BALTIC OFFSHORE BETA WINDFARM

Baseline and assessment of harbour porpoises

Scientific Report from DCE – Danish Centre for Environment and Energy No. 543 2023

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Signe Sveegaard
Jakob Tougaard

Aarhus University

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Data sheet

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Author: Signe Sveegaard & Jakob Tougaard
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Abstract: Aarhus University (AU) has been commissioned by Njordr Offshore Wind AB and Rambøll Sweden to conduct a baseline investigation as well as an impact assessment on harbour porpoises of the construction of the Baltic Offshore Beta wind farm in the Baltic Proper (Swedish Territorial Waters). The pre-investigation phase and the operational phase are not included. AU suggested deployment of passive acoustic monitoring stations, but this was not accepted by the Swedish Armed Forces (Marinstaben). Thus, the assessment is a desk-top study based on the available knowledge.

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Preface

In March 2022, Aarhus University (AU) was contacted by Njordr Offshore Wind AB and Rambøll Sweden for an offer to conduct a baseline study and impact assessment of harbour porpoises within and around the pre-investigation area for the Baltic Offshore Beta wind farm located in the Baltic Proper in Swedish Territorial Waters.

Aarhus University recommended passive acoustic monitoring (PAM) within the project site for the Baltic Offshore Beta Wind Farm and proposed the deployment of five PAM stations in the area. However, in preparation of the project, Aarhus University sent an application to Sjöfartsverket (ufs@sjofartsverket.se), Kustbevakningen (registrator@kustbevakningen.se) and the Swedish Military (Försvarsmakten, Marinstaben, exp-hkv@mil.se) on the 21st April 2022 to deploy the five acoustic stations in Swedish waters. On May 4th, 2022, Aarhus University received information on a decision from Marinstaben that they did not allow for the deployment of acoustic harbour porpoise listening stations (CPODs) in Swedish waters to examine the presence and density of harbour porpoises within the proposed area for Baltic Offshore Beta Wind Farm (Appendix 1).

The Baltic harbour porpoise population inhabiting the pre-investigation area is critically endangered and there is no other reliable method than PAM to monitor harbour porpoises in low density areas (SAMBAH 2016). Without acoustic monitoring there is not sufficient available data to assess the impact the construction of a windfarm may have on the population. Furthermore, the Baltic Offshore Beta Wind Farm is located right next to the only identified breeding area for this population (the Hoburgs and Midsjö Banks), and the pre-investigation area may very well be an equally important site. After the rejection was received, Njordr Offshore Wind AB and AU talked to Anders Åkermark, Annika Ericsson and Henric Sörefjord from Marinstaben, Julia Carlström and Kylie Owen from Swedish Museum of Natural History (SMNH) as well as Erland Lettevall and Malin Hemmingsson from Miljöövervakningsenheten in Havs- och vattenmyndigheten all in order to try to find a solution to this problem. Based on these discussions, a second application was sent to Marinstaben on May 30th, 2022. This second proposal was rejected on June 8th, 2022. Consequently, it was not possible to conduct any monitoring with passive acoustic equipment during the assessment of porpoises at Baltic OWF Beta. And since this is the only possible method in the Baltic Proper, due to the low density of porpoises, no monitoring has or will be conducted in the Baltic Offshore Beta Wind Farm, unless the Swedish Navy changes their disposition.

In a follow-up correspondence with Malin Hemmingsson from Havs- och vattenmyndigheten, the problem of not being able to collect new data was addressed (See Appendix 3 for the original emails). Malin Hemmingsson wrote that in this situation, the assessment must be based on existing knowledge and expert knowledge. And further, that the assessment should take into account and include 1) the critically endangered conservation status of the Baltic Proper porpoise population, 2) uncertainty in the distribution of porpoises, 3) the precautionary principle and 4) mitigation measures.

Thus, AU have conducted this assessment based only of the SAMBAH (Static Acoustic Monitoring of the Baltic Sea Harbour Porpoise, Amundin et al. 2021) data (collected in 2011-2013) and the ongoing Swedish national monitoring programme. None of the SAMBAH stations were located within the proposed Baltic Offshore Beta Wind Farm site and thus the conclusion of the assessment will be based on the precautionary principle. AU proposed to include CPOD data from within a range of 40 km of the Baltic Offshore Beta Wind Farm site.

The report thus includes the following:

- A baseline description of the area based on a literature study and a review of data from CPOD stations within 40 km of the OWF site. This will include data from SAMBAH and the Swedish and Danish national monitoring programs.

- The report will also include an impact assessment of potential impacts on the porpoises from the construction of the windfarm based on project assumptions and information on construction impact provided from Njordr Offshore Wind / Ramboll Sweden. Due to the limited data available, conclusions will be based on the precautionary principle.

Summary

Aarhus University (AU) has been commissioned by Njordr Offshore Wind AB and Rambøll Sweden to conduct a baseline investigation as well as an impact assessment on harbour porpoises of the construction of the Baltic Offshore Beta wind farm in the Baltic Proper (Swedish Territorial Waters). The pre-investigation phase and the operational phase are not included. AU suggested deployment of passive acoustic monitoring stations, but this was not accepted by the Swedish Armed Forces (Marinstaben). Thus, the assessment is a desktop study based on the available knowledge.

Baseline

There have never been any monitoring conducted within the proposed wind farm area. Alternatively, data within a radial distance of 40 km from the wind farm area was included in the review of baseline conditions. This included data from the SAMBAH project (2011-2013) and newer national monitoring data from Denmark (2018-2019) and Sweden (2017-2020). Here, it was found that the stations north-east of the Baltic Offshore Beta area had relatively high level of porpoise detections both summer and winter, while the stations on the south-eastern stations had low levels of detections. Without conducting new acoustic monitoring, we do not know whether the density within Baltic Offshore Beta wind farm is high or low or somewhere in between. However, as a precautionary approach, since the Baltic Proper harbour porpoise population is critically endangered, the uncertainty should benefit the harbour porpoise and the assessment will have to assume a worst-case scenario in which all of the Baltic Offshore Beta area as well as the 20 km buffer zone should be considered important for the Baltic Proper harbour porpoise population throughout the year.

Assessment

To assess the impact significance, the sensitivity of porpoises is combined with the impact magnitude of construction activities. The magnitudes were estimated under assumption of use of Best Available Technology and Best Environmental Practice (BAT/BEP), in the form of combined use of either a double big bubble curtain (DBBC) or a DBBC together with a hydrosound damper system (HSD). The assessments are presented in Table 1. In summary, the impact of pile driving on hearing loss (PTS and TTS) are assessed to be negligible with use of both DBBC and DBBC+HSD. The impact of pile driving on behaviour with regard to displacement/disturbances are assessed to be minor to moderate in all seasons for both DBBC and DBBC+HSD, with the lowest potential impact in autumn with use of DBBC+HSD and highest in winter when using only DBBC. The impact significance of masking due to pile driving is assessed to be negligible. The impact of shipping on behaviour is assessed to be low and by masking to be negligible. The impact of sediment spill on visual impairment and behaviour is assessed to be low.

Table 1. Summary tables of activity, impact, sensitivity, and assessment in the Swedish waters relevant for each activity for harbour porpoise. All impacts are assessed with noise mitigation using either double bubble curtain (DBBC) or DBBC + HSD (Hydro Sound Damper). *Number of days where porpoise behaviour may be impacted at each turbine.

Activity	Mitigation	Impact	Sensitivity	Reversibility	Spatial extent	Temporal extent	Impact magnitude	Impact significance
Pile driving	DBBC	PTS	High	Irreversible	0	not relevant	Negligible	Negligible
		TTS	Low	Reversible	< 50 m	not relevant	Negligible	Negligible
		Behaviour – masking	Low	Reversible	< 12 km	9-30 days	Negligible	Negligible
	DBBC	Behaviour - displacement/ disturbance, winter	Medium	Reversible	< 12 km	15-80 days*	Medium-Minor	Moderate-minor
		Behaviour - displacement/ disturbance, spring	Medium	Reversible	< 10 km	13-65 days*	Medium-Minor	Moderate-minor
		Behaviour - displacement/ disturbance, summer	Medium	Reversible	< 6 km	9-30 days*	Medium-Minor	Moderate-minor
		Behaviour - displacement/ disturbance, autumn	Medium	Reversible	< 8 km	11-50 days*	Medium-Minor	Moderate-minor
	DBBC + HSD	Behaviour - displacement/ disturbance, winter	Medium	Reversible	< 6 km	9-30 days*	Medium-Minor	Moderate-minor
		Behaviour - displacement/ disturbance, spring	Medium	Reversible	< 5 km	7-22 days*	Medium-Minor	Moderate-minor
		Behaviour - displacement/ disturbance, summer	Medium	Reversible	< 3 km	3-8 days*	Medium-Minor	Moderate-minor
		Behaviour - displacement/ disturbance, autumn	Medium	Reversible	< 4 km	5-14 days*	Medium-Minor	Moderate-minor
Shipping	DBBC	Behaviour - displacement/ disturbance	Medium	Reversible	< 400 m	Hours	Minor	Low
		Behaviour – masking	Low	Reversible	< 400 m	Hours	Negligible	Negligible
Sediment spill	DBBC	Visual impairment	Low	Reversible	local	few days after ended impact	Minor	Low
		Behaviour - displacement/ disturbance	Low	Reversible	local	few days after ended impact	Minor	Low

Impact on Natura 2000 sites

The proposed area for the Baltic offshore Beta wind farm is located approximately 8 km from the Natura 2000 site "Hoburgs bank och Midsjöbankarna" designated for harbour porpoises in 2016. This is the only Natura 2000 site potentially impacted by the construction of the Baltic offshore Beta wind farm. The impact will be in the form of behavioural disturbances and possibly masking and not PTS and TTS.

When using the mitigation method of double bubble curtain together with a hydrosound damper system, the maximum distance of behavioural impact (in winter months) is expected to be 6 km. The Natura 2000 site is 8 km away and thus the impact significance of pile driving on behaviour of porpoises from the Baltic Offshore Beta wind farm is assessed to be **negligible** in all seasons.

When using DBBC, it will be the installation of the most eastern turbines that may have an impact inside the Natura 2000 site and only if the installation is conducted during winter or spring, where sound propagations characteristics will increase the impact range. The behavioural impact on porpoises will affect up to 0.44 % of the Natura 2000 area over a maximum of 12 days over a period of two years during winter. And a maximum on 0.13 % of the Natura 2000 site for a maximum of 7 days in spring. The impact significance of pile driving on behaviour of porpoises from the Baltic Offshore Beta wind farm is thus assessed to be **negligible** in the summer and autumn. In the winter and spring, the impact significance of pile on behaviour of porpoises is assessed to be **moderate** due to the restrictions on impacts on behaviour described in the management plan describing the restrictions and regulations of the Natura 2000 site.

1 Baseline of harbour porpoises

This Chapter introduces the harbour porpoise and gives an overview to the current knowledge on their biology, distribution and abundance in the Baltic Sea. It will also look deeper into the existing relevant data - particularly passive acoustic monitoring data - and try to extrapolate information for the relevant Baltic Offshore Beta area.

1.1 Population structure

Studies on morphometric skull differences (Galatius et al. 2012) and genetics (Wiemann et al. 2010; Lah et al. 2016) have examined the population structure in the HELCOM (The Helsinki Commission; protection of the marine environment of the Baltic Sea) area between the Belt Sea and Baltic Sea porpoise populations. Both studies found that two populations (or subpopulations) might exist in this area, i.e. 1) in the Baltic Proper, 2) in the western Baltic, the Belt Sea and the southern Kattegat (called the Belt Sea population) and 3) in Skagerrak and the North Sea. These studies, however, were not able to determine exact borders between the populations, perhaps due to some overlap in distribution between them. This overlap located in so-called transition zones was examined further by re-examining the genetics and including data from satellite tracked porpoises (Sveegaard et al. 2011) and passive acoustic monitoring (subset of data from SAMBAH (2016) - see below and sambah.org) to determine the best possible management area for the Belt Sea population (Sveegaard et al. 2015). Sveegaard et al. (2015) found that during the summer period (May-Sept) a clear decreasing gradient in porpoise density occurs east of 13.50 E, indicating that only few porpoises from the more abundant Belt Sea population cross this line (Figure 1-1).

For the Baltic Proper population, a summer population border was suggested based on the SAMBAH data by Carlén et al. (2018). Here, a southern management border during May – October for the Baltic Proper population stretching from Hanö Bight in southeastern Sweden to a point on the Polish coast was identified (Figure 1-1). South of this border, the majority of porpoises were considered to belong to the Belt Sea population.

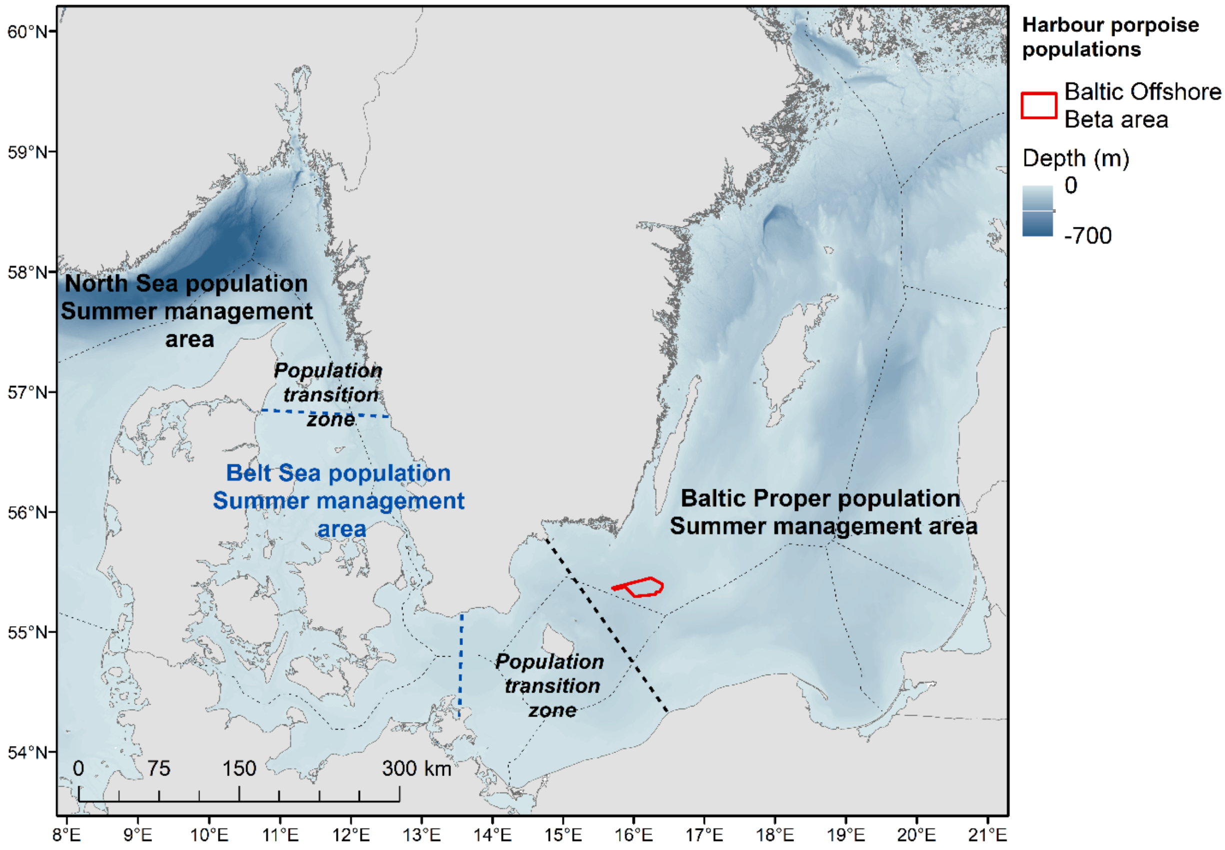


Figure 1-1. Map of population summer management units in the waters between the North Sea and the Baltic Sea. Note that only part of the Baltic Proper and the North Sea management unit are shown. The Baltic Offshore Beta area is outlined in red.

1.2 The harbour porpoise

1.2.1 Life and reproduction

In the Baltic, harbour porpoises have a maximum length of 1.8 m and a maximum weight of up to 90 kg. They are relatively short-lived compared to other toothed whales, with a maximum recorded lifetime in the wild of 23 years (confirmed by tooth growth layers (Lockyer and Kinze 2003)). In nature, however, Kesselring et al. (2017) found that the average age at death was merely 3.67 (± 0.30) years for harbour porpoises in the German Baltic Sea, indicating that relatively few animals will reach sexual maturity and have time to reproduce.

