIC OF IRELAND		2012	7 284	2 100	Ó Cadhla et al., 2013
ICELAND		2017	6 269	1 452	Granquist and Hauksson, 2019a

CANADA	Sable Island	2021		81 300	DFO 2022
	Gulf of St Lawrence + eastern Canada	2021		16 900	DFO 2022
FRANCE	Saint-Pierre et Miquelon (NW Atlantic)	2022	182*	0	DTAM; C. Vincent, unpublished data * Summer counts (harbour seal moult)
USA	USA east coast	2019		6 253	Wood et al., 2019

Table 1-7 Recent ringed seal survey data

Country		Survey Year(s)	Moult (All seals)	References
SWEDEN, FINLAND	Bothnian Bay	2018	9 919	HELCOM (close to normal ice conditions)
	Bothnian Bay	2021 2015	11 509 19 936	HELCOM (unusual ice conditions) 2015: the highest unusual result
ESTONIA, FINLAND, RUSSIA	Gulf of Finland	2021	116	M. Verevkin, *pers. comm*. (suitable ice only on Russian side)
ESTONIA, LATVIA	Gulf of Riga	2022	849	M. Jüssi, *pers. comm*.
FINLAND	Finnish Archipelago Sea	2018	122, population estimate 200–300	M. Kunnasranta, *pers. Comm*.

1.3.1 Arctic

Biotelemetry data from 13 marine mammal species (collected by 33 scientific institutes) were synthesized to identify species hotspots and areas with high species richness across the circumpolar Arctic (Hamilton *et al.*, 2022). This study included for the pinnipeds in the ICES regions: ringed seals, bearded seals, walrus, hooded seals, harp seals, harbour seals and grey seals. For a few species, the study did have some gaps in either geographical or temporal coverage and in some cases, did not cover all sex and age classes. This resulted however, in the identification of seasonal summer (June-November) and winter (December-May) hotspots for individual species, but also for groups of marine mammals, facilitating an initial identification of potential treats with relation to global warming and increased human use.

1.3.2 Norway and Swedish Skagerrak

Harbour seal: Harbour seals on the east coast of Skagerrak (starting from the mouth of Oslofjorden in the north) are monitored annually as part of the monitoring programme by Sweden. Three surveys are carried out annually in the moulting season in August, and an average of the three full survey results is used as an abundance index. The abundance of harbour seals in the east coast of Skagerrak is indicating a levelled off growth (Figure 1-5).

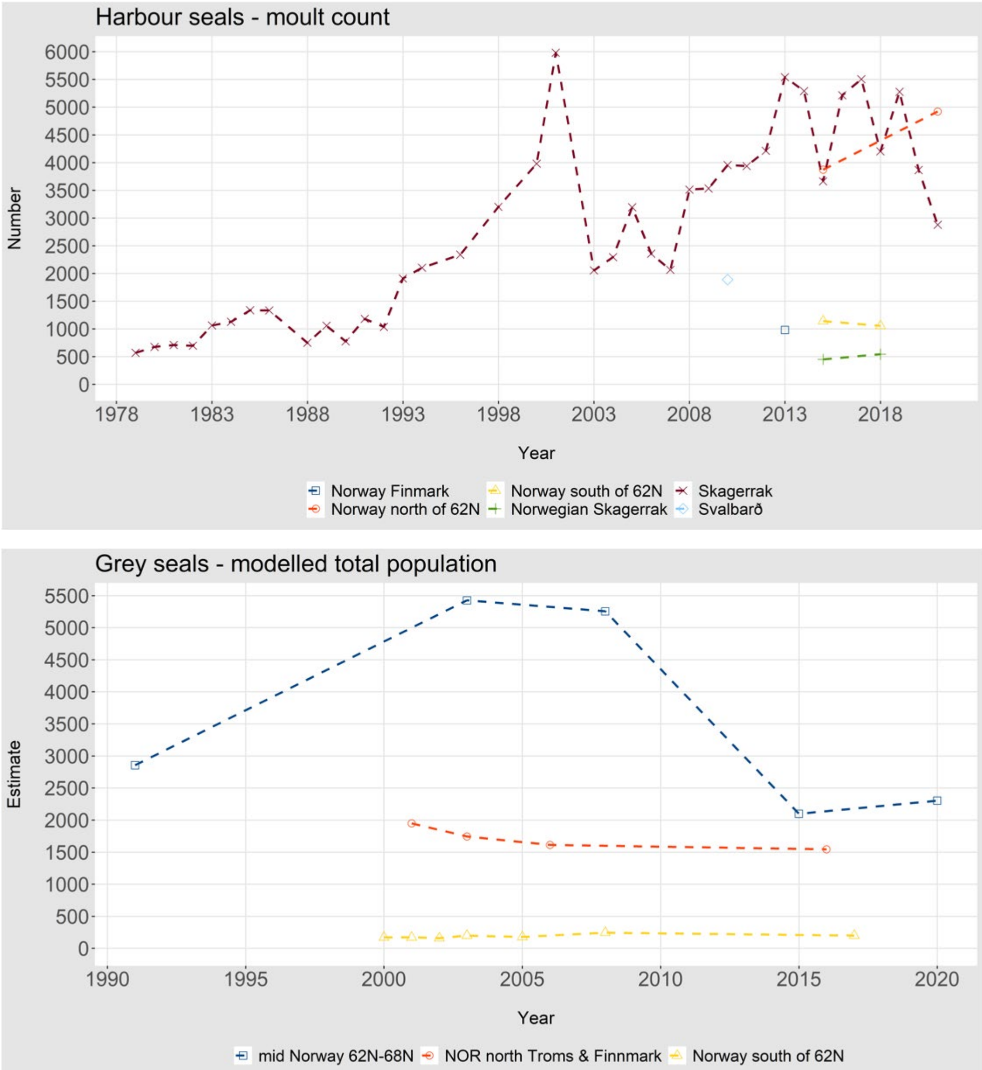


Figure 1-5. Trends of moult counts of harbour seals in the Skagerrak and Norwegian coast (top). Trends of counts of grey seal pups in Norway (bottom).

1.3.3 Baltic Sea

Harbour seal: Harbour seals in the Baltic (HELCOM) area (Denmark and Sweden) are monitored annually using replicate annual aerial surveys during the moulting period in August (Figure 1-6). They are split into four management units: Limfjord, Kattegat and the Danish Belt Sea, Southwestern Baltic, and Baltic Proper (Kalmarsund).

The number of harbour seals counted in Limfjord has fluctuated around 1000 since the early 1990s and, thus, the numbers appear to be fluctuating around a carrying capacity. Genetic analyses indicate that the seals in the fjord originate in two different populations, (1) the population originally inhabiting the fjord, primarily found in the Central Limfjord, 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 what extent they interbreed with the native seal population. A proper assessment of the Limfjord harbour seals is contingent on clarification of these issues. In 2022, 1074 seals were counted in the fjord, 727 of these in the central part (Aarhus University).

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% and about 30% of the population died in 1988 and 2002, respectively (Härkönen *et al.*, 2006). Unusually large numbers also died in 2007, but the reason for this mortality remains unclear (Härkönen *et al.*, 2007a). In spring and summer of 2014, some seals, appearing to show signs of pneumonia, were found in Sweden and Denmark. Avian influenza H10N7 was 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 due to the influenza epidemic is taken into account (Zohari *et al.*, 2014; Krog *et al.*, 2015; Bodewes *et al.*, 2016). This is likely to be caused by density dependence, indicating that the population is approaching carrying capacity. The 2022 count was 8 315 seals (Aarhus University/Swedish Museum of Natural History).

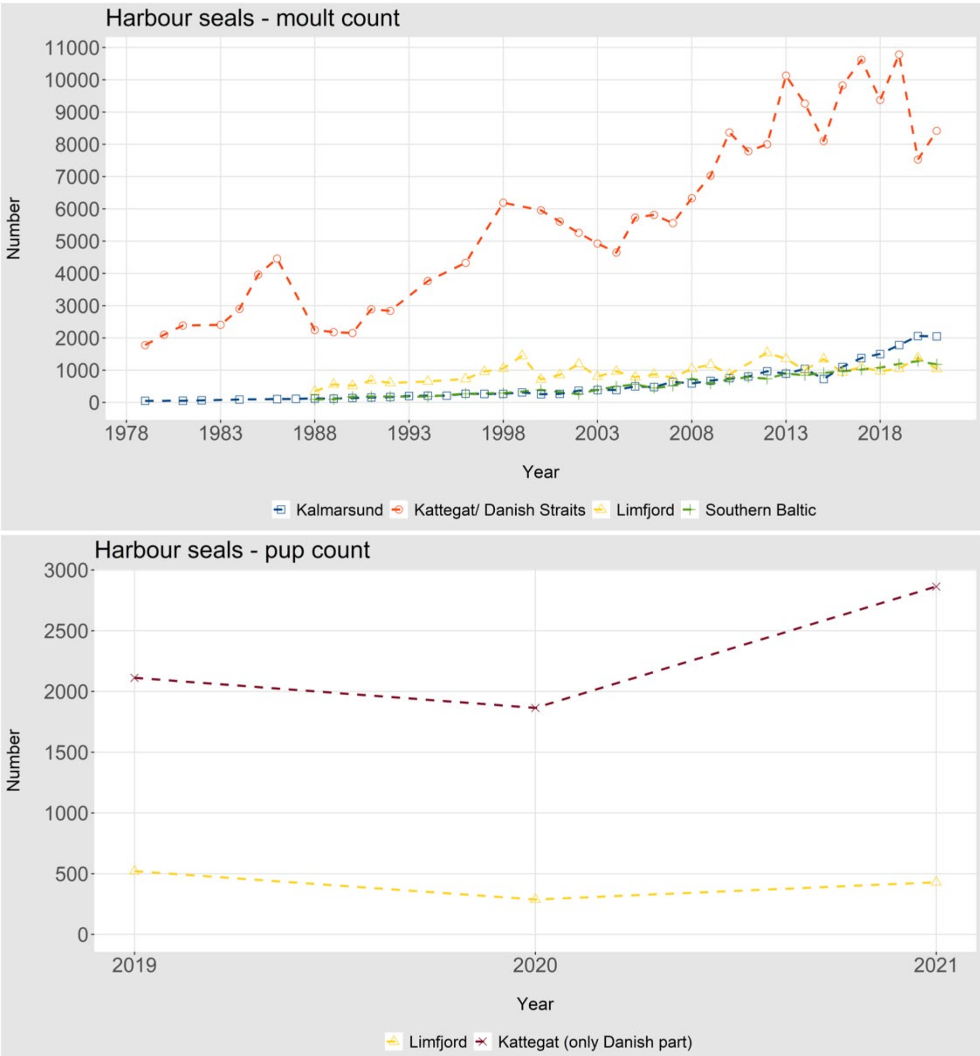


Figure 1-6. Trends of moult counts of harbour seals in the Kattegat and the Danish Belt Sea (Danish Straits), Southwestern Baltic, Limfjord and Kalmarsund (top). And available pup counts (bottom).

The Southwestern Baltic population appears to have been growing exponentially since it was first surveyed in 1990, with little influence from the 2002 PDV epidemic (Galatius *et al.*, 2021). On average 1 127 seals were counted in the area in 2022 (Aarhus University).

The harbour seal population in the Baltic Proper/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 2 028 harbour seals were counted in 2021 (Swedish Museum of Natural History). In contrast to other harbour seal reporting units, the maximum result of replicate surveys is used for the Kalmarsund population.

Grey seal: Grey seals in the Baltic Sea are thought to form a separate sub-species called the Baltic grey seal (*Halichoerus grypus grypus*). Monitoring of the grey seal population in the Baltic Sea is coordinated internationally during the moulting season, with coverage of 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; Figure 1-7), although levelling off was suspected in the mid-2010's when the result for the whole Baltic was just over 30 000 for four years. Then around 38 000 seals were counted in 2019, 40 000 in 2020, 42 000 in 2021, and 37 000 in 2022 (HELCOM EG MAMA).

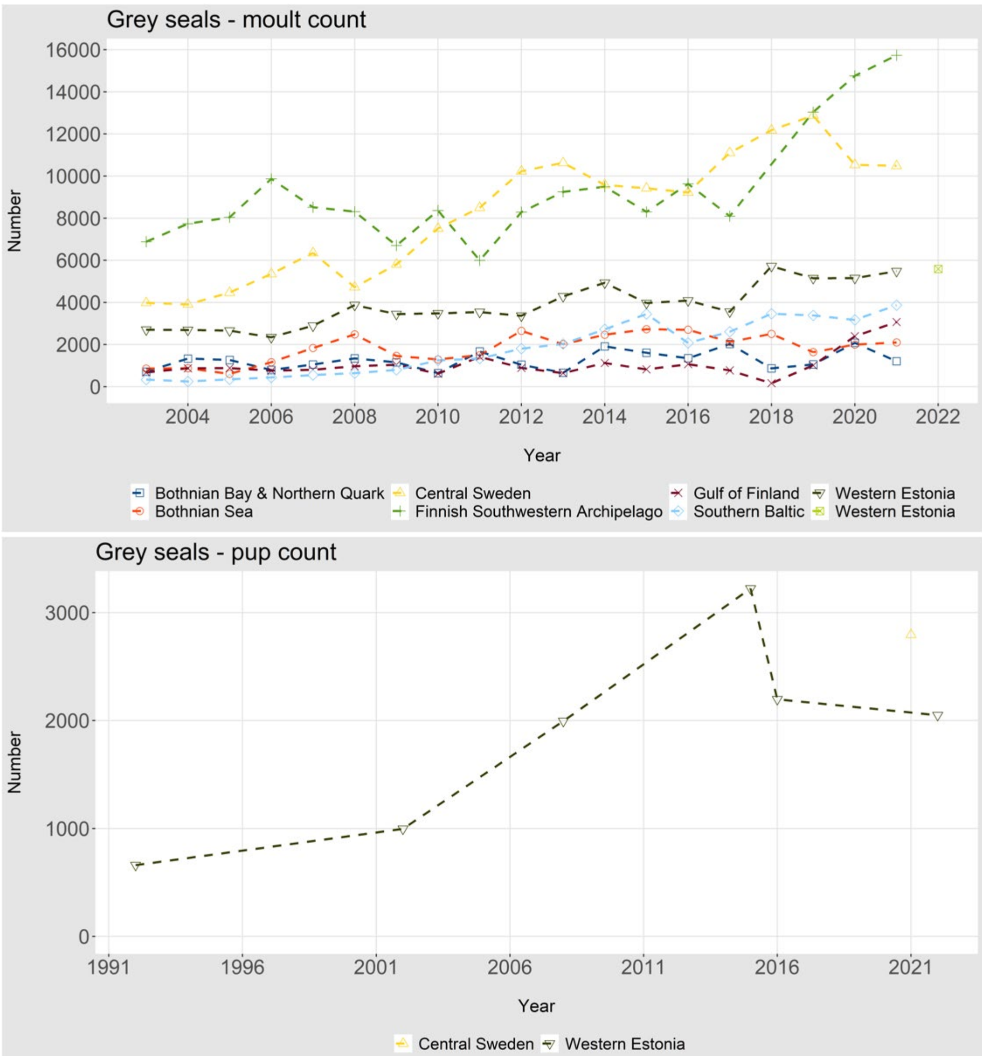


Figure 1-7. Trends of moult counts of grey seals in the Baltic (top). And available pup counts (bottom).

The population growth has been most pronounced in the southern and western parts of the moulting distribution until very recently when a regional exchange from central Sweden to southwestern Finland occurred, possibly due to increased hunting pressure in the Swedish area. In 2022, the continuing decrease in the archipelago of central Sweden was reflected in the total abundance estimate. The numbers counted in that one area have decreased from almost 13 000 to 7 100, a decline of 45 %. Of the hauled-out population, around 75 % were still 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 size of the population has increased, its range has expanded to also include the southern Baltic, where Baltic grey seals have been breeding regularly, although in small numbers, since 2003 (Galatius *et al.,* 2020). In recent years, pups have also been observed in the Kattegat area (Galatius *et al.,* 2020). This expansion has brought Baltic grey seals in contact with the Atlantic subspecies, and there are strong indications of hybridisation between the two subspecies, based on microsatellite data from the southern Baltic (Fietz *et al.,* 2016).

Grey seals commonly use islands in the northern parts of the main Baltic proper for breeding in mild winters. This is the core breeding area for Baltic grey seals and during the last few decades, it has been lacking ice-cover in most winters. The number of pups born on land is negatively correlated to the maximum ice cover in the Baltic Sea, as ice is the preferred breeding platform (Jüssi *et al.,* 2008). Pup surveys on the Estonian west coast have been systematic since 1990 and in those years when there was no coastal ice during the breeding season in February-March, there has been an increasing trend (Figure 1-7). Since 2021, the land breeding sites in the core breeding area of Sweden have been surveyed.

Ringed seal: The Baltic ringed seal was separated from the arctic nominate subspecies along with the process of retreating ice after the ice age and is now considered a subspecies (*Pusa hispida botnica)*. Together with other seal species, the Baltic ringed seal has historically been an important resource for humans, but also seen as a competitor over fish stocks. Resulting first from extirpation campaigns fuelled by governmental bounty practices and followed by infertility caused by environmental contaminants, Baltic ringed seal population collapsed from 200 000 to just a few thousands during the first half of 1900's (Hårding & Härkönen 1999). After banning the hunt and the contaminants, the northernmost population in the Bothnian Bay has been recovering. However, the smaller southern sub-population fragments have not been growing. More than other ringed seal populations, they have been facing the effects of a new threat, climate warming, for example through the loss of breeding habitat on the ice.

Since 1990's, suitable ice-conditions for breeding have become increasingly rare in the southern breeding areas, the Archipelago Sea, the Gulf of Finland and the Gulf of Riga. In these areas, no signs of population growth have been observed. In Estonia, standardised surveys in ice-free conditions have been carried out for a few years. The resulting counts have been roughly at the same level as previous results from aerial surveys over ice, with no indication of population growth. Standardised methods are being tested in the Russian area of the Gulf of Finland and are under development in the Finnish Archipelago Sea, where material for photo-ID studies is also collected.

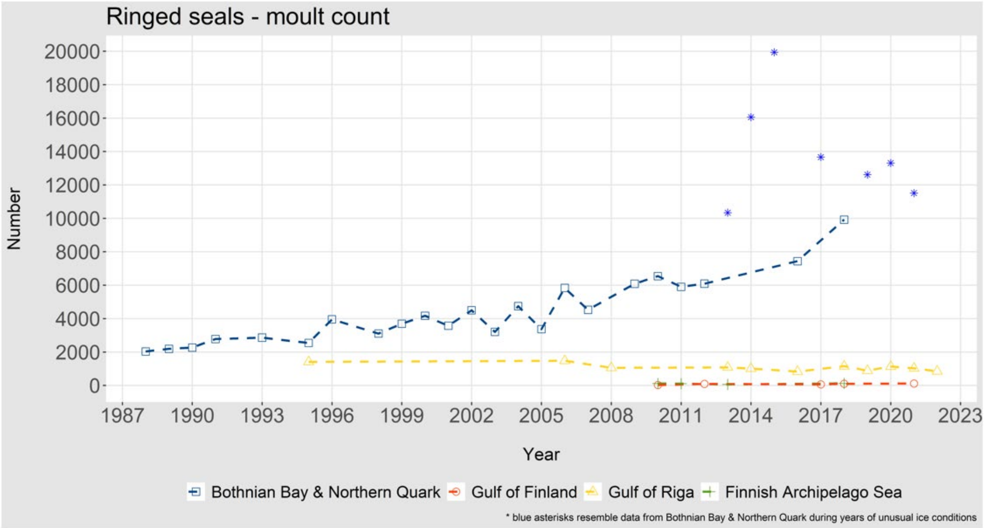


Figure 1-8. Trends of estimated numbers of ringed seals hauled out on sea ice and haul-outs during moult surveys in the Baltic. Counts in years during which the ice conditions resulted in unusual results are represented with *.

Ice-winters have become milder even in the Bothnian Bay, leading often to earlier ice-breakup. Monitoring of the population is based on aerial surveys for the ringed seals hauling out on ice in April. Since 2013, most survey results have been exceptionally high, supposedly due to advanced ice breakup linked to behavioural change of the ringed seals. These recent results have not been comparable to earlier results nor with each other. Therefore, no estimate for population trend can be drawn for the last decade (Figure 1-8). Extensive studies are needed to better understand ringed seal behaviour prior to and during moulting time.

Saimaa ringed seal: Studies indicate potential inbreeding in the endangered Saimaa ringed seals *Pusa hispida saimensis*. Translocation of individuals within the Lake Saimaa has been suggested as a way to support augmented gene flow (Sundell *et al.*, 2023).

1.3.4 United Kingdom

***Harbour seal*:** UK harbour seal population monitoring programmes are designed to track and detect medium to long-term changes in population size and such programmes have usually been directed towards obtaining indices of population size as it is challenging to estimate absolute abundance. These indices are based on the numbers of individuals observed hauled-out, and so their application depends on this being constant over time and unaffected by any changes in population density or structure. Such time series data are suitable to describe population dynamics so long as the number of individuals observed to haul-out remains unaffected by population density or structure. Monitoring of UK harbour seals is carried out during the annual moult when the most stable and often the highest and numbers of adult and juvenile seals are hauled out. However, to understand local population dynamics, breeding success provides a more sensitive index of current population status than using moult counts when the seals have already dispersed from their breeding grounds.

Harbour seal moult counts in the UK are conducted in August largely at the scale of Seal Monitoring Units (SMUs). Scotland, Northern Ireland and Southeast (SE) England account for the majority of UK harbour seals, with only small populations elsewhere (South England, Northeast England). Annual surveys are conducted covering different areas, with the aim of covering the Scottish and English SMUs within a five-year period. 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 1-9). Comprehensive surveys of the harbour seal populations in East Scotland, Moray Firth and Northern Ireland SMUs, as well as a regional survey of the First of Tay and Eden SAC were carried out during the summer of 2021.

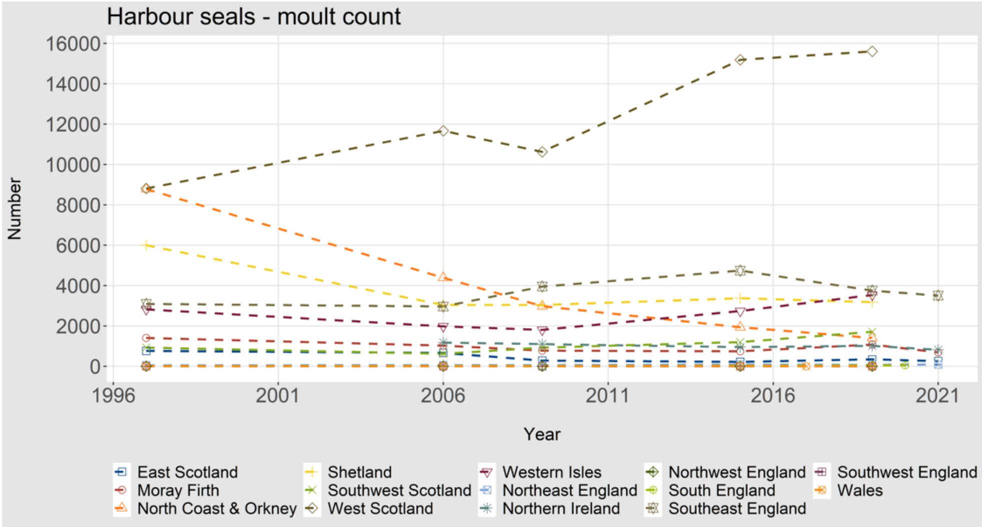


Figure 1-9. Trends of moulting harbour seals in the subareas of the UK.

The latest UK count total from surveys conducted between 2016 and 2021 gives rise to an estimated UK harbour seal population of 42 900 (approximate 95% CI: 35 100-57 100) (SCOS, 2022). The UK population is presently similar to that estimate from the previous survey round (2009-2015), (approximately 1% lower). However, significant differences in the population dynamics between regions are apparent. Similar to previous reports, there are general declines in harbour seal counts in several regions around Scotland. This varies between populations with some either stable or increasing. In response to the observed declines in harbour seal abundance in the South-East England SMU, three surveys of the coast, from Donna Nook to Scroby Sands, including the Wash, as well as a single survey of the Greater Thames Estuary within the MU were carried out in 2021. A further three surveys of these same stretches of coastline within the Southeast England SMU, the Moray Firth and the east coast from Fraserburgh to Donna Nook (East Scotland SMU and Northeast England SMU) were carried out in August 2022. Results from these surveys will be available for WGMME 2024.

The UK component of the southern metapopulation (Carroll *et al.*, 2020) comprises almost entirely the Southeast England SMU. The majority of harbour seals in that SMU haul out and breed within The Wash and North Norfolk Coast SAC. Counts during the August moult are around 24% (95% CIs: 13-33%) lower than in 2015 (Russell et al., 2022). Given that until recently, this SMU was the single unit in the UK showing sustained increases in abundance when many eastern and northern coast SMUs had depleted or declining populations (Thompson *et al.*, 2019; 2021), the decline is considered to be of concern, and the Special Committee on Seals (SCOS) recommended that research is required to determine the time course and potential causes of this reduction (SCOS, 2022). At present, it is not possible to determine the cause of the decrease in both harbour seal pup and moult counts in the Southeast England SMU. A research programme is being developed presently in England to investigate the potential causes.

In contrast to other regions of the UK, harbour seals on the east coast of England breed on open sand banks where pups are relatively easy to observe and count. As part of an effort towards increasing the sensitivity of the UK monitoring programme, an occasional single breeding season survey has been carried out since 2001 of the coast from Donna Nook (Lincolnshire) to Blakeney

Point (Norfolk) at the end of June or beginning of July when peak counts are anticipated. Following a period of no surveys in 2019, 2020 or 2021, in 2022 a survey was carried out covering the coastline between Donna Nook and Blakeney Point. 1 141 pups and 2 893 1+ age class seals were counted in the Wash area, similar to results of the 2017 and 2018 surveys; no pups were sighted at Blakeney Point or at Donna Nook. The total pup count within the Wash in 2022 was 24% lower than that of 2018, and 24% lower than the mean of the peak counts in surveys from 2014 to 2018 (preceding five years). The count of +1 age class seals was also 26% lower than the average of the peak counts in the preceding five years for the same area. The reported 24% decrease in pups between the 2018 and 2022 surveys coincided with the fall in the moult counts for the same area (see above) (Thompson *et al.*, 2022).

Counts in the <u>northern metapopulation</u> show varying trends from continuing decline (Orkney & North Coast, East Scotland SMUs), depleted but stable (Shetland, Moray Firth), stable (Western Isles, Southwest Scotland) with indications of an increase (West Scotland). Surveying of the Orkney & North Coast, and Shetland SMUs was last completed in 2019, and therefore there is no update to abundance in these regions since WGMME, 2022. Complete surveys of both the Moray Firth, and East Scotland SMUs were carried out in 2021. Counts in the Moray Firth SMU (690) were 32% lower than that of the 2019 count. Counts of harbour seals in the East Scotland SMU (261) were 24% lower than that of the 2016 count. Within the Firth of Tay and Eden Estuary SAC (within the East Scotland SMU), 41 seals were counted. This value is equal to the mean of the previous 5 years' count, but represents a 94% decrease from mean counts recorded between 1990 and 2002 (641) suggesting that individuals may not be using the designated SAC region as persistently anymore (SCOS, 2022). Research is ongoing into the proximate and ultimate cause of the declines in Scotland. The rate of decline suggests that they are, in part, due to increased adult mortality. Ultimate causes under investigation are biotoxins, grey seal competition and predation.

A complete survey of <u>Northern Ireland</u> was carried out in August 2021 where 821 harbour seals were counted. This value is 23% lower than that counted in 2018 (1012). While only four synoptic surveys have been carried out of Northern Ireland's harbour seal population, a subset of the population from Carlingford Loch to the Copeland Islands has been monitored more frequently from 2002 to 2021. In the two years of complete coverage of the area in this time period, 80-85% of the total population were counted here. The most recent count in 2021 suggests that the decline previously observed in this subset between 2002 and 2011 (average rate of 2.7% p.a.) has continued.

Grey seal: The UK grey seal population appears to comprise one metapopulation that extends into the rest of Europe. Considerable movement occurs between UK Seal Monitoring Units, Ireland, and the continent (Brasseur *et al.*, 2015; Russell and Carter, 2021). UK population size is estimated using a Bayesian state–space population dynamics model, (WGMME, 2022; SCOS, 2022). Major grey seal breeding colonies in Scotland and on the east coast of England are presently surveyed biennially. The most recent synoptic census of all principal grey seal breeding sites in Orkney, the Inner and Outer Hebrides and the North Sea (the Firth of Forth, and along the coast of eastern England) was carried out in 2019. This census, including a correction for less frequently monitored sites (not surveyed in 2019), resulted in an estimate of 67 850 (approximate 95% CI 60 500-75 100) pups born throughout the UK in 2019. In 2021, a complete survey programme covering the North Sea colonies (Isle of May, Firth of Forth Islands, Fast Castle, Farne Islands, Donna Nook, Blakeney and Horsey) was carried out. A further programme of surveys of all other major Scottish colonies (Orkney, Moray Firth, North Coast, Inner & Outer Hebrides was carried out in 2022. Results of those surveys will be available for WGMME 2024.

Scaling up the output of the population model provides a UK population estimate (individuals of age 1+) at the start of the 2022 breeding season (before pups are born) of at 162 000 (approximate 95% CI 146 000-179 000). This estimate is based on the most recent pup production estimates in 2019 for aerially surveyed colonies in Orkney and the Inner and Outer Hebrides, the Firth of Forth, and the colonies on the east coast of England for combined aerial and ground surveyed colonies in the North Sea.

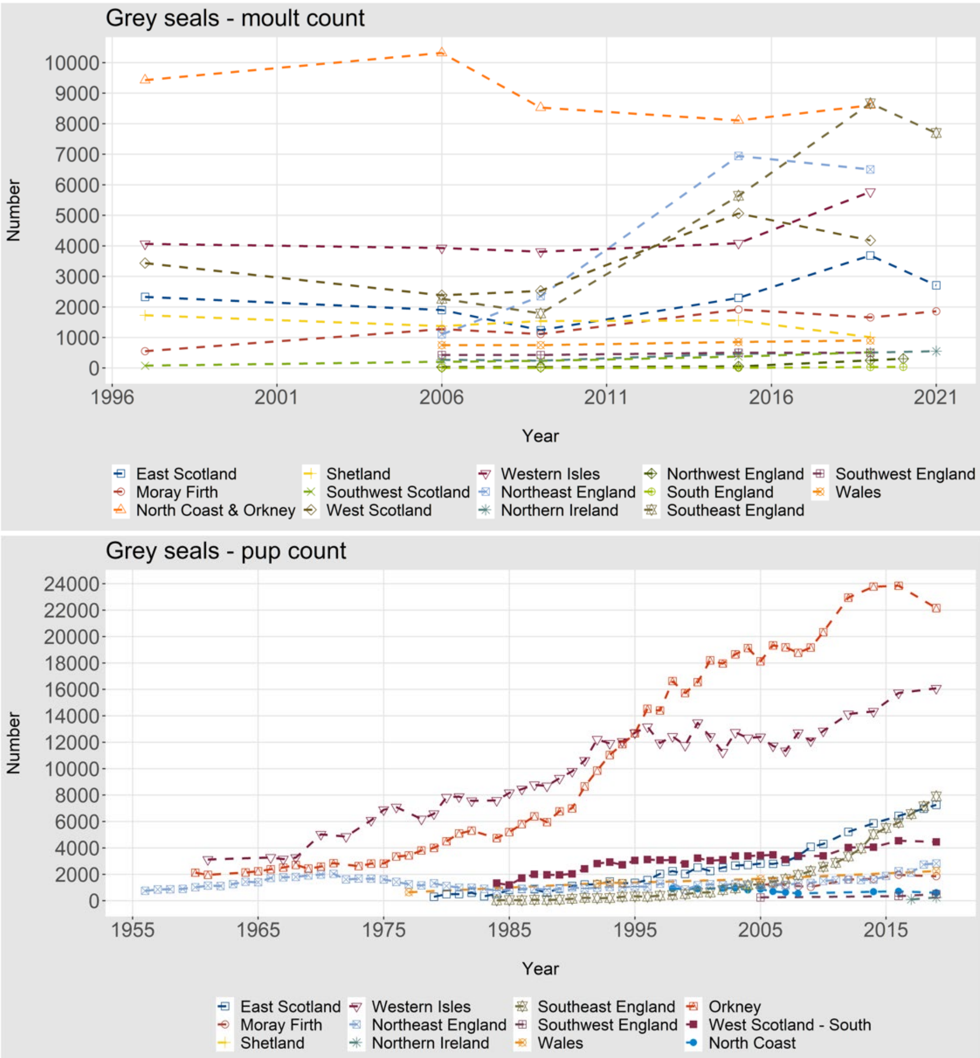


Figure 1-2. Trends of moulting grey seals in the subareas of the UK. (top). And available pup counts (bottom).

Notwithstanding changes in aerial survey methods which are associated with a jump in pup production between 2010 and 2012, pup production appears to have levelled off in three of the pup monitoring regions (Inner Hebrides c. 2000, Outer Hebrides mid-1990s, Orkney early 2000s), with only the North Sea showing continued increase (Russell *et al.*, 2019). Grey seal pup count trends for subareas in the UK are shown in Figure 1-10.

1.3.5 Ireland

There were no new seal counts for the Republic of Ireland. For harbour seals the latest moult count was carried out in 2018 when a total of 4 007 seals were counted (Figure 1-11). However, within the whole island of Ireland, genetic analyses revealed the presence of three genetically distinct local populations. They were characterised by high genetic diversity, hereby defined as: East Ireland, South-west Ireland, and North-west & Northern Ireland. The latter could not be distinguished from a previously identified Northern UK metapopulation (Steinmetz, *et al.*, 2023). The authors suggest conservation strategies for harbour seals in Irish waters should be amended to accommodate at least three genetically distinct local populations and management units.

For grey seals, there were also no new counts, the last pup counts being carried out in 2012 leading to a population estimate of 7 284–9 365 seals of all ages (ICES 2022; Figure 1-11). In addition, 3 698 grey seals were counted during the August harbour seal surveys in 2017-2018 (Morris and Duck, 2019).

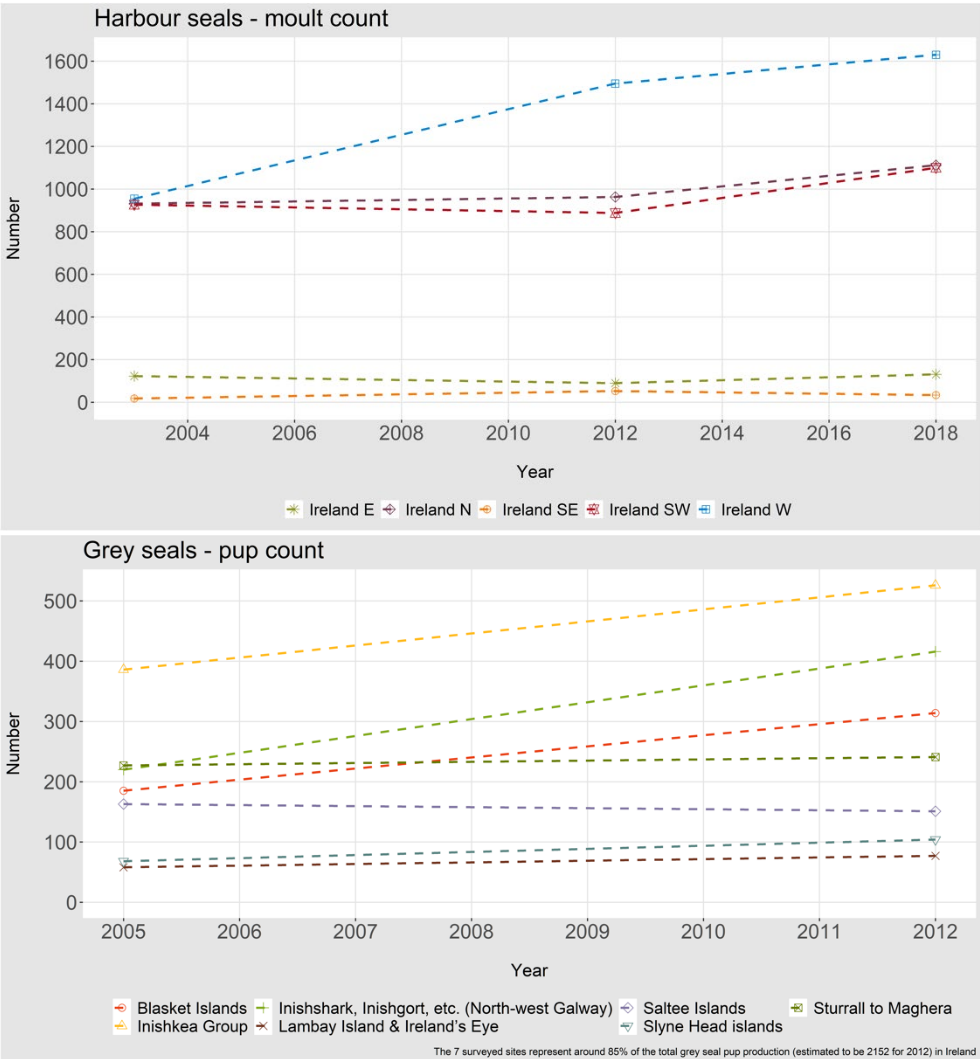


Figure 1-3. Trends of moulting harbour seals in the subareas of the Republic of Ireland (top). Trends of pup counts of grey seals in the subareas of the Republic of Ireland (bottom).

1.3.6 Wadden Sea (Denmark, Germany, the Netherlands)

Harbour seal: The Wadden Sea harbour seal populations is one of the largest in the world and is protected under the Bonn Convention of Migratory species. Harbour seals have been monitored since 1974 and surveys in the Wadden Sea are coordinated among Danish, German and Dutch scientists. Five annual counts are coordinated trilaterally and cover both the pupping and breeding seasons. After the PDV epidemic in 2002, population growth rate based on moult counts in August had been close to the maximum intrinsic exponential growth rate for harbour seals, at 12–13% (Brasseur *et al.*, 2018). However, since 2012, the trend changed abruptly and levelled off with a median annual growth rate of 1.6% until 2020. Trends in individual areas varied with numbers in Denmark declining throughout this period, and other areas showing variation from year to year (Figure 1-12). In contrast, pup counts continued to increase in this period, often representing 30-40% of the moult counts (Galatius *et al.*, 2021). The causes of this apparent mismatch between pup production and population growth remain unclear. The underlying mechanisms have not been studied and, as such, possible explanations continue to be hypothetical.

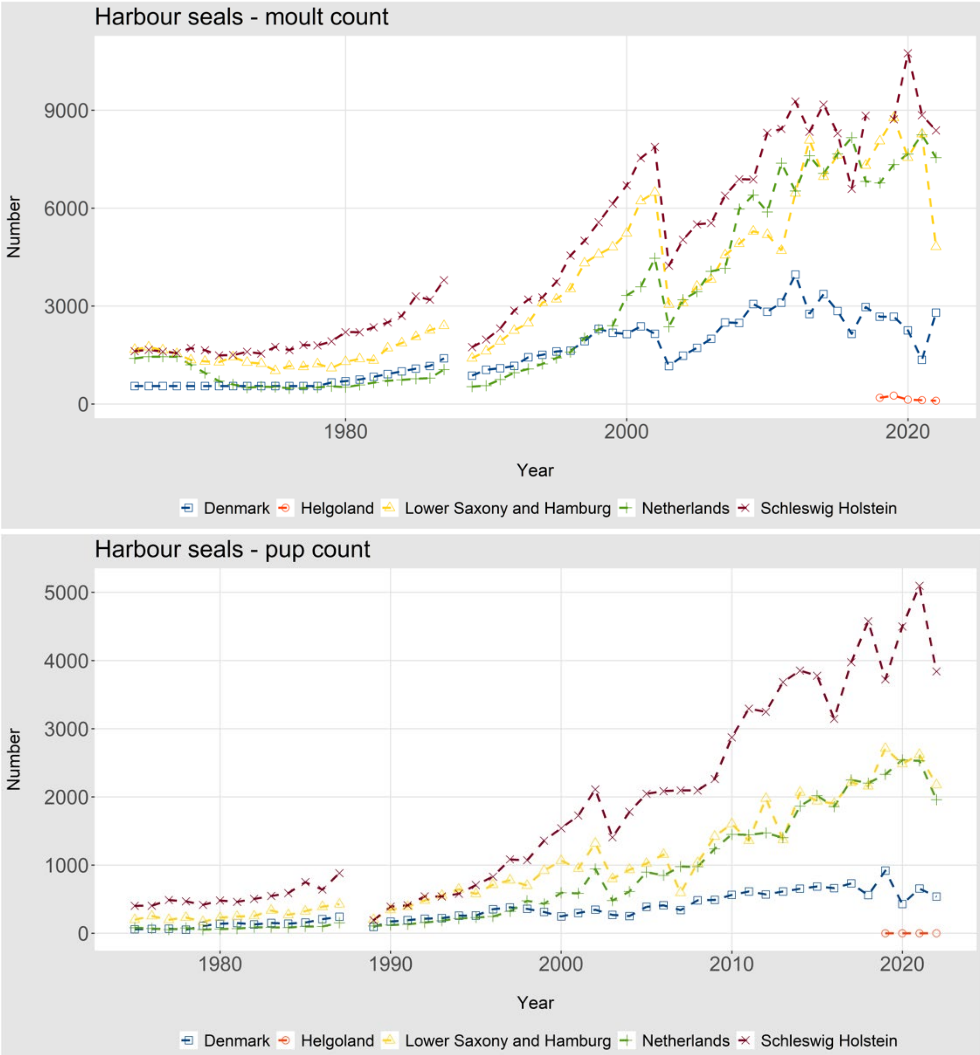


Figure 1-4. Trends of counts of moulting harbour seals (top) and harbour seal pups (bottom) in the Wadden Sea.

In 2022, also the trend in the pup counts changed: throughout the whole Wadden Sea area, these dropped by 22%: from 10 903 pups in 2021 to 8 514 (Galatius *et al.*, 2022a). Moreover, in many areas, moult counts also dropped, with the total falling from 26 838 animals in 2021 to 23 654 in 2022, with falls of 8% in the Netherlands, 42% in Lower Saxony, 16% at Helgoland, and 5% in Schleswig-Holstein (Figure 1-12). The exception was a 106% increase in Denmark (the count in 2021 was, however, extremely low). The severe drop in the counted number of moulting seals in Lower Saxony could be influenced by a new counting method, and therefore data in the Wadden Sea are represented separately. As the entire Wadden Sea area is monitored synchronously, lack of population growth is unlikely to be an artefact of redistribution of the animals. In general, strandings of dead animals are poorly recorded, though Denmark and Germany do conduct some necropsies. In the Netherlands, strandings are recorded voluntarily and are potentially underestimated still, 478 dead harbour seals were recorded (waarneming.nl), representing more than 6% of the moult counts. Future efforts should concentrate on collecting information to understand the mechanisms underlying the recent changes in population trends as well as ways to minimise potential human factors which might be responsible for the recent decline.

