HELCOM

Harbour porpoise distribution

INDICATOR TYPE: State
INDICATOR CATEGORY: Pre-core
BSAP SEGMENT: Biodiversity
MSFD CRITERIA: D1C4

Distribution of harbour porpoises

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1. Key message

This indicator is a HELCOM pre-core indicator.

This HELCOM pre-core indicator is evaluated for the purposes of the 'State of the Baltic Sea' report (HOLAS 3) and further development towards a core indicator is expected in the future. An overview of indicator development is set out in the HELCOM indicator manual.

This pre-core indicator evaluates whether the distribution of harbour porpoises (*Phocoena phocoena*) in the Baltic Sea is adversely affected due to anthropogenic pressures, and thus, if its distributional range and pattern is in line with prevailing physiographic, geographic and climatic conditions. For this expert-based evaluation (currently addresses only one population), good environmental status (GES) for distribution is achieved when the distributional range, and the frequency of harbour porpoise records, in the Baltic Sea is the same as that indicated by historical records (starting from late 17th century), taking confounding factors into account (see Confidence of the qualitative assessment). This is not achieved in the Baltic Proper population (Figure 1).

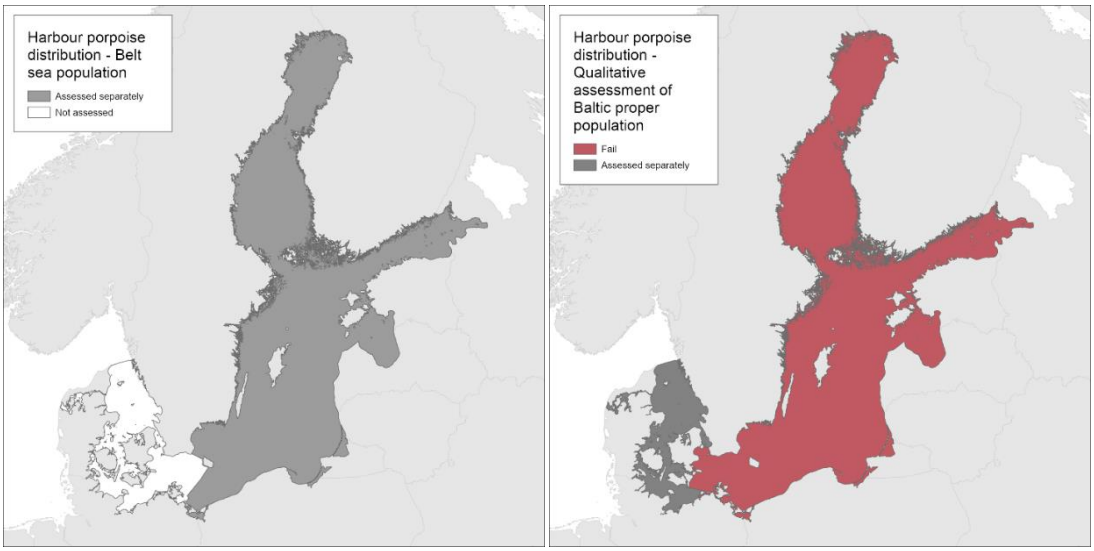

Figure 1. Left: Status evaluation results of the Belt Sea harbour porpoise population-based evaluation of the indicator 'Distribution of harbour porpoises' [not yet evaluated]. Right: Status qualitative evaluation results based on an evaluation of the distribution and frequency of historical records of harbour porpoises within the May-October management range of the Baltic Proper harbour porpoise. The evaluation is carried out using Scale 2 HELCOM assessment units (defined in the HELCOM Monitoring and Assessment Strategy Attachment 4). **See 'data chapter' for interactive maps and data at the HELCOM Map and Data Service.**

The HELCOM area is currently inhabited by two separate harbour porpoise populations: (i) the Belt Sea population in southern Kattegat, the Belt Sea, the Sound, and south-western Baltic, and the (ii) the Baltic Proper population in the waters east thereof (Carlén *et al.*, 2018; Sveegaard *et al.*, 2015). While there are reasonable estimates for distribution to support management (especially in relation to summer distribution) there remain some uncertainties, especially with regard to the Baltic Proper population. The

evaluation of population distribution is always completed on the population level (based on the results of population level surveys, e.g. SCANS, MiniSCANS and SAMBAH), together with the population level abundance evaluation to determine whether any observed change in distribution is likely to be a positive or negative factor. This two-step process is due to the nature of highly mobile marine species. It is very difficult to assess whether an increase or decrease in distributional range is a good or bad thing without additional information on population status, or ideally, habitat quality over the current range (Owen *et al.* 2022).

According to the Marine Strategy Framework Directive (MSFD), directional trends can be used as proxies until threshold values are established. Since population-wide surveys do not happen regularly for this species in the region, key site monitoring data will be used to supplement population-wide surveys and assess trends in the distribution at shorter time intervals than if based on population-scale evaluations only. Key site monitoring will occur as a part of ongoing national monitoring programmes, long-term visual or acoustic monitoring, or the establishment of new monitoring programmes at key sites in each country. Trends in distribution are to be evaluated on population-wide data when available. On shorter time scales, a trend in porpoise distribution at key sites is to be evaluated, indicative of potential changes in the population distribution.

The evaluation of the Baltic Proper population is based on data from one passive acoustic monitoring (PAM) survey (SAMBAH) in 2011-2013 (Carlén *et al.*, 2018; Amundin *et al.*, 2022). Due to the very low density of the Baltic Proper population, only dedicated acoustic methods should be applied. The SAMBAH survey identified a summer core area for the Baltic Proper population around the offshore banks, Hoburg's Bank, and the Northern and Southern Mid-Sea Banks (Carlén *et al.*, 2018).

Due to the lack of appropriate data for a quantitative distribution evaluation, a qualitative evaluation was carried out as part of the HELCOM BLUES project (2021-2022), based on historical information on harbour porpoise occurrence within the May-October management range of the Baltic Proper population (HELCOM, 2022). The expert-based qualitative evaluation show that the distribution of the Baltic Proper harbour porpoise does not achieve good environmental status (Figure 1).

It is currently not possible to make an evaluation of distribution for the Belt Sea population and consequently this population is not described further in this version of the indicator.

This qualitative evaluation evaluates the status of the distribution of the Baltic Proper harbour porpoise. The current abundance and distributional pattern are compared to historical data on harbour porpoise occurrence within the population's management range. No quantitative thresholds are available, but the comparisons show that the distribution of the Baltic Proper harbour porpoise does not achieve good environmental status. The qualitative evaluation is applicable in the waters of all nine countries bordering the Baltic Sea, including areas such as Bothnian Bay, which often is considered to be outside of the current distributional range of the Baltic Proper harbour porpoise population.

The confidence of the qualitative evaluation is high, although not quantifiable. The confidence in the evaluation is considered high since the results show that the current

status is far from previous levels and thus the failure to achieve GES is strongly apparent. The evaluation also utilises extensive spatial and temporal data as its basis.

1.1 Citation

The data and resulting data products (e.g. tables, figures and maps) available on the indicator web page can be used freely given that it is used appropriately and the source is cited. The indicator should be cited as follows:

HELCOM (2023) Distribution of harbour porpoises. HELCOM pre-core indicator report. Online. [Date Viewed], [Web link].

