Marine mammals in the Baltic Sea in relation to the Nord Stream 2 project – Baseline report

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Table of content

1. Introduction

There are four resident marine mammal species in the Baltic Sea; harbour porpoise (*Phocoena phocoena*), the harbour seal (*Phoca vitulina*), the grey seal (*Halichoerus grypus grypus*) and the ringed seal (*Pusa hispida botnica*). Both the ringed seal and the grey seal inhabiting the Baltic Sea are isolated subspecies endemic to the Baltic Sea.

Although not native to Baltic waters, additional cetacean species such as the minke whale (*Balaenoptera acutorostrata*), fin whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), common dolphin (*Delphinus delphis*) and white-beaked dolphin (*Lagenorhynchus albirostris*) are sighted from time to time, mainly in the southern part of the Baltic Sea (www.hvaler.dk). These species will not be covered in the present report.

The aim of this report is to describe the biology, distribution and abundance of the four marine mammal species resident to the Baltic Sea based on existing data and literature. This information will be used as the baseline for the assessment of the environmental impacts on marine mammals during construction and operation of the planned Nord Stream 2 (NSP2) pipeline. This report pays special attention to Danish, Swedish, Finnish and Russian waters. Marine mammals in German waters are not included.

2. Harbour porpoise (*Phocoena phocoena*)

2.1 Population structure

Several studies using various methods have tried to describe the population structure of harbour porpoises in the Northeast Atlantic and in particular the transition zone between the North Sea and the Baltic Sea. This transition zone consists of waters from the Skagerrak in the north through the Kattegat, the Danish Belt Seas, Øresund and the western Baltic Sea to the Baltic Proper. It has been speculated that the harbour porpoises in the Baltic Proper leaves the area during winter to avoid sea ice (reviewed by e.g. Teilmann & Lowry 1996, Koschinski 2002). Until World War II catches of harbour porpoises during winter in the Little Belt were believed to originate from this seasonal migration. Whether these catches played a role in the severe decline in the Baltic during the 20th century is unclear. It is also unclear whether the speculated migration out of the Baltic during winter still exists (Koschinski 2002).

Studies on morphometric skull differences (Galatius et al. 2012) and genetics (Wiemann et al. 2010) have aimed to elucidate the population structure between the Belt Sea and Baltic Sea porpoise populations. Both studies found that three populations (or subpopulations) may exist in this area, namely 1) in the Baltic Proper, 2) in the western Baltic, the Belt Sea and the southern Kattegat (hencefort called the Belt Sea population) and 3) in Skagerrak and the North Sea. These studies were however 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. 2015a). They found that during the summer period (May-Sept) a clear decreasing gradient in porpoise density occurs east of 13.5^0 E, indicating that only few porpoises from the more abundant Belt Sea population cross this line (Fig. 2.1.1).

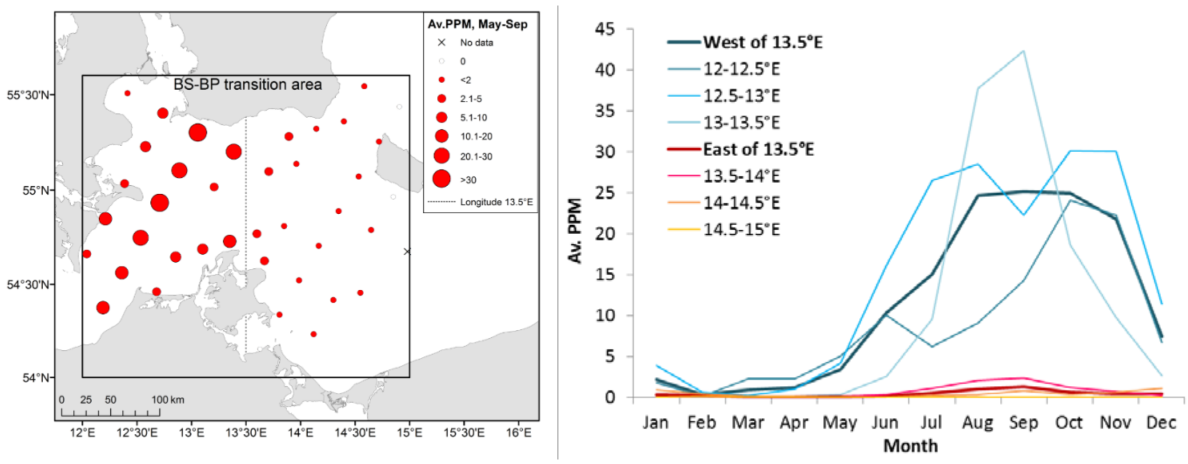

Figure 2.1.1 Left panel: map of the transition zone between the Belt Sea and Baltic Sea populations, with SAMBAH acoustic stations shown with red dots. Right panel: Showing the average number of minutes with porpoise detections per day. Each line shows the monthly variation in half degree longitude increments over the area shown in the left panel (From Sveegaard et al. 2015a).