There may be some exchange with adjacent areas like Helgoland, which was recently included in the count, as well as between the Dutch Delta and the Danish Limfjords (see above). However, given the relatively low numbers in those areas, changes there cannot explain the recent decline in the Wadden Sea.

***Grey seal**:* Grey seals have gradually recolonised the Wadden Sea area since the last century (Härkönen *et al.*, 2007b). Numbers observed have grown both as a result of an increasing breeding population and as the result of animals visiting the area from the much larger population in the UK. During the breeding season of 2021-2022, pup numbers rose 15% compared to 2020-2021, and amounted to 2 214 pups (Figure 1-13). The average growth rate in pup numbers over the last five years was 12% (Schop *et al.*, 2022). Although more than 50% of these are born in the Dutch part of the Wadden Sea, colonies in Germany, Helgoland and Lower Saxony are gaining in importance.

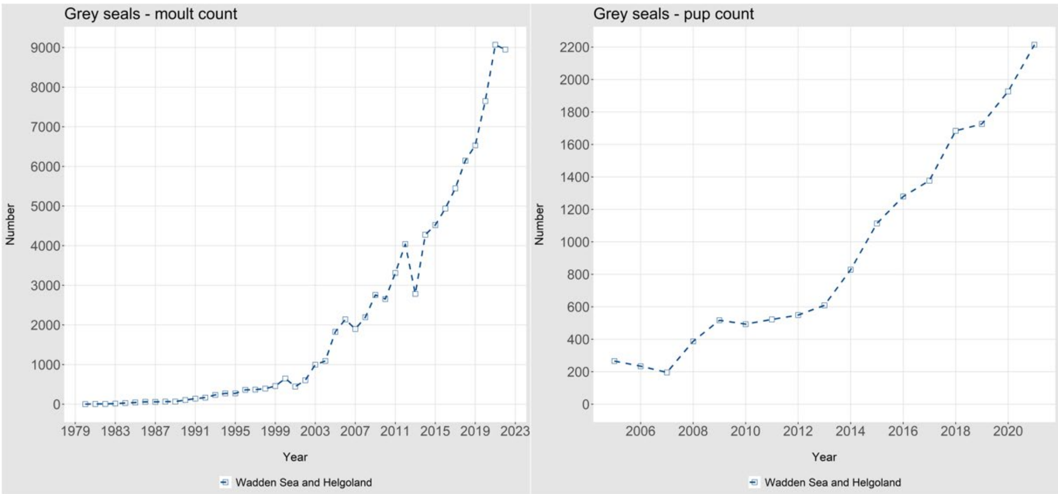


Figure 1-5. Trends of moulting grey seals (left) and grey seal pups in the Wadden Sea (right).

During the moult, the number of animals observed could be influenced by the exchange between the UK or other areas and smaller colonies like the Dutch Delta (see below). In the last five years, the average annual growth in numbers counted during the moult was 10%. However, in 2022, the numbers counted decreased slightly by (1%) (to a total of 8 948 grey seals) compared to 2021. In 2022, 259 grey seals were reported dead by voluntary observers on the Dutch Wadden sea coasts (waarneming.nl).

1.3.7 Dutch Delta

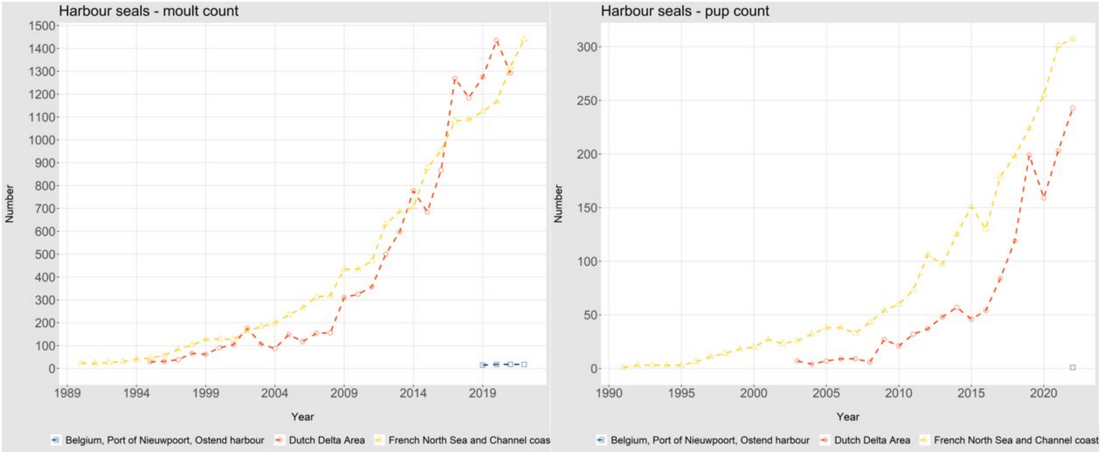


Figure 1-6. Trends of moulting harbour seals (left) and harbour seal pups in the Dutch Delta, Belgium and France (right).

Harbour seal: Despite a growing number of pups (243 pups in 2022, compared to 203 in 2021), the harbour seal colony in the Dutch Delta area in the southern Netherlands is thought to still be dependent on exchange with the Wadden Sea population. Otherwise, there are insufficient local births to explain its growth (Figure 1-14). Also, despite the reporting being incomplete, relatively large numbers of seals are reported dead along those coasts: 153 in 2022 (waarneming.nl). Over 1 293 animals were counted in the Dutch Delta area in 2022 (Hoekstein *et al.,* 2022, 2023 in press), showing a drop of 10% compared to 2021 and thus a change in trend as the numbers had been growing at c. 15% annually previously.

Grey seal: The growing trend in counts of the grey seals in the Dutch Delta is even more dependent on the exchange with other areas, as very few pups are born locally. In winter of 2021 only 33 pups were seen during the breeding season while the consecutive moult count reached 2738 individuals (Figure 1-16; Hoekstein *et al.,* 2022, 2023 in press). Relatively large numbers of grey seals are reported dead in this area: 127 in 2022. These records are incomplete as they rely entirely on voluntary reporting from the public.

1.3.8 Belgium

Along the Belgian coast, 18 harbour seals were counted on land and for the first time a pup was observed. In 2022, the Royal Belgian Institute of Natural Sciences performed two aerial marine mammal surveys covering Belgian waters, when more seals were observed (offshore) than in any previous aerial survey (20 in March and 40 in October). Figure 1-15 shows the general increase in numbers of dead seals stranded from 2005 to 2022, with a marked peak in 2021 due to an unusually large number of grey seals.

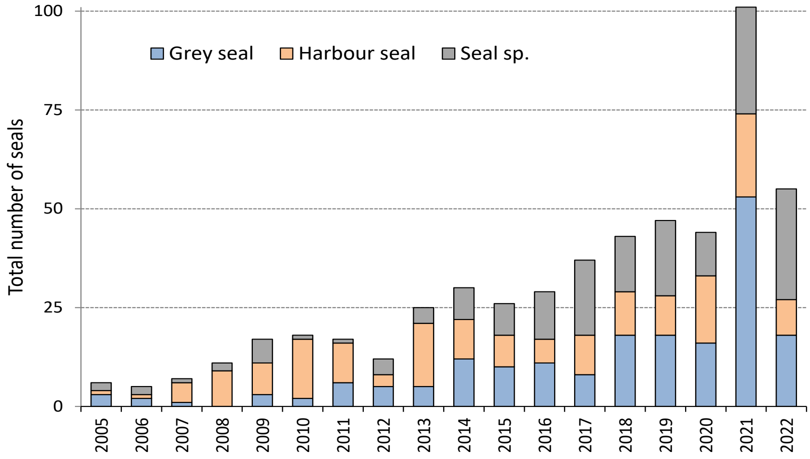


Figure 1-7. Belgian seal stranding results 2005-2022 (Haelters et al., 2023).

1.3.9 France

Harbour seal: The maximum abundance of harbour seals in mainland France is assessed by summing the maximum numbers of seals counted during the moult (when these haul-out numbers are highest; Figure 1-15) over the whole area (mainly from the northern border to the Baie du Mont-Saint-Michel). In 2022, this summer estimate gave a total of 1 440 harbour seals, while 307 harbour seal pups were estimated to be born in those colonies (Poncet *et al.*, in prep). Overall, the total number of harbour seals in France continues to increase, although not as fast as it used to, 5-10 years ago (Vincent *et al.*, 2017).

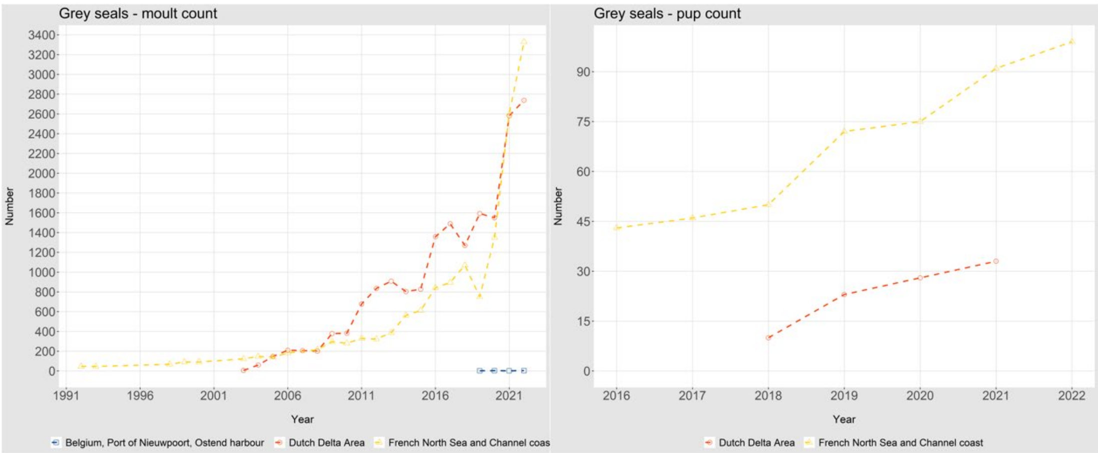


Figure 1-8. Trends of moulting grey seals (left) and grey seal pups in the Dutch Delta, Belgium and France (right).

Grey seal: In mainland France, seal haul-out counts (for both grey and harbour seals) are conducted locally by a large number of collaborators from NGOs, marine parks or nature reserves. In some regions, censuses are planned on similar dates in order to avoid double counts, but this is not always feasible. Because grey seals are highly mobile, and because seasonal variations are substantial (Poncet *et al.*, 2022), it makes it hard to obtain an overall grey seal abundance estimate for the French coasts (Figure 1-16). Grey seal pup production was estimated at 99 individuals in 2022 (Poncet *et al.*, in prep), but the number of seals hauled out clearly exceeds the expected number of juvenile adult seals expected to be produced locally by this number of pups. Therefore, pup production cannot be used at a national scale to estimate total grey seal "abundance" at a scale that is meaningful for local managers. The "estimated number of grey seals" for France in 2022 is therefore the sum of local maxima obtained seasonally, and this method clearly suffers biases. At several colonies (especially Molene archipelago, Sept Iles and Baie de Somme), the highest numbers of grey seals hauled out are counted during the moulting season, while in other areas these maxima are counted during summer. Seal numbers in these main sites are, however, in the same order of magnitude during the other season, which probably limits the consequences of this biased method. Poncet *et al.* (in prep) obtained a total of over 3330 grey seals for 2022 in mainland France. As in every previous year, this is a new record (the same estimate gave 1 300 grey seals in 2019 and 2 800 in 2021). The strongest rate of increase clearly comes from counts in the Eastern Channel, mostly Walde and Baie de Somme. In Walde (Northern France, south of the North Sea), high grey seal numbers were occasionally observed these last years, especially during strong westerly winds, and it was hypothesised that these were grey seals temporarily moving from the nearby Goodwin Sands in southern England. These large numbers of grey seals are no longer exceptional any more (1 420 grey seals were the maximum in 2022 for Walde only).

1.3.10 Faroe Islands

Grey seal: With an isolated breeding population, the grey seal is the only pinniped in the Faroe Islands archipelago. Due to human impact and limited breeding space, this population has never increased to high numbers. During historical time, grey seals have been hunted by the locals, also during bounty hunts. In more recent years, seals have been culled in relatively high numbers around salmon farms, but this practice was banned in 2020. A project was initiated in 2018 with the aim of obtaining a total count of the grey seal population in summer. A preliminary minimum uncorrected total count, using the highest numbers in each of four main survey areas (surveys in 2018, 2019 and 2021) is 604 grey seals. The census will continue, aiming to correct for availability and movements between areas from telemetry studies.

1.3.11 Iceland

Harbour seal: A new paper was published in 2022, investigating changes in the Icelandic harbour seal population over a period of 40 years; 1980-2020 (Granquist, 2022). The population has decreased from an estimated abundance of 33 000 animals in the first census in 1980 to 10 319 individuals in 2020. Despite a slight recent increase, the number is still below the set management target of a population size of 12 000 harbour seals (Figure 1-17). A new census is planned for 2023.

Figure 1-9. Trends of estimated population abundance based on counts of moulting harbour seals (top) and of counted grey seal pups in Iceland (bottom).

Grey seal: The Icelandic grey seal population has been surveyed at irregular intervals since 1982 when the population abundance was estimated to be 9 000 animals. A new estimate based on the pup production of 2022 is underway and will be finalised during 2023. The latest estimate from 2017 indicated a population abundance of 6 269 animals, based on a pup survey yielding 1 452 pups (Figure 1-18).

1.3.12 Greenland

Harbour seal*:* Greenlandic harbour seals (*Phoca vitulina*) have been hunted to near extinction in West Greenland. A small population of about 50 animals (42 seen in August 2019) lives in the south-eastern part (from Cape Farewell to around 62°N). Harbour seals are also seen further north along the east coast, especially around 63-64°N, but the moulting and breeding sites for these seals are still not located and there is no estimate of their numbers. On the west coast, there is a known breeding/moulting site with 20+ seals (a group of 17-19 adult seals seen June 2020), located in a fjord (Majorariaq - 62°38N, 50°05W). At another site (Kangerlussuaq - 67°00N, 50°43W), which had hundreds of harbour seals in the 1960s have each year during 2019-2021 had 2 adult seals. A few harbour seals are also regularly seen at other localities along the west coast, indicating that there are a few more stocks, but their breeding/moulting sites have still not been located and there is no estimate of their numbers (Rosing-Asvid, *pers. comm*., February 2023).

Harp seal: Gercian *et al.* (2022) assessed how migratory and dive behaviour develops over the first year of life of harp seals, by tracking seals using animal-borne satellite relay data loggers. Similarities were found in migratory movements and differences in diving behaviour between 38 juveniles that were tracked from the Greenland Sea and Northwest Atlantic breeding populations. In both regions, periods of resident and transitory behaviour during migration were associated with proxies for food availability: sea ice concentration and bathymetric depth. However, while ontogenetic development of dive behaviour was similar for both populations of juveniles over the first 25 days, after this time Greenland Sea animals performed shorter and shallower dives and were more closely associated with sea ice than Northwest Atlantic animals.

1.3.13 **Mediterranean**

Mediterranean monk seal The Greek NGO, Archipelagos – Environment and Development, has surveyed Mediterranean monk seals since 1985, with input from its Italian sister organization (Archipelagos – Ambiente e Sviluppo) since 2015. This summary of their work was provided by Gema Herandez-Milian (IEO-CSIC). During 1985-2002, around 150 marine caves or sites with overhanging rocks were identified as potentially suitable monk seal habitat in the Ionian Sea. Use of 43 of these sites by monk seals was confirmed, amongst which ten caves were used frequently. It was estimated that around 20 individual monk seals frequented the area. Photo-identification studies, using infra-red camera traps mounted in 15 caves, were launched in 2018 and 25 adult and sub-adult individuals were identified, leading to a tentative overall population estimate for the Central Ionian Sea of 40-50 seals. Similar activities in Zakynthos Island, South Ionian Sea (1990-1999), revealed 72 suitable caves and overhangs, of which 25 were used by the seals, 7 on a regular basis. The population was estimated at a minimum of ca. 20 individuals of all age classes.

There are occasional sightings from the Adriatic Sea. Historical records indicate the presence of monk seals in Croatia, Montenegro, Albania and Apulia/Southern Italy. More than 20 suitable caves were identified along the coast on Montenegro and 8 in the National Marine Park of Karaburun-Sazan in Albania. Camera traps have been used to confirm monk seal presence in two of these caves in Albania. A survey of the coast of Salento (Apulia, south Italy) revealed 15 caves suitable for the monk seal. The extensive Croatian coastline appears to include much suitable habitat but has not been surveyed. Bundone *et al.* (2022), for the first time, have documented use of caves along the Albanian coast by Mediterranean monk seals using infra red camera traps and finding of scats. The authors were unable to estimate the numbers of seals using the detected localities, however.

During 2009-2018, a monitoring programme including field surveys, camera traps and an information network in Cyprus, an increasing number of monk seal sightings were recorded along with several pups (Nicolaou *et al.*, 2021). Camera trap surveys in north Cyprus, spanning the pupping period, detected four adult or sub-adult monk seals and three pups in three of eight monitored caves (Beton *et al.,* 2021), adding to previous detections of monk seals in southern Cyprus (Nicolaou *et al.*, 2019).

Camera trap monitoring of 20 caves in south-eastern Turkey over 3 years (2015-2018), covering the entire range of monk seals in the area, identified 37 individuals based on pelage patterns (Kurt and Gücü, 2021). Using mark-recapture analysis, the population abundance was estimated at 46 (SE=7.7) for a closed population or 53 (SE=34.8) for an open population. These estimates indicate a decrease in abundance. Ranges of the seals were up to six times larger than previously reported for the area, with documented travels of up to 245 km.

In Italy, the Italian Institute for Envornmental Protection and Research (ISPRA) validates sighting information of this species obtained from third party observers along Italian coasts and manages a database on such information since 1998. Confirmed sightings of Mediteranean monk seals have been documented for various locations in the Tyrrhenian Sea, Sicily Channel, Ionian Sea and Adriatic Sea, particularly around Sardinia, Sicily (the coast of the main island, Egadi, Pantelleria, Pelagie and Eolian islands), Calabria, Puglia, Liguria, Tuscany (various sites in its archipelago), Lazio (Pontine islands). ISPRA is also conducting remote monitoring of historical caves in Italian key regions. Based on this database and monitoring activities, for the last reporting under the Habitats Directive (2013-2018) on this species, Italy declared "an increase in recurrent sighting locations" between 2007 and 2018 (http://cdr.eionet.europa.eu/).

Valsecchi *et al.* (2022) developed three species-specific qPCR assays to detect eDNA of Mediterranean monk seals. The assays were tested on a diverse set of samples. They allowed detection of monk seal DNA from 47.2% of samples collected from a ferry in the Tyrrhenian Sea and 66.7% of samples collected in the Strait of Sicily. This study confirmed the presence of this species using a different approach.

1.3.14 **French territory**

Only one full census around the islands of the small French archipelago of Saint-Pierre and Miquelon (French territory south of Newfoundland, Canada) could be conducted in 2022. It took place in mid-May 2022 and a total of 825 harbour seals were counted hauled out. No inter-annual trends can be estimated from this one census, as in previous years a limited number of censuses were conducted in different seasons; however, it is hoped that in the coming years these counts will allow such trends to be calculated. On 8 June 2022, a drone was used over the breeding colony in *Grand Barachois* in order to count new-borns. This was the first attempt to estimate pup production for decades in the archipelago, and 169 harbour seal pups could be counted from aerial photography (Vincent *et al.*, 2022). However, this only provides a lower estimate of local production as only one census was conducted during the whole breeding season.

A total of 182 grey seals were counted on the haul-out sites. More grey seals are usually observed in Saint-Pierre et Miquelon during summer, before they move to their breeding ground (in Canada) in late autumn (Vincent *et al.*, 2022). No grey seal breeding has been observed in the archipelago.

1.3.15 USA

There were no surveys in 2022 to provide new population estimates for the harbour seal abundance trends in the Gulf of Maine (Figure 1-18), and grey seals (Figure 1-19). Using data collected from stranded harbour, harp, and grey seals from 2002 to 2017 in Massachusetts, New Hampshire, and Maine, spatiotemporal correlations between stranding density and environmental/human factors. In the Gulf of Maine proximity to coastal human population centres and large seal haul-outs were found to be the greatest drivers of reported seal stranding density. Environmental factors played an important role only for harp seals, which do not breed in the study area, although recent shifts in the environmental seascape have the potential to affect all seal species in the Gulf of Maine (Haverkamp *et al.*, 2023).

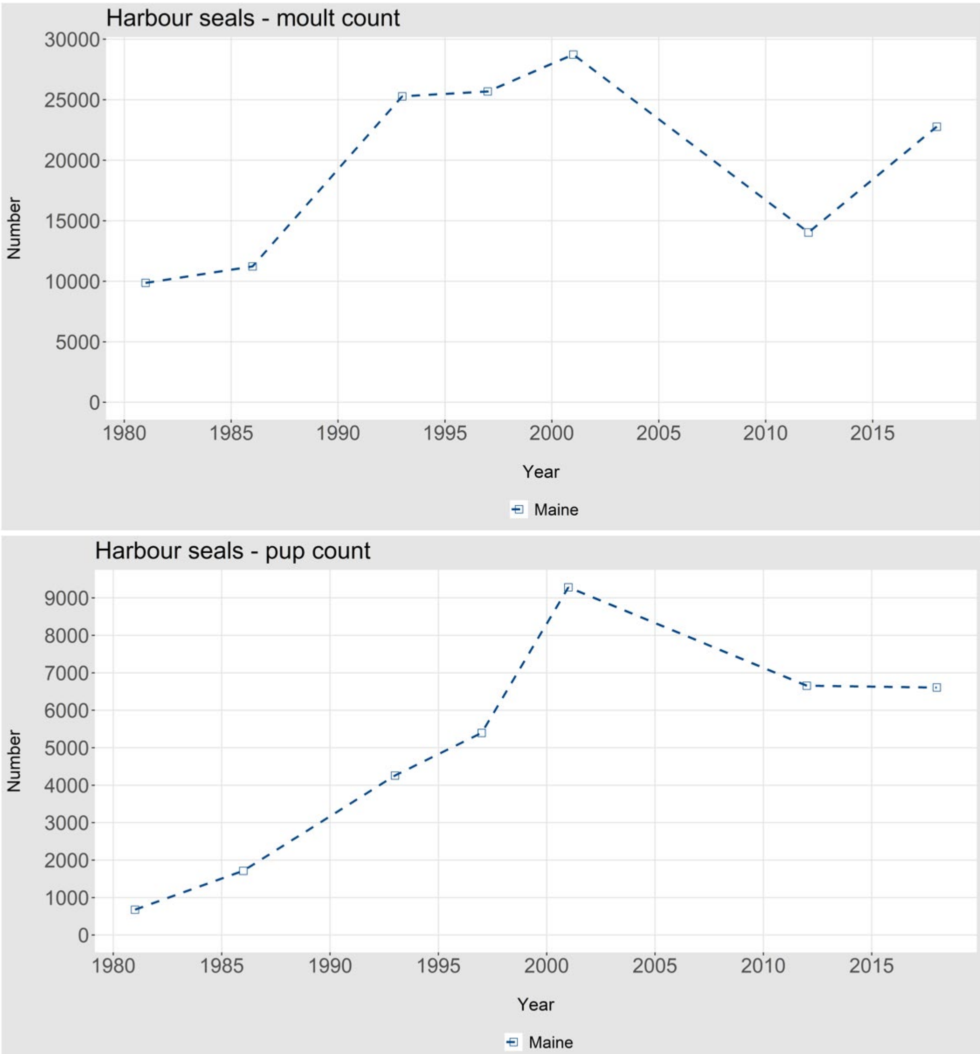


Figure 1-10. Trends of counts of moulting harbour seals (top) and of pup counts of harbour seals in the Gulf of Maine (bottom)

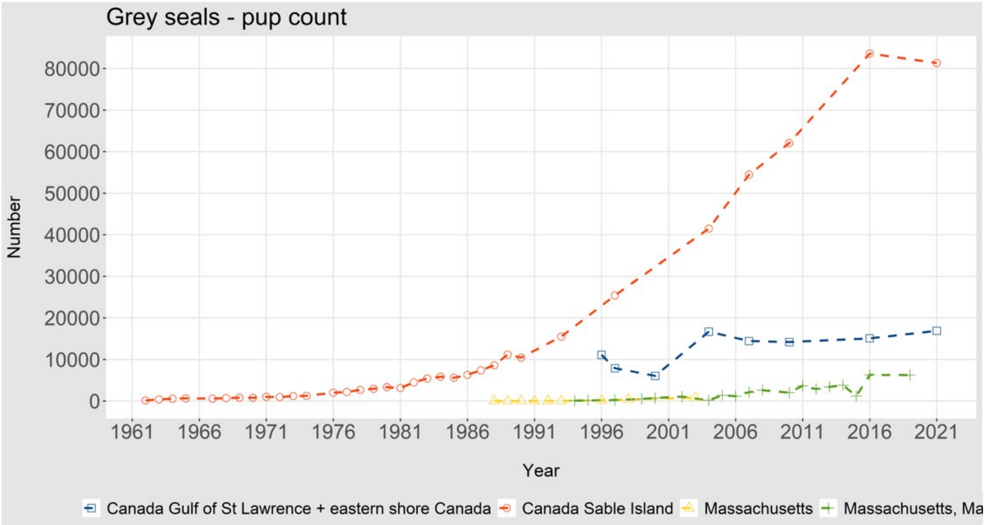


Figure 1-19. Trends of counted grey seal pups in Canada and the United States.

1.4 Vagrant pinnipeds

While it is natural that within certain spatial limits, seals travel over long distances to explore their habitat, and utilise different types of resources (Carter *et al.*, 2019; Peschko *et al.*, 2020), due to different reasons, occasionally, seals travel beyond their described natural range (Bester, 2021). Animals seen outside their natural range are termed “vagrants” and underlying mechanisms for such behaviour can be complex and are usually difficult to characterise. A collation of such sightings has been made in order to enable an assessment over a large spatial scale (Table 1-8).

A total of four walruses were seen throughout the North Sea and Baltic coasts in 2022-2023 (Table 1-8): A young female walrus that had been observed in the Lofoten Isles and back there after showing up in Denmark, roamed through the southern North Sea in 2021, then to the UK. She was shot by the Norwegian authorities in August 2022.

In the Baltic, another female that had been seen in June-July 2022 througout Germany, Poland, Latvia, Estonia and Finland, died under anaesthetics whilst being transported to Helsinki Zoo.

A male walrus was observed at Petten, on the west coast of the Netherlands, on 5 November 2022; the animal moved south and was seen at sea near the Zwanenwater on 7th, then near the Oosterschelde, in the southern Netherlands on the 13th. The walrus, possibly an adult male, was later observed along the French coast in November and December. It was recognised based on marks and its tusks. The first observation was made on 18 November in Dieppe. It was re-sighted the day after, then in northern Brittany on 25 & 26 November, at Cap de la Hague on 29 November, and back to Dieppe (France) on 2 December. It travelled again across the Channel and was observed on the coast of Hampshire (England) on 10 December, then back to Dieppe (France) on 15 December. It was observed nearby in Le Tréport on 21 December, and then along the English North Sea coast at Scarborough (Yorkshire) on 30 December, and Blyth on 3 January 2023. The individual was finally re-sighted in Breiðdalsvík, Iceland on 25 February 2023.

A second male walrus was observed on the Treshnish Isles in the Inner Hebrides, Scotland on 27 February 2023.

Table 1-8. New sighting data of vagrant seal species

Year	Place and country	Number of individuals	Comment
Walrus			
2019 Dec – 2022 Aug	Various locations in Norway, Wadden Sea in Denmark Germany, and the Netherlands, UK, Sweden,	1	Young female was killed by the Norwegian authorities in August 2022, named Freya and Wanda
2022 Jun - 2022 Jul	Baltic coast of Germany, Poland, Latvia, Estonia, Finland	1	Female, died on 19 July 2022 whilst being transported to Helsinki Zoo under anaesthetic
2022 Nov-2023 Feb	West coast of the Netherlands, Normandy, Brittany in France, Hampshire coast, Scarborough & Blyth in the UK and Breiddalsvik, Iceland	1	Male named Thor
2023 27 Feb	Treshnish Isles in the Inner Hebrides, West Scotland	1	
Hooded seal			
2023 27 Mar	Vlieland, the Netherlands	2	Adult female gave birth to a male pup. In the Netherlands, a hooded seal female hauled out on the Island of Vlieland and gave birth to a pup. As she left after a few days (weaning occurs after approximately four days in this species) the pup was relocated to a less disturbed area. The pup left this sight and was not observed afterwards.

1.5 Developments in Methodology

SealNet, a software package for automated photo identification of seals using facial recognition, was developed (Birenbaum *et al.*, 2022). It is suitable for small data sets.

Changes in prey size and aggregation on a simulated harbour porpoise population were investigated (Gallagher *et al.*, 2022). This was done by incorporating prioritisation of energy allocation (to survival over growth and reproduction) and with the type of prey searching behaviour based on energetic status, prey encounter rates and competition for food. The reduction in energy intake due to declining prey size or reduced prey aggregation was shown to ultimately lead to population decline.

Fernandes *et al.* (2021) argued that presence-only models (e.g. based on MAXENT) are intrinsically preferable to presence-absence models (e.g. based on GLM or GAM), essentially because absences during surveys do not necessarily imply unsuitable habitat. However, this conclusion is likely to depend on survey design, in particular the representativeness of the points sampled within the overall study area.

The use of environmental DNA (eDNA) in marine mammal studies was reviewed by Suarez-Bregua *et al.* (2022). It was observed that eDNA metabarcoding has been used for single species detection, biodiversity assessment, and genetic characterization. This technique has the potential to be used for routine distribution monitoring, at least as a complementary approach, and may be particularly useful to monitor the occurrence of rare, elusive or threatened species. Further work is still needed to support the interpretation of non-detections, for example considering the rate of eDNA degradation over time (see also Alter *et al.*, 2022). The method was applied in East Greenland where using the 12S region, several species of cetacean and pinnipeds were identified, as well as different fish species. This allowed for a first analysis of distribution and overlap (Jensen *et* al., 2023)

1.6 New information on population structure and status and other relevant studies (seals and cetaceans)

1.6.1 Genetic Studies

Atlantic white-sided dolphin: Gose *et al.* (2023) used a combination of high-resolution genomic and classical population genetic DNA markers to assess structure and diversity in Atlantic white-sided dolphin, across much of the species' range (Figure 1-20). They describe strong regional connectivity based on an absence of detectable population structure and low familial relatedness, indicating species-wide panmixia.

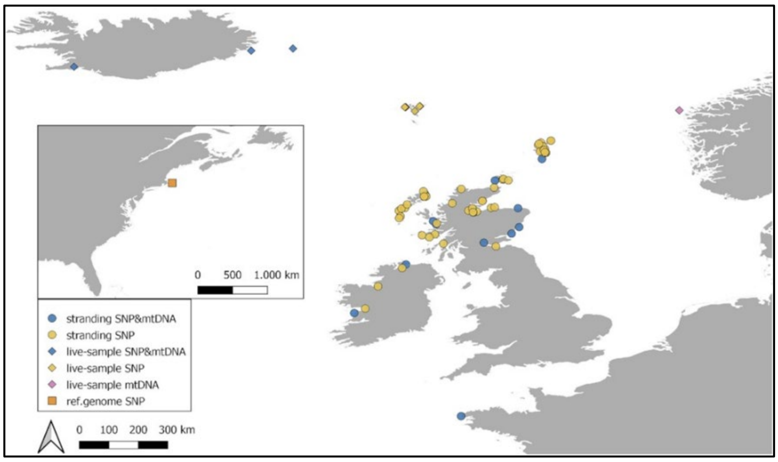


Figure 1-11. Maps of the North Atlantic Ocean displaying spatial distribution of 93 white-sided dolphin tissue samples and the reference genome sample used in this study. Point shapes indicate sample type and point colour indicates data type associated with each sample.

Harbour seal: Genetic diversification, origin and expansion of harbour seals were reviewed throughout their range using 13 500 single nucleotide polymorphisms from 286 individuals and 22 localities (Liu *et al.*, 2022). The results indicate a North Pacific origin for the species and a stepwise colonisation of the North Atlantic via the Canadian Arctic, with a successive loss of genetic diversity.

Grey seal: Range-wide variation of skull shape in grey seals was investigated by Galatius *et al.*, (2022b). They found that differences in skull shape between West Atlantic, East Atlantic and Baltic seals were trivial with large overlaps in shape between all areas of distribution. From a morphological point of view, the results imply that the current subspecies status of Baltic and Atlantic grey seals is questionable. Moreover, Ahlgren *et al.* (2022) studied mitochondrial control region DNA from grey seals from the Mesolithic in Sweden and Germany and found that most haplotypes from that time are not found in contemporary Baltic grey seals. The most likely implication is that grey seals went extinct in the Baltic between the Mesolithic and the Bronze Age, and that ancestors of the current population recolonised the Baltic during the Bronze or Iron Age.

Monk seal: Rey Iglesia *et al.* (2021) analysed 42 mitogenomes of Mediterranean monk seals, from across their present and historical ranges. They found a decrease in genetic diversity over the last 200 years. Recent seals showed an almost fourfold reduction in genetic diversity, compared to historical seals. Despite their geographic proximity, seals from Madeira and Cabo Blanco were clearly segregated. There was evidence of gene flow between the Atlantic and Mediterranean basins. Likewise, Salmona *et al.* (2022) investigated population genetics and demographics of the Mediterranean monk seal with data including both extinct and extant populations from the Mediterranean and eastern North Atlantic. They found that monk seals are divided into four populations; Cabo Blanco (Western Sahara/Mauritania), Madeira, western Mediterranean (now extinct) and eastern Mediterranean. The structure is probably the consequence of recent drift, combined with long-term isolation by distance. All populations and particularly Madeira, show high levels of inbreeding and low genetic diversity. The results suggest that early growth of human populations around the Mediterranean and the development of seafaring were the main drivers of the historical decline of the monk seals. In Greece, a nuclear DNA study of monk seals in the eastern Mediterranean Sea revealed that seals here are found in three isolated genetic clusters with small effective population sizes, low diversity, and high levels of inbreeding (Karamanlidis *et al.*, 2021). The results indicated male philopatry over short distances.

De Larrinoa *et al.* (2021) estimated age-specific survival rates and reproductive rates of monk seals of the Cabo Blanco population from Mauritania and Western Sahara. Pup survival from birth to two months was estimated at 0.59. From birth to one year, estimated survival rate was 0.46, from 1 to 2 years, it was 0.75. After 2 years, rates were differentiated by sex, with 0.94 for males and 0.97 for females; the youngest females having pups were 3 years old. Female reproductive rate exceeded 0.80 from age 6 to 17 years. A Leslie matrix estimated an intrinsic growth rate of 1.058.

1.6.2 Sweden

Grey seal: In Baltic grey seals, ulcers in the large intestines were associated with high intensities of acanthocephalan parasites and occurred more in older seals and in seals from the Bothnian Sea. The prevalence of these ulcers increased in the early 1980s and decreased after the mid-1990s. This temporal trend coincides with the trend in levels of certain contaminants (BDE-47, PFOS and cadmium) (Bäcklin *et al.*, 2021). It may be suggested that the prevalence of intestinal ulcers and acanthocephalan parasites may be a useful indicator both of individual health and population status.

1.6.3 Germany

Grey seal: Four grey seals stranded in the Baltic in winter 2019 showed 100% prevalence and severe loads of the anisakid nematode *Contracaecum osculatum*, reflecting the high level of infection in their (fish) prey. Other parasitic nematodes (e.g. Anisakis simplex and *Pseudoterranova decipiens*), were not found in the digestive tracts. Six harbour porpoises examined at the same time had small loads of the *Pseudalid nematodes*, *Pseudalius inflexus* and *Stenurus minor* in their bronchi and inner ears (Gabel *et al.*, 2021). The authors commented that "nematodes can be utilized as indicators for the population and the food spectrum of their mammalian final hosts".

1.6.4 Belgium

Results on the investigation of marine mammals in 2021 were reported in the yearly report (Haelters *et al.*, 2022a). Only strandings of seals and harbour porpoises were recorded.

Harbour porpoise: Relatively few porpoises washed ashore in 2022: 44, the lowest number since 2004. Very preliminary results of the investigations indicate that six animals died due to grey seal predation (attempts), 10 animals died of other natural causes and one animal was bycaught. These figures will change in the coming months. Four of the porpoises, including a pregnant animal, washed ashore alive; all were adults and they died very shortly after stranding or during rehabilitation.

Seals: Most striking was the very high number of dead seals washed ashore: 101, or more than twice the number of any previous year. The most likely cause of death of a large proportion of those seals was bycatch in static fishing gear (Haelters *et al.*, 2022b). In 2022, 12 grey seals and 3 harbour seals were admitted to Sealife for rehab; two of the grey seals were injured by monofilament netting around their neck. Additionally, three seals were observed with nets around their necks: two with pieces of heavy towed gear (one could be freed) and one with monofilament net (freed). Fifty-three dead seals washed ashore: 18 grey seals, 7 harbour seals and 28 seals that were not (yet) identified to the species level (preliminary data).

1.6.5 United Kingdom and Ireland

Harbour seal: Based on genetic information from mitochondrial control region sequences and microsatellite loci, Steinmetz *et al.* (2023) identified the presence of three genetically distinct local populations of harbour seal in Ireland: East Ireland (EI), South-west Ireland (SWI)) and North-west & Northern Ireland (NWNI). While the latter appear to be part of the Northern UK metapopulation, the other two populations could be considered as separate Management Units.

Grey seal: Zatrak *et al.* (2022) describe statistics of rehabilitation of juvenile grey and harbour seals in the United Kingdom and Ireland from 1988 to 2020. In that period, there are records for 1 435 harbour seals and 2 691 grey seals from rehabilitation centres in the two countries. The most common (non-exclusive) grounds for admission were malnourishment (37%), maternal abandonment (15%), lethargy (12%) and infections with parasites (8%). It was estimated that grey seals had 4.55 higher survival odds than harbour seals, and the probability of survival to release was increased by 1.07 for every kg over age-predicted weight.

1.6.6 Mediterranean

Mediterranean monk seals: In Greece, fishers have always claimed that they suffer considerable losses because of damage caused by several marine vertebrates including monk seals. Fishers have traditionally regarded monk seals as enemies and deliberately killed them because of the damage incurred to their fishing gear and catch as the seals eat the fish caught in their nets. In a study of cases of dead seals and causes of death, in 50% of the known cases the cause was deliberate killing by fishers. An additional 12% were deliberate killings by people other than fishers. Altogether, accidental deaths in gear and deliberate killings accounted for 85% of all known cases of dead seals and it was obvious that mortality related to coastal fisheries was a key threat to the population (Jacobs & Panou 1988; Jacobs *et al.*, 1992; Panou *et al.*, 1993).

In 1985-1986, a pilot project was carried out to evaluate damage caused by monk seals to gill net fisheries in winter by boats from Kefalonia in the central Ionian Sea. Seal damage was registered during 19% of the fishing trips. The gill nets were always set in the same place and the seals had learned to exploit this readily available food source (Panou *et al.*, 1987). Subsequent monitoring over 15 months (1986-88) at the port of Poli in NW Ithaca, where the 13 fishers used trammel nets, gill nets, bottom long lines and beach seines, showed that nets were damaged in 0% to 22% of (monthly) trips (average 7%). Damage was most frequent in gill and trammel nets, rare with longlines, and absent for beach seines (Jacobs & Panou 1988; Panou *et al.*, 1993). Damage caused can be divided into direct damage (loss of catch and damage to gear) and indirect damage (loss of fishing opportunities and time due to repairing gear, cost of purchasing new gear). In a third project on Zakynthos, southern Ionian Sea, the frequency of seal damage varied from 0 to 33% of trips (Jacobs *et al.*, 1992; Archipelagos 1998).

It was estimated that seal damage reduced fisher income by around 3-4%, roughly equivalent to losing one day's fishing per month, without including the cost of replacing nets. They argued that the cessation of killings of monk seals would be achieved only if fishers received adequate compensation for their losses. Indeed, an increase in seal numbers due to effective conservation measures could lead to increased damage and in turn lead to an increase in killing (Jacobs & Panou 1988; Panou *et al.*, 1993).

In November 1997, a new pilot project was launched in NE Zakynthos to evaluate damage caused by seals (Archipelagos 1998). A trammel net of length 270 metres with a mesh size of 21 mm (the same as the fishers use) was set 30 times in several places with a high risk of seal damage. This experimental net was checked after hauling, each time marking the 'seal holes' to distinguish old from new holes. Seal damage was seen after four hauls (damage frequency 20%).

The fish catch per unit effort (CPUE) decreased by 33% after the four seal attacks, presumably due to a combination of fish eaten by the seals and fish not caught because of the damage. The CPUE of striped mullet *Mullus surmuletus*, an expensive fish favoured by both Greeks and tourists decreased by 93%. Consequently, gross earnings from the catch (i.e. not accounting for costs of fuel, manpower, purchase of gear, etc.) decreased by 80% - and the part attributable to striped mullet by 91% - after the four seal attacks (Archipelagos 1998).

1.6.7 Iceland

Cetaceans: Research on stock structure of several cetacean species, including fin whales, sei whales, humpback whales, common minke whales, killer whale and harbour porpoises is ongoing using genetic and other methods (Olsen *et al.,* 2022, Marine & Freshwater Research Institute, Iceland, unpublished information).

1.6.8 Greenland

Bowhead whale: The genomic diversity in the endangered East Greenland-Svalbard-Barents Sea (EGSB) population of bowhead whales was studied (Cerca *et al*., 2022). Previous lack of genomic baseline data has made it difficult to evaluate the impacts of potential stressors on the population. In the study, twelve EGSB bowhead whales were re-sequenced and mapped to a previously published draft genome. Despite the small population size, mean autosome wide heterozygosity was higher than for most mammals for which comparable estimates are calculated using the same parameters, and three times higher than a conspecific individual from the Eastern Canada-West Greenland bowhead whale stock. Demographic history analyses indicated a continual decrease of Ne from ca. 1.5 million to ca. 250 000 years ago, followed by a slight increase until ca. 100 000 years ago, followed by a rapid decrease in Ne between 50 000 and 10 000 years ago. These estimates are lower than previously suggested based upon mitochondrial DNA, but suggested demographic patterns over time are similar (Cerca *et al.*, 2022).

2 ToR B: Management and management frameworks

Review and report on any new information on seal and cetacean management frameworks (including indicators and targets for MSFD assessments) in the NE Atlantic (including North Sea and Baltic Sea

2.1 Maritime Spatial Planning Directive (cetaceans, seals)

The Maritime Spatial Planning Directive (2014/89/EU) was adopted in 2014 to create a common framework for maritime spatial planning in the European Union. Member States are legally required to develop and implement Maritime Spatial Plans (MSP) by 2021 at the latest. The aim has been to promote the sustainable growth of maritime economies, the sustainable development of marine areas, and the sustainable use of marine resources. An ecosystem-based approach has been recommended to cover all marine taxa including top predators such as marine mammals. UNEP/ASCOBANS has established an MSP Working Group and is developing guidelines for cetacean-friendly MSP that incorporate both area- and pressure-based conservation measures.

2.2 National work

2.2.1 United Kingdom

Bycatch

Following the UK's exit from the European Union (EU), the overarching fisheries policy and regulatory framework set out by the EU has been replaced with the Fisheries Act 2020 (The Act). The Act now sets out the UK's high-level policy objectives and framework to manage fisheries as an independent coastal state.