The breeding period of Baltic harbour porpoises begins in mid-June and ends in late August. Ovulation and conception typically take place in late July and early August (Sørensen and Kinze 1994). The gestation is approx. 11 months and females can thus give birth to the single calf in early summer. The calf begins suckling immediately after parturition and accompany their mother until May the following year and possibly longer. However, as females often give birth every year, the suckling period will usually end after 12 months at the latest. Previous studies indicated that females conceive at the age of 3 or 4 years (Kinze et al. 2003). In a recent study, however, Kesselring et al. (2017) found females to reach sexual maturity at an age of 4.95 (± 0.6) years in the German Baltic. Changes in food resources may influence the reproduction of porpoises.

Calves in company with their mother are sighted throughout the range of harbour porpoises and areas of relatively high porpoise density may therefore also be considered to be important for reproduction (Hammond et al. 1995; Kinze et al. 2003). In the Baltic Proper, the summer concentrations on the Midsjö Banks south of Gotland found in the SAMBAH project should be considered important for reproduction.

1.2.2 Diving Behaviour

The diving behaviour of harbour porpoises has been studied in Danish and adjacent waters by use of satellite linked dive recorders on 14 harbour porpoises (Teilmann et al. 2007). The average number of dives per hour was 29 during April-August and 43 during October-November. This may indicate a shift in available prey or an increased need for prey intake due to the colder water. Daily maximum dive depth corresponds to the depth of the Belt Seas and Kattegat where depth generally does not exceed 50 m. Maximum dive depth recorded was 132 m from animals moving north into Skagerrak. Maximum dive duration was frequently recorded in the category 10-15 min. The diurnal pattern shows that harbour porpoises dive continuously during day and night but with peak activity during daylight hours. On average they spent 55 % of their time in the upper 2 meters of the water column during April-August. Generally, adult animals make fewer but longer dives while younger animals make more dives of shorter duration (Teilmann et al. 2007).

No specific data on diving behaviour exists for the area relevant for this report.

1.2.3 Feeding

The average daily food intake per adult harbour porpoise is app. 1.75 kg consisting mainly of fishes of up to 20-25 cm in length with a preference for fatty species like mature herring and sprat (Börjesson and Berggren 2003). Different species of codfish, gobies and sandeel were also important prey items.

Between 1985 and 1990, the stomach contents of 21 harbour porpoises from the southern part of the Belt Seas and the western part of the Baltic Sea were studied. Herring made up 36 % while cod and eelpout made up 41 % and 10 % respectively of the total fish weight intake (Börjesson & Berggren 2003). Besides these, the most important species were mackerel, saithe, plaice, flounder, black goby, sandeel and garfish (Börjesson and Berggren 2003). In the same area, Lockyer & Kinze (2003) found eelpout, eel, sandeel, garfish, gobies, cod, whiting, herring, anchovies and flatfishes in porpoise stomachs. In conclusion, the harbour porpoise is an opportunistic feeder with a diet varying both spatially and temporally. In a more recent tagging study of the Belt Sea population, Wisniewska et al. (2016) found that harbour porpoises made up to 550 feeding attempts on small fish (3-10 cm) every hour with a 90 % success rate. This indicates that porpoises could have experienced a shift towards smaller and more prey items in their diet, potentially due to an ecological change in fish species composition.

1.2.4 Echolocation and hearing

All toothed whales (odontocetes) have good underwater hearing and use sound actively for navigation and prey capture (echolocation). Harbour porpoises produce short ultrasonic clicks (130 kHz peak frequency, 50-100 µs duration; (Møhl & Andersen 1973, Teilmann et al. 2002, Kyhn et al. 2013) and are able to orient and find prey in complete darkness. Data from porpoises tagged with acoustic data loggers indicate that they echolocate almost continuously (Linnenschmidt et al. 2013, Wisniewska et al. 2016).

Hearing is the key sensory modality for harbour porpoises for most aspects of their life. A few studies have investigated other senses, such as the anatomy and chemistry of the eye (Peich et al. 2001), but regarding functionality hearing is the only sense that has been investigated to greater extent.

Harbour porpoise hearing is very sensitive and covers a frequency range extending far up into the ultrasonic range, to about 150 kHz, but with poorer hearing at low frequencies, below a few kHz (Andersen 1970, Popov et al. 1986, Kastelein et al. 2002,).

Mammals do not hear equally well over their frequency range of hearing. For sound intensities close to the hearing threshold, the audiogram is a good approximation of the perceived sound levels (the loudness of the sound). In marine mammals, there is a great difference in sensitivity between the frequencies of best hearing and the frequencies at the upper and lower slopes of the audiogram. In humans, this frequency dependent sensitivity is dealt with by auditory frequency weighting (A-weighting) of sounds for impact assessment purposes and this principle has been transferred to marine mammals (see Houser et al, 2017). Currently, the recommended auditory frequency weighting for porpoises is the so-called VHF-weighting function of Southall et al. (2019). This auditory weighting function was developed for and applicable to assessment of acoustic trauma (permanent threshold shift, PTS; Southall et al. 2019; Tougaard et al. 2022) and is recommended in guidelines of for example US (NMFS, 2018) and Denmark (Energistyrelsen, 2022). Furthermore, the VHF-weighting function is applicable also for assessment of behavioural reactions to noise (Tougaard, 2021) and part of the recently updated guidelines in Denmark (Energistyrelsen, 2022).

1.3 Distribution and abundance

The harbour porpoise is the smallest and also the most numerous cetaceans in Europe and the only species living in the Baltic Sea. It is widely but unevenly distributed throughout European waters. The distribution is presumably linked to the distribution of prey (e.g., Sveegaard et al. 2012), which in turn is linked to parameters such as hydrography and bathymetry (Gilles et al. 2011).

1.3.1 Baltic Sea

Until the first half of the 20th century, the harbour porpoise was widely distributed in the Baltic Sea, but a dramatic decline has been observed during the past 50-100 years. Until recently, little was known about the distribution and status in the Baltic Proper (Skora et al. 1988; Koschinski 2002; Andersen et al. 2001).

The severe decline of the harbour porpoise population in the Baltic Proper makes it the smallest population of this species in the world (Anon. 2002) and it is listed as “critically endangered” in this sea by the International Union for

Conservation of Nature (IUCN) (Hammond et al. 2008) and by HELCOM (HELCOM 2019).

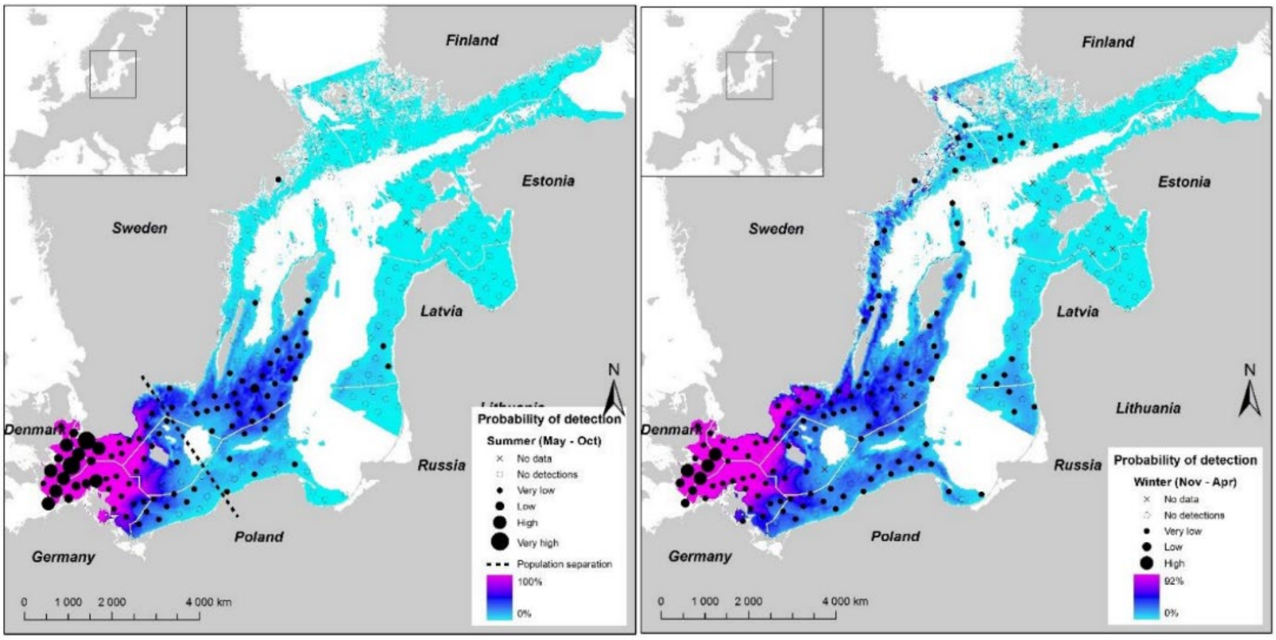


Figure 1-2. Mean acoustic detection rate (measured in average clicks per second) of harbour porpoises as well as modelled probability of detection of harbour porpoise in Summer (May-October) and Winter (November-April). The shading shows the main survey area and each dot an acoustic CPOD station active 24h for two years. The May–October management border (stipled line on left panel) was proposed by Carlén et al. (2018). Figure from SAMBAH (2016).

In 2011-2013, the SAMBAH project estimated the remaining number of porpoises in the Baltic Proper to be approx. 500 (95% CI 80-1,100) (Amundin et al. 2022). The porpoise detections from the SAMBAH project were analysed as Porpoise Positive Seconds per day (PPS) and split into two seasons (Figure 2-2). In the summer period, the data were further divided into the two population groups i.e., east and west of the estimated population border suggested by Carlén et al. (2018). During the breeding period in summer, porpoises in the Baltic Proper concentrate around the shallow Midsjö Banks south of Gotland and Öland. There is a clear drop in density from this area in all directions, confirming the isolation of this population. During winter, the porpoises are more widespread, and porpoises were detected as far north as the southwestern Finnish waters.

Predictions of probability of occurrence of harbour porpoises were modelled for the two seasons (Figure 1-2) and for each month during the SAMBAH project (Appendix 3). Results resemble the results of the actual data and show that during the summer season, high probability of detection of porpoises occurred on and around the offshore banks south of Gotland and east of Öland. The aggregation of animals in this area is most obvious during May–August, i.e. the reproduction period. This is also the period when the separation from the cluster in the south-western area between Denmark, Germany and Sweden is most clear. During the winter season, especially during January–March, animals were more spread out, and intermediate probabilities of detection occurred along the coasts of Poland and the Baltic states, as well as in Finnish and northern Swedish waters.

1.3.2 Local distribution near Baltic Offshore Beta

Investigation area

The area of the Baltic Offshore Beta wind farm is 431 km^2. It is located in Swedish waters approx. 43 km south of the nearest Swedish coast, 5 km east of the Danish border and 23 km from the Polish border. Furthermore, there is less than 9 km from the most eastern point of the Baltic Offshore Beta area to the south-western point of the large (10.511 km^2) Natura 2000 site "Hoburgs bank och Midsjöbankarna" designated for harbour porpoises in 2016.The area is also located inside the Summer (May-Oct) management border for the Baltic Proper population of harbour porpoises proposed by Carlén et al. (2018). It is therefore assumed that mainly individuals from the Baltic Proper porpoise population are inhabiting this area.

The water depth within the Baltic Offshore Beta wind farm area varies between 55 m and 80 m.

The most severe impact of offshore wind farms to harbour porpoises are assessed to be during the construction period and more specifically during the pile driving, where the foundations are driven into the seabed by percussive piling. Several studies have estimated the impact on porpoises during the construction phase of a wind farm, by comparing the presence of porpoises before, during and after construction work has ended. All studies concluded that when using mitigation in the form of soft start/ramp up and acoustic deterrent devices (to scare porpoises out of the core area to protect them from injury) and noise abatement (such as air bubble curtains to lower the radiated noise level and thereby reduce impact on behaviour), the maximum impact distance range between 10 km and 16 km (Dähne, et al., 2013; Dähne, et al., 2017; Brandt, et al., 2018). Thus, during assessments of wind farm constructions the study area must include a buffer area of at least 16 km around the proposed wind farm area. This way the investigation area is the largest area in which porpoises could potentially be affected by underwater noise generated during the construction from piling of pin piles/monopiles for the foundations, given that mitigation measures with noise abatement are used. However, it must be noted that previous studies on the affected distance was done on the much smaller piles that are currently used. Also, the bathymetry, seafloor condition and hydrography affect the sound propagation. Therefore, the affected area should be estimated for the sound levels predicted to occur from the specific piles in the specific project.

As data are limited, we have also included a 40 km buffer around the Baltic Offshore Beta area, in order to enable review of more current data from the Swedish national monitoring data (Figure 1-4).

Passive acoustic monitoring data

During the SAMBAH project, 300 passive acoustic dataloggers (called CPODs) were deployed across the Baltic Proper in 2011-2013. The stations were placed in a relatively even grid with 20-30 km spacing between stations. Waters >80 m depths were not included assuming that these waters held fewer porpoises due to the permanent oxygen depletion below 80 m. Moreover, the inclusion of the deeper waters would constitute a challenge in order to retrieve and service stations from these depths. Consequently, no stations were deployed in the waters south-west of the Baltic Offshore Beta area towards Bornholm.

No stations were deployed during the SAMBAH project within the Baltic Offshore Beta area, but 6 stations (all within Swedish waters) were within the 20 km buffer zone and an additional 9 stations (5 Swedish, 2 Danish, 2 Polish) were within the 40 km buffer zone (Figure 1-4). Of these 15 stations, six have been redeployed after SAMBAH, during the Swedish monitoring program (station ID: 1020, 1025, 1026, 1029) with data available from April 2017 to March 2020 and two stations (8020, 8021) under the Danish monitoring programme with data available from June 2018 to June 2019. Both monitoring datasets have been published and will be compared to the SAMBAH data (Owen et al. 2021, Sveegaard 2020). Here, we first present the original SAMBAH data for all 15 stations within the 40 km buffer zone and then followed by the six stations.

SAMBAH data

In the SAMBAH project, the porpoise detections were analysed as "Detection Positive Seconds" (DPS) per day per season for each station. Data from the 15 stations are presented in Figure 1-4 (graph) and Figure 1-5 (map). The figures illustrate that all the highest levels of detections within 40 km of the Baltic Offshore Beta area are found in the north-eastern part of the Swedish waters. The highest summer detection level within the 20 km buffer zone is found at station 1021 and at station 1026, 1027 and 1029 in the 20-40 km buffer zone. In the winter season, station 1017 and 1023 have the highest detection levels in the 20 km buffer zone and 1020, 1025 and 1027 the highest levels in the 20-40 km buffer zone. The lowest densities for both seasons are found on the seven stations in the south-western part of the study area.

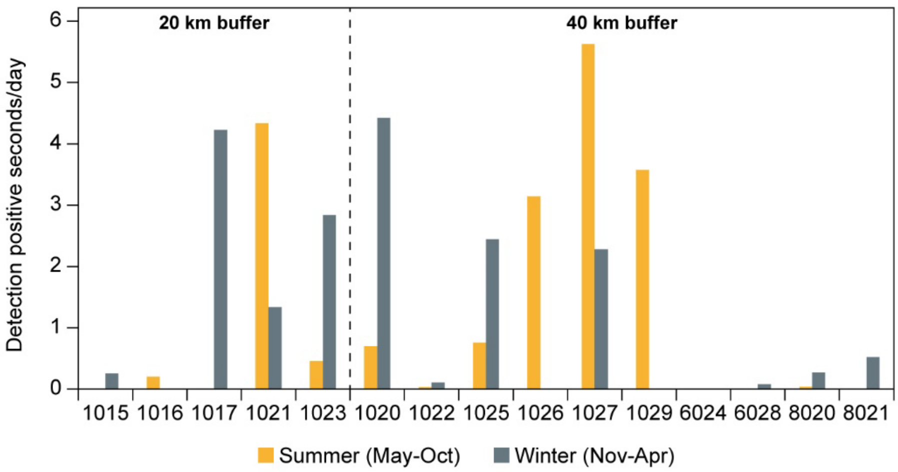


Figure 1-3. Harbour porpoise detections during the SAMBAH project (2011-2013) analysed as Detection positive seconds per day per season (Summer: May-Oct, Winter: Nov-Apr) for the 15 stations within the two buffer zones 0-20 km and 20-40 km of the Baltic Offshore Beta area, respectively.

