Agenda Item 3.2	Species Action Plan Conservation Plan for the Harbour Porpoises Population in the Western Baltic, the Belt Sea and the Kattegat (WBBK Plan)
Information Document 3.2/Rev.1	Progress Report on the Conservation Plan for the Harbour Porpoise Population in the Western Baltic, the Belt Sea and the Kattegat 2023
Action Requested	Take note
Submitted by	Baltic HP Coordinator

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

PROGRESS REPORT

on

THE CONSERVATION PLAN
FOR THE HARBOUR PORPOISE POPULATION
IN THE WESTERN BALTIC, THE BELT SEA AND THE KATTEGAT
2023

Ida Carlén

&

Peter G.H. Evans, ***Sea Watch Foundation, UK***

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

Background & History

Following the establishment of a Recovery Plan for Baltic Harbour Porpoises (the Jastarnia Plan) and a Conservation Plan for Harbour porpoises in the North Sea, it was decided at the 18th Meeting of the ASCOBANS Advisory Committee in Bonn, Germany in 2011 that there should also be a Conservation Plan for porpoises inhabiting the waters between these two regions, i.e. the Western Baltic, the Belt Sea and the Kattegat. Concern had been expressed over potential declines in harbour porpoise abundance in this region from the two wide-scale surveys of SCANS in 1994 and SCANS II in 2005.

A draft paper containing background information and proposed objectives and measures for the 'gap area' not covered by the Jastarnia Plan was commissioned following a recommendation by the 7th meeting of the Jastarnia Group (Copenhagen, Denmark, February 2011). This paper was reviewed and refined by the 8th meeting of the Jastarnia Group (Bonn, Germany, January/February 2012), and again, following the 19th Meeting of the Advisory Committee in Galway, Ireland (March 2012). It was formally adopted by the 7th Meeting of the Parties in Brighton, UK, in September 2012.

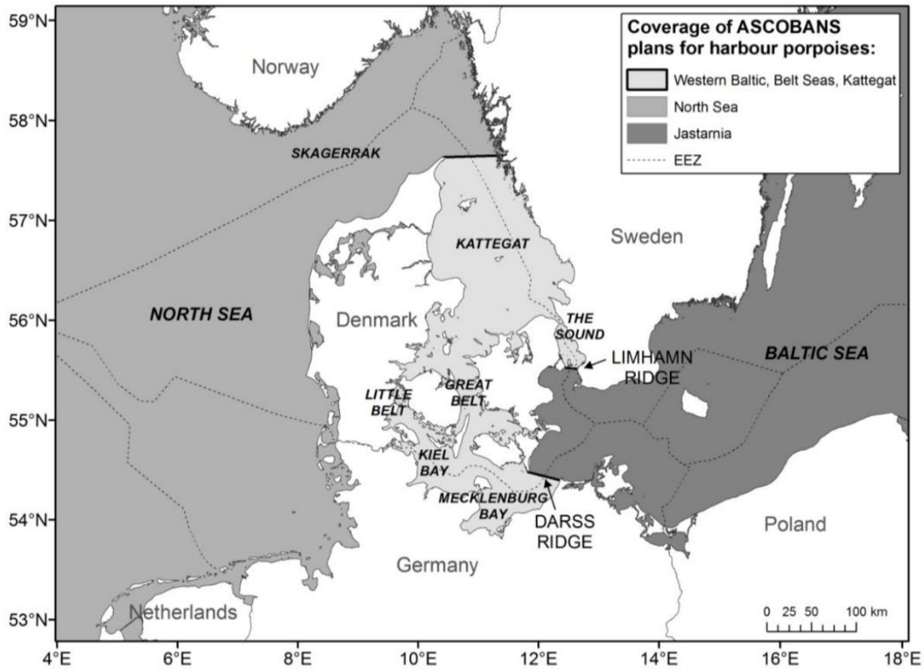

Figure 0.1. Map of the North Sea and the Baltic indicating where the geographical area covered by the Plan for the population in the Western Baltic, the Belt Sea and the Kattegat adjoins that of the ASCOBANS North Sea Plan and the ASCOBANS Jastarnia Plan. The dashed line indicates the national borders of the Exclusive Economic Zone (EEZ) (Source: ASCOBANS, 2012)

The draft plan (ASCOBANS, 2012) covered the 'gap area', and included the waters north and west of the Darss and Limhamn ridges up to the north-western border of the Baltic Sea as defined by HELCOM (i.e. a line from the northern point of Denmark to the coast of Sweden at 57°44.43'N) (see Figure 0.1). This area is now referred to as the Western Baltic, the Belt Sea and the Kattegat (shortened to WBBK). It was agreed in 2021 that the Jastarnia and WBBK areas will be adjusted as plans are updated, so that the WBBK plan will include waters from 56.95°N to 13.5°E, and the Jastarnia plan will include the Baltic east of 13.0°E.

A series of actions have been proposed in the WBBK Conservation Plan (ASCOBANS, 2012). Progress on each of these is reviewed below.

Actions

1. *Actively seek to involve fishermen in the implementation of the plan and in mitigation measures to ensure a reduction in bycatch*

Denmark
Denmark was the first country in Europe to trial the use of Remote Electronic Monitoring (REM) to assess bycatch, in 2008, operating on pelagic trawl fisheries (Ulrich et al., 2015, 2013). Since 2010, they have been used routinely in Danish fisheries (Kindt-Larsen et al., 2012), and currently 8-10 boats are using REM in the WBBK area as part of the Danish Data Collection Framework monitoring. A report on REM data on harbour porpoise bycatch came out in 2021 (Larsen et al., 2021). REM has proved to be a cost-effective and accurate method of monitoring. Part of its success has been due to the relationship built up between fisheries authorities and fishers themselves, through a mixture of trust and incentives. Collaborations with the fishing industry have also taken place in exploring mitigation measures such as pingers, and the use of alternative fishing methods. The developing and testing of electronic pingers and rattle pingers continues, directly involving fishermen, as well as testing the use of lights and low nets to reduce bycatch. In developing and testing alternative gear, studies are taking place to improve the catch efficiency of cod traps, using push-up traps for cod as well as developing and testing small-scale Danish seine for cod. These actions are being undertaken in collaboration with SLU, Sweden.

Germany
Germany has been investigating alternative management approaches and the use of alternative fishing gear. The "Stella" Project (November 2016 – December 2019) had a number of strands: building data, modifying gillnets, investigating the feasibility of alternative gear, creating incentives for data collection, synthesizing the results, and promoting social responsibility within the German Baltic EEZ. This inter-disciplinary project was funded by the Federal Agency for Nature Conservation (BfN) and conducted by the Thünen Institute of Baltic Sea Fisheries, and work is currently continuing in STELLA II. The project engages fishermen of the German Baltic Sea, and amongst other tasks, will synthesise the results of the various disciplines - fisheries biology, fishing technology and social sciences, and derive policy advice for decision makers for example through a dialogue forum, considering also the interest of nature conservation.

Within the Stella projects, Thünen Institute of Baltic Sea Fisheries are carrying out trials on fish pots, pontoon traps and acoustically reflective gillnets, so called pearl-nets. For the pearl-nets, the first step was to find the optimal size and material of a small sphere that would resonate at 130kHz. Acrylic glass spheres were found to be the best available option, of 9.6 or 6.4 mm diameter, and echograms of pearl nets show significantly increased reflectivity at 120 kHz. In 2020, field trials with pearl nets were carried out in the Black Sea turbot fishery, where harbour porpoise bycatch rates are higher than in the Baltic Sea. Over a total of ten hauls, 5 porpoises were bycaught in standard gillnets, and 2 in pearl gillnets. These results are not statistically significant, and the mechanisms behind bycatch in modified nets have to be looked more closely into. Next steps include behavioural experiments to look at porpoise behaviour around standard and modified nets, further trials in commercial fisheries to investigate target species catch rates, and development of an automated process to put pearls on nets.

There has been a voluntary agreement with fishers since 2013 in Schleswig-Holstein, for the conservation of harbour porpoises and sea ducks in the German Baltic. This has involved the Fishery Association and Fishery Protection Union of Schleswig-Holstein, the Baltic Sea Information Centre (OIC), and the Ministry of Energy Transition, Agriculture, Environment and Rural Areas Schleswig-Holstein (MELUR). The result has been a reduction in the total length of gillnets in the months of July and August to 4km for boats >8m, to 3km for boats between 6 and 8m, and to 1.5km for boats <6m. This agreement was recently extended to December 2026.

In addition, almost 1,700 alternative acoustic deterrence devices, Porpoise Alerting Devices or PALs, has been handed out to fishers through the OIC in Eckernförde since 2017. PALs operate by replicating the sounds of porpoises (synthesising supposedly aggressive click trains at 133 kHz) and were designed to serve as an alerting device rather than as a deterrent, by increasing their rate of echolocation (B. Culik et al., 2015). Trials in a Danish fishery in the Western Baltic and the sound using REM to monitor bycatch rates had indicated a 70% reduction when PALs were deployed (Culik et al., 2017), although the size of the effect was much smaller than with pingers. The device has also been tested in a Danish North Sea fishery but was found to have no effect there (B. M. Culik et al., 2015). Reasons for the different results are unclear but it is possible the two different porpoise populations are responding differently to the signals. To date, there is no clear evidence that PAL operates as an alerting device, and a research study with funding from BfN and led by the German Oceanographic Museum started in 2021 to investigate the effectiveness of PALs more closely.

Sweden

The Swedish authorities have been holding dialogue meetings with fishermen concerning the regulation of fisheries in protected areas, both for specific areas and more generally, the latter in conjunction with the Swedish Agency for Marine & Water Management (SwAM). As a result, a delegated act regulating fisheries in some Marine Protected areas in Kattegat came into effect in July 2022.

Projects on remote electronic monitoring (REM) and mobile electronic monitoring (MEM) have been carried out at the Department of Aquatic Resources at the Swedish University of Agricultural Sciences (SLU Aqua) and at present approximately 10-15 fishermen are engaged in Skagerrak, Kattegat, the Sound and the Baltic. SLU Aqua is looking for more fishermen to participate.

There are no longer any gillnet vessels over 12 m active in the areas where implementation of pingers is mandatory according to the Technical Conservation Measures regulation 2019/1241, i.e. no vessels in Swedish waters are mandated to use pingers according to this regulation. In 2015, SLU Aqua started a project in ICES Subdivisions 3.a.21 and 3.a.23 with the purpose of implementing pingers in the lumpfish and cod fishery on a voluntary basis. After discussions with fishermen, high-frequency Banana pingers were chosen for the project. The fishers consider the Banana pinger to be practical to use and they report their catch, effort and bycatch (Benavente Norrman and Königson, 2020). With the new areas where pingers are mandatory, stipulated by delegated acts 2022/303 and 2022/952, fishermen have been applying EFF funding to buy new pingers.

In the area where pingers have been used in the commercial lumpfish fisheries in southern Sweden, a study looking at the distribution of harbour porpoises in relation to commercial fishing nets with pingers has recently ended. Results show that harbour porpoise detections in the area were low when fisheries with pingers were carried out. However, when the pingers were switched off, the harbour porpoise detections increased and were at the same levels as areas where no fishing with pingers had been carried out. In the Swedish small-scale coastal fisheries, alternative fishing gear has been, and is still being, developed, in cooperation with fishermen, see 5. Alternative fishing gear.

Key Conclusions and Recommendations *All three Range States are actively engaged in collaborative projects with fishermen but there is always scope to do more. Denmark has had a long history of working with fishermen on pinger deployment and over the last ten years with remote electronic monitoring and Sweden is now also running a similar program. Such measures could be applied more widely with good effect through the region.*

2. Cooperate and inform other relevant bodies about the conservation plan

Explicit information about the Conservation Plan specifically has not been disseminated to the public in any of the three countries. However, several of the actions recommended within the Plan have been promoted within each country. Raising of public awareness of harbour porpoises in general is ongoing, particularly within Germany but also recently public awareness efforts have increased in Sweden.

In **Denmark**, there is no comprehensive coordinated stranding scheme although reporting is encouraged to the Maritime Museum in Esbjerg (https://fimus.dk/en/about-the-museum/emergency-management-for-marine-mammals/). There is also no active public sighting reporting scheme, but Fjord&Bælt in Kerteminde has developed the "Marine Tracker" app which can be used to report sightings, and the Facebook group hvaler.dk is very active with people posting sightings of marine mammals. In the town of Middelfart there is an active listening station where the public can visit, both "IRL" and online (https://www.youtube.com/watch?v=aPOlRi9Ouls), to listen in real time to any porpoises present around the hydrophone in Middelfart harbour.

In **Germany**, sightings and strandings programmes involving the public are well developed. For Schleswig-Holstein, they are coordinated by the Terrestrial and Aquatic Wildlife Research (ITAW) in Büsum, and for Mecklenburg – Vorpommern they are administered by the German Oceanographic Museum in Stralsund, who have also produced an app "OstSeeTiere" (Baltic Sea Animals) https://www.deutsches-meeresmuseum.de/wissenschaft/sichtungen/sichtung-melden

Public engagement activities include an exhibition "Die letzten 300" in collaboration with NGOs NABU and OceanCare as well as with ASCOBANS. The exhibition displayed the many works received as part of the creative competition, and was on display in the German Oceanographic Museum from January – April 2015, and visited by an estimated 30,000 people. Every year, the museum also participates in the International Day of the Baltic Harbour Porpoise coordinated by ASCOBANS, with specific activities and information for the public. The museum has implemented a marine mammal science education project (https://marine-mammals.com/) together with other organisations in the Baltic Sea Region, which focuses mainly on school activities and educating teachers, providing tools for using marine mammals in education. In 2017, the German Oceanographic museum produced an app ("Be the Whale") depicting a humpback whale, and in 2018 did the same using the beluga. Although not focused upon the harbour porpoise, these are designed to make children aware of dangers to cetaceans in general. Noise, pollution and bycatch are all included as threats as well as shipping in general (ship strikes) and prey depletion. Although located in the Baltic Proper, the museum serves the public over a much wider region and their conservation education activities are clearly relevant to the Western Baltic region to which this Conservation Plan applies.

In **Sweden**, records of strandings are collected opportunistically by the Swedish Natural History Museum (SMNH) in collaboration with the Swedish National Veterinary Institute (SVA) and sometimes the Gothenburg Museum of Natural History. SMNH collects reports of opportunistic sightings and strandings at https://marinadaggdjur.nrm.se/rapportera-tumlare, and has also done quite a few radio/TV interviews in later years as well as written several popular science articles. A press release on the increase in detection rate between SAMBAH and the national monitoring program resulted in a lot of interest from the press in 2022. The SMNH teachers' educational activities now have information about harbour porpoises and how they are affected by underwater noise, and there is online teaching material available. In a youth project revolving around the global sustainable development goals the harbour porpoise has been brought up as an example of how SMNH works with biodiversity. There is an exhibit at the SMNH about harbour porpoises and harbour porpoise information at the dolphinarium at Kolmården Wildlife Park. Sightings and strandings of porpoises can also be reported to Artdatabanken (https://www.artportalen.se/), at https://rapportera.artfakta.se/eftersokta/rappen/skapa and at www.valar.se. SwAM did press releases on the 30 year anniversary of ASCOBANS and for the International Day of the Baltic Harbour Porpoise, SMNH, Lund University, SVA, and SLU Aqua did several interviews for newspapers, radio and podcasts and the Skåne County Administrative Board have public information about porpoises for tourists around Kullaberg. WWF Sweden, the Swedish Society for Nature Conservation and Coalition Clean Baltic also do awareness-raising, mainly through social media.

Key Conclusions and Recommendations *Germany has a long history of working with stakeholders and the general public on conservation issues, and Sweden is getting more active as well with the harbour porpoise gaining more attention. NGO efforts to raise awareness are present in Germany and Sweden, but slightly less so in Denmark. Efforts should be made to address this, particularly with respect to citizen science projects.*

3. Protect harbour porpoises in their key habitats by minimizing bycatch as far as possible

In recent years, there has been a concerted effort to identify and establish Natura 2000 sites as Special Areas of Conservation (SACs) under the EU Habitats Directive (1992/43/EEC). Figure 3.1 shows the Natura 2000 sites established for harbour porpoises in the WBBK and the surrounding area, as of 31 December 2021. No new sites have been added since.

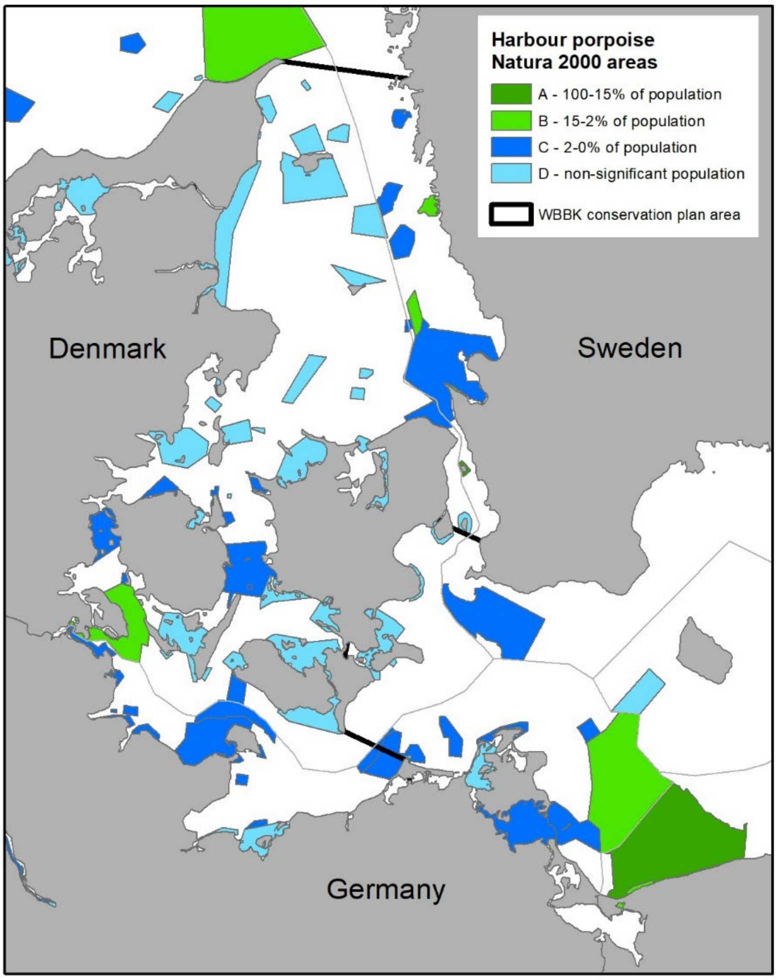

Figure 3.1. Natura 2000 sites where the harbour porpoise is on the list of species. Green and blue colours refer to the population assessment of the site (source: https://www.eea.europa.eu/data-and-maps/data/natura-13, as of 31 Dec 2021)

The next step is to develop management plans for the SACs that are still missing them, and to implement conservation measures including fisheries regulations to avoid bycatch and ensure sufficient prey availability. To date, very few of these areas have any concrete conservation measures in place.

In **Denmark**, in 2020 the harbour porpoise was added to an additional 20 Natura 2000 sites, which means that there are now a total of 35 Natura 2000 areas designated for harbour porpoise in accordance with the EU Habitats Directive. The designation was based on a review of existing knowledge at the time (Sveegaard et al., 2018). None of the Natura 2000 areas currently have any specific conservation or fisheries measures implemented to protect harbour porpoises, and the only statement about porpoise conservation is the same in all the management plans, namely that the Danish Nature Agency are developing a strategy for protection of harbour porpoise in Danish waters.

This strategy was planned for 2021 but is not in place yet in June 2023. The fishing pressure, also with static nets, is quite high in some of the protected areas (https://mst.dk/media/194110/n1-basisanalyse-2022-27-skagens-gren-og-skagerrak.pdf). Since 2011, harbour porpoises have been monitored as part of the Danish monitoring programme, NOVANA, both within the SCIs and in their entire range.

In **Germany** there are general national ordinances set for the marine protected areas (mainly Natura 2000 areas) designated for porpoises, which include prohibition of some constructions and aquaculture as well as obligations for compatibility studies for windfarm construction, pipe laying and material extraction. Recreational fisheries are also prohibited in some parts of areas. In February 2022 the management plans for the Natura 2000 areas in the EEZ of the German Baltic Sea came into force. A joint recommendation on fisheries measures for mobile bottom-contacting gear in protected areas has been positively evaluated by the STECF and are currently waiting for approval by the EU. Apart from the Natura 2000 sites included in the Baltic porpoise delegated act of February 2022, measures for passive gears are currently under development, being discussed nationally and taking into account the outcomes of the Stella I and II project. There are 12 German SACs designated for harbour porpoise within the WBBK area.

In **Sweden**, there are 9 SACs within the WBBK area designated for harbour porpoise. All of them have management plans, and four areas have fisheries regulations in place through the 2022 Delegated Acts 2022/303 and 2022/952. In the Natura 2000 area Sydvästskånes utsjövatten, pingers are obligatory on static nets from May-October, and static nets are completely banned from November- April. In the Natura 2000 areas Fladen, Lilla Middelgrund and Stora Middelgrund och Röde bank, all in Kattegat, approximately 50% of each area is completely closed to all fisheries, while the rest of the areas are so-called restricted fishing zones (Fig. 3.2). This means that pelagic trawling, handheld gear and pots and traps are allowed, and static nets are allowed if the vessel is part of a national program conducted by or on behalf of the national authorities for monitoring and assessing accidental bycatch of harbour porpoise and seabirds by use of remote electronic monitoring (REM) including the use of CCTV and position data.

Since May 2019, the Swedish national monitoring program for harbour porpoises includes 14 stations within Swedish SACs designated for harbour porpoise.

On 2 July 2020, the European Commission sent a letter of formal notice to Sweden for non-compliance with articles 6.2 and 12.4 of the Habitats Directive, specifically for not establishing a system to monitor incidental bycatch of harbour porpoise and taking the necessary measures to protect harbour porpoise to ensure such incidental capture and killing does not negatively impact the species (art 12.4), as well as taking the appropriate steps to avoid disturbance within SACs designated for the species (art 6.2). The Commission also raised the issue of not correctly transposing the indicated articles from the Habitats Directive into Swedish law. Sweden responded to the enquiry in October 2020, and if the response or actions taken by Sweden are unsatisfactory, the Commission will take the next step which would be to send a reasoned opinion. It is not yet known whether this will happen. The third and final step, if Sweden does not fulfil the requirements, is a case in the European Court of Justice.