Implementation of the majority of UK fisheries policy is devolved, meaning that the authority and responsibility for legislation lies with the individual country authorities in England (the Marine Management Organisation (MMO)), Scotland (Marine Scotland), Wales (Welsh Government), and Northern Ireland (Department of Agriculture, Environment and Rural Affairs (DAERA)). Under the legal requirement in Section 2 of The Act, Joint Fisheries Statements were published in November 2022 by these authorities to lay out how The Act's objectives will be met.

The ecosystem objective of The Act aims to minimise and, where possible, eliminate the unwanted bycatch and entanglement of sensitive species including cetaceans (whales, dolphins, and porpoises), seals, seabirds and elasmobranchs (sharks, skates, and rays). Under this, the UK Bycatch Mitigation Initiative (BMI[1]) was published in August 2022 and outlines how the UK will achieve its ambitions to minimise and, where possible, eliminate the bycatch of sensitive marine species. The initiative brings together, and builds upon ongoing work in the UK such as the Bycatch Monitoring Programme and Clean Catch UK, further using and investing in scientific monitoring and research to fill knowledge gaps, diversify monitoring techniques, and support the development of new technologies and approaches for mitigation.

[1]https://www.gov.uk/government/publications/marine-wildlife-bycatch-mitigation-initiative/marine-wildlife-bycatch-mitigation-initiative

UK Dolphin & Porpoise Conservation Strategy[2]:

This strategy seeks a joint approach with UKs devolved policy and nature conservation bodies working together, using both site-based and wider measures to conserve eight of the most commonly found dolphin and porpoise species in UK waters including the minke whale as the only whale species in the strategy., and proposes a series of high-level actions to deliver the outcomes.

The development and publishing of the strategy is currently led by Scottish Government, in collaboration with the Department for Environment, Food and Rural Affairs (Defra), Welsh Government, DAERA and the UKs Statutory Nature Conservation Bodies (Joint Nature Conservation Committee (JNCC), Natural England (NE), Natural Resources Wales (NRW) and NatureScot (NS)). Together, the groups have developed a strategy to ensure effective management to achieve and/or maintain favourable conservation status (FCS) for the chosen cetacean species.

Supporting services/Other Effective Area-based Conservation Measures (OECMs)
The UK is presently undertaking a programme to assess whether the management of fisheries is required within offshore English MPAs. Using powers set out within the Fisheries Act 2020, in 2022, the UK introduced byelaws prohibiting specific fishing activities within four English MPAs where there is evidence that the activities harm wildlife or damage habitat. The sites are:

- Dogger Bank Special Area of Conservation (SAC)
- South Dorset Marine Conservation Zone (MCZ)
- Inner Dowsing, Race Bank and North Ridge Special Area of Conservation (SAC); and
- The Canyons Marine Conservation Zone (MCZ)

The byelaws restrict the use of bottom trawls, dredges, demersal seines and semi-pelagic trawls (bottom-towed gear) over certain areas of the sites where particularly sensitive benthic habitats are present. Within Inner Dowsing, Race Bank and North Ridge SAC and The Canyons MCZ, the use of static gears such as pots, nets or lines over particularly sensitive areas is also prohibited. The Dogger Bank Special Area of Conservation (SAC) overlaps partially with the Southern North Sea SAC which is designated for the presence of harbour porpoise. Harbour porpoise, grey seals and harbour seals are already non-qualifying features of the Dogger Bank SAC.

The UK is currently reviewing the impacts of fishing activities in two SACs (Southern North Sea and Bristol Channel Approaches) designated for harbour porpoise, with a timetabled plan to agree an approach to assess and manage said impacts.

Noise mitigation
UK Regulations such as those outlined above make it an offence to kill, injure or disturb marine European Protected Species (EPS) in UK waters, which includes all cetaceans. Mitigation guidelines developed by JNCC for geophysical surveys, piling and explosive use, have been adopted as part of the consenting regime within the United Kingdom Continental Shelf (UKCS) as well as several other areas of the world as best practice, where local guidelines are not available. The guidelines do not directly deal with disturbance. However, the measures

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[2] https://www.gov.scot/publications/uk-dolphin-porpoise-conservation-strategy-high-level-report/#:~:text=The%20strategy%20aims%20to%20ensure,ninth%20species%20in%20the%20strategy

contained may also assist in reducing potential disturbance. At a minimum, they are intended to reduce the potential for injury to negligible levels by recommending methods to ensure no marine mammals are within a prescribed zone before a noisy activity begins.

JNCC are presently reviewing all three mitigation guidelines with the intention to update where required in 2023/24. New guidance for the use of Passive Acoustic Monitoring (PAM) as part of mitigation is due to be published by April 2023 and will sit alongside the three previously listed mitigation guidelines. This guidance will cover when PAM is appropriate to use, and how use should be recorded in post-mitigation reports.

Noise management

Under UK regulations ((The Conservation of Habitats and Species Regulations 2017; The Conservation of Offshore Marine Habitats and Species Regulation 2017 and; The Conservation (Natural Habitats, etc.) Regulation (Northern Ireland) 1995 (as amended)), relevant potential impacts on Special Areas of Conservation (SACs) for harbour porpoise in England, Wales and Northern Ireland marine areas from plans or projects require formal consideration in Habitats Regulations Assessments (HRAs).

In 2020, JNCC together with the UK's Statutory Nature Conservation Bodies published guidance[3] on what could constitute a Significant Disturbance in such SACs. Here, noise disturbance within an SAC from a plan/project, individually or in combination, is considered to be significant if it excludes harbour porpoises from more than:

1. 20% of the relevant area* of the site in any given day, or
2. an average of 10% of the relevant area of the site over a season*,

A guidance document giving full supporting information on the definitions of these statements can be found at https://hub.jncc.gov.uk/assets/2e60a9a0-4366-4971-9327-2bc409e09784.

To deter both grey and harbour seals from approaching sea pens containing farmed fish (commonly salmon) in coastal areas of Scotland, the aquaculture industry has historically used acoustic deterrent devices (ADD's). These devices, however, can disturb European Protected Species (EPS) such as dolphins and porpoises which are protected under the Conservation (Natural Habitats, &c.) Regulations 1994. Under these regulations, an ADD which disturbs such protected species may only be used by an operator who has obtained an EPS licence. In November 2021, the Scottish Government Aquaculture Code of Practice (published in September 2021) became subject to the enforcement powers provided in the Aquaculture and Fisheries (Scotland) Act 2007. This step has tightened the requirements on fish farm operators in Scotland to apply for an EPS licence or prove a licence is not required, if they intend to use an ADD.

2.2.2 Spain

In Spain, the **Ministerial Order APA/1200/2020, of the 16th December, establishing mitigation and improvement measures based upon scientific knowledge to reduce cetacean bycatch on fishing activities**, was published on the 18th December 2020 in the Official State Bulletin (BOE). It includes actions related to both monitoring and mitigation of cetacean bycatch.

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[3] https://hub.jncc.gov.uk/assets/2e60a9a0-4366-4971-9327-2bc409e09784

Article 3 of APA/1200/1200 establishes an **on-board observers programme focused on cetacean bycatch**. All fishing vessels operating in national fishing grounds of the Bay of Biscay and the Iberian coast, as well as in non-Spanish European waters in the Bay of Biscay, must take scientific observers on board when requested to do so by the General Secretariat for Fisheries. The programme is focused on the national fleet segment that, according to scientific analysis, poses the highest risk of interaction with vulnerable species. The aim is to cover at least those trawling activities involving a major vertical opening (pair bottom trawl), as well as vessels using bottom gillnets or trammel nets with a mesh size equal to or bigger than 80mm. Article 3 also proposes to complement the observer programme with a **pilot project on remote electronic monitoring (REM)**. REM systems have automatic sensors which cannot be manipulated, unequivocally recording fishing operations. Currently, only REM systems with an associated image-analysis software are used. Since they are connected to on-board navigation systems, these images are linked to specific stages of the fishing process. Associated software analysis makes the image processing more efficient. It also guarantees stronger and more reliable data, excluding the possibility of human error.

Article 4 of APA/1200/2020 establishes the obligation to use **acoustic deterrent devices (pingers)** for all Spanish bottom trawlers whose fishing activity is conducted in Cantabrian and Northwest fishing grounds in national waters and in the non-Spanish EU waters of the Bay of Biscay. Currently, 65 trawlers are using pingers in the north-western Cantabrian Sea, plus 12 more in the non-Spanish EU waters of the Bay of Biscay. The devices are used in accordance with the Annex to Commission Implementing Regulation (EU) 2020/967 of 03.07.2020, which lays down rules on the signal and implementation characteristics of acoustic deterrent devices as described in Part A of Annex XIII of Regulation (EU) 2019/1241 of the European Parliament and the Council on the conservation of fisheries resources and the protection of marine ecosystems through technical measures.

Article 6 establishes a **move-on rule** for fishing activities using bottom trawl gear. If more than three cetaceans are caught in the same fishing manoeuvre, or any cetacean is caught in two consecutive hauls, fishing vessels shall move a minimum of 5 miles from the relevant point to continue their fishing activities, at a high navigational speed.

Article 7 of APA/1200/2020 establishes the **obligation to notify by-catch in logbooks.** All fishing vessels, irrespective of the gear used, are obliged to record and transmit information on all bycatch events involving any cetacean species, via their logbook. They shall indicate the number of specimens caught, the species, their vital status and relevant morphological characteristics, such as approximate size or whether they show previous marks of possible contact with fishing gear.

On 8 March 2021, the BOE published the **Resolution of 2nd March, by the General Secretariat for Fisheries**, allocating fishing quotas for scientific purposes in order to implement pilot projects on REM in the context of the mitigation measures for cetacean bycatch. The first stage of this initiative included 13 vessels using bottom trawling and gillnetting. The **Resolution of the 15th March 2022, by the General Secretariat for Fisheries** provided the basis for continuing the REM project, involving 21 vessels: 61.5% more than those involved in 2021. The project is expected to continue in 2023.

2.2.3 Faroe Islands

In the Faroe Islands, no management plan exists for grey seals. A census was initiated in 2018, in order to count the total population during summer. This survey, which also includes photo monitoring and satellite tracking, is ongoing and may deliver an abundance estimate within the next two years.

2.3 Other recent information

Jog *et al.* (2022) reviewed approaches to management of marine mammal-fishery interactions globally, including bycatch. They noted that insufficient understanding of the social dimensions of interactions and uncertainties concerning animal and human behaviours are major challenges to effective management (citing various papers which have said this), suggesting that an area-specific adaptive management framework could be effective to reduce the risk to marine mammals from fisheries - coupling technical solutions with socio-economic and political interventions. They concluded that a "silver bullet" management solution to marine mammal interactions with fisheries does not yet exist.

Goldsworthy *et al.* (2022) reported on mitigation of sea-lion bycatch in gillnets in southern Australia (SA), finding that estimated bycatch mortality was reduced by 98% within the management zone using a combination of "100% electronic monitoring of gillnet fishing off SA, permanent spatial gillnet closures around all sea-lion breeding sites, bycatch mortality limits that triggered temporal (18 months) spatial closures when zone-specific bycatch trigger limits were reached, and incentives for gillnet fishers to switch to an alternate fishing method (longlines)."

Manlik *et al.*, (2022) developed an approach to calculating mortality limits which considered stochastic factors ("sustainable anthropogenic mortality in stochastic environments" (SAMSE)). The example they give is based on PBR for a well-documented small bottlenose dolphin population in Shark Bay (Australia). Including stochasticity reduced the PBR value by 50% or more. However, it is not clear whether a similar approach could be applied in data-poor situations.

Ritter (2022) pleads for a paradigm shift to "mindful" conservation, involving "the consciousness of humans being an integral part of the planetary system" and "respecting 'holiness' of nature".

Sousa *et al.* (2021) assessed cetacean vulnerability to climate change in Macaronesia, adapting the Marine Mammal Climate Vulnerability Assessment (MMCVA) method, which is based on expert elicitation. For over half of the 21 species management units, vulnerability was assessed as high or very high. This approach could be developed for assessing risk from other types of threat.

3 ToR C: Anthropogenic threats and knowledge gaps with regards to marine mammals

Review and report on any new information on i) seal and cetacean anthropogenic threats (including cumulative effects) to individual health and population status in the NE Atlantic (as defined above); and ii) identify gaps in our knowledge with regards to anthropogenic threats to marine mammals in the NE Atlantic

3.1 General Introduction

This ToR is designed to gather up-to-date information on anthropogenic threats to marine mammals in the ICES areas and the North Atlantic coast of the United States and Canada. The report identifies threats within the ICES subregions, based on the marine mammal threat matrix developed in the 2019 ICES report (ToR D) and on new perceived treats, such as the Influenza A virus. Given the significance of several of these threats and their impact on marine mammal species, it is recommended that monitoring efforts be increased for both current and emerging threats, even in areas with no reported information.

3.2 Cumulative Effects

The impacts of multiple pressures upon marine mammal populations have been considered in previous reports of WGMME, with reference to frameworks such as Population Consequences of Disturbance (PCoD) (National Research Council 2005; New *et al*., 2014; Pirotta *et al*., 2018), the interim Population Consequences of Disturbance model (iPCoD) (Harwood *et al*., 2015; King *et al*., 2015), and Population Consequences of Multiple Stressors (PCoMS) (National Academies, 2017).

One of the many challenges of Cumulative Impact Assessments (CIA) in a marine ecosystem arises from the numerous pathways and wide variation of interactions between pressures and receptors that can take place (e.g., different types of interactions among effects, time and spatial ranges of effects). In order to deal with this complexity, Brignon *et al.* (2022) developed the "ECUME" risk-based approach to classify these pathways based on their impact level, to identify and prioritize the most critical ones to be consider in CIA. This approach requires an inventory of pairs of pressures and receptors in the targeted ecosystem, and decisions on which pressures and receptors should be prioritized and considered for a CIA. The authors applied this approach to two offshore windfarms projects near the coast of Normandy.

Hague *et al.* (2022) evaluated the current practices for Cumulative Effects Assessments (CEA) of different maritime industries in the United Kingdom. The scores obtained varied significantly among industries, being highest (i.e., with the strongest CEA) for offshore windfarm industry and lowest for the aquaculture industry. The authors noted a lack of CEA which accounted for interactions between multiple stressors. They provided recommendations for the standardization and improvement of CEA to help decision-makers to implement mitigation measures for potential impacts.

3.3 Fisheries Interactions

3.3.1 General

Lucas & Berggren (2022) carried out a systematic review of sensory deterrents for bycatch mitigation of marine megafauna. A total of 116 papers and 25 reviews published between 1991 and 2022 were reviewed. The aim of the study was to examine the potential of using sensory deterrents to reduce bycatch in four major marine megafaunal taxa: marine mammals, sea turtles, seabirds, and elasmobranchs. The use of lights on gillnets was the only technology that showed significant reductions in bycatch events in the four groups of marine megafauna.

In order to assess the management responses to marine mammal interactions with fisheries, Jog *et al.* (2022) performed a systematic review of articles published between 1995 and 2021. There were only 8 articles that consider human behaviour and socioeconomics in marine mammal management. Integrating social aspects into management strategies could lead to more effective conservation efforts by addressing important knowledge gaps.

3.3.2 Norway

An entanglement risk assessment has recently been performed on harbour seals in gillnet fisheries occurring in Norway (Elnes *et al.,* 2023). The study aims to simulate the seasonal movement of harbour seals and to estimate the risk of bycatch in coastal fisheries in different seasons based on the overlap between seal distribution and fishing locations. The findings can be used to inform management practices and reduce bycatch of harbour seals in Norwegian coastal fisheries.

Moan & Bjørge (2023) performed trials to evaluate the effect of acoustic deterrent devices (ADD) on harbour porpoise and harbour seal bycatch in three Norwegian commercial gillnet fisheries. Between 2018 and 2020, catch data were collected by 8 different vessels. In that period, a total of 20 harbour porpoises and 9 harbour seals were bycaught, with 19 harbour porpoises and 6 harbour seals out of the total, bycaught when pingers were not in use. Carrying out GAMMs to analyse these data showed that harbour porpoise bycatch could be reduced by 94% (CI: 77-100%) when using pingers in the nets. On the other hand, models showed no significant effect of the pingers on the catch rates of fish or harbour seals.

Ryeng *et al.* (2022) investigated the health status of bycaught harbour porpoises from the northernmost Norwegian Arctic coastline. Gross, histopathological and parasitological investigations were conducted on 61 harbour porpoises accidentally captured in fishing gear from February to April 2017 along the coast of northern Norway. Most animals displayed a good nutritional status. Pulmonary nematodiasis (*Pseudalius inflexus*, *Halocercus invaginatus* and *Torynurus convolutus*) was found in 77%, in 33% of the cases associated with severe bronchopneumonia. The majority (92%) had parasites in the stomach and intestine (*Anisakis simplex*, *Pholeter gastrophilus*, *Diphyllobothrium stemmacephalum*, *Hysterothylacium aduncum* and *Pseudoterranova decipiens*). In conclusion, the major pathological findings in the investigated arctic porpoises were parasitic infestations in multiple organs with associated severe lesions, particularly in the lung, liver and stomach. Most of the animals showed freshly ingested prey in their stomachs. Thus, they suggested that harbour porpoises were able to tolerate the detected parasitic burdens and associated lesions without significant health problems.

3.3.3 Sweden

Current information of the extent of bycatches of marine mammals in Sweden is lacking (Lundström *et al.*, 2010; Vanhatalo *et al.*, 2014). Alternative fishing gear, in particular gillnets, were investigated with the purpose of avoiding seal damage and depredation as well as reducing bycatches (Königson *et al.*, 2015; Kindt-Larsen *et al.*, 2023).

3.3.4 Finland

Lehtonen *et al.* (2022) tested acoustic deterrent devices (ADDs) in Baltic salmon (*Salmo salar*) trap-nets (pontoon traps) to mitigate conflicts of resource competition between grey seal and coastal fisheries in the Baltic Sea (southern and southwestern coast of Finland). The use of ADDs devices in trap-nets showed a positive effect on the salmon catches since the average economic benefit increased by 64%. However, little is known about the behavioural responses of grey seals to ADDs.

3.3.5 Denmark

During May and June 2019, Brennecke *et al.* (2022) conducted a study on the behavioural reactions of harbour porpoises towards pingers. A drone was used to track 16 harbour porpoises in Danish waters, and videos were recorded before and during exposure to pinger sounds. Among the individuals studied, avoidance behaviours were observed in four porpoises, which swam rapidly away from the pinger and surfaced less frequently. In addition, eight of the 16 porpoises disappeared from the drone's view as soon as the pinger was activated, either by deep diving or swimming away from the area. The remaining four individuals did not react to the pinger activation. Pinger use was suggested to be limited to critical time periods and/or regions to avoid these strong aversive reactions in the porpoises. It is encouraged to develop devices that cause less severe behaviour reactions in the animals.

Lusseau *et al.*, (2023), applied a combination of DEPONS (Disturbance Effects on the Harbour Porpoise population in the North Sea), and PCoD frameworks to evaluate the effects of pingers on harbour porpoises in the inner Danish waters between Denmark and Sweden, not only through reduction of bycatch mortality but also accounting for the effects of noise disturbance on population growth. The study demonstrated the utility of including condition-mediation mechanisms in the behavioural response to noise exposure, considering that porpoises adapt and change behaviour to noise exposure over time (see Graham *et al.*, 2019; Kindt-Larsen *et al.*, 2019). The authors concluded that pinger implementation can be an effective bycatch mitigation tool, although its effectiveness depends on the pinger deployment schedule. High pinger prevalence could lead to effects on the reproductive rate. The authors noted the need to include indirect effects of implemented mitigation plans in the current European Legislation (EU, 2019).

3.3.6 Germany

Barz (2022) carried out interviews with fishermen operating in the German Baltic Sea to study the behaviour of the fishermen towards bycatch. A total of 22 Problem-centred Interviews (PCI) were performed. The results indicated that fishers tend to view seabird bycatch incidents as a regular occurrence in their fishing routine, whereas the bycatch of marine mammals is perceived as a crisis.

3.3.7 The Netherlands:

IJsseldijk *et al.* (2022) shared the results of the anatomopathological analysis of 612 harbour porpoises stranded between 2008 and 2019, and assessed their relationship to age, sex, season, and location. The largest anthropogenic category was bycatch (17%), with mainly juveniles affected and peak periods in March and September to October. Cases related to trauma (4%), were largely most likely due to ship collisions, and marine debris ingestion and entanglement (0.3%) were less prevalent. They found that the risk of dying from anthropogenic causes was higher for juveniles. Lesions compatible with noise-induced hearing loss were found in two porpoises out of 50 analysed cases. Non-direct human-induced threats included infectious diseases (32%), which affected mainly adults. Also, grey seal attacks were detected (24%). In recent years, some porpoises appeared with lesions that suggested escape from grey seal attacks, which could suggest that porpoises adapted to this threat.

3.3.8 Belgium

In 2021, an exceptionally high number of seals stranded on the Belgian coasts. Detailed information was collected for 90 of the 101 stranded seals. Severe head and neck lesions were found in 64% (58) of the cases, while 27 of these had circular lesions known as ligature marks. The authors (Haelters *et al.*, 2022) deduce that these marks are the result of fishing nets potentially causing these injuries when being hauled. Given the high occurrence, they suggest further investigation including the system of bycatch, the spatial and temporal extent, the number of seals bycaught, and the type of fishing vessel involved.

3.3.9 France

A model-based approach was employed to estimate PETS bycatch from non-representative samples, using simulated data. Authier *et al.* (2021) conducted a statistical analysis using multilevel regression with post-stratification, which allowed for the estimation of total bycatch in realistic scenarios of data sampling, including under- and over-sampling. The bycatch risk for each week within a year was modelled. The results indicated that this model-based approach improved the accuracy and precision of estimates under mild assumptions.

In July 2020 and 2021, non-systematic scientific surveys were carried out in waters of Brittany, France (Lehnoff *et al.*, 2022). The aim of these surveys was to test a bio-inspired acoustic device for limiting fishery bycatch. This acoustic device emits returning echoes from the echolocation clicks of common dolphins from a fishing net. Surface visual observations, along with automatic detection of echolocation clicks, buzzes, burst-pulses and whistles were recorded and analysed to detect behavioural responses in dolphins. While the device was active, significant differences were found in the number of clicks and whistles (they increased by a factor of 2.46 and 3.38 respectively), while no differences were detected in buzzes or burst-pulses. The acoustic device resulted in a heightened echolocation ability in common dolphins, leading to a greater overall net detection rate.

Peltier *et al.* (2021a) studied common dolphin mortalities occurring along the French Atlantic coasts during winter 2021. They combined strandings data and carcasses observed from winter aerial surveys (SAMM-II) to produce these estimates. A total of 699 small cetaceans stranded on French Atlantic coasts between the 1 January and 31 March 2021. The main identified species stranding was the common dolphin (85%). From these stranded animals, a total of 4 250 common dolphins (95% CI: 3 190 – 6 000) was estimated to have been bycaught in fishing gear between January and March. The aerial surveys estimated that 3 125 (95%, CI: 1 646 – 6 775) small delphinids died in the Bay of Biscay during the month of March. Combining the two estimates, approximately 6 800 small delphinids died during the winter of 2021 in the Bay of Biscay.

The co-occurrence of common dolphin mortalities and fishing effort of the gillnetting fleet between 2010 and 2019 was studied by Peltier *et al.* (2021b). All fishing boats were classified in 5 fleets, depending on the distance to the coast where they occur. Regardless of the year tested since 2014, netters targeting hake showed a positive relationship with the mortality zones of common dolphin (88%), as did trammel nets targeting anglerfish (75% of the tested years). Netters targeting flounder, regardless of the distance to the coast where they were fishing, showed a less frequent but regular positive co-occurrence with mortality zones of common dolphins (13%).

3.3.10 Bay of Biscay

Peltier *et al.* (2022) used reverse drift modelling to infer the likely at-sea origins of stranded common dolphins and then performed a GAMs to explore the spatial overlap between fishing effort and bycatch locations in the coastal zone of north-east Biscay.

3.3.11 Iberian Peninsula

Updates on the bycatch mortality of the Iberian porpoise were reported by Pierce *et al.* (2022). New data were available from strandings and onboard observers. Portugal reported bycaught animals from onboard observers, while Spain reported zero porpoise bycatch. The minimum bycatch mortality rates for both countries, based on reported information of strandings and onboard observers, is 0.5% (14 individuals bycaught per year). Both types of data (bycatch and strandings) can be used to estimate the total bycatch and bycatch rate of a population, based on population size and overall mortality rate. However, it is necessary to assume that the samples are representative, which is unlikely. Despite this limitation, the results from all data sources consistently suggest an annual bycatch mortality rate of at least 8% (or around 230 individuals) per year.

3.3.12 Portugal

Alexandre *et al.*, (2022) conducted face-to-face interviews with fishers of coastal artisanal fisheries to assess the level of interactions between air breathing marine megafauna species (cetaceans, marine birds, and marine turtles) and fisheries in the Portuguese mainland south coast (Algarve). They found that the fishing gears of most concern for cetaceans were purse seine (especially for common dolphin) and bottom set-nets, which were associated with important bycatch numbers.

In coastal waters of mainland Portugal, onboard observations also detected interactions between the purse seine fishery and different species of cetaceans (common dolphin, bottlenose dolphin, and harbour porpoise). Between 2003 and 2018, common dolphins occurred in 89% of all interaction events. Dias *et al.* (2022) found that the abundance of sardine (*Sardina pilchardus*) and chub mackerel (*Scomber colias*) in the area has a significant effect on the probability of common dolphin bycatch.

3.3.13 United Kingdom

Estimates of humpback and minke whale entanglements in the Scottish static pot fishery were carried out by Leaper *et al.* (2022). They were based on interviews to fishermen performed between 2018 and 2019, collecting information related to whale entanglements between 2008 and

2019. The results suggested a total of 6 humpbacks and 30 minke whales become entangled per year, with 83% and 50% respectively of the entanglements reported being caused by groundlines between creels. The amount of gear set by a vessel seemed to be positively correlated with the number of minke whales entangled. An increasing trend was observed in the entanglement reports for both species over the years.

3.3.14 Ireland

Luck *et al.* (2022) carried out a Population Viability Analysis (PVA) for the grey seal population inhabiting Irish waters and affected by fisheries bycatch. Four different scenarios were simulated, testing different levels of bycatch probability, bycatch bias towards age-sex classes, immigration events from other populations and colony-specific bycatch rates for each breeding colony. The results showed that 800 bycaught individuals per year would lead to a 99% reduction of the population size in 100 years. When simulating a bias towards juveniles, males and females, the PVA was more sensitive for females and more robust for juveniles and males. If 500 individuals migrate from other populations to the Irish one each year, the population would be viable even in the scenario of 800 bycaught individuals per year. The colonies from the South and Southwest of Ireland seemed to be the first ones that would show evidence of decline when increasing bycatch impacts.

3.3.15 Canada

Vessel-based photography was used to estimate entanglement rates of humpback, fin and blue whales in the Gulf of St. Lawrence, between 2009 and 2016 (Ramp *et al.,* 2021). The fin whale bycatch rates were later compared to the ones obtained from an analysis based on drone imagery collected between 2018 and 2019. The estimated entanglement rates for “non-fluking” whales were found to be biased low due to insufficient photographic documentation of the body regions that are susceptible to scarring related to entanglement. According to the results of the photo-ID analysis, a total of 6.5% of the fin whales showed scars probably caused by entanglement, while the drone imagery analysis showed that between 41.3% and 54.7% of the individuals presented entanglement-related scars.

3.3.16 United States

The risk encounter between grey seal pups and gillnet fisheries in the Gulf of Maine and southern New England was examined by Murray *et al.* (2022). Satellite telemetry was deployed on 30 pups (3-4 weeks old) between 2019 and 2020. Fishing effort was extracted from mandatory Vessel Trip Reports (VTR). Encounter risk was analysed in a mesh with cells of 30-minutes resolution, containing seal presence and fishing effort, for every season. Later, this expected risk was validated with reported bycatch events by onboard observers in fishing vessels. A greater encounter risk was observed in South-eastern Massachusetts during spring.

3.4 Hunting (Greenland, Sweden, Iceland, Norway, Denmark)

Seal hunting to acquire resources has probably been going on for as long as humans and seals have co-existed (Storå, 2002). At the end of the 19th century, bounty systems were introduced, e.g., in Sweden, Finland and Denmark, with the purpose of reducing problems for fisheries while at the same time providing important income for hunters. Consequently, several seal populations were reduced in size and range during the first half of the 20th century. Owing to protection measures in the form of hunting bans and improved environmental conditions, seal populations started to recover at the end of the 20th century. (Heide-Jørgensen and Härkönen, 1999, Hårding and Härkönen, 1999, Kokko *et al.*, 1999, Olsen *et al.*, 2018).

As a consequence of growing seal populations and seal-induced damage to catches and fishing gear during the 21st century, conflicts between seals and fisheries have reappeared and become aggravated. Effective stakeholder lobbying and political decisions have resulted in the reintroduction of seal hunting as a management measure.

3.4.1 Sweden

Although no effects in terms of reduced damage to fishing gear could be observed in a hunt study, hunting of grey seals was reintroduced in Sweden in 2001 in the form of a regional quota protection hunt (Westerberg *et al.*, 2006). Quota protection hunts of harbour seals in the Kattegat-Skagerrak and ringed seals in the Bothnian Bay started in 2009 and 2016, respectively. A limited number of personal permits for protection hunting of single seals were assigned before the general regional quotas were introduced. The objective of the protection hunt was to reduce damage to fishing gear and catches, based on the theory that it is a limited number of seals that are the main cause of damage. Initially, the protection hunt took place in specific seal damage areas but, later, hunting was only allowed in the vicinity of 'a place where fishing is conducted and where seals have caused damage to fishing gear or taken catch from the gear'. In more recent protective hunt decisions, hunting has also been allowed in fish-protection areas. Hunting licences were introduced in Sweden in 2020 for grey seals and in 2022 for harbour seals. The purpose of hunting licences is to regulate the seal population in order to reduce conflicts between seals and humans in regions with high seal abundance (Swedish Agency for Marine and Water Management, 2019). When the licensed hunt of grey seals started, a common quota for the entire Swedish Baltic Sea was allocated (n=2 000), in contrast to previous region-specific quotas. In 2022, the national hunt quotas in Sweden were 2 000 grey seals (April 20, 2022 - January 15, 2023), 730 harbour seals (April 20, 2022 – April 19, 2023) and 420 ringed seals (May 1, 2022 – January 15, 2023).

3.4.2 Estonia

Hunting of grey seals was reintroduced in Estonia in 2015 (HELCOM, 2022). Hunt quotas are set annually according to census data and, in 2021, the quota was 55 grey seals.

Table 3-1. Reported number of seals from the harbour seal hunt 2011-2022 in Sweden, Norway and Denmark. Data from the Swedish Environmental Protection Agency, Norwegian Institute of Marine Research, the Danish Environmental Protection Agency and HELCOM.

Year	Sweden	Norway	Denmark
2011	87	230	5
2012	3	355	16
2013	93	511	8
2014	134	409	11
2015	162	297	23
2016	181	362	13
2017	159	338	35
2018	353	385	29
2019	328	448	50
2020	390	391	53
2021	232	238	31
2022	224	251	66

3.4.3 Finland and Åland

The seal hunt history in Finland and Åland follow similar patterns as in Sweden, going from a ban on hunting in the 1970s-1980s to reintroduction of some form of hunting during the late 1990s-early 2000s to deal with increasing conflicts between fisheries and growing seal populations (Ministry of Agriculture and Forestry, 2007; Government of Åland, 2007).

In 2022, the quota for grey seals was 1 050 in Finland and 500 in Åland. The quota for ringed seals in Finland was 375 in 2022.

3.4.4 Norway

In Norway, harbour seals and grey seals have not been protected to the same extent as in Sweden, Finland and Denmark. A hunting programme on both species had been introduced already in the 1980s and from 1997, the hunt has been regulated by quotas (Norwegian Ministry of Fisheries and Coastal Affairs, 2010a, Norwegian Ministry of Fisheries and Coastal Affairs, 2010b). Harbour seals and grey seals in Norway are managed according to national management plans, aiming at ensuring viable seal populations throughout the natural distribution range but also providing harvest quotas for stabilization of population sizes at politically agreed levels. This allows for sustainable seal hunting that takes ecological and socioeconomic considerations into account. Hunting quotas are given according to whether populations are larger or smaller than the political target levels. According to the current management plans, harbour seals should be stabilized at about 10 000 seals, corresponding to 7 000 counted annually at moulting haul-out sites. Grey seals should be stabilized at a level resulting in an annual pup production of about 1 200 pups. In 2022, the Norwegian hunt quotas were 200 grey seals and 268 harbour seals.

The quantities of seals reported shot in relation to allowed hunt quotas vary between countries, regions and years, but typically less than 50% of the grey seal quotas and more than 50% of the ringed seal and harbour seal quotas have been filled.

Table 3-2. Reported number of seals from the grey seal hunt 2011-2022 in Sweden, Finland, Åland, Estonia, Norway, and Denmark. Data from the Swedish Environmental Protection Agency, the Finnish Wildlife Agency, the Government of Åland, Univeristy of Tartu (Estonia), Norwegian Institute of Marine Research, the Danish Environmental Protection Agency and HELCOM.

Year	Sweden	Finland	Åland	Estonia	Norway	Denmark
2011	72	290	90		111	
2012	92	177	114		64	
2013	102	134	104		194	
2014	110	172	115		216	0
2015	285	180	123	10	82	0
2016	190	195	73	10	33	0
2017	263	218	72	9	40	0
2018	499	220	128	18	66	0
2019	959	285	343	20	62	3
2020	1 114	231	215	19	16	6
2021	943	413	207	26	29	0
2022	689	315	132	na	133	1

Table 3-3. Reported number of seals from the ringed seal hunt 2011-2022 in Sweden and Finland. Data from the Swedish Environmental Protection Agency, the Finnish Wildlife Agency and HELCOM.

Year	Sweden	Finland
2011	2	5
2012	2	12
2013	5	10
2014	4	14
2015	59	21
2016	76	95
2017	39	199
2018	130	217
2019	274	266
2020	286	311
2021	291	273
2022	85	263

Denmark

The Danish Environmental Protection Agency currently authorises the regulation of hunting a small number of harbour seals and grey seals annually to limit damage to fisheries. Licences for hunting are granted on the condition that it is conducted in the vicinity of fishing gear. Protective hunting of harbour seals has been allowed in Denmark since 2008, and protective hunting of grey seals since 2014. The purpose of the hunt is to reduce damage to fishery catches and fishing gear (Danish Environmental Protection Agency, 2020).

3.4.5 Faroe Islands

In the Faroes, long-finned pilot whales and, on occasions, Atlantic white-sided dolphin and bottlenose dolphin, are taken in drive fisheries. Strandings of northern bottlenose whales occur fairly regularly and are also recorded in the statistics. The traditional drive hunt (called 'Grindadráp' or 'Grind') usually involves the long-finned pilot whale and occasionally the Atlantic white-sided dolphin. In September 2021, a Grind, believed to be the largest one ever, involved the taking of over 1 400 Atlantic white-sided dolphins (ASCOBANS, 2021). In 2019 and 2020, 10 and 35 dolphins, respectively, were killed. Contracting parties to ASCOBANS (except Denmark who did not participate in the vote) agreed to send a letter from the ASCOBANS Secretariat to Denmark and the Faroe Islands on the practice of the grind, indicating therein their preference for applying the same strict cetacean protection as other EU member states. (see https://www.whaling.fo/en/regulated/450-years-of-statistics/catches/).

The grey seal population is not subject to recreational hunting or significant bycatch pressure, but, historically, a limited harvest has occurred, and bounty hunts have also periodically been in action, the motivation being reducing numbers and competition with fishermen. With the development of the aquaculture industry, grey seals were culled as a protective act around fish farms, a removal that seemed to prevent the population from increasing in numbers. However, culling of grey seals around fish farms was banned by law in 2020.

3.4.6 Greenland

Four pinniped species are common in Greenland: ringed seal, harp seal, hooded seal and bearded seal. Only ringed seals and harp seals are hunted in large numbers, and the hunt is believed to be sustainable. Harbour seals were once common, but overhunting resulted in the species becoming critically endangered in Greenland. Harbour seals have been protected since 2010; their confirmed distribution is limited to South Greenland, with few observations outside the localities mentioned above (see ToR A).

Advice on catch levels for harp and hooded seals are given by an ICES/NAFO/NAMMCO working group. Hooded seals that breed in the Greenland Sea are protected against commercial hunting, because they were reduced in the years following the Second World War. The catch numbers of the other stocks have been below the estimated allowable catch for many years (ICES, 2019c).

Advice on ringed seals and bearded seals in the Atlantic region is given by NAMMCO. Unlike the harp and hooded seals that breed at high densities in the same areas every year, ringed and bearded seals are spread out all over the Arctic, and the ringed seals give birth in lairs that they dig out in the snow. As a result, there are not the same opportunities to monitor the populations. Their distribution spanning very wide areas, however, protects them against overharvest, because the hunt only occurs in a small fraction of their habitat. An evaluation of the ringed seal situation was undertaken by NAMMCO in 1996 (NAMMCO, 1996). A new evaluation on ringed seals will be made by NAMMCO in 2023. The situation for bearded seals has never been thoroughly evaluated, but this species will also be examined by NAMMCO in 2023.

3.4.7 Iceland

A new regulation for seal hunting in Iceland was enacted in 2019 to ban all seal hunting due to the vulnerable status of the Icelandic harbour seal and grey seal populations. It is, however, possible for landowners to apply for exemptions for so-called traditional utilization of seals. The hunting numbers have, however, been low since the hunting ban was enacted (Granquist, S., personal communication, 1 February 2023).

Harbour seals from the Icelandic population were studied by Granquist (2022), along with trends in the population over a 40-year period. In total, 13 full aerial censuses were carried out during the moulting season (July-August) between 1980 and 2020. The most recent census from 2020 yielded an estimate of 10 319 (95% CI: 6 733-13 906) animals, indicating that the population is 69% smaller than when systematic monitoring of the population commenced in 1980 (33 327 seals). The observed decrease puts the population on the national red list for threatened populations. Trend analyses indicate that most of the decline occurred during the first decade, when the population decreased about 50% concurrently with large human induced removals of harbour seals. After that point, the population decline slowed down but continued, and currently the population seems to fluctuate around a stable minimum level. The author underlines the need to assess and sustainably manage current threats to the population, including human induced removals, anthropogenic disturbance, and various environmental factors (contaminants, climate change and fluctuation in prey availability) and recommends to perform regular censuses and to increase monitoring of population demographic factors.

3.5 Chemical Pollution (including Marine Debris)

3.5.1 General

Marine debris, particularly plastic debris, is a global threat to both the marine environment and wildlife (Agamuthu *et al.*, 2019). Negative impacts on marine mammals have been reported, primarily due to entanglement and ingestion (Panti *et al.*, 2019). The latest review showed that 61 out of 90 known cetacean species were reported to interact with marine debris through entanglement and/or ingestion (Eisfeld-Pierantonio *et al.*, 2022). Microplastics, mainly fibres and fragments, were found in the gastrointestinal tracts of both stranded harbour seals and grey seals (Philipp *et al.*, 2022). No significant differences in the occurrence of microplastics were found between sex or age groups. In German waters, Salazar-Casals *et al.* (2022) found that the entanglement rate of grey seals in fishing nets has quadrupled in recent years, while the incidence of ingested debris is higher in stranded harbour seals. In addition, they observed that juvenile animals were more affected by marine debris than adults. In Norwegian waters, Similä *et al.* (2022) identified a 2.8 m fishing line embedded in the stomach of a sperm whale. Only one of three stranded male sperm whales analysed presented marine debris in the stomach contents.

3.5.2 Arctic

Dietz *et al.* (2022) carried out a risk assessment of mercury (Hg) exposure based on a systematic review of the literature. This risk assessment included both marine and terrestrial mammals occurring in the Arctic. A total of 13 marine mammal species were classified in five different categories, ranging from "No risk" to "Severe risk" of health effects from Hg exposure. Hooded seals showed the highest concentration of Hg, probably due to their consumption of redfish, while toothed whales showed very high concentrations of Hg, due to their high position in the food chain, and their lack of ability to excrete these substances. Almost 6% out of 3 500 individuals of marine mammals analysed were classified at high or severe risk of health effects from Hg exposure.

3.5.3 Northern Europe

A total of 65 apex predator and potential prey samples were collected and analysed for PFAS determination (per- and polyfluoroalkyl substances) (Androulakakis *et al.*, 2022). For the apex predators (grey seal, harbour seal and harbour porpoise among others), liver samples were collected between 2015 and 2018 in the United Kingdom, Germany and the Netherlands. PFAS concentrations were determined using liquid chromatography electrospray ionization tandem mass spectrometry (LC-ESI-MS/MS). Concentration ranges for per- and polyfluoroalkyl substances were 0.02 - 1.25 and 0.05 - 3.79 ng / g wet weight respectively. The harbour porpoise was the second most polluted species in the study. In seals, an increase in the PFAS concentration was detected, maybe caused by changes in their diet.

3.5.4 Estonia

Trace element pollutants and their effects on health status were evaluated in blood samples of stranded grey seals from the Gulf of Riga (Puchades *et al.*, 2022). The highest concentrations were found for zinc, followed by copper, selenium, lead, mercury and arsenic. Chromium and cadmium were not detected in the samples. Trace element concentrations were generally comparable to other data from seals. Significant positive correlations were found between concentrations and several biochemical parameters, but most relationships did not strongly imply toxicology from the detected concentrations.

3.5.5 Sweden

Mauritsson *et al.* (2022) constructed a new population model, termed a toxicokinetic-toxicodynamic (TKTD) model, to model the effects of polychlorinated biphenyls on Baltic grey seals. The model incorporates a toxicokinetic submodel describing bioaccumulation, elimination and vertical transfer from mother to offspring of PCBs. This is linked to a toxicodynamic model for estimation of PCB-related damage, hazard and stress impacts on fertility and survival rates. Both submodels were linked to a Leslie matrix population model to calculate changes in population growth rate and age structure. Model parameters related to pathology of reproductive organs were calibrated with data on observed pregnancy rates of females with known PCB concentrations. The model performed well in describing age-specific bioaccumulation pattern of PCBs in Baltic grey seals and the effects of PCBs on historic population abundance trends. The authors suggest the model used for analyses of marine mammal population viability, with the inclusion of additional pressures, such as other pollutants, bycatch and hunting.

3.5.6 Germany

Philipp *et al.* (2022) studied occurrence of microplastics in 63 harbour seals and grey seals from German waters in the Baltic and North Seas between 2014 and 2019. Higher loads were found in the stomach compared to intestines. No significant differences in life history parameters such as sex and age, nor parasite infestation were detected. Likewise, correlations of microplastic concentrations and parasite infestations or inflammation responses were not detected. Slightly higher occurrence of microplastics (>100 mu m) were found in specimens from the Baltic Sea compared to the North Sea.

3.5.7 United Kingdom

Desclos-Dukes *et al.* (2022) presented a new protocol for assaying microplastics on seal faecal samples. Using enzymatic digestion, filtration and microscopic identification, they detected 71 microplastic particles including both fragments and fibres in 66 grey seal faecal samples.