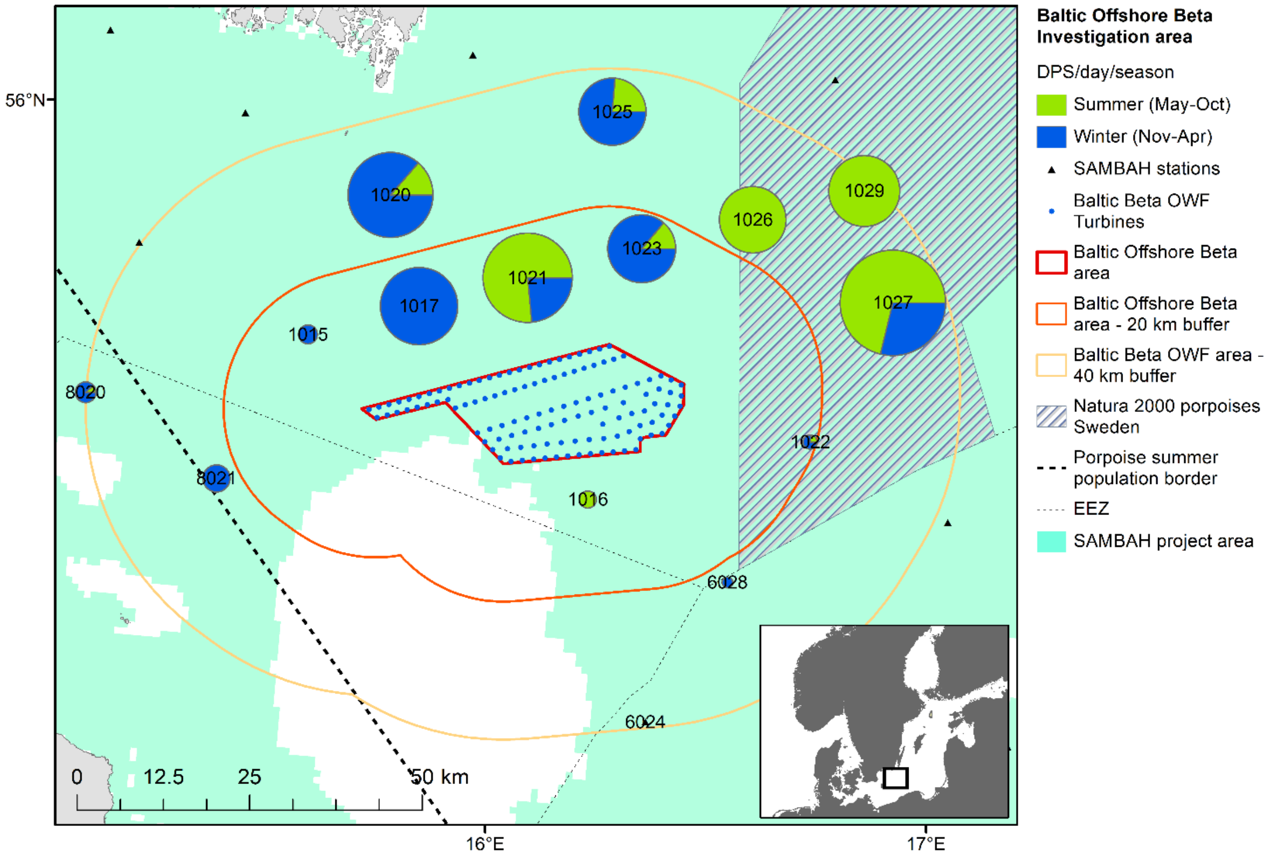


Figure 1-4. Map illustrating Harbour porpoise detections during the SAMBAH project (2011-2013) analysed as Detection positive seconds per day (DPS) per season (Summer: May-Oct, Winter: Nov-Apr) for the 15 stations presented as pie charts. The size of each pie illustrates the sum of the DPS for the two seasons.

New Monitoring data

As part of the national monitoring of harbour porpoises, several of the Swedish SAMBAH stations were redeployed in 2017 and have been monitored continuously since then. The data from 2017-2020 was published in Owen et al. (2021) and based on their results, we calculated the percent detection positive days (%DPD) per total number of recording days (full year) and for the summer season (Table 1-1). For comparison the three Swedish stations with the highest recorded level of detection within the Natura 2000 site "Hoburgs bank och Midsjöbankarna" were also included. In Denmark, ten of the SAMBAH stations were redeployed from 2018-2019 (Sveegaard 2020). Two of the stations (8020-8021) were located within the 20-40 km buffer zone. Unfortunately, only data from the whole year is at present available for the Danish data. Thus, the percentage change for the summer season is missing in Table 1-1.

The analysis show that more detections were recorded during the national monitoring programs compared to SAMBAH on half of the six stations. The exceptions were station 1020, 1025 and 8021. During summer, the level of detection increased by 69-135 % at the four Swedish stations.

Table 1-1 Comparison on selected stations of percent Detection positive Days (%DPD) found during SAMBAH (2011-2013) and the subsequent national monitoring program (NMP) by the Swedish Museum of Natural History (station 1020-1029) from 2017-2020 and Danish Centre For Environment And Energy (8020-8021) from 2018-2019. BB OWF = Baltic offshore Beta wind farm.

Stations monitored after SAMBAH (2011-2013)	Station	Full data %DPD			Summer (May-October) %DPD in season		
		SAMBAH	NMP	Change DPD (%)	SAMBAH	NMP	Change DPD (%)
Swedish stations within 40 km buffer of BB OWF	1020	1.8	1.8	0	0.7	1.2	69
	1025	1.1	1.2	6	0.6	1.1	105
	1026	1.0	2.7	164	1.3	3.0	135
	1029	2.6	4.1	58	2.6	5.5	112
Danish stations within 40 km buffer of BB OWF	8020	0.7	3.3	371	-	-	-
	8021	0.5	0.6	20	-	-	-
Swedish stations within Natura 2000 with highest detections	1032	2.9	5.8	104	3.3	7.9	137
	1036	48.5	52.6	8	65.7	72.6	10
	1041	9.2	20.1	119	15.9	30.1	90

For the Danish stations, the level of detections has increased by 20-371 % for the full dataset (all year). This could indicate that the level of porpoise detections might also have increased on the low-density stations, but no data after SAMBAH exists here.

The overall increase from 2011-2013 to 2017-20 indicates that either the number of porpoises in the area has increased since SAMBAH was conducted or that the porpoise distribution has changed.

The percent detection positive days (%DPD) describes the percentage of days that you may encounter a harbour porpoise at some point in that area. During the national monitoring programs in recent years, the %DPD detected on the SAMBAH stations (Table 1-1) a porpoise will be detected from 0.6-4.1% of days (Average = 2.3%) on the stations within a buffer of 40 km from the Baltic Offshore Beta wind farm. On the three stations with the highest levels of detections within the Natura 2000 site porpoises are detected on 5.8-52.6% of days (average = 26%). So if the pre-cautionary principle is implemented, and we assume that the detection rate with in the Baltic Offshore Beta wind farm is as high as within the Natura 2000 site, porpoises will occur in the wind farm area on 5.8-52.6% of days. It is, however, very likely that the actual "encounter rate" is lower and instead similar to the levels found within the 40 km buffer i.e. on max. 4.1% of days.

Conclusion

The Baltic Offshore Beta area is located between the high density north-eastern stations and the low density south-eastern stations. The levels of detection at the three stations just north of the Baltic Offshore Beta area are similar to the levels at station 1026, 1027 and 1029 that are located within the Natura 2000 site "Hoburgs bank och Midsjöbankarna" and this area may thus be considered an important area for harbour porpoises both summer and winter. The stations south and west of the Baltic Offshore Beta area had relatively low detection levels during SAMBAH but the Danish national monitoring in 2018-19 indicates that the detection levels on these stations may have increased since SAMBAH.

In conclusion, there is no reliable method to estimate the level of importance of the Baltic Offshore Beta area to harbour porpoises without conducting new passive acoustic monitoring and deploying stations within the area. The open question is if the area is an extension of the high-density breeding area detected to the north-east or if it is part of the lower importance area around the south-eastern stations. As described above for the %DPD, it is likely somewhere in between. However, since the Baltic Proper harbour porpoise population is critically endangered, the uncertainty should benefit the harbour porpoise and the assessment will have to assume a worst-case scenario in which all of the Baltic Offshore Beta area as well as the 20 km buffer zone should be considered important for the Baltic Proper harbour porpoise population throughout the year.

1.4 Protection

A number of international treaties, agreements and legislations have been enacted in order to protect harbour porpoises. In northern European waters, the species has been listed in annex II and IV of the Habitats Directive (92/43/EEC), annex II of the Bern Convention, annex II of the Bonn Convention and annex II of the Washington Convention. Furthermore, the harbour porpoise is covered by the terms of the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS), a regional agreement under the Bonn Convention and HELCOM The Baltic population of harbour porpoises is listed as 'Critically endangered' by the World Conservation Union (Hammond et al. 2016).

Harbour porpoises are listed under annex IV of the Habitats Directive, which implies that "*Member States shall take the requisite measures to establish a system of strict protection for the animal species listed in Annex IV (a) in their natural range, prohibiting: ... (b) Deliberate disturbance of these species, particularly during the period of breeding, rearing, hibernation and migration ...*" (article 12).

The ASCOBANS agreement covers all small toothed whales and thus also porpoises. It states that member states are obligated to "*Work towards ..(c) the effective regulation, to reduce the impact on the animals of activities which seriously affect their food resources, and (d) the prevention of other significant disturbance, especially of an acoustic nature*" (Annex to Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (www.ascobans.org)). Furthermore, as an extension of the ASCOBANS agreement, the member states have signed the "*Recovery plan for porpoises in the Baltic Sea*" (Jastarnia plan, ASCOBANS 2016), which highlights the highly threatened status of the harbour porpoise population of the Baltic Proper. The aim of the recovery plan is to re-establish the porpoise population in the Baltic at min. 80 % of its carrying capacity. Although the recommendations of the plan are focused on measures to reduce incidental bycatch in fisheries, the serious situation that the population currently faces is reflected in the recommendations: "*In other words, analysis indicated that recovery towards the interim goal of 80 % of carrying capacity could only be achieved if the bycatch in this part of the Baltic were reduced to two or fewer porpoises per year (compared with the estimated current minimum bycatch of seven*".

Natura 2000 sites

Harbour porpoises are listed as part of the selection criteria in one Natura 2000 site within the 40 km buffer, namely "Hoburgs Bank and Midsjö Bank" located less than 10 km from the Baltic Offshore Beta area.

In 2019, NGOs submitted a joint request[1] for emergency measures for the Baltic Proper harbour porpoise to the European Commission, and in May 2020 the International Council for the Exploration of the Sea, ICES, published scientific advice (ICES 2020) on how to minimise harbour porpoise bycatch in the Baltic Sea. In line with the EU Common Fisheries Policy, this advice was discussed within the Baltic Sea regional fisheries body, BaltFish, and during 2020-2021 BaltFish submitted two joint recommendations to the European Commission on measures to minimise bycatch of the Baltic porpoise. These joint recommendations were transcribed into a so-called delegated act that is now approved by the European Parliament and was implemented in June 2022. According to the delegated act, the Natura 2000 site "Hoburgs Bank and Midsjö Bank" now has a full year ban on static net fisheries.

[1] https://irp.cdn-website.com/53007095/files/uploaded/ngo-letter-on-baltic-proper-harbour-porpoise-2020-09-25.pdf

2 Assessment

The purpose of the assessment is to assess the potential impacts on harbour porpoises in relation to construction of the proposed Baltic Offshore Beta wind farm in Swedish waters. Whether such an impact is acceptable and within the limits set by the Habitats Directive and other legislation is a legal/political consideration and is therefore not addressed here.

2.1 Introduction to impacts

Assessing the impact at the population level is often difficult unless all factors related to the population structure and abundance of the animals, as well as all other factors affecting their survival in relation to direct and indirect impacts (including cumulative impact from other stressors) are known. In this report, information on the animals using the impacted areas are not well known, but we know that the status of the populations is poor. However, based on the baseline review of existing data in the neighbouring waters, we make the precautious assumption that the Baltic Offshore Beta wind farm area is a high-density area in all seasons for the Baltic Proper harbour porpoise population.

The main pressures on marine mammals during construction of the Baltic Offshore Beta wind farm are assumed to be underwater noise from pile driving and ship activities, and to a minor degrees sediment spill from the installation of the foundations and the cable. These impacts have been thoroughly described and modelled in Ramboll (2022) and Ramboll (2023). Impacts from pre-investigation phase and the operational phase are not included in this report.

Underwater noise is a significant disturbing factor. During the construction of an offshore wind farm, the pile driving will be the noisiest activity. The noise modelling is based on a scenario with installation of jacket foundations by means of pin piles. The engines and propellers of construction vessels and service ships will also be a source of noise.

The consequences of sediment spill on marine mammals relate to the increased turbidity of the water, and a possible decrease in prey availability through secondary effects of the suspended sediment on fish.

In addition, the project can potentially alter the benthic habitat, by introducing hard substrates (the turbine foundations) to the otherwise (in many places) soft bottom habitat.

2.2 Assessment methodology

The overall aim of an impact assessment is to assess the significance of the impact. This is done by combining the sensitivity of the receptor (here the harbour porpoise) with the magnitude of the impact (Table 2-1).

Table 2-1. Method of assessing impact significance by combining sensitivity of the receptor (here, harbour porpoises) with the impact magnitude

Impact significance		Impact magnitude			
		None or negligible	Minor	Medium	High
Sensitivity of receptor	Low	None or negligible	Minor	Minor	Moderate
	Medium	None or negligible	Minor	Moderate	High
	High	None or negligible	Moderate	Moderate	High

2.2.1 Sensitivity of harbour porpoises

During the impact assessment on marine mammals of Nord Stream 2 (in the Baltic Prober), sensitivity was described in the following way: "*Sensitivity of an impacted target (e.g. organism, site, area) describes its susceptibility to any change caused by project or ancillary activities*"; "*Various criteria are used to determine the sensitivity including, among others, resistance to change, adaptability, rarity, diversity, value to other resources/receptors, naturalness, fragility and whether a resource/receptor is actually present during the active phase of the project*"; and furthermore: "*Regulations and social values should also be used to determine sensitivity*" (Sveegaard et al. 2017).

When assessing sensitivity of harbour porpoises in relation to the type of impact, the main focus is biology (physiological impact), population status (declining/stable/increasing), abundance, vulnerable periods (e.g. breeding or moulting season), protection status (national and international), and distribution (their presence during the impact). The assessment methodology of harbour porpoise sensitivity has been summarized in Table 2-2.

Table 2-2. The assessment methodology of harbour porpoise sensitivity.

Low	The population is stable and the abundance is increasing. The impact area does not include nationally or regionally important areas (used for breeding, feeding or migration). Marine mammals only occur in low density. The marine mammal species is not sensitive to environmental changes i.e. their biology (physiology or behavior) is not or only temporarily affected by the impact.
Medium	The population is stable. The impact area includes parts of nationally or regionally important areas (used for breeding, feeding or migration). Marine mammals only occur regularly (= medium density). The biology of the marine mammal species are moderately affected by the impact.
High	The population is decreasing and/or the abundance is low. The impact area includes nationally or regionally important areas (used for breeding, feeding or migration). Marine mammals occur in high densities within the impact area. The marine mammal species is highly sensitive to environmental changes i.e. their biology (physiology or behavior) is severely affected or damaged by the impact.

2.2.2 Impact magnitude

Sveegaard et al. (2017) used the following description of Impact magnitude in Baltic waters: "*Magnitude of the change is a measure of intensity, direction (direct/indirect), spatial extent and duration of the change caused by the project*"; and: "*In general, the spatial extent of the particular impact can be ranged as local, regional, national or transboundary. The duration of the impact can be categorized temporary, short-term or long-term. The spatial extent of the impact varies from local where only* *the waters directly above or in the near vicinity of the impact are affected to large scale impacts affecting several hundred square kilometres. Finally, the magnitude of the change for every examined impact will be assessed into subclasses high, medium, low and negligible.*" Here, we will apply the same method. The general method for assessing the impact magnitude is summarized in Table 2-3.

Table 2-3. Assessment categories and methodology of impact magnitude for marine mammal populations. From Sveegaard et al. 2017.