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2. Relevance of the indicator

The qualitative evaluation signals changes in the abundance and distributional range of a top predator in the Baltic Sea. As a top predator in the marine ecosystem, the harbour porpoise is a good indicator of the state of food webs, levels of hazardous substances, and the degree of human disturbance on the ecosystem. Given the critically endangered status of the Baltic Proper population (IUCN and HELCOM) (Hammond *et al.*, 2008a; HELCOM, 2013), and the fact that all indicators for this population (and species) are still under development within HELCOM, this qualitative evaluation is necessary for the population to be included in HOLAS 3 as a key component of the ecosystem.

2.1 Ecological relevance

Harbour porpoises are likely to have played an important role in the past functioning of the Baltic Sea ecosystem. However, it is highly unlikely that they fulfil this role currently, due to the low population abundance and critically endangered status, which means that the Baltic Proper harbour porpoise is in practice ecologically extinct. The presence of top predators allows for natural control of the distribution, abundance, diversity, and health of their prey species, with harbour porpoises likely previously playing an important role in maintaining a natural balance in the Baltic Sea ecosystem. Being a highly mobile species both horizontally over space and vertically over depth, harbour porpoises also likely played an important role in nutrient transfer across the Baltic Sea region. If not severely reduced, the species can also act as a good indicator of changes in the Baltic Sea ecosystem, as they are sensitive to changes at lower levels in the ecosystem and human induced pressures.

One of the strongest threats to harbour porpoises is the risk of being bycaught in fishing gear, which results in direct mortality (e.g. ICES, 2019; IMR-NAMMCO, 2019). Survival and fecundity can also be reduced by exposure to contaminants (Beineke *et al.*, 2007a, 2007b; Jepson *et al.*, 2005; Murphy *et al.*, 2015). Additionally, both impulsive and continuous underwater noise have negative influences on porpoises, ranging from behavioural disturbance that reduces the efficiency of foraging and communication, through to permanent injury and death (e.g. Hermannsen *et al.*, 2014; Lucke *et al.*, 2009; Sarnocińska *et al.*, 2020; Siebert *et al.*, 2022; Wisniewska *et al.*, 2018). Harbour porpoises have high-energy requirements and must feed almost continuously to meet energy demands (e.g. MacLeod *et al.*, 2014; Spitz *et al.*, 2012; Wisniewska *et al.*, 2016). This makes the species particularly susceptible to negative impacts from resource depletion and disturbance from human presence. In populations that are healthy and not exposed to high levels of pressures, harbour porpoises have shown population increases of 9-10% per year (Forney *et al.*, 2020). As the abundance of the Baltic Proper population is critically low, it is not influenced by density dependence issues. A level of growth (or a decline) significantly lower than the level of known possible population growth for the species indicates that there is likely something within the ecosystem that is restricting the population, and that human pressures may be causing an issue in the natural state of the Baltic Sea.

2.2 Policy relevance

The indicator on the distribution of harbour porpoise addresses the 2021 Baltic Sea Action Plan's (BSAP 2021) overall goal of achieving a good environmental status of Baltic Sea, specifically the ecological objective of 'Viable populations of all species'. Under the theme 'Conservation of species', this indicator is related to action B8:

- 'By 2022 at the latest, specify knowledge gaps on all threats to the Baltic Proper harbour porpoise population, and by 2023 for the western Baltic population, including by-catch and areas of high by-catch risk, underwater noise, contaminants and prey depletion. Knowledge gaps related to areas of high by-catch risk are to be addressed and by 2028 at the latest additional areas of high by-catch risk for both Baltic Sea populations are to be determined. To strengthen the Baltic harbour porpoise population, by 2025 identify possible mitigation measures for threats other than by-catch and implement such measures as they become available.'

The indicator has relevance to the HELCOM Recommendation 17/2 (HELCOM, 2020) on protection of harbour porpoise in the Baltic Sea and HELCOM Recommendation 37/2 on the protection of species classified as threatened on the HELCOM Red List.

Other BSAP 2021 ecological objectives of 'Natural distribution, occurrence and quality of habitats and associated communities' and 'Functional, healthy and resilient food webs' towards achieving the biodiversity segment goal of a "Baltic Sea ecosystem [that] is healthy and resilient".

The indicator also addresses the following qualitative descriptors of the MSFD for determining good environmental status (European Commission 2008), further elaborated under Commission Decision (EU) 2017/848 that lays down criteria and methodological standards on good environmental status of marine waters (see also Table 1):

- Descriptor 1: Species groups of birds, mammals, reptiles, fish and cephalopods
- Descriptor 4: Ecosystems, including food webs;
- Descriptor 8: Concentrations of contaminants are at levels not giving rise to pollution effects and
- Descriptor 11: 'Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment'.

The indicator is also highly relevant to the implementation of the Habitats Directive (HD, 92/43/EEC). Additionally, the indicator is of relevance to the ASCOBANS Recovery Plan for Baltic Harbour Porpoises (ASCOBANS 2016), Jastarnia Plan, and ASCOBANS Resolution 9.2 on the Baltic Proper harbour porpoise (ASCOBANS, 2020). There is also some relevance of this indicator to the EU Delegated Regulation regarding measures to reduce incidental catches of the resident population of the Baltic Proper harbour porpoise (*Phocoena phocoena*) in the Baltic Sea (2022/303), the EU Regulation on the conservation of fisheries resources and the protection of marine ecosystems through technical measures (2019/1241), the EU Common Fisheries Policy (1380/2013), and the EU Maritime Spatial Planning Directive (2014/89/EU).

Table 1. Policy relevance for this HELCOM indicator.

	Baltic Sea Action Plan (BSAP)	**Marine Strategy Framework Directive (MSFD)**
Fundamental link	Segment: Biodiversity Goal: "Baltic Sea ecosystem is healthy and resilient" • Ecological objective: "Viable populations of all native species ", and "Natural distribution, occurrence and quality of habitats and associated communities". • Management objective: "Effectively managed and ecologically coherent network of marine protected areas ", "Minimize disturbance of species, their habitats and migration routes from human activities"; "Effective and coordinated conservation plans and measures for threatened species, habitats, biotopes, and biotope complexes".	Descriptor 1 Species groups of birds, mammals, reptiles, fish and cephalopods. • Criteria 4 The species distributional range and, where relevant, pattern is in line with prevailing physiographic, geographic and climatic conditions. • Feature – Species groups (Small toothed cetaceans). • Element of the feature assessed – Species lists (harbour porpoise).
Complementary link	Segment: Biodiversity Goal: "Baltic Sea ecosystem is healthy and resilient" • Ecological objective: "Functional, healthy and resilient food webs". • Management objective: "Reduce or prevent human pressures that lead to imbalance in the food web". Segment: Hazardous substances and litter goal Goal: "Baltic Sea unaffected by hazardous substances and litter" • Ecological objective: "Marine life is healthy".	Descriptor 1 Species groups of birds, mammals, reptiles, fish and cephalopods. • Criteria 1 The mortality rate per species from incidental by-catch is below levels which threaten the species, such that its long-term viability is ensured. • Criteria 2 The population abundance of the species is not adversely affected due to anthropogenic pressures, such that its long-term viability is ensured. • Criteria 3 The population demographic characteristics (e.g. body size or age class structure, sex ratio, fecundity, and survival rates) of the species are indicative of a healthy population which is not adversely affected due to anthropogenic pressures. • Criteria 5 The habitat for the species has the necessary extent and condition to support the different stages in the life history of the species