Marine mammals from 11 different species stranded on the coasts of the United Kingdom between 2010 and 2013 were sampled (Megson *et al.*, 2022). A total of 19 muscle samples were collected and analysed for quantification and determination of 209 different PCB congeners. At least 145 congeners were found in all the samples. The highest PCB concentration was found in killer whales (318 mg PCB / kg lipid). Most of the samples analysed exceeded the 9 mg PCB / kg lipid threshold value for adverse effects on individual health. A new PCB signature was recorded in sei whales, for the first time in marine mammals, showing that 5% of the PCB congeners' profile was composed of lighter and inadvertent congeners such as PCB 11, which denotes that the main source of exposure was through the atmosphere rather than terrestrial discharges.

Tranganida *et al.* (2023) examined the potential impacts of plastic pollution in terms of phthalates on grey seals. Expression of adipose-specific genes was examined in blubber explants exposed to benzyl butyl phthalate. There were substantial differences in insulin-induced transcription activity of Ppar gamma (and Adipoq in some animals) in a tissue depth and moult stage-specific manner. Basal as well as insulin-induced Akt phosphorylation was unchanged by exposure. Given the detected effects, it is likely that phthalate exposure will have effects on blubber development or functions, but more knowledge on actual phthalate exposure and toxicokinetics are necessary to assess whole animal effects in the wild.

Watkins *et al.* (2022) investigated faecal microbiota profiles of grey seal pups and yearlings at the Isle of May, Scotland. Microbial diversity was lower in pups than yearlings, but not significantly so. Composition was, however, markedly different between these age groups. Highly significant differences were found between pups from three different habitats. The authors suggest that microbiota composition can potentially be used as an index of environmental quality.

3.5.8 Macaronesia (Canary Islands)

Lozano-Bilbao *et al.* (2021) studied the presence of trace elements and toxic heavy metals in muscle and liver tissue of six species of stranded cetaceans in the Canary Islands (Bottlenose, Atlantic spotted, Common and, Risso´s dolphins, short-finned pilot whale and sperm whale). Deep-diving animals differ in their concentrations of Cr, Cu, Mg, Mn, Mo, and Zn with respect to shallow-diving animals in muscle and in the liver in Al, B, Cr, K, Mn and Mo. Males present differences in their concentrations of B, Cd, K and Mg in muscle tissue with respect to females, while differences in the liver were only detected in the Fe content. The study of the correlations shows that as the size of the animal increases, the concentration of Cd increases while the concentrations of Al, Cu and Zn decrease.

3.5.9 Iceland

García-Garín *et al.* (2022) studied the concentration of phthalates in fin whales sampled in the western waters of Iceland between 1986 and 2015. A total of 31 muscle samples were analysed to determine the presence and concentration of 13 phthalates. Only 5 of those 13 phthalates were found, showing no statistical relationship with biological variables. In the 29 year-period studied, no variation was found in the concentration of phthalates, and no adverse effects on health due to these compounds were detected.

Transplacental transfer of plasticizers and flame retardants in fin whales from western waters of Iceland were studied (Sala *et al.*, 2022). A total of eight pregnant females were sampled during the summer of 2018. Determination and quantification analysis for organophosphate esters (OPEs), halogenated flame retardants (HFRs) and short chain chlorinated paraffins (SCCPs) were carried out. The results showed that the three families of pollutants were found in 100% of the foetuses, while HFRs and SCCPs were found in only 87.5% of the females (100% females had OPEs). The models showed that a high lipophilicity of the compounds reduces the transplacental transfer. This study shows the first documented case of maternal transfer of plasticizers and flame retardants in fin whales.

3.5.10 Canada

Ringed seals from subsistence-harvest were sampled in four different locations of the Arctic and sub-arctic regions of Canada (Facciola *et al.*, 2022). A total of 38 individuals were studied for dietary and pollutant analysis. Blubber fatty acids and muscle stable isotope analysis were carried out, along with quantification and determination of heavy metals and persistent organic pollutants (POPs). Results showed differences between the arctic and sub-arctic ringed seals regarding their fatty acid signatures and stable isotopes concentrations. Shifts in prey distribution due to climate change might be influencing the accumulation of some pollutants. Specifically, pelagic fish species from the sub-arctic region going northwards into the arctic seem to increase new POP accumulation, such as the PFAS (per- and polyfluoroalkyl substances) while decreasing others such as Hg, PBDEs and DDTs.

MacMillan *et al.* (2022) investigated trace element concentrations in muscle, liver, heart and kidney from hunted grey seals from the Gulf of St Lawrence, Canada. Lower concentrations were generally found in pups <6 weeks old compared to older animals, but progressive age-dependent accumulation was not found. There were no large differences between the sexes, but males had 30-70% higher concentrations of mercury in muscle and manganese and zinc in the liver.

3.5.11 USA

Temporal trends of polybrominated diphenyl ether (BDE) flame retardants and brominated alternative fire retardants were studied in three harbour seal populations from California, the Gulf of Maine and southern Sweden during 1999 - 2016 (Sun *et al.*, 2022a). Decreasing trends in the order of 9-11% annually were found in all three areas, mainly driven by declining concentrations of tetra- and penta-BDEs. Levels of Sigma a-brominated flame retardants decreased significantly in California and Sweden, while no trend was detected in Maine. Dechloranes did not decrease significantly in any of the three regions. Sigma a-brominated flame retardants and dechloranes showed varying compositions between regions, indicating different local pollution sources of these alternative flame retardants. The results indicate that the commercial penta-brominated flame-retardant mix has been effectively regulated and warrant further monitoring of higher brominated BDEs and alternative flame retardants. Sun *et al.* (2022b) investigated the connections between liver fatty acid composition and concentrations of flame retardants and perfluorinated compounds (PFASs) in the samples from Maine and Sweden. Correlations were found in both regions, with several flame retardants and perfluorinated compounds being associated with estimated desaturating enzyme activity. Hence, the results suggest a lipid metabolism disrupting potential for these pollutants in marine mammals.

3.6 Underwater Noise

3.6.1 General

Branstetter & Sills (2022) conducted a review of laboratory psychoacoustical experiments, focused on the auditory mechanisms driving masking patterns in marine mammals. The topics reviewed include the detection of tones with masking noises, signal detection with complex sounds, spatial release from masking, and the differences between energetics and informational masking. Regarding tone-on-tone masking, the patterns described in marine mammals are similar to those observed in human studies where higher amplitude tones produce more masking and lower frequencies mask high frequencies better. The largest amount of masking occurs when signal and masker present similar frequencies. Despite the differences in basilar membrane size and morphology between odontocetes, their critical ratios are remarkably similar. Most of the studies focus on signal detection, but signal recognition thresholds are also of relevance for informing communication space models (e.g., recognize a signal 80% of the time). Finally, the usability of Power Spectrum Models (PSM) of masking, based on auditory filters and standard critical ratios, is highlighted when predicting auditory masking for mitigation purposes. However, critical ratios have become the standard metric to use given their simplicity and ease of data collection to calculate them. An added complication when using PSM and predicting realistic scenarios is the masking release, given the features of signals and/or noises and their spatial relationships.

A scientometric analysis of the existing literature on the impact of offshore energy development, on a variety of marine species, has been conducted by Kulkarni and Edwards (2022). Their analysis aimed to evaluate the literature from an epistemological perspective, employing the interpretivist philosophical stance and inductive reasoning. The results show a significant increase of research on the topic over the last decade, especially carried out by academic institutions and government research facilities, but with a noticeable absence of private sector involvement. Most of the research is focused on the Atlantic and Pacific Oceans, particularly on coral reefs, lagoons estuaries and sea grass. Moreover, the literature indicates that most marine species are not adversely affected in the long term, although short-term disruption or disturbance may be of concern. The most recommended method for reducing this impact is (i) the use of acoustic deterrent strategies, (ii) the establishment of protected areas or development of structures that help to recover habitats from damage and, finally, (iii) prioritisation of further research, especially in areas with critical concerns about the impact of offshore development.

3.6.2 Sweden

Königson *et al.* (2022) tested the deterrent effect of an experimental pinger to avoid the "dinner bell effect" of traditional pingers for seals, while decreasing the bycatch of other non-target species such as harbour porpoises. The experimental pinger, a modified Fishtek Banana pinger, transmitted at 60-85 kHz with low frequency components potentially audible to seals but only at close distances (hearing sensitivity of phocoenids is considered poor above 60 kHz). Experimental results showed a significant negative effect of the pinger on the click rate trains per hour, although this does not necessarily imply the total absence of porpoises around the net since they may be present but undetected. After turning off the pinger, click activity increased to the same level as before turning it on (between 0-100 m), indicating a short-range displacement of the porpoises (<400 m). No signs of habituation to pinger sounds were observed over consecutive days. The theoretical pinger detection range for harbour seals was calculated to be around 80 m for the 55 kHz component.

3.6.3 Denmark

Tougaard *et al.* (2022) reviewed data made available since 2015 on the underwater sound levels required to elicit temporary hearing threshold shifts in harbour porpoises and harbour seals. For porpoises (and other cetaceans with high frequency hearing), there was strong support to maintain current thresholds for impulsive noise sources, while for harbour seals (and other phocids) the current thresholds are not strongly supported. For non-impulsive sound sources, there is good correspondence between exposure functions and empirical thresholds below 10 kHz for porpoises and between 3 and 16 kHz for seals. Above 10 kHz for porpoises and outside the range 3-16 kHz for seals, there are differences up to 35 dB re 1 µPa between predicted thresholds for temporary hearing threshold shift and empirical studies. Addressing these discrepancies requires further empirical data.

Lusseau *et al.*, (2023), applied a combination of DEPONS (Disturbance Effects on the Harbour Porpoise population in the North Sea, Beest *et al.*, (2017)) and PCoD (Population Consequences of Disturbance) frameworks to evaluate the effects of pingers on harbour porpoises in the inner Danish waters between Denmark and Sweden, not only through reduction of bycatch mortality but also accounting for the effects of noise disturbance on population growth. The study demonstrated the utility of including condition-mediation mechanisms in the behavioural response to noise exposure, considering that porpoises adapt and change behaviour to noise exposure over time (see Graham *et al.*, 2019; Kindt-Larsen *et al.*, 2019). The authors concluded that pinger implementation can be an effective bycatch mitigation tool, although its effectiveness depends on the pinger deployment schedule. High pinger prevalence could lead to effects on the reproductive rate. The authors noted the need to include indirect effects of implemented mitigation plans in the current European Legislation (EU, 2019).

3.6.4 Estonia

The movement and diving behaviour of three ringed seals were documented in the Suur väin (Suur Strait), Estonia, by GPS tracking (Prawirasasra *et al.,* 2022). While transiting through the Strait, their path crossed that of ferries, exposing them to ship-noise. On 3 occasions the seals were within 35-50 m of the ferries during their travel at sea. While their dive bouts were regular away from the boats, they switched either to deep dive, or series of short surfacing and shorter, shallower dives when they were close to the ferries. The seals' direction of travel and swimming speed did not seem to be affected by the passage of the ships. The authors assume that the seals' energy budget may not be affected by these behavioural changes, due to the short exposure time.

3.6.5 The Netherlands

Morell *et al*. (2021) reported the first case of concurrent noise-induced hearing loss, and toxoplasmosis in free-ranging harbour porpoises. The individual examined was stranded alive on the Dutch coast and was aged 7. Along with the histopathology and immunochemistry diagnostic techniques, toxoplasmosis was confirmed by positive staining of protozoa. In addition, through scanning electron microscopy, it was observed a scattered loss of outer hair cells in the apical turn and in a focal region from the apex of the cochlea, both compatible with noise-induced hearing loss.

3.6.6 United Kingdom

Hastie *et al.* (2021) measured the influence of acoustic signals, such as pile driving and underwater tidal turbines, on foraging decisions and foraging success of grey seals. In a captive environment, acoustic playbacks were made close to low- or high-density prey patches (fish delivered at a controlled rate). Seals foraged at high rates during silent control experiments. When the speaker was located close to the high-density prey patch, foraging success was similar to controls, while it was reduced by 16%-28% when the speaker was located at the low-density prey patch. These results are consistent with a risk/profit balancing approach, and they highlight the importance of the foraging context of the seals when predicting the consequences of anthropogenic activities.

Findlay *et al.* (2022) investigated the potential of acoustic deterrent devices (ADDs) to impact non-target seals at a population level. They combined GPS tracking data from seven harbour seals with modelled maps of ADD noise on the west coast of Scotland. They predicted temporary and permanent hearing loss in the seals using the location data and published noise exposure criteria. All tagged seals and waters around 51 of 56 protected sites were predicted to be exposed to ADD noise exceeding median ambient sound levels. Temporary hearing loss was predicted to occur in one of the seven tagged seals and in 1.7% of waters surrounding protected habitats over a 24-hour period. Although risk of hearing loss was low, the chronic exposure to noise may entail negative consequences for individual seals.

JNCC (Joint Nature Conservation Committee), along with other public bodies and departments of the UK, provide guidance for assessing the significance of noise disturbance in relation to the Conservation Objectives of harbour porpoise Special Areas of Conservation (SACs) in the UK. In the advice, a quantitative definition of significant noise disturbance is provided, in terms of area and/or period of time covered, considering it significant when it excludes porpoises from more than 20% of a relevant area of the SAC in a day or an average of 10% over a season. The document also provides guidance on a noise management approach in SACs to ensure that disturbance does not affect site integrity, with respect to the deterrence of the species from a significant portion of the site for a prescribed period of time. This is based on the assumption that large-area displacement over long periods of time can be detrimental to the Conservation Status of the species, through the loss of access to habitats, reduction of carrying capacity and finally the reduction of the long-term viability of the population. Advice on noise management is also provided, based on an approach that both reduces the accumulated noise at seasons with higher densities and incentivises the industry to employ alternatives to reduce the noise footprint. Also, the minimum effective deterrence ranges are proposed for the different activities. The advice will be periodically reviewed to remain effective and updated with the best evidence available.

The response of small cetaceans, i.e., harbour porpoises, to disturbance during offshore windfarm construction was investigated using arrays of hydrophone clusters in Scotland (Graham *et al.*, 2023). The use of these arrays allowed the detection of cetacean movements from the distribution of bearings to detections. During the periods taken as reference (baseline periods), detections of individuals were distributed in all directions and were weakly directional. By contrast, the results showed that when acoustic deterrent devices were used and piling soft starts applied, the harbour porpoises showed significant directional movement away from the sound source.

3.6.7 Spain

In the context of the MSFD assessment of underwater noise, several groups of experts are currently discussing new approaches and considerations in order to define threshold values from which to evaluate the GES. In relation to continuous low frequency noise, given the information provided by both (i) the assessment of sound pressure level (SPL), on a local or regional scale for the ⅓ octave band (63kHz y 125kHz), and (ii) the identification of long term trends, their study and evaluation were considered a priority to date. With the aim of providing an accurate assessment, Bou *et al.* (2022) presented a methodology to perform the assessment of a specific area, by providing a risk index linked to the potential occurrence of masking effect, caused by underwater noise produced by marine traffic. The risk index is defined as the reduction of the communication distance between individuals, expressed as percentages. The risk is articulated by calculating the area under the curve defined by the density of animals and a variable related to the sound pressure level. This methodology was applied to a real case study of a bottlenose dolphin population inhabiting the waters of the continental shelf of northern Spain.

3.6.8 Macaronesia (Canary Islands)

Globally, there has been a growth in commercial whale-watching activity, making the Canary Islands (Spain) the fourth most popular destination for this activity. However, there is a lack of regulation on noise levels from whale-watching vessels, which is not considered in the existing guidelines. Arranz *et al.* (2021) tested the behavioural response of resting mother-calf pairs of short-finned pilot whales (n=36) to whale-watching vessel approaches using a hybrid vessel, changing the use of the engines. The same approaches were conducted, between 2020 and 2021, in an area where ambient noise levels are low, at 60 m distance from the pilot whales, using only the quieter electric engine (136-140 dB) or only the petrol engine (151-139 dB). The experiments showed a significant decrease in the proportion of time nursing for the calf (81%) and in the proportion of time resting of the mother-calf pairs (29%) during petrol engine approaches, compared with the control treatment in contrast to the electric engine which had no influence. Thus, petrol engine approaches produce an increased energy consumption by mothers, given the lack of resting periods, and a reduction of the energy gained by calves due to reduced nursing. The changes observed in pilot whale behaviour may be caused by the differences in the lower frequency components of noise being at least 61 dB above ambient noise for the petrol engine, compared to the 50 dB of the electric engine. Therefore, they recommend a source level lower than 150 dB at close whale-watching distances (60 m) or even lower in quieter ambient noise conditions such as in the Canary Islands, to minimise the excess noise difference.

3.6.9 Greenland

Using custom-made heart rate-accelerometer-depth recorders, Williams *et al.* (2022) monitored the physiological responses of 13 adult narwhals in the presence and absence of seismic airgun pulses and vessels associated to seismic activities (source level = 241 dB re 1 μPa-m). The data from the recorders showed a marked increase in cardiovascular, respiratory and locomotor reactions when animals were exposed to seismic pulses compared with the control. Other behavioural responses were also recorded in exposed narwhals such as a reduction of gliding duration during dive descents, prolongation of high intensity activity (i.e., elevated stroke frequency (>40 strokes/minute)) and intense bradycardia, but decoupled from stroking frequency. Thus, the energetic cost of diving for arctic narwhals exposed to seismic noise doubled (2.0-2.2). This unusual fear reaction (heart rate suppression despite the high rates of exercise) could be used as a new metric to determine the fear reaction level of marine mammals exposed to different environmental stressors.

3.6.10 Canada

Sweeney *et al.* (2022) demonstrate how different marine mammals may perceive shipping noise differently. Noise levels were recorded along a shipping route in an inlet of Northern Baffin Island, Canada. Broadband SPLs (10 Hz–25 kHz), unweighted and with auditory weighing functions, were compared between times that ore carriers (travelling < 9 knots) were present or absent. Three groups of marine mammals were defined to apply different weighting functions to noise recordings to simulate the hearing sensitivity of different species: high-frequency cetacean, low-frequency cetacean, and phocid carnivores in water. High-frequency cetaceans were unlikely to perceive shipping noise unless ships were in close proximity (<3 km) and ambient noise levels were low. While low-frequency cetaceans were likely to experience similar SPLs to unweighted levels. Pinnipeds would likely perceive shipping noise at only slightly lower levels compared to the low-frequency cetaceans, although ambient noise levels could play a more important role in masking their perception.

3.6.11 USA

The effect of noise on the communication between two bottlenose dolphins that need to coordinate to perform a cooperative task was investigated in a controlled environment in Florida by Sørensen *et al.* (2023). The dolphins were exposed to increasing levels of anthropogenic noise and the whistles were recorded using DTAG-3 attached to each of them. The recordings of the DTAGs showed acoustic compensatory mechanisms (double whistle duration and increased whistle amplitude) in response to increasing noise. But, apparently, these compensatory mechanisms were not sufficient, as a 22% decrease in the successful performance of cooperative tasks was observed, demonstrating noise communication impairment in bottlenose dolphins.

3.7 Shipping

3.7.1 North East Atlantic

Robbins *et al.* (2022) compared vessel traffic in the North East Atlantic in 2013, 2015 and 2017 using AIS. Previous studies (Tournadre, 2014) had shown a four-fold increase in commercial vessel movements between 1992 and 2012. The current study shows traffic densities increased by 34%, including an increase of 73% in Marine Protected Areas. Western Scotland and the Bay of Biscay experienced the largest increases in vessel density, predominantly from small and slow vessels.

3.7.2 United Kingdom

Koroza & Evans (2022) studied the behavioural responses of bottlenose dolphins to boat traffic of various types in New Quay Bay (West Wales, within the Cardigan Bay Special Area of Conservation). Land-watch data collected during April to October from 2010 to 2018 were used for this analysis. During these watches, the ID of boats, behaviour of the dolphins and environmental conditions were recorded. GLMs were fitted to the dataset, obtaining results which suggest a negative response of the dolphins towards vessels that broke the code of conduct (specially speed boats, small motorboats and kayaks), while positive reactions were observed towards boats complying with the code of conduct (visitor passenger boats).

3.7.3 Iberian Peninsula

Esteban *et al.* (2022) studied the interactions between killer whales and vessels that have occurred since 2020. They compiled a list of all the interactions that occurred, investigated damage suffered and the characteristics of the boats involved in the interactions, as well as identified the individuals and their behaviour during those events, and listed mitigation measures. Interactions were analysed with photos, videos, testimonies, and boat examinations. Apparently, sailing boats were the most targeted type of boats, and spade rudders were the most targeted rudders by the killer whales. Vessels affected had a mean size of 12 meters (range 5-21 m) and interactions showed an average duration of < 0.5 hours, with a maximum of 2 hours.

3.7.4 North American Arctic

The potential risk of vessel strike for two different arctic bowhead whale populations was examined by Halliday *et al.* (2022). This vessel strike risk was estimated from the overlap of vessel traffic densities and whale relative density in the study area. Bowhead whale density estimates were obtained from satellite and aerial surveys: a total of 226 individuals were tagged between 2001 and 2018, and aerial surveys were performed between July and October between 2000 and 2019. For the vessel density and speed estimates, AIS data provided by exactEarth (Cambridge, Ontario, Canada) was processed. Apart from identifying probable vessel strike risk areas for both populations, it was observed that this risk is higher in the months of August and September.

3.8 Disturbance (Tourism)

3.8.1 Norway

Palomino-González *et al.*, (2021) assessed the impact of drones on marine mammals in Svalbard, Norway. They studied the drones' sound levels and marine mammal behaviour prior to and after flights. Harbour seals were more sensitive during pre-breeding than during moulting, reacting at distances of 80 m, whereas walruses responded at distances <50 m. Polar bears reacted to the sound of drones during take-off at 300 m, although response levels were relatively low. Belugas reacted to the sight of drones when flown ahead of the pod, below 15 m. The variations in sound levels generated by manoeuvres increased disturbance potential more than drone size, and therefore the authors recommend pre-programmed flight paths. Results also showed that tidal state and swell, the presence of young individuals, ambient noise levels, and approach strategies can influence marine mammal sensitivity to drones.

3.8.2 The Netherlands

Grey and harbour seals were tracked during the construction of a wind farm in the southern Netherlands, bordering the wind farms in Belgium. Piling noise was mitigated using bubble curtains. Generally, seals avoided the area (a number vacating the area completely) and only 3 seals were observed within 15 km of any piling event. Brasseur *et al.* (2022) used habitat models to determine potential avoidance of the wind farm. Even with the bubble curtain mitigation, the study shows a significant avoidance of the wind farm area by the harbour seals up to 10 km. However, most tracked seals had completely left the area and as a consequence, it was not possible to define a clear distance at which seals demonstrate a change in diving behaviour. Nevertheless, the remaining animals were seen to significantly change their diving behaviour at distances beyond 30 km. The study also demonstrates changes in haul-out distribution and reported strandings in the construction period.

3.8.3 Ireland

The effects of anthropogenic disturbance due to ecotourism activities on a grey seal colony were assessed during breeding and pupping seasons in Southwest Ireland (Pérez Tadeo *et al.*, 2021). Ethograms were recorded for grey seals on their haul-out from direct observation, and disturbance was recorded when the ferries approached the colony. Results showed that the grey seal colony was affected by ecotourism activities: a reduction in the abundance of seals hauled out, an increase in the proportion of seals vigilant and rapidly entering the water, as well as a reduction in the proportion of resting individuals, were recorded. The strongest influence was observed when vessels approached within 500 m of the seals. The authors conclude there is a need for a strict code of conduct for tourists and boats.

Drones, or unmanned aerial vehicles (UAVs), are increasingly used for recreational activities but also for scientific monitoring of wildlife populations. Pérez Tadeo *et al.* (2023) assessed the behavioural responses of harbour seals before, during and after UAV approaches. Results showed a significant increase in the proportion of seals vigilant, and a decrease in resting behaviour. Stronger reactions were observed at lower flying altitudes between 10 m and 20 m. Sound levels at different flying altitudes were also recorded to provide reference levels for future studies. The authors provide best practice advice for future research on harbour seals using drones.

3.8.4 Iceland

Tourism has increased tremendously in Iceland during the last decades, and whale and seal watching are popular activities. This activity can cause disturbance that can affect the behaviour and distribution patterns of the animals. Therefore, research is being conducted to estimate impacts of land-based and boat-based tourism on pinnipeds and cetaceans in Iceland. Laute *et al.* (2022) investigated impacts of whale-watching vessels on humpback whale calling behaviour on an Icelandic foraging ground (Skjálfandi Bay). Acoustic recordings, visual observations, and Automatic Identification System data were used to measure humpback whale (*Megaptera novaeangliae*) calling behaviour. Pre-pandemic summer months (2018) were compared with pandemic (2020) conditions, when the whale watching activities were reduced by 69%, to quantify reductions in vessel activity and determine changes in calling behaviour. Humpback whales reduce their calling effort in the presence of vessel sound independent of the overall ambient sound. Several additional publications on the effects of tourism on marine mammals in Iceland are underway.

3.8.5 USA

Recovery of marine mammal populations and growing human populations in coastal areas has led to increased human harassment of protected pinniped populations. Newcomb *et al.* (2022) demonstrate that in 14.7% of the 3 525 stranded pinnipeds, there is evidence of one marine mammal–human interaction with the majority (75.3%) of these cases involving harassment. Other potential interactions included vessel trauma, entanglement, hooking, gunshot, mutilation or ingestion of debris or fishing gear.

3.9 Climate Change

3.9.1 General

Orgeret *et al.* (2022) conducted a review on the effects of climate change and climate vulnerability on seabirds and marine mammals. They found that the likelihood of concluding that climate change had an impact increased with study duration. However, the temporal thresholds for the effects of climate change to be discernible varied from 10 to 29 years depending on the species, the biological response, and the oceanic study region. Species with narrow thermal ranges and relatively long generation times were more often reported to be affected by climate change. They also found that tropical regions and non-breeding life stages were poorly covered in the literature, a concern that should be addressed to enable a better understanding of the vulnerability of marine predators to climate change.

The Northeast Atlantic is a highly productive maritime area showing a high diversity of species and habitats, but it is exposed to a wide range of direct human pressures, such as fishing, shipping, coastal development, pollution, and non-indigenous species (NIS) introductions and anthropogenically-driven global climate change. Following the 2017 OSPAR assessment of marine biodiversity for the Northeast Atlantic, McQuatters-Gollop *et al.* (2022) applied a semi-quantitative approach to evaluate holistically the state of Northeast Atlantic marine biodiversity across marine food webs, from plankton to top predators. Their analysis revealed widespread degradation in marine ecosystems and biodiversity, particularly for marine birds and coastal bottlenose dolphins, as well as for benthic habitats and fish in some regions, likely the result of cumulative effects of human activities, such as habitat destruction or disturbance, overexploitation, eutrophication, the introduction of NIS, and climate change. However, bright spots were also revealed, such as recent signs of recovery in some fish and marine bird communities, recovery in harbour and grey seal populations, and the condition of coastal benthic communities in some regions. The status of many indicators across all ecosystem components remains uncertain due to gaps in data, unclear pressure-state relationships, and the non-linear influence of some pressures on biodiversity indicators.

Blanchet *et al.* (2021) carried out a review of harbour seals (*Phoca vitulina*) throughout its wide range of distribution, from temperate to Arctic regions. The aim of the study was to provide information on the population structure, status, and threats in a rapidly changing environment. Changes in water and air temperature directly influence harbour seal thermoregulation; in cold environments, they must mitigate heat loss at sea (high energy cost) while in warm environments they are subject to hyperthermia (i.e., overheating). In arctic and sub-arctic regions, the habitat of harbour seals is associated with thin sea ice. Since ice-covered areas have decreased in recent years due to ocean warming, an increase in available habitat may result in a northward range expansion. In the Barents Sea, changes in the community structure have been observed due to increase in water temperature. As a result, harbour seal foraging patterns and diet composition has been affected.

3.9.2 Arctic

Carlyle *et al.* (2022) conducted stable isotope analysis (δ13C and δ15N) and measured highly branched isoprenoid diatom lipid biomarkers of ringed seals from the low, intermediate, and high Arctic (from 61.1°N to 77.5°N). Both δ13C and highly branched isoprenoids indicated that ringed seals from higher latitudes had more sympagic (ice-associated) carbon in their diet than those at lower latitudes. Ringed seal trophic position increased from the low (3.78 ± 0.02) to high (4.76 ± 0.03) Arctic, suggesting increased fish consumption or a different trophic structure coinciding with the latitudinal change in carbon source (phytoplanktonic vs sympagic primary production). Such information on ringed seal prey and energy shifts over large spatial scales provides insights into potential future changes to Arctic ecosystem function with continued sea-ice decline.

Chambault *et al.* (2022) used 28 years of satellite tracking data, together with environmental data, to predict possible movement patterns of bowhead whale, beluga, and narwhal under different climate change scenarios. For those three whale species, projected habitats suggested northward shifts in distribution due to loss of current summer habitats. However, simulations also raise some concerns about the ability of these polar species to cope with the disappearance of their traditional colder habitats.

3.9.3 Barents Sea

Environmental changes (e.g., warming, ocean circulation, nutrient supply) can affect the entire food web structure through bottom-up cascades. De la Vega *et al.* (2022) combined specific stable nitrogen isotopes (δ15N) biomarkers on harp seal teeth with ocean-biogeochemical modelling to detect the impact of environmental change on the marine ecosystem from 1951 to 2012. δ15N values in harp seal teeth showed a significant negative trend. This result, together with the decreasing in the nitrogen assimilated into phytoplankton organic matter (δ15NPOM), suggests that isotopic signature was mainly driven by environmental changes.

3.9.4 Baltic Sea

Van Beest *et al.* (2022) used the maximum entropy (MaxEnt) algorithm to estimate how environmental and climate change can alter the habitat suitability of three marine predators (Baltic grey seals, harbour seals and harbour porpoises in the southwestern region of the Baltic Sea. Model output suggested a marked redistribution of area use by these marine predators in the region, driven by changes in sea surface salinity and sea-level rise. In the future, habitat suitability for Baltic grey seals and harbour seals was predicted to decrease over space and time, while it would slightly increase for harbour porpoises.

Sundqvist *et al.* (2012) investigated the impact of a warming climate on the Baltic ringed seals population. They simulated how winter temperatures would affect the availability of breeding ice during the next 90 years. Results suggested that the climate trend will negatively affect pup survival due to reduced ice cover and, therefore, growth rates of the population will be severely hampered.

3.9.5 Greenland

Climate-driven changes are affecting sea ice conditions off Tasiilaq, Southeast Greenland, with implications for marine mammal distributions. To better understand marine mammal presence, biodiversity, and community composition, especially during winter months, seasonal patterns of acoustic marine mammal presence relative to sea ice concentration were investigated by Mattmüller *et al.* (2022). This was done at two recording sites between 2014 and 2018, with one (65.6°N, 37.4°W) or three years (65.5°N, 38.0°W) of passive acoustic recordings. Seven marine mammal species were recorded. Ambient noise levels in 1/3-octave level bands, ranged between 75.6 to 105 dB re 1 μPa.

3.9.6 Iceland

A study by Malinauskaite *et al.* (2022) conducted on behalf of the ARCPATH project investigated the effects of climate change on arctic social-ecological systems using whales as model species. Three categories of impacts on whales due to climate change were identified: changes in distributions and migration, prey availability, and sea-ice and ocean temperature. A relationship between sea-surface temperature and cetacean sightings for minke whales, blue whales and white-beaked-dolphins was found, these species having changed their feeding areas. The paper concludes that further increases in temperature are likely to further affect whale distributions. The reliance of the local tourism sector on whale watching makes Húsavík vulnerable to the effects of climate change on whales.

3.9.7 Canada

The total pup production of Northwest Atlantic harp seals was estimated in 2017 by photographic and visual aerial surveys off Newfoundland, Labrador and the Gulf of St. Lawrence. In the Southern Gulf, the timing of births was much later than normal, while it was unusually early at the Front (Newfoundland and Labrador). The authors suggest that some females from the Gulf population may have moved to the Front for pupping due to a lack of ice in the Gulf. Unusual ice conditions, distribution of breeding seals and timing of pupping highlight the ongoing difficulties in assessing a population that is being impacted by climate change.

Warming ocean temperature may influence the abundance and distribution of low trophic levels (e.g., zooplankton) in space and time, and therefore, alter the habitat use of predator species (Meyer-Gutbrod *et al.,* 2021; O'Brien *et al.,* 2022). Meyer-Gutbrod *et al.* (2022) analysed North Atlantic right whale sightings in the Gulf of Maine and surrounding waters, from 1990 to 2018, to examine their patterns in habitat use. Results indicated that the occurrence of calanoid copepods was correlated with the foraging habitat selection of endangered North Atlantic right whales. However, right whale distribution is driven by complex spatial and temporal patterns in environmental cues and prey abundance.

3.10 New Pathogens

3.10.1 Arctic

Nymo *et al.* (2022) analysed serum samples from live captured Svalbard white whale (*Delphinapterus leucas*) (2001-2016) for influenza A virus antibodies (Abs) (n=27) and RNA (n=25); morbillivirus (MV) Abs (n=3) and RNA (n=25); *Brucella* spp. Abs; and *Toxoplasma gondii* Abs (n=27). Influenza A virus Abs were found in a single adult male that was captured in Van Mijenfjorden in 2001, although no RNA was detected. *Brucella* spp. Abs were found in 59% of the sample group (16/27). All MV and *T. gondii* results were negative.

3.10.2 Denmark

Stokholm *et al.,* (2022) analysed tissues (lung, spleen and reproductive organs) of 77 harbour porpoises and 277 seals (including harbour seals, grey seals and ringed seals) from the Baltic and North Sea region looking for pestiviruses. A juvenile harbour porpoise stranded in Denmark during winter of 2011 tested positive, being the first documented case of *Phocoena pestivirus* (PhoPeV) in the Baltic Sea. This extends the range of PhoPeV from the North Sea population to the Danish Belt Sea population. No positive cases of PhoPeV were found in the seals analysed.

In a recent study, Stokholm *et al.* (2023) investigated the presence of influenza A virus (IAV), phocine distemper virus (PDV) and cetacean morbillivirus (CeMV) in tracheal swabs and lung tissue samples from 298 seals (including harbour seals, grey seals, and ringed seals) and 78 harbour porpoises from the Baltic Sea and North Sea, stranded between 2002–2019. They detected one case of PDV and two cases of IAV in seals linked to the documented viral outbreaks in seals in 2002 and 2014, respectively. All grey seals, ringed seals, and harbour porpoises tested negative for IAV, CeMV and PDV. Reports of isolated cases of PDV in North Sea harbour seals and IAV (H5N8) in Baltic and North Sea grey seals suggest introductions of those pathogens within the sampling period. Thus, they recommend continuous sample collection of swabs, tissue, and blood samples across Baltic Sea countries.

3.10.3 Germany

High loads of the highly pathogenic avian influenza virus H5N8 were found in brain tissue from three harbour seals stranded on the German North Sea coast in 2021 (Postel *et al.,* 2022). The authors propose that replication of such viruses in seals may allow avian influenza viruses to adapt to mammalian hosts. Shin *et al.,* (2022) found that primary tracheal cell culture from a grey seal was readily infected by H5N8 2016 virus from a seal, while the more commonly used primary seal kidney cells required presence of exogenous trypsin to initiate infection. When applied to an ex vivo lung slice model, compared with recombinant human H3N2 virus or H9N2 LPAI virus, the H5N8/Seal-2016 virus replicated to a high titre and caused a strong detrimental effect; with these characteristics, the virus was superior to a human H3N2 virus and to an H9N2

LPAI virus. The results indicate that the airway epithelium of carnivores may be the main target of H5N8 viruses.

3.10.4 Sweden

Avian flu was detected in a grey seal stranded in the southern Baltic Sea in 2021 (Swedish National Veterinary Institute, 2022). Avian flu was detected also in a harbour porpoise stranded on the Swedish Skagerrak coast in 2022, the first confirmed case of avian flu in the species[4].

Harbour porpoises and both harbour and grey seals from Swedish waters are scanned for presence of avian flu antibodies by the Swedish National Veterinary Institute.

[4] https://phys.org/news/2022-08-world-case-bird-flu-porpoise.html

https://www.sva.se/aktuellt/pressmeddelanden/forsta-fallet-av-fagelinfluensa-bekraftad-hos-tumlare/

4 ToR D: Bycatch

In collaboration with WGBYC, contribute to the Roadmap for ICES PETS bycatch advice by i) reviewing selected aspects of marine mammal-fishery interactions and assembling data and qualitative information on marine mammals available from other sources not fully covered by WGBYC (incl. strandings, entanglement, interviews, research projects, national/local monitoring), ii) reviewing available information on those marine mammal species and/or regional populations for which bycatch estimates from at-sea monitoring are lacking or poorly known, iii) identifying gaps in our knowledge and provide guidance on prioritization of marine mammal species of bycatch concern

WGMME in collaboration with WGBYC contributes to the Roadmap for ICES PETS bycatch advice by reviewing selected aspects of marine mammal-fishery interactions from sources (e.g. strandings, entanglement, interviews, research projects, national/local monitoring) not fully covered by WGBYC. It was agreed that for the 2023 meeting, WGMME would focus on knowledge gaps and minimum data needs from strandings, as well as reviewing available information on those marine mammal species and/or regional populations for which bycatch estimates from at-sea monitoring were lacking or poorly known, identifying gaps in our knowledge and making recommendations on which marine mammal species of bycatch concern should be prioritized.

In addition, during the meeting, it was agreed that coordination and communication between WGBYC and WGMME needs to be improved to ensure complementing without duplicating effort in the advice that these groups provide.

4.1 Stranding and by-catch data

Stranded marine mammals are an important source of information providing information on location and cause of death, including bycatch. However, carcasses also allow us to extend the current knowledge on the biology and ecology of the species or populations in the area including life history, population status, anthropogenic interactions and feeding ecology. Often, stranding data is therefor a primary source of information, especially for rare or elusive species (Peltier *et al.,* 2012; Ortiz-Alvarez *et al.,* 2022). Information on some species and areas are well recorded (i.e. larger cetaceans and accessible areas) while especially information on pinnipeds is absent in many areas.

Strandings data can provide information on various topics: identifying cause of death, which might be relevant to assess threats (e.g. by-catch, health status and disease), life history information, and diet. In the following sections, the minimum data needs depending on resources (e.g. personnel, time and financial) and the different methods to derive the various sources of information from strandings are briefly described. However, information from stranded or by-caught animals might not represent an unbiased sample of the population in terms of health status and age-composition. For instance, stranding data might be affected by the mortality of a higher proportion of individuals that are in poor health or that are inexperienced/old (Pierce *et al.*, 2004) while dietary information from by-caught individuals may be biased toward inexperienced animals and the target species of the fishery.

4.1.1 Diet

To understand the role that marine mammals play in the marine environment, it is essential to describe and characterize their diet (Pierce and Boyle, 1991; Trites *et al.*, 1997; Ford *et al.*, 1998; Estes, 2016). Diet data are necessary not only to determine trophic relationships, prey consumption and feeding strategies (Holt, 1977; Holt and Polis, 1997; Link, 2002; Skern-Mauritzen *et al.*, 2022) but also to assess the potential competition for resources with fisheries (Beverton, 1985; Vingada *et al.*, 2011). For both stranded, bycaught, and in some cases live animals, there are several methods to investigate diet (Table 4-1). These methods differ in cost, temporal scale, impact and the extent to which quantitative measurements can be made (e.g. amounts of prey eaten and relative importance among various food sources). They are briefly described here; for a more detailed description, see Tollit *et al.*, (2010), Bowen and Iverson (2013) and Nielsen *et al.* (2018).

Table 4-1 Methods for marine mammal diet estimation and impact when collected from a live animal.

Method	Diet history	Relative cost	Prey id	Impact on animal
Scat analysis	Days	Low	Yes	Low (disturbance)
Stomach contents	Days	Low	Yes	High (regurgitates)
DNA	Days	Moderate	Yes	High (regurgitates)
Fatty Acids	Days-months	Moderate	Potentially	Moderate (biopsy)
Stable Isotopes	Days - years	Low	Potentially	Moderate (biopsy, whisker)
Tracking	Days - years	High	Spatial overlap	Moderate (tag attachment)

All methods including identifying hard prey remains, DNA metabarcoding, stable isotopes, or fatty acid analysis require a reference collection or database that holds the chemical signature or sequenced DNA of prey species or prey groups. Moreover, every sample and method used is potentially biased. For example, the stomach contents of dead animals might cause a bias in diet estimation towards diseased animals or in case of bycaught animals be related to the fishing. Also, species occurrence (and size) could be over or underestimated depending on the relative size/ resilience of a hard remain, the amount of DNA produced or the likeliness of decay or digestion of fatty acids.

Scat analysis is most widely used for pinnipeds as scats can be collected from the animals' haul-out sites. And although potentially biased towards the more coastal feeding, there are no biases concerning the health of the predator. Stomach contents analysis relies mainly on stranded and bycaught individuals and is the most used method for estimating cetacean diets. Both these methods provide information on diet composition from recovery of hard prey remains from scats/stomachs by identifying hard prey remains. Also, molecular techniques tracing the prey's DNA in the stomachs have been applied (for example Flanders *et al.*, 2020). Recognisable prey remains include mostly fish otoliths, cephalopod beaks, but also other fish bones (Watt *et al.*, 1997). To estimate the original size and weight of the prey ingested based on the size of the prey remains, correction factors for 1) partial digestion using species- and grade-specific correction factors and 2) complete digestion using recovery rates should be applied to minimize bias in estimates of diet composition and prey consumption. Such factors have been estimated for grey seal (Grellier and Hammond, 2006) and harbour seals (Wilson *et al.*, 2017) in captivity. Such experimental set ups will be more feasible for smaller marine mammal species such as seals but will be challenging for cetaceans especially for large whales.

A number of important considerations regarding the use of stomach and scat analysis for robust diet estimates were described in the WGMME report of 2021. Diet from hard prey remains either from scat or strandings data will be associated with the location at which foraging occurred and local prey abundance. Therefore, to determine a zone of plausible locations where an animal may have foraged prior to stranding, telemetry data (Ransijn *et al.*, 2021) and/or drift models are needed (Peltier *et al.*, 2013). DNA metabarcoding could be used alongside scat analysis to identify prey with no digestion-resistant hard parts or are more problematic to quantify (e.g. salmon (Tollit *et al.*, 2009)) or to identify the species or sex of the predator (Wilson and Hammond, 2016). However, there could be potential biases related to the ability of prey DNA to survive digestion and the "freshness" of the sample. Studies are still needed to better understand if and how the amount of DNA could translate into prey quantity.

Other methods such as stable isotopes or fatty acid analysis can also provide information on diet. These methods might also enhance traditional diet estimates as isotopes and fatty acids deposited in the predator's organs allow for the collection of information spanning longer time periods (Table 4-1). Depending on the organ sampled diet inference from stable isotope or quantitative fatty acid signature analysis (QFASA) represents diet integrated over weeks (i.e. blood), months (blubber, muscle), or even years (baleen, bone and teeth) and are useful for picking up, in general, signals such as changes in trends, phenology and trophic level. These methods may alleviate some of the issues of bias that are associated with inferences from stomach content/scat data. QFASA provides dietary information on relative importance of prey species on a potentially large spatial scale (Iverson *et al.*,2004). Stable isotope analysis provides information on the predators' trophic level and/or the origin of prey resources.