No or negligible	No detectable impacts on marine mammals.
Low	Impacts are of low intensity, the spatial extent is small and/or the duration is short (hours). Impacts are reversible and do not lead to any permanent change.
Medium	Moderate impacts on marine mammal species. Impact time is from days to weeks. Limited spatial extent. Some impacts may be irreversible.
High	Significant long-lasting (months) or permanent impacts on marine mammals (i.e. high intensity) Large geographical extent. Most impacts are irreversible.

2.2.3 Disturbance of Natura 2000 sites

In the management plan (Länsstyrelsen 2021) for the Natura 2000 area Hoburgs bank and Midsjöbankarna, the following relevant conservation objectives are mentioned (translated from Swedish by the authors of this report):

1. In the Natura 2000 area Hoburgs bank and Midsjöbankarna, impulsive noise must not come from human activities that can cause temporary hearing loss (TTS) in porpoises.

2. In the Natura 2000 area Hoburgs bank and Midsjöbankarna, impulsive noise or continuous underwater noise, including shipping, should not cause behavioural impact within the areas where the detection rate of porpoises is highest. Within parts of Natura 2000 - the area where the detection rate of porpoises is lower activities that generate underwater noise that exceeds the porpoise's hearing threshold by 40 dB should be minimized. In the Natura 2000 area Hoburgs bank and Midsjöbankarna there must be clear limit values and guidelines for continuous noise, such as shipping, cable laying and operation of offshore wind power, to minimize the impact on porpoises.

3. In the Natura 2000 area Hoburgs bank and Midsjöbankarna there must be clear limit values and guidelines for impulsive noise such as seismic surveys, underwater blasting and piling, to minimize impact on porpoises.

According to the management plan the clear limits values from point 3) and 4) will be set by 2025 at the latest. Until the national guidance is established, the CMS guidance for environmental impact statements for noise-generating activities is applied (CMS 2021) with the detailed information on harbour porpoises and noise described in section B1 of the supporting material (Prideaux 2017). These documents reviews the knowledge on impacts and porpoises and finds that "*the onset of a response is triggered by the perceived loudness of the sound, not just received levels (Dyndo et al. 2015). At least for harbour porpoises, this finding lends weight to the recent proposal by Tougaard et al (2015) that behavioural responses can be predicted from a certain level above their threshold at any given fre-*

quency (e.g., in the range of 40–50 dB above the hearing threshold for harbour porpoise)." This is similar to what is mentioned in point 2) in the management plan. In the plan, the 40dB is explained by this argument (listed under potential threats in the Natura 2000 site):

- Strong impulsive noise for example from sonars, seismic surveys, underwater blasting or piling for structures can cause physiological damage at short distances and has documented a strong impact on the behaviour of porpoises within long distances. Weaker impulsive noise from, for example, sonar in boats commercial shipping and recreational boats can cause behavioural changes. Noise that is 40-50dB above the porpoise's hearing threshold leads, for example, to escape behaviour and also to the animals stops echo locating and foraging.

With regard to 2) the information on high and lower densities within the Natura 2000 site it relatively limited since only five passive acoustic stations have been deployed in the Natura 2000 site since SAMBAH (Owen et al. 2021). Consequently, if no information is available for whether a potential impacted area holds high or lower densities, this report, as a precautionary principle, will assume that the potential impacted areas may hold high densities.

2.3 Sensitivity of harbour porpoises

Noise, sediment spill, turbidity, ship traffic and changes in the habitat may have either a negative or positive impact on the behaviour of harbour porpoises by either deterring or attracting the animals from the site of impact or by disturbing the normal behaviour such as foraging or socializing.

Here, the sensitivity of harbour porpoises to underwater noise (pile driving and shipping) and sediment spill is assessed, based on the method described in section 2.2.1.

2.3.1 Sensitivity to underwater noise

Underwater noise is well known as a source of impact on harbour porpoises. This impact can occur through a number of processes and usually the following issues are considered:

- Physical injury (incl. blast injury) - not relevant here

- Hearing loss (incl. PTS/TTS)

- Disturbance of animal behaviour

- Masking of relevant sounds to the animals, such as sounds for communication.

In addition to the above listed issues, are more general physiological reactions to noise such as elevated stress hormone concentrations in the blood following exposure to loud noise (Romano et al. 2004) and possibly also chronic stress due to long term exposure. However due to the limited number of experimental studies physiological impacts are most often excluded from impact assessments. An additional zone of audibility is sometimes included (Richardson et al. 1995), but since the fact that a noise can be heard not by itself implies an impact, it is therefore only useful as a precautionary proxy for extend of impact, in situations where no other information is available.

The issues of hearing loss (incl. PTS/TTS), disturbance of animal behaviour and masking of relevant sounds to the animal have been discussed in detail in Ramboll (2023). Here, only a brief description as well as the assessment of sensitivity will be provided.

***Hearing Loss* (PTS/TTS)**

The mammalian inner ear is adapted to be extremely sensitive to sound, and it is therefore a well-established assumption that injury from exposure to sound will manifest itself in the inner ear before any other tissue (Southall et al., 2007). Criteria and thresholds for noise-induced permanent hearing loss are given in Table 2-4. These criteria and thresholds operate with two central principles: they are frequency weighted according to the hearing of target species and they are expressed as sound exposure level (SEL), cumulated over the duration of the exposure (up to a limit of 24 hours).

In terms of severity, there is a transition from temporary hearing loss (TTS) where the animal will regain full sensitivity after a shorter period (minutes to hours) to permanent hearing loss (PTS), where the hearing only recovers partially, resulting in a permanent loss in hearing sensitivity.

In a very precautionary approach, some consider TTS an unwanted impact on the animals. However, the actual consequences for a porpoise of suffering a small elevation in hearing threshold at low frequencies, which recovers completely within a few hours at most (Popov, et al. 2011), are likely to be very low. TTS induced by pile driving noise occurs at very low frequencies, well outside the frequencies used for echolocation and communication (Kastelein, et al. 2015). Neither echolocation, nor communication between mother and calf will thus be affected by TTS induced by pile driving noise.

The overall effect of inducing small amounts of TTS in porpoises as a consequence of pile driving is thus assessed to be insignificant for the long-term survival and reproduction of the animal, and thus in turn also without any effects at the level of the population. However, as a precaution due to the poor status of the Baltic Proper harbour porpoise, we assess the sensitivity of harbour porpoises to TTS as **low** and not negligible.

PTS is much less well studied than TTS for ethical reasons. Based on a comprehensive review of the entire literature on TTS and PTS in marine mammals, guidance on thresholds have recently been provided in the US (National Marine Fisheries Service 2018; Southall, et al. 2019). All measurements of TTS in marine mammals were combined with all available information on auditory sensitivity in marine mammals (audiograms) to create appropriate frequency weighting curves and TTS-growth curves. Based on this the onset PTS thresholds were estimated in a precautionary way as the sound exposure level required to elicit 40 dB of TTS, which was considered indicative of a significantly increased risk of developing PTS. At the onset of PTS in porpoises, the animal will mainly lose the ability to hear lower frequency sounds which will probably not significantly influence their ability to use their echolocation. However, this phenomenon has not been studied in live animals and here, we will assess PTS to be of high impact. The sensitivity to PTS caused by pile driving is thus assessed to be **high** for harbour porpoises.

Noise from ship traffic is of significantly lower intensity than pile driving noise and will not be able to inflict hearing loss in porpoises.

Table 2-4. Harbour porpoise noise exposure criteria for hearing loss. From Ramboll (2023).

Species	Functional hearing group	Noise effect	Threshold (Impulsive noise)	Threshold (Non-impulsive noise)	Reference
Harbour porpoise	Very High frequency cetaceans VHF	PTS	155 dB re 1µPa^{2}s SELcum (weighted)/ 202 dB re 1µPa (peak)	173 dB re 1µPa^{2}s SELcum (weighted)	*Southall et al. 2019*
		TTS	140 dB re 1µPa^{2}s SEL cum(weighted) / 196 dB re 1µPa (peak)	153 dB re 1µPa^{2}s SELcum (weighted)	*Southall et al. 2019*

2.3.2 Disturbance of animal behaviour

Pile driving

Underwater noise is able to affect and alter the behaviour of animals, which may have implications for the long-term survival and reproductive success of individual animals, and thereby ultimately on the population status (National Research Council, 2003). Effects can occur directly from severe immediate reactions as for example panic or fleeing, by which there is an increased risk of direct mortality due to for example bycatch in gill nets or separation of dependent calves from mothers. More commonly, however, is probably less severe effects where animals are temporally displaced from habitats, or their foraging behaviour disrupted due to noise (as demonstrated for example by Wisniewska et al., 2018).

This means that during the period of piling, foraging by the animals in the impacted area will be reduced. No data is available on temporal and spatial variation in presence of harbour porpoises at and near the Baltic Offshore Beta wind farm area. Consequently, there is insufficient knowledge to judge whether porpoises displaced from the wind farm area during piling are able to forage in similar quality habitats elsewhere.

Additionally, the animals' reaction may vary depending on season, behavioural state, age, sex, as well as in response to the intensity, frequency and time structure of impact causing behavioural changes.

At the population scale, harbour porpoises may thus be sensitive to permanent or long-term large scale changes or disturbances in their habitat if a large percentage of the population should be displaced into areas of poor quality or where they would have to compete with conspecifics or other marine mammal species. On the other hand, they may be relatively unaffected by short-term avoidance behaviour.

A review of results from behavioural reactions to noise in wild porpoises was conducted by Tougaard et al. (2015). This review proposes a generic response threshold of a sound pressure level 40-50 dB above the hearing threshold (audiogram) of the porpoise, which corresponds to about 100 dB re. 1 µPa VHF weighted (sensu Southall et al., 2019). Recently, this review has been updated, with a recommendation of a VHF-weighted threshold of 103 dB re 1 µPa, rms average over 125 ms (Tougaard, 2021; Energistyrelsen 2022).

Table 2-5 summarizes criteria for assessing impacts of harbour porpoises used for the noise modelling report for behavioural impacts (Ramboll 2023).

It is difficult to make a direct coupling between behavioural disturbances and impact on fitness and survival. The field of energetics are however receiving increased attention in recent years, and our knowledge will improve. In general, a temporary short-term displacement is assessed to have less than a major impact and for an animal from a population in favourable conservation status assessed to be minor. Here, however, with a population categorized as critically endangered and where alternative foraging habitats may be scarce (although no hard evidence is available), the sensitivity to disturbance of animal behaviour caused by pile driving is assessed to be **medium** for the Baltic harbour porpoises.

Table 2-5. Harbour porpoise noise exposure criteria for behavioural displacement. From Ramboll (2023).

Species	Noise type	Threshold	Reference
Harbour porpoise	Impact piledriving	143 dB re 1μPa²s (unweighted)	*Brandt et al. 2018*
	I-type and other sounds	103 dB re 1μPa rms 125 ms (VHF weighted)	*Danish Energy Agency 2022*
	Sonar	122 dB re 1μPa rms	*Kastelein et al. 2019*

Shipping

Little information is available on the behaviour of porpoises in reaction to ship noise. However, studies in captivity indicate that porpoises react to the higher frequencies of the noise, above 1 kHz, and at low levels, L_{eq} around 130 dB re. 1 μPa (Dyndo et al., 2015). Other studies on noise from various merchant ships in the outer Baltic have shown that there is considerable energy in the noise also at ultrasonic frequencies up to at least 100 kHz, and out to ranges of at least 1 km (Hermannsen et al., 2014). In addition, studies where sound recorders as well as motion detectors (accelerometers) have been placed on free-swimming porpoises have shown short term (minutes), but nevertheless clear reactions of individual porpoises to ships (Wisniewska et al., 2018).

A study conducted on porpoises in the Istanbul Strait showed that porpoises are more likely to change behaviour, for example from surface-feeding or travelling to diving, if vessels are within a 400 m radius of the porpoise. Furthermore, vessel speed and distance have a significant effect on the probability of response of the porpoises to the ship (Bas et al., 2017). Such changes in behaviour indicate that vessels do disturb the animals at close range, but the study found no overall significant effect of the disturbance on the animals' cumulative (diel) behavioural budget (i.e., total amount of time spent on the different types of behaviour). The study found a correlation between swimming speed and the probability of porpoises responding by changing their swimming direction. Bas et al. (2017) found that at any given ship speed there is little probability (<10%) of a behavioural reaction if the boat is more than 400 m away and furthermore that as ship speed increases from slow (<3 knots) to fast (>9 knots), the probability of reaction to the ship 200 m away increases from about 10% to 40%.

It should be noted that the activity of the ships may play an important role in how the animals react. A cable laying ship will for instance produce a very different soundscape than a cargo vessel in the shipping lane.

No similar studies are available for Baltic harbour porpoises, so it is not known whether the same distances apply to porpoises in the Baltic. Nevertheless, based on these results, a precautionary threshold for reaction could be set to 200 m. This was done by Tougaard and Griffiths (2020) when estimating the additional impact of shipping from the Nord Stream 2 gas pipeline crossing of the marine protected Natura 2000 area Hoburgs bank and Midsjöbanks. This study based on modelling of AIS data indicated that porpoises were not adversely affected beyond low and negligible impact.

To summarize, several studies have examined the effect of ship traffic on porpoises and depending on methodology, the impacted population of porpoises and the geographic structure of the area, where the study was conducted the results are very different ranging from almost no impact to behavioural disturbances up to 400 m away. Based on this and since the population is categorized as critically endangered, the sensitivity to disturbance of animal behaviour caused by shipping is assessed to be **medium** for harbour porpoises.

Masking
Masking is the phenomenon that noise can negatively affect the ability to detect and identify other sounds. The masking noise must be audible, coincide with (within tens of milliseconds), and have energy in the same frequency band, as the masked sound. See Erbe et al. (2016) for a current review.

Masking potential of pile driving noise has not been studied specifically; however, some preliminary conclusions can be drawn. Porpoises depend critically on their echolocation, but their echolocation clicks are in the extreme ultrasonic range, above 100 kHz, considerably above the range where pile driving noise is located. This means that it is very unlikely that pile driving noise would mask echolocation of porpoises. Here, due to the poor status of the porpoise population a precautionary approach is taken and the sensitivity to masking caused by pile driving are thus not assessed to be negligible but to be **low**.

The source level of ship noise is substantially lower than pile driving noise. Porpoises have poor hearing below a few kHz and it is unknown what they may use this low-frequency hearing for, if at all. Ship traffic may cause masking, although very little is known about this. However, if it occurs it may affect porpoises, and thus masking caused by ship traffic are also assessed to be **low**.

2.3.3 Sensitivity to sediment spill

The impact of sediment spill on harbour porpoises are assumed to relate to either visual impairment or disturbance of behaviour.

Visual impairment
The harbour porpoise use echolocation for orientation in the environment as well as for prey localisation. Studies of porpoises tagged with acoustic/satellite transmitters have shown that they often hunt at night and move into depth of complete darkness with or without an accompanying calf (Wisniewska et al. 2016; Teilmann, Larsen, and Desportes 2007). It is at present unknown how the sediment particles may alter the acoustic properties in the water and consequently the echolocation of the harbour porpoise. Consequently, the sensitivity of harbour porpoises to the visual impairment caused by sediment plumes is assessed to be **low**.

Behavioural impacts
Activities causing increased turbidity or sediment plumes, may affect the behaviour of the harbour porpoise. Behavioural changes are, however, inherently difficult to evaluate due to the vast distances at which they may occur

and due to the paucity of studies looking at effects at a population level (NRC 2003). Potential behavioural effects range from very strong reactions, such as panic or flight, to more moderate reactions where the animal may orient itself towards the disturbance; move slowly away or will cease an on-going behaviour. The reaction of harbour porpoises to sediment plumes is unknown, but as sediment plumes are naturally occurring and as it is unlikely to affect their echolocation, the sensitivity of porpoises to sediment spill is assessed to be **low**.

2.3.4 Changes in the habitat

The physical presence of the turbines alter the existing habitat. In the construction phase most sessile benthic flora and fauna will be disturbed and likely destroyed in the immediate vicinity of the turbines and non-sessile animals displaced e.g., prey species of porpoises. However, as this impact is indirect, local and impossible to assess, it is not further addressed here.

2.3.5 Vulnerable periods of harbour porpoises

Recollecting the information in chapter 1.2.1 on Life and reproduction, harbour porpoises in the Baltic give birth from April to October, with the peak season in May-August. Calves of a few months of age follow their mother closely and are only left alone for short periods when the mother dives to forage (Camphuysen and Krop 2011). The calf will swim with its mother until approx. 11 month old and it is likely around this age the calf now dives independently and eventually breaks away. Before this age, calves are unlikely to survive on their own and disturbances that may lead to separation of mother and calf will have negative impact. The period March-May is the period with the most bycatches which is interpreted as the period where calves from the previous year begin to separate from their mother and may be especially prone to end as bycatch. Harbour porpoises are therefore assessed as being highly vulnerable to disturbances from underwater noise all year.