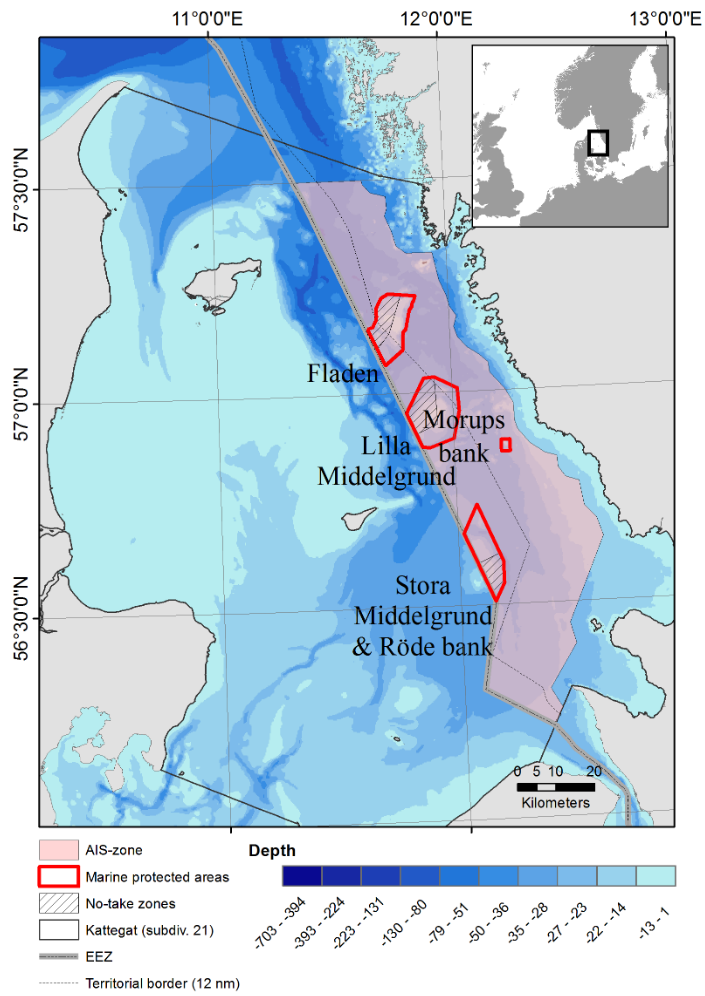

Figure 3.2. Map showing the fisheries regulations in place in Swedish Natura 2000 areas in Kattegat. (Source: The Swedish Agency for Marine and Water Management, https://www.havochvatten.se/arkiv/aktuellt/2022-06-20-nya-fiskeregleringar-for-att-skydda-biologisk-mangfald-i-bade-den-danska-och-svenska-delen-av-kattegatt.html)

Key Conclusions and Recommendations *Several Natura 2000 sites now exist in the Western Baltic, Belt Sea and Kattegat. The next step is to develop management plans for each site and more importantly to ensure that there are mitigation measures in place to minimise adverse effects of human activities such as fisheries and noise disturbance. There should also be adequate regular monitoring of porpoises in and around these areas.*

4. Implement pinger use in fisheries causing bycatch

Regulation 812/2004 was repealed in 2019 and replaced by regulation 2019/1241, but the regulations relating to harbour porpoise bycatch remain unchanged, mainly the areas where pinger use is mandatory are the same (Fig. 4.1). Unfortunately, these areas are clearly not based on data on harbour porpoise distribution in the Baltic Proper, and miss for example the Sound and the Danish Belts which are important areas for the Belt Sea population . Also, the fact that the new regulation still only includes vessels with a length of over 12 m means that most static net fisheries in the region are excluded, and the regulation hence has very little actual impact on harbour porpoise conservation. Monitoring effort of pinger use is very low, and compliance is very likely low in all three countries.

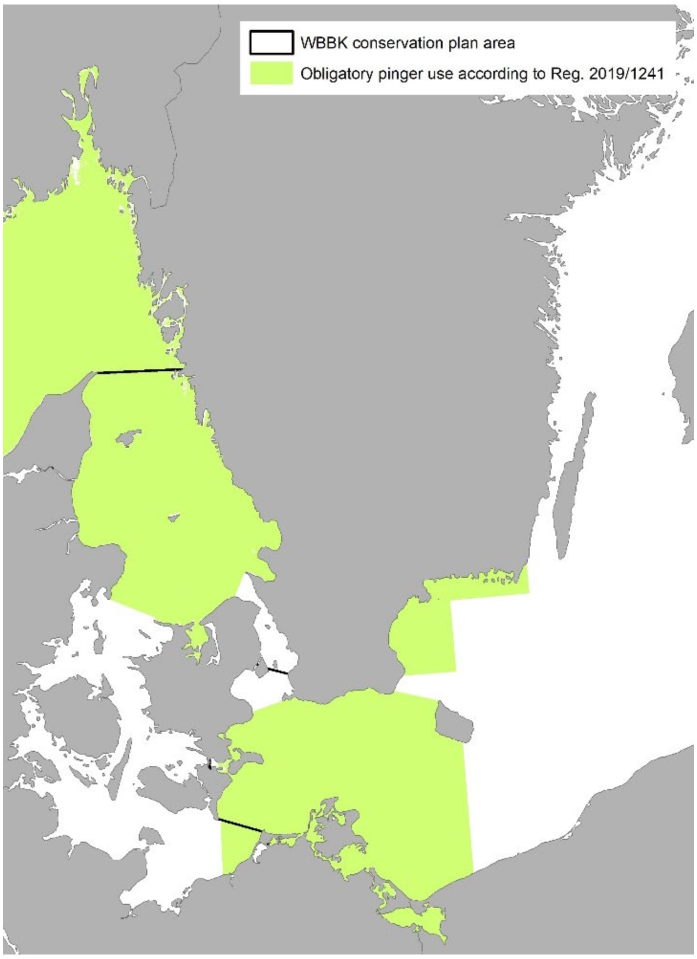

Figure 4.1. Areas where pinger use is mandatory under EC Regulation 2019/1241, on bottom set gillnets and entangling nets from vessels ≥ 12 m.

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

In 2021, a total of 12 vessels ≥12m were registered as gillnetters in Germany but only 7 of them were active. It is unclear how many of those were active in Mecklenburg-Vorpommern. During 2016 inspections, none of these vessels were encountered in ICES Division 3.24 during the setting of gillnets in the course of sea inspections. Coastal waters of Schleswig-Holstein in the Baltic Sea do not fall within the scope of Reg 2019/1241 (see Figure 4.1).

In Schleswig-Holstein, almost 1,700 alternative acoustic deterrence devices, Porpoise Alerting Devices or PALs, has been handed out to fishers through the OIC in Eckernförde since 2017. PALs operate by replicating the sounds of porpoises (synthesising supposedly aggressive click trains at 133 kHz) and were designed to serve as an alerting device rather than as a deterrent, by increasing their rate of echolocation (B. Culik et al., 2015). Trials in a Danish fishery in the Western Baltic and the sound using REM to monitor bycatch rates had indicated a 70% reduction when PALs were deployed (Culik et al., 2017), although the size of the effect was smaller than with pingers. The device has also been tested in a Danish North Sea fishery but was not found to have any effect there (B. M. Culik et al., 2015). Reasons for the different results are unclear but it is possible the two different porpoise populations are responding differently to the signals. To date, there is no clear evidence that PAL operates as an alerting device. A research project to investigate the effectiveness of PALs to mitigate bycatch and other factors such as habituation is being funded by BfN and started in 2021, led by the German Oceanographic Museum.

In **Denmark**, a total of 22 vessels were obliged to use pingers in 2017. Monitoring of pinger use is part of the inspection of gillnet fisheries in Denmark, however in 2017 no inspections were carried out due to re-organisation and transfer of responsibility from one ministry to another.

Currently, a large pinger project is looking at distance effects, testing different pingers in real fisheries and using drones to study porpoise behaviour around nets and pingers. There are also studies ongoing on estimation of drop-out rates of harbour porpoises caught in gillnets, and trials of gillnets with thinner twine as well as simple mechanical “pingers” to reduce bycatch.

Sweden reported that the implementation of pingers as was laid down in Reg. 812/2004, and which is now transferred to regulation 2019/1241 (see Fig. 4.1), most likely is not being implemented in regulated fisheries in Sweden. However, very few gillnet vessels in Sweden are over 12 m and hence required by the Regulation to use pingers. In 2015, a project started with the purpose of implementing pingers on a voluntary basis on boats below 12 m (and hence not obliged to use pingers according to the regulations) in the Sound, ICES divisions 3.21 and 3.23. The fishermen report their catch, effort and bycatch and the pingers do decrease the bycatch rate. The voluntary pinger use has continued (Benavente Norrman and Königson, 2020) and there is funding for pingers available from the European Maritime Fund for Aquaculture and Fisheries.

In the area where pingers have been used in the commercial lumpfish fisheries in southern Sweden, a study looking at the distribution of harbour porpoises in relation to high frequency pingers has recently ended. Results show that harbour porpoise detections in the area were low when pingers were active. However, when the pingers were switched off, the harbour porpoise detections increased and were at the same levels as areas where no fishing with pingers had been carried out (Königson et al., 2021). The study also showed that these high frequency pingers were unlikely to cause the so-called dinner-bell effect where seals hear the pingers and use them to find the nets, because seals can only hear the pinger signal at very short distances.

A large pinger project was carried out in cooperation between DTU Aqua and Fjord & Bælt in Denmark. This project examined distance effects and carried out a drone study on reactions of harbour porpoise to pingers. The project ran until the end of 2020. A paper has been published on the fine-scale behaviour of porpoises towards pingers, showing that pingers can elict strong aversive reactions but also that reactions may vary quite significantly between individuals and/or situations (Brennecke et al., 2022).

Key Conclusions and Recommendations *Pingers are deployed in parts of the static gillnet fisheries by the fleets of all three Range States, mainly as part of projects or voluntary efforts. Compliance with regulations is not fully checked or enforced throughout the region, and is very likely not fully implemented. Given the arbitrary delimitation of areas where pingers should be used under Regulation 2019/1241, and the 12 m vessel size limit which clearly has nothing to do with bycatch risk, countries should carry out bycatch risk modelling and implement pinger use, introduction of alternative fishing gear, or fisheries closures in areas and fisheries with high risk of bycatch.*

The German PAL system needs further investigation to determine to what extent it functions as an alerting rather than deterrent device, and to establish its potential in different situations. A project monitoring the PAL effectiveness in German waters is being initiated and the results will be very important for the continuation of this effort and possibly for the continued development of acoustic deterrent devices.

5. *Where possible, replace gillnet fisheries known to be associated with high porpoise bycatch with alternative fishing gear known to be less harmful*

In **Germany**, a voluntary agreement has been in place with fishermen since 2013 in Schleswig-Holstein, resulting in a reduced length of gillnets deployed in the months of July and August. This agreement has recently been prolonged until December 2026.

Germany has also been investigating alternative management approaches and the use of alternative fishing gear. The “Stella” Project (November 2016 – December 2019) had a number of strands: building data, modifying gillnets, investigating the feasibility of alternative gear, creating incentives for data collection, synthesizing the results, and promoting social responsibility within the German Baltic EEZ. This inter-disciplinary project was funded by the Federal Agency for Nature Conservation (BfN), and conducted by the Thünen Institute of Baltic Sea Fisheries. Within the Stella project, Thünen Institute of Baltic Sea Fisheries carried out trials on developing acoustically reflective gillnets. The first step was to find the optimal size and material of a small sphere that would resonate at 130kHz. Acrylic glass spheres were found to be the best available option, of 9.6 or 6.4 mm diameter, and echograms of pearl nets show significantly increased reflectivity at 120 kHz. In the last step, field trials with pearl nets were carried out in the Black Sea turbot fishery, where harbour porpoise bycatch rates are higher than in the Baltic Sea. Over a total of ten hauls, 5 porpoises were bycaught in standard gillnets, and 2 in pearl gillnets. These results are not statistically significant, and the mechanisms behind bycatch in modified nets have to be looked more closely into. Next steps should include behavioural experiments to look at porpoise behaviour around standard and modified nets, further trials in commercial fisheries and development of an automated process to put pearls on nets. The final report from the Stella project was published in 2022 (Krumme et al., 2022), but trials with modified gillnets as well as behavioural studies of harbour porpoises in relation to gillnets will continue under the umbrella of Stella II. Stella and Stella II will synthesise the results of the various disciplines - fisheries biology, fishing technology and social sciences, and derive policy advice for decision makers, considering also the interest of nature conservation.

With regard to bycatch mitigation, in **Denmark** a simple type of rattle pinger is being developed and tested, as well as more standard type of pingers, and trials are also conducted using lights and setting nets lower to examine whether such measures can decrease bycatch. In developing and testing alternative gear, studies are taking place to improve the catch efficiency of cod traps, using push-up traps for cod as well as developing and testing small-scale Danish seine for cod. These actions are being undertaken in collaboration with SLU, Sweden, however the work on cod gear has slowed down considerably since the ban on cod fishing in Kattegat and the Baltic Proper. In 2022, trials using pearl nets will begin.

In the small-scale coastal fisheries in **Sweden** alternative fishing gear is continuously being developed. Pontoon traps for fishing salmon, white fish, trout and vendace are now used in commercial fisheries in the northern Baltic. During recent years, a pontoon trap has been developed for use in the southern Baltic cod fishery. The results show that during certain times catches of cod can be high. However, gear needs further development with regards to resistance to rough seas and open archipelagos as well as practical handling (Nilsson, 2018).

Several studies have been undertaken to evaluate the catch efficiency of different cod and lobster pots and what factors affect it (Hedgärde et al., 2016; Ljungberg et al., 2016; Nilsson, 2018). This is done partly by studying the behaviour of cod in relation to cod pot models and other fisheries related factors such as soak-time. The rate of cod entering pots gives an indication on the catch efficiency of the pots and by studying the entry rate in relation to factors such as cod pot model, number of fish inside the pot, and current strength, one gains information on what factors are affecting catchability. The results are show that the number of entrances on the pot and the number of cod already inside the pot affect the entry rate of the cod entering the pot (Hedgärde et al., 2016). Another study has shown that using a funnel on the entrance opening to the fish holding chamber also affects the behaviour of cod while entering the pots. However, it increases the catch per unit effort due to the decreasing number of cod exiting the pots (Ljungberg et al., 2016).

An alternative to both trawl and gillnet fisheries is bottom seine netting, such as Danish Bottom Seine. Bottom seines are generally considered less damaging than bottom trawls, and well-managed seine fisheries generally have minor ecosystem impacts (Morgan and Chuenpagdee, 2003). In 2016, SLU Aqua continued to develop a seine net modified for small open boats and tested it in pelagic and demersal species as a possible alternative to gillnet fisheries. The development is still under progress and the upcoming years there will be a focus on evaluating the seines environmental impact on the benthic habitat. Currently also pots, trap-nets and fyke-nets are being developed in cooperation with small-scale fishermen.

Key Conclusions and Recommendations *Studies are ongoing in all three countries to find alternative fishing methods that are less harmful to marine wildlife including porpoises. These should be strongly encouraged, and knowledge gained should be shared widely across the fishing industry and other marine stakeholders. When economically viable gear are available, effort should be made to implement these into active fisheries.*

6. Estimate total annual bycatch

In 2021, a total of six harbour porpoises were reported bycaught in the WBBK area, five porpoises were reported bycaught in the Sound (27.3.b.23) and one in the Belt Sea (27.3.c.22) (ICES, 2022a).

The **German** commercial fleet in the Baltic Sea consists of about 60 trawlers and larger (>10 m total length) polyvalent vessels, and about 650 vessels using exclusively passive gear (< 12 m total length). There is no specific monitoring of bycatch, instead bycatch monitoring is included as part of the Data Collection Framework (DCF) scheme.

In **Denmark**, until recently, no specific monitoring programmes for incidental bycatch of cetaceans were undertaken. However, since 2022, CCTV and observer monitoring of incidental catches of marine mammals that was previously conducted as scientific projects is included under the Data Collection Framework scheme.

In 2021 a report was published which estimated the total bycatch in the Danish commercial gillnet fleet based on data collected in 2010-2018 (Larsen et al., 2021). The bycatch of harbour porpoises in the Belt Sea and the Sound was estimated to 595 animals per year. A recently published paper (Kindt-Larsen et al., 2023) estimated the yearly average bycatch in the region to 2088 animals (95% CI: 667-6798).

In autumn 2022, **Sweden** introduced a dedicated bycatch monitoring program focusing on the bycatch of marine mammals, with the aim to cover approximately 5% of static fishing net effort within the Belt and Baltic Sea population ranges. The monitoring uses on-board observers as well as mobile electronic monitoring with cameras. There are not yet any results available from this monitoring programme. Previously, the monitoring effort conducted and provided by Sweden was part of the EU Data Collection Framework where on-board observer data are mainly from trawl fisheries but also pot fisheries for Norwegian lobster. In the WBBK area, harbour porpoises are bycaught mainly in gillnets and not in pelagic trawls, and therefore observing 5% of Swedish pelagic trawl effort was insufficient to provide an estimate of total cetacean bycatch with acceptable confidence limits.

Table 6.1. Monitoring effort in Swedish static net fisheries between June – December 2022

Area	EM days	Observer days
Green – low risk	0	0
Orange – low risk	0	4
Yellow – medium risk	26	11
Red – high risk	16	0
Blue – Belt Sea population	121	16

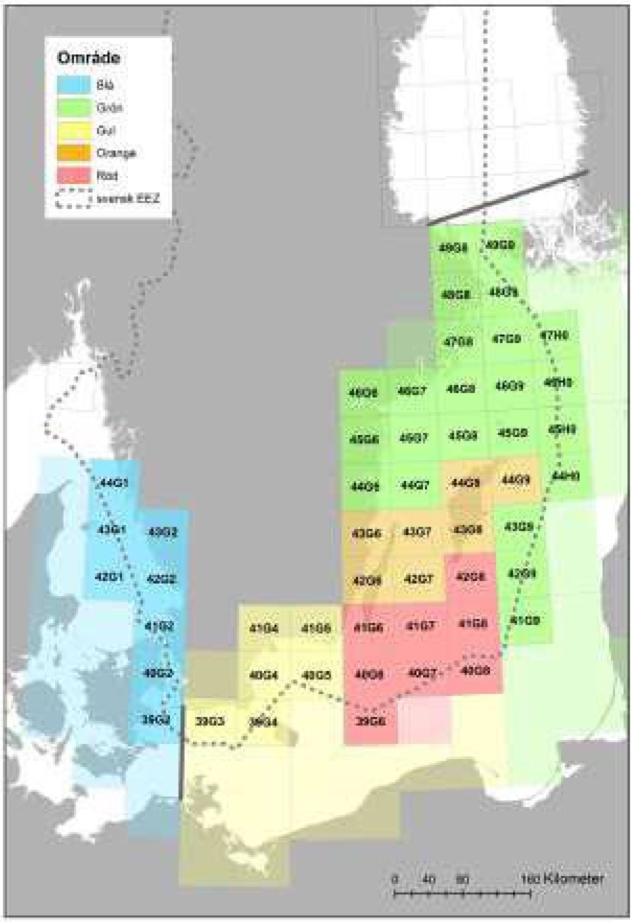

Figure 6.1. Risk areas in Swedish waters, based on porpoise density from SAMBAH and Natura 2000 areas where harbour porpoise is included for conservation. Sampling design areas are divided into: Green, low risk area; Orange, low risk area; Yellow, medium risk area; Red, high risk area and Blue - Belt Sea population area.

Within **HELCOM**, the Action project has developed a map of estimated bycatch per unit effort for the Kattegat and the Belt Sea (ICES subdivisions 21, 22 and 23) using a generalised linear model with bycatch rates from the extensive remote electronic monitoring programme in Denmark, and the spatial distribution of fishing effort in Denmark and Sweden and mesh size as input variables. The resulting maps of estimated bycatch per unit effort and uncertainty are shown in Figure 6.1.

For the third HELCOM Holistic Assessment of the Baltic Sea Ecosystem (HOLAS III), an analysis was carried out by the Swedish Museum of Natural History calculating the mPBR (modified potential biological removal) for the Belt Sea population using code that the OSPAR Marine Mammal Expert Group has developed from the US MMPA PBR methodology. The ASCOBANS conservation objective was used as a basis, stating that the population should reach 80% of carrying capacity (here assumed to be 50 000 animals) within 100 years (Owen et al., 2022). Depending on the recovery factor used, estimates of removal limits vary between 29-292 animals per year. In the HOLAS III indicator for number of drowned mammals and waterbirds in fishing gear, the threshold level for the WBBK harbour porpoise population was set to 73 animals per year based on this mPBR analysis. Comparing the results from this mPBR to the estimated bycatch calculated by for example Larsen et al. (2021) and Kindt-Larsen et al (2023) for the Danish gillnet fisheries, it is clear that the current bycatch significantly exceeds this limit, and the HELCOM HOLAS III indicator was assessed as sub-GES (HELCOM, 2023a).