As described in the WGMME reports of 2020-2022, there is a need for marine mammal diet estimates for both North Sea prey guild models and various ecosystem models. In many cases data are limited and spread in time and space. A brief methodology to overcome data sparsity and identified available data was described in the WGMME report of 2022. Currently, these methods in conjunction with estimates from multi-species functional response models for grey seal, harbour seal, and harbour porpoise have been used to hindcast these predator diets to for instance the base year (i.e. 1991) of the Ecopath with Ecosim (EwE) North Sea model. The incorporation of marine mammals into such models is crucial to better understand the impacts of anthropogenic and environmental change and bottom-up and top-down control. However, diet information (including temporal and spatial variation) is not readily available for all species and within the North Sea, most published records are primarily for grey seal, harbour seal, harbour porpoise and minke whale. A meta database that identifies the holders of various diet data and ideally the data itself would be beneficial. Furthermore, it could be linked to associated other data (e.g. if samples are from stranded or by-caught individuals, it could hold demographic information and cause of death).

4.1.2 Causes of death and population health status

Strandings provide key information to determine the cause of death of marine mammals. Both external and internal examination of stranded marine mammals, together with a wide range of pathological analysis available, allow one to diagnose cause of death and to assess the effects of the identified threats at individual and population levels. However, stranding monitoring programmes ensuring deep analysis and a constant coverage over time, space and species, is often challenging due to the nature of stranding events and the common limitations of economic, human and training resources of the networks. These constraints lead to inconsistencies in the data collected resulting in a lack of knowledge of the cause of death affecting certain taxa or species (e.g. fewer carcasses of seals are collected for necropsy compared to small cetaceans in many areas), especially in some areas (e.g. where there is a lack of resources to attend strandings or qualified personnel to perform necropsies), preventing the identification of some threats (e.g. detection of emergent diseases, such as avian flu in seals, relies on the collected and analysed samples from stranded individuals).

To address these knowledge gaps, some recommendations for future efforts are here described based on the information provided by stranding networks operating in the ICES region from the questionnaires developed under the auspices of this WGMME (ICES, 2021c, 2022a). There is a primary necessity for ensuring constant and sufficient funding to enable networks to build their teams and provide materials, that directly or indirectly will help to develop their activities (coordinating reports, attending strandings, collecting samples, performing necropsies, sharing results, collaborating with other institutions and sectors). Efforts to homogenize the criteria for diagnosing causes of death are essential to optimise the interpretation of the information gathered from stranded animals. It is also necessary to standardise necropsy protocols, which, while ultimately pursuing the "gold standard" ideal, can be adapted to the financial and personnel capacities of each network, and to establish what priority data should be collected from strandings that cannot be necropsied (e.g. Table 5.7. in ICES (2022a), which shows the applicability of data collected from strandings accordingly to different levels of network capacities).

To effectively apply the information collected from strandings for management and conservation purposes, it would be desirable for the organisations in charge of data collection to be fully aware of the type of data needed by management agencies to achieve their objectives, and vice versa. Similarly, marine users and the scientific community need to exchange information to better understand the status of marine resources and build the most realistic scenarios. Each piece of the puzzle needs to be connected, i.e. it would be advisable to strengthen the communication flow between the multidisciplinary teams of the stranding networks, management agencies, sea users and the scientific community, for a better understanding of the needs of each sector and efficient applicability of their efforts (for example, thanks to the questionnaires developed last year by this WGMME, it is known that all responding stranding networks agreed that a unified data call for stranding data would be convenient for them, as it can be for management agencies and the scientific community).

4.2 Stranding minimum data needs

In 2021, a workshop was organised by ASCOBANS to further develop a stranding and necropsy database. Many of the aspects relating to this database including data requirements are described in the WGMME report of 2022. This year, it was decided that WGMME would update the table regarding minimum data requirements given various scenarios (i.e. personal, financial and time constraints). In Table 4-2 a prioritization of samples taken in these different scenarios and the limitations and usage of data gathered are summarised.

Table 4-2. Prioritisation of samples taken from stranded individuals given financial and time cost.

Scenario	Usage	Source	State of animal	Sample	Extra information	Time cost	Financial cost	Personnel	Prioritisation	Limitation
1	Species, location, date, decomposition status, length est., condition, sex, (individual ID, cause of death)	Photographs and location	Dead or alive (including rescue) decomposition state not relevant	Pictures of whole body (with size reference)	Photo-ID (e.g. cetaceans: dorsal fin, tail flukes; pinnipeds: pelage patterns of head, neck shoulders, and body), marks or tags	Low	Low	Trained volunteers/ public	High	Administration (database and computer storage)
+2	General health, precise length, scan for disease	External inspection	Dead or alive (including rescue) decomposition state not relevant	Body measurements (e.g. length, weight, girth), swaps, blubber biopsies		Low	Low	Trained personnel	High	Administration, finance for analysis
+3	Diet quantitative & qualitative, age, DNA, (micro) plastics, contaminants, disease	Internal inspection (minimal) & samples	Dead; decomposition state not relevant	Opportunistic collection of samples (e.g stomach contents, teeth, bone, whiskers, tissue)		Low-medium	Medium	Trained personnel	Medium	Administration, finance and time for analysis is high, Autolysis
+4	Cause of death	Necropsy	Dead (fresh-medium)			High	Medium	Veterinary pathologist	Medium	Transport, trained veterinary pathologist
+5	Antibodies, contaminants, bone density, isotopes, contaminants, histology, gene expression, age determination, hormones, reproduction	Extensive sampling		Internal organs, blood, sample collections (parasites)		High	Medium-high (depending on storage)	Veterinary pathologist	Low	Transport, trained veterinary pathologist, storage capacity, sample bank, facilities/equipment, long term storage in freezers

4.3 Future directions for stranding reporting

To obtain appropriate spatio-temporal coverage of strandings and by-caught animals, harmonising efforts to centralise data are required. A common database for strandings data, with an agreed data structure shared among different regional organisations, will have several advantages:

- Stranding networks that submit data will reply to one data call only;
- A data standard will be developed and adopted between organisations, which will enhance cooperation;
- Development of best-practices for the collection and use of information from marine mammal strandings will be achieved;
- There would be a centralised hub that warrants quality-assurance and data storage;
- It would facilitate public access to selected information on stranding data.

To develop a common data standard is no trivial task and it needs consultation and buy-in from data providers and end users, as is being attempted in the work done towards WGJCDP.

A technical workshop on a common (cetacean) stranding database, funded through ASCOBANS, took place in April 2023 at the European Cetacean Society annual conference. The workshop focussed on scoping the need and feasibility of developing a common stranding database and data format in Europe. The workshop aimed to create a design brief for the development, maintenance and functionality of an online international strandings portal.

4.4 Bycatch estimates in the Baltic, North Atlantic (excluding the arctic), Mediterranean and Black Seas

Bycatch estimates, albeit often based upon limited monitoring effort, have been derived by WGBYC for harbour porpoise in the North and Celtic Seas and common dolphin in the Bay of Biscay and Celtic Sea from observation schemes aboard fishing vessels (ICES WGBYC, 2022). However, bycatch rates for many species and regional populations cannot be calculated either because they are present in too low numbers or because the fisheries that are thought to pose a bycatch risk to them are monitored inadequately or not at all. WGMME was asked to identify in the Baltic, North Atlantic (excluding the arctic), Mediterranean and Black Seas those gaps and make recommendations for actions needed to address these. Table 4-3 reviews the main species and populations of cetaceans and pinnipeds identified, the associated gear types of bycatch risk, and the areas where potential conflict are thought to occur. The most recent conservation status (for the period 2013-18) by country applied through Article 17 of the Habitats Directive by EU member states is also given. The focus is upon the ICES area equivalent to FAO Area 27.

4.5 Cetaceans

Onboard bycatch observation monitoring has produced data for the most part for just two species of cetaceans – harbour porpoise and common dolphin, and primarily for the Greater North Sea (ICES subareas 4a, 4b, 4c), West Scotland and the Celtic Seas (ICES subareas 6a, 6b, 7a, 7b, 7c, 7f, 7g, 7j), and the Bay of Biscay (8a, 8b, 8c). These have been regularly analysed, from which bycatch rates have been derived (see, for example, ICES 2022). The historical significant mortality of harbour porpoise, bottlenose dolphin and common dolphin in the Black Sea has also been documented, and more recently, bycatch of harbour porpoise in particular, in the bottom set gillnet fishery for turbot, has been highlighted (Carpentieri *et al.*, 2021).

4.5.1 Iberian harbour porpoise

Iberian harbour porpoises constitute a small population of less than 3 000 animals, distributed along the Atlantic coasts of Spain and Portugal (Hammond *et al.*, 2021). The conservation status of the population is reported as "Unfavourable-Inadequate" by both Spain and Portugal under Article 17 of the Habitats Directive (see Table 4-3), "in danger of extinction" in the Spanish Catalogue of Threatened Species, and as "Vulnerable" in the Red Book of Portuguese Vertebrates. A separate IUCN assessment for the population is currently lacking.

The main threat facing Iberian porpoises is fishery bycatch, with animals being caught in trawl nets, gillnets, bottom-set gillnets, trammel nets, purse-seines, beach seines, and longline fisheries (Sequeira and Ferreira 1994; Lens 1997; Lens & Díaz 2009; Vingada *et al.*, 2011; Goetz *et al.*, 2014, ICES 2013, 2014; Pereira 2015; Read 2016; Vingada & Eira 2018; Martínez-Cedeira *et al.*, 2021). Mortality rates seem to be unsustainable (Read *et al.*, 2020; Pierce *et al.*, 2022), and genetic time series suggest a rapid population decline over the last 30 years (Ben Chehida *et al.*, 2021).

The quantity and/or quality of information available on the population has so far been a limiting factor to take efficient conservation measures (e.g., the population was not considered by WKMOMA due to a lack of data available (ICES 2021b)). Priority actions include the implementation of bycatch mitigation measures, as well as improving our knowledge on population abundance, demographic parameters, and bycatch estimates for this population. Although monitoring of all fleets is necessary, there is a particular knowledge gap regarding small vessels (12 metres or less) and beach seine activities.

4.5.2 Baltic Proper harbour porpoise

With only a few hundred harbour porpoises left in the Baltic Proper (Amundin *et al.*, 2022), this population is listed as critically endangered by both IUCN and HELCOM, and the conservation status is reported as unfavourable-bad by most range states (see Table 4-3).

Bycatch in static nets is the most immediate threat to the survival of the population, and despite the first measures being implemented during 2022 (closures of static net fisheries and/or mandatory use of pingers in Natura 2000 sites designated for the species as well as some other areas), bycatch mitigation is still lacking in most of the population's range.

To minimise bycatch as far as possible, according to ICES scientific advice (ICES 2020b, 2020c), pingers should be mandatory on static nets in the rest of the population range. If, for any reason, pingers cannot be used, other effective bycatch mitigation measures such as further closures need to be applied urgently.

4.5.3 Coastal Bottlenose Dolphin

Populations of bottlenose dolphins (often of relatively small population size and showing site-fidelity) inhabit several coastal areas around Atlantic Europe and the Mediterranean Sea (ICES 2016b). Bycatch mortality has been recorded in several areas, although mainly in southern and south-western Europe. These seem to have involved mainly static gear (GNS, GTR, GTN, GND see http://vocab.ices.dk/?ref=1498) but have also included a wide range of other gears (PS, SB, OTM, OTB, PTM, PTB, TBB, LL, LLD, LX see http://vocab.ices.dk/?ref=1498) (Fortuna *et al.*, 2010;

ICES 2011, 2012, 2013, 2014, 2015, 2017, 2019, 2020a; Chavez-Rosales *et al.,* 2017; ACCOBAMS 2019), particularly in the Mediterranean. Some bycatch around the Iberian Peninsula and in the Mediterranean Sea appears to be associated with depredation attempts by bottlenose dolphins (Di Natale & Mangano 1981, 1982; Bearzi 2002; Díaz López 2006; Díaz López & Bernal Shirai, 2007; Gonzalvo *et al.,* 2008). There has also been bycatch in the pelagic driftnet fishery in Turkish waters (Öztürk *et al.,* 2001) and, more recently, involving bottom-set gill nets in Turkish, Ukrainian, Bulgarian and Romanian waters of the Black Sea (Tonay & Öztürk 2003; ICES 2010; Birkun *et al.,* 2014; Radu & Anton 2014; ACCOBAMS 2019). Except in the Black Sea, numbers of bycaught animals have been generally low by comparison with some other species, but this may reflect the relatively low regional sizes of most coastal bottlenose dolphin populations.

4.5.4 **Common Dolphin**

Whereas bycatch rates of common dolphins in the Bay of Biscay and parts of the Celtic Sea have been estimated from both onboard observer programmes and stranding schemes (ICES, 2020a, 2021a), relatively little attention has been paid to establishing levels of mortality of this species around the Iberian Peninsula from coastal purse-seine and beach seine fisheries as well as coastal bottom-set gillnet (GNS, GTR) and trawl fisheries (López *et al.,* 2003; Ferreira 2007; Vingada *et al.*, 2011; Goetz *et al.,* 2014, Marçalo *et al.*, 2015; Vingada *et al.*, 2015; Dias *et al.*, 2022). In the western Mediterranean, illegal driftnet fisheries for large pelagic fish (swordfish, bluefin and albacore tuna) continue to result in common /striped dolphin bycatch (ACCOBAMS 2019). Both species suffered heavy mortality in the Strait of Gibraltar and Alboran Sea during the 1990s and early 2000s before the fishery was banned (Tudela *et al.,* 2005; ACCOBAMS 2019).

4.5.5 **Striped Dolphin**

The striped dolphin is a subtropical to warm temperate pelagic species which is rare north of the Bay of Biscay, although its range is extending northwards in response to climate warming. Within the ASCOBANS Agreement Area, the SCANS-2 survey estimated the abundance of striped dolphins in summer 2016 at around 19,000 animals beyond the shelf in the Bay of Biscay, although a small proportion of 107,000 unidentified common or striped dolphins are likely to be striped dolphins (Hammond *et al.*, 2021). In the Mediterranean Sea, the striped dolphin is the most abundant cetacean species, estimated from aerial surveys in 2018-2019 at more than 425,000 animals, with greatest numbers in the western Mediterranean (particularly the Strait of Gibraltar and Alboran Sea) (ACCOBAMS Survey Initiative).

From the mid-1980s until the mid 2000s, driftnet (GND) fisheries in both the eastern Atlantic and Mediterranean (particularly the western sector) were responsible for high levels of bycatch of striped dolphin (Di Natale, 1995; Tudela et al., 2005; David et al., 2010; Carpentieri et al., 2021). As noted in the section on common dolphin, although bycatch mortality was greatest from the late 1980s and through the 1990s up to the ban in 2005, illegal driftnet fisheries continue to cause some mortality of this species (ACCOBAMS, 2019). Several other gear types have also been recorded as causing bycatch mortality. These include fixed nets (GNS, GTR), longlines (LLD), purse seines (PS), pair trawls (PTM), and otter trawls (OTB) (Carpentieri *et al*., 2021, and references therein). In the eastern Atlantic, bycatch of striped dolphins has been recorded also in pelagic trawls (PTM, OTM - Morizur *et al*., 1999; ICES 2014, 2015, 2019), bottom trawls (OTB) (ICES 2014, 2015, 2019), and static nets (GNS, GTR) (ICES 2011).

4.5.6 White-beaked Dolphin

The central and eastern North Atlantic range of the white-beaked dolphin extends largely from Icelandic waters in the west across to the Barents Sea in the east south to the shelf seas around Britain and Ireland. The SCANS-III survey in July 2016 estimated about 36 000 animals between southern Norway and the Iberian Peninsula, with the majority in the North Sea (Hammond *et al.,* 2021). However, larger numbers of the species occur around Iceland eastwards to the Barents Sea and the coast of northern Norway, with c. 60 000 estimated in Icelandic waters alone (Pike *et al.,* 2020a). The species has been recorded as bycatch in a variety of gears including gill nets, and pelagic trawls (Couperus, 1997; CEC 2002; ICES 2015, 2017, 2020a), but catches for this species are generally thought to be under-reported (Lien *et al.,* 2001). Scars or wounds thought to be the results of fishing gear entanglement or marine debris have been found in 15 of 90 photo-identified white-beaked dolphins around Iceland (Bertulli *et al.,* 2012), showing that sub-lethal interactions with fisheries are not uncommon.

4.5.7 Atlantic White-sided Dolphin

The Atlantic white-sided dolphin is a cold temperate to subarctic pelagic species with its central and eastern North Atlantic main range extending from Iceland eastwards to the western Barents Sea and south to the British Isles and Ireland. It is the most abundant dolphin species around the Faroe Islands, off the west Norwegian coast, in the Northern Isles of Scotland and west of the Hebrides (Evans 2020). The SCANS-III survey in July 2016 estimated about 15 500 animals between southern Norway and the Iberian Peninsula, mainly along the shelf edge northwest of Scotland (Hammond *et al.,* 2021). Incidental mortality in fishing gear (particularly pelagic trawls, but also bottom trawls, drift nets and bottom set gillnets) has been documented in several countries including Ireland (Couperus 1997), the United Kingdom (Northridge 1991), Canada (Béland *et al.,* 1987; Gaskin 1992, Palka *et al.,* 1997), and the United States (Gilbert and Wynne, 1987, Waring *et al.,* 1990, Bisack 1993; Palka *et al.,* 1997).

Substantial bycatches were recorded from the former mid-water trawl fisheries for mackerel and horse-mackerel along the shelf edge west and south of Ireland in 1992-94, about 90% of this mortality occurring in February and March (Couperus 1997). Morizur *et al.* (1999) investigated marine mammal bycatch in 11 pelagic trawl fisheries operated offshore west of Ireland and Scotland by France, the Netherlands, United Kingdom, and Ireland, and found that one of the main marine mammal species identified in bycatches was Atlantic white-sided dolphin. All bycatches occurred during night-time. White-sided dolphins were observed feeding around the net during towing, behaviour which may have made them more vulnerable to capture.

Besides mid-water trawl fisheries, white-sided dolphins have been reported bycaught also in bottom set gillnets, bottom trawls, and drift nets (Palka *et al.,* 1997; Morizur *et al.,* 1999; Reeves *et al.,* 1999; Waring *et al.,* 2006; Chavez-Rosales *et al.,* 2017; ICES 2013, 2015, 2017, 2018, 2019). Since the 1990s, reported catches have been low compared with some other dolphin species although likely to be under-reported.

4.5.8 Risso's Dolphin

In the North Atlantic, the Risso's dolphin occurs in greatest numbers in warm temperate and subtropical seas although its range extends into cool temperate waters off the Faroe Islands and northern Scotland. It tends to favour the continental slope but also coastal waters around the British Isles, north-west France, the Iberian Peninsula and parts of the Mediterranean. The SCANS-III survey in July 2016 estimated around 13 500 between southern Norway and the

Iberian Peninsula (Hammond *et al.*, 2021), whilst c. 2 600 were counted around Ireland during the ObSERVE survey in the summer of 2016 (Rogan *et al.*, 2017).

Most records of bycatch in Europe come from the Mediterranean involving longline fisheries (ACCOBAMS 2008; ICES 2012; Macías López *et al.*, 2012; ACCOBAMS 2019; Carpentieri *et al.*, 2021) although bycatch has been reported in several gears (OTB, TBB, GNS, GTR, and GND; see http://vocab.ices.dk/?ref=1498: (ICES 2013, 2014, 2017, 2018, 2019; Carpentieri *et al.*, 2021).

Longline fisheries generally have been poorly monitored, due partly to the fact that they usually operate well offshore and, following depredation attempts upon cephalopods baits, marine mammals are often released alive at sea (ACCOBAMS, 2019). An on-board observer programme was implemented by the Spanish Institute of Oceanography to study incidental catches caused by different types of longline used by the Spanish fleet in the Western Mediterranean (Macías López *et al.*, 2012). Although the number of bycatches observed between 2000 and 2009 was relatively low (57 individuals occurring in 52 out of 2 587 sets), Risso's dolphins were the species most frequently affected (33/57 of the bycatch) particularly where longlines were set at depth, occurring mainly south-west of the Balearic Islands and in the Alboran Sea (Macías López *et al.*, 2012).

A considerable amount of longlining occurs in the eastern North Atlantic west of the Iberian Peninsula (Evans *et al.*, 2021). On-board observations are largely lacking, but there is overlap between the occurrence of the species and longline fisheries so attention is recommended, particularly where cephalopods are used as bait, to quantitatively assess bycatch rates for this species.

4.5.9 Long-finned Pilot Whale

The long-finned pilot whale is found in the temperate seas of the North Atlantic and Mediterranean, particularly in deep waters beyond the continental shelf. During the SCANS-III survey from southern Norway to the southern end of the Iberian Peninsula in July 2016, a total of c. 25 800 pilot whales was counted, with the highest densities north and west of the Outer Hebrides and along the Biscay coast of Spain (Hammond *et al.*, 2021). Around 7 400 were additionally counted in Irish waters mainly along the shelf edge west of Ireland during summer 2016 in the ObSERVE survey (Rogan *et al.*, 2017). Further north, the NASS survey in 2015 resulted in a total abundance estimate of c. 590 000 whales (corrected for perception bias), with densities highest around the Faroe Islands and south-west of Iceland, with no apparent long-term trends (NAMMCO 2018; Pike *et al.*, 2019a, b).

Bycatch of pilot whales has been recorded in several fisheries including longlines, mid-water and bottom trawls, and drift nets (Di Natale, 1995; ACCOBAMS, 2008; López *et al.*, 2012; Macías López *et al.*, 2012; Vázquez *et al.*, 2014; ICES 2014, 2017, 2018, 2019; Chavez-Rosales *et al.*, 2017; Carpentieri *et al.*, 2021). Given the high abundance of the species, bycatch rates recorded are comparatively low. However, there are several regions with poor observer coverage where pilot whales are common including the offshore Atlantic beyond the continental shelf, and parts of the Mediterranean (Evans *et al.*, 2021). Drifting longlines, particularly when set at depth and baited with cephalopods, are known to lead to bycatch of pilot whales (Macías López *et al.*, 2012).

4.5.10 Killer Whale

Although the killer whale has a very widespread distribution, abundance is greatest in arctic and subarctic waters, particularly east of Iceland and west of Norway, with smaller numbers in northern Scotland, western Ireland, and around the Iberian Peninsula including the Strait of Gibraltar. There are no overall abundance estimates although the NASS survey in 2015 yielded an abundance estimate of around 30 500 (corrected for perception bias) in the central and eastern North Atlantic north of the British Isles (Pike *et al.,* 2020c), with around 15 000 in Norwegian waters (Leonard & Øien 2020a, 2020b). Concerns for the conservation status of the species have been raised, primarily in relation to high loads of persistent contaminants (Desforges *et al.,* 2018).

Information on bycatch is scant, but mortality of the species has been recorded from entanglement in ropes from creels and traps in the Scottish Hebrides (Deaville 2018), in a midwater pair trawl in the Strait of Gibraltar (ACCOBAMS 2008), and a tuna trap off the coast of Sicily (Di Natale & Mangano 1983a). Although mortality events appear to be rare, risk of killer whale bycatch may be increased during attempts at depredation of large pelagic fish (Couperus 1994; Luque *et al.,* 2006; Guinet *et al.,* 2007). In the Norwegian purse-seine fishery, it was estimated from analysis of log books that 100 killer whales were entrapped between 2011 and 2020, most of which were successfully disentangled resulting in an estimated mortality of 6% (Bjørge *et al.,* 2022).

4.5.11 Sperm Whale

In the North Atlantic, sperm whales are widely distributed usually in deep waters beyond the continental shelf offshore at least to the mid-Atlantic ridge and oceanic archipelagos of Macaronesia. In the eastern North Atlantic, the species (for the most part, mature or adolescent males) ranges mainly from the Iberian Peninsula north to Iceland and Norway. There is also a population in the Mediterranean Sea. The abundance estimate from the SCANS-III survey spanning the seas west of southern Norway to the southern tip of the Iberian Peninsula in July 2016, was c. 13 500, mainly in the Bay of Biscay and north-west of Scotland (Hammond *et al.,* 2021); insufficient numbers were seen west of Ireland for an abundance estimate from the ObSERVE survey (Rogan *et al.,* 2017). Further north, the NASS survey in summer 2015 estimated around 23 200 sperm whales, with greatest numbers around the Faroe Islands, and c. 5 700 in the Norwegian Sea (NAMMCO, 2018; Pike *et al.,* 2019a; Leonard & Øien, 2020b).

Bycatch of sperm whales has been reported largely from driftnets targeting large pelagic fish such as albacore tuna and swordfish in the Mediterranean Sea, particularly from the late 1970s to the 1990s (Duguy *et al.,* 1983a, b; Di Natale & Mangano, 1983b; Di Natale, 1995; Mussi *et al.,* 2004; Reeves & Notarbartolo di Sciara, 2006; ACCOBAMS, 2008, 2019; Carpentieri *et al.,* 2021). Di Natale and Mangano (1983b) provided details for 448 sperm whales stranded in the central Mediterranean between 1978 and 1982, some of which showed clear evidence of entanglement indicating that bycatch at that time may have had an impact on the population. Although a driftnet ban was introduced in 2002, illegal setting of driftnets continued for several years (Cornax & Pardo, 2009), and may still persist (Carpentieri *et al.,* 2021). Other gear types in which sperm whales have been reported bycaught include bottom otter trawls, gillnets, and longlines (Duguy *et al.,* 1983a, b; Di Natale & Mangano, 1983b; Mussi *et al.,* 1998; ACCOBAMS, 2008, 2019; Carpentieri *et al.,* 2021). Without dedicated observer programmes in all of these fisheries, it is very difficult to determine bycatch rates for this species.

4.5.12 Minke Whale

The minke whale is a cold temperate to arctic species inhabiting a large part of the northern North Atlantic, with greatest abundance in shelf waters of the central and northern North Sea, west of Britain and Ireland, west and north of Norway, and around Iceland. The SCANS-III survey between southern Norway and the southern tip of Portugal in 2016 yielded an abundance estimate of c. 14 800 minke whales (Hammond *et al.*, 2021) with an additional c. 6 500 in Irish waters from the ObSERVE survey (Rogan *et al.*, 2017). Further north, the NASS surveys in 2015 estimated around 42 500 around Iceland and the Faroes (NAMMCO 2018; Pike *et al.*, 2019b) whilst between 80 000 and 90 000 minkes are estimated from Norwegian surveys around Norway including the Barents Sea (Solvang *et al.*, 2015; NAMMCO 2018).

In those coastal areas where fish traps, pots/creels are set, minke whale entanglement can occur in the groundlines connecting the pots, and in Scotland appears to be the largest source of non-natural mortality recorded in stranded baleen whales (Northridge *et al.*, 2010; Leaper *et al.*, 2022). From strandings alone, an estimated 30 minke whales become entangled each year, with the number of entanglements positively correlated with the average amount of gear set (Leaper *et al.*, 2022). Further investigations should take place to establish the conditions for using particular arrangements of sinking groundlines as a mitigation measure. There is also a need for similar studies to be undertaken in west Norway and Iceland to establish bycatch rates of minke whales (and other baleen whales) in those regions.

4.5.13 Humpback Whale

In the central and eastern North Atlantic, the humpback whale occurs around Iceland, Norway, the British Isles, and Ireland. Numbers in the North Atlantic have recovered well since commercial exploitation. Norwegian surveys between 2014 and 2018 estimated around 10 700, with numbers greatest in the Barents Sea (Leonard & Øien 2020b). The North Atlantic Sightings surveys in 2015 yielded a corrected estimate of c. 9 900 humpbacks in Icelandic and Faroese waters with greatest numbers north and west of Iceland (Pike *et al.*, 2019a). Further south, numbers have been too small to derive abundance estimates from the SCANS-III or ObSERVE surveys in 2016 (Rogan *et al.*, 2017; Hammond *et al.*, 2021).

As with the minke whale, bycatch of humpback whales has been reported mainly from traps and pots/creels. Leaper *et al.*, (2022) estimated that an average of six humpbacks become entangled in Scottish waters each year, with 50% of these caught in groundlines between creels and showing an increasing trend. Numbers caught in pots and traps around Iceland and in Norway need to be determined where there have been anecdotal reports and video footage of humpback whale entanglements. A proportion of whales entangled are freed successfully. In Norway, a total of 78 humpback whale were estimated to be entrapped in the Norwegian purse-seine fishery for herring between 2011 and 2020, although most were disentangled alive resulting in an estimated mortality of 5% (Bjørge *et al.*, 2022).

4.6 Pinnipeds

Over the last thirty years, monitoring of marine mammal bycatch has tended to focus upon cetaceans, with bycatch of seals receiving relatively little attention, and on-board observer monitoring schemes (including mostly larger vessels) generally reporting a seal bycatch of very few animals. More recently, however, with increased attention to bycatch in seals, it has become clear that seal mortality in some fisheries and areas may be substantial.

4.6.1 Harbour Seal

Harbour seal populations have shown recoveries from the severe overhunting in the 20th century in several regions in the North Sea, Skagerrak, Kattegat and Danish Belt Sea since the PDV epidemics of 1988 and 2002. In some areas, however, (e.g. Northern Isles, north and east coasts of Scotland), populations have declined since the 1990s (SCOS 2022) or started to decline more recently (e.g. Iceland, Eastern England, Skagerrak, Danish Wadden Sea). For example, the Icelandic population has decreased from an estimated abundance of 33 000 animals in 1980 to 10 300 in 2020 (Granquist 2021, ICES 2022a).

Bycatch of harbour seals has been recorded in a variety of gears including static nets, traps, and both midwater and bottom trawls (ICES 2018, 2019, 2020a, 2021a, 2022b; Cosgrove *et al.*, 2013, 2016; Bjørge *et al.*, 2017; Sigurdsson 2017; Luck 2020). Static gears appear to cause the most bycatch, with greatest numbers taken in Icelandic (Sigurdsson 2017) and Norwegian fisheries (Bjørge *et al.*, 2017) and smaller numbers in the Celtic and North Seas (Cosgrove *et al.*, 2016; Luck, 2020; ICES 2020a, 2021a, 2022b). Annual marine mammal bycatch in the lumpsucker fishery based on observations from 2014–2018 was estimated at 1 389 (95% CI: 903–1 875) harbour seals, and may be contributing to the observed population decline. Bycatch estimates of 240 (95% CI: 82–398) harp seals, 49 (95%CI: 1–98) ringed seals, and 28 (95%CI: 10–46) bearded seals were also made (ICES 2019b).

In a new study Elnes *et al.*, (2023) estimate the temporal and spatial distribution of the 555 harbour seals that become entangled annually along the Norwegian coasts (Bjørge *et al.*, 2017), most often in large-mesh gillnet fisheries targeting cod and monkfish. It was assumed based on earlier studies that mostly young animals are likely to do so.

In the Baltic, bycatch of seals in the combined Danish and Swedish gillnet fleets has recently been analysed for the year 2018 by HELCOM (2021) for the Skagerrak, Kattegat, Belt Seas and the Sound (subdivisions 3a21, 3b.23 and 3c.220). Since the analysis utilised electronic monitoring data which did not discriminate between seal species, seal bycatch of harbour and grey seals were pooled together, although in this region, harbour seal bycatch was believed to dominate. Estimated seal bycatch per season by area captured in the combined Danish and Swedish gillnet fleets were calculated by HELCOM (2021): 177 in spring and 0 in summer in subdivision 3a21; 37 in spring, 30 in summer, 0 in autumn, and 37 in winter in subdivision 3b.23; and 13 in spring, 60 in summer, 9 in autumn, and 0 in winter in subdivision 3c.22. Overall annual seal bycatch estimates in all areas were 286 (95% CI: 213-368) individuals. Most casualties were predicted in spring in the Kattegat (3a.21) and in the spring and summer in the Belt Seas (3c.22). Confidence limits for bycatch in the Kattegat in spring were large and should therefore be treated with caution. Since the German gillnet effort was not accounted for, seal bycatch in subdivision 3c.22 is likely to be higher than reported here.

Moreover, in Belgium an unusual number of strandings in 2021, led to a closer analysis showing that over 50% of the stranded animals potentially died as a result of bycatch in monofilament used in standing nets (Haelters *et al.*, 2023). However, the animals were found decapitated or otherwise mutilated, suggesting they may have fallen out of the gear rather than being hauled in. If this would happen frequently, bycatch of seals in these types of gear might be underestimated by an even greater amount, or actually remain undetected.

Similar lesions are frequently observed along the Dutch coasts, although systematic reports are lacking as strandings of seals are not officially documented. Based on voluntary reports, the number of harbour seals found dead along the Dutch coasts amounts to at least 400-700 per year, which is an unknown part of the actual strandings.

Some records are available: (Osinga *et al.*, 2012) summarised observations made based on findings from a rescue centre, indicating that in harbour seals, bycatch was the most common (19%) cause of death (confirmed and inferred) (1979-2008). More recently (Salazar-Casals *et al.*,

2022) studied 145 seals affected by marine debris collected by the Dutch rescue centres (2010-2020). Out of the total, 27 animals (18.6%) were harbour seals, all collected along the northwestern coast of the Netherlands. Some animals had ingested debris but by far the most harbour seals in this study (77.8%), were entangled, and most often in fishing gear.

4.6.2 **Grey Seal**

Grey seal populations have been increasing over the last 30 years in most parts of the northern and eastern North Atlantic (ICES 2022a). However, in Iceland, that trend is reversed, with a general decline (based upon pup counts at irregular intervals) between 1982 and 2017, the latest estimate from 2017 indicating a population abundance of 6 269 animals compared with 9 000 in 1982 (Granquist & Hauksson 2019). Annual marine mammal bycatch in the lumpsucker gillnet fishery based on observations from 2014–2018 was estimated at 989 (95% CI: 405-1 573) grey seals (ICES 2019). There is concern that mortality due to the lumpsucker fishery is affecting the Icelandic grey seal and harbour seal populations, especially as other fisheries also occur in the area. Another region showing a significant reduction in pup production since 2014 has been mid-Norway (Trøndelag and Nordland counties) (Nilssen & Bjørge 2017). The most probable reason for this marked decline is thought to be high bycatches of grey seals in gillnet fisheries for mainly monkfish, but also in cod gillnets (ICES 2022b).

Bycatch of grey seals has been observed throughout its range in central and eastern North Atlantic in gillnets, pelagic and bottom trawls, traps and anchored seines (ICES 2019, 2020a, 2020b, 2021a, 2022b). The ICES Workshop on Marine Mammal Mortality (ICES 2020b) analysing 574 grey seals recorded as bycaught between 2005 and 2021 found that higher bycatch rates in the most recent period 2015-20 occurred in vessels up to 12 m length compared with larger ones. Highest frequencies occurred in small vessels using GNS in ICES areas 5 (Iceland) and 7 (Celtic Sea). The average number of grey seals caught per bycatch event was between 1 and 1.5 individuals in most métiers and areas, except for small vessels using GNS in area 5 where 3.5 individuals were observed on average. Overall bycatch estimates for grey seals in the three assessment units (Iceland, Greater North Sea and Ireland) were 761 (95% CI: 333-1 715) in Iceland, 2 229 (95% CI: 1 598-3 199) in the Greater North Sea, and 108 (95% CI: 89-129) in Ireland. Gillnets were the main gears with observed bycatch in all assessment units, but a small amount of bycatch was also estimated in OTM in the Greater North Sea assessment unit.

In the Baltic, Vanhatalo *et al.*, (2014) undertook a Bayesian analysis of results from interview surveys to estimate grey seal bycatch rates for 2012 in different subareas of the Baltic Proper in Finland, Sweden and Estonia. Their analysis showed that the total annual bycatch by trap and gillnets, with 90% probability, was more than 1 240 but less than 2 860, with the posterior median and mean of the total bycatch being 1 550 and 1 880 seals respectively. Trap nets comprised about 88% of the total bycatch. Taking possible under-reporting in one area into account, the posterior mean of the total bycatch was between 2 180 and 2 380.

More than half of the seals found dead along the Belgian coast in 2021 were young grey seals (Haelters *et al.*, 2023). A large proportion of these dead seals were estimated to be bycaught (see harbour seal above).

As was the case in harbour seals, systematic reports are lacking in the Netherlands since strandings of seals are not officially documented. Based on voluntary reports, numbers of grey seals found dead along the Dutch coasts amount to at least 200-300 per year, which is an unknown part of the actual strandings.

Osinga *et al.*, (2012) summarised observations made based on findings from a rescue centre, indicating that in grey seals, bycatch was the most common (15%) cause of death (confirmed and inferred) (1979-2008). In that period, relatively few grey seals were seen in the Netherlands, although numbers were growing. More recently (Salazar-Casals *et al.*, 2022) studied 145 seals affected by marine debris collected by the Dutch rescue centres (2010-2020). Most animals reported (118) were grey seals. Some animals had ingested debris but by far the most harbour seals in this study (92.4%) were entangled and most often in fishing gear.

4.6.3 Ringed Seal

Two management areas are recognised for this subspecies in the Baltic. The largest population occurs in Bothnian Bay (the northern management area) and has increased from c. 2 000 in 1988 to 9 919 in 2018, an average annual increase of 4.7% (ICES 2022b). It has been recovering from a population decline in the 20th century due to hunting (encouraged by concerns of competition with fisheries) as well as subsequent reproductive problems caused by contaminants. Elsewhere, small populations occurring in the Gulf of Finland, Gulf of Riga, and Finnish Archipelago Sea have either remained stable or declined over the last ten or more years, with populations in this southern management area in a critical state (HELCOM 2018, ICES 2022b). The overall population size of ringed seals is c. 13 000 animals, less than one tenth of the estimated historical abundance at the beginning of the 20th century (Oksanen *et al.*, 2015), and the species currently faces the additional pressure of climate change resulting in decreasing ice cover necessary for breeding (HELCOM 2018, ICES 2022b).

Bycatch is a further pressure upon ringed seal populations but quantitative information is largely lacking (HELCOM 2021). In the 1990s, an annual bycatch of 80 ringed seals was estimated in the Baltic (ICES 1995). A more recent study estimated a bycatch of 52 ringed seals in 2001 from voluntary logbooks across all gear types in Swedish fisheries (Lunneryd *et al.*, 2005). An analysis of 1 767 fishing days from 4-6 fyke nets (FYK) annually over a five-year period, 2008-13, yielded a total of 103 ringed seals bycaught in Bothnian Bay (subdivision 31) (Oksanen *et al.*, 2015).

4.6.4 Mediterranean Monk Seal

The Mediterranean monk seal has a discontinuous range that includes the eastern Mediterranean, Mauritania (West Africa), and Madeira. Its global population is estimated to be c. 600-700 individuals (Karamanlidis *et al.*, 2016; Karamanlidis & Dendrinos 2015; Kiraç *et al.*, 2020). The Mediterranean subpopulation is considered endangered (Karamanlidis *et al.*, 2019) with 300-400 in Greece and at least 100 in Turkey. Occasional sightings have occurred in Albania, Croatia, Egypt, Israel, Italy, Lebanon, Libya, Spain and Syria, and in the Black Sea in Bulgaria and Turkey (Notarbartolo di Sciara *et al.*, 2019; Carpentieri *et al.*, 2021). Over 360 monk seals have been counted around Cabo Blanco (Mauritania) and less than 50 in Madeira (Carpentieri *et al.*, 2021).

An analysis of bycatch records in Turkey found 12 cases between 1994 and 2018, involving set nets (although purse seine and bottom trawls were not investigated) (Kiraç *et al.*, 2020). Adults appear to generally be able to free themselves whereas pups and juveniles under one year old are more susceptible to mortality following entanglement (Kiraç *et al.*, 2020). There can be conflict between fishers and monk seals over damage to their nets and depredation resulting in loss of catch (Panou *et al.*, 1993; Cebrian 1998; Ríos *et al.*, 2017; Carpentieri *et al.*, 2021). This can cause retaliation.

The majority of gear entanglements between monk seals and fisheries have occurred in coastal areas especially involving small-scale fisheries using trammel nets, gillnets, longlines or traps (Güçlüsoy *et al.,* 2004; Karaminlidis *et al.,* 2008; Carpentieri *et al.,* 2021). Most of these accounts, however, are quite old and there is limited current information on bycatch. Occasional entanglements have also been recorded in trawls and purse seines, although they are not considered to present a problem for monk seals (Cebrian & Vlachoutsikou 1994; Cebrian 1998; Danyer *et al*., 2018). Bycatch is not considered to be a problem in Madeira due to the fact that the use of fishing nets has been banned and fishers have switched to alternative, less harmful, fishing methods such as hand-lines (Hale *et al.,* 2011).