	• Management objective: "Minimize input and impact of hazardous substances from human activities". Segment: Sea-based activities Goal: "Environmentally sustainable sea-based activities" • Ecological objective: "No or minimal disturbance to biodiversity and the ecosystem".	• Feature – Species groups (Small toothed cetaceans). • Element of the feature assessed – Species lists (harbour porpoise). Descriptor 4 Ecosystems, including food webs. • Criteria 1 The diversity (species composition and their relative abundance) of the trophic guild is not adversely affected due to anthropogenic pressures. • Criteria 2 The balance of total abundance between the trophic guilds is not adversely affected due to anthropogenic pressures. • Criteria 4 Productivity of the trophic guild is not adversely affected due to anthropogenic pressures. • Feature – Species groups (Small toothed cetaceans). • Element of the feature assessed – Trophic guilds. Descriptor 8 Concentrations of contaminants are at levels not giving rise to pollution effects. • Criteria 2 The health of species and the condition of habitats (such as their species composition and relative abundance at locations of chronic pollution) are not adversely affected due to contaminants including cumulative and synergetic effects. • Criteria 4 The adverse effects of significant acute pollution events on the health of species and on the condition of habitats (such as their species composition and relative abundance) are minimized and, where possible, eliminated. • Feature – Species groups (Small toothed cetaceans). • Element of the feature assessed – Species lists (harbour porpoise). Descriptor 11 Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment. • Criteria 1 The spatial distribution, temporal extent, and levels of anthropogenic impulsive sound sources do not exceed levels that adversely affect populations of marine animals. • Feature – Impulsive sound in water.

		• Element of the feature assessed – Impulsive sound in water and relevant species lists. • Criteria 2 The spatial distribution, temporal extent and levels of anthropogenic continuous low-frequency sound do not exceed levels that adversely affect populations of marine animals. • Feature – Continuous low frequency sound. • Element of the feature assessed – Continuous low frequency sound and relevant species lists.
Other relevant legislation:	• In some Contracting Parties also: Habitats Directive (92/43/EEC), EU Delegated Regulation regarding measures to reduce incidental catches of the resident population of the Baltic Proper harbour porpoise (*Phocoena phocoena*) in the Baltic Sea (2022/303), EU Water Framework Directive (2000/60/EC), EU Maritime Spatial Planning Directive (2014/89/EU), and EU Common Fisheries Policy (1380/2013). • UN Sustainable Development Goal 14 (Conserve and sustainably use the oceans, seas and marine resources for sustainable development) is most clearly relevant, though SDG 12 (Ensure sustainable consumption and production patterns) and 13 (Take urgent action to combat climate change and its impacts) also have relevance.	

2.3 Relevance for other assessments

The status of biodiversity is assessed using several HELCOM indicators, generally integrated or evaluated by key trophic or species groups. Each indicator focuses on one important aspect of the complex issue. In addition to providing an indicator-based evaluation of the distribution of harbour porpoises, this indicator will also contribute to the overall thematic assessment of biodiversity as part of HOLAS 3, in association with the other biodiversity indicators.

3 Threshold values

Distribution of harbour porpoises

The metric to be used for a distributional indicator for this species is yet to be defined. Determining a distribution indicator for a highly mobile marine species is challenging, as the animals are difficult to observe in the field, have seasonal movement patterns, and their distribution may vary between years due to natural cycles and anthropogenic pressures. As a result, for this qualitative evaluation, good environmental status is achieved when the distributional range and frequency of harbour porpoise records in the Baltic Sea are the same as those recorded historically (in the early 1900s), taking confounding factors into account (see Confidence of the qualitative evaluation).

3.1 Setting the threshold value(s)

No quantitative threshold value exist at this stage, but the HOLAS 3 evaluation on the distribution of harbour porpoise in the Baltic Proper is an expert-based evaluation. Based on the spatiotemporal distribution of the records compiled it is evident that the harbour porpoise was commonly occurring in the entire Baltic Sea in the beginning of the 1900s. A contraction of the range, resulting in more irregular observations and very few encountered dead animals in the Gulf of Bothnia and the Gulf of Finland in more recent years, likely occurred around the mid-1900s (HELCOM 2022).

More advanced threshold value setting approaches are expected to be developed in the future to facilitate quantitative evaluations, though extensive further work to achieve this is needed.

4 Results and discussion

The results of the indicator evaluation that underlie the key message map and information are provided below.

4.1 Status evaluation

The two populations are addressed separately below.

Baltic Proper harbour porpoise population

As only one dedicated survey has been carried out to evaluate the distribution of the Baltic Proper harbour porpoise population (within the SAMBAH project, preceding the HOLAS 3 period), the results of this indicator describe the recent distribution pattern based on all available collated information, but cannot be used for a status evaluation per se (i.e. not against a quantitative threshold value). The SAMBAH project identified two main areas with high probability of harbour porpoise detection during the reproductive season. One of those areas, situated on and around the offshore banks Hoburg's Bank and the Northern and Southern Midsea Banks, is clearly separated from the known distribution range of the Belt Sea population during breeding season, suggesting this is an important breeding ground for the Baltic Proper population. This separation led to the identification of a south-western management border during May – October for the Baltic Proper harbour porpoise population stretching from Hanö Bay in south-eastern Sweden to a point on the Polish coast close to Słupsk (Carlén *et al.*, 2018).

Due to the lack of appropriate data, as well as the absence of threshold values for a robust quantitative abundance evaluation, an expert-based qualitative evaluation on the distribution of the Baltic Proper harbour porpoise was carried out. The qualitative evaluation, supported by extensive observation data, considered the population's currently known distribution in relation to the distribution and frequency of historical records of harbour porpoises within the May-October management range (Carlén *et al.*, 2018).

In 2011-2013, the abundance of the Baltic Proper harbour porpoise population was estimated to 71-1105 individuals (95% CI, point estimate 491; Amundin *et al.*, 2022). The number of historical records, the number of animals observed in the rare events of animals believed to have suffocated under sea ice (Ekman, 1938; Johansen, 1929; Lönnberg, 1940; Tägström, 1940), and data on catches from Polish fisheries statistics (Psuty, 2013), demonstrate that the abundance of harbour porpoises within the presently known management range of the Baltic Proper population (Carlén *et al.*, 2018) was much higher up to year 1940 than today, likely several orders of magnitudes greater. The report on 48 bycaught animals by Swedish fishermen primarily using driftnet for salmon in 1961 (Lindroth, 1962), indicate that the abundance was at least an order of magnitude greater at that time.

Based on the spatiotemporal distribution of the records compiled, it is evident that the harbour porpoise was commonly occurring in the entire Baltic Sea in the beginning of the 1900s. A contraction of the range, resulting in more irregular observations and very few

encountered dead animals in the Gulf of Bothnia and the Gulf of Finland, likely occurred around the mid-1900s. The species was regularly reported up until and including the 1930s, but due to confounding factors, it is not possible to determine more accurately when the contraction took place. Due to the contraction in range, the distribution of the Baltic Proper harbour porpoise is evaluated to not achieve GES (Figure 2).

Figure 2. The Baltic Proper harbour porpoise does not achieve good environmental status with regard to distribution. Only one dedicated survey has been carried out in 2011-2013, and no threshold has been set, but the currently known distribution is drastically reduced in comparison to opportunistic records before 1950.

Belt Sea harbour porpoise population

No evaluation on distribution is currently applied for the Belt Sea harbour porpoise population. Ongoing work aims to achieve this for future evaluations.