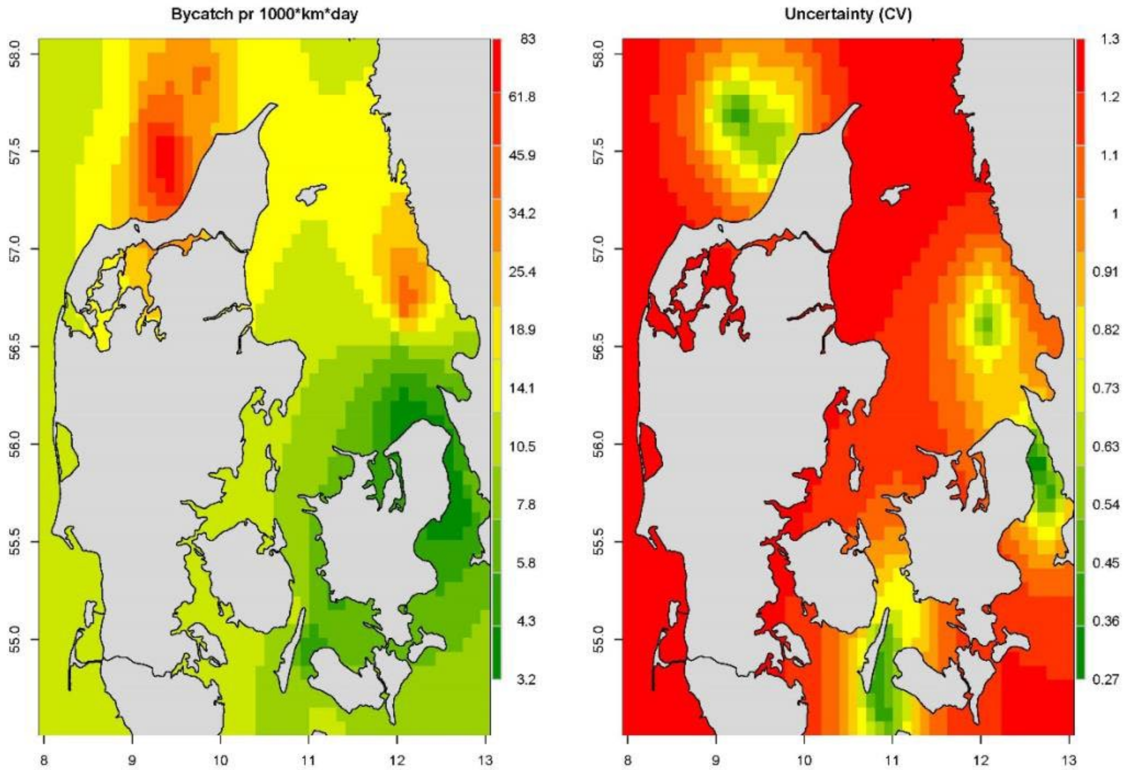

Figure 6.2. Left: Estimated bycatch per unit effort (number of porpoise per 1000 km*day). Right: Uncertainty of the estimates on left map (coefficient of variation). The green/yellow regions in the uncertainly map (right) indicate where data are present, whereas red areas are unsampled and thus quite uncertain (from HELCOM ACTION, 2021).

Key Conclusions and Recommendations *Sweden recently introduced a dedicated monitoring program for marine mammal bycatch, and the CCTV monitoring in Denmark has been incorporated into the Danish DCF monitoring program. Dedicated marine mammal bycatch monitoring is not implemented in Germany, which should be done urgently. Further efforts should also be made to gather data on static net fishing effort in German waters. If logbook or VMS data are not available, alternative methods should be considered.*

Remote electronic monitoring appears to be effective but the key challenge is to cover a sufficient part of the fleet of higher risk fisheries to arrive at reliable bycatch estimates.

The bycatch estimates and the risk maps developed within the HELCOM Action project should be regularly updated using new information on fishing effort and animal distribution, and should immediately be put to use to introduce mitigation measures especially in high-risk areas.

Last but not least, recent bycatch estimates show that bycatch significantly exceeds sustainable levels, and urgent action is needed to ensure the stability of the population.

7. *Estimate trends in abundance of harbour porpoises in the Western Baltic, the Belt Sea and the Kattegat*

The abundance of harbour porpoises in northern European waters, (excluding the Baltic Proper) has been estimated three times from internationally coordinated large-scale dedicated surveys; SCANS (Small Cetacean Abundance in the North Sea and Adjacent waters) in July 1994 (Hammond et al., 2002), SCANS-II in July 2005 (Hammond et al., 2013), SCANS-III in July 2016 and SCANS-IV in July 2022. Results from SCANS-IV are not yet available.

In addition to the three SCANS surveys, the Belt Sea Management Unit has been surveyed in the two MiniSCANS surveys in July 2012 (Viquerat et al., 2014) and in June-July 2020 (Unger et al., 2021, Figure 7.1). All estimates from SCANS and MiniSCANS surveys are included in table 7.1.

The latest abundance estimate of 17,301 (95% CI = 11,695-25,688) is the lowest since the SCANS-II survey in 2005. A dedicated trend analysis completed by the University of Veterinary Medicine Hannover as a part of the HELCOM BLUES project, could not detect a trend using conventional methods, however using Bayesian statistics a small negative trend could be discerned (Gilles et al., 2022).

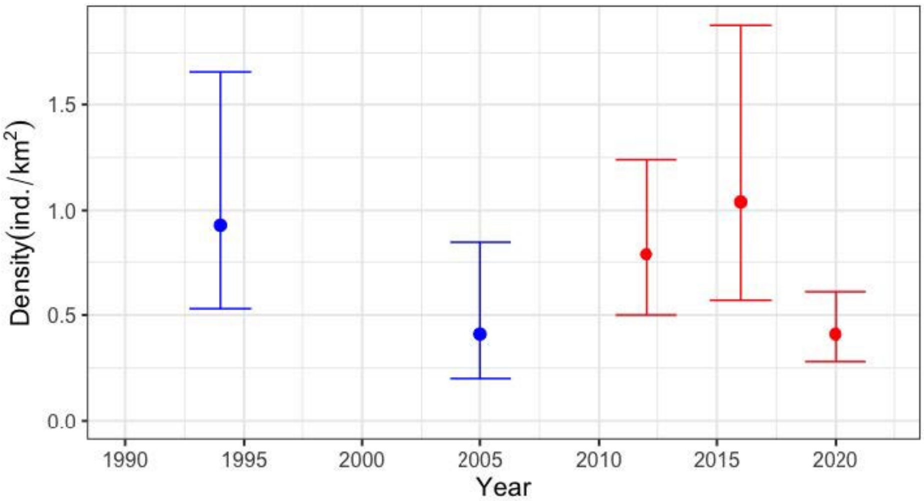

Figure 7.1. Time series of harbour porpoise mean density estimates for surveys in the Belt Sea population region. Surveys either covered solely the distribution range of the population (i.e., western Baltic Sea, Belt Sea, The Sound and Kattegat) (red) or covered a larger area, including the Skagerrak to different extents (blue). Figure from Unger et al. 2020.

Table 7.1 summarises porpoise abundance estimates from each survey, with the SCANS estimates subdivided into the original blocks (Skagerrak, Kattegat and Belt Seas) and then within the management unit area of the Belt Sea harbour porpoise population in the Kattegat and Belt Seas.

Table 7.1. Overview of harbour porpoise abundance and density (ind./km2) estimates from SCANS and MiniSCANS surveys in the Belt Sea population region. Surveys were either conducted solely on the distribution range of the population (i.e., western Baltic Sea, Belt Sea, The Sound and Kattegat) (BS) or covered a larger area, including the Skagerrak, to different extents (S). *For ship surveys, effort refers to km in sea conditions Beaufort ≤2, and for aerial surveys, under good or moderate conditions. From Unger et al 2021.

Year	**1994**	**2005**	**2012**	**2016**	**2020**
Survey dates	27 June-09 July 1994	27 June-16 July 2005	02-21 July 2012	5-24 July 2016	24 June-10 July 2020
Survey	SCANS	SCANS-II	MINISCANS	SCANS-III	MiniSCANS-II
Block	I + X	S		2	MS A-I
Area	S/BS	S/BS	BS	BS	BS
Area (km2)	55,295	68,372	51,511	40,707	42,244
Platform	ship + aerial	ship	ship	ship	aerial
Effort (km)*	2,292	1,279	826	1,028	4,533
Abundance	51,660	27,901	40,475	42,324	17,301
CV	0.30	0.39	0.24	0.30	0.20
CI low_abu	29,058	13,387	25,614	23,368	11,695
CI high_abu	91,841	58,149	65,041	76,658	25,688
Density	0.93	0.41	0.79	1.04	0.41
CI low_dens	0.53	0.20	0.50	0.57	0.28
CI high_dens	1.66	0.85	1.24	1.88	0.61
Reference	Hammond et al. (2021), revised from Hammond et al. (2002)	Hammond et al. (2021), revised from Hammond et al. (2013)	Viquerat et al. (2014)	Hammond et al. (2021)	Unger et al. (2021)

In **Denmark**, an acoustic monitoring program began in 2012. C-PODs are circulated between in harbour porpoise SACs, and in 2021-2022 SACs in the Northern Sound and Fehmarn Belt was monitored. Results from most of the areas show a steady increase in detections since 2012 (Fig. 7.4).

Acoustic monitoring in **German** waters of the WBBK area continues to use C-PODs (see Figure 7.5). Germany also has an established monitoring programme of their waters using visual and digital aerial surveys within the WBBK region (west of 13.5° E around the island of Rügen, see Figure 7.5). This is funded by BfN, with surveys in summer every two years. Around Fehmarn, however, the surveys are undertaken annually. There are also winter surveys (in association with seabird monitoring) around the Pomeranian Bay ("Pommersche Bucht").

In **Sweden**, 14 acoustic monitoring stations in Natura 2000 sites in the WBBK area were added into the national monitoring programme in May 2019 (Fig. 7.7-7.8). Most stations have detections almost every day, and there are indications of summer detection frequencies increasing in Skåne while decreasing slightly in Halland.

In **HELCOM**, for HOLAS III, a qualitative assessment was made for the WBBK harbour porpoise population abundance, and the status was assessed as bad (HELCOM, 2023b).

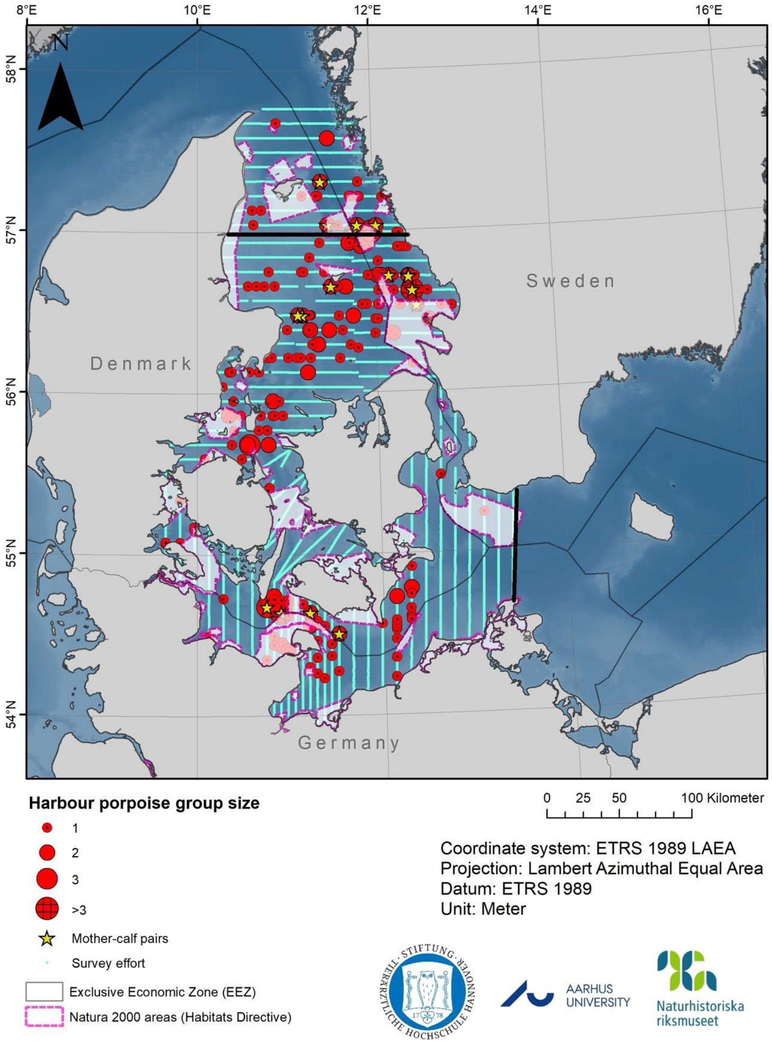

Figure 7.2. Survey effort and distribution of harbour porpoise sightings during aerial surveys (under good or moderate conditions) in the strata MSA-MSI and NK during the MiniSCANS-II survey. The map shows all Natura 2000 areas in the study area, where the harbour porpoise is listed as protected species. The thick black lines indicate the borders of the management area of the Belt Sea population (defined in Sveegaard et al., 2015). From Unger et al 2021.

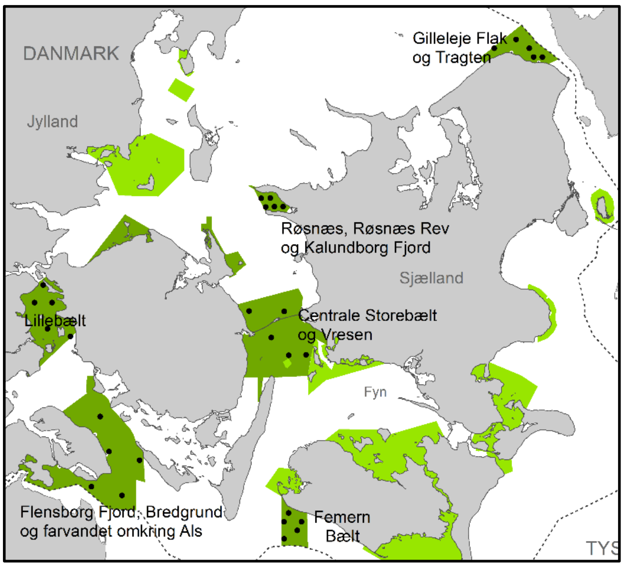

Figure 7.3. Areas and stations in the Danish passive acoustic monitoring program.

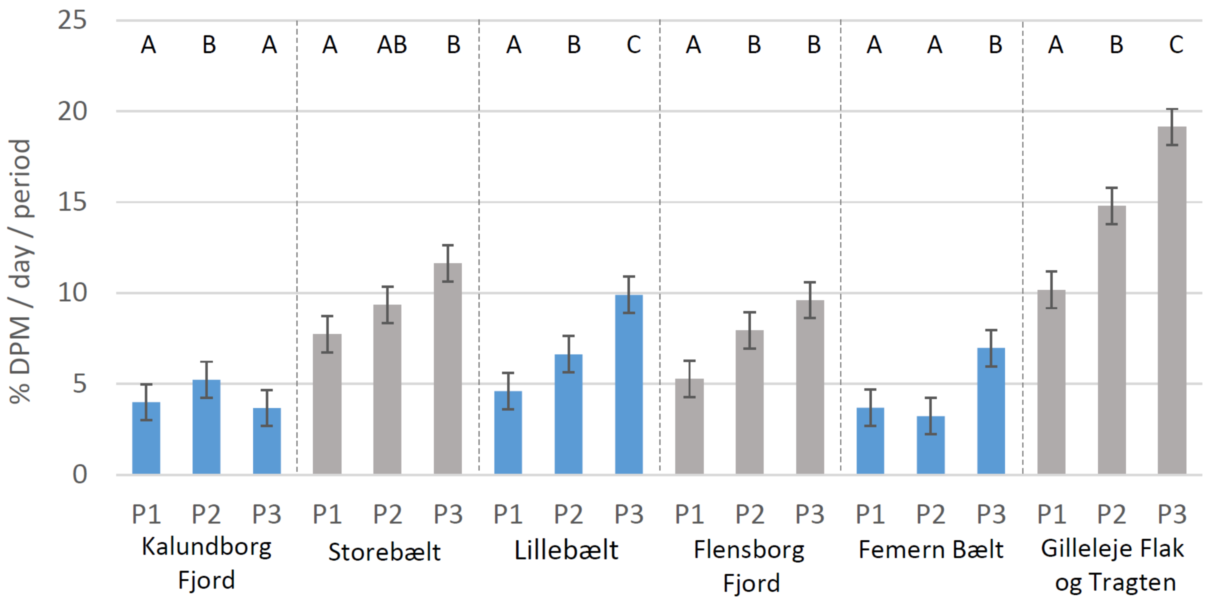

Figure 7.4. Results from the Danish passive acoustic monitoring program for three monitoring periods 2012-2021). Results for each period represents the average of the five acoustic stations within each of the six Natura 2000 sites (see Figure 7.3). Vertical lines indicate 95 % CI. A, B and C refereres to statistical significant differences (α=0,05), so that different letters are different and the same letter indicates that they are not statistically different. Each period is approx 1 year: Kalundborg Fjord and Storebælt: P1 = Jan12-Dec12, P2 = Jan14-Dec14, P3 = Mar17-Apr18, Lillebælt and Flensborg Fjord: P1 = Feb13-Apr14, P2 = Sep15 - Sep16, P3 = Sep19-Sep20, Femern Bælt: P1 = Apr15-Mar16, P2 = Apr15 – Mar16, P3 = Oct20-Oct21, Gilleleje Flak og Tragten: P1 = Apr14-Jul15, P2 = Aug15-Dec16, P3 = Oct20-Oct21.

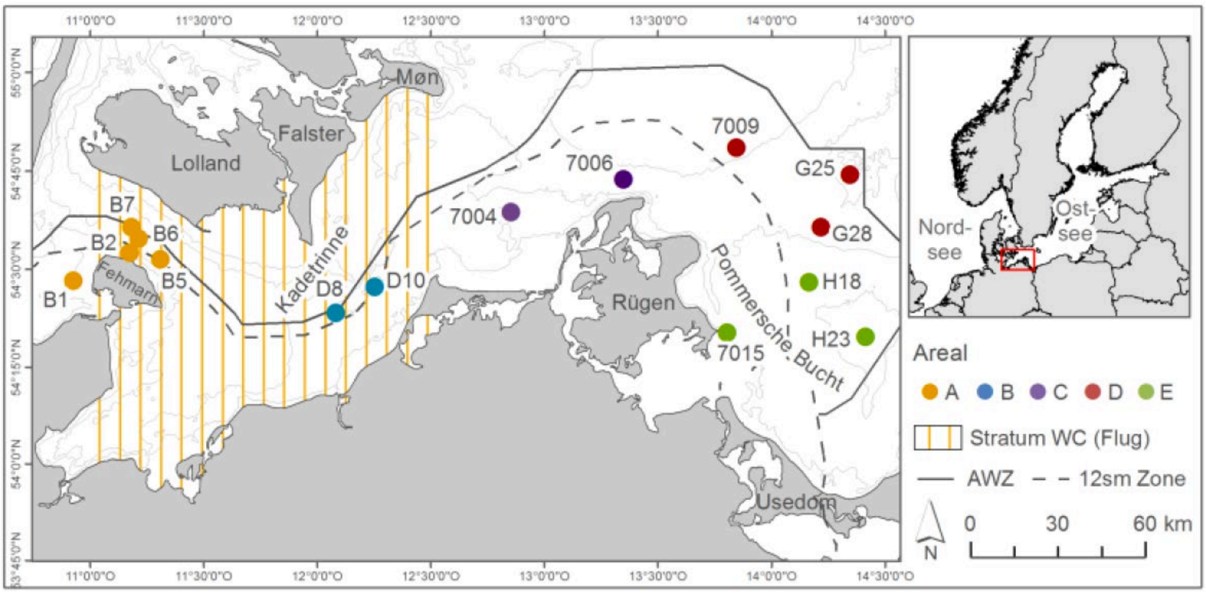

Figure 7.5. Locations of C-PODs deployed as part of the German Acoustic Monitoring Programme

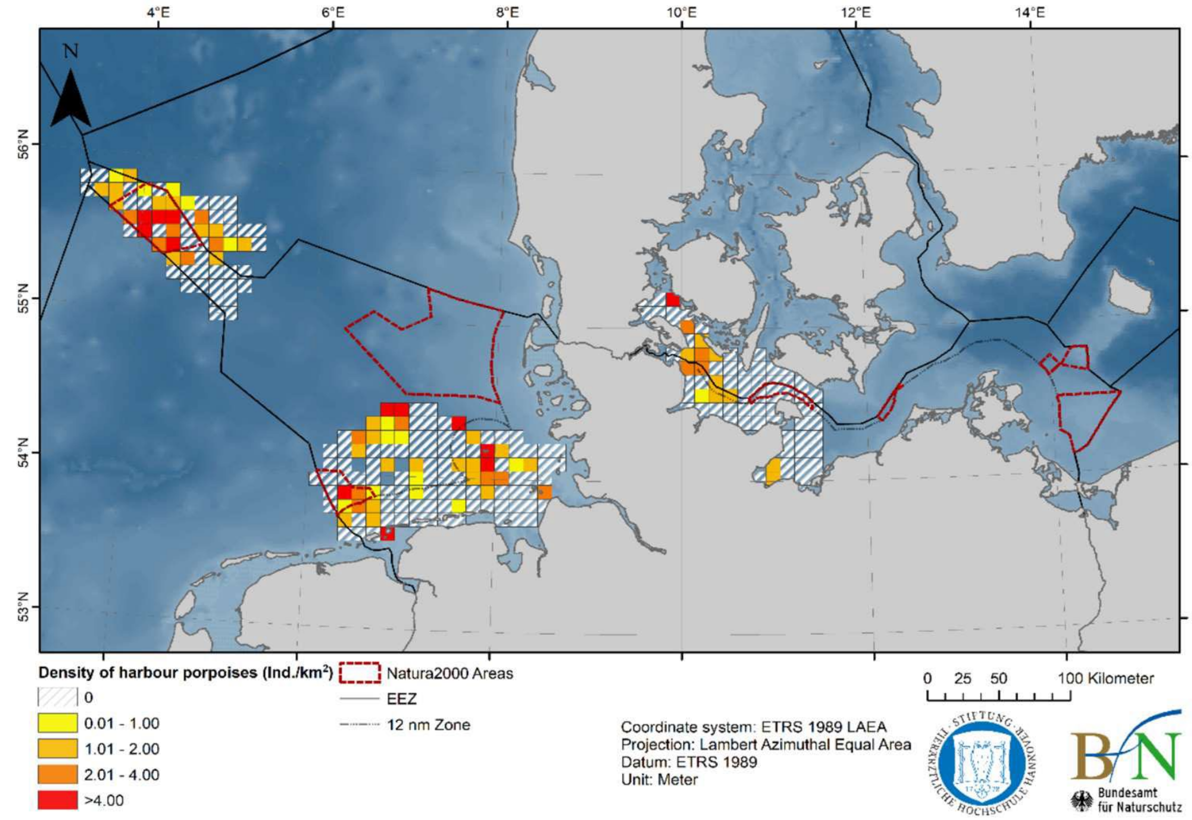

Figure 7.6. Results from the German aerial survey in summer 2021.