Table 4-3.

a) Cetacean species/regional populations (in the Baltic, North Atlantic (excluding the arctic), Mediterranean and Black Seas) at bycatch risk in poorly monitored fisheries see http://vocab.ices.dk/?ref=1498 for gear types

Species Population	Conservation Status (by country/region)	Area	ICES Subarea	Gear Type(s)	Priority Action
Iberian Harbour Porpoise	Endangered (ES, 2021) Unfavourable-Inadequate (ES, PT)	Iberian Peninsula (Spain & Portugal)	8c, 9a	GNS, GTN, GTR, OTB, PS, SB, LL	Bycatch mitigation + monitoring of all fleets but particular gap is small vessels (12m or less), and beach seines
Baltic Harbour Porpoise	Unfavourable-Bad (DE, DK, PL, SE,	Baltic Proper	3d	GNS, possibly other gears	Bycatch mitigation + monitoring of all fleets
Coastal Bottlenose Dolphin	Unknown (ES), Unfavourable-Inadequate (FR), Favourable (FR, IE, PT, UK)	Celtic Seas, Western Channel, Bay of Biscay, Iberian Peninsula, Mediterranean Sea, Black Sea	7b, 7j, 7e, 8a, 8c, 9a, Med Black Sea	GNS, GND, GTN, GTR, PS, SB,	Monitoring of all inshore fleets particularly small vessels, beach seines
Common Dolphin	Unknown (ES) Unfavourable-Inadequate (PT)	Bay of Biscay, Iberian Peninsula, Western Mediterranean	8c, 9a, Med	PS, SB, GND	Monitoring of all inshore fleets particularly small vessels, beach seines, illegal driftnetting
White-beaked Dolphin	Favourable (DK, IE), Unknown (FR, NL, UK)	Celtic Seas, North Sea, West Scotland, West Norway	2a, 4a, 4b, 4c, 5b, 6a, 7b, 7j, 7e	PT, GN	Monitoring of trawl fleets (inshore & offshore) in some areas
Atlantic White-sided Dolphin	Favourable (IE), Unknown (UK, FR)	Celtic Seas, North Sea, West Scotland, West Norway	2a, 4a, 5b, 6a, 6b, 7b, 7c, 7j, 7k	PTM, OTB, TBB, GN, GNS	Monitoring of offshore trawl fleets in some areas

Risso's Dolphin	Unknown (ES, FR, PT, UK), Favourable (IE)	Celtic Seas, Iberian Peninsula, Mediterranean Sea	6a, 6b, 7b, 7c, 7j, 8c, 8d, 9a,9b, Med	LLD, LLS	Monitoring of longline fleets
Long-finned Pilot Whale	Unknown (ES, FR, PT, UK), Favourable (IE)	Celtic Seas, Iberian Peninsula, Mediterranean Sea	6a, 6b, 7b, 7c, 7j, 8c, 8d, 9a,9b, Med	LLD, LLS, also GND, OTM, OTB, TBB, PTM	Monitoring of longline fleets
Killer Whale	Favourable (ES), Unknown (FR, IE, PT, UK)	Celtic Seas, West Scotland, West Norway, Iceland	2a, 4a, 5b, 6a, 6b, 7b, 7c, 7j, 7k,	FIX, PTM, PS, possibly also other gears	Monitoring of coastal fisheries
Sperm Whale	Unfavourable-Bad (GR), Unknown (ES, FR, IT, HR, MT)	Mediterranean Sea	Med	GND, also OTB, GTR, LLD	Monitoring of illegal driftnet fisheries for swordfish
Minke Whale	Unknown (UK) Favourable (IE)	West Scotland, West Norway, Celtic Seas	2a, 4a, 6a, 7b, 7j	FPO	Monitoring of creel/pot fisheries
Humpback Whale	Unknown (UK, IE)	West Norway. West Scotland, Celtic Seas	2a, 4a, 6a, 7b, 7j	FPO, PS	Monitoring of creel/pot fisheries

b) Pinniped species/regional populations (in the Baltic, North Atlantic (excluding the arctic), Mediterranean and Black Seas) at bycatch risk in poorly monitored fisheries

Species Population	Conservation Status (by country/region)	Area	ICES Subarea	Gear Type(s)	Priority Action
Grey Seal	Unfavourable-Inadequate (DK) Favourable (BE, DE, FR, IE, NL, SE, UK)	Iceland; Baltic, Skagerrak, North Sea, West Scotland, Celtic Seas Norwegian waters	3a, 3b, 3c, 3d, 4a, 4b, 4c, 5a, 6a, 6b, 7a, 7b, 7f, 7g, 7j,	mainly GNS; also GTR, OTM, FPO, FYK	Monitoring of all GNS fleets particularly small vessels
Harbour Seal	Unfavourable-Inadequate (BE, UK), Favourable (DE, DK, NL, SE)	Iceland, Baltic, Skagerrak, North Sea Norwegian waters	3a, 3b, 3c, 4a, 4b, 4c, 5a, 6a, 7a, 7b, 7j	GNS, GTR, FPO, FYK	Monitoring of all inshore fleets particularly small vessels
Ringed Seal	Unknown (PL), Unfavourable-Inadequate (FI), Unfavourable-Bad (EE, LV, SE)	Baltic Proper	3d, 5a	GNS, FPO	Monitoring of all fleets, recreational fisheries
Mediterranean Monk Seal	Unknown (ES), Unfavourable-	Mediterranean Sea, Madeira	9b + Med	GNS	Monitoring of all inshore fleets

	Inadequate (PT, CY, GR), Unfavourable-Bad (IT)	

5 ToR E: WGJCDP and WGMPAS

Review the main results from WGJCDP and WGMPAS with focus on developing relevant data products (WGJCDP) and assessment methods of trade-offs between human activities and biodiversity benefits derived from MPAs (WGMPAS).

5.1 Update on progress of the Joint Cetacean Data Programme (JCDP)

The Joint Cetacean Data Programme (JCDP) aims to better facilitate access to, and use of, effort related cetacean survey data, by collating the growing evidence-base from across the Northeast Atlantic into a single accessible resource. The JCDP is a collaboration with partners from across the region; with representation from policy makers, academics, marine industry and NGOs. The JCDP encourages data collectors to make standardised high quality data more readily available and enable development of open access data products to better inform research and policy.

The Joint Cetacean Data Programme platform was launched in 2022, and comprises three elements:

- The JCDP Information hub hosted on the JNCC website with background resources, guides and the published JCDP data standard (jncc.gov.uk/jcdp)
- The JCDP Data Portal, hosted on the ICES data centre for biodiversity (cetaceans.ices.dk)
- The JCDP Metadata Catalogue, hosted on ICES GeoNetwork with records for the whole JCDP database and each survey data. The metadata records are INSPIRE compliant (gis.ices.dk/geonetwork)

Since the launch in Summer 2022, the JCDP is governed by a newly formed ICES working group (WGJCDP) to maximise the benefits and reach of the programme. The first WGJCDP meeting was held in September, 2022 where ToRs for the period between 2022 and 2024 were agreed. The next annual meeting of the group has been planned for April 2023. The agreed deliverables are as follows:

a) Establish a governance framework, setting out a forward-looking plan for JCDP: including responsibilities, priorities, processes, and resources.

b) Review the JCDP data holdings in terms of standardisation, data quality and number of datasets, with regards to production of high-quality outputs using the ICES governance evaluation.

c) Identify proactive methods of promotion of the JCDP Data Standard across data collectors involved, and those not yet engaged with the JCDP to drive standardisation and subsequent compatibility for analyses.

d) Development of analyses and data products derived from the JCDP to contribute to assessment and reporting requirements, and research and policy priorities, as agreed by the Group, and in collaboration with WGMME.

e) Review use of the JCDP datasets, provide a platform for end user feedback, and promote high-quality science.

The present focus of the group is to expand data holdings of the JCDP, expand membership and representation on the working group and to develop concepts for publicly available data products (ToR D). These data products will have the capability to feed into existing needs such as national and international status assessments, species action plans, strategies etc. To ensure these resources are robust and relevant, with consideration for available data, resources and expertise, WGJCDP aim to actively engage with other working groups (WGMME and WGBYC) in support of ongoing shared priorities with work commencing in Spring 2023.

Ideas for data products were considered during the development phases of the JCDP, with suggestions and insights collected through 'user stories'. These stories identified the needs of each stakeholder group and followed a prescribed format, designed to link user needs to a function;

"As a {who}, I need {what}, so I can {why}"

From such stories, further development can be based in combination with input from other stakeholders.

Considerations for any data products developed for the JCDP include, but are not limited to:

- Use of both dynamic & static (but repeatable) methods, hosted by the current JCDP data portal.
- Associated metadata for each data product, with information on method, base data and confidence hosted as part of the JCDP metadata catalogue on ICES GeoNetwork.
- Balance the needs of various stakeholders and users, and the available expertise and resources.

The JCDP Data Portal currently contains 12 316 observations across 20 2667 km of survey effort between 2005 and 2022 and holds recordings of 28 unique species. WGJCDP will continue to engage with present data collectors and support data submission, while also expanding engagement with new data providers to both gather present and future survey data but also include as much historic data as possible. A request was made to WGMME members to flag potential data providers with the WGJCDP and open channels of communication where appropriate.

The scope of WGMME extends beyond cetacean species. Plenary discussions with the group emphasised the JCDP Data Portal's potential capability to hold ancillary data such as opportunistic sightings of other marine taxa (e.g. pinnipeds, birds, elasmobranchs, large fish) collected during survey effort which may complement existing monitoring programmes for such taxa. Marine mammal data combined with the observations of other important marine taxa could provide a first broader insight into the distribution of top predators in general and may help to identify areas of interest and importance for conservation of these species.

WGJCDP will continue to welcome intersessional feedback from WGMME on a) data products in the form of user stories, b) potential data providers, and c) expressions of interest for membership within WGJCDP from WGMME members.

5.2 Status of WGMPAS

WGMME was requested to consider ways it can support the newly-formed WGMPAS (the ICES Working Group on Marine Protected Areas and other Spatial Conservation Measures), established to develop methods to assess trade-offs between human activities and biodiversity benefits derived from Marine Protected Areas (MPAs).

WGMPAS set out three Terms of Reference:

a) Explore and develop approaches for the effective evaluation and quantification of potential biodiversity benefits arising from various types of MPAs (e.g. the provision of best-practice guidance, indicator tool box);
b) Coordinate and develop assessment methods (including specific tools in line with the ICES EBM framework to evaluate the potential consequences and trade-offs between various human activities and the biodiversity benefits derived from MPAs;
c) Develop assessment approaches and guiding principles to inform optimal operational design and monitoring of networks of MPAs in response to climate change by testing the outcomes of ToR (a) and (b) under different MPA network design and climate scenarios.

WGMME attempted to arrange a meeting with the Chairs of WGMPAS, but because of their conflicting schedules, this proved impossible, and they were unable to participate in the WGMME meeting. So far, their focus has been upon benthic biodiversity and they have not yet considered top predators. It was therefore decided that it would be premature to take this forward at the 2023 meeting of WGMME but to wait until WGMPAS had clarified its next steps and to what extent WGMME could help it achieve its objectives. This will therefore be reviewed during 2023 in case it should be on the agenda for the next meeting of WGMME in 2024.

6 REFERENCES

ACCOBAMS 2008. International Workshop on Cetacean Bycatch within the ACCOBAMS Area. Organised by ACCOBAMS and GFCM, Rome, Italy. 58pp.

ACCOBAMS 2019. Review of Bycatch Rates of Cetaceans in the Mediterranean and the Black Sea. ACCOBAMS-MOP7/2019/Doc 29. 22pp.

Agamuthu, P., Mehran, S. B., Norkhairah, A., and Norkhairiyah, A. 2019. Marine debris: A review of impacts and global initiatives. Waste Management & Research, 37(10), 987-1002.

Aguilar, A., and Borrell, A. 2022. Unreported catches, impact of whaling and current status of blue whales in the South European Atlantic Shelf. Scientific Reports, 12(1), 5491.

Ahlgren, H., Bro-Jorgensen, M. H., Glykou, A., Schmolcke, U., Angerbjorn, A., Olsen, M. T., and Liden, K. 2022. The Baltic grey seal: A 9000-year history of presence and absence. Holocene 32, 569-577.

Albrecht, S., Jung, J. L., Lémery-Peissik, D., Lazar, L., Baithe, M., Eider, D., and Rasmussen, M. H. 2022. Minke whales' distribution dependence on food, their small-scale site fidelity in North Iceland and its implications regarding a distribution shift northward in the Atlantic. Marine Biology Research, DOI: 10.1080/17451000.2021.2016839

Alexandre, S., Marçalo, A., Marques, T. A., Pires, A., Rangel, M., Ressurreição, A., Monteiro, P., Erzini, K., and Gonçalves, J. M. 2022. Interactions between air-breathing marine megafauna and artisanal fisheries in Southern Iberian Atlantic waters: results from an interview survey to fishers. *Fisheries Research*, *254*, 106430.

Alter, S. E., Meyer, M., Post, K., Czechowski, P., Gravlund, P., Gaines, C., and Hofreiter, M. 2015. Climate impacts on transocean dispersal and habitat in gray whales from the Pleistocene to 2100. Molecular Ecology, 247., 1510-1522.

Alter, S. E., King, C. D., Chou, E., Chew Chin, S., Rekdahl, M., and Rosenbaum, H. C. 2022. Using Environmental DNA to Detect Whales and Dolphins in the New York Bight. Frontiers in Conservation Science 3:820377. doi: 10.3389/fcosc.2022.820377

Amundin, M., Carlström, J., Thomas, L., Carlén, I., Koblitz, J. C., Teilmann, J., Tougaard, J., Tregenza, N. J. C., Wennerberg, D., Loisa, O., Kosecka, M., Kyhn, L.A., Ljungqvist, C.T., Sveegaard, S., Burt, L., Pawliczka, I., Jussi, I., Koza, R., Arcizewski, B., Galatius, A., Jabbusch, M., Laaksonlaita, J., Lyytinen, S., Niemi, J., Šaškov, A., MacAuley, J., Wright, A. J., Gallus, A., Yermakovs, V., Benke, H., Blankett, P., Skora, K. E., Dähne, M., and Acevedo-Gutiérrez, A. 2022. Estimating the abundance of the critically endangered Baltic Proper harbour porpoise (*Phocoena phocoena)* population using passive acoustic monitoring. Ecology and Evolution, 2022;12: e8554. https://doi.org/10.1002/ece3.8554

Androulakakis, A., Alygizakis, N., Gkotsis, G., Nika, M.-C., Nikolopoulou, V., Bizani, E., Chadwick, E., Cincinelli, A., Claßen, D., and Danielsson, S. 2022. Determination of 56 per-and polyfluoroalkyl substances in top predators and their prey from Northern Europe by LC-MS/MS. Chemosphere 287, 131775.

Archipelagos. 1998. Technical-economical investigation of the effects of the Mediterranean monk seal on coastal fisheries on the western coasts of Zakynthos Island. Final report, sub-project WWF Greece, EU programme LIFE96NAT/GR/3225, contract B4-3200/96/500 «The Mediterranean monk seal in Greece: Conservation in action», co-ordinated by the Hellenic Society for the Study and Protection of the Monk Seal HSSPMS-MOm. Argostoli, Kefalonia, Greece. March 1998, 69p. + appendices. Compiled by A. Panou.

Arranz, P., Glarou, M., and Sprogis, K. R. 2021. Decreased resting and nursing in short-finned pilot whales when exposed to louder petrol engine noise of a hybrid whale-watch vessel. Scientific Reports, 11(1), 21195. https://doi.org/10.1038/s41598-021-00487-0

Arso Civil, M., Quick, N. J., Cheney, B., Pirotta, E., Thompson, P. M., and Hammond, P. S. 2019. Changing distribution of the east coast of Scotland bottlenose dolphin population and the challenges of area-based management. Aquatic Conservation: Marine and Freshwater Ecosystems, 29, 178-196.

ASCOBANS, 2021.Mass killing of the Atlantic White-sided Dolphin (*Lagenorhynchus acutus*) in the Faroe Islands in September 2021. ASCOBANS/AC26/Inf.4.2. Dist. 19 October 2021.

Authier, M., Rouby, E., and Macleod, K. 2021. Estimating cetacean bycatch from non-representative samples (I): A simulation study with regularized multilevel regression and post-stratification. Frontiers in Marine Science, 1459.

Aynsley, C. L. 2017. Bottlenose dolphins (*Tursips truncatus*) in north-east England: A preliminary investigation into a population beyond the southern extreme of its range. Master's Thesis. Newcastle University

Bäcklin, B.-M., Persson, S., Faxneld, S., Rigét, F. F., and Roos, A. M., 2021. Temporal and Geographical Variation of Intestinal Ulcers in Grey Seals (*Halichoerus grypus*) and Environmental Contaminants in Baltic Biota during Four Decades. Animals 11, 2968.

Barz, F. 2022. Identifying social practices to inform fisheries management—the case of bycatch practices of marine mammals and seabirds of German gillnet fishers. ICES Journal of Marine Science.

Bearzi, G. 2002. Interactions between cetaceans and fisheries: Mediterranean Sea. In G. Notarbartolo di Sciara, ed. Cetaceans in the Mediterranean and Black Seas: state of knowledge and conservation strategies, section 9. ACCOBAMS, Monaco.

Beest, F. M. van, Dietz, R., Galatius, A., Kyhn, L. A., Sveegaard, S., and Teilmann, J. 2022. Forecasting shifts in habitat suitability of three marine predators suggests a rapid decline in inter-specific overlap under future climate change. Ecology & Evolution, 12, e9083.

Béland, P., Martineau, D., Robichaud, P., Plante, R., and Greendale, R. 1987. Echouages de mammifères marins sur les côtes du Québec dans l'estuaire et le golfe du Saint-Laurent de 1982 à 1985. Rapport Technique Canadien Sciences halieutiques et aquatiques, 1506: 1-44.

Ben Chehida, Y., Stelwagen, T., Hoekendijk, J., Ferreira, M., Eira, C., Pereira, A., Nicolau, L., *et al.*, 2021. Harbor porpoise losing its edges: genetic time series suggests a rapid population decline in Iberian waters over the last 30 years. BioRxiv. https://doi.org/10.1101/2021.08.19.456945.

Bertulli, C., Cechetti, A., van Bressem, M-F., and van Waerebeek, K. 2012. Skin disorders in common minke whales and white-beaked dolphins off Iceland, a photographic assessment. Journal of Marine Animals and Their Ecology, 5, 29-40.

Bester, M. N. 2021. Vagrant sub-Antarctic fur seal at tropical Ascension Island, South Atlantic Ocean. Polar Biology, 44(2), 451-454.

Beton, D., Broderick, A. C., Godley, B. J., Kolac, E., Ok, M., and Snape, R. T. E. 2021. New monitoring confirms regular breeding of the Mediterranean monk seal in Northern Cyprus. Oryx, 55, 522-525.

Beverton, R. J. H. 1985. Analysis of marine mammal-fisheries interactions. Marine mammals and fisheries, 3-33.

Birenbaum, Z., Do, H., Horstmyer, L., Orff, H., Ingram, K., and Ay, A., 2022. SEALNET: Facial recognition software for ecological studies of harbor seals. Ecol Evol 12.

Birkun, A., Jr, Northridge, S. P., Willstead, E. A., James, F. A., Kilgour, C., Lander, M., and Fitzgerald, G. D. 2014. Studies for carrying out the Common Fisheries Policy: Adverse fisheries impacts on cetacean populations in the Black Sea. Final Report to the European Commission, Brussels. 347pp.

Bisack, K. 1993. Estimates of total bycatch in the Gulf of Maine sink gillnet fishery. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, NEFSC Ref. Doc. 93-11: 1-23.

Biuw, M., Øigård, T. A., Nilssen, K. T., Stenson, G., Lindblom, L., Poltermann, M., Kristianssen, M., *et al.*,2022. Recent harp and hooded seal pup production estimates in the Greenland Sea suggest ecology-driven declines. NAMMCO Scientific Publications 12. https://doi.org/10.7557/3.5821

Bjørge, A., Moan, A., Nilssen, K. T., and Øigård, T. A. 2017. Bycatch of harbour and grey seals in Norway. Institute of Marine research, Norway. Paper submitted to NAMMCO SC/24/BYCWG/07

Bjørge, A., Moan, A., Ryeng, K. A., and Wiig, J. R. 2022. Low anthropogenic mortality of humpback (*Megaptera novaeangliae*) and killer (*Orcinus orca*) whales in Norwegian purse seine fisheries despite frequent entrapments. Marine Mammal Science, 1-11. https://doi.10 1111/mms.12985

Blanchet, M. A., Vincent, C., Womble, J. N., Steingass, S. M., and Desportes, G. 2021. Harbour seals: Population structure, status, and threats in a rapidly changing environment. Oceans, 2(1), 41-63. https://doi.org/10.3390/oceans2010003

Bland, R., Methion, S., Sharp, S. P., and López, B. D. 2023. Assessing variability in marine traffic exposure between baleen whale species off the Galician Coast, Spain. Marine Pollution Bulletin, 186, 114439.

Bodewes, R., Zohari, S., Krog, J. S., Hall, M. D., Harder, T. C., Bestebroer, T. M., van de Bildt, M. W., Spronken, M. I., Larsen, L.E., and Siebert, U., 2016. Spatiotemporal analysis of the genetic diversity of seal influenza A (H10N7) virus, northwestern Europe. Journal of Virology 90, 4269-4277.

Bou-Cabo, M., Lara, G., Gutiérrez-Muñoz, P., Saavedra, C., Miralles, R., and Espinosa, V. 2022. A Risk-Based Model Using Communication Distance Reduction for the Assessment of Underwater Continuous Noise: An Application to the Bottlenose Dolphin (Tursiops truncatus) Inhabiting the Spanish North Atlantic Marine Demarcation. Journal of Marine Science and Engineering, 10(5), 605. https://doi.org/10.3390/jmse10050605

Bowen, W. D. and Iverson, S. J., 2013. Methods of estimating marine mammal diets: a review of validation experiments and sources of bias and uncertainty. Marine Mammal Science, 29(4), pp.719-754.

Branstetter, B. K., and Sills, J. M. 2022. Mechanisms of auditory masking in marine mammals. Animal Cognition, 25(5), 1029-1047. https://doi.org/10.1007/s10071-022-01671-z

Brasseur, S., van Polanen Petel, T., Gerrodette, T., Meesters, E., Reijnders, P., and Aarts, G. 2015. Rapid recovery of Dutch grey seal colonies fuelled by immigration. Marine Mammal Science. 31: 405-426.

Brasseur, S. M. J. M., Reijnders, P. J. H., Cremer, J., Meesters, E., Kirkwood, R., Jensen, L. F., Jeβ, A., Galatius, A., Teilmann, J., and Aarts, G., 2018. Echoes from the past: Regional variations in recovery within a harbour seal population. PLOS ONE 13, e0189674.

Brasseur, S., Aarts, G., and Schop, J., 2022b. Measurement of effects of piledriving in the Borssele wind farm zone on the seals in the Dutch Delta area: Changes in dive behaviour, haul-out and stranding of harbour and grey seals No. C055/22, Wageningen Marine Research.

Brennecke, D., Siebert, U., Kindt-Larsen, L., Midtiby, H. S., Egemose, H. D., Ortiz, S. T., Knickmeier, K. *et al.*, 2022. The fine-scale behavior of harbor porpoises towards pingers. Fisheries Research, 255, 106437.

Brignon, J.-M., Lejart, M., Nexer, S. M., Quentric, A., and Thiebaud, L. 2022. A risk-based method to prioritize cumulative impacts assessment on marine biodiversity and research policy for offshore wind farms in France. Environmental Science & Policy 128: 264-276

Britt-Marie, B., Sara, P., Suzanne, F., Frank, R. F., and Anna, R. M. 2021. Temporal and Geographical Variation of Intestinal Ulcers in Grey Seals (*Halichoerus grypus*) and Environmental Contaminants in Baltic Biota during Four Decades. Animals 11, 2968.

Bundone, L., Hernandez-Milian, G., Hysolakoj, N., Bakiu, R., Mehillaj, T., Lazaj, L., Deng, H., Lusher, A., and Pojana, G., 2022. First Documented Uses of Caves along the Coast of Albania by Mediterranean Monk Seals (*Monachus monachus*, Hermann 1779): Ecological and Conservation Inferences. Animals-Basel 12.

Carlyle, C. G., Roth, J. D., Yurkowski, D. J., Kohlbach, D., Young, B. G., Brown, T. A., Riget, F. F., Dietz, R. and Ferguson, S. H. 2022. Spatial variation in carbon source use and trophic position of ringed seals across a latitudinal gradient of sea ice. Ecological Indicators, 145:109746.

Carpentieri, P., Nastasi, A., Sessa, M., and Srour, A. (eds) 2021. Incidental catch of vulnerable species in Mediterranean and Black Sea Fisheries - a review. Studies and Reviews No. 101 (General Fisheries Commission for the Mediterranean), FAO, Rome. https://doi.org/10.4060/cb5405en. 308pp.

Carroll, E. L., Hall, A., Olsen, M. T., Onoufriou, A. B., Gaggiotti, O. E., and Russell, D. J. F. 2020. Perturbation drives changing metapopulation dynamics in a top marine predator, Proceedings of the Royal Society B.

Carter, M. I. D., Boehme, L., Duck, C. D., Grecian, W. J., Hastie, G. D., McConnell, B. J., Miller, D. L., Morris, C. D., Moss, S. E. W., Thompson, D., Thompson, P. M., and Russell, D. J. F. 2020. Habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles. Report to BEIS, OESEA-16-76/OESEA-17-78, Sea Mammal Research Unit, University of St Andrews.

Cebrian, D. 1998. La foca monje (*Monachus monachus*) (Hermann 1779) en ef Mediterráneo Oriental (Grecia y Croacia). PhD thesis, Complutense University of Madrid, Spain.

Cebrian, D. and Vlachoutsikou, A. 1994 The Mediterranean monk seal on Zakynthos island, Greece 1992-1993. In Report of the WWF Integrated Ionian Project for the Study and Conservation of the monk Seal in Zakynthos, pp. 1-17. Report No. GR0034.02. WWF-Greece, Athens.

CEC 2002. Incidental catches of small cetaceans. Report of the second meeting of the subgroup on fishery and the environment (SGFEN) of the Scientific, Technical and Economic Committee for Fisheries (STECF). SEC (2002) 1134, Commission of the European Communities, Brussels, Belgium. 63pp.

Cerca, J., Westbury M., Heide-Jørgensen M. P., Kovacs K., Lorenzen E., Lydersen C., Shpak O., *et al.*, 2022. High genomic diversity in the endangered East Greenland Svalbard Barents Sea stock of bowhead whales (*Balaena mysticetus*). Scientific Reports. 12. 6118. 10.1038/s41598-022-09868-5.

Chambault, P., Kovacs, K. M., Lydersen, C., Shpak, O., Teilmann, J., Albertsen, C. M., and Heide-Jørgensen, M. P. 2022. Future seasonal changes in habitat for Arctic whales during predicted ocean warming. Science Advances, 8(29), eabn2422. https://doi.org/10.1126/sciadv.abn2422

Chavez-Rosales, S., Lyssikatos, M. C., and Hatch, J. 2017. Estimates of cetacean and pinniped bycatch in Northeast and Mid-Atlantic bottom trawl fisheries, 2012–2016. US Dept. of Commerce, Northeast Fisheries Science Center Ref Document.

Chicco, C. 2022. Acoustic Analysis of *Megaptera novaeangliae* in Southern Iceland. Masters in Environmental Biology, University of Turin, Italy, 79 pp.

Cornax, M. J. and Pardo, E. 2009. *Adrift Swordfish and driftnets in the Mediterranean Sea. Oceana-MarViva Mediterranean Sea Project 2008*. Oceana, Madrid, Spain.

Corr, S., Dudley, R., Brereton, T., Clear, N., Crosby, A., Duncan, S., Durban, J., Evans, P. G. H., Jones, D., Sayer, S., Taylor, T., Tregenza, N., Williams, R., Witt, M. J., and Ingram, S. N. 2023. Using citizen science data to assess the vulnerability of bottlenose dolphins to human impacts along England's south and west coast. Animal Conservation (in press).

Cosgrove, R., Cronin, M., Reid, D., Gosch, M., Sheridan, M., Chopin, N., and Jessopp, M. 2013. Seal depredation and bycatch in set net fisheries in Irish waters. Fisheries Resource Series, Vol. 10. 38pp.

Cosgrove, R., Gosch, M., Reid, D., Sheridan, M., Chopin, N., Jessopp, M., and Cronin, M. 2016. Seal bycatch in gillnet and entangling net fisheries in Irish waters. Fisheries Research, 183: 192-199.

Couperus, A. S. 1994. Killer whales (*Orcinus orca*) scavenging on discards of freezer trawlers north-east of the Shetland islands. *Aquatic Mammals*, 20: 47-51.

Couperus, A. S. 1997. Interactions between Dutch midwater trawl and Atlantic white-sided dolphins (*Lagenorhynchus acutus*) southwest of Ireland. *Journal of Northwest Atlantic Fishery Science*, 22: 209-218.

Covelo, P., Ocio, G., and Hidalgo, J. 2017. First record of a live blue whale (*Balaenoptera musculus*) in the Iberian Peninsula after three decades. Galemys 29, 34–37.

Danish Environmental Protection Agency. 2020. Forvaltningsplan for sæler 2020. Miljø- og Fødevareministeriet. Miljøstyrelsen. 38 pp + 8 appendices.

Danyer, E., Danyer, I. A., Tonay, A. M., Erol, U. & Dede, A. 2018. Stranding records of Mediterranean monk seal Monachus monachus (Hermann, 1779) on the Aegean and Mediterranean Sea coasts of Turkey between 2012 and 2018. Journal of Black Sea/Mediterranean Environment, 24(2), 128–139.

David, L., Dhermain, E., Chenoz, M., and Dalègre, K. 2010. Synthèse des études scientifiques entrrprises pendant six ans sur la pêche méditerranéenne de la <<thonaille >>: capture accidentelles et solutions. In T. Yamane, J. Sacchi, F. Poisson, eds. Proceedings of the French-Japanese Symposium, Ifremer, Sète, France, 1-3 September 2010; How minimizing the footprint of aquaculture and fisheries on the ecosystem? Pp. 159-163. Ifremer, Bres, France.

de la Vega, C., Buchanan, P. J., Tagliabue, A., Hopkins, J. E., Jeffreys, R. M., Frie, A. K., Biuw, M. *et al.*, 2022. Multi-decadal environmental change in the Barents Sea recorded by seal teeth. Global Change Biology, 28, 3054-3065. https://doi.org/10.1111/gcb.16138

de Larrinoa, P. F., Baker, J. D., Cedenilla, M. A., Harting, A. L., Haye, M. O., Munoz, M., M'Bareck, H. *et al.*, 2021. Age-specific survival and reproductive rates of Mediterranean monk seals at the Cabo Blanco Peninsula, West Africa. Endangered Species Research, 45, 315-329.

Deaville, R. (compiler) 2018. UK Cetacean Strandings Investigation Programme Final report for the period 1st January 2011 - 31st December 2017. Zoological Society of London, UK.

Delarue, J. J-Y., Moors-Murphy, H., Kowarski, K. A., Davis, G. E., Urazghildiiev, I. R., and Martin, S. B. 2022. Acoustic occurrence of baleen whales, particularly blue, fin, and humpback whales, off eastern Canada, 2015-2017. Endangered Species Research, 47, 265-289.

Desclos-Dukes, L., Butterworth, A., and Cogan, T. 2022. Using a non-invasive technique to identify suspected microplastics in grey seals (*Halichoerus grypus*) living in the western North Sea. Vet Rec 190.

Desforges, J.-P., Hall, A., McConnell, B., Rosing-Asvid, A., Barber, J. I., Brownlow, A., De Guise, S. *et al.*, 2018. Predicting global killer whale population collapse from PCB pollution. *Science*, 361: 1373-1376.

DFO, 2022. Stock assessment of Northwest Atlantic grey seals (*Halichoerus grypus*) in Canada in 2021, In: 2022/018, S.A.R. (Ed.), DFO Can. Sci. Advis. Sec. Res.Doc.. 30 pp.

Dietz, R., Letcher, R. J., Aars, J., Andersen, M., Boltunov, A., Born, E. W., Ciesielski, T. M., Das, K., Dastnai, S., Derocher, A. E., Desforges, J.-P., Eulaers, I., Ferguson, S., Hallanger, I. G., Heide-Jørgensen, M. P., Heimbürger-Boavida, L.-E., Hoekstra, P. F., Jenssen, B. M., Kohler, S. G., Larsen, M. M., Lindstrøm, U., Lippold, A., Morris, A., Nabe-Nielsen, J., Nielsen, N. H., Peacock, E., Pinzone, M., Rigét, F. F., Rosing-Asvid, A., Routti, H., Siebert, U., Stenson, G., Stern, G., Strand, J., Søndergaard, J., Treu, G., Víkingsson, G. A., Wang, F., Welker, J. M., Wiig, Ø., Wilson, S. J., and Sonne, C., 2022. A risk assessment review of mercury exposure in Arctic marine and terrestrial mammals. Science of The Total Environment 829, 154445.

Di Natale, A. 1995. Driftnets impact on protected species: observer data from the Italian fleet and proposal for a model to assess the number of cetaceans in the bycatch. *Collective Volume of Scientific Papers ICCAT*, 44: 255-263.

Di Natale, A., and Mangano, A. 1981. Report of the progress of Project Cetacea. VI. July 1978-October 1981. Special supplement, *Memorie di Biologia Marina e di Oceanografica*, 11: 1-49.

Di Natale, A., and Mangano, A. 1982. Report on the progress of the Project Cetacea. VI. July 1978-October 1981. Special supplement, *Memorie di Biologia Marina e di Oceanografica*, 9 (Suppl. Spec.): 1-9.

Di Natale, A., and Mangano, A. 1983a. Killer whale *Orcinus orca* (Linnaeus) and false killer whale *Pseudorca crassidens* (Owen), in the Italian seas. *Rapports et procès-verbaux des reunion de la Commission international pour l'exploration scientifique de la mer Méditerranée*, 28(5): 181-182. CIESM, Monte-Carlo, Monaco.

Di Natale, A., and Mangano, A. 1983b. Biological and distribution new data on the sperm whale, Physeter microcephalus, in the Central Mediterranean Sea. *Rapports et procès-verbaux des reunion de la Commission international pour l'exploration scientifique de la mer Méditerranée*, 28(5): 183-184. CIESM, Monte-Carlo, Monaco.

Dias, I. C., Marçalo, A., Feijó, D., Domingos, I., and Silva, A. A. 2022. Interactions between the common dolphin, Delphinus delphis, and the Portuguese purse seine fishery over a period of 15 years (2003–2018). *Aquatic Conservation: Marine and Freshwater Ecosystems*, *32*(8), 1351-1364. https://doi.org/10.1002/aqc.3828

Díaz López, B. 2006. Interactions between Mediterranean bottlenose dolphins (*Tursiops truncatus*) and gillnets off Sardinia. *ICES Journal of Marine Science*, 63: 946-951.

Díaz López, B. and Bernal Shirai, J.A. 2007. Bottlenose dolphin (*Tursiops truncatus*) presence and incidental capture in a marine fish farm on the northeastern coast of Sardinia (Italy). *Journal of the Marine Biological Association of the United Kingdom*, 87: 113-117.

Díaz López, B., Methion, S., Giralt Paradell, O., and Mosca, O. 2021. Proyecto BALAENATUR: seguimiento del rorcual azul en la red Natura 2000. Bottlenose Dolphin Research Institute, O Grove. 44pp.

Dietz, R., Letcher, R. J., Aars, J., Andersen, M., Boltunov, A., Born, E. W., Ciesielski, T. M., Das, K., Dastnai, S., Derocher, A. E., Desforges, J.-P., Eulaers, I., Ferguson, S., Hallanger, I. G., Heide-Jørgensen, M. P., Heimbürger-Boavida, L.-E., Hoekstra, P. F., Jenssen, B. M., Kohler, S. G., Larsen, M. M., Lindstrøm, U., Lippold, A., Morris, A., Nabe-Nielsen, J., Nielsen, N. H., Peacock, E., Pinzone, M., Rigét, F. F., Rosing-Asvid, A., Routti, H., Siebert, U., Stenson, G., Stern, G., Strand, J., Søndergaard, J., Treu, G., Víkingsson, G. A., Wang, F., Welker, J. M., Wiig, Ø., Wilson, S. J., and Sonne, C., 2022. A risk assessment review of mercury exposure in Arctic marine and terrestrial mammals. Science of The Total Environment, 829, 154445.

Dudley, R. H. 2017. Using citizen science data to assess the social structure, residency and distribution of bottlenose dolphins (*Tursiops truncatus*) in Southwest England. [Master's Thesis]. University of Plymouth, Plymouth.

Duguy, R., Besson, J., Casinos, A., Di Natale, A., Filella, S., Raduan, A., Raga, J., *et al.*, 1983a. L'impact des activités humaines sur les cétacés de la Méditeranée Occidentale. *Rapports et procès-verbaux des reunions de la Commission international pour l'exploration scientifique de la mer Méditerranée*, 28: 219-222. CIESM, Monte-Carlo, Monaco.

Duguy, R., Casinos, A., Di Natale, A., Filella, S., Ktari-Chakroun, F., Lloze, R., and Marchessaux, D. 1983b. Répartition et frequence des mammifères marins en Méditerranée. *Rapports et procès-verbaux des reunions de la Commission international pour l'exploration scientifique de la mer Méditerranée*, 28: 223-230. CIESM, Monte-Carlo, Monaco.

Ellis, G. 2022. 'From Tayside to Scarborough', Citizen Fins Blog, March 2022. Available at https://citizenfins.wp.st-andrews.ac.uk/2022/03/11/from-tayside-to-scarborough/

Elnes, J. O., Moan, A., Nilssen, K.T., Vøllestad, A., and Bjørge, A. 2023. Temporal and Spatial Distribution of Harbor Seal *Phoca vitulina* Risk of Entanglement in Gillnets at the Norwegian Coas. In preparation.

Elwen, S. H., and Gridley, T. E. 2013. Gray whale (*Eschrichtius robustus*) sighting in Namibia (SE Atlantic)–first record for Southern Hemisphere. International Whaling Commission Scientific Committee SC/65a/BRG30.

Esteban, R., López, A., de los Rios, Á. G., Ferreira, M., Martinho, F., Méndez-Fernandeza, P., Andréu, E. *et al.*, 2022. Killer whales of the Strait of Gibraltar, an endangered subpopulation showing a disruptive behavior. Marine Mammal Science, 38 4), 1699-1709.

Esteban, R., Verborgh, P., Gauffier, P., Alarcón, D., Salazar-Sierra, J. M., Giménez, J., Foote, A. D., and De Stephanis, R. 2016. Conservation status of killer whales, *Orcinus orca*, in the Strait of Gibraltar. Advances in Marine Biology, 75, 141-172.

Estes, J. A., Heithaus, M., McCauley, D. J., Rasher, D. B., and Worm, B. 2016. Megafaunal Impacts on Structure and Function of Ocean Ecosystems. Annual Review of Environment and Resources, 41(1), 83-116. https://doi.org/10.1146/annurev-environ-110615-085622

EU, 2019. Regulation (EU) 2019/1241 of the European Parliament and of the Council of 20 June 2019 on the conservation of fisheries resources and the protection of marine ecosys- tems through technical measures, amending Council Regulations (EC) No 1967/2006, (EC) No 1224/2009 and Regulations (EU) No 1380/2013, (EU) 2016/1139, (EU) 2018/973, (EU) 2019/472 and (EU) 2019/1022 of the European Parliament and of the Council, and repealing Council Regulations (EC) No 894/97, (EC) No 850/98, (EC) No 2549/2000, (EC) No 254/2002, (EC) No 812/2004 and (EC) No 2187/2005 Page OJ L.

Evans, P. G. H. 2020. *European Whales, Dolphins and Porpoises*. *Marine Mammal Conservation in Practice*. Academic Press, London & New York. 306pp.

Evans, P. G. H. and Waggitt, J. J. 2020. Cetaceans. Pp. 134-184. In: Crawley, D., Coomber, F., Kubasiewicz, L., Harrower, C., Evans, P., Waggitt, J., Smith, B., and Mathews, F. (Editors) *Atlas of the Mammals of Great Britain and Northern Ireland*. Published for The Mammal Society by Pelagic Publishing, Exeter. 205pp.

Evans, P. G. H. and Waggitt, J. J. 2023. *Modelled distributions and abundance of cetaceans and seabirds of Wales and surrounding waters*. NRW Evidence Report No. 646. 354pp.

Evans, P. G. H., Carrington, C., and Waggitt, J. 2021. Risk Assessment of Bycatch of Protected Species in Fishing Activities. European Commission, Brussels. 213pp. https://ec.europa.eu/environment/nature/natura2000/marine/docs/RISK MAPPING REPORT.pdf

Facciola, N., Houde, M., Muir, D. C., Ferguson, S. H., and McKinney, M. A. 2022. Feeding and contaminant patterns of sub-arctic and arctic ringed seals: Potential insight into climate change-contaminant interactions. Environmental Pollution 313, 120108.

FAO 2020. The State of Mediterranean and Black Sea Fisheries. General Fisheries Commission for the Mediterranean. Food & Agriculture Organisation, Rome, Italy. https://www.fao.org/documents/card/en/c/cb2429en. 172pp.

Fernandez, M., Alves, F., Ferreira, R., Fischer, J.-C.,Thake, P., Nunes, N., Caldeira, R., and Dinis, A. 2021. Modeling fine-scale cetaceans'distributions in oceanic islands : Madeira archipelago as a case study. Frontiers in Marine Science 8 :688248. Doi : 10.3389/fmars.2021.688248.

Ferreira, M. 2007. Ocorrência e captura acidental de cetáceos no Centro/Norte de Portugal. MSc dissertation, Schoolof Sciences, University of Minho, Minho. 92pp.

Fietz, K., Galatius, A., Teilmann, J., Dietz, R., Frie, A. K., Klimova, A., Palsbøll, P. J., *et al.*,2016. Shift of grey seal subspecies boundaries in response to climate, culling and conservation. Molecular Ecology 25(17):4097–4112. doi:10.1111/mec.13748.

Findlay, C. R., Hastie, G. D., Farcas, A., Merchant, N. D., Risch, D., and Wilson, B. 2022. Exposure of individual harbour seals (*Phoca vitulina*) and waters surrounding protected habitats to acoustic deterrent noise from aquaculture. Aquatic Conservation, 32, 766-780.

Flanders, K. R., Olson, Z. H., and Ono, K. A., 2020. Utilizing next-generation sequencing to identify prey DNA in western North Atlantic grey seal *Halichoerus grypus* diet. Marine Ecology Progress Series, 655, 227-240.

Fontaine, M. C., Snirc, A., Frantzis, A., Koutrakis, E., Özturk, B., Özturk, A. A. *et al*. 2012. History of expansion and anthropgenic collapse in a top marine predator of the Black Sea estimated from genetic data. *Proceedings of the National Academy of Sciences*, 109(38), E2569-E2576. Doi: 10.1073/pnas.1201258109.

Ford, J. K., Ellis, G. M., Barrett-Lennard, L. G., Morton, A. B., Palm, R. S., and Balcomb III, K. C. 1998. Dietary specialization in two sympatric populations of killer whales (*Orcinus orca*) in coastal British Columbia and adjacent waters. Canadian Journal of Zoology, 76(8), 1456-1471. https://doi.org/10.1139/z98-089

Fortuna, C. M., Vallini, C., Filidei Jr, E., Ruffino, M., Consalvo, I., Di Muccio, S., Gion, C., Scacco, U., Tarulli, E., and Giovanardi, O., 2010. By-catch of cetaceans and other species of conservation concern during pair trawl fishing operations in the Adriatic Sea (Italy). Chemistry and Ecology 26, 65-76.

Gabel, M., Theisen, S., Palm, H. W., Dähne, M., and Unger, P. 2021. Nematode parasites in Baltic Sea mammals, grey seal (*Halichoerus grypus* (Fabricius, 1791)) and harbour porpoise (*Phocoena phocoena* (L.)), from the German coast. Acta Parasitologica, 66, 26-33.

Galatius, A., Brasseur, S., Carius, F., Jeß, A., Meise, K., Meyer, J., Schop, J., *et al.*, 2022a. Survey Results of Harbour Seals in the Wadden Sea in 2022, In: Common Wadden Sea Secretariat, W., Germany. (Ed.).

Galatius, A., Engbo, S. G., Teilmann, J., and van Beest, F. 2021. 'Using environmental variation to optimize aerial surveys of harbour seals', ICES Journal of Marine Science. https://doi.org/10.1093/icesjms/fsab041

Galatius, A., Svendsen, M. S., Messer, D., Valtonen, M., McGowen, M., Sabin, R., Dahl, V. A., Dahl, A. B., and Olsen, M. T., 2022b. Range-wide variation in grey seal (*Halichoerus grypus*) skull morphology. Zoology 153.

Galatius, A., Teilmann, J., Dähne, M., Ahola, M., Westphal, L., Kyhn, L. A., Pawliczka, I., *et al.*, 2020. Grey seal *Halichoerus grypus* recolonisation of the southern Baltic Sea, Danish Straits and Kattegat. Wildlife Biology, 2020(4). https://doi.org/10.2981/wlb.00711

Gallagher, C. A., Chimienti, M., Grimm, V., and Nabe-Nielsen, J. 2022. Energy-mediated responses to changing prey size and distribution in marine top predator movements and population dynamics. Journal of Animal Ecology, 91(1), 241-254.

García-Garín, O., Sahyoun, W., Net, S., Vighi, M., Aguilar, A., Ouddane, B., and Borrell, A. 2022. Intrapopulation and temporal differences of phthalate concentrations in North Atlantic fin whales (*Balaenoptera physalus*). Chemosphere, 300, 134453.

García-Vernet, R., Aguilar, A., Zafra, J., Víkingsson, G., Halldórsson, S. D., and Borrell, A. 2022. Sulfur stable isotope ratios provide further insight into movements of the fin whale, an oceanic long-range migrant. Marine Ecology Progress Series, 692, 185-194.