4.2 Trends

This qualitative evaluation, for use in HOLAS 3, is the first time an evaluation of the distribution of the harbour porpoise population has been conducted (Table 2). Accordingly, no trend in comparison to a previous evaluation (e.g., HOLAS II) is available. Trends in the data utilised to support the qualitative evaluation are presented in the discussion text below.

Table 2: Assessment unit specific evaluation result summary and comparison. Please note that the table only presents qualitative values, as no quantitative threshold values exist.

HELCOM Assessment unit name (and ID)	Threshold value achieved/failed	Distinct trend between current and previous evaluation.	Description of outcomes, if pertinent.
Belt Sea population (SEA-001 - SEA-005)	Not yet evaluated	Not applicable, first iteration of this indicator.	NA
Baltic Proper population (SEA-006 - SEA-017)	Failed (qualitative)	Not applicable, first iteration of this indicator.	Expert-based qualitative evaluation determines the Baltic Proper population to be far from achieving Good Environmental Status due to a severe reduction in distribution, based on collated historical records.

4.3 Discussion

Records of harbour porpoise observations

Of the 11,492 records (bycatch, hunted or killed, stranded, incidental sightings, effort sightings, and reports with unknown type) in the HELCOM/ASCOBANS harbour porpoise database (HELCOM, 2022), 508 were identified as being within the May-October management range of the Baltic Proper population (see Methodology below for area description and data inclusion protocol), and included in this qualitative evaluation. Additionally, a total 281 records within the management range that were not previously in the HELCOM/ASCOBANS harbour porpoise database were identified. An overview of years from which records with a geographical position located east of the May-October management range of the Baltic Proper harbour porpoise population (Carlén *et al.*, 2018) were compiled, divided per country, is shown in Figure 3. Despite that absence data are not known, the overview clearly shows a gap in Swedish records from 1907 until the late 1900s, and that Polish data with geographical information is missing before 1950. No data with a geographical position is available from the Danish waters within the area of concern.

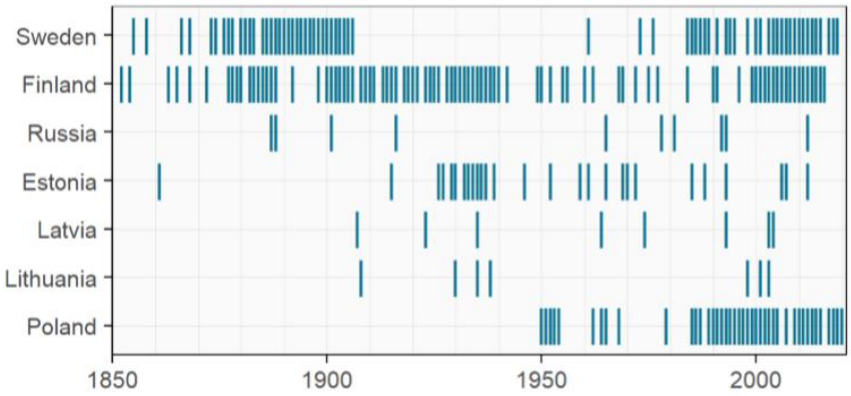

Figure 3. Overview of years from which records on harbour porpoises (bycatch, hunted or killed, stranded, incidental sightings, effort sightings, and reports with unknown type observations) with a geographical position located east of the May-October management border of the Baltic Proper harbour porpoise (Carlén *et al.*, 2018) were compiled, divided per country.

The analysis was carried out over four regions (Gulf of Bothnia, Gulf of Finland, Gulf of Riga, and the Baltic Proper) to ease interpretation, with the results for each region discussed individually below. A summary for the population level then follows.

Spatial distribution of harbour porpoise records over time

All records with a geographical position are shown in Figure 4. Each record may be of one or more individuals, and records with the same geographical position are only shown as one position. Positions of animals primarily encountered dead (bycatch, stranding, and incidental sightings of dead animals) are shown separately from those primarily encountered alive (incidental sightings not noted to be dead, and hunted or killed animals). With the exception of acoustic monitoring data not included here, no effort sighting with a geographical position was found within the area of concern. Figure 4 also shows the borders of the four regions for which data were compiled; the Gulf of Bothnia (Bothnian Bay, The Quark, and Bothnian Sea), the Gulf of Finland, the Gulf of Riga, and the Baltic Proper (Åland Sea, Northern Baltic Proper, Western Gotland Basin, Eastern Gotland Basin, Gdansk Basin, and the eastern part of Bornholm Basin. The southwestern border of the Baltic Proper region follows the May-October management border of the Baltic Proper harbour porpoise population (Carlén *et al.*, 2018), while the other regional borders follow delimitations of HELCOM Scale 2 HELCOM assessment units. The records are divided into three time periods: before 1950, 1950-1990, and after 1990 (see Methodology for justification).

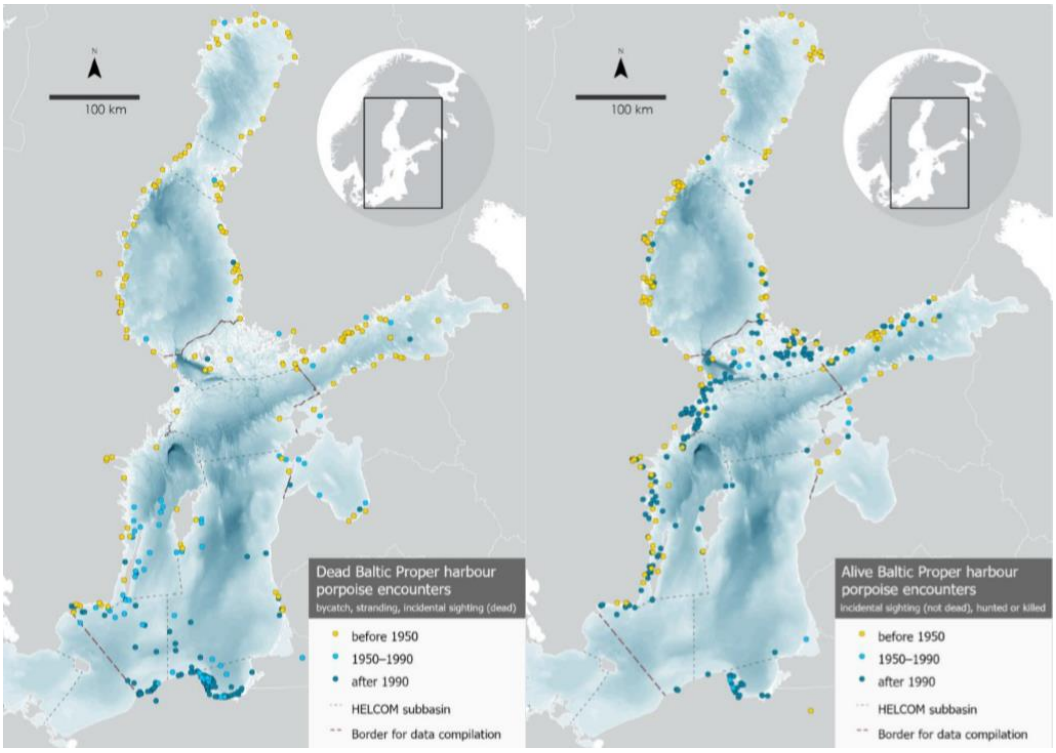

Figure 4. Maps showing the geographical positions of all records for which this was found or could be assigned, and the borders of the four regions for which data were compiled; the Gulf of Bothnia (Bothnian Bay, The Quark, and Bothnian Sea), the Gulf of Finland, the Gulf of Riga, and the Baltic Proper (Åland Sea, Northern Baltic Proper, Western Gotland Basin, Eastern Gotland Basin, Gdansk Basin, and the eastern part of Bornholm Basin). The southwestern border of the Baltic Proper region follows the May-October management border of the Baltic Proper harbour porpoise population (Carlén *et al.*, 2018), while the other regional borders follow delimitations of HELCOM Scale 2 HELCOM assessment units. Left: Animals primarily encountered dead (bycatch, stranding, and incidental sightings of dead animals). Right: Animals primarily encountered alive (incidental sightings of animals not noted to be dead, and hunted or killed animals). Bathymetry database © BSHC.