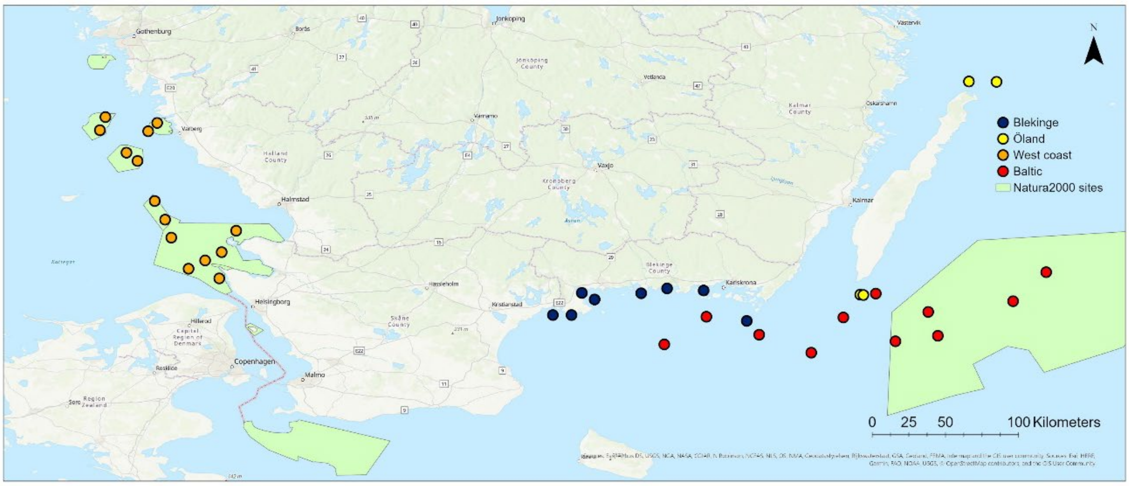

Figure 7.7. Locations of C-PODs deployed as part of the Swedish Acoustic Monitoring Programme. In total 14 stations are located within the WBBK area.

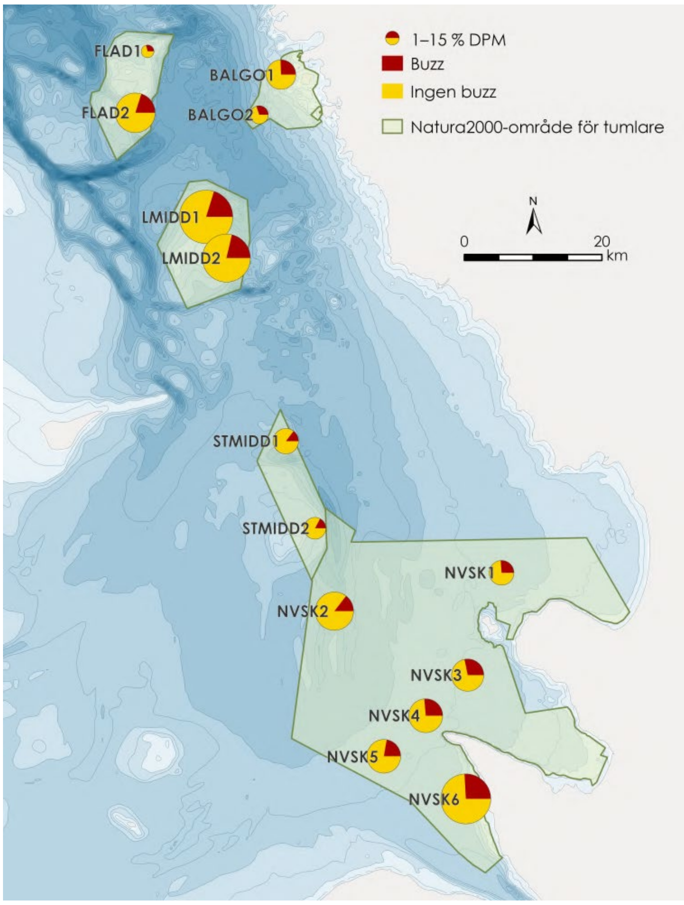

Figure 7.8. Map showing the average detection frequency over all monitored minutes in entire monitoring period May 2019 – October 2022 in the Natura 2000 areas in the Swedish part of Kattegat. Circle diameter increases with increased detection frequency, from 1% at FLAD1 to 15% at LMIDD1. The red field in the circle indicates the buzz frequency between 15-30%.

Key Conclusions and Recommendations *The SCANS-III survey in July 2016 provided an abundance estimate of approximately 42,000 porpoises for the area of the WBBK management unit. MiniSCANS-II was carried out in summer 2020 with the lowest population estimate for the area since the first SCANS survey in 1994 with 17,300 animals. The decline is not significant but should be a cause for concern, and a trend analysis using Bayesian methods indicated a small negative trend from 2005-2020. The results from the SCANS-IV survey will be useful in clarifying any trends in abundance.*

No attempt has yet been made to visually monitor seasonal variation in abundance. Acoustic monitoring provides some measure of this but so far has been patchy in space and time. It is recommended that monitoring, both visually and acoustically, is extended, ideally to fill those gaps. For the region as a whole, coverage could usefully be raised to visual line transect surveys carried out in both summer and winter on an annual basis.

8. *Monitoring population health status, contaminant load and causes of mortality*

Within the WBBK area, only **Germany** has a dedicated stranding scheme, which operates in both Schleswig-Holstein and Mecklenburg-Vorpommern. The scheme is administered in the former region by the Terrestrial and Aquatic Research Institute (ITAW) in Büsum, and in the latter region by the German Oceanographic Museum in Stralsund. Since German waters span the transition zone, it is difficult to know how many animals come from the Baltic Proper and the Belt Sea population, respectively, but it is likely that the major part of animals found on German shores are from the Belt Sea population. In 2021, 195 animals were reported stranded in Schleswig-Holstein and 72 in Mecklenburg-Vorpommern. Necropsies are undertaken on fresh specimens to determine cause of death and collect life history information.

Kesselring et al. (2017) investigated the first signs of sexual maturity for a period of almost two decades (1990-2016). Ovaries from 111 female harbour porpoises stranded or bycaught from the German North Sea and Baltic Sea were examined for the presence and morphological structure of follicles, corpora lutea and corpora albicantia. They found that whereas there were no significant differences in the demographic structure of females between the two regions, the average age at death differed significantly with 5.70 (± 0.27) years for North Sea animals and 3.67 (± 0.30) years for those in the Baltic Sea. By comparing the age structure with the average age at sexual maturity, it has been estimated that around 28% of the female harbour porpoises found dead along the German Baltic coast of Schleswig-Holstein had lived long enough to reach sexual maturity. In comparison, about 45% of the dead females from the North Sea had reached sexual maturity. They concluded that growing evidence existed to suggest that the shortened lifespan of Baltic Sea harbour porpoises is linked to an anthropogenically influenced environment with rising bycatch mortalities probably due to local gillnet fisheries since about 30% of the animals sampled were thought to be by-caught.

A first study on microplastics in harbour porpoises in the Baltic Sea Region was carried out in 2020 (Philipp et al., 2021). Gastrointestinal samples were collected from harbour porpoises from the German Baltic (16 samples) and North Seas (14 samples) during necropsies, and the amount of microscopic plastic particles (mainly particles ≥100 µm) was analysed on an individual level. No differences between sexes or age groups could be detected, meaning there does not seem to be accumulation of microplastic particles over time. However, the burden of microplastics was found to be significantly higher in individuals from the Baltic Sea compared to individuals from the North Sea. No connection was found between health status and microplastic burden, however there were signs that a good nutritional status was connected to a higher quantity of microplastics. Further studies are needed to resolve any health effects of microplastic burden.

In **Denmark**, the Danish Nature Agency funds the dissection and necropsy of 25 stranded or bycaught porpoises per year to examine health and cause of death, and carcasses that are in good enough condition to be autopsied and/or used for a blubber thickness indicator study for the HELCOM indicator for nutritional state are collected by Aarhus university. However, since there is no stranding scheme in place to collect these animals, the actual numbers of examined specimens is often much lower, e.g., from 2008-2016, 0-5 porpoises were dissected per year. A review of Danish strandings (see Table 8.1) was published by Kinze et al. (2018). Between 2008 and 2017, 34 porpoises have been autopsied (see https://fimus.dk/wp-content/uploads/2018/10/Beredskabsrapport-2017-1.pdf).
In 2021, 264 harbour porpoises were found stranded in Denmark and 10 were reported bycaught. All of the bycaught animals were necropsied, as well as another 28 individuals. In total at least 22 of the

38 animals necropsied were bycaught (https://fimus.dk/media/5ldbsgdw/beredskabsrapport-2021.pdf).

A study was published in 2022 (Kyhn et al., 2022) comparing blubber thickness of marine mammals in the time periods 1988-2017 and 2019-2021. No difference in harbour porpoise blubber thickness over time could be seen, but porpoises in the Belt Sea population generally had thicker blubber layers in the winter than porpoises from the North Sea, probably due to the higher water temperatures in the North Sea.

Table 8.1. Summary of harbour porpoise strandings for the period 2008-2017 divided by zoo-geographical region Outer Danish Waters (ODW), Inner Danish Waters (IDW) and the Waters Around Bornholm (WAB)

	Zoo-geographical region			
Year	**ODW**	**IDW**	**WAB**	**Total**
2008	149	75	0	**224**
2009	49	84	1	**134**
2010	73	46	0	**119**
2011	97	50	1	**148**
2012	66	52	3	**121**
2013	102	34	0	**136**
2014	78	43	0	**121**
2015	9	13	1	**23**
2016	57	19	1	**77**
2017	51	18	0	**69**
Total	**731**	**434**	**7**	**1172**

In **Sweden**, records of strandings are collected opportunistically by the Swedish Museum of Natural History (SMNH) in and collected in collaboration with SVA and in some cases the Gothenburg Museum of Natural History. Necropsies are carried out by SMNH and the Swedish National Veterinary Institute. From the Baltic Sea coast all carcasses are collected even if they are too decomposed for necropsy, and full skeletons are prepared and added to the collections of SMNH. Some form of genetic samples are also always taken. From the Swedish west coast, i.e. the Belt Sea population range, carcasses are collected if they are fresh enough for necropsy. The aim for this programme is to continue to undertake necropsies at the level of 30 animals/year, which is a slight increase since 2019.

A total of 41 porpoises found dead in 2022 were necropsied, and the majority of the animals were likely from the Belt Sea population based on the location of the finding. 22 of them were found stranded and 19 were bycaught and submitted by fishermen between March-May and July-October. There were 22 females and 19 males, whereof 13 sexually mature animals, 12 immature and 16 calves. All the 5 adult females were pregnant. In previous years, bycatch was the most common diagnosis for stranded porpoises, but in 2022, a smaller proportion (n=3) of stranded animals were diagnosed as bycaught than in previous years. The first fatal case of highly pathogenic avian influenza virus (H5N1) was found in a stranded harbour porpoise in 2022. This case coincided in time and space with a large influenza outbreak in seabirds and reflected the high viral infection pressure in the marine environment. Three of the porpoises died from Erysipelothrix rhusiopathiae bacterial pneumonia. This apparent increase in cases may reflect a more pathogenic strain of bacteria, lowered host immune status or both. Skin infections are commonly seen and further characterization is ongoing, as well as a study on diet.

In 2020 a report was published by SVA and the Swedish Museum of Natural History on health and causes of death in 109 harbour porpoises dead between 2006-2019 (Neimane et al., 2020). Most of the animals necropsied and included in this study were from the Swedish west-coast, so most probably belong to the Belt Sea population. In 2021, Sweden has recently started up a health and disease monitoring program for harbour porpoise, although at a small scale to begin with. This is very good news and we hope that this effort will be continued and expanded.

In 2021, a report was published on 22/23 harbour porpoises from the North Sea and Belt Sea populations (based on locations of findings) analysed for organichlorines, PBDEs, HBCDD and CPs in blubber, PFAS and OCTs in liver, metals and Se in muscle and liver and SI (C13 and N15) in muscle tissue. No difference could be detected in contaminant levels between the two populations. A few individuals had levels of contaminants that exceeded known thresholds for adverse health effects.

In all three countries, the protocols used for examining strandings, and for undertaking necropsies, have been the ones recommended from the pathology workshops held by the European Cetacean Society (Garcia Hartmann, 2001; Kuiken, 1996; Kuiken and Garcia Hartmann, 1992). HELCOM indicators on health and reproduction and on nutritional status is being developed, the latter with input from a blubber thickness project in Denmark as well as data from Sweden and Germany.

Key Conclusions and Recommendations *For studies of health status, contaminant loads and causes of death, there needs to be regular necropsies undertaken of a reasonable sample size. Germany has a stranding scheme and performs necropsies on a routine basis. Sweden now has a health monitoring programme performing necropsies on quite a large sample of stranded animals each year. There is a need in Denmark, to have routine necropsies undertaken, although the situation has improved here, too, in recent years.*

9. *Ensure a non-detrimental use of pingers by examining habitat exclusion and long-term effects of pingers*

A number of studies have examined possible long-term effects of pingers through habitat exclusion (Carlström et al., 2009, 2002; Hardy et al., 2012; Kyhn et al., 2015; Teilmann et al., 2015). In **Denmark**, Kyhn et al (2015) examined the effects of two types of pingers (Airmar: 10 kHz tone; Save-Wave Black Saver: 30−160 kHz sweep) on the presence of wild harbour porpoises, at two sites in Jammerland Bay in the Great Belt, Denmark and concluded that if pingers are used as deterrent devices, the impact of habitat exclusion needs to be considered concurrently with mitigation of bycatch, especially when regulating fisheries in Marine Protected Areas. Another study in Denmark took into account not only the direct effects but also the sub-lethal population level effects of pinger use resulting from e.g. reduced foraging efficiency, and showed through the use of an individual-based model that a combination of time-area fishing closures and the use of pingers was likely the most beneficial way of mitigating bycatch (van Beest et al., 2017). Since this study, further studies have tried to better understand behavioural responses of porpoises in the presence of pingers, for example using drones, so as to improve their effectiveness without deleterious side effects. A scientific paper was published in 2022 on the fine-scale behaviour of porpoises around pingers (Brennecke et al., 2022), showing that pingers can elict strong aversive reactions but also that reactions may vary quite significantly between individuals and/or situations.

Sweden has in 2015-2020 carried out an extensive long-term study on the distribution and displacement of harbour porpoises in relation to commercial gillnet fisheries with pingers. Results show that harbour porpoise detections in the area are low when fisheries with pingers are carried out. However, when the pingers were switched off, the harbour porpoise detections increase and are at the same levels as areas where no fishing with pingers has taken place. SLU Aqua is currently continuing to study pinger effects on both harbour porpoise bycatch and abundance using seal-safe Banana pingers (Fishtek Marine Ltd) and Future Oceans pingers.

Germany is currently not undertaking studies of possible habitat exclusion or habituation in the presence of pingers. Although the Thünen Institute's development of PAL devices was to tackle the acoustic deterrent issue, there remains uncertainty whether those devices serve only an alerting function or also deter animals in the same way as pingers do. The scientific community has called for monitoring of the effects of the massive deployment of PALs in German waters and the PAL-CE project ("Por-poise ALert (PAL) use in German waters – Current Efficiency and mode of operation") started in 2021. This project will investigate whether the proven effect of PALs persist over longer periods of time. The project will compare the reaction of naive harbour porpoises in the Danish Belt Sea with the behaviour and reactions to PALs of harbour porpoises in Schleswig-Holstein (Germany) that already know the warning signal. The project is funded by the Bundesamt für Naturschutz and is led by the Deutsches Meeresmuseum. The project will end in 2024.

Key Conclusions and Recommendations *Scientists from the Range States have led much of the research that has been undertaken to date on the interactions between porpoises and pingers. The main objective is to ensure that with pinger deployment, porpoises are alerted to the presence of a net in a manner that avoids entanglement whilst not being deterred enough that it excludes them from important habitat for significant periods of time resulting in a population impact. Studies continuing to investigate the efficacy of pingers should be encouraged.*

We strongly recommend close monitoring of the large-scale deployment of PALs in German Baltic waters. The ability of these devices to decrease bycatch, as well as their effects on harbour porpoise distribution and behaviour, needs to be investigated, and we encourage the implementation of the PAL monitoring project being initiated in 2021.

10. Include monitoring and management of important prey species in national harbour porpoise management plans

In general, studies are largely lacking on the effects of prey depletion on porpoise energetics and its impact upon population dynamics. A major gap exists in understanding prey preferences and how diet varies in time and space. In the North Sea, the availability of sandeel has been found to correlate with the number of harbour porpoise that starved to death (MacLeod et al., 2007), indicating that the availability of a specific prey species can have significant effects on harbour porpoise survival. It has also been indicated that harbour seal around the UK have seen declines in areas were seals are more dependent on sandeel and where sandeel stocks have declined (Wilson and Hammond, 2019). In the Baltic, a study found that the weight of herring affected the blubber thickness of Baltic grey seals (Kauhala et al., 2017), which raises the question of prey quality and its effects on harbour porpoise.

In the WBBK region, important work has been undertaken. Sveegaard et al. (2012) examined the stomach contents of 53 harbour porpoises collected between 1987 and 2010 in the Öresund Sound (ICES SubDivision 23) that links the western Baltic with the Kattegat (high season, April-Oct, n=34 porpoises; low season, Nov-Mar, n=19 porpoises). A total of 1,442 individual prey specimens from thirteen fish species were identified. The distribution in terms of occurrence and number of fish species differed between seasons, indicating a seasonal shift in prey intake. During the porpoise high-density season, the mean and total prey weight per stomach as well as the prey species diversity was higher, and results were interpreted as indicating a higher quality of prey in the high-density season. Atlantic cod was found to be the main prey species in terms of weight in the high-density season while Atlantic herring and Atlantic cod were equally important during the low-density season. They considered that prey availability and predictability were likely to be the main drivers for harbour porpoise distribution in this region. This is supported at smaller spatial scales by results showing that harbour porpoise presence around Kullaberg in the Swedish part of Kattegat is strongly correlated to foraging frequency, suggesting that harbour porpoises spend more time in areas where they can find more prey (Stedt et al., 2023).

More recently, Andreasen et al., 2017, analysed a much larger sample size, a data set including 339 stomachs collected over a 32-year period (1980–2011) from the western Baltic Sea (ICES SubDivisions 22-24) with a few additional samples from the Kattegat (ICES SubDivision 21). As is usually the case, the stomach contents were mainly hard parts of fish and in particular otoliths. Atlantic cod and herring were the main prey of adult porpoises, constituting on average 70% of the diet by mass. Juvenile porpoises also frequently consumed gobies, the mass contribution by gobies averaging 25%, which was as much as cod. In this region, other species such as whiting, sprat, eelpout, and sandeels were of minor importance for both juveniles and adults. The diet composition differed between years, quarters, and how the carcass was found (bycaught or stranded). Yearly consumption rates for porpoises in the western Baltic Sea were obtained in three scenarios on the daily energy requirements of a porpoise in combination with an estimate including the 95% CI of the porpoise population size. Cod of age groups 1 and 2 and intermediate-sized herring were estimated to be the most interesting prey for porpoises in this region.

The stocks of cod and herring in the region have all declined markedly over the last fifty years. The spawning stock biomass of cod in the Kattegat (ICES SubDivision 21) has declined from around 35,000 tonnes in the early 1970s and reached historically low levels in 2020 (Fig. 10.1; ICES, 2022b).

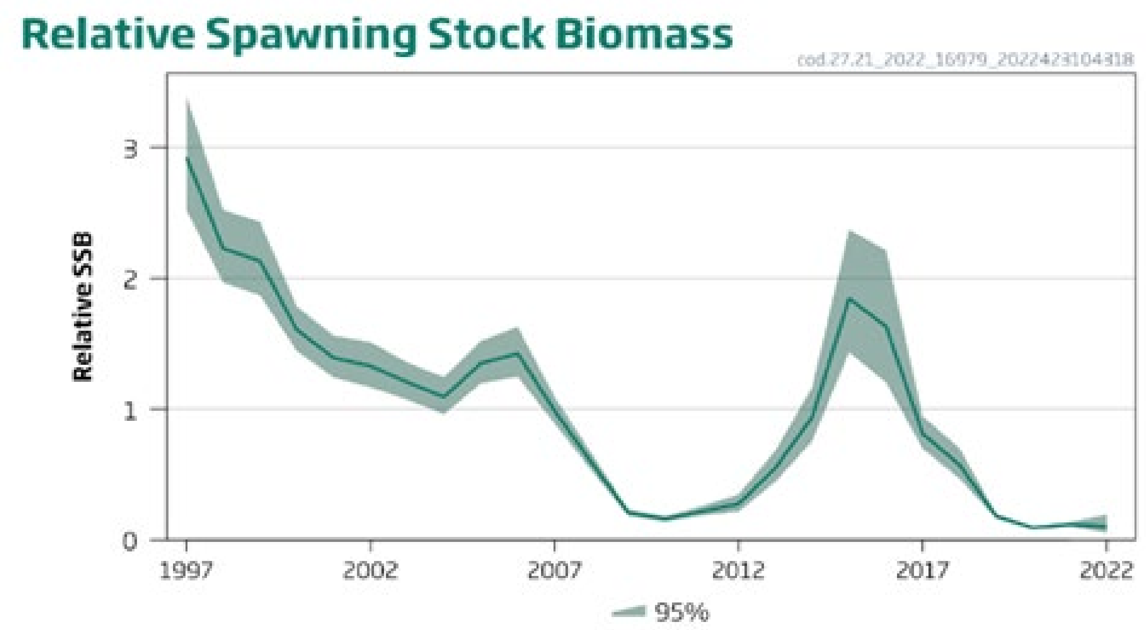

Figure 10.1. Realtive spawning stock biomass (SSB) trend for the Kattegat cod stock (from ICES, 2022b)

The Western Baltic stock of cod (ICES SubDivisions 22-24) has fluctuated over the same time period, now being at record low levels (Figure 10.2; ICES, 2022c). There is no sign of a full recovery in stock size from the historical levels (ICES, 2012), with it suffering from a fishing mortality above sustainable levels, and reduced recruitment (Oceana, 2016), and there is now a complete ban on targeted fishing on both the eastern and western Baltic cod stocks. Spawning takes place in the Sound, in the Belt Sea, and at various locations in the Arkona basin (HELCOM, 2013).