Gaskin, D. E. 1992. Status of the Atlantic white-sided dolphin, *Lagenorhynchus acutus*, in Canada. *Canadian Field-Naturalist, 106:* 64-72.

Grecian, W. J., Stenson, G. B., Biuw, M., Boehme, L., Folkow, L. P., Goulet, P. J., Jonsen, I. D., Malde, A., Nordøy, E. S., and Rosing-Asvid, A., 2022. Environmental drivers of population-level variation in the migratory and diving ontogeny of an Arctic top predator. Royal Society Open Science 9, 211042.

Gilbert, J. R. and Wynne, K. M. 1987. Marine Mammal Interactions with New England Gillnet Fisheries. Report for the U.S. National Marine Fisheries Service Northeast Fisheries Science Center, Woods Hole, Massachusetts, Contract No.NA-84-EA-C-00070.

Goetz, S., Read, F. L., Santos, M. B., Pita, C. and Pierce, G. J. 2014. Cetacean–fishery interactions in Galicia (NW Spain): results and management implications of a face-to-face interview survey of local fishers. *ICES Journal of Marine Science*, 71: 604-617.

Goldsworthy, S. D., Page, B., Hamer, D. J., Lowther, A. D., Shaughnessy, P. D., Hindell, M. A., Burch, P., Costa, D. P., Fowler, S. L., and Peters, K., 2022. Assessment of Australian sea lion bycatch mortality in a gillnet fishery, and implementation and evaluation of an effective mitigation strategy. Frontiers in Marine Science, 53.

Gonzalvo, J., Valls, M., Cardona, L., and Aguilar, A. 2008. Factors determining the interaction between common bottlenose dolphin and bottom trawlers off the Balearic Archipelago (western Mediterranean Sea). Journal of Experimental Marine Biology and Ecology, 36(1): 47-52.

Goodman, S. J., 1998. Patterns of extensive genetic differentiation and variation among European harbor seals (*Phoca vitulina vitulina*) revealed using microsatellite DNA polymorphisms. Molecular Biology and Evolution 15, 104-118.

Gose, M-A, Humble, E., Brownlow, A., Mikkelsen, B., Loftus, C., Wall, D., Rogan, E., ten Doeschate, M., Davison, N., and Ogden, R. 2023. Stranding collections indicate broad-scale connectivity across the range of a pelagic marine predator, the Atlantic white-sided dolphin (*Lagenorhynchus acutus*), ICES Journal of Marine Science, 2023; fsad050, https://doi-org.ezproxy.library.wur.nl/10.1093/icesjms/fsad050

Government of Åland. 2007. Förvaltningsplan för gråsälen på Åland. 56pp.

Graham, I. M., Merchant, N. D., Farcas, A., Barton, T. R., Cheney, B., Bono, S., Thompson, P. M., 2019. Harbour porpoise responses to pile-driving diminish over time. Royal Society Open Science, 6, 190335.

Graham, I. M., Gillespie, D., Gkikopoulou, K. C., Hastie, G. D., and Thompson, P. M. 2023. Directional hydrophone clusters reveal evasive responses of small cetaceans to disturbance during construction at offshore windfarms. Biology Letters, 19(1), 20220101. https://doi.org/10.1098/rsbl.2022.0101

Granquist, S. M. 2021 *The Icelandic harbour seal (Phoca vitulina): Population estimate in 2020, summary of trends and the current status*. (HV 2019-36). Marine and Freshwater Research Institute, Reykjavik, Iceland.

Granquist, S. M. 2022. The Icelandic harbour seal (*Phoca vitulina*) population: trends over 40 years (1980–2020) and current threats to the population. NAMMCO Scientific Publications, 12.

Granquist, S.M. and Hauksson, E. 2019 Aerial census of the Icelandic grey seal (*Halichoerus grypus*) population in 2017: Pup production, population estimate, trends and current status [Útselstalning 2017: Stofnstærðarmat, sveiflur og ástand stofns]. Marine and Freshwater Research Institution, HV 2019-02. Reykjavík 2019. 19pp.

Granquist, S.M. and Hauksson, E. 2019. Population estimate, trends and current status of the Icelandic harbour seal (*Phoca vitulina*) population in 2018 [Landselstalning 2018: Stofnstærðarmat, sveiflur og ástand stofns]. Marine and Freshwater Research Institution, HV 2019-36. Reykjavík 2019. 22pp.

Grecian, W. J., Stenson, G. B., Biuw, M., Boehme, L., Folkow, L. P., Goulet, P. J., *et al.*2022. Environmental drivers of population-level variation in the migratory and diving ontogeny of an Arctic top predator. *Royal Society Open Science*, *9*(3), 211042.

Grellier, K., and Hammond, P. S. 2006. Robust digestion and passage rate estimates for hard parts of grey seal (*Halichoerus grypus*) prey. Canadian Journal of Fisheries and Aquatic Sciences, 63(9), 1982-1998.

Güçlüsoy, H., Kirac, C. O., Savas, Y., and Veryeri, N. O. 2004. Status of the Mediterranean Monk Seal *Monachus monachus* (Hermann, 1779) in the Coastal waters of Turkey. Ege University Journal of Fisheries and Aquatic Sciences, 2004. Cilt/Volume 21, Says/No (3-4), 201-210.

Guinet, C., Domenici, P., de Stephanis, R., Barrett-Lennard, L., Ford, J. K. B., and Verborgh, P. 2007. Killer whale predation on blue fin tuna: exploring the hypothesis of the endurance-exhaustion technique. Marine Biology Progress Series, 347: 111-119.

Gutiérrez-Muñoz, P., Walters, A. E., Dolman, S. J., and Pierce, G. J. 2021. Patterns and Trends in Cetacean Occurrence Revealed by Shorewatch, a Land-Based Citizen Science Program in Scotland (United Kingdom). Frontiers in Marine Science, 8.

Hackett, K. 2022. Movement and Ecology of Bottlenose Dolphins (*Tursiops truncatus*) along the North-East Coast of the UK. MSc Thesis, Bangor University.

Haelters, J., Kerckhof, F., and Brasseur, S., 2022b. High prevalence of head and neck lesions in stranded seals: cause of death? Lutra 65(2): 271-283.

Haelters, J., Moreau, K., Team Sealife, Jauniaux, T., and Kerckhof, F., 2022a. Strandingen en waarnemingen van zeezoogdieren in België in 2021 [Strandings and sightings of marine mammals in Belgium in 2021]. Koninklijk Belgisch Instituut voor Natuurwetenschappen (KBIN), Brussel. 34 pp.

Hague, E. L., Sparling, C. E., Morris, C., Vaughan, D., Walker, R., Culloch, R. M., Lyndon, A. R., Fernandes, T. F., and Mcwhinnie, L. H. 2022. Same Space, Different Standards: A Review of Cumulative Effects Assessment Practice for Marine Mammals. Frontiers in Marine Science, 9(822467). https://doi.org/10.3389/fmars.2022.822467

Hale, R., Pires, R., Santos, P., and Karamanlidis, A. A. 2011. Mediterranean Monk Seal (*Monachus monachus*): Fishery interactions in the archipelago of Madeira. *Aquatic Mammals*, 37(3): 298-304.

Halliday, W. D., Le Baron, N., Citta, J. J., Dawson, J., Doniol-Valcroze, T., Ferguson, M., Ferguson, S. G., Fortune, S., Harwood, L. A., Heide-Jørgensen, M. P., Lea, E. V., Quakenbush, L., Young, B. G., Yurkowski, D., and Insley, S. J. 2022. Overlap between bowhead whales (Balaena mysticetus) and vessel traffic in the North American Arctic and implications for conservation and management. Biological Conservation 276.

Hamilton, C. D., Lydersen, C., Aars, J., Acquarone, M., Atwood, T., Baylis, A., and Kovacs, K. M. 2022. Marine mammal hotspots across the circumpolar Arctic. Diversity and Distributions.

Hammond, P.S., Lacey, C., Gilles, A., Viquerat, S., Börjesson, P., Herr, H., Macleod, K., Ridoux, V., Santos, M. B., Scheidat, M., Teilmann, J., Vingada, J., and Øien, N. 2021. Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys. Final Report, University of St Andrews, Scotland. Available at: https://synergy.standrews.ac.uk/scans3/files/2017/04/SCANS-III-design-based-estimates-2017-04-28- final.pdf

Harding, K. C., and Härkönen, T. J., 1999. Development in the Baltic grey seal (*Halichoerus grypus*) and ringed seal (*Phoca hispida*) populations during the 20th century. Ambio 28, 619-627.

Hårding, K. C., Heide-Jørgensen M. P., and Lage, J. 2022. On the availability bias in narwhal abundance estimates. NAMMCO Scientific Publications. NAMMCO Scientific Publications 12. https://doi.org/10.7557/3.6518

Härkönen, T. J. 1999. Development in the Baltic grey seal (*Halichoerus grypus*) and ringed seal (*Phoca hispida*) populations during the 20th century. Ambio, 28: 619-625.

Härkönen, T., Dietz, R., Reijnders, P., Teilmann, J., Harding, K., Hall, A., Brasseur, S., Siebert, U., Goodman, S. J., Jepson, P. D., Rasmussen, T. D., and Thompson, P., 2006. The 1988 and 2002 phocine distemper virus epidemics in European harbour seals. Diseases of Aquatic Organisms 68, 115-130.

Härkönen, T., Harding, K., Rasmussen, T. D., Teilmann, J., and Dietz, R., 2007a. Age- and sex-specific mortality patterns in an emerging wildlife epidemic: the phocine distemper in European harbour seals. PLoS One 2, e887.

Härkönen, T., Brasseur, S. M. J. M., Teilmann, J., Vincent, C., Dietz, R., Abt, K., and Reijnders, P. J. H., 2007b. Status of grey seals along mainland Europe from the Southwestern Baltic to France, Grey Seals in the North Atlantic and the Baltic, NAMMCO, Polar Environmental Centre, Tromso, Norway, pp. 57-68.

Harris, G. 2022. Humpback Whale Ecology, Movement and Distribution in the UK. MSc Thesis, Bangor University.

Harwood, J., King, S. L., Schick, R. S., Donovan, C., and Booth, C. G. 2014. A protocol for implementing the interim population consequences of disturbance (PCoD) approach: Quantifying and assessing the effects of UK offshore renewable energy developments on marine mammal populations. Report SMRUL-TCE-2013-014. In Scottish Marine and Freshwater Science (Vol. 5, Issue 2).

Hastie, G. D., Lepper, P., McKnight, J. C., Milne, R., Russell, D. J. F., and Thompson, D. 2021. Acoustic risk balancing by marine mammals: anthropogenic noise can influence the foraging decisions by seals. Journal of Applied Ecology 58:1854-1863.

Haverkamp, H., Chang, H.-Y., Newcomb, E., Doughty, L., Walk, D., Seton, R., Jones, L. S., Todd, S., and Cammen, K. M., 2023. A retrospective socio-ecological analysis of seal strandings in the Gulf of Maine. Marine Mammal Science 39, 232-250.

Heide-Jørgensen, M. P., and Härkönen, T. J. 1988. Rebuilding seal stocks in the Kattegat-Skagerrak. Marine Mammal Science, 4: 231-246.

Heide-Jørgensen, M. P., and Lage, J. (2022). On the availability bias in narwhal abundance estimates. NAMMCO Scientific Publications, 12.

HELCOM 2018 State of the Baltic Sea – Second HELCOM holistic assessment 2011-2016. Baltic Sea Environment Proceedings. 155pp.

HELCOM 2021. Bycatch in Baltic Sea commercial fisheries: High-risk areas and evaluation of measures to reduce bycatch. HELCOM, Helsinki, Finland. 76pp.

HELCOM 2022. Status of national management plans for marine mammals. HELCOM EG MAMA 1-2022. 8 pp.

Hoekstein, M. S. J., Sluijter, M., and Van Straalen, K. D. (2022). Watervogels en zeezoogdieren in de Zoute Delta 2020/2021. Rijkswaterstaat, Centrale informatievoorziening. Deltamilieu Projecten, Vlissingen, Deltamilieu Projecten Rapportnr, 1.

Hoelzel, A. R., Sarigol, F., Gridley, T., and Elwen, S. H. 2021. Natal origin of Namibian grey whale implies new distance record for in-water migration. Biology Letters, 17(6), 20210136.

Holt, R. D. 1977. Predation, apparent competition, and the structure of prey communities. Theoretical population biology, 12(2), 197-229. https://doi.org/10.1016/0040-5809(77)90042-9

Holt, R. D., and Polis, G. A. 1997. A theoretical framework for intraguild predation. The American Naturalist, 149(4), 745-764. https://doi.org/10.1086/286018

Hurk, Y. van den. 2020. On the Hunt for Medieval Whales: Zooarchaeological, Historical, and Social Perspectives on Cetacean Exploitation in Medieval Northern and Western Europe. British Series, UCL Institute of Archaeology Series. Oxford: BAR publishing. https://doi.org/10.30861/9781407357201

Hurk, Y. van den, Spindler, L., McGrath, K., and Speller, C. 2020. Medieval Whalers in the Netherlands and Flanders: Zooarchaeological Analysis of Medieval Cetacean Remains. Environmental Archaeology: The Journal of Human Palaeoecology, 27(3): 243-257. https://doi.org/10.1080/14614103.2020.1829296

IAMMWG. 2015. Management Units for cetaceans in UK waters (January 2015). JNCC Report No. 547, JNCC Peterborough.

IAMMWG. 2023. Review of Management Unit boundaries for cetaceans in UK waters (2023). JNCC Report 734, JNCC, Peterborough, ISSN 0963-8091

ICES 1995. Report of the Study Group on Seals and Small Cetaceans in European Seas. International Council for the Exploration of the Seas, Copenhagen. 22pp (+41pp Appendices).

ICES 2010. NAMMCO/ICES Report of the Joint Workshop on observation schemes for by-catch of mammals and birds (WKOSBOMB). International Council for the Exploration of the Seas, Copenhagen. 40pp.

ICES 2011. Report of the Working Group on Bycatch of Protected Species (WGBYC 2011), 1-4 February 2011, ICES HQ, Copenhagen, Denmark. ICES CM 2011/ACOM:26. 75pp.

ICES 2012. Report of the Working Group on Bycatch of Protected Species (WGBYC 2012), 7-10 February 2012, ICES HQ, Copenhagen, Denmark. ICES CM 2012/ACOM:28. 67pp.

ICES 2013. Report of the Working Group on Bycatch of Protected Species (WGBYC), 4-8 February 2013, ICES HQ, Copenhagen, Denmark. ICES CM 2013/ACOM:27. 73pp.

ICES 2014. Report of the Working Group on Bycatch of Protected Species (WGBYC), 4-7 February 2014, ICES HQ, Copenhagen, Denmark. ICES CM 2014/ACOM:28. 93pp.

ICES 2015. Report of the Working Group on Bycatch of Protected Species (WGBYC), 2-6 February 2015, ICES HQ, Copenhagen, Denmark. ICES CM 2015/ACOM:26. 82pp.

ICES 2016a. Report of the Working Group on Bycatch of Protected Species (WGBYC), 1-5 February 2016, ICES HQ, Copenhagen, Denmark. ICES CM 2016/ACOM:27. 77pp.

ICES 2016b. OSPAR Request on indicator assessment of coastal bottlenose dolphins. ICES Special Request Advice. Northeast Atlantic Region. International Council for the Exploration of the Sea, Copenhagen. 14pp.

ICES 2017. Report of the Working Group on Bycatch of Protected Species (WGBYC), 12-15 June 2017, Woods Hole, Massachusetts, USA. ICES CM 2017/ACOM:24. 80pp.

ICES 2018. Report of the Working Group on Bycatch of Protected Species (WGBYC), 1–4 May 2018, Reykjavik, Iceland. ICES CM 2018/ACOM:25. 128pp.

ICES 2019. Report of the Working Group on Bycatch of Protected Species (WGBYC). ICES Scientific Reports. 1: 51. 163pp. http://doi.org/10.17895/ices.pub.5563

ICES. 2019. ICES/NAFO/NAMMCO Working Group on Harp and Hooded Seals (WGHARP). ICES Scientific Reports. 1:72. 193 pp. http://doi.org/10.17895/ices.pub.5617

ICES 2020a. Report of the Working Group on Bycatch of Protected Species (WGBYC), ICES Scientific Reports. 2:81. 209 pp. http://doi.org/10.17895/ices.pub.7471

ICES 2020b. 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). https://doi.org/10.17895/ices.pub.7472

ICES 2020c. EU request on emergency measures to prevent bycatch of common dolphin (*Delphinus delphis*) and Baltic Proper harbour porpoise (*Phocoena phocoena*) in the Northeast Atlantic. https://doi.org/10.17895/ICES.ADVICE.6023

ICES 2021a. Report of the Working Group on Bycatch of Protected Species (WGBYC), ICES Scientific Reports. 3:107. 175 pp. http://doi.org/10.17895/ices.pub.9256

ICES 2021b. Workshop on estimation of MOrtality of Marine MAmmals due to Bycatch (WKMOMA). ICES Scientific Reports. 3:106. 95pp. https://doi.org/10.17895/ices.pub.9257

ICES 2022a. Report of the Working Group on Marine Mammal Ecology (WGMME), ICES Scientific Reports. 4:61. 151pp. http://doi.org/10.17895/ices.pub.20448942

ICES 2022b. Report of the Working Group on Bycatch of Protected Species (WGBYC), ICES Scientific Reports. 4:91. 265 pp. http://doi.org/10.17895/ices.pub.21602322

ICES. 2014. Report of the Working Group on Marine Mammal Ecology (WGMME), 10–13 March 2014, Woods Hole, Massachusetts, USA. ICES CM 2014/ACOM:27. 232 pp.

IJsseldijk, L., Leopold, M., Begeman, L., Kik, M., Wiersma, L., Morell, M., Bravo Rebolledo, E.L., Jauniaux, T., Heesterbeek, H., and Gröne, A. 2022. Pathological findings in stranded harbor porpoises (*Phocoena phocoena*) with special focus on anthropogenic causes. Frontiers in Marine Science 9, 1-19.

Iverson, S. J., Field, C., Bowen, W. D., and Blanchard, W. 2004. Quantitative fatty acid signature analysis: A new method of estimating predator diets. Ecological Monographs 74:211–235.

Jacobs J., and Panou A. 1988. Conservation of the Mediterranean Monk Seal, *Monachus monachus*, in Kefalonia, Ithaca and Lefkada isl., Ionian Sea, Greece. Institute of Zoology, University of Munich, Germany, 128 p. + appendices. Final report, contract 6611/28 «Descriptive Analysis and Pilot Project for the Establishment of a Conservation Strategy for the Monk Seal and its Habitat», Institut Royal des Sciences Naturelles de Belgique, Brussels, Belgium. December 1988.

Jacobs, J., and Panou, A. (1992). "Project 3871: Monk Seal Conservation in the Eastern Mediterranean". WWF-Projekt, Statusreport (München, Deutschland: Universität München, Zoologisches Institut.

Jensen, M. R., Høgslund, S., Knudsen, S. W., Nielsen, J., Møller, P. R., Rysgaard, S., and Thomsen, P. F., 2023. Distinct latitudinal community patterns of Arctic marine vertebrates along the East Greenlandic coast detected by environmental DNA. Diversity and Distributions 29, 316-334

JNCC 2020. Guidance for assessing the significance of noise disturbance against Conservation Objectives of harbour porpoise SACs (England, Wales & Northern Ireland). JNCC Report No. 654, JNCC, Peterborough, ISSN 0963-8091.

Jog, K., Sutaria, D., Diedrich, A., Grech, A., and Marsh, H. 2022. Marine Mammal Interactions With Fisheries: Review of Research and Management Trends Across Commercial and Small-Scale Fisheries. Front. Mar. Sci. 9:758013. doi: 10.3389/fmars.2022.758013

Jüssi, M., Härkönen, T., Helle, E., and Jüssi, I., 2008. Decreasing ice coverage will reduce the breeding success of Baltic grey seal (*Halichoerus grypus*) females. AMBIO: A Journal of the Human Environment, 37(2), 80-85.

Karamanlidis, A. A. and Dendrinos, P. 2015. *Monachus monachus* (errata version published in 2017). The IUCN Red List of Threatened Species. 2015:e.T1365A117647375

Karamanlidis, A.A., Adamantopoulou, S., Tounta, E. & Dendrinos, P. 2019. Monachus monachus (Eastern Mediterranean subpopulation). The IUCN Red List of Threatened Species 2019: e.T120868935A120869697. https://dx.doi.org/10.2305/IUCN.UK.2019-1.RLTS.T120868935A120869697.en. Accessed on 30 September 2023.

Karamanlidis, A. A., Androukaki, E., Adamantopoulu, S., Chatzispyrou, A., Johnson, W. M., Kotomatas, S., Papadopoulos, A., Paravas, V., Paximadis, G., Pires, R., Tounta, E., and Dendrinos, P. 2008. Assessing accidental entanglement as a threat to the Mediterranean monk seal *Monachus monachus*. *Endangered Species Research*, 5: 205-213.

Karamanlidis, A. A., Dendrinos, P., Fernandez de Larrinoa, P., Gücü, A. C., Johnson, W. M., Kirac, C. O., and Pires, R. 2016. The Mediterranean monk seal *Monachus monachus*: status, biology, threats and conservation priorities. Mammal Review, 46(2): 92-105.

Karamanlidis, A. A., Skrbinsek, T., Amato, G., Dendrinos, P., Gaughran, S., Kasapidis, P., Kopatz, A., and Stronen, A. V. 2021. Genetic and demographic history define a conservation strategy for earth's most endangered pinniped, the Mediterranean monk seal *Monachus monachus*. Scientific Reports UK 11.

Kindt-Larsen, L., Berg, C. W., Northridge, S., and Larsen, F. 2019. Harbor porpoise (*Phocoena phocoena*) reactions to pingers. Marine Mammal Science, 35(2), 552-573.

Kindt-Larsen, L., Berg, C. W., Hedgärde, M., and Königson, S. 2023. Avoiding grey seal depredation in the Baltic Sea while increasing catch rates of cod. Fisheries Research, 261: 106609.

King, S. L., Schick, R. S., Donovan, C., Booth, C. G., Burgman, M., Thomas, L., and Harwood, J. 2015. An interim framework for assessing the population consequences of disturbance. Methods in Ecology and Evolution, 6, 1150–1158. https://doi.org/10.1111/2041-210X.12411

Kirac, C. O., Veryeri, N. O. and Savag, Y. 2020. Mediterranean monk seal bycatch along Turkish coasts. Technical Report Submitted to the Republic of Turkey. The Ministry of Agriculture & Forest – DG Fishery and Aqua Products by SAD-AFAG, 2 April 2020. 12pp.

Kokko, H., Helle, E., Lindström, J., Ranta, E., Sipilä, T., and Courchamp, F. 1999. Backcasting population sizes of ringed and grey seals in the Baltic and Lake Saimaa during the 20th century. Annales Zoologici Fennici, 36: 65-73.

Königson, S. J., Fredriksson, R. E., Lunneryd, S.-G., Strömberg, P., and Bergström, U. M. 2015. Cod pots in a Baltic fishery: are they efficient and what affects their efficiency? Ices Journal of Marine Science, 72: 1545-1554.

Königson, S., Naddafi, R., Hedgärde, M., Pettersson, A., Östman, Ö., Benavente Norrman, E., and Amundin, M. 2022. Will harbor porpoises (*Phocoena phocoena*) be deterred by a pinger that cannot be used as a "dinner bell" by seals? Marine Mammal Science, 38(2), 469-485. https://doi.org/10.1111/mms.12880

Koroza, A., and Evans, P. G. H. 2022. Bottlenose Dolphin Responses to Boat Traffic Affected by Boat Characteristics and Degree of Compliance to Code of Conduct. Sustainability 14, 5185.

Krog, J. S., Hansen, M. S., Holm, E., Hjulsager, C. K., Chriél, M., Pedersen, K., Andresen, L. O., Abildstrøm, M., Jensen, T. H., and Larsen, L. E. 2015. Influenza A(H10N7) Virus in Dead Harbor Seals, Denmark. Emerging Infectious Diseases, 21, 684-687.

Kulkarni, S. S., and Edwards, D. J. 2022. A bibliometric review on the implications of renewable offshore marine energy development on marine species. Aquaculture and Fisheries, 7(2), 211-222. https://doi.org/10.1016/j.aaf.2021.10.005

Kurt, M., and Gucu, A.C., 2021. Demography and population structure of Northeastern Mediterranean monk seal population. Mediterr Mar Sci 22, 79-87.

Laran, S., Genu, M., Authier, M., Blanchard, A., Doremus, G., Sanchez, T., Spitz, J., and Van Canneyt, O. 2022a. Distribution et abondance de la mégafaune marine en France métropolitaine. SAMM (cycle II). Atlantique-Manche Hiver, 2021.Rapport finale. Université de la Rochelle, La Rochelle, France. 91pp.

Laran, S., Blanchard, A., Genu, M., Sanchez, T., Dorémus, G., Authier, M., Van Canneyt, O., and Spitz, J. 2022b. Suivi de la mégafaune marine au large des Pertuis charentais, de l'Estuaire de la Gironde et de Rochebonne par observation aérienne. Campagnes SPEE-III (2021-2022). Rapport final. Université de la Rochelle, La Rochelle, France. 180pp.

Laute, A., Grove, T., Rasmussen, M. H., Smith, A., Loisa, O., Fournet, M. E. H. 2022. Impact of whale-watching vessels on humpback whale calling behaviour on an Icelandic foraging ground during the Covid-19 pandemic. Mar. Ecol. Prog. Ser., 701: 159-173.

Leaper, R., MacLennan, E., Brownlow, A., Calderan, S.V., Dyke, K., Evans, P. G. H., Hartny-Mills, L., Jarvis, D., McWhinnie, L., and Philp, A., 2022. Estimates of humpback and minke whale entanglements in the Scottish static pot (creel) fishery. Endangered Species Research, 49, 217-232.

Lechwar, A., Rasmussen, M., Basran, B., and Collins, S. 2023. Habitat preference and trend in relative abundance of common minke whales (*Balaenoptera acutorostrata*) in Skjálfandri Bay, Iceland. Journal of Cetacean Research & Management, 24, 29-46.

Lehnhoff, L., Glotin, H., Bernard, S., Dabin, W., Le Gall, Y., Menut, E., Meheust, E., Peltier, H., Pochat, A., Pochat, K., Rimaud, T., Sourget, Q., Spitz, J., Van Canneyt, O., Mérigot, B. 2022. Behavioural Responses of Common Dolphins Delphinus delphis to a Bio-Inspired Acoustic Device for Limiting Fishery By-Catch. Sustainability, 14, 13186.

Lehtonen, E., Lehmonen, R., Kostensalo, J., Kurkilahti, M., Suuronen, P. 2022. Feasibility and effectiveness of seal deterrent in coastal trap-net fishing – development of a novel mobile deterrent. Fisheries Research, 252, 106328. https://doi.org/10.1016/j.fishres.2022.106328

Lens, S. 1997. A note on the harbour porpoise (*Phocoena phocoena*) in the coastal waters of Spain. *Report of the International Whaling Commission*, 47: 841-847.

Lens, S. and Díaz, P. 2009. Annual Report of Spain to the European Commission on the Implementation of Council Regulation 812/2004 on Cetacean Bycatch. Work conducted during 2008. Instituto Español de Oceanografía, Spain.

Leonard, D. M., and Øien, N. I. 2020a. Estimated Abundances of Cetacean Species in the Northeast Atlantic from Two Multiyear Surveys Conducted by Norwegian Vessels between 2002–2013. *NAMMCO Scientific Publications*, 11. https://doi.org/ 10.7557/3.4695

Leonard, D. M., and Øien, N. I. 2020b. Estimated Abundances of Cetacean Species in the Northeast Atlantic from Norwegian Shipboard Surveys conducted in 2014–2018. *NAMMCO Scientific Publications*, 11. https://doi.org/ 10.7557/3.4694

Lien, J, Nelson, D, and Hai, D. J. 2001 Status of the white-beaked dolphin, *Lagenorhychus albirostris,* in Canada. Canadian Field Naturalist, 115: 118-126.

Link, J. 2002. Does food web theory work for marine ecosystems?. Marine ecology progress series, 230, 1-9. https://doi.org/10.3354/meps230001

Liu, X., Schjøtt, S. R., Granquist, S. M., Rosing-Asvid, A. *et al.*,2022. Origin and expansion of the world's most widespread pinniped. Molecular Ecology. https://doi.org/10.1111/mec.16365

Lohrengel, K. and Evans, P. G. H. 2023. Bottlenose dolphin monitoring in Cardigan Bay. Interim report 2022 to Natural Resources Wales, Bangor. 45pp.

López, A., Pierce, G. J., Santos, M. B., Gracia, J., and Guerra, A. 2003 Fishery by-catches of marine mammals in Galician waters: Results from on-board observations and an interview survey of fishermen. Biological Conservation, 111: 25–40.

López, A., Santos, M. B., Pierce, G. J., González, A. F., Valeiras, X. and Guerra, A. 2002 Trends in strandings and by-catch of marine mammals in northwest Spain during the 1990s. *Journal of the Marine Biological Association of the United Kingdom*, 82: 513-521.

López, A., Vázquez, J. A., Martínez-Cedeira., J. A., Marcos-Ipiña, E., Laria, L., Maestre, I., Carbo, A., Llanova, A., Fernández, M., Díaz, J. I., Santos, L., Ruano, A., Fernández, R. and Méndez, P. 2012. Bases para el desarrollo de los planes de conservación de las especies de cetáceos protegidas en la Demarcación Marina Noratlantica. Volumen 2 Impactos. Ministerio de Agricultura, Alimentación y Medio Ambiente – Fundación Biodiversidad.

Lozano-Bilbao, E., Alcázar-Treviño, J., Alduán, M., Lozano, G., Hardisson, A., Rubio, C., González-Weller, D., Paz, S., Manuel Carrillo, M., and Gutiérrez, Á. J. 2021. Metal content in stranded pelagic vs deep-diving cetaceans in the Canary Islands. Chemosphere, 285, 131441.

Lucas, S., and Berggren, P. 2022. A systematic review of sensory deterrents for bycatch mitigation of marine megafauna. Rev Fish Biol Fisheries.

Luck, C., Jessopp, M., Cronin, M., and Rogan, E. 2022. Using population viability analysis to examine the potential long-term impact of fisheries bycatch on protected species. Journal for Nature Conservation 67, 126157.

Luck, C., Jessopp, M., Tully, O., Cosgrave, R., Rogan, E., and Cronin, M. 2020. Estimating protected species bycatch from limited observer coverage: A case study of seal bycatch in static net fisheries. Global Ecology and Conservation, 24. doi: 10.1016/j.gecco.2020.e01213

Lundström, K., Lunneryd, S. G., Königson, S., and Hemmingsson, M. 2010. Interactions between harbour seals (*Phoca vitulina*) and coastal fisheries along the Swedish west coast: an overview. NAMMCO Scientific Publications, 8: 329-340.

Lunneryd, S. G., Hemmingsson, M., Tamlünd, S., and Fjälling, A. 2015. A voluntary logbook scheme as a method of monitoring the bycatch of seals in Swedish coastal fisheries. ICES CM (X:04). International Council for the Exploration of the Sea, Copenhagen, Denmark.

Luque, P. L., Davis, C. G., Reid, D. G., Wang, J., and Pierce, G. J. 2006. Opportunistic sightings of killer whales from Scottish pelagic trawlers fishing for mackerel and herring off North Scotland (UK) between 2000 and 2006. Aquatic Living Resources, 19(4): 403-410. https://doi.org/10.1051/alr:2007009

Lusseau, D., Kindt-larsen, L., and Beest, F. M. Van. 2023. Emergent interactions in the management of multiple threats to the conservation of harbour porpoises. Science of the Total Environment, 855(158936). https://doi.org/10.1016/j.scitotenv.2022.158936

Macías López, D., Barcelona, S. G., Báez, J. C., de la Serna, J. M., and Ortiz de Urbina, J. M. 2012. Marine mammal bycatch in Spanish Mediterranean large pelagic longline fisheries, with a focus on Risso's dolphin (*Grampus griseus*). Aquatic Living Resources, 25: 321-331.

MacMillan, G. A., Amyot, M., Daoust, P. Y., and Lemire, M., 2022. Age-specific trace element bioaccumulation in grey seals from the Gulf of St. Lawrence. Chemosphere 294.

Malinauskaite, L., Cook, D., Davidsdóttir, B., Karami, M. P., Koenigk, T., Kruschke, T., Ögmundardóttir, H., and Rasmussen, M. 2022. Connecting the dots: An interdisciplinary perspective on climate change effects on whales and whale watching in Skjálfandi Bay, Iceland. Ocean and Coastal Management, 226: 106274.

Manlik, O., Lacy, R. C., Sherwin, W. B., Finn, H., Lonergan, N. R., and Allen, S. J. 2022. A stochastic model for estimating sustainable limits to wildlife mortality in a changing world. Conservation Biology. DOI: 10.1111/cobi.13897.

Marçalo, A., Katara, I., Feijó, D., Araújo, H., Oliveira, I., Santos, J., Ferreira, M., Monteiro, S., Pierce, G. J., Silva, A., and Vingada, J. 2015. Quantification of interactions between the Portuguese sardine purse-seine fishery and cetaceans. *ICES Journal of Marine Science*, 72: 2438-2449. doi: http://dx.doi.org/10.1093/icesjms/fsv076.

Martínez-Cedeira, J. A., Vázquez Bonales, J. A., Izquierdo Ferreiro, I., and Fernández Acevedo, O. 2021. Proyecto VIRADA: Bases para la reducción de la mortalidad por captura accidental en artes de pesca de la marsopa (*Phocoena phocoena*) y el delfín mular (*Tursiops truncatus*) en áreas Red Natura 2000 de Galicia. Informe campaña aérea. CEMMA and OPFF-4. Vigo, Spain.

Mattmüller, R. M., Thomisch, K., Van Opzeeland, I., Laidre, K. L., and Simon, M. 2022. Passive acoustic monitoring reveals year-round marine mammal community composition off Tasiilaq, Southeast Greenland. The Journal of the Acoustical Society of America, 151, 1380-1392.

Mauritsson, K., Desforges, J. P., Harding, K. C. 2022. Maternal Transfer and Long-Term Population Effects of PCBs in Baltic Grey Seals Using a New Toxicokinetic-Toxicodynamic Population Model. Arch Environ Con Tox 83, 376-394.

Mcquatters-Gollop, A., Guérin, L., Arroyo, N. L., Aubert, A., Artigas, L.-F., Bedford, J., Corcoran, E., Dierschke, V., Elliott, S. A. M., Geelhoed, S. C. V., Gilles, A., González-Irusta, J. M., Haelters, J., Johansen, M., Le Loc'h, F., Lynam, C.P., Niquil, N., Meakins, B., Mitchell, I., Padegimas, B., Pesch, R., Preciado, J., Rombouts, I., Safi, G., Schmitt, P., Schückel, U., Serrano, A., Stebbing, P., De La Torriente, A., and Vina-Herbon, C. 2022. Assessing the state of marine biodiversity in the Northeast Atlantic. Ecological Indicators, 141,109148.

Megson, D., Brown, T., Jones, G. R., Robson, M., Johnson, G. W., Tiktak, G. P., Sandau, C. D., and Reiner, E. J. 2022. Polychlorinated biphenyl (PCB) concentrations and profiles in marine mammals from the North Atlantic Ocean. Chemosphere 288, 132639.

Merkel, B., Lydersen, C., Yoccoz, N. G., and Kovacs, K. M. 2013. The world's northernmost harbour seal population - how many are there? PloS ONE, 8(7), e67576. https://doi.org/10.1371/journal.pone.0067576

Meyer-Gutbrod, E. L., Greene, C. H., Davies, K. T. A., and Johns, D. G. 2021. Ocean regime shift is driving collapse of the North Atlantic right whale population. Oceanography, 34(3), 22-31.

Meyer-Gutbrod, E. L., Davies, K. T., Johnson, C. L., Plourde, S., Sorochan, K. A., Kenney, R. D., Ramp, C., Gosselin, J. F., Lawson, J. W, and Greene, C. H. 2022. Redefining North Atlantic right whale habitat-use patterns under climate change. Limnology and Oceanography. https://doi.org/10.1002/lno.12242

Ministry of Agriculture and Forestry. 2007. Management Plan for the Finnish Seal Populations in the Baltic Sea. Ministry of Agriculture and Forestry 4b/2007: 96 pp.

Moan, A., and Bjørge, A. 2023. Pingers reduce harbour porpoise bycatch in Norwegian gillnet fisheries, with little impact on day-to-day fishing operations. Fisheries Research, 259, 106564.

Morell, M., IJsseldijk, L. L., Berends, A. J., Gröne, A., Siebert, U., Raverty, S. A., Shadwick, R. E., and Kik, M. J. 2021. Evidence of hearing loss and unrelated toxoplasmosis in a free-ranging harbour porpoise (*Phocoena phocoena*). Animals, 11(11), 3058. https://doi.org/10.3390/ani11113058

Morizur, Y., Berrow, S. D, Tregenza, N. J. C., Couperus, A. S., and Pouvreau, S. 1999. Incidental catches of marine mammals in pelagic trawl fisheries of the north-east Atlantic. *Fisheries Research*, 41(3): 297-307.

Morris, C. D., and Duck, C. D. 2019. Aerial thermal-imaging survey of seals in Ireland, 2017 to 2018. Irish Wildlife Manuals, No. 111 National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht, Ireland.

Mrusczok, M.-T. 2022a. Killer whales of Iceland (2011–2021). Photo-identification catalogue with an emphasis on West Iceland. Grundarfjörður: Report no. 21 of the West Iceland Nature Research Centre (Náttúrustofa Vesturlands).

Mrusczok, M.-T., Violi, B., Fakhri, M., Calogero, G., Biasissi, E., Jaouhar, A., Scullion, A., and Würtz, M. 2022b. Long-distance movements of North Atlantic killer whales (*Orcinus orca*) from Iceland via Spain and Italy to Lebanon. Marine Mammal Science, 38(2), 778–787. https://onlinelibrary.wiley.com/doi/10.1111/mms.12866

Murray, K. T., Hatch, J. M., Di Giovanni, R. A., Jr., and Josephson, E. 2021. Tracking young-of-the-year gray seals *Halichoerus grypus* to estimate fishery encounter risk. Mar Ecol. Prog Ser 671:235-245.

Mussi, B., Gabriele, R., Miragliuolo, A., and Battaglia, M. 1998. Cetacean sightings and interactions with fisheries in the archipelago Pontino Campano, southern Tyrrhenian Sea, 1991-1995. In: P.G.H. Evans & E.C.M. Parsons, eds. *European Research on Cetaceans, Volume 12. Proceedings of the twelfth annual conference of the European Cetacean Society, Monaco, 20-24 January 1998*, pp. 63-65. European Cetacean Society, Valencia, Spain.

Mussi, B., Miragliuolo, A., De Pippo, T., Gambi, M. C., and Chiota, D. 2004. The submarine canyon of Cuma (southern Tyrrhenian Sea, Italy), a cetacean key area to protect. In: P.G.H. Evans & E. O'Boyle, eds. *European Research on Cetaceans, Volume 15. Proceedings of the fifteenth annual* *conference of the European Cetacean Society, Rome, Italy, 6-10 May 2001*, pp. 178-182. European Cetacean Society, Kiel, Germany.

Mussi, B., Miragliuolo, A., De Pippo, T., Gambi, M. C., and Chiota, D. (2004) The submarine canyon of Cuma (southern Tyrrhenian Sea, Italy), a cetacean key area to protect. In: P.G.H. Evans & E. O'Boyle, eds. European Research on Cetaceans, Volume 15. Proceedings of the fifteenth annual conference of the European Cetacean Society, Rome, Italy, 6-10 May 2001, pp. 178-182. European Cetacean Society, Kiel, Germany.

NAMMCO. 2018. Report of the NAMMCO Scientific Working *Group on Abundance Estimates.* Available at https://nammco.no/topics/sc-working-group-reports/

National Academies. 2017. Approaches to Understanding the Cumulative Effects of Stressors on Marine Mammals. In Washington, DC: The National Academies Press. https://doi.org/10.17226/23479

National Research Council. 2005. Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects. The National Academies Press. https://doi.org/10.17226/11147

New, L. F., Clark, J. S., Costa, D. P., Fleishman, E., Hindell, M. A., Klanjšček, T., Lusseau, D., Kraus, S., McMahon, C. R., Robinson, P. W., Schick, R. S., Schwarz, L. K., Simmons, S. E., Thomas, L., Tyack, P., and Harwood, J. 2014. Using short-term measures of behaviour to estimate long-term fitness of southern elephant seals. Marine Ecology Progress Series, 496, 99–108. https://doi.org/10.3354/meps10547

Nicolaou, H., Dendrinos, P., Marcou, M., Michaelides, S., and Karamanlidis, A. A. 2021. Re-establishment of the Mediterranean monk seal *Monachus monachus* in Cyprus: priorities for conservation. Oryx 55, 526-528.

Nielsen, J. M., Clare, E. L., Hayden, B., Brett, M. T., and Kratina, P., 2018. Diet tracing in ecology: Method comparison and selection. Methods in Ecology and Evolution, 9(2), 278-291.

Nilssen, K. T. and Bjørge, A. 2017. Haver tog steinkobbe (Grey and harbour seals). Pp. 68-69 in I.E. Bakketeig, M. Hauge and C. Kvamme (eds). Havforskningsrapporten 2017. Fiske nog havet, saenr, 1-217. 98pp.

Nilssen K. T. and Bjørge A. 2019. Status for kystsel: Anbefaling av jaktkvoter for 2020 [Status of coastal seals: recommendation of hunting allowances for 2020]. Norway: Sjøpattedyrutvalget [Committee for Ma-rine Mammals], Institute of Marine Research

Nilssen, K. T., Bjørge, A., and Biuw, M. 2021. Status for kystsel - anbefaling av jaktkvoter 2022. Møte i Sjøpattedyrutvalget, Tromsø, 24–25 October 2021. 14 pp. (In Norwegian).

Northridge, S., Cargill, A., Coran, A., Mandleberg, L., Calderan, S., and Reid, R.J. 2010. Entanglement of minke whales in Scottish waters: an investigation into occurrence, causes and mitigation. Sea Mammal Research Unit, Final Report to Scottish Government CR/2007/49. 57pp.

Northridge, S. P. 1991. An Updated Review of Interactions between Marine Mammals and Fisheries. FAO Fisheries Technical Paper 251, Suppl. 1. Food and Agriculture Organisation of the United Nations, Rome.

Norwegian Ministry of Fisheries and Coastal Affairs. 2010a. Forvaltningsplan for havert (Management plan for grey seal). 19pp.

Norwegian Ministry of Fisheries and Coastal Affairs. 2010b. Forvaltningsplan for steinkobbe (Manegement plan for harbour seal). 15pp.

Notarbartolo di Sciara, G., Mo, G., Gazo, M., and Gonzalvo, J. 2019. Draft updated strategy for the regional conservation of monk seals in the Mediterranean Sea. UNEP Mediterranean Action Plan, Regional Activity Centre for Specially Protected Areas, Tunis.

Nymo, I. H., Siebert, U., Baechlein, C., Postel, A., Breines, E. M., Lydersen, C., and Tryland, M. 2022. Pathogen Exposure in White Whales (Delphinapterus leucas) in Svalbard, Norway. Pathogens, 12(1), 58.