3 Magnitude of impact

This chapter briefly describes the magnitude of impacts of underwater noise and sediment spill during the construction period as modelled by Ramboll (2022, 2023) and assesses the impact magnitude.

3.1 Impact magnitude of underwater noise

Ramboll (2023) modelled the spatial extent and magnitude of underwater noise produced as a consequence of the construction of the Baltic Offshore Beta wind farm in great detail. The construction is assessed to have pile driving and shipping activity as noise generating activities.

The construction will also include cable laying. This is however, regarded as "*low impact noise emission as the sediment is soft clay and the inter array cables will be first placed on the bottom and then jetted into the clay, called post-lay trenching. No rock dumping within the site for inter array cables are assumed. This will be needed only closer to landfall.*" (Personal communication with Ove Magne Kallestad, Njordr Offshore Wind, 16. Dec. 2022). AU were thus not asked to assess the cable laying, and cable laying with regard to underwater noise is therefore not discussed further.

For general information on underwater sound modelling and of harbour porpoise hearing we refer to Chapter 6 and Chapter 8 of Ramboll (2023), respectively.

3.1.1 Pile driving

The Baltic Offshore Beta wind farm is planned to have 127 individual wind turbine generators (WTG) with each a capacity of 20 megawatt (MW). The foundation type will be jacket foundations, fixed to the bottom with piles with a maximum diameter of 4.5 m, alternatively through suction technology.

Ramboll has provided the following information via email on the timing of the construction. The construction will probably be conducted over at least two years - potentially divided into two phases i.e. there could be a year without installations in the middle. The installation may take place all year except for June - August due to the protection of cod. A jacket foundation consists of four piles. In the technical description of the installation process, an average of 3-5 hours (excl. moving time), have been estimated for each pile to allow for extreme cases where some difficulties may arise. Moving between the four jacket piles may take two hours. So theoretically the maximum installation time per jacket will be 26 hours (4 piles x 5 hours + 3 moves of each 2 hours). The general time of piling driving activity is likely to be four times 3-5 hours i.e., 12-20 hours per jacket foundation. In summary, this means that the 127 turbines will affect approx. 127 days to install over a two year period.

The noise modelling results include the fact that marine mammals do not hear equally well at all frequencies and thus the model include frequency weighting (Very High Frequency - VHF) as proposed by Southall et al. (2019) and recommended by Energistyrelsen (2022) when assessing the risk for inflicting TTS and PTS.

Furthermore, the model includes the noise abatement system double Big Bubble Curtain (DBBC, see Bellmann et al. 2020 and Ramboll 2023). This is a frequently used noise mitigation system and has proved very efficient (e.g. Bellmann et al. 2020; Dähne et al., 2017). A DBBC can reduce the broadband sound exposure level (SEL) with up to 18 dB (maximum measured noise reduction) and potentially more in the higher frequencies. However, the average noise reduction of an optimized DBBC mostly ranges between 15 dB and 16 dB (Ramboll 2023). This system is described in detail in Ramboll (2023) and will not be further described here.

An additional noise abatement method, the Hydro Sound Damper (HSD) is also included as mitigation measure. The HSD is "*a deployed fishnet with attached elements of different sizes and distances to each other. These attached elements can be everything from gas-filled balloons or foam plastic, typically spherical in shape*" Ramboll (2023). Bellmann et al. (2020) have summarized the measured reduction in radiated noise at different frequencies for different abatement systems, alone and in combination (**Figure 3-1**). They found that the mitigation system of HSD together with a DBBC created a high noise reduction at the higher frequencies relevant to harbour porpoise. This is also illustrated in the noise modelling by Ramboll (2023) where adding the HSD creates a reduction of 50 % in the radial distance from the bubble curtain to the threshold limits. The HSD system was developed for monopoles and is at present being considered for jacket foundations (Bellmann et al., 2020).

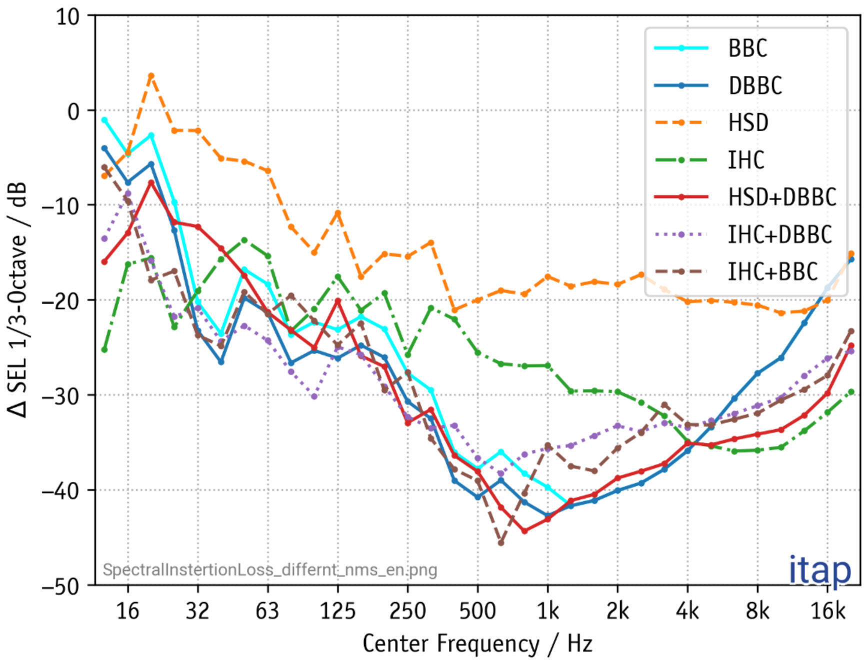


Figure 3-1 Noise mitigation reduction spectrum (Bellmann et al. 2020).

As the hydrographical conditions change over the year, so does the sound propagation characteristics of the water column change. Therefore, prediction models were performed for each of the four seasons. The model results on the radial distances for pile driving of the jacket foundations are shown in Table 3-1. Noise abatement, such as the DBBC and/or the HSD are considered fully commercially available systems for mono piles (Technology Readiness Level 9) and must therefore be considered BAT and BEP (Best Available Technology and Best Environmental Practice). Thus, it is not considered a viable option to pile without noise abatement. However, for reference, the area affected under worst case assumptions without noise abatement is included in Table 3-1 for comparison. It shows that the noise mitigation system (both DBBC and DBBC+HSD) essentially eliminates the risk of inflicting PTS and TTS on porpoises and significantly lowers the area where behavioural impact can be expected.

Table 3-1. Construction activity modelling results/radial distance to threshold limits for harbour Porpoises, average maximum. DBBC = Double Big Bubble Curtain. From Ramboll (2023)

Season	Activity	PTS	TTS	Behaviour
Winter	Jacket piling 4,5 m dia.	600 meters	30 km	41 km
	Jacket piling, 4.5 m. diameter (with double BBC)	<20 m from BBC	30 m	12 km
	Jacket piling, 4.5 m. diameter (with double BBC + HSD)	<20 m from BBC	30 m from BBC	6 km
Spring	Jacket piling 4,5 m dia.	350 m	26 km	38 km
	Jacket piling, 4.5 m. diameter (with double BBC)	<20 m from BBC	20 m from BBC	10 km
	Jacket piling, 4.5 m. diameter (with double BBC + HSD)	<20 m from BBC	20 m from BBC	5 km
Summer	Jacket piling 4,5 m dia.	50 m	12 km	22 km
	Jacket piling, 4.5 m. diameter (with double BBC)	<20 m from BBC	<20 m from BBC	6 km
	Jacket piling, 4.5 m. diameter (with double BBC + HSD)	<20 m from BBC	10 m from BBC	3 km
Autumn	Jacket piling 4,5 m dia.	150 m	21 km	28 km
	Jacket piling, 4.5 m. diameter (with double BBC)	<20 m from BBC	<20 m from BBC	8 km
	Jacket piling, 4.5 m. diameter (with double BBC + HSD)	<20 m from BBC	10 m from BBC	4 km

Based on the modelling results, Ramboll (2023) concludes:

- Because of the mitigation measures used for the pile driving, the noise modelling results show that there is practically no risk of permanent hearing injury (PTS) for harbour porpoises during construction activities with noise mitigation (DBBC). Harbour porpoises will have to be within <20 m to get PTS. However, as a ramp up period are used during pile driving of jacket foundations, the likelihood of porpoises being within 20 m of the pile driving are negligible. If no mitigation is used PTS will be possible in a radial distance of 600 m during winter, 350 m during spring, 50 m during summer and 150 m during autumn.

- There will be a risk of TTS up to 20 m from the pile driving when mitigation is used. However, as a ramp up period are used during pile driving of jacket foundations, the likelihood of porpoises being within this distance of the pile driving are negligible. If no mitigation is used TTS will be possible in a radial distance of 30 km during winter.

- Modelled behaviour threshold distances are up to 6 km (VHF weighted noise levels) from the jacket pile driving (with DBBC+HSD) in the winter, 5 km in spring, 3 km in the summer and 4 km in autumn. If only DBBC are used the distances are 12 km in the winter, 10 km in spring, 6 km during summer and 8 km in autumn. If no mitigation is used impact ranges increased significantly and behavioural disturbance may occur in a radial distance of 41 km during winter, 38 km in spring, 22 km during summer and 28 km during autumn.

The mitigated radial distances of behavioural impacts are illustrated in Figure 3-1 (DBBC) and Figure 3-2 (DBBC+HSD) for spring, autumn and winter. Summer is irrelevant due to the protection of cod that will not allow for pile driving to take place in this season. For DBBC (Figure 3-1), the most eastern part of the winter impact area (12 km buffer zone) and the most eastern part of the spring impact area (10 km) overlaps with the Natura 2000 site "Hoburgs bank och Midsjöbankarna". For DBBC+HSD (Figure 3-2), none of the impact areas overlaps with the Natura 2000 site "Hoburgs bank och Midsjöbankarna". For assessment of impact on the Natura 2000 site see section 4.2.

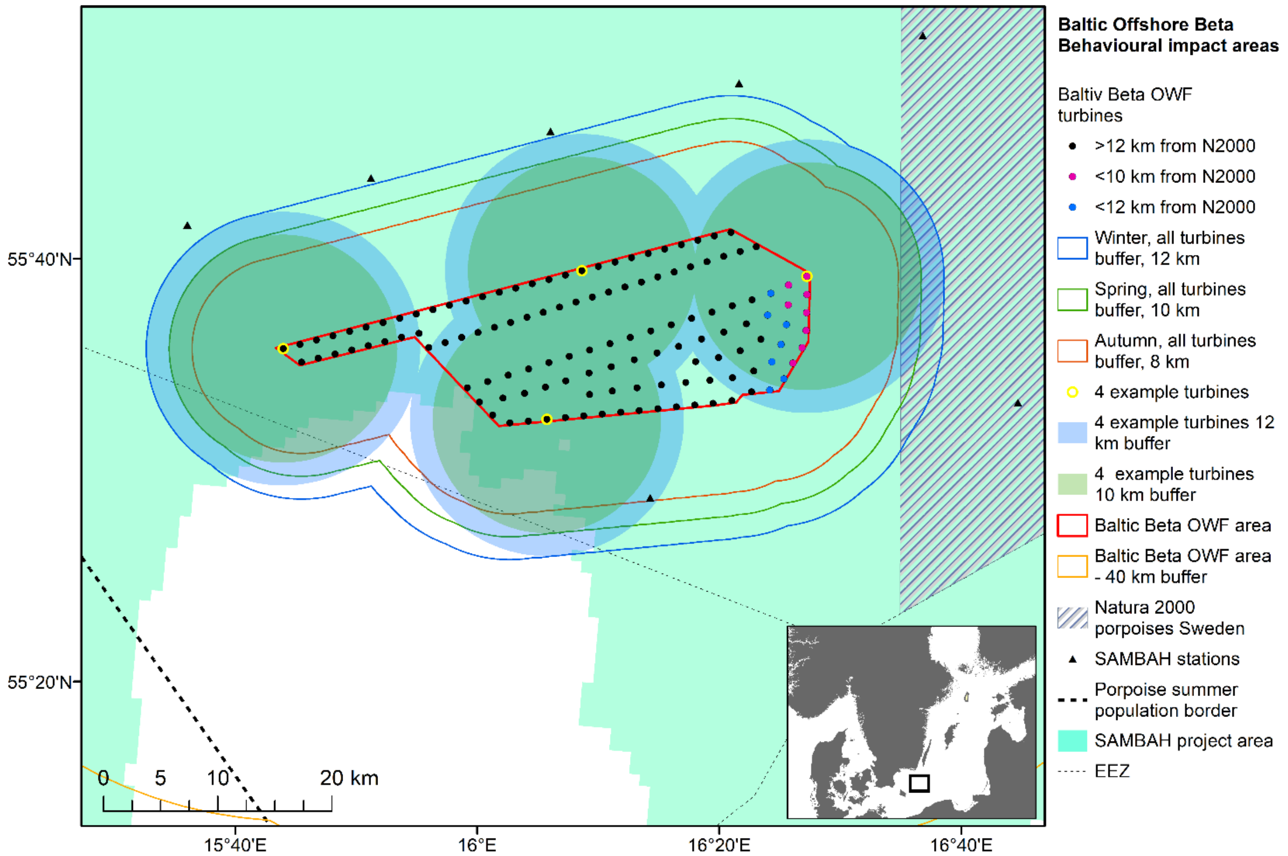


Figure 3-2. Map illustrating the combined behavioural impact areas for winter, spring and autumn for all turbines as modelled by Ramboll (2023) are illustrated in red colours as well as impact distances for selected 4 turbines. Turbines within 12 km of the N2000 site are marked in light green.

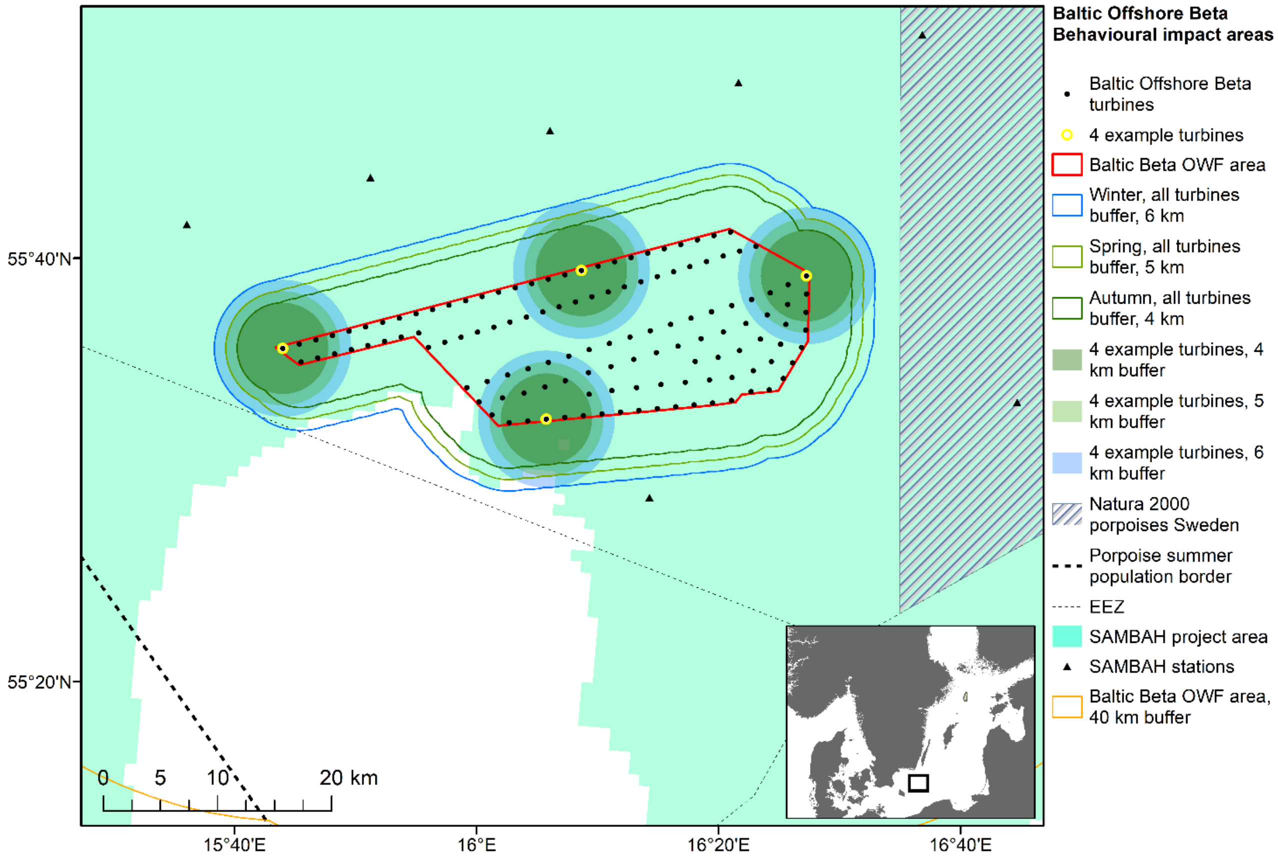


Figure 3-3. Map illustrating the combined behavioural impact areas for winter, spring and autumn for all turbines as modelled by Ramboll (2023), using DBBC and HSD, are illustrated in red colours as well as impact distances for selected 4 turbines.