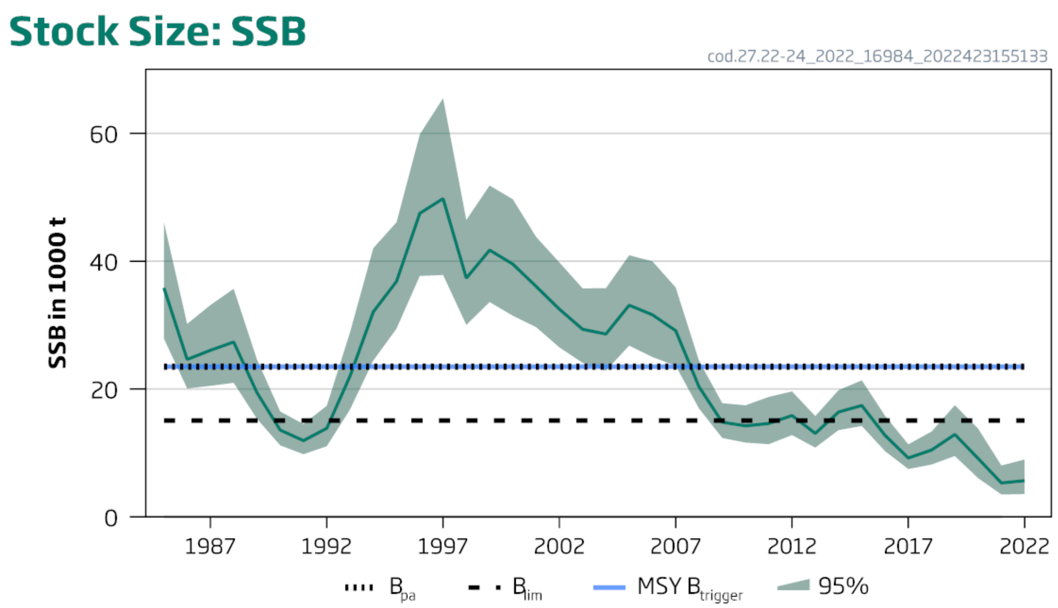

Figure 10.2. Spawning stock biomass (SSB) trend for the Western Baltic cod stock, in 1000 tonnes (Source: ICES, 2022c)

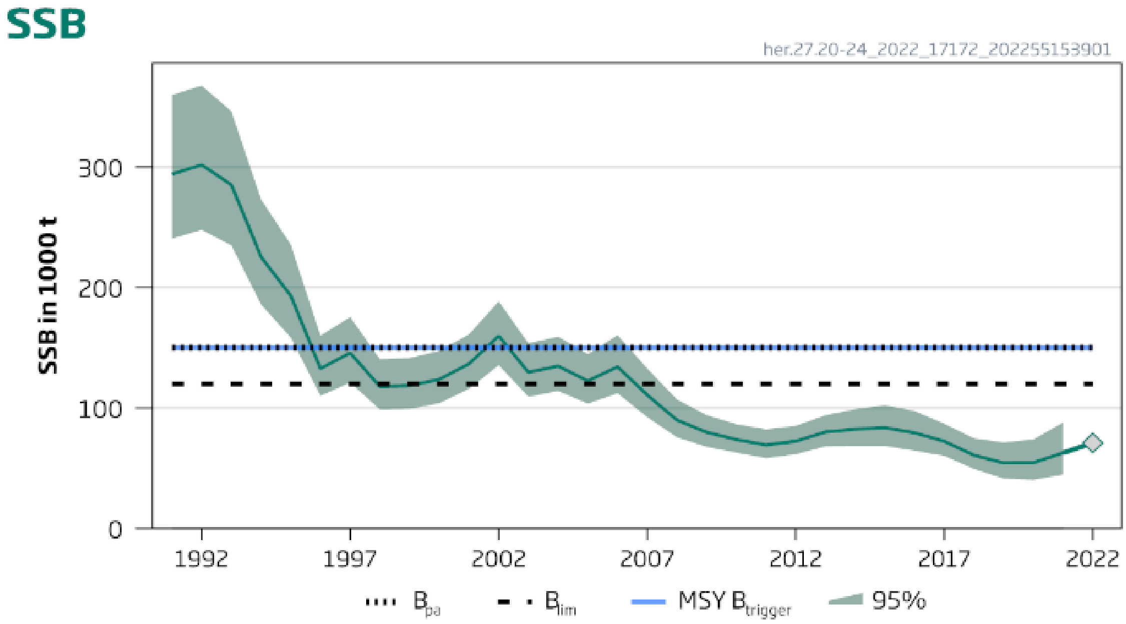

Figure 10.3. Trend in spawning stock biomass (SSB) for spring spawning herring in ICES SubDivisions 20-24 (Source: ICES, 2022d)

Important stocks of spring spawning herring exist in the Skagerrak (ICES SubDivision 20), Kattegat (ICES SubDivision 21) and Belt Seas (ICES SubDivisions 22-24). A comparison of the spawning stock biomass and assessment of maximum sustainable yield shows a marked decline for the stock in ICES SubDivisions 20-24 during the 1990s, and the ICES advice has now been to allow zero catch of this stock for the last four years, continuing in 2023 (ICES, 2022d).

Figure 10.4 shows the distribution of extraction of fish of three target species, and harbour porpoise prey species (cod, herring and sprat) for the Kattegat, Belt Seas, Western Baltic and Baltic Proper.

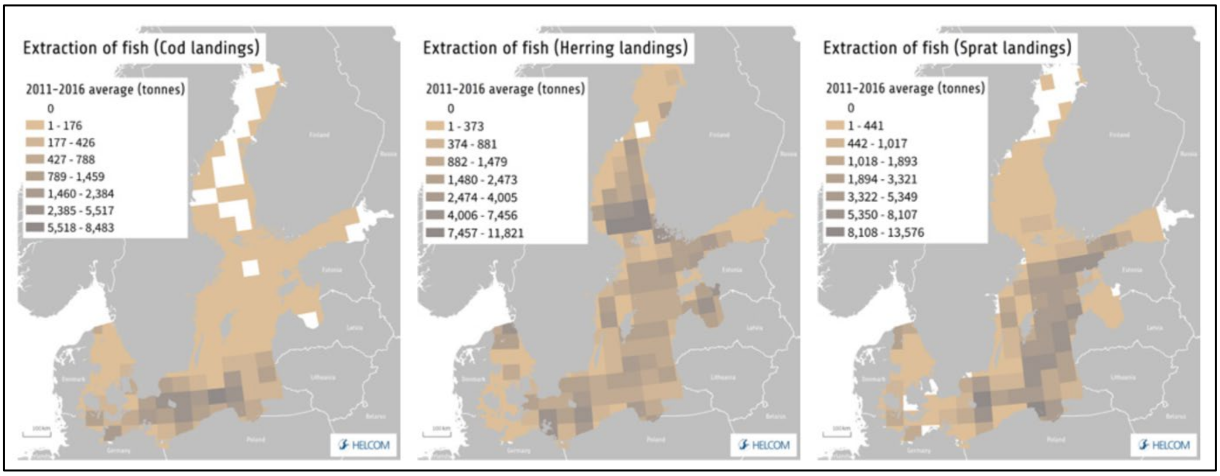

Figure 10.4. Spatial distribution of commercial landings of cod, herring and sprat in the Baltic Sea (Source: HELCOM, 2018a)

Herring biomass is dependent on the size of the cod stock, which is its main predator, and on the size of the sprat stock, with which it competes for food. For herring, there are also large differences in growth rates between regions: individuals are small in the northern areas and larger in the south. This has been shown to influence grey seal blubber thickness (Kauhala et al., 2017) and could have implications for other top predators like harbour porpoise.

The state of cod and herring stocks may impact harbour porpoises in various ways: by triggering shifts in their main areas of concentration, switching to other prey, and/or reduced body condition which could lead to lower reproductive rates. These relationships need to be investigated further. The same applies to porpoises in the Baltic Proper where high fishing mortality has led to long-term changes in the stock sizes of various fish species (cod, herring and sprat in particular)(HELCOM, 2018a).

In this context, a new study by Torres Ortiz and colleagues (Torres Ortiz et al., 2021) show that porpoises hunt in collaborative groups and use role specialization which is considered the most sophisticated form of collaborative hunting.

Key Conclusions and recommendations *Recent studies have provided insight into the diet of porpoises in the region, illustrating the importance of cod and herring for adult porpoises whilst juveniles also consumed a significant quantity of gobies. Both cod and herring stocks have declined in the Skagerrak, Kattegat and Belt Seas as well as in the Baltic. Trends in the stocks of these important prey species could potentially affect porpoise reproductive rates and possibly also survival rates. It is recommended that studies investigate in more detail predator-prey interactions at an ecosystem level.*

11.Restore or maintain habitat quality

One of the main human pressures that can affect the environment in which harbour porpoises live is the production of underwater noise. It may cause behavioural changes to both porpoises and their prey, mask communication, and even have physiological impacts. Underwater noise can be divided into continuous sounds largely derived from shipping, and impulsive sounds derived from sources such as seismic survey airguns, pile driving, detonations and active sonar. For this reason, under the EU Marine Strategy Framework Directive, two indicators were developed for Descriptor 11 on the introduction of energy/noise:

- 11.1. Distribution in time and place of loud, low and mid frequency impulsive sounds
- 11.2. Continuous low frequency sound

In December 2022, a set of threshold values were adapted for descriptor 11 under the EU MSFD, for both continuous and impulsive underwater noise (https://environment.ec.europa.eu/news/zero-pollution-and-biodiversity-first-ever-eu-wide-limits-underwater-noise-2022-11-29_en). It remains to be seen how these threshold values are implemented nationally in EU Member States to decrease the impact of underwater noise in the marine environment.

Impulsive noise

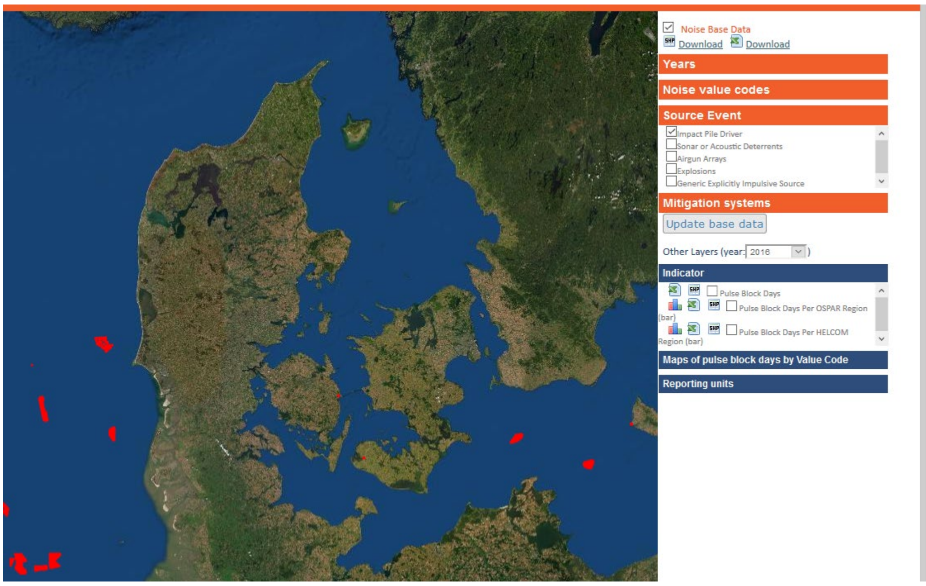

Figure 11.1. Noise Map of Impulsive sound produced from pile driving between 2010 and 2019 (Source: ICES database)

For Indicator 11.1, ICES have set up a registry in support of HELCOM and OSPAR. This registry provides an overview of the spatial and temporal distribution of impulsive noise events over the frequency band of 10 Hz to 10 kHz causing a "considerable" displacement (http://ices.dk/data/data-portals/Pages/underwater-noise.aspx). "Considerable" displacement is defined as displacement of a significant proportion of individuals for a relevant time period and at a relevant spatial scale. Maps downloaded in December 2022 showing the blocks with activity for each of the main source types for the years 2008-19, are depicted in Figures 11.1-11.4.

Denmark, Germany and Sweden have all contributed data, although there are probably more still to come before these maps fully reflect the usage of a variety of sources of impulsive sound active within the Western Baltic, Belt Sea and Kattegat. These are three types of gaps: 1) activities that have to be reported but are not. These should reduce as procedures for reporting improve; 2) activities that can be reported, but are not mandatory, including military activities. It is to be hoped that navies will cooperate to ensure as comprehensive reporting as possible; and 3) activities that do not have to be reported, but are likely to cause significant disturbance. Those include sources above 10 kHz such as seal scarers and some sonars. Work is underway in TG-Noise and elsewhere, to address this issue.

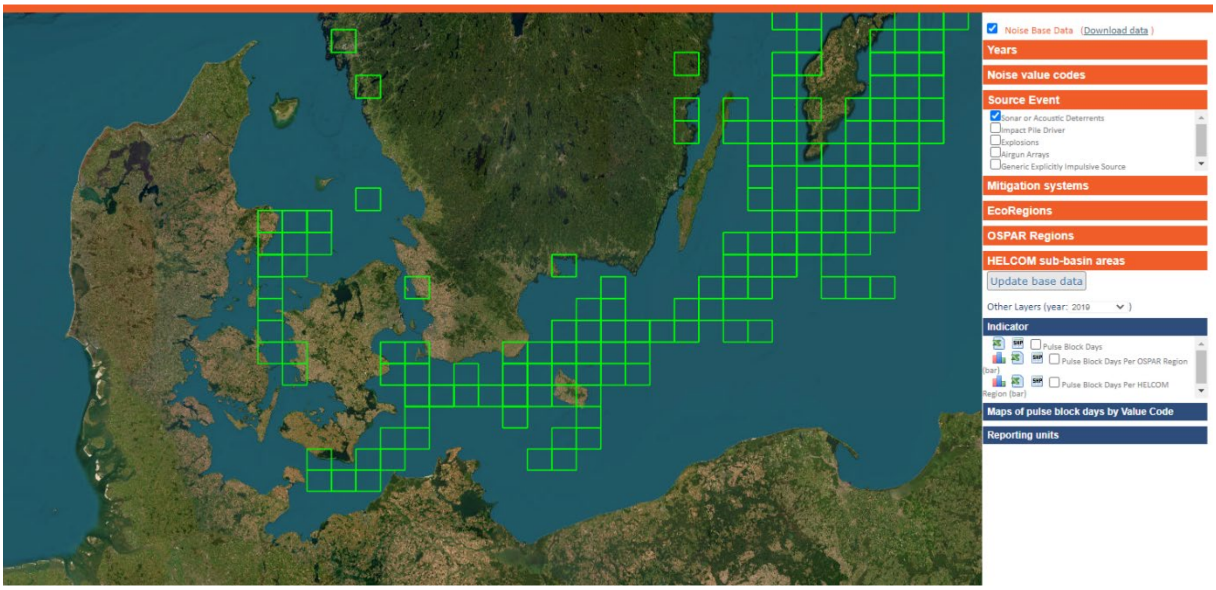

Figure 11.2. Noise Map of Impulsive sound produced from sonar or ADDs between 2013 and 2022 (Source: ICES database)

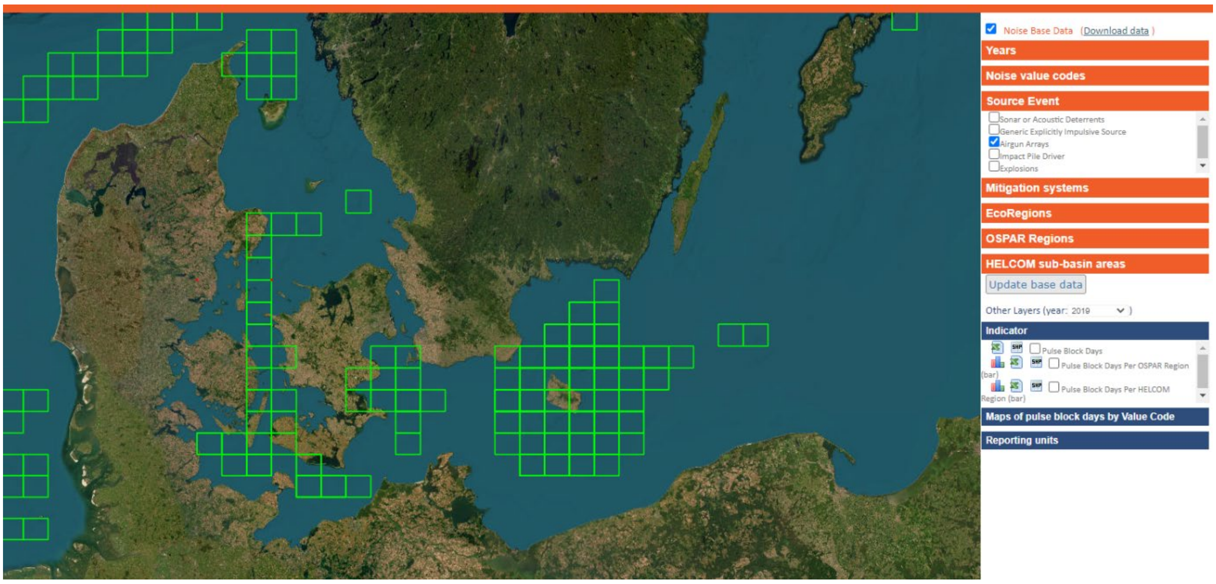

Figure 11.3. Noise Map of Impulsive sound produced from airgun arrays between 2013 and 2022 (Source: ICES database)

In some areas, seal scarers have the potential to be a significant issue although there is no evidence as yet that it is one in the WBBK area. Since it may become an issue in the future, some regulation of their use now would be advisable.

The ICES noise register also allows for the calculation of pulse block days by time period (e.g. year) for each of the five categories of sources. A start on this has been made in the Western Baltic and Belt Seas (Fig. 11.5). An example of how marine noise budgets might be examined is discussed in (Merchant et al., 2018). This method could usefully be adapted for use by HELCOM in the WBBK and Baltic areas.

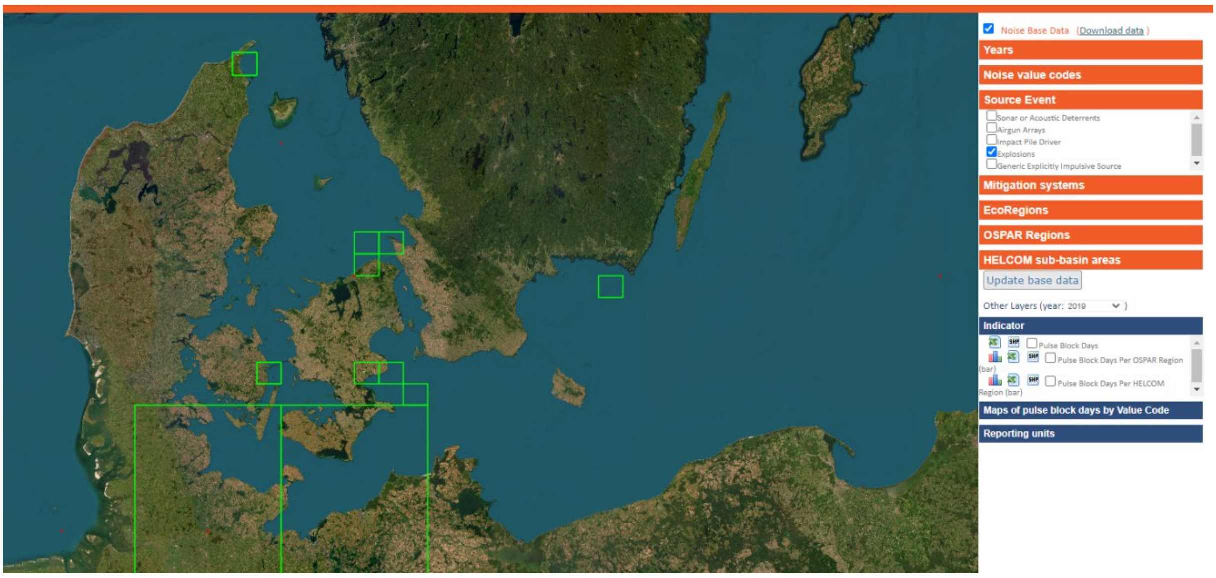

Figure 11.4. Noise Map of Impulsive sound produced from explosions between 2013 and 2022 (Source: ICES database)

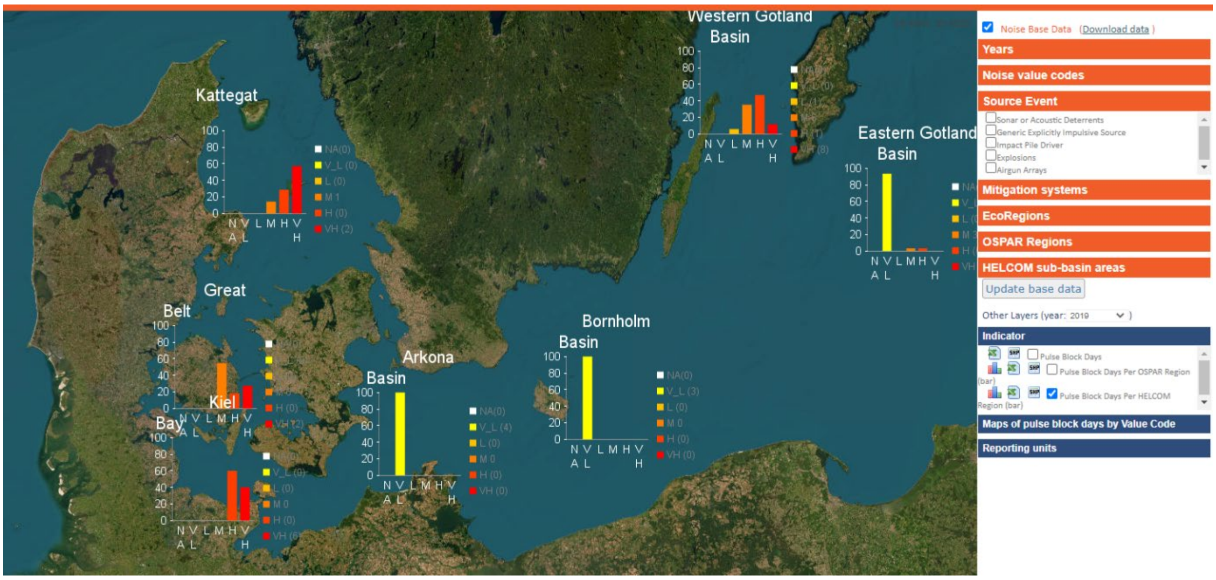

Figure 11.5. Pulse block days per HELCOM sub-basin in 2022 (Source: ICES database)

Of impulsive sound sources, pile driving during marine construction (for example of offshore wind turbines) has received much research attention in the last two decades. During the construction phase of the Nysted wind farm in the Danish Western Baltic a strong decrease in harbour porpoise presence up to 10 km away from the construction site was found to have occurred (Carstensen et al., 2006). Subsequent monitoring of the operational phase showed that the negative effect persisted even after several years (Teilmann et al., 2009). Pile driving has generally been found to be the most disturbing activity during wind farm and other construction work, causing a decrease in porpoise density up to 17 km away, although porpoises appear to react differently at different sites and to sometimes come back to the area after construction has finished (Brandt et al., 2011; Dähne et al., 2013; Scheidat et al., 2011; Siebert et al., 2012; Tougaard et al., 2009). This probably depends on the nature of the construction activity, noise attenuation due to seabed features, prey availability, and the importance of the area to the porpoises, as well as the presence of other disturbance factors besides noise. Studies on the effectiveness of different mitigation measures have taken place in German waters. These include the use of gravity-based foundations or alternative installation procedures (Koschinski and Lüdemann, 2014), air bubble curtains (Dähne et al., 2017; Lucke et al., 2011), and acoustic deterrents such as seal scarers (Brandt et al., 2013).