Ó Cadhla, O., Keena, T., Strong, D., Duck, C., and Hiby, L. 2013. Monitoring of the breeding population of grey seals in Ireland, 2009–2012. National Parks and Wildlife Service, Department of the Environment, Heritage and the Gaeltacht, Dublin, Ireland.

O'Brien, O., Pendleton, D. E., Ganley, L. C., McKenna, K. R., Kenney, R. D., Quintana-Rizzo, E., Mayo, C. A., Kraus, S. D., and Redfern, J. V. 2022. Repatriation of a historical North Atlantic right whale habitat during an era of rapid climate change. Scientific Reports, 12(1), 1-10. https://doi.org/10.1038/s41598-022-16200-8

Oksanen, S.M., Ahola, M.P., Oikarinen, J., and Kunnasranta, M. 2015. A novel tool to mitigate bycatch mortality of Baltic seals in coastal fyke net fishery. *PLoS One* 10(5): e0127510.doi:10.1371/journal.pone.0127510.

Olsen, M.T., Andersen, L.W., Dietz, R., Teilmann, J., Härkönen, T., Siegismund, H. R., *et al.* 2014. Integrating genetic data and population viability analyses for the identification of harbour seal (*Phoca vitulina*) populations and management units. Molecular Ecology 23, 815-831.

Olsen, M. T., Galatius, A., and Härkönen, T. 2018. The history and effects of seal-fishery conflicts in Denmark. Marine Ecology Progress Series, 595: 233-243.

Olsen, M. T., Nielsen, N. H., Biard, V., Teilmann, J., Ngô, M. C., Víkingsson, G., Gunnlaugsson, T., Stenson, G., Lawson, J., and Lah, L., 2022b. Genetic and behavioural data confirm the existence of a distinct harbour porpoise ecotype in West Greenland. Ecological Genetics and Genomics 22, 100108.

Orgeret, F., Thiebault, A., Kovacs, K. M., Lydersen, C., Hindell, M. A., Thompson, S. A., Sydeman, W. J., and Pistorius, P.A. 2022. Climate change impacts on seabirds and marine mammals: The importance of study duration, thermal tolerance and generation time. Ecology Letters 25:218-239.

Ortiz-Alvarez, C., Guidino, C., Verhaegen, C., Alfaro-Shigueto, J., and Mangel, J. C. 2022. Lessons from 12 years of marine fauna stranding data in the south of Peru. Environmental Monitoring and Assessment, 194(3), 142. https://doi.org/10.1007/s10661-022-09782-3

Osinga, N., Shahi Ferdous, M. M., Morick, D., García Hartmann, M., Ulloa, J.A., Vedder, L., Udo de Haes, H. A., Brakefield, P. M., Osterhaus, A. D. M. E., and Kuiken, T., 2012. Patterns of Stranding and Mortality in Common Seals (*Phoca vitulina*) and Grey Seals (*Halichoerus grypus*) in The Netherlands between 1979 and 2008. Journal of Comparative Pathology 147, 550-565.

Öztürk, B., Öztürk, A. A., and Dede, A. 2001 Dolphin by-catch in the swordfish driftnet fishery in the Aegean Sea. Rapports de procés-verbaux des reunions de la Commission international pour l'exploration scientifique de la mer Méditerranée, 36: 308. CIESM, Monte-Carlo, Monaco.

Palka, D., Read, A., and Potter, C. 1997. Summary of knowledge of white-sided dolphins (*Lagenorhynchus acutus*) from US and Canadian Atlantic waters. *Report of the International Whaling Commission, 47:* 729–734.

Palomino-González, A., Kovacs, K. M., Lydersen, C., Ims, R. A. and Lowther, A. D. 2021. Drones and marine mammals in Svalbard, Norway. Marine Mammal Science 37:1212-1229.

Panou A., Beudels R., and Harwood, J. 1987. Interactions Between Monk Seals and fishermen. In: Population Biology of the Mediterranean Monk Seal in Greece (Harwood, J., Ed.), 45-50, SMRU, Cambridge (U.K.)

Panou, A., Jacobs, J., and Panos, D. 1993 The endangered Mediterranean monk seal *Monachus monachus* in the Ionian Sea. *Biological Conservation*, 64(2): 129-140.

Panti, C., Baini, M., Lusher, A., Hernandez-Milan, G., Rebolledo, E. L. B., Unger, B., Syberg, K., Simmonds, M. P., and Fossi, M. C. 2019. Marine litter: One of the major threats for marine mammals. Outcomes from the European Cetacean Society workshop. Environmental pollution, 247, 72-79. https://doi.org/10.1016/j.envpol.2019.01.029

Paxton, C. G. M., Waggitt, J. J., Evans, P. G. H., Miller, D. L, and Chudzinska, M. E. 2022. Production of Seabird and Marine Mammal Distribution Models for the East of Scotland. Report to Marine Scotland. Centre for Research into Ecological and Environmental Modelling, St Andrews University. 155pp.

Peltier, H., Authier, M., Daniel, P., and Spitz, J. 2022. Co-occurrence des mortalités de dauphins communs avec l'effort de pêche des sous-flottilles de fileyeurs 2013-2020. Rapport scientifique dans le cadre de la convention avec le MTE. Observatoire PELAGIS – UAR 3462, La Rochelle Université / CNRS, 6 pages.

Peltier, H., Authier, M., Caurant, F., Dabin, W., Daniel, P., Dars, C., Demaret, F., Meheust, E., Van Canneyt, O., Spitz, J., and Ridoux, V. 2021b. In the Wrong Place at the Wrong Time: Identifying Spatiotemporal Co-occurrence of Bycaught Common Dolphins and Fisheries in the Bay of Biscay (NE Atlantic) From 2010 to 2019. Frontiers in Marine Science. 8:617342.

Peltier, H., Authier, M., Dabin, W., Dars, C., Demaret, F., Doremus, G., Laran, S., Mendez-Fernández, P., Meheust, E., Ridoux, V., Spitz, J., and Canneyt, O.V. 2021a. Common dolphin mortalities in fisheries off the French Atlantic coast in the winter 2021: combining stranding and aerial survey data

Peltier, H., Baagøe, H. J., Camphuysen, K. C. J., Czeck, R., Dabin, W., Daniel, P., Deaville, R., Haelters, J., Jauniaux, T., Jensen, L. F., Jepson, P. D., Keijl, G. O., Siebert, U., Van Canneyt, O., and Ridoux, V.

2013. The stranding anomaly as population indicator: the case of harbour porpoise *Phocoena phocoena* in North-Western Europe. PLoS ONE, 8(4), 1–14.

Peltier, H., Dabin, W., Daniel, P., Van Canneyt, O., Dorémus, G., Huon, M., and Ridoux, V. 2012. The significance of stranding data as indicators of cetacean populations at sea: Modelling the drift of cetacean carcasses. Ecological Indicators, 18, 278–290. https://doi.org/10.1016/J.ECOLIND.2011.11.014

Pereira, A. T. 2015. Monitorização do uso costeiro por pequenos cetáceos e avaliação do uso de pingers para mitigação de capturas acidentais na região norte de Portugal. Mestrado Recursos Biológicos Aquáticos, Departamento de Biologia, Universidade do Porto.

Pérez Tadeo, M., Gammell, M., and O'Brien, J. 2021. Assessment of Anthropogenic Disturbances Due to Ecotourism on a Grey Seal (*Halichoerus grypus*) Colony in the Blasket Islands SAC, Southwest Ireland and Recommendations on Best Practices. Aquatic Mammals 47, 268-282.

Pérez Tadeo, M., Gammell, M., O'Callaghan, S.A., O'Connor, I., and O'Brien, J. 2023. Disturbances due to unmanned aerial vehicles (UAVs) on harbor seal (*Phoca vitulina*) colonies: Recommendations on best practices. Marine Mammal Science, *Early online version*.

Peschko, V., Müller, S., Schwemmer, P., Mercker, M., Lienau, P., Rosenberger, T., Sundermeyer, J., and Garthe, S. 2020. Wide dispersal of recently weaned grey seal pups in the Southern North Sea. ICES Journal of Marine Science, 77(5), 1762–1771. https://doi.org/10.1093/icesjms/fsaa045

Philipp, C., Unger, B., and Siebert, U., 2022. Occurrence of Microplastics in Harbour Seals (*Phoca vitulina*) and Grey Seals (*Halichoerus grypus*) from German Waters. Animals-Basel 12.

Pierce, G.J., Petitguyot, M.A.C., Gutiérrez-Muñoz, P., Fernández-Fernández, D., Fariñas-Bermejo, A., Read, F.L., Saavedra, S., López, A., and Martínez-Cedeira, J. 2022. Iberian harbour porpoise - an update on fishery bycatch mortality. Paper SC/68D/HIM/10. Report of the International Whaling Commission, 67.

Pike, D. G., Gunnlaugsson, T., Desportes, G., Mikkelsen, B., Víkingsson, G. A., and Bloch, D. 2019b. Estimates of the relative abundance of long-finned pilot whales in the North-east Atlantic from 1987-2015 indicate no long-term trends. *NAMMCO Scientific Publications* 11. https://doi.org/10.7557/3.4643

Pike, D. G., Gunnlaugsson, T., Mikkelsen, B., Halldórsson, S. D., and Víkingsson, G. A. 2019a. Estimates of the abundance of cetaceans in the Central North Atlantic based on the NASS Icelandic and Faroese Shipboard Surveys conducted in 2015. *NAMMCO Scientific Publications* 11. https://doi.org/10.7557/3.4941

Pike, D. G., Gunnlaugsson, T., Mikkelsen, B., Víkingsson, G. A., and Desportes, G. 2020b. Distribution and abundance of killer whales in the Central North Atlantic, 1987-2015. *NAMMCO Scientific Publications* 11. https://doi.org/10.7557/3.5579

Pike, D. G., Gunnlaugsson, T., Sigurjónsson, J., and Víkingsson, G. A. 2020a. Distribution and abundance of cetaceans in Icelandic waters over 30 years of aerial surveys. *NAMMCO Scientific Publications* 11. https://doi.org/10.7557/3.4805

Pirotta, E., Booth, C. G., Costa, D. P., Fleishman, E., Kraus, S. D., Lusseau, D., Moretti, D., New, L. F., Schick, R. S., Schwarz, L. K., Simmons, S. E., Thomas, L., Tyack, P. L., Weise, M. J., Wells, R. S., and Harwood, J. 2018. Understanding the population consequences of disturbance. Ecology and Evolution, 8(19). https://doi.org/10.1002/ece3.4458

Poncet, S., Mercereau, I., Couvrat, C., Le Baron, M., Francou, M., Hemon, A., Frémau, M.-H.,. Elder, J.-F., Gicquel, C., Monnet, S., Rault, C., Karpouzopoulos, J., Lefebvre, J., Everard, A., Colomb, F., Diard Combot, M., Provost, P., Deniau, A., Urtizberea, F., Koelsch, D., Letournel, B., and C. Vincent, C. 2022. Recensement des colonies et reposoirs de phoques en France en 2020 et 2021. 50 pp.

Popov, D., Meshkova, G., Vishnyakova, K., Ivanchikova, J., Paiu, M., Timofte, C., Öztürk, A. A., Tonay, A. M., Panayotova, M., Düzgünes, E., and Gol'din, P. (in press) Assessment of the bycatch level for the Black Sea harbour porpoise in the light of new data on population abundance. *Frontiers in Marine Science*, 10.1119983. doi: 10.3389/fmars.2023.1119983.

Postel, A., King, J., Kaiser, F. K., Kennedy, J., Lombardo, M. S., Reineking, W., de le Roi, M., Harder, T., Pohlmann, A., Gerlach, T., Rimmelzwaan, G., Rohner, S., Striewe, L. C., Gross, S., Schick, L.A., Klink, J. C., Kramer, K., Osterhaus, A. D. M. E., Beer, M., Baumgartner, W., Siebert, U., and Becher, P. 2022. Infections with highly pathogenic avian influenza A virus (HPAIV) H5N8 in harbor seals at the German North Sea coast, 2021. Emerg Microbes Infec 11, 725-729.

Prawirasasra, M. S., Jüssi, M., Mustonen, M., and Klauson, A. 2022. Underwater noise impact of a ferry route on dive patterns of transiting Baltic ringed seals. Estonian Journal of Earth Sciences 71, 201-213.

Puchades, L., Gallego-Rios, S.E., Di Marzio, A., and Martinez-Lopez, E. 2022. Trace elements in blood of Baltic gray seal pups (*Halichoerus grypus*) from the Gulf of Riga and their relationship with biochemical and clinical parameters. Marine Pollution Bulletin, 182.

Radu, G. and Anton, E. 2014. Impact of turbot fishery on cetaceans in the Romanian Black Sea area. *Scientia Marina*, 78: 103-109.

Ramp, C., Gaspard, D., Gavrilchuk, K., Unger, M., *et al.* 2021. Up in the air: drone images reveal underestimation of entanglement rates in large rorqual whales. Endang Species Res 44:33-44.

Ransijn, J. M., Hammond, P. S., Leopold, M. F., Sveegaard, S., and Smout, S. C. 2021. Integrating disparate datasets to model the functional response of a marine predator: A case study of harbour porpoises in the southern North Sea. Ecology and Evolution, 11(23), 17458-17470.

Read, F. L. 2016. *Understanding Cetacean and Fisheries Interactions in the North-West Iberian Peninsula*. PhD thesis, University of Vigo, Spain.

Read, F. L., Santos, M. B., Ferreira, M., López, A., and Pierce, G. J. 2020. Harbour porpoise (*Phocoena phocoena*) and fisheries interactions in the north-west Iberian Peninsula. Paper Presented at the Scientific Committee of the International Whaling Commission SC/68B/SM/06.

Reeves, R., McClellan, K., and Werner, T. 2013. Marine mammal bycatch in gillnet and other entangling net fisheries, 1990 to 2011. Endangered Species Research, 20, 71–97.

Reeves, R. R. and Notarbartolo di Sciara, G. (eds.) 2006. *The status and distribution of cetaceans in the Black Sea and Mediterranean Sea*. Workshop report – Monaco, 5-7 March 2006. IUCN Centre for Mediterranean Cooperation, Malaga, Spain.

Reeves, R. R., Smeenk, C., Brownell, L., and Kinze, C. C. 1999. Atlantic white-sided dolphin *Lagenorhynchus acutus* (Gray, 1828). Pp. 31-56. In: *Handbook of Marine Mammals. Vol. 6: The second book of dolphins and porpoises* (Eds. S.H. Ridgway & R.J. Harrison). Academic Press, San Diego.

Rey-Iglesia, A., Gaubert, P., Themudo, G. E., Pires, R., de la Fuente, C., Freitas, L., Aguilar, A., Borrell, A., Krakhmalnaya, T., Vasconcelos, R., and Campos, P. F., 2021. Mitogenomics of the endangered Mediterranean monk seal (*Monachus monachus*) reveals dramatic loss of diversity and supports historical gene-flow between Atlantic and eastern Mediterranean populations. Zool J Linn Soc-Lond 191, 1147-1159.

Ríos, N., Drakulic, M., Paradinas, I., Milliou, A., and Cox, R. 2017. Occurrence and impact of interactions between small-scale fisheries and predators, with focus on Mediterranean monk seals (*Monachus monachus* Hermann, 1779), around Lipsi island complex, Aegean Sea, Greece. Fisheries Research, 187: 1-10.

Ritter, F. 2022. Marine mammal conservation in the 21st century: A plea for a paradigm shift towards mindful conservation. Advances in Marine Biology, 93, 3-21.

Robbins, J. R., Bouchet, P. J., Miller, D. L., Evans, P. G. H., Waggitt, J., Ford, A. T., and Marley, S. A., 2022. Shipping in the north-east Atlantic: Identifying spatial and temporal patterns of change. Marine Pollution Bulletin, 179, 113681

Rodrigues, A. S., Charpentier, A., Bernal-Casasola, D., Gardeisen, A., Nores, C., Pis Millán, J. A., and Speller, C. F. 2018. Forgotten Mediterranean calving grounds of grey and North Atlantic right whales: evidence from Roman archaeological records. Proceedings of the Royal Society B: Biological Sciences, 285(1882), 20180961

Rogan, E., Breen, P., Mackey, M., Cañadas, A., Scheidat, M., Geelhoed, S., and Jessopp, M. 2018. *Aerial surveys of cetaceans and seabirds in Irish waters: Occurrence, distribution and abundance in 2015-2017*. Department of Communications, Climate Action & Environment and National Parks and Wildlife Service (NPWS), Department of Culture, Heritage and the Gaeltacht, Dublin, Ireland. 297pp.

Russell, D. J. F., and Carter, M. I. D. 2021. Estimating the proportion of grey seals hauled out during August surveys. SCOS Briefing Paper 21/XX, Sea Mammal Research Unit, University of St Andrews.

Russell, D. J. F., Duck, C. D., Morris, C. D., Riddoch, N.G., and Thompson, D. 2022. Trends in seal abundance and grey seal pup production. SCOS BP 22/02.

Russell, D. J., Morris, C. D., Duck, C. D., Thompson, D., and Hiby, L., 2019. Monitoring long-term changes in UK grey seal pup production. Aquatic Conservation: Marine and Freshwater Ecosystems, 29, 24-39.

Ryeng, K.A., Lakemeyer, J., Roller, M., Wohlsein, P., and Siebert, U., 2022. Pathological findings in bycaught harbour porpoises (*Phocoena phocoena*) from the coast of Northern Norway. Polar Biology 45, 45-57.

Sala, B., Garcia-Garin, O., Borrell, A., Aguilar, A., Víkingsson, G. A., and Eljarrat, E. 2022. Transplacental transfer of plasticizers and flame retardants in fin whales (*Balaenoptera physalus*) from the North Atlantic Ocean. Environmental Pollution, 313, 120168.

Salazar-Casals, A., de Reus, K., Greskewitz, N., Havermans, J., Geut, M., Villanueva, S., and Rubio-Garcia, A., 2022. Increased Incidence of Entanglements and Ingested Marine Debris in Dutch Seals from 2010 to 2020. Oceans, 3, 389-400.

Salmona, J., Dayon, J., Lecompte, E., Karamanlidis, A. A., Aguilar, A., de Larrinoa, P. F., Pires, R., Mo, G. L., Panou, A., Agnesi, S., Borrell, A., Danyer, E., Oztürk, B., Tonay, A. M., Anestis, A. K., Gonzalez, L. M., Dendrinos, P., and Gaubert, P., 2022. The antique genetic plight of the Mediterranean monk seal (*Monachus monachus*). P Roy Soc B-Biol Sci 289.

Samarra, F. I. P., Selbmann, A., Aoki, K., and Miller, P. J. O. 2022. Occurrence of cetaceans in the waters of the Surtsey Nature Reserve between 2008 and 2021. Surtsey Research, 15: 89-96, doi: 10.33112/surtsey.15.6

Sanpera, C. and Jover, E. 1986. Report of the 'Ballena 4' fin whale sighting cruise. Paper SC/37/Ba2. Report of the International Whaling Commission 36, 253-255.

Sanpera, C., Aguilar, A., Grau, E., and Jover, E. 1984. Report of the 'Ballena 2' whale marking and sighting cruise in the Atlantic waters off Spain. Paper SC/35/O 12. Report of the International Whaling Commission 34, 663-666.

Sanpera, C., Grau, E., Jover, E., Recasens, A., Aguilar, A., and Olmos, M. 1985. Report of the 'Ballena 3' fin whale marking and sighting cruise off Spain, 1983. Paper SC/36/O 15. Report of the International Whaling Commission 35, 495-497.

Scheinin, A. P., Kerem, D., MacLeod, C. D., Gazo, M., Chicote, C. A., and Castellote, M. 2011. Gray whale (*Eschrichtius robustus*) in the Mediterranean Sea: anomalous event or early sign of climate-driven distribution change? Marine Biodiversity Records, 4, e28.

Schop, J., Abel, C., Brasseur, S., Galatius, A., Jess, A., Meise, K., Meyer, J., van Neer, A., Stejskal, O., and Siebert, U., 2022. Grey Seal Numbers in the Wadden Sea and on Helgoland in 2021-2022, In: Common Wadden Sea Secretariat, W., Germany. (Ed.).

SCOS. 2022. *Scientific Advice on Matters Related to the Management of Seal populations: 2021*. Natural Environment Research Council Special Committee on Seals, UK. 266pp.

Selbmann, A., Basran, C. J., Bertulli, C. G., Hudson, T., Mruszok, M.-T., Rasmussen, M. H., Rempel, J. N., Scott, J., Svarvarsson, J., Wensveen, P. J., Whitaker, M., and Samarra, F. I. P. 2022. Occurrence of long finned pilot whales (*Globicephala melas*) and killer whales (*Orcinus orca*) in Icelandic coastal waters and their interspecific interactions. Acta ethologica https://doi.org/10.1007/s10211-022-00394-1

Sequeira, M. and Ferreira, C. 1994. Coastal Fisheries and Cetacean Mortality in Portugal. Reports of the International Whaling Commission, 15: 165-174.

Shin, D. L., Siebert, U., Haas, L., Valentin-Weigand, P., Herrler, G., and Wu, N. H., 2022. Primary harbour seal (*Phoca vitulina*) airway epithelial cells show high susceptibility to infection by a seal-derived influenza A virus (H5N8). Transboundary Emergent Diseases, 69, E2378-E2388.

Sigurdsson, G.M. 2017. Incidental marine mammal and seabird bycatch in Icelandic waters, 2014-2016. Marine & Freshwater Institute, Reykjavik, Iceland. Report submitted to NAMCCO SC/24/BYCWG10.

Sigurdsson, G. M. 2017. Incidental marine mammal and seabird bycatch in Icelandic waters, 2014-2016. Marine & Freshwater Institute, Reykjavik, Iceland. Report submitted to NAMCCO SC/24/BYCWG10.

Similä, T., Haug, T., Lindblom, L., Lockyer, C., and O'Callaghan, S. A. 2022. Stomach Contents of Three Sperm Whales (Physeter macrocephalus) Stranded on Andøya, Northern Norway. Aquatic Mammals, 48(5). https://doi.org/10.1578/AM.48.5.2022.449

Skern-Mauritzen, M., Lindstrøm, U., Biuw, M., Elvarsson, B., Gunnlaugsson, T., Haug, T., Kovacs, K. M., Lydersen, C., McBride, M. M., Mikkelsen, B., Øien, N., and Víkingsson, G. 2022. Marine mammal consumption and fisheries removals in the Nordic and Barents Seas. ICES Journal of Marine Science, 79(5), 1583-1603. https://doi.org/10.1093/icesjms/fsac096

Solvang, H. K., Skaug, H. J., and Øien, N. 2015. Abundance estimates of common minke whales in the Northeast Atlantic based on survey data collected over the period 2008-2013. IWC SC/66ª/RMP/8 for the International Whaling Commission. 10pp.

Sørensen, P. M., Haddock, A., Guarino, E., Jaakkola, K., McMullen, C., Jensen, F. H., Tyack, P. L., and King, S. L. 2023. Anthropogenic noise impairs cooperation in bottlenose dolphins. Current Biology. https://doi.org/10.1016/j.cub.2022.12.063

Sousa, A., Alves, F., Arranz, P., Dinis, A., Fernandez, M., García, L.G., Morales, M., Lettrich, M., Coelho, R.E., and Costa, H., 2021. Climate change vulnerability of cetaceans in Macaronesia: Insights from a trait-based assessment. Science of the Total Environment 795, 148652.

Steinmetz, K., Murphy, S., Cadhla, O. Ó., Carroll, E. L., Onoufriou, A. B., Russell, D. J. F., Cronin, M., and Mirimin, L., 2023. Population structure and genetic connectivity reveals distinctiveness of Irish harbour seals (*Phoca vitulina*) and implications for conservation management. Aquatic Conservation: Marine and Freshwater Ecosystems, 33, 160-178.

Stenson, G., Gosselin, J.-F., Lawson, J., Buren, A., Goulet, P., Lang, S., Nilssen, K. T., and M. Hammill, M. 2022. Pup production of Harp Seals in the Northwest Atlantic in 2017 during a time of ecosystem change. NAMMCO Scientific Publications 12.

Stockin, K. A., Weir, C. R., and Pierce, G. J., 2006. Examining the importance of Aberdeenshire (UK) coastal waters for North Sea bottlenose dolphins (*Tursiops truncatus*). Journal of the Marine Biological Association of the United Kingdom 86, 201-207.

Stokholm, I., Fischer, N., Baechlein, C., Postel, A., Galatius, A., Kyhn, L. A., Thøstesen, C. B., Persson, S., Siebert, U., and Olsen, M. T., 2022. In the Search of Marine Pestiviruses: First Case of Phocoena Pestivirus in a Belt Sea Harbour Porpoise. Viruses 14, 161

Stokholm, I., Baechlein, C., Persson, S., Roos, A., Galatius, A., Kyhn, L. A., Sveegaard, S., Thøstesen, C. B., Olsen, M. T., and Becher, P., 2023. Screening for Influenza and Morbillivirus in Seals and Porpoises in the Baltic and North Sea. Pathogens 12, 357.

Storå, J. 2002. Neolithic seal exploitation on the Åland Islands in the Baltic Sea on the basis of epiphyseal fusion data and metric studies. International Journal of Osteoarchaeology, 12(1), 49-64.

Suarez-Bregua, P., Álvarez-González, M., Parsons, K. M., Rotllant, J., Pierce, G. J., and Saavedra, C. 2022. Environmental DNA (eDNA) for monitoring marine mammals: challenges and opportunities. Frontiers in Marine Science **9**, 987774. doi: 10.3389/fmars.2022.987774

Sun, J. C., Shaw, S. S., Berger, M., Halaska, B., Roos, A., Backlin, B. M., Zheng, X. S., Liu, K. Y., Wang, Y., and Chen, D. 2022a. Spatiotemporal Trends of Legacy and Alternative Flame Retardants in Harbor Seals from the Coasts of California, the Gulf of Maine, andS weden. Environ Sci Technol 56, 5714-5723.

Sun, J. C., Zhang, L., Zhou, F. L., Shaw, S., Roos, A., Berger, M., Backlin, B. M., Huang, Y. C., Zheng, X. S., Wang, X. D., and Chen, D. 2022b. Hepatic Fatty Acid Profiles Associated with Exposure to Emerging and Legacy Halogenated Contaminants in Two Harbor Seal Populations across the North Atlantic. Environ Sci Technol 56, 1830-1840.

Sundell, T., Kammonen, J. I., Mustanoja, E., Biard, V., Kunnasranta, M., Niemi, M., Nykänen, M., Nyman, T., Palo, J. U., Valtonen, M., Paulin, L., Jernvall, J., and Auvinen, P. 2023. Genomic evidence uncovers inbreeding and supports translocations in rescuing the genetic diversity of a landlocked seal population. Conservation Genetics.

Sundqvist, L., Harkonen, T., Svensson, C. J., and Harding, K. C. 2012. Linking Climate Trends to Population Dynamics in the Baltic Ringed Seal: Impacts of Historical and Future Winter Temperatures. *AMBIO*, *41*, 865–872. https://doi.org/10.1007/s13280-012-0334-x

Swedish Agency for Marine and Water Management. 2019. Nationell förvaltningsplan för gråsäl (*Halichoerus grypus*) i Östersjön. Havs- och vattenmyndighetens rapport, 2019:24: 83 pp.

Swedish National Veterinary Institute. 2022. Hälsa, sjukdomar och dödsorsaker hos marina däggdjur 2021. Resultat från obduktion och provtagning av marina däggdjur som undersökts på SVA. Report from the Swedish National Veterinary Institute. 28 pp

Thompson, D. 2022. Preliminary report on the distribution and abundance of harbour seals (*Phoca vitulina*) during the 2022 breeding season in The Wash. SCOS Briefing Paper 22/06. In press. Available at: http://www.smru.st-andrews.ac.uk/scos/scos-reports/

Thompson, D., and Russell, D. J. F. 2021. Recent changes in status of harbour seals in the Wash and North Norfolk SAC and adjacent sites. SCOS Briefing paper 21/06. Available at: http://www.smru.st-andrews.ac.uk/files/2022/08/SCOS-2021.pdf

Thompson, D., Duck, C. D., Morris, C. D. and Russell, D. J. 2019. The status of harbour seals (*Phoca vitulina*) in the UK. Aquatic Conservation: Marine and Freshwater Ecosystems, 29, pp.40-60.

Tollit, D. J., Pierce, G. J., Hobson, K. A., Bowen W. D., and Iverson, S. J. 2010. Diet. In: IL Boyd, WD Bowen and SJ Iverson (Eds) Marine Mammal Ecology and Conservation, A Handbook of Techniques. OUP, Oxford.

Tollit, D. J., Schulze, A. D., Trites, A. W., Olesiuk, P. F., Crockford, S. J., Gelatt, T. S., Ream, R. R. and Miller, K. M., 2009. Development and application of DNA techniques for validating and improving pinniped diet estimates. Ecological Applications, 19(4), pp.889-905.

Tonay, A. M. 2016. Estimates of cetacean by-catch in the turbot fishery on the Turkish Western Black Sea coast in 2007 and 2008. Journal of the Marine Biological Association of the United Kingdom, 96(4), 993-998. doi:10.1017/S002531546000060.

Tonay, A. M. and Öztürk, B. 2003. Cetacean bycatches in turbot fishery on the western coast of the Turkish Black sea. In I.K. Oray, M.S. Çelikkale & G. Özdemir, eds. International Symposium of Fisheries and Zoology in memory of Ord. Prof. Curt Kosswig on his 100th birth anniversary, pp. 131-138. Fisheries Faculty, Istanbul University, istanbul.

Tougaard, J., Beedholm, K., and Madsen, P. T. 2022. Thresholds for noise induced hearing loss in harbor porpoises and phocid seals. Journl of the Acoustical Society of America, 151, 4252-4263.

Tournadre, J. 2014. Anthropogenic pressure on the open ocean: The growth of ship traffic revealed by altimeter data analysis. Geophysical Research Letters, 41(22), 7924-7932.

Tranganida, A., Hall, A. J., Armstrong, H. C., Moss, S. E. W., and Bennett, K. A. 2023. Consequences of in vitro benzyl butyl phthalate exposure for blubber gene expression and insulin-induced Akt activation in juvenile grey seals. Environmental Pollution, 316.

Trites, A. W., Christensen, V., and Pauly, D. 1997. Competition between fisheries and marine mammals for prey and primary production in the Pacific Ocean. Journal of Northwest Atlantic Fishery Science, 22, 173-187. https://doi.org/10.2960/J.v22.a14

Tudela, S., Kai Kai, A., Maynou, F., El Andalossi, M., and Guglielmi, P. 2005. Driftnet fishing and biodiversity conservation: the case study of the large-scale Moroccan driftnet fleet operating in the Alboran Sea (SW Mediterranean). Biological Conservation, 121: 65-78.

Valsecchi, E., Coppola, E., Pires, R., Parmegiani, A., Casiraghi, M., Galli, P., and Bruno, A. 2022. A species-specific qPCR assay provides novel insight into range expansion of the Mediterranean monk seal (*Monachus monachus*) by means of eDNA analysis. Biodiversity and Conservation, 31(4), 1175-1196.

Vanhatalo, J., Vetemaa, M., Herrero, A., Aho, T., and Tiilikainen, R. 2014. Bycatch of grey seals (*Halichoerus grypus*) in Baltic fisheries – A Bayesian Analysis of Interview Survey. *PLoS One*, 9(11), p e113836.doi: 10.1371/journal.pone.0113836

Vázquez, J. A., Cañadas, A., Martínez-Cedeira, J., López, A., Tejedor, M., Gauffier, P., Gazo, M., and Brotons, J. M. 2014. *Documento tecnico sobre la incidencia de la captura accidental de especies de ceta´ceos amenazadas en artes de pesca*. Ministerio de Agricultura, Alimentación y Medio Ambiente, Madrid.

Vincent, C., J. Kiszka, T. Garnier, S. Wynn-Simmonds, Y. Planque, M. Caputo, N. Tucker, J. Spitz, F. Caurant, F. Urtizberea, D. Koelsch, B. Letournel, L. Quénée, T. Jeanniard-Du-Dot, J. Detcheverry, R. Etcheberry and S. Detcheverry. 2022. COPEMAM - Mieux comprendre les conflits entre pêches et mammifères marins dans l'archipel de Saint Pierre et Miquelon - Rapport final. 98pp.

Vincent, C., Huon, M., Caurant, F., Dabin, W., Deniau, A., Dixneuf, S., Dupuis, L., Elder, J.-F., Fremau, M.-H., Hassani, S., Hemon, A., Karpouzopoulos, J., Lefeuvre, C., McConnell, B. J., Moss, S. E. W., Provost, P., Spitz, J., Turpin, Y., and Ridoux, V. 2017. Grey and harbour seals in France: Distribution at sea, connectivity and trends in abundance at haulout sites. Deep Sea Research Part II: Topical Studies in Oceanography 141:294-305.

Vingada, J. and Eira, C. 2018. Conservation of Cetaceans and Seabirds in Continental Portugal. The LIFE+ MarPro project. Final project report NAT/PT/00038. 257pp.

Vingada, J., Ferreira, M., Marçalo, A., Santos, J., Araújo, H., Oliveira, I., Monteiro, S., Nicolau, L., Gomes, P., Tavares, C., and Eira, C. 2011. SAFESEA - Manual de Apoio para a Promoção de uma Pesca Mais Sustentável e de um Mar Seguro para Cetáceos. Programa EEAGrants - EEA Financial Mechanism 2004-2009 (Projecto 0039), Braga. 114pp.

Vingada, J., Pereira, A., Ferreira, M., Monteiro, S., Costa, E., Gomes, T., *et al.* 2015. Implementation of mitigation measures in fishing gears. Annex to the 4th progress report of the LIFE MarPro project. NAT/PT/00038.

Vishnyakova, K. A. 2017. The harbor porpoise (*Phocoena phocoena*) in the Sea of Azov and the northeastern Black Sea: population morphology and demography. Schmalhausen Institute of Zoology, Kyiv, Ukraine.

Waring, G. T., Josephson, E., Fairfield, C. P. *et al.* (eds.) 2006. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments – 2005. *NOAA Technical Memorandum NMFS-NE – 194.* 346pp.

Waring, G. T., Gerrior, P., Payne, P. M., Parry, B. L., and Nicholas, J. R. 1990 Incidental take of marine mammals in foreign fishery activities off the northeastern United States, 1977-88. *Fisheries Bulletin*, 88: 347-360.

Watt, J., Pierce, G. J., and Boyle, P. R., 1997. Guide to the identification of North Sea fish using premaxillae and vertebrae. , ICES Cooperative Research Report, , ICES, Copenhagen. 231pp.

Watkins, C. A., Gaines, T., Strathdee, F., Bailey, J. L., Watson, E., Hall, A. J., Free, A., and Dagleish, M. P. 2022. A comparative study of the fecal microbiota of gray seal pups and yearlings - a marine mammal sentinel species. Microbiologyopen 11.

Westerberg, H., Lunneryd, S. G., Fjälling, A., and Wahlberg, M. 2006. Reconciling fisheries acivities with the conservation of seals throughout the development of new fishing gear: A case study from the Baltic fishery-grey seal conflict. American Fisheries Society Symposium, 2006: 587-597.

Westphal, L., Klemens, L., Reif, F., van Neer, A., and Dähne, M., 2023. First evidence of grey seal predation on marine mammals in the German Baltic Sea. Journal of Sea Research, 192, 102350.

Williams, A. D. and Browning, L. J. 1999. Analysis of sightings, photo-identification and acoustic data from a small group of bottlenose dolphins in central southern England: moving towards an integrated approach. European Research on Cetaceans, 12: 196-201.

Williams, A. D., Williams, R., Heimlich-Boran., J. R., Evans, P. G. H., Tregenza, N. J. C., Ridoux, V. Liret, C. and Savage, S. 1997. A preliminary report on an investigation into bottlenose dolphins (*Tursiops truncatus*) of the English Channel: a collaborative approach. European Research on Cetaceans, 10: 217-220.

Williams, T. M., Blackwell, S. B., Tervo, O., Garde, E., Sinding, M. H. S., Richter, B., and Heide-Jørgensen, M. P. 2022. Physiological responses of narwhals to anthropogenic noise: A case study with seismic airguns and vessel traffic in the Arctic. Functional Ecology, 36(9), 2251-2266. https://doi.org/10.1111/1365-2435.14119

Wilson, L., and Hammond, P. 2016a. Grey Seal Diet Composition and Prey Consumption Scottish Marine and Freshwater Science Report.

Wilson, L. J. and Hammond, P. S. 2016b. Harbour seal diet composition and diversity. Scottish Marine and Freshwater Science Report, 7(21), 1–86

Wilson, L.J., and Hammond, P.S., 2016c. Comparing the diet of harbour and grey seals in Scotland and eastern England. Marine Scotland Science.

Wilson, L. J., Grellier, K., and Hammond, P. S. 2017. Improved estimates of digestion correction factors and passage rates for harbor seal (Phoca vitulina) prey in the northeast Atlantic. Marine Mammal Science 33: 1149-1169.

Zatrak, M., Brittain, S., Himmelreich, L., Lovick-Earle, S., Pizzi, R., Shaw, K. J., Grant, R. A., and Geary, M., 2022. Factors affecting the survival of harbor (*Phoca vitulina*) and gray seal (*Halichoerus grypus*) juveniles admitted for rehabilitation in the UK and Ireland. Mar Mammal Sci.

Zohari, S., Neimanis, A., Härkönen, T., Moraeus, C., and Valarcher, J. F. 2014. Avian influenza A (H10N7) virus involvement in mass mortality of harbour seals (*Phoca vitulina*) in Sweden, March through October 2014. European Surveillance, 19(46): 20967

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Annex 1: List of marine mammal species names

clad	species	
pinnipeds		
Phocidae	Atlantic grey seal	*Halichoerus grypus atlantica*
	Baltic grey seal	*Halichoerus grypus grypus*
Phocidae	Arctic ringed seal	*Pusa hispida hispida*
Phocidae	Baltic ringed seal	*Pusa hispida botnica*
Phocidae	Bearded seal	*Erignathus barbatus*
Phocidae	Eastern Atlantic harbour seal	*Phoca vitulina vitulina*
	Western Atlantic harbour seal	*Phoca vitulina concolor*
Phocidae	Harp seal	*Pagophilus groenlandicus*
Phocidae	Hooded seal	*Cystophora cristata*
Phocidae	Ringed seal	*Pusa hispida hispida*
Phocidae	Saimaa ringed seal	*Pusa hispida saimensis*
Phocidae	Mediterranean monk seal	*Monachus monachus*
Odobenidae	Walrus	*Odobenus rosmarus rosmarus*
cetaceans		
Balaenopteridae	Blue whale	*Balaenoptera musculus*
Balaenopteridae	Fin whale	*Balaenoptera physalus*
Balaenopteridae	Bryde's whale	*Balaenoptera brydei*
Balaenopteridae	Minke whale	*Balaenoptera acutorostrata*
Balaenopteridae	North Atlantic right whale	*Eubalaena glacialis*
Balaenopteridae	Bowhead whale	*Balaena mysticetus*
Balaenopteridae	Humpback whale	*Megaptera novaeangliae*
Eschrichtiidae	Grey whale	*Eschrichtius robustus*
Delphinidae	Killer whale	*Orcinus orca*
Delphinidae	Long-finned pilot whale	*Globicephala melas*
Delphinidae	Short-finned pilot whale	*Globicephala macrorynchus*
Delphinidae	Striped dolphin	*Stenella coeruleoalba*

Delphinidae	Atlantic spotted dolphin	*Stenella frontalis*
Delphinidae	Atlantic white-sided dolphin	*Lagenorhyunchus acutus*
Delphinidae	White-beaked dolphin	*Lagenorhynchus albirostris*
Delphinidae	Bottlenose dolphin	*Tursiops truncatus*
Delphinidae	Common dolphin	*Delphinus delphis*
Delphinidae	Risso´s dolphin	*Grampus griseus*
Monodontidae	Narwhal	*Monodon monoceros*
Monodontidae	Beluga	*Delphinapterus leucas*
Phocoenidae	Harbour porpoise	*Phocoena phocoena*
Physeteridae	Sperm whale	*Physeter macrocephalus*
Ziphiidae	Northern bottlenose whale	*Hyperoodon ampullatus*
Ziphiidae	Cuvier's beaked whale	*Ziphius cavirostris*

Annex 2: List of participants

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Annex 3: Resolutions

Working Group on Marine Mammal Ecology (WGMME)

Only experts appointed by national Delegates or appointed in consultation with the national Delegates of the expert's country can attend this Expert Group.

2022/FT/EPDSG04 The Working Group on Marine Mammal Ecology (WGMME), chaired by Sophie Brasseur, The Netherlands, and Peter Evans, UK, will meet on 30 January - 2 February 2023 at the Swedish Museum of Natural history, Stockholm, to:

a) Review and report on any new information on seal and cetacean population abundance, distribution, population/stock structure in the NE Atlantic (including North Sea and Baltic Sea), including information on rare or vagrant species of marine mammals in the area of interest and updating the seal database with abundance estimates and new data points;

b) Review and report on any new information on seal and cetacean management frameworks (including indicators and targets for MSFD assessments) in the NE Atlantic (as defined above);

c) Review and report on any new information on i) seal and cetacean and anthropogenic threats (including cumulative effects) to individual health and population status in the NE Atlantic (as defined above);and ii) identify gaps in our knowledge with regards to anthropogenic threats to Marine mammals in the NE Atlantic

d) In collaboration with WGBYC, contribute to the Roadmap for ICES PETS bycatch advice by

i) reviewing selected aspects of marine mammal-fishery interactions and assembling data and qualitative information on marine mammals available from other sources not fully covered by WGBYC (incl. strandings, entanglement, interviews, research projects, national/local monitoring), ii) reviewing available information on those marine mammal species and/or regional populations for which bycatch estimates from at-sea monitoring are lacking or poorly known, and iii) identify gaps in our knowledge and provide guidance on prioritization of marine mammal species of bycatch concern.

e) Review the main results from WGJCDP and WGMPAS with focus on developing relevant data products (WGJCDP) and assessment methods of trade-offs between human activities and biodiversity benefits derived from MPAs (WGMPAS).

WGMME will report by 2 March 2023 for the attention of ACOM.

Supporting information

Priority	The activities of this Group contribute to the understanding of the ecological role o marine mammals.
Scientific justification	ToRs a and b are standing terms of reference. Its scope was expanded by toR c) sin it would be useful to include information on threats to population status, including cumulative effects of multiple stressors. ToR d reflects common interests between WGMME and WGBYC, includingsome aspects of marine mammal fishery

	interactions may otherwise not be covered by either group. Detailed content of this ToR will be agreed between WGMME and WGBYC in consultation with the ICES Secretariat. ToR e will support collaboration between WGMME and othe relevant ICES WGs.
Resource requirements	None.
Participants	The Group is expected to be attended by 15–20 members.
Secretariat facilities	None beyond sharepont facilities and editorial support for the report.
Financial	None.
Linkages to advisory committees	ACOM
Linkages to other committees or groups	WGBYC, WGHARP, WGBIODIV, WGMPAS, WGSAM, WGJCDP, EPDSG, SCICOI
Linkages to other organizations	OSPAR, HELCOM, ASCOBANS, IWC