Based on the modelling results in Ramboll (2023) and the information on timing received from Ramboll by email, we here assess that the impact magnitude of the mitigated pile driving (Both DBBC and DBBC+HSD) of the 127 turbines over 127 days across two years, will be **negligible** with regard to PTS and TTS in all seasons due to the very short radial distances (<20 m) and the high likelihood that the ramp up of the piling will have deterred porpoises from this area prior to full power piling.

With regard to behaviour disturbances of porpoises, the impact on a single day will be as illustrated by each of the four turbine examples in Figure 3-1 for DBBC i.e. the impacted area wherein the animals are likely to be disturbed are in a radial distance of 12 km from the piling (equals a total impacted area of 452 km^2) in the winter, 10 km in spring (≈314 km^2) and 8 km (≈201 km^2) in autumn. For DBBC+HSD (illustrated in Figure 3-2) the impacted area wherein the animals are likely to be disturbed are in a radial distance of 6 km from the piling (equals a total impacted area of 113 km^2) in the winter, 5 km in spring (≈79 km^2) and 4 km (≈50 km^2) in autumn. However, as the turbines are located relatively close to each other, the area around each turbine will be impacted not only by the pile driving of that turbine but also by the installation of the neighboring turbines. For the behavioral impacted area when the mitigation method is DBBC, this means that depending on the location of the turbine, each turbine area will be impacted from 17 days (the areas in the most western part of the wind farm with few turbines) to >80 days (in the central part of the wind farm) in pile driving occur during winter. During spring and autumn each turbine area will be impacted from 13 to 65 and from

11 to 50, respectively. The impact during summer will be from 9 to 30 days, but this is not relevant since pile driving will not take place during summer due to the cod ban. If DBBC+HSD (or similar) is used as mitigation method the area may be impacted from 9 to 30 days (in the central part of the wind farm) if pile driving occurs during winter. During spring, summer, and autumn each turbine area may be impacted from 7 to 22, 3 to 8 days and 5 to 14, respectively. The interval between installations of turbines are at present unknown but it may be from 0 days to several month, highly dependent on weather.

It is impossible to estimate how many porpoises will be affected by the pile driving, especially because the density of animals in the area is expected to be low on an absolute scale (i.e., compared to densities for example in the Western Baltic and Danish Straits). However, if we look at the percent detection positive days detected on the SAMBAH stations found during the national monitoring programs in recent years (Table 1-1), it appears that at a given station a porpoise will be detected from 0.6-4.1% of days (Average = 2.3%) on the stations within a buffer of 40 km from the Baltic Offshore Beta wind farm. On the three stations with the highest levels of detections within the Natura 2000 site porpoises are detected on 5.8-52.6% of days (average = 26%). So, if the precautionary principle is implemented, and we assume that the detection rate within the Baltic Offshore Beta wind farm is as high as within the Natura 2000 site, porpoises will be close to a turbine pile site on 5.8-52.6% of days. It is, however, very likely that the actual "encounter rate" is lower and instead similar to the levels found within the 40 km buffer i.e., on max. 4.1% of days. This means that e.g., for the winter piling of turbines porpoises in the centre of the wind farm where the sound of the pile driving may affect a given turbine location on 30 days, porpoises would be present 15 days of those days (worst case scenario) or 1 day (likely scenario). In the autumn, this would be 7 days (worst case scenario) and 0.5 day (likely scenario). Furthermore, as the unit is a "detection positive day", but a pile driving is expected to last less than 3-5 hours per jacket followed by a 2 hour break, the likelihood that porpoises are present within that period is further reduced, to approx. 50 % of the numbers above (piling lasting a maximum of 10only mean that a porpoise was detected at some point during those 24 hours e.g. just for 1 minute and not that it was present all day.

To sum up, the modelled area affected by noise above behaviour threshold by pile driving indicate that porpoises are likely to be disturbed by the noise over a certain area in all seasons especially in the winter. According to the assessment methodology (table 2-3), the impact magnitude of pile driving on behaviour should be medium since "impact time is from days to weeks" and not just hours. However, "the impact is reversible and do not lead to any permanent change" points to the impact magnitude being minor. Here, we assess the impact magnitude of pile driving on harbour porpoise behaviour in all seasons to be **medium to minor**. However, the impact magnitude will obviously be lower in autumn and spring compared to winter.

It should be noted that, that the critically endangered status of the Baltic Proper harbour porpoise population is a major factor in the assessment of the sensitivity of the species towards impacts. For the larger neighbouring Belt Sea population, these behavioural temporary impacts would be considered negligible to minor. The main factor driving the assessment of the impact up is therefore the precautionary assumptions that have been made to accommodate the fact that Baltic Proper porpoises are assessed as critically endangered.

At present the chosen mitigation method is DBBC since HSD still isn't a commercially available system for jacket foundations. That means that DBBC at present is both BAT and BEP, i.e., no other technologies for abatement of pile driving noise are currently available (M. Bellmann pers. Comm. April 2023). However, new mitigations are being developed and the HSD-system and similar might be available at the time of the construction. If a wind farm is to be constructed in the proposed area on jacket foundations, there are no means available to entirely avoid a temporary impact on the behaviour of harbour porpoises in the area.

3.1.2 Shipping

The background noise in the Baltic Sea is mainly affected by the high level of ship traffic. According to Ramboll (2023), it is estimated that about 2000 sizeable ships are at sea at any time, and each month around 3,500-5,000 ships traffic the waters of the Baltic Sea. And furthermore, that "based on the number of ships passing and data from baseline underwater noise measurements in the Baltic Sea, the average existing background noise levels from shipping range from 100 dB (re. 1 μPa.) away from the ship lanes to up to 120 dB (re. 1 μPa.) close to the ship lanes." Detection range of harbour porpoise depend on background noise levels as well as hearing thresholds. Based on this high level of background noise, Ramboll (2023) estimate that the impact of the additional ships used during construction, may impact the behaviour of harbour porpoises in distances of up to 50 m.

As described in section 2.3.1 under sensitivity of porpoises to shipping, very little information is available on the behaviour of porpoises in reaction to ship noise with estimated reaction distance being up to 400 m depending on ship type and speed.

However, none of the studies mentioned can be directly transferred to assess the impact magnitude of ship traffic from the construction of the Baltic Offshore Beta wind farm. According to Ramboll, the fleet related to the construction of the wind farm will be 10 ships and there will be approximately 1050 trips in total over approximately three years. This adds up to that only a few vessels will be in the area at the same time.

Based on this information, as well as the fact that the amount of existing ship traffic within this area is relatively large, we here assess that the impact magnitude of ship traffic to porpoise behaviour to be **minor**.

The source level of ship noise is substantially lower than pile driving noise. Porpoises have poor hearing below a few kHz and it is unknown what they may use this low-frequency hearing for. Ship traffic may cause masking, although very little is known about this. It is assumed that it will only occur very close to the vessels in distances where the presence of the ship will already have disturbed the porpoises to swim away. Thus, the impact of masking by ships are assessed to be **negligible**.

3.2 Impact magnitude of sediment spill

Sediment spill will occur primarily during installation of the foundations and the cables. The magnitude of the sediment spill is given in Ramboll (2022). A short summary of each report is given below.

The widest spreading of suspended sediments in the water mass will occur during installation of the foundation although the levels between installation of foundations and cables are comparable.

Ramboll (2022) provides the following results for the installation of the foundations:

- The maximum sedimentation observed is 3517 g/m^2. This translates to a settled layer thickness of approximately 3.5 mm. Note that this maximum is confined to a small area.

- 109.1 km^2 is covered with a layer thickness of settled sediments of at least 100 g/m^2 (≈ .1 mm).

- The maximum observed concentration in the water column is 56.2 mg/l. Note that this maximum is observed for a short period (<1 h) and in a confined area.

- The area that exceeds the threshold of 5 mg/l exceeded for at least one hour, is 121 km^2. For a threshold of 10 mg/l, the area exceeded for at least one hour is 44.8 km^2.

Selected results for the cable installation scenario:

- The maximum sedimentation observed is 3142 g/m^2. This translates to a settled layer thickness of approximately 3.1 mm. Note that this maximum is confined to a small area.

- 274.2 km^2 is covered with a layer thickness of settled sediments of at least 100 g/m^2 (≈0.1 mm).

- The maximum observed concentration in the water column is 104.2 mg/l. Note that this maximum is observed for a short period (<1 h) and in a confined area.

- The area that exceeds the threshold of 5 mg/l, exceeded for at least one hour, is 278.2 km^2. For a threshold of 10 mg/l, the area exceeded for at least one hour is 174.1 km^2.

The sediment plumes can cover long distances from the installation and the scale of sediment spill is thus quite large. The duration is, however, temporary and the impact is reversible, and the impact magnitude is thus assessed to be **minor**.

4 Conclusion

In this chapter, the sensitivity of harbour porpoises and the impact magnitude of the activities are compared, and the overall impact significance assessed according to the method described in section 2.2.

4.1 Impact significance

To assess the impact significance, the sensitivity of porpoises is combined with the impact magnitude of construction activities. The magnitudes were estimated under assumption of use of Best Available Technology and Best Environmental Practice (BAT/BEP), in the form of combined use of either a double big bubble curtain (DBBC) or a DBBC together with a hydrosound damper system (HSD). The assessments are presented in Table 4-1. In summary, the impact of pile driving on hearing loss (PTS and TTS) are assessed to be **negligible** with use of both DBBC and DBBC+HSD. The impact of pile driving on behaviour with regard to displacement/disturbances are assessed to be **minor to moderate** in all seasons for both DBBC and DBBC+HSD, with the lowest potential impact in autumn with use of DBBC+HSD and highest in winter when using only DBBC. The impact significance of masking due to pile driving is assessed to be **negligible**.

The impact of shipping on behaviour are assessed to be **low** and on masking to be **negligible**.

The impact of sediment spill on visual impairment and behaviour are assessed to be **low**.

Table 4.1. Summary tables of activity, impact, sensitivity, and assessment in the Swedish waters relevant for each activity for harbour porpoise. All impacts are assessed with noise mitigation using either double bubble curtain (DBBC) or DBBC + HSD (Hydro Sound Damper). *Number of days where porpoise behaviour may be impacted at each turbine

Activity	Mitigation	Impact	Sensitivity	Reversibility	Spatial extent	Temporal extent	Impact magnitude	Impact significance
Pile driving	DBBC	PTS	High	Irreversible	0	not relevant	Negligible	Negligible
		TTS	Low	Reversible	< 50 m	not relevant	Negligible	Negligible
		Behaviour – masking	Low	Reversible	< 12 km	9-30 days	Negligible	Negligible
	DBBC	Behaviour - displacement/ disturbance, winter	Medium	Reversible	< 12 km	15-80 days*	Medium-Minor	Moderate-minor
		Behaviour - displacement/ disturbance, spring	Medium	Reversible	< 10 km	13-65 days*	Medium-Minor	Moderate -minor
		Behaviour - displacement/ disturbance, summer	Medium	Reversible	< 6 km	9-30 days*	Medium-Minor	Moderate-minor
		Behaviour - displacement/ disturbance, autumn	Medium	Reversible	< 8 km	11-50 days*	Medium-Minor	Moderate-minor
	DBBC + HSD	Behaviour - displacement/ disturbance, winter	Medium	Reversible	< 6 km	9-30 days*	Medium-Minor	Moderate-minor
		Behaviour - displacement/ disturbance, spring	Medium	Reversible	< 5 km	7-22 days*	Medium-Minor	Moderate-minor
		Behaviour - displacement/ disturbance, summer	Medium	Reversible	< 3 km	3-8 days*	Medium-Minor	Moderate-minor
		Behaviour - displacement/ disturbance, autumn	Medium	Reversible	< 4 km	5-14 days*	Medium-Minor	Moderate-minor
Shipping	DBBC	Behaviour - displacement/ disturbance	Medium	Reversible	< 400 m	Hours	Minor	Low
		Behaviour – masking	Low	Reversible	< 400 m	Hours	Negligible	Negligible
Sediment spill	DBBC	Visual impairment	Low	Reversible	local	few days after ended impact	Minor	Low
		Behaviour - displacement/ disturbance	Low	Reversible	local	few days after ended impact	Minor	Low

4.2 Impact on Natura 2000 sites

The proposed area for the Baltic offshore Beta wind farm is located approximately 8 km from the large (10.511 km^2) Natura 2000 site "Hoburgs bank och Midsjöbankarna" designated for harbour porpoises in 2016. This is the only Natura 2000 site that potentially could be impacted by the construction of the Baltic offshore Beta wind farm. The impact could be in the form of behavioural disturbances and masking and not PTS and TTS.

If the mitigation method of DBBC + HSD or similar will be used, the maximum distance behavioural distance will be 6 km (in the winter), and thus the impact on the Natura 2000 site located 8 km away, will be **negligible.**

When applying he mitigation method of DBBC, it will be the installation of the 12 most eastern turbines that will have an impact inside the Natura 2000 site "Hoburgs bank och Midsjöbankarna" during winter and the 7 most eastern turbines during spring. Pile driving during summer and autumn will not affect the Natura 2000 site.

The maximum area impacted within the Natura 2000 site is 46 km^2 during winter and 14 km^2 during spring. This will occur during piling of the most eastern turbine exemplified in Figure 3-1. The Natura 2000 site is 10.511 km^2. This means that it will be maximum 0.44 % of the Natura 2000 area impacted over a maximum of 12 days over a period of two years during winter. And a maximum on 0.13 % of the Natura 2000 site for a maximum of 7 days in spring.

However, the management plan (Länsstyrelsen 2021) for the site states that within the Natura 2000 area Hoburgs bank and Midsjöbankarna, impulsive noise or continuous underwater noise, including shipping, should not cause any behavioural impact within the areas where the detection rate of porpoises is highest within the Natura 2000 area "Hoburgs bank and Midsjöbankarna". For the parts of the Natura 2000 sites with the lower detection rates, activities that generate underwater noise that exceeds the porpoise's hearing threshold by 40 dB should be minimized.

This "area of highest detection" activity is assessed by Owen et al. (2021) to be area surrounding the Northern Midsea Bank. The three stations deployed here 2017-2020 (station ID: 1032, 1036 and 1041) had the highest level of detections of the 12 stations monitored after SAMBAH ended in 2013. None of the three high level stations are within the 40 km buffer area of the proposed Baltic Offshore Beta wind farm area. However, as the 46 km^2 potentially affected by the piling of the 12 most eastern turbines have never been monitored (Figure 3-1), the level of detections in this area are unknown. Thus, the optimal approach would be to not cause any behavioural disturbances within the Natura 2000 site (see also Section 2.2.3).

This could be obtained if the installation of the specific 12 most eastern turbines were conducted in the autumn where the sound propagation in warmer water will lower the range of the noise levels. As the four seasonal models are based on average variables for the three months in each season, new specific models should be run when the period for the pile driving of the eastern turbines are known. This is important since the impact e.g. in autumn in September will be lower than the average impact range for that season, but the impact range for November will be larger and may thus affect the Natura 2000 site after all.

The impact significance of pile driving on behaviour of porpoises from the Baltic Offshore Beta wind farm is thus assessed to be **negligible** in the summer and autumn. In the winter and spring, the impact significance of pile on behaviour of porpoises is assessed to be **moderate** due to the restrictions on impacts on behaviour described in the management plan (Länsstyrelsen 2021). The impact assessment in winter could potentially be lowered if further mitigation methods e.g. Hydro Sound Dampener in combination with the current DBBC could reduce the emitted noise levels and thus avoid impact on the Natura 2000 site.