The production of guidelines on the impacts of particular impulsive sound sources, and when new noisy activities can commence, have formed a series of publications as well as reports funded by the Danish Energy Agency. Noise sources include pile driving (Clausen et al., 2018; Danish Energy Agency, 2015; Nabe-Nielsen et al., 2018; Tougaard et al., 2015) and seismic surveys (Tougaard, 2016; van Beest et al., 2018). Tougaard & Dähne (2017) have emphasised the importance of considering frequency weighting in the context of underwater noise regulatory frameworks. Whether and how this is applied has significant implications, as indicated also from several reviews of noise exposure criteria (Finneran, 2016; Houser et al., 2017; NMFS (National marine Fisheries Service), 2016; Southall et al., 2007).

Continuous noise

For indicator 11.2, the trends of ambient noise measured in 1/3 octave bands centred at 63 and 125 Hz are to be monitored. In the Baltic marine region, the LIFE+ project called BIAS (Baltic Sea Information on the Acoustic Soundscape), running from September 2012 – August 2016, measured the ambient noise during 2014 and modelled monthly soundscape maps based on the measurements, data on AIS traffic and environmental covariates (www.bias-project.eu). In addition to the MSFD centre frequencies, BIAS also measured the ambient noise at 2 kHz, as a compromise between the hearing ranges of herring, seals and the harbour porpoise. Figure 11.6 shows the 38 recording stations used to monitor continuous noise.

The BIAS project produced soundscape maps in 2016, showing the underwater noise generated by commercial vessels, the major source of human-induced underwater noise in the Baltic Sea. The study area extended into the western Baltic and Belt Seas but not the Kattegat. Seasonal soundscape maps were produced for each of the demersal, pelagic and surface zones and will serve as a baseline for the development of monitoring and assessment of ambient noise in this region. Figure 11.7 shows noise maps across the whole water column for the three centre frequencies, 63 Hz, 125 Hz, and 2 kHz.

It is important to note that since porpoises are high frequency echolocators with a hearing range most sensitive above 15 kHz (maximum sensitivity c. 125 kHz) (Kastelein et al., 2015, 2002), the MSFD frequencies are unsuitable for assessing direct impact of continuous noise on this species (Dyndo et al., 2015; Hermannsen et al., 2014; Wisniewska et al., 2018). On the other hand, they may function as proxies for higher frequencies. The issue with higher frequencies of course is that they do not propagate very far from the source (just a few hundred metres at frequencies above 100 kHz), which means that a noise map to a large extent may simply be a map of the location of the sources.

Since the end of the BIAS Project, countries have been maintaining some of their recording stations (Fig. 11.8). In **Sweden** there are currently three stations: one on the Northern Midsea Bank in the Baltic Proper, and one at Hönö on the Swedish west coast, which have both been active since 2015. Monitoring was also started at another BIAS station in the Bothnian Bay in 2018. However, from approximately summer 2019 until summer/autumn 2020, there is a gap in monitoring, mostly due to the fact that there is no long-term planning or funding for this monitoring. In the Belt Seas, **Denmark** increased the number of recording stations from one to four in 2018, and further to a total of six stations in 2019. In **Germany**, two BIAS stations in the Arkona basin and in Fehmarn Belt have been active since 2019, one was added in Kiel Bight in 2022, and work is ongoing to expand with more stations. Unfortunately, there is no Baltic-wide coordination, and although it is hoped that this can be done through the HELCOM expert network on underwater noise (EN NOISE) it is not yet happening. The BIAS data-sharing platform where monitoring data can be shared, has been adopted by ICES.

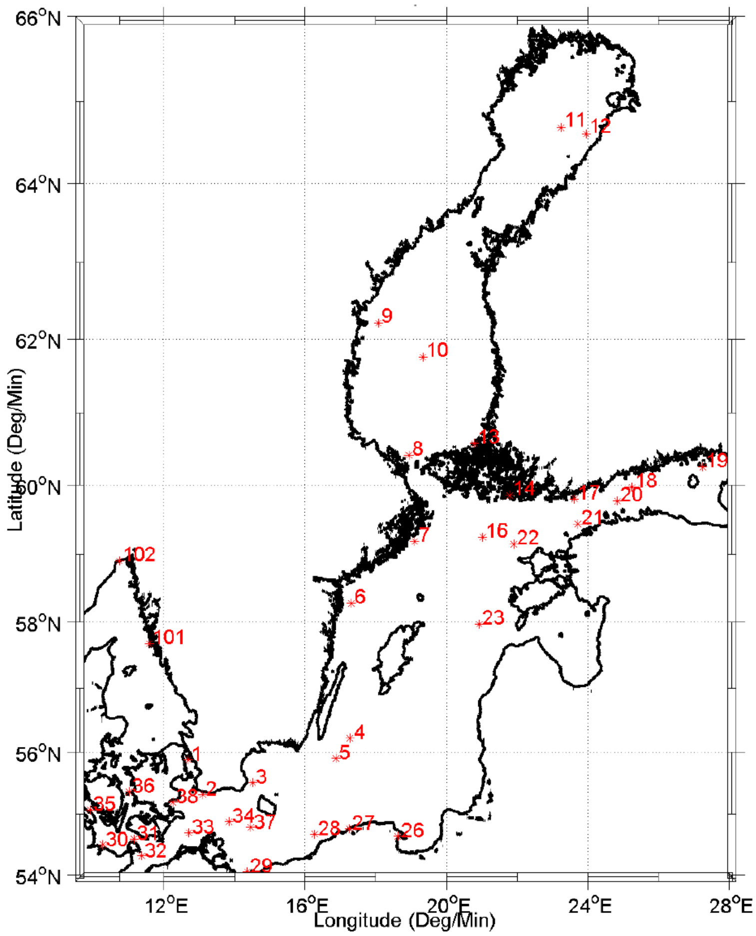

Figure 11.6. Baltic Sea Regional Map showing the positions of the acoustic measurements in the BIAS project. carried out by the BIAS Project (Source: Folegot et al., 2016)

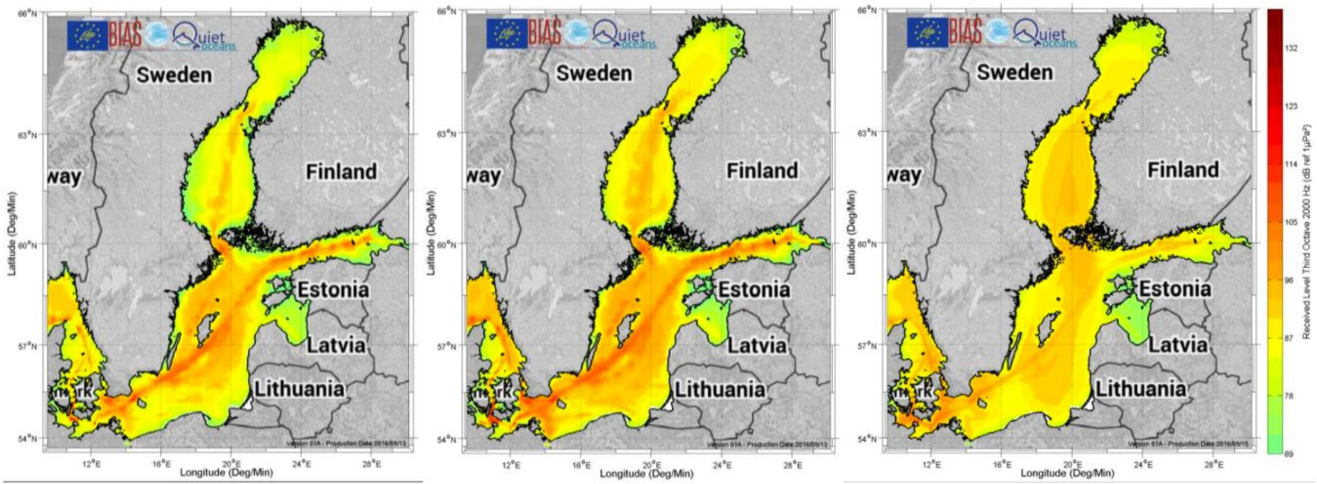

Figure 11.7. Annual median noise maps for the full water column for the 63 Hz third-octave (left), the 125 Hz third-octave (middle), and the 2kHz third-octave (right) (Source: Folegot et al., 2016)

The BIAS project focused upon modelling shipping noise which generates most sound at low frequencies, below 1 kHz. Whereas shipping noise is thought to have greatest potential effect upon baleen whales due to their good hearing at low frequencies, where ships produce most noise power, recent findings indicate significant energy also generated at medium- to high-frequencies. For example, Hermannsen et al. (2014) using a broadband recording system in four heavily ship-trafficked marine habitats in Denmark, found that vessel noise from a range of different ship types substantially elevated ambient noise levels across the entire recording band from 0.025 to 160 kHz at ranges between 60 and 1000 m. These ship noise levels are estimated to cause hearing range reduction in harbour porpoises of >20 dB (at 1 and 10 kHz) from ships passing at distances of 1190 m and >30 dB reduction (at 125 kHz) from ships at distances of 490 m or less. They conclude that a diverse range of vessels produce substantial noise at high frequencies, where toothed whale hearing is most sensitive, and that vessel noise should therefore be considered over a broad frequency range, when assessing noise effects on porpoises and other small, toothed whales.

Dyndo et al (2015) conducted an exposure study inside Kerteminde harbour in the Danish Belt Sea where the behaviour of four harbour porpoises in a net-pen was logged while they were exposed to 133 mainly small or medium vessel passages. Using a multivariate generalised linear mixed-effects model, they showed that low levels of high frequency components in vessel noise elicit strong, stereotyped behavioural responses in porpoises. Since such low levels will routinely be experienced by porpoises in the wild at ranges of more than 1,000 metres from vessels, this suggests that vessel noise may be a substantial source of disturbance in shallow water areas where there are high densities of both porpoises and vessels.

Wisniewska et al. (2018) used animal-borne acoustic tags to measure vessel noise exposure and foraging efforts in seven harbour porpoises in highly trafficked coastal waters of Denmark. Tagged porpoises encountered vessel noise 17–89% of the time and occasional high-noise levels coincided with vigorous fluking, bottom diving, interrupted foraging and even cessation of echolocation, leading to significantly fewer prey capture attempts at received levels greater than 96 dB re 1 mPa (16 kHz third-octave). The study concluded that if such exposures occur frequently, porpoises, with their high metabolic requirements (see for example Wisniewska et al., 2016), may be unable to compensate energetically leading to negative long-term fitness consequences. Bas et al. (2017) studied the effects of marine traffic on the behaviour of porpoises in the Istanbul Strait at the entrance to the Black Sea. This was significant in looking specifically at responses of porpoises to large ships under natural conditions. The observations indicated reaction ranges of some few hundred metres. Some years earlier, Evans et al. (1994) studying reactions of porpoises to different vessels in Shetland, found strong negative reactions to large ships at ranges of two kilometres. One might expect similar reactions to occur in the presence of large vessels in the Baltic Sea Region.

In 2019, a decision was made to move a shipping lane in Kattegat closer to the Swedish coast, which meant it now passes through some Swedish Natura2000 sites for harbour porpoises. Since 2019, Aarhus University, the Swedish Defence Research Agency and the Swedish Museum of Natural History have been cooperating in the TANGO study to gather before and after data in the area, to examine the effects of this move on harbour porpoise occurrence and foraging behaviour. The shipping lane was moved on 1 July 2020, and data collection was finalised in August 2021. Results show that there was no change in the long-term presence or foraging behaviour or harbour porpoises, despite confirmed changes in vessel traffic and underwater noise levels, which suggests that within the recorded levels of noise, porpoises continue to use their preferred habitat. The potential effects on individual stress levels and population-level impacts remain unknown.

Ship noise extending to higher frequencies and thus potentially affecting toothed whales and dolphins has been reported also by other authors (see for example McKenna et al., 2012; Southall et al., 2017; Veirs et al., 2016; Williams et al., 2014). Also, recreational vessels has been found to increase background noise by on average 5 – 10 dB higher than the average of large commercial ships (Veirs and Veirs, 2005). It would therefore be prudent to establish better ways to monitor these craft and to regulate their activities in close proximity to cetaceans, as is done in many parts of the world already, however, recreational craft are generally not equipped with AIS and so are largely un-monitored.

In 2021, the SATURN project was initiated in Denmark. This project will use data from tagged harbour porpoises to investigate impacts of disturbances on marine populations and the importance of animal movements and energetics. The project will run until 2025.

HELCOM work

In the 2013 HELCOM Copenhagen Ministerial Declaration, it was agreed that the level of ambient and distribution of impulsive sounds in the Baltic Sea should not have a negative impact on marine life, and that human activities that are assessed to result in negative impacts on marine life should be carried out only if relevant mitigation measures are in place.

Further work on the threshold values setting is envisaged in HELCOM, since within the EU work there are options to set lower threshold values based on regional specificities. For continuous noise, such regional specificities could be indicator species or populations considered particularly vulnerable and/or endangered, such as the Baltic Proper harbour porpoise, uncertainty in the noise model, for example related to effects of strong sound speed gradients, which are common in the Baltic Sea, or influence from sources such as recreational boats not included in the current models, all of which requires a precautionary approach. Such regional specificities are to be considered towards HOLAS 4. For HOLAS III, no HELCOM threshold levels were adopted and the indicators on continuous and impulsive noise were set as pre-core, but a thematic assessment addressing underwater noise was carried out, aligning with the EU work on setting threshold values for underwater noise (HELCOM, 2023c).

For continuous noise, good status is achieved when the indicator is below the spatial threshold, which expresses a proportion of area, for all months in 2018 (which was considered representative for the evaluation period from 2016-2021), for fish (125 Hz decidecade band) and marine mammals (500 Hz decidecade band). The recommendation from EU TG-Noise is to use a spatial threshold of 20% or lower, and as there has not been an opportunity to discuss and agree on a regionally specific threshold value for the HELCOM areas at this stage, the choice was made to use 20%. Two variants of the indicator were evaluated, one using the median total sound pressure level as metric and one using the median excess (elevation of ambient noise by anthropogenic sources) as metric. Both variants were below the 20% spatial threshold for all assessment units for marine mammals.

The pre-core indicator is still to be developed in a range of aspects. While spatial and temporal threshold values have just been adopted at EU level, formal discussions and agreements still remain about their implementation, including the possibility of adopting stricter thresholds and decisions left to be made at the regional level. Most important, this relates to decisions on habitat designation and establishing species(group)-specific values for level of onset of negative effects (LOBE). The indicator will therefore be further discussed and developed towards HOLAS 4.

Meanwhile, in the HELCOM BLUES project, new soundscape maps were made for the biologically significant dedicades 125 Hz (fish) and 500 Hz (mammals) for the year 2018, based on the BIAS methodology. These maps are available through the ICES portal by looking for data for the year 2018 (https://underwaternoise.ices.dk/continuous/viewonmap)(Fig. 11.8). The 500 Hz dedicade is a little too low to fully represent harbour porpoise hearing, but was used as a compromise between seal and harbour porpoise and also because modelling higher frequencies become less meaningful given their relatively short dispersion distance.

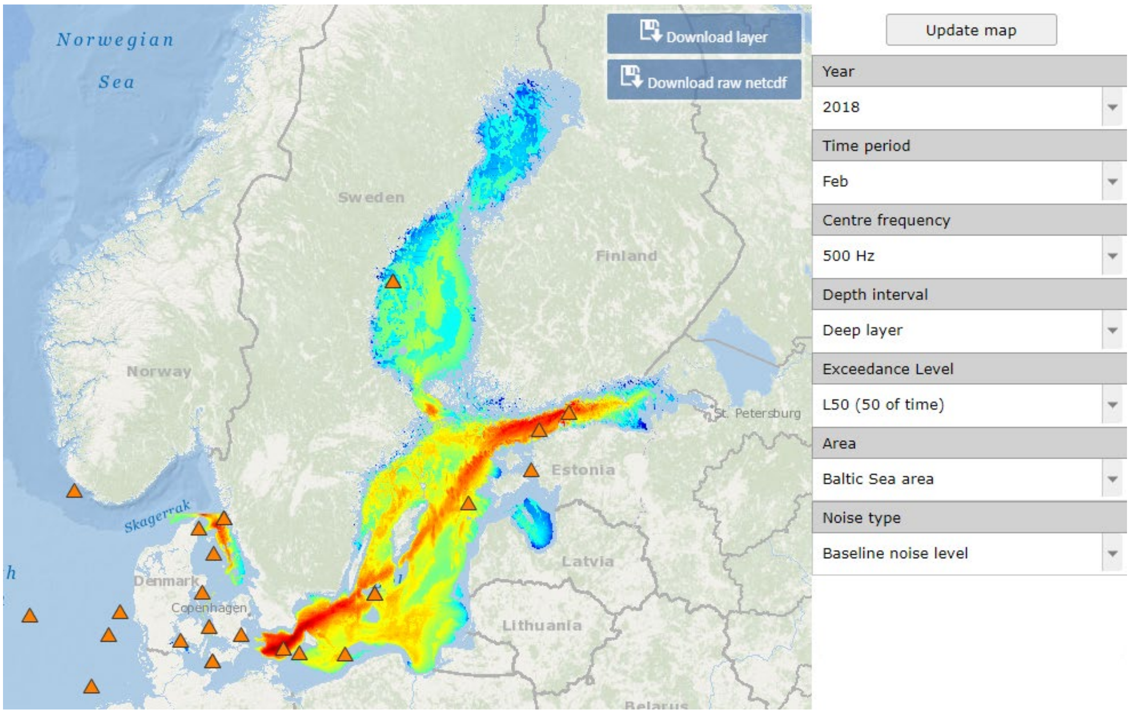

Figure 11.8. Underwater noise map from the HELCOM BLUES project, calculated using the BIAS methodology with AIS data from the year 2018 and noise data from the remaining BIAS stations (marked with orange triangles). Source: https://underwaternoise.ices.dk/continuous/viewonmap.

For impulsive noise, the indicator ‘distribution in time and space of loud low- and mid-frequency impulsive sounds’ was evaluated in the HELCOM area. The distribution of sound was partially compared to the distribution of harbour porpoises in the Baltic Sea to get a first idea of overlap of sound and the occurrence of harbour porpoises. Regarding the availability of habitat there should be enough habitat for harbour porpoises to avoid regions impacted by low- and mid-frequency impulsive sounds. This assessment uses methods agreed in HELCOM as well as draft methodology and thresholds proposed by the EU TG-Noise. At the time of the assessment of this indicator, the concept of the proposed threshold values under consideration for approval on EU-level had been formulated by the EU TG Noise to be based on the evaluation of the temporal and spatial proportion of habitats that are impacted and affected by underwater sound, but the quantitative threshold values had not been agreed upon. It was agreed to use an interim assessment threshold value of a daily fraction of exposed area of 10% of the Baltic Sea, which is in agreement with the threshold concept under discussion at EU level.

The pre-core indicator is still to be developed in a range of aspects in alignment with EU processes and taking into account regional specificities. While spatial and temporal threshold values have now just been adopted at EU level, formal discussions and agreements still remain about the use of these as well as e.g., subbasin and habitat size in the assessment, and sound level of onset of negative effects (LOBE). The indicator will therefore be further discussed and developed towards HOLAS 4.

It is proposed that environmental targets are defined using a risk-based approach even if the status and impacts are not fully known, since there is a risk of degradation in environmental status, in particular in relation to activities known to cause significant pressures on the environment. Decision support trees for establishing environmental targets for impulsive noise and continuous noise have been developed within HELCOM, but no thresholds have been set.

Indicators will be used to seek synergies with the work of OSPAR and be provided as input to the work of EU TG Noise and the decision to establish GES principles and threshold values which is to be made at European Union level. The international framework provided by IMO (in relation to continuous noise) will also be applicable when considering further work.

Mitigation

Mitigation of impulsive underwater noise is done for some events such as piling and detonations of unexploded ordinance, and there are guidelines for this in for example Germany, while in other countries the knowledge on possible mitigation techniques is limited. For continuous noise there are no mitigation measures in place except the IMO non-obligatory Guidelines for the Reduction of Underwater Noise from Commercial Shipping to Address Adverse Impacts on Marine Life (http://www.imo.org/en/MediaCentre/HotTopics/Documents/833%20Guidance%20on%20reducing%20underwater%20noise%20from%20commercial%20shipping%2C.pdf).

In HELCOM, action in relation to noise mitigation is included in the Regional Action Plan on Underwater Noise (HELCOM, 2021). Action 7 aims to increase the use of Best Environmental Practice (BEP) and Best Available Technology (BAT) in mitigation of impact from impulsive noise by establishing HELCOM guidelines for mitigation of impact from impulsive noise, action 9 aims to improve protection of sensitive areas and species by obligating adequate noise mitigation measures, and action 35 aims to reduce the impact from underwater explosions in connection to munition clearance, by developing international guidelines for the safe removal and detonation of ammunition. The status of the implementation of these actions can be followed on the HELCOM website (https://helcom.fi/wp-content/uploads/2023/02/Reporting-on-implementation-of-the-RAP-Noise_October_2022.xlsx). There is also one action in the Baltic Sea Action Plan addressing mitigation measures for underwater noise, action S55, which aims to "Identify at the latest by 2025, as well as regularly update every two years, mitigation measures according to Best Environmental Practice and Best Available Technique for continuous underwater noise in the Baltic Sea and implement thereafter in line with recommendations and regulations of the international Maritime Organization (IMO)".