The spatial distribution of animals primarily encountered dead during the three time periods show that in the Gulf of Bothnia and the Gulf of Finland, the vast majority (90 and 85%) of records are from before 1950. In the Baltic Proper region, records from before 1950 dominate in the north, most records during 1950-1990 are in the central and southern parts of the region, while records after 1990 dominate in the south. In the Gulf of Riga, there is a small number of records from all three time periods and no spatial trend can be seen over time.

Also, for animals primarily encountered alive, records from before 1950 dominate in the Gulf of Bothnia (85%). In the Gulf of Finland, about half are before 1950 (45%). However, after 1990, there are more records of animals primarily encountered alive than dead. In the Baltic Proper region, there are very few records during 1950-1990, and records before and after this period are spatially mixed, with the exception of the southern coast where records from after 1990 dominate. Again, there is a small number of records from all time periods in the Gulf of Riga, and no spatial trend can be seen over time.

Temporal distribution of harbour porpoise numbers within summary regions

Histograms of the number of geographically positioned observed animals per year within the Gulf of Bothnia and the Gulf of Finland is shown in Figure 5. The bars show the total number of animals recorded, and they may be from one or more records. Animals primarily encountered dead are shown separately from those primarily encountered alive.

In the Gulf of Bothnia, the numbers of records of both dead and alive animals peaked in the late 1800s and early 1900s (Figure 5). From the late 1870s to 1906, the species was recorded almost every year. During the 1910s-1930s, animals primarily encountered dead were recorded in eight years, and animals primarily encountered alive in seven years, at the most seven dead and nine alive in a year. The highest recorded number of animals primarily encountered dead in any year was eight (year 1902), and alive 28 (year 1891). During 1940-1999, there were a total of eight records of animals primarily encountered dead, and one alive. During 2000-2019, there is not a single dead animal, but records of 1-11 primarily alive animals per year, during 15 of these 20 years. The temporal pattern reflects that the compilation of historical records in Swedish waters only reaches to year 1906 (note that the last years are not complete), and that sightings schemes were established in both Finland and Sweden in the early 2000s (see methodology and Table 5). However, despite these shortcomings of the opportunistically collected data, it is obvious that the frequency of sightings and number of observed animals is significantly lower during recent decades than in the late 1800s and early 1900s. The pattern is most striking for animals primarily encountered dead, which also is a more reliable category than animals observed alive, with very few records after 1940.

In the Gulf of Finland, the general temporal pattern is similar to that in the Gulf of Bothnia, although the number of animals is smaller and there are fewer records before 1906 (Figure 5). The majority of the primarily dead animals were recorded up to the 1930s, and the last dead animal was recorded in 1992. The pattern for animals primarily encountered alive is not as clear, and the first year with a higher number of primarily alive animals in modern times was 1990. The highest number of primarily dead animals in one year was 22 (1916), and the highest number of primarily alive animals in one year was 16 (1913). Similar to the Gulf of Bothnia, the establishment of strandings programmes and reporting systems (Estonia in the 1990s, Finland in 2001; see methodology and Table 5) is likely to have influenced the number of animals primarily encountered alive since then (more than the number primarily encountered dead as only a small proportion of animals that die at sea are washed ashore, and the species identification is more reliable of dead animals), and the temporal pattern of animals primarily encountered dead shows a significant decrease since 1940.

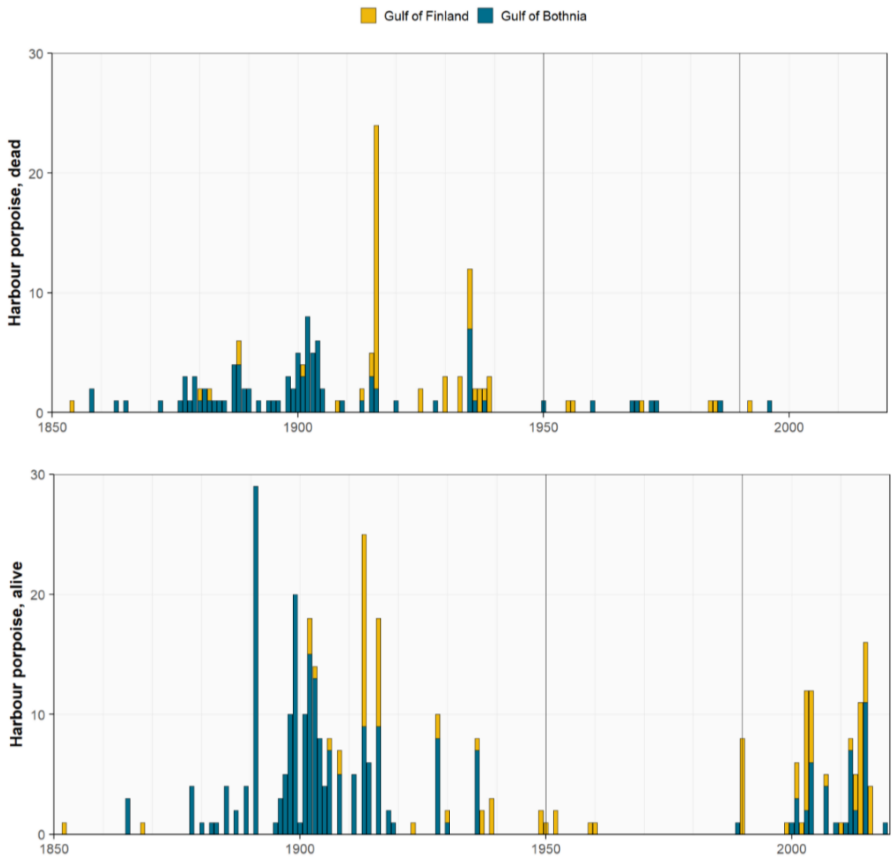

Figure 5. Number of geographically positioned observed animals per year within the Gulf of Bothnia (Bothnian Bay, The Quark, and Bothnian Sea) and the Gulf of Finland. Top panel: Animals primarily encountered dead (bycatch, stranding, and incidental sightings of dead animals); bottom panel: animals primarily encountered alive (incidental sightings not noted to be dead, and hunted or killed animals). The vertical lines show the time periods used in Figure 3.