5 References

Amundin, M., Carlström, J., Thomas, L., Carlén, I., Teilmann, J., Tougaard, J., Loisa, O., Kyhn, L. A., Sveegaard, S., Burt, M. L., Pawliczka, I., Koza, R., Arciszewski, B., Galatius, A., Laaksonlaita, J., MacAuley, J., Wright, A. J., Gallus, A., Dähne, M., ... Blankett, P. (2022). Estimating the abundance of the critically endangered Baltic Proper harbour porpoise (*Phocoena phocoena*) population using passive acoustic monitoring. Ecology and Evolution, 12(2), [e8554]. https://doi.org/10.1002/ece3.8554

Andersen, L.W., Ruzzante, D.E., Walton, M., Berggren, P., Bjørge, A. & Lockyer, C. (2001). Conservation genetics of the harbour porpoise, *Phocoena Phocoena*, in eastern and central North Atlantic. Conservations Genetics vol. 2: 309-324.

Andersen, S. (1970). Auditory sensitivity of the Harbour Porpoise *Phocoena phocoena*. Investigations on Cetacea 2, 255-258.

Anon. 2002. ASCOBANS, "Recovery Plan for Baltic Harbour Porpoises (Jastarnia Plan)". http://www.ascobans.org/index0503.html

ASCOBANS. 2016. ASCOBANS Recovery Plan for Baltic Harbour Porpoises Jastarnia Plan (2016 Revision). 2016. https://www.ascobans.org/sites/default/files/document/ASCOBANS_JastarniaPlan_MOP8.pdf

Bas, A.A., Christiansen, F., Ozturk, A.A., Ozturk, 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.

Bellmann, M. A., Brinkmann, J., May, A., Wendt, T., Gerlach, S. and Remmers, P. 2020. Underwater noise during the impulse pile-driving procedure: Influencing factors on pile-driving noise and technical possibilities to comply with noise mitigation values. Report to the Federal Maritime and Hydrographic Agency. I. Gmbh,Oldenburg, Germany. pp.

Börjesson, P. and Berggren, P. (2003). Diet of harbour porpoises in the Kattegat and Skagerrak Seas: Accounting for individual variation and sample size. Mar. Mamm. Sci. 19, 38-58.

Brandt, M. J., Dragon, A. C., Diederichs, A., Bellmann, M. A., Wahl, V., Piper, W., Nehls, G. 2018. Disturbance of harbour porpoises during construction of the first seven offshore wind farms in Germany. Marine Ecological Progress Series, 596, 213-232. https://doi.org/10.3354/meps12560

Brandt, M., Dragon, A-C., Diederichs, A., Bellmann, M. A., Wahl, V., Piper, W., Nabe-Nielsen, J., & Nehls, G. (2018). Disturbance of harbour porpoises during construction of the first seven offshore wind farms in Germany. Marine Ecology - Progress Series, 596(213-232), 213-232. https://doi.org/10.3354/meps12560

Camphuysen, K., Krop, A. 2011. Maternal care, calf-training and site fidelity in a wild harbour porpoise in the North Sea. Lutra 54 (2): 123-126.

Carlén, I., Thomas, L., Carlström, J., Amundin, M., Teilmann, J., Tregenza, N., Tougaard, J., Koblitz, J. C., Sveegaard, S., Wennerberg, D., Loisa, O., Dähne, M., Brundiers, K., Kosecka, M., Kyhn, L. A., Ljungqvist, C. T., Pawliczka, I., Koza, R., Arciszewski, B., ... Acevedo-Gutiérrez, A. (2018). Basin-scale distribution of harbour porpoises in the Baltic Sea provides basis for effective conservation actions. Biological Conservation, 226, 42-53. https://doi.org/10.1016/j.biocon.2018.06.031

CMS 2021. CMS Family Guidelines on Environmental Impact Assessment for Marine Noise-generating Activities. UNEP/ASCOBANS/Res. 8.11 (Rev. MOP9). 30 pp. https://www.ascobans.org/sites/default/files/document/ascobans_res8.11_rev.mop9_cms-family-guidelines-eia-noise.pdf

Dähne, M., Gilles, A., Lucke, K., Peschko, V. 2013. Effects of pile driving on harbour porpoises (*Phocoena phocoena*) at the first offshore wind farm in Germany. s.l. Env Res Lett 8: 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. Marine Ecology - Progress Series, 580, 221–237. https://doi.org/10.3354/meps12257

Danish Energy Agency. 2022. Guideline for underwater noise - Installation of impact or vibratory driven piles. May 2022. https://ens.dk/sites/ens.dk/files/Vindenergi/guidelines_for_underwater_noise_energistyrelsen_maj_2022_1.pdf

Dyndo, M., Wiśniewska, D.M., Rojano-Doñate, L., Madsen, P.T., 2015. Harbour porpoises react to low levels of high frequency vessel noise. Scientific Reports 5, 11083.

Energistyrelsen. 2015. Marine mammals and underwater noise in relation to pile driving – Working Group 2014. Report from working group. Second revision 21.01.2015. pp. 20.

Erbe, C., C. Reichmuth, K. Cunningham, K. Lucke, and R. Dooling. 2016. Communication masking in marine mammals: A review and research strategy. Marine pollution bulletin. 103:15-38.

Galatius, A., Kinze, C.C. and Teilmann, J. (2012). Population structure of harbour porpoises in the greater Baltic region: Evidence of separation based on geometric morphometric comparisons. Journal of the Marine Biological Association of the United Kingdom 92(8): 1669-1676. DOI:10.1017/S0025315412000513

Gilles, A., Adler, S., Kaschner, K, Scheidat, M., Siebert, U. 2011. Modelling harbour porpoise seasonal density as a function of the German Bight environment: implications for management. Endangered Species Research 14: 157–169. doi: 10.3354/esr00344.

Hammond, P. S., Benke, H., Berggren, P., Borchers, D. L., Buckland, S. T., Collet, A., Heide-Jørgensen, M-P., Heimlich-Boran, S., Hiby, A. R., Leopold, M. F., and Øien, N. (1995) Distribution and abundance of the harbour porpoise and other small cetaceans in the North Sea and adjacent waters. Final report Life 92-2/UK/027. p. 240.

Hammond, P.S., Bearzi, G., Bjørge, A., Forney, K.A., Karczmarski, L., Kasuya, T., Perrin, W., Scott, M.D., Wang, J.Y. , Wells, R.S. & Wilson, B. 2016. Phocoena phocoena (Baltic Sea subpopulation) (errata version published in 2016). The IUCN Red List of Threatened Species 2008: e.T17031A98831650. https://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T17031A6739565.en. Accessed on 21 December 2022.

HELCOM. 2019. Species information sheet: Baltic Sea subpopulation. https://helcom.fi/wp-content/uploads/2019/08/HELCOM-Red-List-Phocoena-phocoena.pdf

Houser, D. S., Yost, W., Burkard, R., Finneran, J. J., Reichmuth, C. and Mulsow, J. 2017. A review of the history, development and application of auditory weighting functions in humans and marine mammals. The Journal of the Acoustical Society of America 141:1371-1413.

ICES. 2020. EU request on emergency measures to prevent bycatch of common dolphin (*Delphinus delphis*) and Baltic Proper harbour porpoise (*Phocoena phocoena*) in the Northeast Atlantic. In Report of the ICES Advisory Committee, 2020. ICES Advice 2020, eu.2

Kastelein, R. A., Bunskoek, P., Hagedoorn, M., Au, W. W. L., and Haan, D. 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., Janssen, M., Verboom, W. C., & Haan, D. d. (2005). Receiving beam patterns in the horizontal plane of a harbour porpoise (*Phocoena phocoena*). Journal of the Acoustical Society of America, 118, 1172-1179.

Kastelein, R.A., von Benda-Beckmann, A.M., Lam, F.A., Jansen, E.,de Jong, C.A.F. 2019. Effect of a Bubble Screen on the Behavioral Responses of Captive Harbor Porpoises (*Phocoena phocoena*) Exposed to Airgun Sounds. Aquatic Mammals 2019, 45(6), 706-716, DOI 10.1578/AM.45.6.2019.706.

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(10): e0186951. https://doi.org/10.1371/journal.pone.0186951

Kinze, C. C., Jensen, T., and Skov, R. (2003) Focus på hvaler i Danmark 2000-2002. Tougaard, S. Esbjerg, Denmark, Fisheries and Maritime Museum. Biological Papers No. 2,

Koschinski S (2002). Current knowledge of the harbour porpoises (*Phocoena phocoena*) in the Baltic Sea. Ophelia 55: 167-197.

Kyhn, L. A., Tougaard, J., Beedholm, K., Jensen, F. H., Ashe, E., Williams, R., Madsen, P. T. (2013) Clicking in killer whale habitat: Narrow-band, high frequency biosonar clicks of harbour porpoise (*Phocoena phocoena*) and Dall's porpoise (*Phocoenoides dalli*). PLoS One, 8, e63763.

Lah L, Trense D, Benke H, Berggren P, Gunnlaugsson Þ, Lockyer C, et al. (2016) Spatially Explicit Analysis of Genome-Wide SNPs Detects Subtle Population Structure in a Mobile Marine Mammal, the Harbor Porpoise. PLoS ONE 11(10): e0162792. doi:10.1371/journal.pone.0162792.

Länsstyrelsen. 2021. Bevarandeplan för Natura 2000-området SE0330308 Hoburgs bank och Midsjöbankarna. LÄNSSTYRELSEN, Gotlands län, Kalmar län. 48 pp. https://www.lansstyrelsen.se/download/18.63dca67817dc1ece7ef7b17/1639996089199/Hoburgsbankoch%20Midsjo%CC%88bankarna%20SE0330273.pdf

Linnenschmidt M, Teilmann J, Akamatsu T, Dietz R, Miller LA. (2013). Biosonar, dive, and foraging activity of satellite tracked harbor porpoises (*Phocoena phocoena*). Marine Mammal Science 29: E77–97.

Lockyer, C. & Kinze, C.C. (2003). Status and lift history of harbour porpoise (*Phocoena phocoena*) in Danish waters. NAMMCO Scientific Publication 5: 143-176.

Møhl, B. and Andersen, S. (1973). Echolocation: high-frequency component in the click of the harbour porpoise (*Phocena* ph. L.). J. Acoust. Soc. Am. 54, 1368-1372.

Moore, B. C. (2012). An Introduction to the Psychology of Hearing. Emerald Group Ltd.

National Marine Fisheries Service. 2018. 2018 Revision to: Technical Guidance for Assessing the Effects of An-thropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. NOAA Technical Memorandum NMFS-OPR-59. N. U.S. Department of Commerce, Silver Spring, MD. 167 pp.

National Research Council. 2003. Ocean noise and marine mammals. The National Academies Press, Washington, D.C.

Owen, K., Sköld, M., Carlström, J. 2021. An increase in detection rates of the critically endangered Baltic Proper harbour porpoise in Swedish waters in recent Years. Conservation Science and Practice. 2021;3:e468. https://doi.org/10.1111/csp2.468

Peich, L., Behrmann, G., and Kröger, R. H. H. (2001). For whales and seals the ocean is not blue: a visual pigment loss in marine mammals. Eur. J. Neurosci. 13, 1520-1528.

Popov, V. V., Supin, A. Y., Wang, D., & Wang, K. (1986). Evoked potentials of the auditory cortex of the porpoise, *Phocoena phocoena*. Journal of Comparative Physiology A, 158, 705-711.

Prideaux, G., 2017. 'Technical Support Information to the CMS Family Guidelines on Environmental Impact Assessments for Marine Noise-generating Activities', section "B.1. Inshore Odontocetes", Convention on Migratory Species of Wild Animals, Bonn. 76 pp. https://www.cms.int/sites/default/files/basic_page_documents/CMS-Guidelines-EIA-Marine-Noise_TechnicalSupportInformation_FINAL20170918.pdf

Ramboll. 2023. BETA OWF UNDERWATER SOUND MODELLING. Modelling report v. 2.5. Prepared by Christopher McKenzie Maxon. May 10, 2023. Project no. 1100052061.

Ramboll. 2022. BETA VINDKRAFTPARK SEDIMENT SPILL MODELLING Report v2. Prepared by DMONT. Project no. 1320059953-008.

Richardson, W.J., C.R. Greene, C.I. Malme, and D.H. Thomson. 1995. Marine mammals and noise (Academic Press: San Diego).

Skora KE, Pawliczka I, Klinowska M (1988). Observations of the harbour porpoise (*Phocoena phocoena*) on the Polish Baltic coast. Aquat. Mamm. 14 (3): 113-119.

Sørensen, T. B. and Kinze, C. C. (1994). Reproduction and reproductive seasonality in Danish harbour porpoises, *Phocoena phocoena*. Ophelia 39, 159-176.

Southall, B. L., Finneran, J. J., Reichmuth, C., Nachtigall, P. E., Ketten, D. R., Bowles, A. E., Ellison, W. T., Nowacek, D. P. and Tyack, P. L. 2019. Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. Aquatic Mammals 45:125-232.

Southall, B., Bowles, A., Ellison, W., Finneran, J., Gentry, R., Charles, R., et al. (2007). Special Issue: Marine Mammal Noise Exposure Criteria - Initial Scientific Recommendations. Aquatic mammal, 33, 411-509.

Southall, B.L., J.J. Finneran, C. Reichmuth, P.E. Nachtigall, D.R. Ketten, A.E. Bowles, W.T. Ellison, D.P. Nowacek, and P.L. Tyack. 2019. Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. Aquat. Mamm. 45:125-232.
https://doi.org/10.1578/AM.45.2.2019.125

Sveegaard, S., (2020). Notat om resultater fra udlægning af akustiske lyttestationer for marsvin omkring Bornholm som supplerende overvågning af marsvin under Havstrategidirektivet, 8 s., Notat fra DCE - Nationalt Center for Miljø og Energi, Bind 2020, Nr. 5. https://dce.au.dk/fileadmin/dce.au.dk/Udgivelser/Notatet_2020/N2020_5.pdf

Sveegaard, S., Andreasen, H., Mouritsen, K. N., Jeppesen, J. P., and Teilmann, J. (2012). Correlation between the seasonal distribution of harbour porpoises and their prey in the Sound, Baltic Sea. Marine Biology 159: 1029–1037, DOI: 10.1007/s00227-012-1883-.z

Sveegaard, S., Galatius, A. & Tougaard, J. 2017. Marine mammals in Finnish, Russian and Estonian waters in relation to the Nord Stream 2 project. Expert Assessment. Aarhus University, DCE – Danish Centre for Environment and Energy, 80 pp. Scientific Report from DCE – Danish Centre for Environment and Energy No. 238. http://dce2.au.dk/pub/SR238.pdf

Sveegaard, S., Galatius, A., Dietz, R., Kyhn, A., Koblitz, J.C., Amundin, M., Nabe-Nielsen, J., Sinding M.H., Andersen L.W., Teilmann, J. 2015a. Defining management units for cetaceans by combining genetics, morphology, acoustics and satellite tracking. Global Ecology and Conservation 3: 839–850.

Sveegaard, S., Teilmann, J., Tougaard, J., Dietz, R., Mouritsen, K.N., Desportes, G. and Siebert, U. (2011). High density areas for harbor porpoises (*Phocoena phocoena*) identified by satellite tracking. Marine Mammal Science 27(1): 230-246.

Teilmann, J., Larsen, F. & Desportes, G (2007): Time allocation and diving behaviour of harbour porpoises (*Phocoena phocoena*) in Danish waters. Journal of Cetacean Research and Management 9(3): 35-44.

Teilmann, J., Larsen, F., Desportes, G. 2007. Time allocation and diving behaviour of harbour porpoises (*Phocoena phocoena*) in Danish and adjacent waters. Journal of Cetacean Research and Management, 9: 201-10.

Teilmann, J., Miller, L. A., Kirketerp, T., Kastelein, R., Madsen, P. T., Nielsen, B. K., and Au, W. W. L. (2002). Characteristics of echolocation signals used by a harbour porpoise (*Phocoena phocoena*) in a target detection experiment. Aquat.Mamm. 28, 275-284.

Tougaard, J. 2021. Thresholds for behavioural responses to noise in marine mammals. Background note to revision of guidelines from the Danish Energy Agency. D. N. C. F. M. O. E. Aarhus Universitet, Roskilde.