By 2018, a review of sound sources and their impacts upon marine life had been made, along with a summary of potential underwater noise mitigation measures that could be employed for the different sound sources (HELCOM, 2018b). Harbour porpoise was identified as one of the priority species (along with harbour seal, ringed seal, grey seal, cod, herring and sprat). A map compiling noise sensitive areas derived from biological data on noise sensitive species so far identified has also been produced (Fig. 11.9) and incorporated in the latest version of the State of the Baltic Sea report (HELCOM, 2018b). An inventory of noise mitigating measures already used in the Baltic Sea region has been compiled (HELCOM, 2017). The inventory shows that at least three countries (Germany, Denmark, Sweden) are implementing measures to reduce the impact of noise on the marine environment, i.e. by exclusion of noise generating activities for a certain time period or from certain areas, restriction of anthropogenic underwater noise to a certain level, and use of noise reducing techniques (Table 11.1).

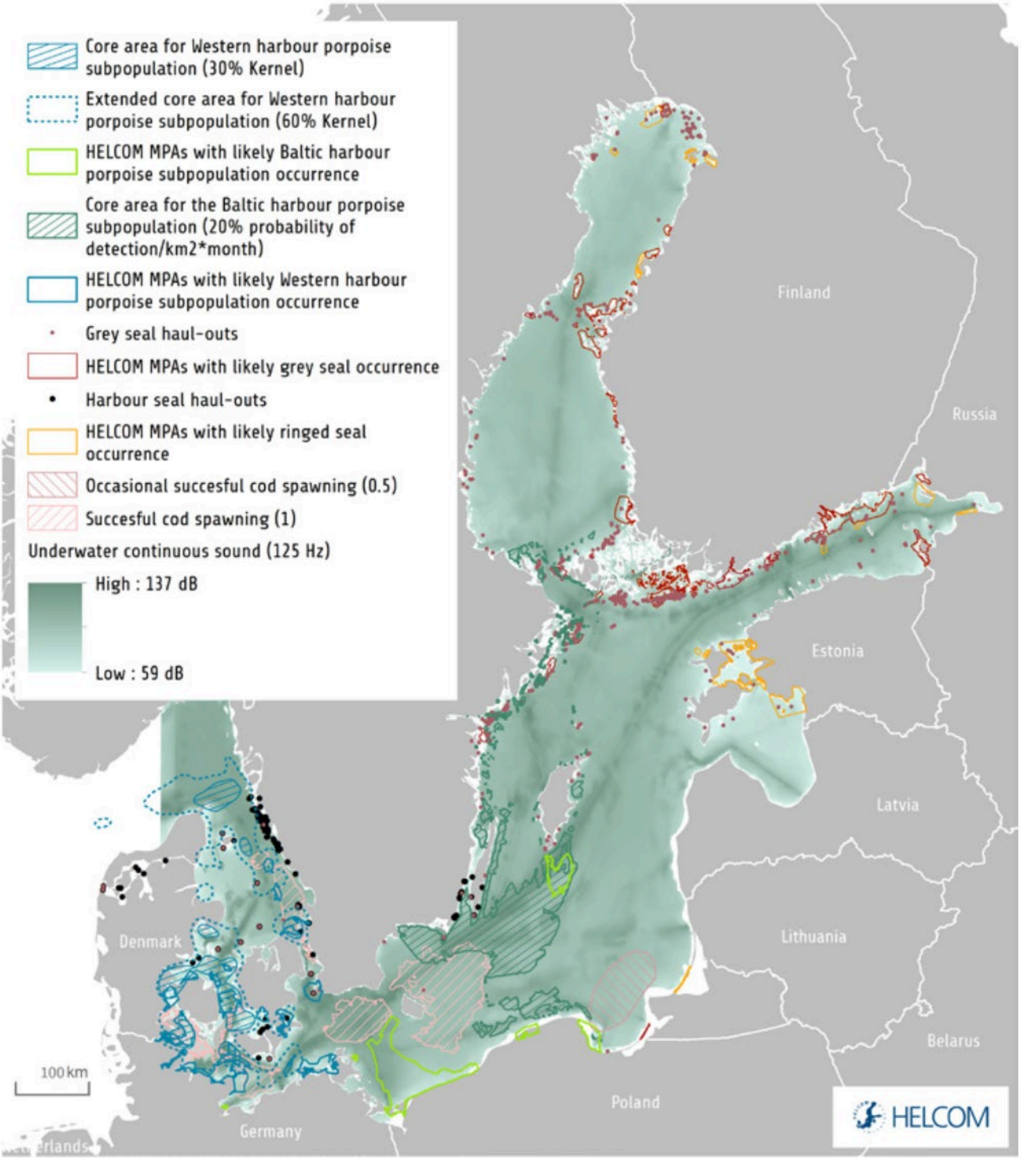

Figure 11.9. Example of how information on the distribution of sound can be compared with important areas for species that are sensitive to sound. The example shows areas identified so far (based on HELCOM, 2016). The soundscape shown is the sound pressure level (dB re 1uPa) for the 125 Hz frequency band occurring 5% of the time, for the whole water column (surface to bottom) in June 2014 (Source: HELCOM, 2018b).

It should be borne in mind that a comparison of progress across countries is not entirely straightforward. For example, the Danish legislation works differently from German legislation especially. It is not based on fixed exposure limits, but underwater noise must be included in any environmental impact assessment, and is thus part of the assessment for any new activity and project proposed. In fact, most countries operate a similar procedure to Denmark under EU regulations.

Table 11.1. Summary of Progress made by countries within the Baltic Sea on noise mitigation actions (Source: Ruiz and Lalander, 2017)

Exclusion of noise generating activities for a certain time period	DK*, FI*, SE
Exclusion of wind farms in Nature Conservation Areas (Maritime Spatial Planning)	DE
Restriction of anthropogenic underwater noise to a certain level	DE, DK, SE
Exclusion of noise generating activities from certain areas (e.g. wind farms)	DE, SE
Spatio-temporal exclusion or limitation of noise causing activities	DK*, SE
Usage of alternative techniques	SE
Modification of operational state of noise source, e.g., reducing ship speed	SE
Refraining from applying activities (e.g. by refrain from using explosives when decommissioning offshore constructions)	SE
The environmental courts may impose any of these restrictions as conditions for granting a project license. For shipping over 500 tonnes, the Swedish Transport Agency may propose "Areas to be avoided" through the IMO. Two such areas were implemented in the Baltic in 2005. No speed restrictions for larger vessels have been proposed, though regional authorities have implemented coastal "Consideration Areas" which include speed restrictions for motorboats. The Swedish Armed Forces use a marine biological calendar when planning exercises to minimize environmental disturbance.	SE

**Potential measure*

Key Conclusions and Recommendations

Underwater noise has the potential to be an important anthropogenic stressor affecting porpoises and their habitat. It can cause a range of effects from the masking of sounds through behavioural responses affecting foraging or reproduction to actual physiological damage. Under the Marine Strategy Framework Directive, countries are obliged to monitor both continuous noise as produced by shipping, and impulsive noise from sources such as seismic, sonar, pile driving, seal scarers and explosions. Some of this has started in the WBBK area, although there is still more to be done before one can establish that the region is in good environmental status.

It is highly recommended that all EU Member States implement the new MSFD threshold values and ensure that they are not exceeded. Furthermore, countries that do not have national guidance documents on EIA procedures to assess noise impact on e.g. harbour porpoises, noise limits/thresholds and control programmes, should develop and implement such documents and programmes. The use of seal scarers should b monitored and regulated.

Summary status assessment of progress of the implementation of the plan

Table 12.1 provides a qualitative assessment of progress by each of the Member States on the various actions identified as priorities. Progress has been variable since the adoption of the plan in 2012. Some aspects (e.g. the monitoring of noise and understanding of the potential impacts of different sources) have received a lot of attention, whereas others (e.g. adequate monitoring to derive robust bycatch estimates, and implementation of effective mitigation measures to reduce bycatch) have made less progress. Status assessment criteria for the WBBK area are attached to this report as Annex I.

Priority Recommendations

1) Monitor and estimate bycatch. Specifically estimate total annual bycatch, and use knowledge to implement mitigation measures in high-risk areas for bycatch
2) Set up stranding/reporting schemes and collection of stranded/bycaught animals in Denmark so that the number of necropsies can be increased
3) Put in place guidelines for impulsive underwater noise in the entire WBBK and Jastarnia areas, similar to those existing in the German North Sea, and ensure effective mitigation is used when generation of impulsive underwater noise cannot be avoided
4) Continue studies to examine behaviour, habitat exclusion and long-term effects of pinger deployments
5) Continue large-scale as well as national surveys and monitoring of abundance and distribution

Table 12.1. Summary of Progress in the Implementation of the Conservation Plan. For status assessment criteria see Annex I.

	Actions from the WBBK Conservation Plan for HP	Priority		SE	DK	DE
1	**Implementation of the CP: co-ordinator and Steering Committee**	High				
2	**Actively seek to involve fishermen in the implementation of the plan and in mitigation measures to ensure a reduction in bycatch**	High		2	2	2
3	**Cooperate and inform other relevant bodies about the conservation plan**	High		2		
4	**Protect harbour porpoises in their key habitats by minimizing bycatch**	High		2	0	0
5	**Implement pinger use in fisheries causing bycatch**	High		2	1	1
6	**Replacement of high-risk gillnets with alternative gear**	High		1	1	1
7	**Estimate total annual bycatch**	High	Monitoring bycatch	2	2	1
			Estimate total annual bycatch	2	2	0
			Facilitate landings of bycaught harbour porpoises	1	2	1
8	**Estimate trends in abundance in the Western Baltic, the Belt Sea and Kattegat**	High	Population-wide surveys	3		
			Reg/nat passive acoustic monitoring	3	2	3
			Reg/nat visuals surveys and modelling	0	0	3
			Identify a survey interval for population-wide surveys	0		
9	**Monitoring population health status, contaminant load and causes of mortality**	Medium		2	2	3
10	**Ensure non-detrimental use of pingers by examining habitat exclusion and long-term effects of pingers**	Medium		1	2	1
11	**Include monitoring & management of important prey species in national HP management plans**	Medium		0	0	0
12	**Restore or maintain habitat quality**	Medium	Monitoring of continuous noise	2	2	1
			Monitoring of impulsive noise	1	1	1
			Mitigating effects of continuous noise	0	0	0
			Mitigating effects of impulsive noise	2	2	2

References

Akkaya Bas, A., Christiansen, F., Amaha Öztürk, A., Öztürk, B., McIntosh, C., 2017. The effects of marine traffic on the behaviour of Black Sea harbour porpoises (Phocoena phocoena relicta) within the Istanbul Strait, Turkey. PLOS ONE 12, e0172970. https://doi.org/10.1371/journal.pone.0172970

Andreasen, H., Ross, S.D., Siebert, U., Andersen, N.G., Ronnenberg, K., Gilles, A., 2017. Diet composition and food consumption rate of harbor porpoises (Phocoena phocoena) in the western Baltic Sea. Mar. Mammal Sci. 33, 1053–1079. https://doi.org/10.1111/mms.12421

ASCOBANS, 2012. Conservation Plan for the Harbour Porpoise Population in the Western Baltic, the Belt Sea and the Kattegat (7th Meeting of the Parties to ASCOBANS No. MOP7/Doc 7-01). Brighton, UK.

Benavente Norrman, E., Königson, S., 2020. Projektrapport för år 2015 - 2019: Öka det frivilliga användandet av pingers i det svenska fisket.

Brandt, M.J., Diederichs, A., Betke, K., Nehls, G., 2011. Responses of harbour porpoises to pile driving at the Horns Rev II offshore wind farm in the Danish North Sea. Mar. Ecol. Prog. Ser. 421, 205–216.

Brandt, M.J., Höschle, C., Diederichs, A., Betke, K., Matuschek, R., Nehls, G., 2013. Seal scarers as a tool to deter harbour porpoises from offshore construction sites. Mar. Ecol. Prog. Ser. 475, 291–302.

Brennecke, D., Siebert, U., Kindt-Larsen, L., Midtiby, H.S., Egemose, H.D., Ortiz, S.T., Knickmeier, K., Wahlberg, M., 2022. The fine-scale behavior of harbor porpoises towards pingers. Fish. Res. 255, 106437. https://doi.org/10.1016/j.fishres.2022.106437

Carlström, J., Berggren, P., Dinnétz, F., Börjesson, P., 2002. A field experiment using acoustic alarms (pingers) to reduce harbour porpoise by-catch in bottom-set gillnets. ICES J. Mar. Sci. J. Cons. 59, 816–824.

Carlström, J., Berggren, P., Tregenza, N.J.C., 2009. Spatial and temporal impact of pingers on porpoises. Can. J. Fish. Aquat. Sci. 66, 72–82. https://doi.org/10.1139/F08-186

Carstensen, J., Henriksen, O.D., Teilmann, J., 2006. Impacts of offshore wind farm construction on harbour porpoises: acoustic monitoring of echolocation activity using porpoise detectors (T-PODs). Mar. Ecol. Prog. Ser. 321, 295–308. https://doi.org/10.3354/meps321295

Clausen, K.T., Tougaard, J., Carstensen, J., Delefosse, M., Teilmann, J., 2018. Noise affects porpoise click detections – the magnitude of the effect depends on logger type and detection filter settings. Bioacoustics 1–16. https://doi.org/10.1080/09524622.2018.1477071

Culik, B., Dorrien, C. von, Müller, V., Conrad, M., 2015. Synthetic communication signals influence wild harbour porpoise (Phocoena phocoena) behaviour. Bioacoustics 24, 201–221. https://doi.org/10.1080/09524622.2015.1023848

Culik, B.M., Conrad, M., Chladek, J., 2017. Acoustic protection for marine mammals: new warning device PAL. (DAGA Proceedings). Kiel, Germany.

Culik, B.M., von Dorrien, C., Conrad, M., 2015. Porpoise Alerting Device (PAL): synthetic harbour porpoise (Phocoena phocoena) communication signals influence behaviour and reduce bycatch, in: Proceedings of the Symposium. Stralsund, Germany, pp. 150–155.

Dähne, M., Gilles, A., Lucke, K., Peschko, V., Adler, S., Krügel, K., Sundermeyer, J., Siebert, U., 2013. Effects of pile-driving on harbour porpoises (Phocoena phocoena) at the first offshore wind farm in Germany. Environ. Res. Lett. 8, 025002. https://doi.org/10.1088/1748-9326/8/2/025002

Dähne, M., Tougaard, J., Carstensen, J., Rose, A., Nabe-Nielsen, J., 2017. Bubble curtains attenuate noise from offshore wind farm construction and reduce temporary habitat loss for harbour porpoises. Mar. Ecol. Prog. Ser. 580, 221–237. https://doi.org/10.3354/meps12257

Danish Energy Agency, 2015. Marine mammals and underwater noise in relation to pile driving. Working Group 2014 report.
Dyndo, M., Wiśniewska, D.M., Rojano-Doñate, L., Madsen, P.T., 2015. Harbour porpoises react to low levels of high frequency vessel noise. Sci. Rep. 5, 11083. https://doi.org/10.1038/srep11083
Evans, P.G., Carson, Q., Fisher, P., Jordan, W., Limer, R., Rees, I., 1994. A study of the reactions of harbour porpoises to various boats in the coastal waters of southeast Shetland. Eur. Res. Cetaceans 8, 60–64.
Finneran, J.J., 2016. Finneran, J.J. 2016. Auditory Weighting Functions and Exposure Functions for Marine Mammals Exposed to Underwater Noise (No. Technical Report 3026.). SSC Pacific, San Diego, USA.
Folegot, T., Clorennec, D., Chavanne, R., Gallou, R., 2016. Mapping of ambient noise for BIAS (No. Quiet-Oceans technical report QO.20130203.01.RAP.001.01B). Brest, France.
Garcia Hartmann, M., 2001. Lung Pathology (No. Proceedings of the Third ECS Workshop on Cetacean Pathology. European Cetacean Society Newsletter no. 37, Special Issue).
Gilles, A., Nachtsheim, D.A., Authier, M., Siebert, U., 2022. Report on HELCOM BLUES Subtask 2.4.2: Assessing trends in abundance for assessment of the Belt Sea population. University of Veterinary Medicine Hannover.
Hammond, P.S., Berggren, P., Benke, H., Borchers, D.L., Collet, A., Heide-Jørgensen, M.P., Heimlich, S., Hiby, A.R., Leopold, M.F., Øien, N., 2002. Abundance of harbour porpoise and other cetaceans in the North Sea and adjacent waters. J. Appl. Ecol. 39, 361–376. https://doi.org/10.1046/j.1365-2664.2002.00713.x
Hammond, P.S., Macleod, K., Berggren, P., Borchers, D.L., Burt, L., Cañadas, A., Desportes, G., Donovan, G.P., Gilles, A., Gillespie, D., Gordon, J., Hiby, L., Kuklik, I., Leaper, R., Lehnert, K., Leopold, M., Lovell, P., Øien, N., Paxton, C.G.M., Ridoux, V., Rogan, E., Samarra, F., Scheidat, M., Sequeira, M., Siebert, U., Skov, H., Swift, R., Tasker, M.L., Teilmann, J., Van Canneyt, O., Vázquez, J.A., 2013. Cetacean abundance and distribution in European Atlantic shelf waters to inform conservation and management. Biol. Conserv. 164, 107–122. https://doi.org/10.1016/j.biocon.2013.04.010
Hardy, T., Williams, R., Caslake, R., Tregenza, N., 2012. An investigation of acoustic deterrent devices to reduce cetacean bycatch in an inshore set net fishery. J. Cetacean Res. Manag. 12, 85–90.
Hedgärde, M., Willestofte Berg, C., Kindt-Larsen, L., Lunneryd, S.-G., Königson, S., 2016. Explaining the catch efficiency of different cod pots using underwater video to observe cod entry and exit behaviour. J. Ocean Technol. 11.
HELCOM, 2023a. Number of drowned mammals and waterbirds in fishing gear (HELCOM core indicator report No. ISSN 2343-2543).
HELCOM, 2023b. Abundance and population trends of harbour porpoises (HELCOM core indicator report No. ISSN 2343-2543).
HELCOM, 2023c. HELCOM Thematic assessment of hazardous substances, marine litter, underwater noise and non-indigenous species 2016-2021 (No. 190), Baltic Sea Environment Proceedings.
HELCOM, 2021. HELCOM Recommendation on the Regional Action Plan on Underwater Noise.
HELCOM, 2018a. State of the Baltic Sea – Second HELCOM holistic assessment 2011-2016, Baltic Sea Environment Proceedings.
HELCOM, 2018b. Implementation of the Baltic Sea Action Plan 2018. Three years left to reach good environmental status (No. Background document to the 2018 HELCOM Ministerial Meeting, Brussels. Baltic Marine Environment Protection Commission).
HELCOM, 2017. Progress in implementing the underwater noise road map (No. Baltic Sea Marine Environment Protection Commission MARITIME 17-2017).
HELCOM ACTION, 2021. Bycatch in Baltic Sea commercial fisheries: High-risk areas and evaluation of measures to reduce bycatch. HELCOM, Helsinki, Finland.
Hermannsen, L., Beedholm, K., Tougaard, J., Madsen, P.T., 2014. High frequency components of ship noise in shallow water with a discussion of implications for harbor porpoises (Phocoena phocoena). J. Acoust. Soc. Am. 136, 1640–1653. https://doi.org/10.1121/1.4893908

Houser, D.S., Yost, W., Burkard, R., Finneran, J.J., Reichmuth, C., Mulsow, J., 2017. A review of the history, development and application of auditory weighting functions in humans and marine mammals. J. Acoust. Soc. Am. 141, 1371–1413.

ICES, 2022a. Working Group on Bycatch of Protected Species (WGBYC) (ICES Scientific Reports No. 4:91).

ICES, 2022b. ICES Advice on fishing opportunities, catch, and effort Greater North Sea ecoregion, Cod (Gadus morhua) in Subdivision 21 (Kattegat) (No. ICES Advice 2022-cod.27.21).

ICES, 2022c. ICES Advice on fishing opportunities, catch, and effort Greater North Sea ecoregion, Cod (Gadus morhua) in Subdivisions 22-24, western Baltic stock (western Baltic Sea) (No. ICES Advice 2022-cod.27.22–24).

ICES, 2022d. ICES Advice on fishing opportunities, catch, and effort - Baltic Sea and Greater North Sea ecoregion, Herring (Clupea harengus) in Subdivisions 20-24, spring spawners (Skagerrak, Kattegat and western Baltic) (No. ICES Advice 2022 – her.27.20–24).

ICES, 2012. ICES Advice 2012. (No. Book 8). ICES, Copenhagen, Denmark.

Kastelein, R.A., Bunskoek, P., Hagedoorn, M., Au, W.W., de Haan, D., 2002. Audiogram of a harbor porpoise (Phocoena phocoena) measured with narrow-band frequency-modulated signals. J. Acoust. Soc. Am. 112, 334–344.

Kastelein, R.A., Schop, J., Hoek, L., Covi, J., 2015. Hearing thresholds of a harbor porpoise (Phocoena phocoena) for narrow-band sweeps. J. Acoust. Soc. Am. 138, 2508–2512.

Kauhala, K., Bäcklin, B.-M., Raitaniemi, J., Harding, K.C., 2017. The effect of prey quality and ice conditions on the nutritional status of Baltic gray seals of different age groups. Mammal Res. 62, 351–362.

Kesselring, T., Viquerat, S., Brehm, R., Siebert, U., 2017. Coming of age: - Do female harbour porpoises (Phocoena phocoena) from the North Sea and Baltic Sea have sufficient time to reproduce in a human influenced environment? PLOS ONE 12, e0186951. https://doi.org/10.1371/journal.pone.0186951

Kindt-Larsen, L., Dalskov, J., Stage, B., Larsen, F., 2012. Observing incidental harbour porpoise Phocoena phocoena bycatch by remote electronic monitoring. Endanger. Species Res. 19, 75–83.