In the Baltic Proper (Åland Sea, Northern Baltic Proper, Western Gotland Basin, Eastern Gotland Basin, Gdansk Basin, and the eastern part of Bornholm Basin) and in the Gulf of Riga, there are overall fewer historical records than in the Gulf of Bothnia and Gulf of Finland. In the Baltic Proper during 1880-1979, there are 37 years with records of primarily encountered dead animals and 27 years with records of animals primarily encountered alive (Figure 6). The majority of these records are from 1880-1906, i.e. coinciding with the time period when the number of records peaked in the Gulf of Finland. From 1910 and onwards, there are sporadic records of both animals primarily encountered dead and alive. Most commonly single animals were recorded, but in 1961 the number of animals primarily encountered dead is outstanding: 48. This record is from Lindroth (1962), who asked Swedish fishermen to collect bycaught harbour porpoises, primarily in drift nets for salmon (*Salmo salar*), for analysis of stomach contents. In the 1980s, the number of recorded animals primarily encountered dead increased; during 1984-2019, a total of 193 animals primarily encountered dead were recorded, resulting in an average of 5.3 animals per year. The increase in records of animals primarily encountered alive comes a decade later, in the 1990s, and even more from year 2000 and onwards. The highest numbers of animals primarily encountered alive in any year before 1980 were 23 and 22 (1885 and 1886), and the highest number after 1980 was 47 (2009) (Figure 6).

The lower rate of historical records in the Baltic Proper compared to the Gulf of Bothnia, with the exception of 1961, is believed to reflect that the species was relatively common and therefore observations were not recorded. Still the impact by the digitally searchable database in Sweden with records available until 1906 can be seen in the records, with more frequent observations and higher numbers per year until then. The outstanding number of animals primarily encountered dead recorded in 1961 confirms that the species indeed was frequently encountered at that time. The increase in animals primarily encountered dead in the 1980s is likely a result of increased efforts of carcass collections for studies of environmental pollutants (e.g. Berggren *et al.*, 1999), and increased awareness of the species' decline. The increase in records of animals primarily encountered alive, beginning in the 1990s and reaching the highest annual averages from year 2000, coincides with the time periods for when strandings programmes and reporting systems were established and became more common (see methodology and Table 5).

In the Gulf of Riga, the number of records is small, and no temporal trend can be seen (Figure 6). The last record of an animal likely encountered dead was in 2003, and of an animal likely encountered alive in 2006.

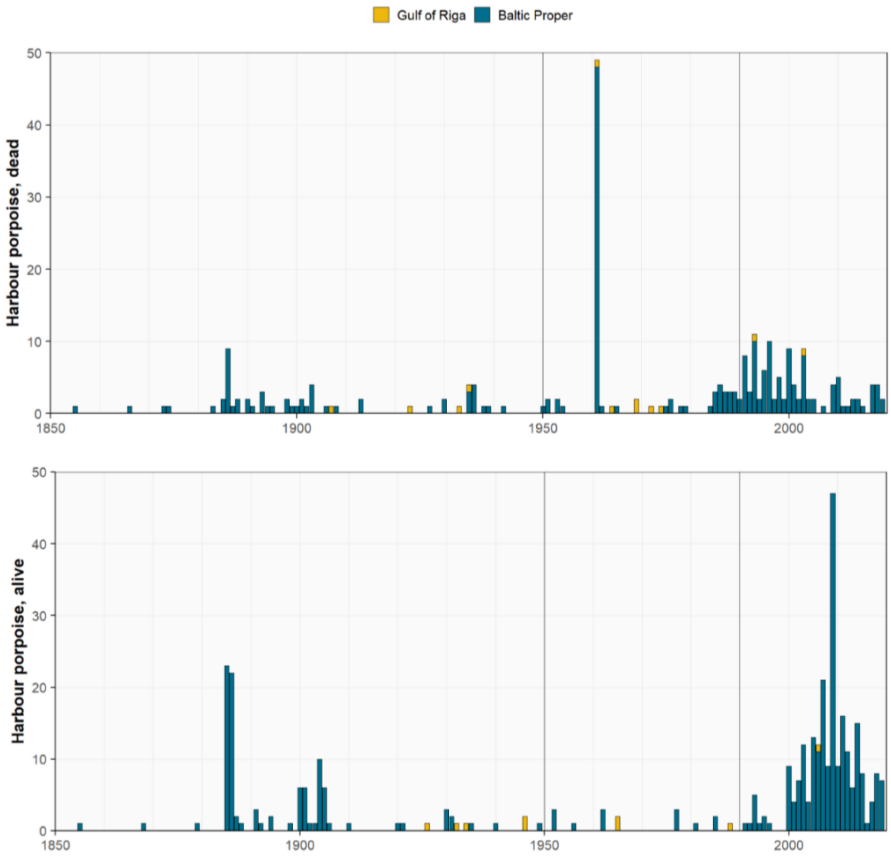

Figure 6. Number of geographically positioned observed animals per year within the Baltic Proper region (Åland Sea; Northern Baltic Proper; Western Gotland Basin; Eastern Gotland Basin; Gdansk Basin; eastern part of Bornholm Basin) and the Gulf of Riga. Top panel: Animals primarily encountered dead (bycatch, stranding, and incidental sightings of dead animals); bottom panel: animals primarily encountered alive (incidental sightings not noted to be dead, and hunted or killed animals). The vertical lines show the time periods used in Figure 3.

5 Confidence

Baltic Proper harbour porpoise population

Despite the lack of quantified thresholds, the confidence of the evaluations is high. All accessible historical records have been reviewed carefully, and only those that have been identified as probable harbour porpoise observations have been included. The description of the locations, on which the geographical positions of the observations were often based on, were overall accurate. Additionally, the time given for the observations was in most cases on the exact day or week. For only 14 of the 281 new records, the information on time was less accurate than year: 3 with a latest year of encounter (e.g. date of donation to a museum, but not the original observation date), 6 with only the decade known, and 5 specified as "some years ago" or with a margin of ±1 year. The level of detail of this information does not reduce the confidence of the qualitative evaluation, as it is based on a broad spatial scale (four large regions covering HELCOM sub-basins) and a historical time perspective (decades).

Possible confounding factors of the evaluation are that the observation effort and the interest in reporting opportunistic records is unknown. The effort is likely to have varied over time due to factors such as: 1) the number and distribution of people at sea, 2) fishing effort and practices, and 3) the methods available to report an observation. For example, there are in general few records during World War I and II. In contrast, as the human population has increased and motorised recreational vessels become readily available, more people are spending time at sea. Also, the fishing effort and the number of active fishers have varied considerably with technical developments, fishing regulations, and varying profitability. The establishment of online reporting systems during the last decades (see methodology and Table 5) has facilitated reporting and data storage.

The willingness of reporting an observation is likely to have varied due to factors such as 1) how "newsworthy" the observation is, 2) awareness of the conservation status of the species, and 3) fear of negative consequences by the reports. For example, before 1950, there were more records in the Gulf of Bothnia than in the Baltic Proper, because an observation in the Gulf of Bothnia was a rarer event than in the Baltic Proper. Also, when the harbour porpoise population was not assessed as endangered, information on direct and incidental catches were shared as exciting stories by the newspapers and caught or bycaught animals were sometimes advertised and put on public display, while in recent times direct reports by fishers are very rare. Contrary, the general public's interest in reporting opportunistic observations, and the scientific efforts in collecting carcasses, have increased when the species has become rarer. For Swedish records, yet another confounding factor is that most of the newspapers only are digitally searchable until around 1906.

Belt Sea harbour porpoise population

Not applicable, since a qualitative evaluation has not been done for the Belt Sea population distribution.

6 Drivers, Activities, and Pressures

Human pressures linked to the indicator

There are a number of human pressures listed in Annex III of the MSFD that are linked to the qualitative evaluation of the Baltic Proper harbour porpoise population (see also Table 4). These include:

Biological features:

A description of the population dynamics, natural and actual range and status of species of marine mammals and reptiles occurring in the marine region or sub-region. For harbour porpoises, this relates to porpoise distribution and abundance.