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

Tougaard, J., Griffiths, E.T. 2020. Harbour porpoises and the construction of Nord Stream 2 gas pipeline. Assessment of the impact on porpoises in the Natura2000 Hoburg's Bank and Midsjöbanks, Swedish Baltic. Aarhus University, DCE – Danish Centre for Environment and Energy, 29 pp. Scientific Report No. 398. http://dce2.au.dk/pub/SR398.pdf

Wiemann, A., Andersen, L.W., Berggren, P., Siebert, U., Benke, H., Teilmann, J., Lockyer, C., Pawliczka, I., Skora, K., Roos, A., Lyrholm, T., Paulus, K.B., Ketmaier, V. & Tiedemann, R. (2010). Mitochondrial Control Region and microsatellite analyses on harbour porpoise (*Phocoena phocoena*) unravel population differentiation in the Baltic Sea and adjacent waters. Conservation Genetics 11: 195–211.

Wisniewska, D. M., Johnson, M., Teilmann, T., Rojana-Doñate, L., Shearer, J., Sveegaard, S., Miller, L. A., Siebert, U., Madsen, P. T. (2016) Ultra-high foraging rates of harbour porpoises make them vulnerable to anthropogenic disturbance. Current Biology.

Wisniewska, D.M., Johnson, M., Teilmann, J., Rojano-Donate, 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. 26, 1441-1446.

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 285.

6 Appendix 1

FÖRSVARSMAKTEN
MARINSTABEN

Yttrande

Datum	Beteckning	
2022-05-04	FM2022-11951:1	Sida 1 (3)

Ert tjänsteställe, handläggare	Ert datum	Er beteckning
Aarhus University, Department of Ecoscience Signe Sveegaard	2022-04-21	
Vårt tjänsteställe, handläggare	**Vårt föregående datum**	**Vår föregående beteckning**
MS OpAvd, handläggare Annika Ericsson ms-opavd-tillstand@mil.se		

Akustisk övervakning av tumlare, i område för en framtida potentiell vindkraftpark, Baltic Offshore Beta Wind Farm.

Bakgrund

Signe Sveegaard inkom med ett mail till Försvarsmakten den 21 april med information om ett akustiskt övervakningsprogram av Tumlare i Sveriges ekonomiska zon. I mailet initieras kontakt med den som berörs av utsättningen.

Utifrån inkomna underlag konstaterar Försvarsmakten att utsättningen är planerad innanför den av Försvarsmakten rödmarkerade linjen, se bild A, inom vilken Försvarsmakten tidigare motsatt sig utsättning av motsvarande utrustning.

Bedömning

Försvarsmakten motsätter sig utsättning.

Det kan inte uteslutas att insamlade informationen kan komma att innehålla delar som är av betydelse för den militära delen av totalförsvaret och därmed omfattas av sekretess enligt 15 kap. 2 § offentlighets- och sekretesslagen (2009:400).

(ACA)

Postadress	Besöksadress	Telefon	Telefax	E-post, Internet
Försvarsmakten Marinstaben, Musköbasen 148 80 Muskö	Musköbasen	08-788 75 00		exp-ms@mil.se www.forsvarsmakten.se

Områden
Avseende områden innanför rödmarkerade linjer har Försvarsmakten synpunkter på utplacering av akustisk övervakningsutrustning.

Utplacering av akustisk övervakningsutrustning i området innanför linjerna bedöms medföra en inte obetydlig påverkan på myndighetens marina verksamhet och operativa undervattensförmåga. Områden utanför linjerna bedöms ha mindre påverkan.

Bild A.

1. E19,0834 N60,1916
2. E19,6807 N59,7767
3. E19,6748 N58,4459
4. E20, 1849 N57,6861
5. E19,6222 N56,8975
6. E16,5118 N55,3547
7. E15,0415 N55,6911
8. E14,3877 N55,3554
9. E14,1944 N55,3831

- o 0 o –

Detta yttrande har beslutats av överste Anders Åkermark. I den slutliga handläggningen har deltagit förvaltare Henric Sörefjord och handläggare Annika Ericsson, den senare som föredragande.

Åkermark, Anders

C MS OPAVD

Handlingen är fastställd i Försvarsmaktens elektroniska dokument- och ärendehanteringssystem.

Sändlista
Section for Marine Mammal Research
Department of Ecoscience, Aarhus University
Signe Sveegaard

ssv@ecos.au.dk

För kännedom
Sjöfartsverket
Kustbevakningen

7 Appendix 2

Mail correspondence between Niclas Erkenstål from Njordr Offshore Wind AB and Malin Hemmingsson from Havs- och vattenmyndigheten in on 23. May 2022 and 7. June 2022. The oldest email is at the bottom.

Från:	Malin Hemmingsson <malin.hemmingsson@havochvatten.se>
Skickat:	Tuesday, 7 June 2022 09:40
Till:	Niclas Erkenstål
Ämne:	SV: Yttrande Dnr 3391-2021 - Baltic Offshore Beta

Hej,

Det får bli laga efter läge. Går det inte att göra egna, nya, undersökningar med C-pods, får ni beskriva så gott det går utifrån befintlig kunskap och med hjälp av experter på området, precis som du beskriver.

Vad ni ska ha med er i den här situationen, med tanke på viss osäkerhet i utbredningen av tumlare och i beaktande av Östersjöpopulationens hotstatus, är att det kan komma att ställas höga mycket höga krav på skyddsåtgärder och att försiktighetsprincipen är viktig.

Vänliga hälsningar,

Malin Hemmingsson
Utredare
Miljöprövningsenheten
Havs- och vattenmyndigheten
+46106986184

Från: Niclas Erkenstål
Skickat: Monday, 23 May 2022 17:11
Till: malin.hemmingsson@havochvatten.se
Kopia: Signe Sveegaard <ssv@ecos.au.dk>; niklas.sondell@njordroffshorewind.eu; Erik Strand Tellefsen <erik@njordr.no>
Ämne: Yttrande Dnr 3391-2021 - Baltic Offshore Beta

Hej Malin,

Tack för samtalet i fredags, återkommer här med ett kort referat.

Som diskuterat har vi anlitat Aarhus Universitet för utredning av Tumlare. Bakgrunden till denna utredning är det HaV skriver i sitt yttrande kring möjliga störningar av arten vid utbyggnad av Baltic Offshore Beta. Som en del av utredningen planerades utplacering av Cpods under ett års tid, för att bland annat kartlägga population och rörelsemönster. Enligt gängse rutin informerade vi bland andra Försvarsmakten och Transportstyrelsen, varvid Försvarsmakten motsatte sig utplacering av dessa Cpods, se bifogat svar.

Vi har sedan detta yttrande kontaktat flera olika parter för att försöka få till ett ändrat beslut, bland annat direkt tillbaka till Försvarsmakten. Vi har än så länge inte fått någon återkoppling, trots ett flertal påstötningar. Vi har även varit i kontakt med Julia Karlström på Naturhistoriska, samt din kollega Erland Lettevall, för att försöka hitta vägar framåt för en utplacering av Cpods. Dessa ansträngningar har tyvärr varit resultatlösa, varför vi idag inte ser någon framkomlig väg alls för inventering med hjälp av Cpods. Vi har även diskuterat andra möjliga metoder, men kommit till slutsats att dessa är för osäkra (till exempel flyginventering). Vi kommer dock att försöka ytterligare en gång med en reviderad ansökan till Försvarsmakten, men vi har förhållandevis låga förhoppningar på ett ändrat beslut.

Får vi ej möjlighet att sätta ut Cpods, kommer vi att samla ihop den information som finns tillgänglig (från bland annat Sambah-projektet) och skriva en utförlig rapport med detta som bas. Detta är det enda som står till buds för oss, och vi vill härmed informera er om detta.

Har ni några inspel till oss kring detta mottar vi de gärna.

Med vänliga hälsningar
Niclas

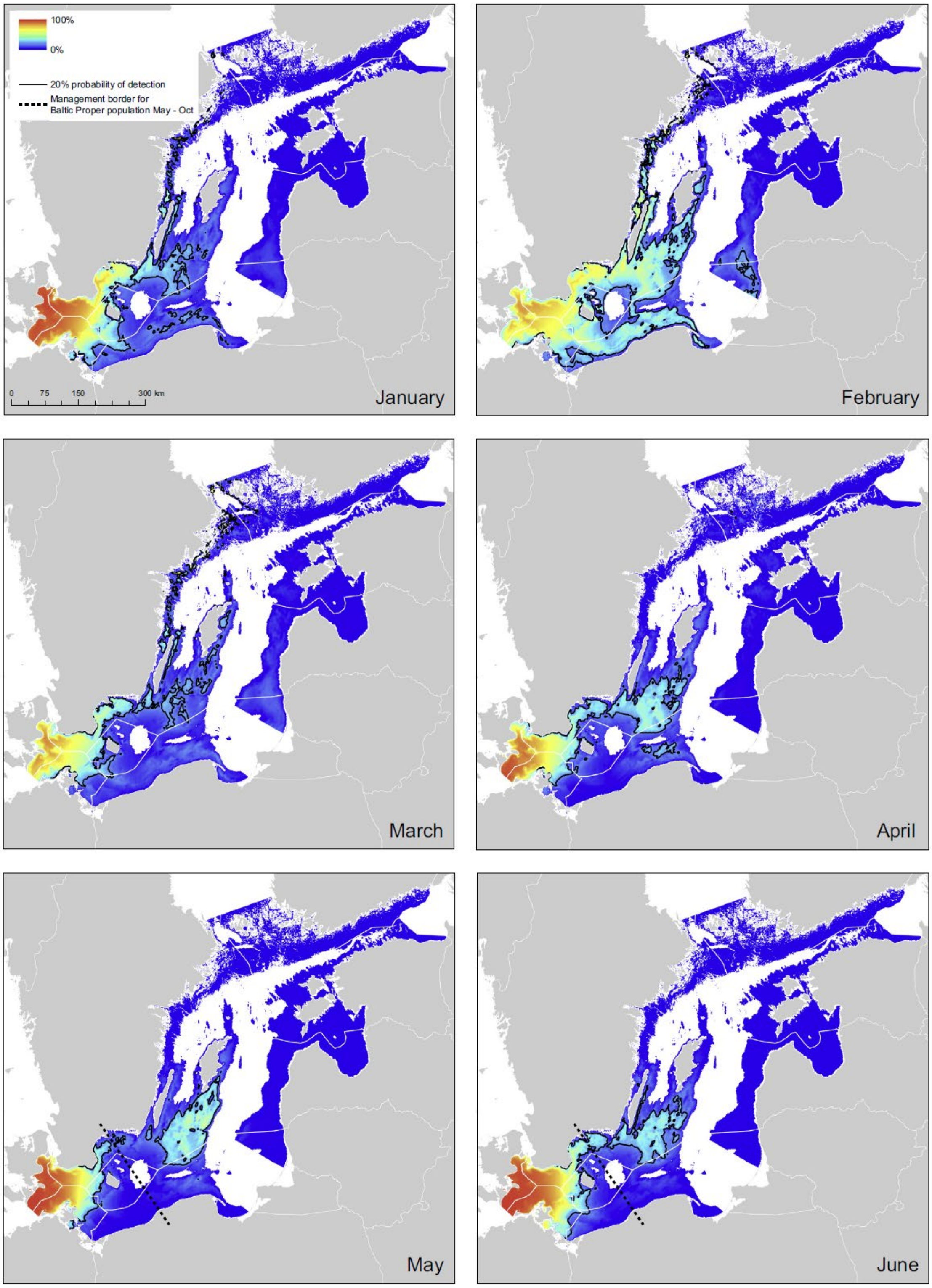
Niclas Erkenstål
Managing Director
Njordr AB

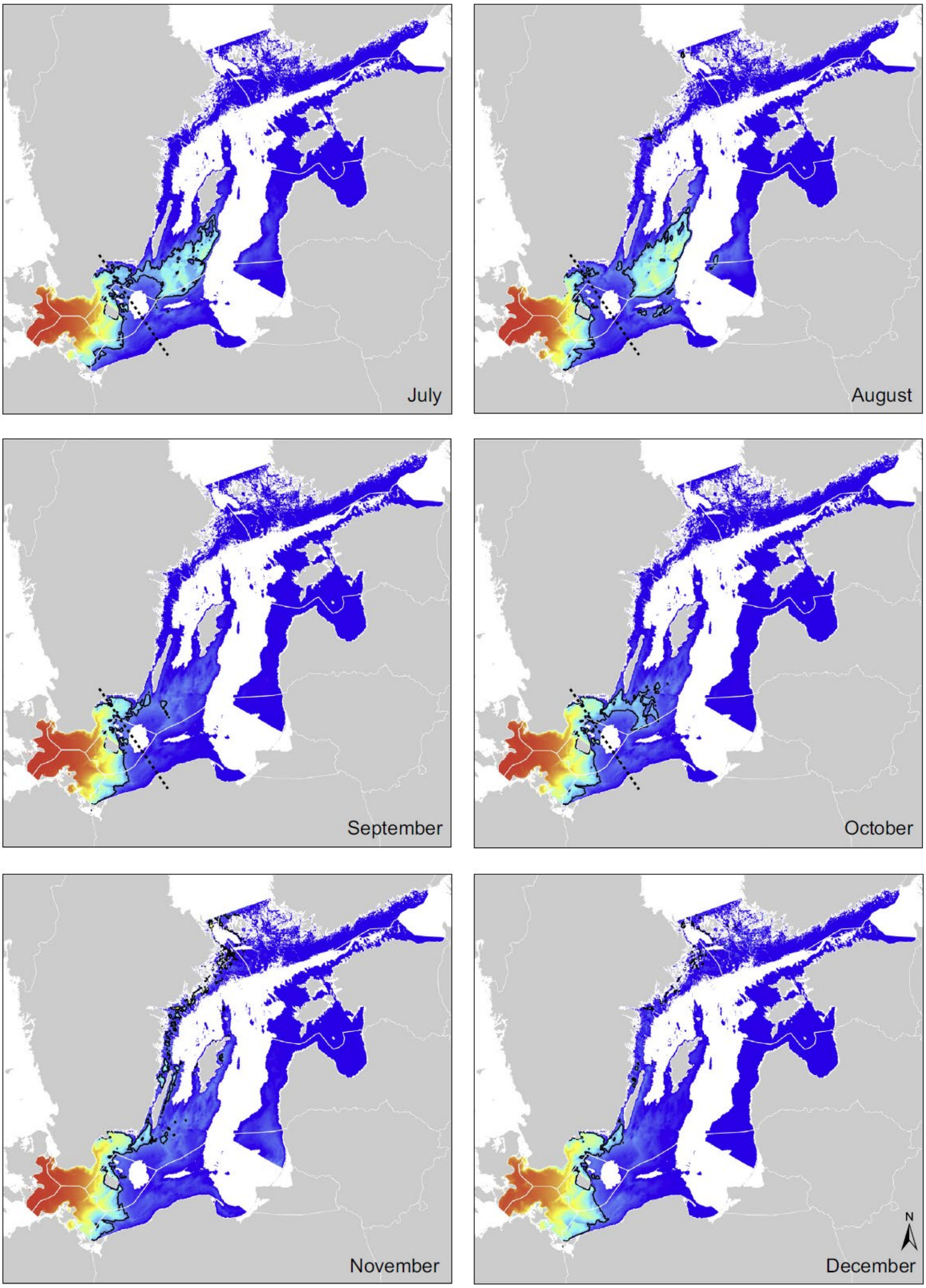
Njordr
WIND POWER PARTNERS

M: +46 708 204 621
niclas.erkenstal@njordr.no
www.njordr.se
www.njordroffshorewind.eu

8 Appendix 3

Predicted monthly probability of detection of harbour porpoises in the study area, for each month January–December. The probability scale is the same in all figures. The black lines indicate the 20% probability of detection. The dotted line shown for May–October is the seasonal management border proposed here for the Baltic Proper population. From Carlén et al. (2018).




July
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N

BALTIC OFFSHORE BETA WINDFARM

Baseline and assessment of harbour porpoises

Aarhus University (AU) has been commissioned by Njordr Offshore Wind AB and Rambøll Sweden to conduct a baseline investigation as well as an impact assessment on harbour porpoises of the construction of the Baltic Offshore Beta wind farm in the Baltic Proper (Swedish Territorial Waters). The pre-investigation phase and the operational phase are not included. AU suggested deployment of passive acoustic monitoring stations, but this was not accepted by the Swedish Armed Forces (Marinstaben). Thus, the assessment is a desk-top study based on the available knowledge

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