Kindt-Larsen, L., Glemarec, G., Berg, C.W., Königson, S., Kroner, A.-M., Søgaard, M., Lusseau, D., 2023. Knowing the fishery to know the bycatch: bias-corrected estimates of harbour porpoise bycatch in gillnet fisheries. Proc. R. Soc. B Biol. Sci. 290, 20222570. https://doi.org/10.1098/rspb.2022.2570

Kinze, Carl Christian, C.C., Thøstesen, C.B., Olsen, M.T., 2018. Cetacean stranding records along the Danish coastline: records for the period 2008-2017 and a comparative review. Lutra 67, 87–105.

Königson, S., Naddafi, R., Hedgärde, M., Pettersson, A., Östman, Ö., Benavente Norrman, E., Amundin, M., 2021. Will harbor porpoises (Phocoena phocoena) be deterred by a pinger that cannot be used as a “dinner bell” by seals? Mar. Mammal Sci. n/a. https://doi.org/10.1111/mms.12880

Koschinski, S., Lüdemann, K., 2014. OSPAR inventory of measures to mitigate the emission and environmental impact of underwater noise. Annex 1. Pp. 10-40. In: Merck T, & Werner S (eds). OSPAR Commission, London, UK.

Krumme, U., Meyer, S., Kratzer, I., Chladek, J.-C., Barz, F., Stepputtis, D., Strehlow, H.V., Kraak, S.B.M., Zimmermann, C., 2022. STELLA - Stellnetzfischerei-Lösungsansätze : Projekt-Abschlussbericht (No. Thünen Rep 97). Johann Heinrich von Thünen-Institut, Germany.

Kuiken, T., 1996. Diagnosis of By-Catch in Cetaceans (No. Proceedings of the Second ECS Workshop on Cetacean Pathology. European Cetacean Society Newsletter, nos. 26, Special Issue).

Kuiken, T., Garcia Hartmann, M., 1992. Cetacean Pathology: Dissection Techniques and Tissue Sampling (No. Proceedings of the First ECS Workshop on Cetacean Pathology. ECS Newsletter No. 17, Special Issue).

Kyhn, L., Jørgensen, P., Carstensen, J., Bech, N., Tougaard, J., Dabelsteen, T., Teilmann, J., 2015. Pingers cause temporary habitat displacement in the harbour porpoise Phocoena phocoena. Mar. Ecol. Prog. Ser. 526, 253–265. https://doi.org/10.3354/meps11181

Kyhn, L.A., van Beest, F.M., Galatius, A., 2022. Spæktykkelse hos tre danske havpattedyr 2019-2021. Overvågning udført for Miljøstyrelsen (No. Teknisk rapport nr. 253). Aarhus Universitet, DCE –Nationalt Center for Miljø og Energi.

Larsen, F., Kindt-Larsen, L., Kirk Sörensen, T., Glemarec, G., 2021. Bycatch of marine mammals and seabirds. Occurrence and mitigation (DTU Aqua Report No. 3892021). National Institute of Aquatic Resources, Technical University of Denmark.

Ljungberg, P., Lunneryd, S.-G., Lövgren, J., Königson, S., 2016. Including cod (Gadus morhua) behavioural analysis to evaluate entrance type dependent pot catch in the Baltic Sea. J. Ocean Technol. 11.

Lucke, K., Lepper, P.A., Blanchet, M.-A., Siebert, U., 2011. The use of an air bubble curtain to reduce the received sound levels for harbor porpoises (Phocoena phocoena). J. Acoust. Soc. Am. 130, 3406. https://doi.org/10.1121/1.3626123

MacLeod, C.D., Santos, M.B., Reid, R.J., Scott, B.E., Pierce, G.J., 2007. Linking sandeel consumption and the likelihood of starvation in harbour porpoises in the Scottish North Sea: could climate change mean more starving porpoises? Biol. Lett. 3, 185–188. https://doi.org/10.1098/rsbl.2006.0588

McKenna, M.F., Ross, D., Wiggins, S.M., Hildebrand, J.A., 2012. Underwater radiated noise from modern commercial ships. J. Acoust. Soc. Am. 131, 92. https://doi.org/10.1121/1.3664100

Merchant, N.D., Faulkner, R.C., Martinez, R., 2018. Marine Noise Budgets in Practice. Conserv. Lett. 11, e12420. https://doi.org/10.1111/conl.12420

Morgan, L.E., Chuenpagdee, R., 2003. Shifting gears: addressing the collateral impacts of fishing methods in US waters.

Nabe-Nielsen, J., van Beest, F.M., Grimm, V., Sibly, R.M., Teilmann, J., Thompson, P.M., 2018. Predicting the impacts of anthropogenic disturbances on marine populations. Conserv. Lett. 11, e12563.

Neimane, A., Stavenow, J., Ågren, E., Wikström, E., Roos, A., 2020. Hälso- och sjukdomsövervakning av marina däggdjur Del 2. Hälsa, sjukdomar och dödsorsaker hos tumlare (Phocoena phocoena) i Sverige de senaste 10 åren (SVA Rapportserie No. ISSN 1654-7098 NR 59). Swedish National Veterinary Insitute.

Nilsson, H., 2018. Sekretariatet för selektivt fiske - Rapportering av 2016 och 2017 års verksamhet (No. 2018:4), Aqua reports. Sveriges lantbruksuniversitet, Institutionen för akvatiska resurser, Lysekil, Sweden.

NMFS (National marine Fisheries Service), 2016. Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts (NOAA Technical Memorandum NMFS-OPR-55). U.S. Dept. of Commerce, NOAA.

Oceana, 2016. Oceana recommendations on fishing opportunities for 2016 - Baltic Sea Stocks. Oceana, Copenhagen, Denmark.

Owen, K., Authier, M., Genu, M., Sköld, M., Carlström, J., 2022. Estimating a mortality threshold for the Belt Sea population of harbour porpoises (No. 3:2022), Report by the Swedish Museum of Natural history. The Swedish Museum of Natural History, Department of Environmental Research and Monitoring.

Philipp, C., Unger, B., Ehlers, S.M., Koop, J.H.E., Siebert, U., 2021. First Evidence of Retrospective Findings of Microplastics in Harbour Porpoises (Phocoena phocoena) From German Waters. Front. Mar. Sci. 8, 508. https://doi.org/10.3389/fmars.2021.682532

Ruiz, M., Lalander, E., 2017. WP 4.1 Deliverable 5: Compilation of internationally available mitigation measures and Baltic Sea country specific information. Theme 4: Noise. Baltic BOOST Appendix 1. Final report.

Scheidat, M., Tougaard, J., Brasseur, S., Carstensen, J., van Polanen Petel, T., Teilmann, J., Reijnders, P., 2011. Harbour porpoises (Phocoena phocoena) and wind farms: a case study in the Dutch North Sea. Environ. Res. Lett. 6, 025102. https://doi.org/10.1088/1748-9326/6/2/025102

Siebert, U., Gilles, A., Dähne, M., Peschko, V., Krügel, K., Benke, H., Lucke, K., Müller, S., Adler, S., Sundermeyer, J., 2012. Ergänzende Untersuchungen zum Effekt der Bau- und Betriebsphase im Offshore-Testfeld „alpha ventus“ auf marine Säugetiere, in: In: Blasche, K., Dahlke, C., Boethling, M., & Binder, A. (Eds). Ekologische Begleitforschung Am Offshore-Testfeldvorhaben „alpha Ventus“ Zur Evaluierung Des Standarduntersuchungskonzeptes Des BSH – StUKplus. Fortschrittsbericht 2011.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene, C.R., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., 2007. Marine mammal noise exposure criteria aquatic mammals. vol 33, 4.

Southall, B.L., Scholik-Schlomer, A.R., Hatch, L., Bergmann, T., Jasny, M., Metcalf, K., Weilgart, L., Wright, A.J., 2017. Underwater Noise from Large Commercial Ships—International Collaboration for Noise Reduction. Encycl. Marit. Offshore Eng. 1–9.

Stedt, J., Wahlberg, M., Carlström, J., Nilsson, P.A., Amundin, M., Oskolkov, N., Carlsson, P., 2023. Micro-scale spatial preference and temporal cyclicity linked to foraging in harbour porpoises. Mar. Ecol. Prog. Ser. 708, 143–161. https://doi.org/10.3354/meps14268

Sveegaard, S., Andreasen, H., Mouritsen, K.N., Jeppesen, J.P., Teilmann, J., Kinze, C.C., 2012. Correlation between the seasonal distribution of harbour porpoises and their prey in the Sound, Baltic Sea. Mar. Biol. 159, 1029–1037. https://doi.org/10.1007/s00227-012-1883-z

Sveegaard, S., Nabe-Nielsen, J., Teilmann, J., 2018. Marsvins udbredelse og status for de marine habitatområder i danske farvande (No. Videnskabelig rapport no. 284). Aarhus Universitet, DCE – Nationalt Center for Miljø og Energi.

Teilmann, J., Sveegaard, S., Balle, J.D., Kyhn, L.A., Carstensen, J., 2015. Porpoise monitoring in pinger-net fishery. Final baseline report (No. Technical Report from DCE – Danish Centre for Environment and Energy No. 68). Aarhus Universitet, DCE-Nationalt Center for Miljø og Energi.

Teilmann, J., Tougaard, J., Carstensen, J., Renvald, L., 2009. Baseline monitoring of harbour porpoises-Rødsand 2 Offshore Wind Farm.

Torres Ortiz, S., Stedt, J., Skov Midtiby, H., Dyrberg Egemose, H., Wahlberg, M., 2021. Group hunting in harbour porpoises (Phocoena phocoena). Can. J. Zool. https://doi.org/10.1139/cjz-2020-0289

Tougaard, J., 2016. Input to revision of guidelines regarding underwater noise from oil and gas activities - effects on marine mammals and mitigation measures (No. Scientific Report from DCE – Danish Centre for Environment and Energy No. 202). Aarhus University, DCE – Danish Centre for Environment and Energy.

Tougaard, J., Dähne, M., 2017. Why is auditory frequency weighting so important in regulation of underwater noise? J. Acoust. Soc. Am. 142, EL415–EL420.

Tougaard, J., Henriksen, O.D., Miller, L.A., 2009. Underwater noise from three types of offshore wind turbines: Estimation of impact zones for harbor porpoises and harbor seals. J. Acoust. Soc. Am. 125, 3766–3773.

Tougaard, J., Wright, A.J., Madsen, P.T., 2015. Cetacean noise criteria revisited in the light of proposed exposure limits for harbour porpoises. Mar. Pollut. Bull. 90, 196–208.

Ulrich, C., Dalskov, J., Egekvist, J., H\aakansson, K.B., Olesen, H.J., Storr-Paulsen, M., 2013. Behind the shine: An appraisal of five years of Danish CCTV trials.

Ulrich, C., Olesen, H.J., Bergsson, H., Egekvist, J., H\aakansson, K.B., Dalskov, J., Kindt-Larsen, L., Storr-Paulsen, M., 2015. Discarding of cod in the Danish Fully Documented Fisheries trials. ICES J. Mar. Sci. 72, 1848–1860.

Unger, B., Nachtsheim, D., Ramírez Martínez, N., Siebert, U., Sveegaard, S., Kyhn, L.A., Dalgaard Balle, J., Teilmann, J., Carlström, J., Owen, K., Gilles, A., 2021. MiniSCANS-II: Aerial survey for harbour porpoises in the western Baltic Sea, Belt Sea, the Sound and Kattegat in 2020. Joint

survey by Denmark, Germany and Sweden. (Final report to Danish Environmental Protection Agency, German Federal Agency for Nature Conservation and Swedish Agency for Marine and Water Management.).
van Beest, F.M., Kindt-Larsen, L., Bastardie, F., Bartolino, V., Nabe-Nielsen, J., 2017. Predicting the population-level impact of mitigating harbor porpoise bycatch with pingers and time-area fishing closures. Ecosphere 8, e01785. https://doi.org/10.1002/ecs2.1785
van Beest, F.M., Teilmann, J., Dietz, R., Galatius, A., Mikkelsen, L., Stalder, D., Sveegaard, S., Nabe-Nielsen, J., 2018. Environmental drivers of harbour porpoise fine-scale movements. Mar. Biol. 165, 95. https://doi.org/10.1007/s00227-018-3346-7
Veirs, S., Veirs, V., Wood, J.D., 2016. Ship noise extends to frequencies used for echolocation by endangered killer whales. PeerJ 4, e1657. https://doi.org/10.7717/peerj.1657
Veirs, V., Veirs, S., 2005. Average levels and power spectra of ambient sound in the habitat of southern resident orcas. NMFS Contract Rep. No AB133F05SE6681 16p.
Viquerat, S., Herr, H., Gilles, A., Peschko, V., Siebert, U., Sveegaard, S., Teilmann, J., 2014. Abundance of harbour porpoises (Phocoena phocoena) in the western Baltic, Belt Seas and Kattegat. Mar. Biol. 161, 745–754. https://doi.org/10.1007/s00227-013-2374-6
Williams, R., Erbe, C., Ashe, E., Beerman, A., Smith, J., 2014. Severity of killer whale behavioral responses to ship noise: A dose–response study. Mar. Pollut. Bull. 79, 254–260. https://doi.org/10.1016/j.marpolbul.2013.12.004
Wilson, L.J., Hammond, P.S., 2019. The diet of harbour and grey seals around Britain: Examining the role of prey as a potential cause of harbour seal declines. Aquat. Conserv. Mar. Freshw. Ecosyst. 29, 71–85. https://doi.org/10.1002/aqc.3131
Wisniewska, D.M., Johnson, M., Teilmann, J., Rojano-Doñate, L., Shearer, J., Sveegaard, S., Miller, L.A., Siebert, U., Madsen, P.T., 2016. Ultra-High Foraging Rates of Harbor Porpoises Make Them Vulnerable to Anthropogenic Disturbance. Curr. Biol. 0. https://doi.org/10.1016/j.cub.2016.03.069
Wisniewska, D.M., Johnson, M., Teilmann, J., Siebert, U., Galatius, A., Dietz, R., Madsen, P.T., 2018. High rates of vessel noise disrupt foraging in wild harbour porpoises (*Phocoena phocoena*). Proc. R. Soc. B Biol. Sci. 285, 20172314. https://doi.org/10.1098/rspb.2017.2314

Status assessment criteria for progress on the implementation of the actions of the WBBK Plan

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

2. **Actively seek to involve fishermen in the implementation of the plan and in mitigation measures to ensure a reduction in bycatch**
   N.A. – Not applicable
   0 – No activity
   1 – Occasional dialogue meetings for certain issues but no established groups
   2 – Dialogue/reference groups established to involve stakeholders in management of some protected areas and/or to mitigate bycatch in some of the distribution range
   3 – Dialogue/reference groups established to involve stakeholders in management of all protected areas and bycatch mitigation in the entire distribution range

3. **Cooperate with and inform other relevant bodies about the conservation plan**
   N.A. – Not applicable
   0 – No activity
   1 – Few contacts with some national governments and/or other relevant national and international bodies
   2 – Occasional contact with national governments and other relevant national and international bodies
   3 – Continuous dissemination of the plan to national governments and other relevant national and international bodies

4. **Protect harbour porpoises in their key habitats by minimising bycatch**
   N.A. – Not applicable
   0 – No activity
   1 – Bycatch mitigation measures and/or ghostnet removal underway in some harbour porpoise MPAs and other key habitats
   2 – Delegated acts in place, bycatch mitigation measures implemented and ghostnet removal completed for some harbour porpoise MPAs and other key habitats
   3 – National regulation, management plans or delegated acts in place, measures on bycatch mitigation implemented and ghostnet removal carried out in all harbour porpoise MPAs and other key habitats

5. **Implement pinger use in fisheries causing bycatch**
   N.A. – Not applicable
   0 – No activity
   1 – Research projects on pinger use underway

2 – Pinger use in some high-risk fisheries, implementation and functionality of pingers controlled regularly
3 – Pinger use mandatory in all high-risk fisheries, implementation and functionality of pingers controlled regularly

6. Replacement of high-risk gillnets with alternative gear

N.A. – Not applicable
0 – No activity
1 – Research projects on development of alternative gear without bycatch underway
2 – Alternative gear without bycatch are available but not implemented in all active static net fisheries
3 – Use of alternative gear without bycatch implemented large-scale in all active static net fisheries

7. Estimate total annual bycatch

Monitoring bycatch
N.A. – Not applicable
0 – No activity
1 – Some assessment of bycatch rates (e.g. questionnaire surveys, sample surveys, logbooks) (under Reg. 2019/1241 or equivalent)
2 – Bycatch monitoring of some fisheries known to cause harbour porpoise bycatch (under Reg. 2019/1241 or equivalent) resulting in an estimate of bycatch rates
3 – Bycatch monitoring in all fisheries known to cause harbour porpoise bycatch (under Reg. 2019/1241 or equivalent) resulting in a robust estimate of bycatch rates

Estimate total annual bycatch
N.A. – Not applicable
0 – No estimates available
1 – Estimate of bycatch available from research project, for some of the fisheries known to cause harbour porpoise bycatch
2 – Estimate of bycatch available for >50% of the fisheries known to cause harbour porpoise bycatch
3 – Robust estimate of bycatch available for all fisheries known to cause harbour porpoise bycatch

Facilitate landing of bycaught harbour porpoises
0 – National and EU legislation does not allow landing of bycaught harbour porpoises
1 – National and EU legislation does not allow landing of bycaught harbour porpoises but there can be derogations from these rules
2 – National or EU legislation allow landing of bycaught harbour porpoises
3 – National and EU legislation allow landing of bycaught harbour porpoises

8. Estimate trends in abundance in the western Baltic, the Belt Sea and Kattegat

Population-wide (including modelling)
N.A. – Not applicable
0 – No activity
1 – Surveys carried out every 10-12 years, results with wide confidence intervals of CV>0.4, distribution maps showing probability of detection
2 – Surveys carried out every 10-12 years, more narrow confidence intervals of abundance estimates with CV>0.2 to 0.4, maps of harbour porpoise density
3 – Surveys carried out every 6 years, even more narrow confident intervals of abundance estimates with CV of ≤0.2, maps of harbour porpoise density

Regional/national passive acoustic monitoring
N.A. – Not applicable
0 – No activity
1 – Some monitoring going on, at local/national scale, not continuously, covering important areas for harbour porpoises where possible (see HELCOM indicator work)
2 – Continuous (year round) monitoring for at least two years every six years covering important areas for harbour porpoises where possible
3 – Continuous (year round) monitoring for the entire six-year cycle, covering important areas for harbour porpoises where possible

Regional/national visual surveys and modelling
N.A. – Not applicable
0 – No activity
1 – Visual surveys taking place irregularly, no density modelling carried out
2 – Visual surveys and density modelling carried out at least every ten years
3 – Visual surveys and density modelling carried out at least every six years

Identify a survey interval based on power analysis in relation to effort and statistical uncertainty, for population-wide surveys
0 – No survey interval identified
3 – Optimal survey interval identified

9. Monitor population health status, contaminant load and causes of mortality

N.A. – Not applicable
0 – No activity, no plan or guidance on how to act in case of a stranding
1 – Samples collected from some carcasses from within the distribution range of the Belt Sea population, no analysis carried out
2 – Some analysis and assessments completed on certain organs or tissues, and/or some necropsies carried out
3 – Full necropsies (according to ASCOBANS protocol) conducted for 20 carcasses per year in good enough condition, and samples analysed for health indicators, e.g. contaminant levels and life history parameters. Regular (at least every 6 years) assessments of results

10. Ensure non-detrimental use of pingers by examining habitat exclusion and long-term effects of pingers

N.A. – Not applicable
0 – No activity
1 – Research projects underway on effects of pingers, such as habitat exclusion or habituation
2 – Some results available, but not conclusive, on effects of pingers, such as habitat exclusion and habituation
3 – Reliable results available on effects of pingers, such as habitat exclusion and habituation

11. Include monitoring and management of important prey species in national harbour porpoise management plans

N.A. – Not applicable
0 – No activity
1 – Knowledge available on the most important prey species for the Belt Sea harbour porpoise population, also non-commercial species and for harbour porpoises relevant sizes of commercial species, and the biology and distribution of those species
2 – Measures taken to ensure availability of harbour porpoise prey species, also non-commercial and for harbour porpoises relevant sizes of commercial species, within harbour porpoise MPAs
3 – Sustainable management of harbour porpoise prey species, also non-commercial and for harbour porpoises relevant sizes of commercial species, in the entire range of the Belt Sea harbour porpoise population

12. Restore or maintain habitat quality

Monitoring of continuous noise (e.g. shipping)
N.A. – Not applicable
0 – No activity
1 – Research projects in place to improve knowledge on impacts on harbour porpoises from continuous noise OR monitoring of continuous underwater noise and the impact on harbour porpoises in the area, is implemented to some extent
2 – Research projects in place to improve knowledge on impacts on harbour porpoises from continuous noise AND monitoring of continuous underwater noise and the impact on harbour porpoises in the area, is implemented to some extent
3 – Monitoring of continuous underwater noise and the impact on harbour porpoises in the area, is implemented in the harbour porpoise distribution range.

Monitoring of impulsive noise (e.g. seismic, sonar, explosions, piling)
N.A. – Not applicable
0 – No activity
1 – Research projects in place to improve knowledge on impacts on harbour porpoises from impulsive noise OR monitoring of impulsive underwater noise and the impact on harbour porpoises, are implemented to some extent
2 – Research projects in place to improve knowledge on impacts on harbour porpoises from impulsive noise AND monitoring of impulsive underwater noise and the impact on harbour porpoises, are implemented to some extent

3 – Monitoring of continuous underwater noise and the impact on harbour porpoises, are implemented in the harbour porpoise distribution range.

Mitigating effects of continuous noise (e.g. shipping)
N.A. – Not applicable
0 – No activity
1 – Mitigation measures to reduce continuous noise (e.g. quieting technologies, speed restrictions, re-routing vessels) under development or being tested
2 – Mitigation measures to reduce continuous noise (e.g. quieting technologies, speed restrictions, re-routing vessels) in place to some extent
3 – Mitigation measures to reduce continuous noise (e.g. quieting technologies, speed restrictions, re-routing vessels) routinely in place

Mitigating effects of impulsive noise (e.g. seismic, sonar, explosions, piling)
N.A. – Not applicable
0 – No activity
1 – Mitigation measures to reduce impulsive noise (e.g. soft starts, bubble curtains, insulation casings) under development or being tested, available mitigation methods used to some extent
2 – Mitigation measures to reduce impulsive noise (e.g. soft starts, bubble curtains, insulation casings) in place to some extent
3 – Mitigation measures to reduce impulsive noise (e.g. soft starts, bubble curtains, insulation casings) routinely in place