Information on the structure of fish populations, including the abundance, distribution and age/size structure of the populations. For harbour porpoises, this relates to prey availability and quality.

Biological disturbance: selective extraction of species, including incidental non-target catches (e.g. by commercial and recreational fishing). For harbour porpoises, this relates to two distinct issues:

1) bycatch of the porpoises themselves resulting in direct mortality, and

2) reduction in the quality and quantity of prey resources due to competition with fisheries. - Other physical disturbance: Underwater noise (e.g. from shipping, underwater acoustic equipment), and marine litter. For harbour porpoises, this includes both impulsive noise (short and powerful noise from sources such as seismic surveys, pile driving, and underwater explosions) as well as continuous noise (from sources such as shipping and wind farm operation).

Marine litter (plastic) is also an issue for marine mammals that often results in mortality or reduced health. Ghost nets (lost or discarded fishing gear) can also result in direct mortality when animals become entangled.

Contamination by hazardous substances- Introduction of synthetic compounds and introduction of non-synthetic substances and compounds. For harbour porpoises, high levels of contaminants have been shown to result in decreased fertility and increased mortality, particularly in calves that receive high levels of contaminants from their mother.

Physical and chemical features: annual and seasonal temperature regime and ice cover, current velocity, upwelling, wave exposure, mixing characteristics, turbidity, residence time. For harbour porpoises this can relate to the influence of climate change resulting in warmer water and more dead zones in the Baltic Sea.

Table 4. Brief summary of relevant pressures and activities with relevance to the indicator.

	General	**MSFD Annex III, Table 2a**
Strong link	The main pressures affecting the distribution of Baltic harbour populations include, by-catches, physical disturbance via underwater noise, and contamination by hazardous substances.	Biological Extraction of, or mortality/injury to, wild species (by commercial and recreational fishing and other activities). Substances, litter and energy Input of other substances (e.g. synthetic substances, non-synthetic substances, radionuclides). Pressures by substances, litter and energy: input of anthropogenic sound (impulsive, continuous).
Weak link	For harbour porpoises this can relate to the influence of climate change resulting in warmer water and more dead zones in the Baltic Sea. Fishery and food availability	Pressures by substances, litter and energy: - input of other forms of energy (including electromagnetic fields, light and heat).

7 Climate change and other factors

The expected change in temperature and stratification, prey distribution, quality and quantity will affect all marine mammals, including Harbour Porpoises, but aggregated effects on their abundance and distribution are unpredictable (HELCOM/Baltic Earth 2021). It is furthermore predicted more maritime traffic in the Baltic Sea, leading to more underwater noise, which are relating to injuries and displacement from habitats. Implications of this also extents to the disturbance of behaviour of harbour porpoises due to the underwater noise affecting the functionality of echolocation. Changes in ecosystem structure and function could compound issues for already vulnerable populations.

8 Conclusions

Based on the spatiotemporal distribution of the records compiled, it is evident that the harbour porpoise was commonly occurring in the entire Baltic Sea in the beginning of the 1900s. A contraction of the range, resulting in more irregular observations and very few encountered dead animals in the Gulf of Bothnia and the Gulf of Finland in present days, likely occurred around the mid-1900s. The species was regularly reported up until and including the 1930s, but due to confounding factors (see Confidence of the qualitative evaluation below), it is not possible to determine more accurately when the contraction took place. Due to the contraction in range, the distribution of the Baltic Proper harbour porpoise is evaluated to not achieve GES.

8.1 Future work or improvements needed

While the current evaluation is a significant step forward to provides an initial evaluation there is need for significant further work to improve future evaluations. There is currently a lack of harmonisation in the passive acoustic monitoring used to monitor harbour porpoises and this issue needs to be addressed to advance future evaluations. There is variation in the filtering and processing methods used by different countries, and some variation in the device used. This prevents comparability between countries. There is a need for future harmonisation to facilitate population level evaluations of indicators, particularly for the critically endangered Baltic Proper population. In addition, further work is needed to establish a full and working understanding of relevant conservation objectives to support the development and agreement on quantifiable threshold values against which future evaluations can be applied. This process will also require the application of relevant methodologies to achieve the establishment of such threshold values and require suitable monitoring to be implemented to achieve the needed data sets for the evaluations. These aspects all require designated resourcing for progress to be made.

9 Methodology

9.1 Scale of assessment

This qualitative evaluation evaluates the abundance and distribution of the Baltic Proper harbour porpoise population using HELCOM assessment unit scale 2 (division of the Baltic Sea into 17 sub-basins) as its base, with these assessment units aggregated to relevant management areas. The assessment units are defined in the HELCOM Monitoring and Assessment Strategy Attachment 4.

9.2 Methodology applied

The review was completed by the Swedish Museum of Natural History as a part of the HELCOM BLUES project, with assistance on data sources from many experts around the Baltic Sea. Harbour porpoise records from the late 17th century until 2019 were reviewed in the waters of all countries around the Baltic Sea. These records could include bycatch, animals that were killed or hunted, incidental sightings, effort sightings, strandings, and reports of unknown type.

In addition to data available through the HELCOM/ASCOBANS harbour porpoise database, data were also compiled from published sources such as newspaper articles, scientific papers, reports, and museum records. Contacts were made with countries from which data access has been limited or unknown.

More specifically, data were compiled from the following sources: Denmark: Historical data on catches of dead animals in the Bornholm area during winter have been compiled from a published report (Johansen, 1929). Estonia: Data have been compiled from a review of harbour porpoise observations in Estonian waters. The review consisted of searches through newspaper articles, museum records and interviews with coastal people, and all records were geographically positioned (Jüssi and Liivak, 2005). Finland: All data, including historical records, were available in the HELCOM/ASCOBANS harbour porpoise database. Germany: TiHo and DMM confirmed they are not aware of any additional records that have not been submitted to the HELCOM/ASCOBANS database. We were directed to www.schweinswale.com that collected records between 1987 to 2014, and as far as we understand these data were already included in the HELCOM/ASCOBANS harbour porpoise database. Latvia: We were informed by the Nature Conservation Agency of the Latvian Government that all information from Latvia is already in the HELCOM/ASCOBANS database, and that there may be additional records in online newspapers. This site only includes newspaper records back until 1990. Lithuania: Data have been compiled from a review of harbour porpoise observations made for a protection plan and a summary of an action plan for harbour porpoises (Lithuanian Ministry of Environment, 2012). We identified geographical positions based on the written descriptions of the record. Poland: Data on historical observations have been compiled from published articles on observations of harbour porpoises, including records from bounty schemes (Psuty, 2013; Skóra *et al.*, 1988). Russia: Data have been compiled from a report for a project reviewing the harbour porpoise presence in Russian territorial waters of the Baltic Sea (Guschin and Fedorov, 2011). This review consisted of questionnaires to sea users, searches through

museum records, and field observations (including beach searches). We identified geographical positions based on the written descriptions of the records. Sweden: We compiled data from historical newspaper articles using a national database with a search for the word 'tumlare' (porpoise in Swedish) and 'pyöriäinen' (porpoise in Finnish). These records consisted of newspaper accounts up until 1906, with new records added over time. The digitisation process for the national database is still ongoing, and all records up to and including 1906 is planned to be available in January 2023. From 1907 and onwards, only the major newspapers will be digitised and searchable. This made a full review of all accounts impossible, but all records that were publicly available online at the time for the Swedish coastal counties ranging from the border to Finland in the north to Blekinge county in the southeast were compiled, i.e. the coastal stretch approximately within the May-October management range of the Baltic Proper harbour porpoise population.

We quality controlled the records for species and determined a geographical position for the record based on the written description. Further, we compiled data on historical observations on the occurrence of harbour porpoises from published reports and articles (Tägström, 1940; Ekman, 1938; Lindroth, 1962; Lönnberg, 1940). All data were compiled in a standardised format to facilitate upload to the HELCOM/ASCOBANS harbour porpoise database. In addition to compiling data on harbour porpoise records, information was also collated on the existence and start date of any strandings programme and reporting system for opportunistic harbour porpoise observations in the countries around the Baltic Sea.

The data on harbour porpoise records were divided into three time periods: before 1950, 1950-1990, and after 1990. These time periods were chosen based on the approximate time for when modern fishing methods were introduced (around 1950), and when strandings programmes and reporting systems for harbour porpoise observations were established (around 1990). Geographically, data were divided into four regions: the Gulf of Bothnia (Bothnian Bay, The Quark, and Bothnian Sea), the Gulf of Finland, the Gulf of Riga, and the Baltic Proper (Åland Sea, Northern Baltic Proper, Western Gotland Basin, Eastern Gotland Basin, Gdansk Basin, and the eastern part of Bornholm Basin). Maps and histograms for the four regions were produced to visualise changes in abundance and distribution over time. Historical data were compared to current information, including the most recent information on distribution and abundance from the SAMBAH project (Amundin *et al.*, 2022; Carlén *et al.*, 2018), and any published information from national monitoring programmes.

As there is no clear spatial separation between the Belt Sea and Baltic Proper harbour porpoise populations during November-April (Carlén *et al.*, 2018), the review focused on data east of the May-October management range for the Baltic Proper harbour porpoise population (Carlén *et al.*, 2018). The results were applied on all HELCOM sub-basins ranging from Arkona Basin and eastwards, i.e. the twelve sub-basins overlapping with the tentative management range of the population during November-April, also including the sub-basins overlapping with the May-October management range.

Methodology applied to the Baltic Proper harbour porpoise population

In the SAMBAH project, passive acoustic monitoring and species distribution models were used to describe the spatial and seasonal distribution of harbour porpoises in the Baltic Proper (Carlén *et al.*, 2018). Porpoise click detectors were deployed over a systematic grid of 304 stations in eight countries and data collected from April 2011 through June 2013 were analysed. Generalized additive models (GAMs) were used to describe the monthly probability of detecting porpoise clicks as a function of spatially-referenced covariates and time.

The qualitative evaluation of the distribution of the Baltic Proper harbour porpoise was completed by the Swedish Museum of Natural History as a part of the HELCOM BLUES project, with assistance on data sources from many experts around the Baltic Sea. Harbour porpoise records from the late 17th century until 2019 were reviewed in the waters of all countries around the Baltic Sea. These records could include bycatch, animals that were killed or hunted, incidental sightings, effort sightings, strandings, and reports of unknown type.

Data were compiled from published sources such as newspaper articles, scientific papers, reports, museum records, as well as the HELCOM/ASCOBANS harbour porpoise database. Additionally, contacts were made with countries from which data access has been limited or unknown.

The data on harbour porpoise records were divided into three time periods: before 1950, 1950-1990, and after 1990. These time periods were chosen based on the approximate time for when modern fishing methods were introduced (around 1950), and when strandings programmes and reporting systems for harbour porpoise observations were established (around 1990). Geographically, data were divided into four regions: the Gulf of Bothnia (Bothnian Bay, The Quark, and Bothnian Sea), the Gulf of Finland, the Gulf of Riga, and the Baltic Proper (Åland Sea, Northern Baltic Proper, Western Gotland Basin, Eastern Gotland Basin, Gdansk Basin, and the eastern part of Bornholm Basin).

As there is no clear spatial separation between the Belt Sea and Baltic Proper harbour porpoise populations during November-April (Carlén *et al.*, 2018), the review focused on data east of the May-October management range for the Baltic Proper harbour porpoise population (Carlén *et al.*, 2018). The results were applied on all HELCOM sub-basins ranging from Arkona Basin and eastwards, i.e. the twelve sub-basins overlapping with the tentative management range of the population during November-April, also including the sub-basins overlapping with the May-October management range.

9.3 Monitoring and reporting requirements

Information on strandings programme and reporting system for harbour porpoise observations in the countries around the Baltic Sea is shown in Table 5.

Table 5. Overview of strandings programmes and reporting systems for harbour porpoise observations in the countries around the Baltic Sea.

Country	Site/location	Strandings /dead animals	Incidental live sightings	Date started
Denmark	Fisheries and Maritime Museum	Yes	No	1991
	University of Southern Denmark/Fjord&Belt: Marine tracker app	No	Yes	2019
Estonia	Nature Observations Database (https://lva.keskkonnainfo.ee/default.aspx?state=1;877954539;est;lvadb;;&lang=eng)	Yes	Yes	1990s
	eBiodiversity, Tartu University Natural History Museum (https://elurikkus.ee/)	Yes	Yes	2000s
Finland	Ministry of the Environment	Yes	Yes	2001
Germany	German Oceanographic Museum (https://www.deutsches-meeresmuseum.de/en/science-research/news/report-sightings and https://www.deutsches-meeresmuseum.de/en/science-research/news/report-stranded-marine-mammals) for Mecklenburg-Western Pomerania	Yes	Yes	1990
	University of Veterinary Medicine Hannover, Foundation (TiHo), Institute for Terrestrial and Aquatic Wildlife Research (ITAW) (https://www.tiho-hannover.de/itaw/uebers-itaw/online-meldebogen for Schleswig-Holstein)	Yes	Yes	1990
	http://www.schweinswale.com/	Yes	Yes	1987
Poland	Hel Marine Station	Yes	Yes	1986
	Hel Marine Station & WWF	Yes	Yes	2010
Latvia	N.a.	No	No	N.a.
Lithuania	N.a.	No	No	N.a.
Russia	Unknown	Unknown	Unknown	Unknown
Sweden	Swedish Museum of Natural History (marinadaggdjur.nrm.se)	Yes	Yes	2003
	Valar.se	Yes	Yes	2007
	Species databank (https://www.artdatabanken.se/hjalpa-till/rapportera-fynd-av-arter/)	Yes	Yes	2002

Monitoring methodology

The current monitoring carried out in HELCOM is not directly relevant to the qualitative evaluation applied for HOLAS 3. The development of optimal and harmonised monitoring is underway and will be vital or future development of this indicator.

Monitoring of the distribution of harbour porpoises in the Contracting Parties of HELCOM is described on a general level in the HELCOM Monitoring Manual in the Harbour porpoise abundance sub-programme.

10 Data

Access and use

All data compiled for the qualitative evaluation will be made available for the HELCOM/ASCOBANS harbour porpoise database and HELCOM Biodiversity Database.

The data and resulting data products (e.g. tables, figures and maps) available on the indicator web page can be used freely given that it is used appropriately and the source is cited.

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Project: HELCOM BLUES

12 Archive

This version of the HELCOM core indicator report was published in April 2023:

The current version of this indicator (including as a PDF) can be found on the HELCOM indicator web page.

This version of the HELCOM pre-core indicator report was published in 2023 and is the first iteration of this indicator, thus no prior version is available.

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14 Other relevant resources

No additional information is provided at this stage.