This result is backed up by satellite tracking of 115 porpoises during the years 1997-2015, incidentally live caught in pound nets in Danish waters, and equipped with satellite transmitters (Fig. 2.1.2 and 2.1.3). Individual animals were tracked for up to 500 days. Animals were only caught in the Danish waters (Kattegat, Belt Seas or Western Baltic) and only rarely moved into the Baltic Proper.

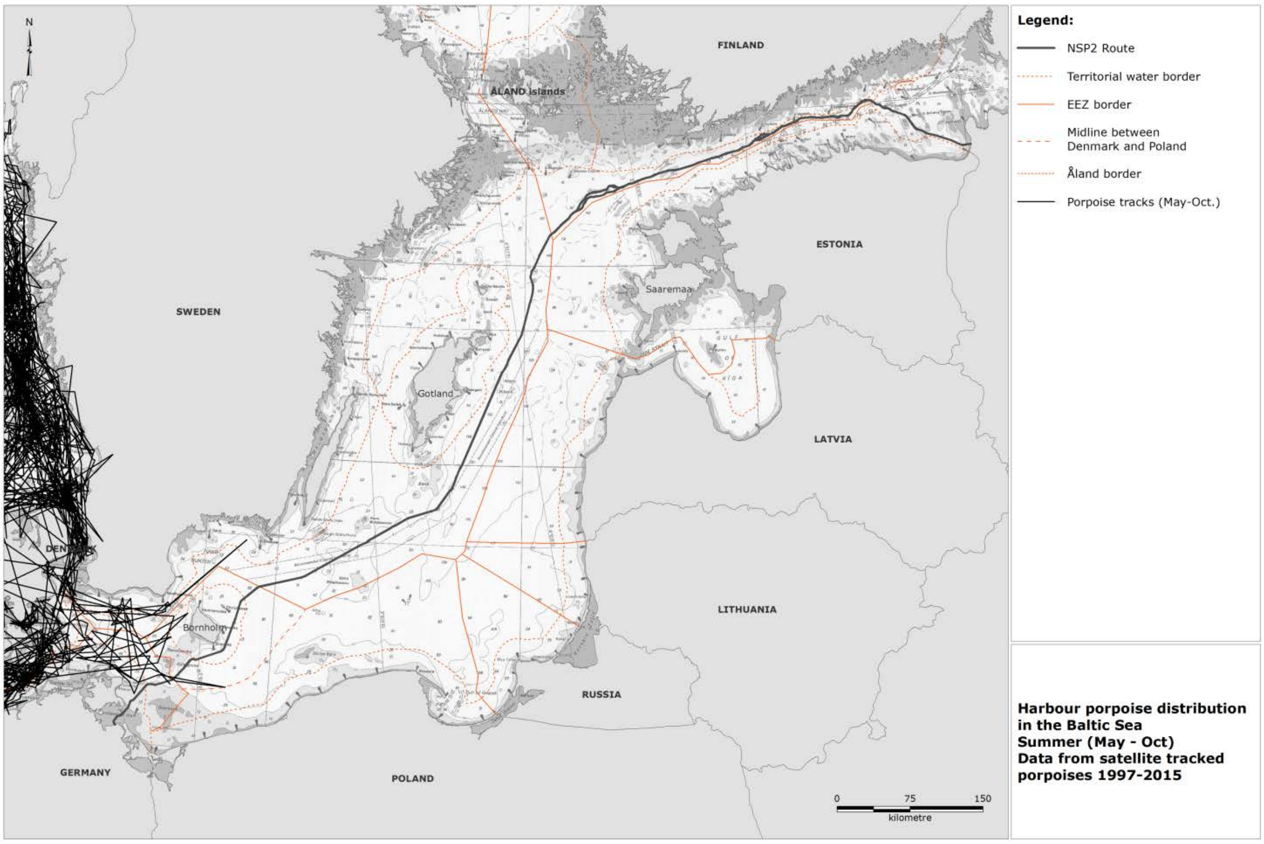

Figure 2.1.2 Tracks of satellite tagged porpoises during ***summer****. Porpoises were tagged in Danish waters (1997-2015). Note that only few animals move past the island Bornholm in southwestern Baltic Sea and only for short periods.*

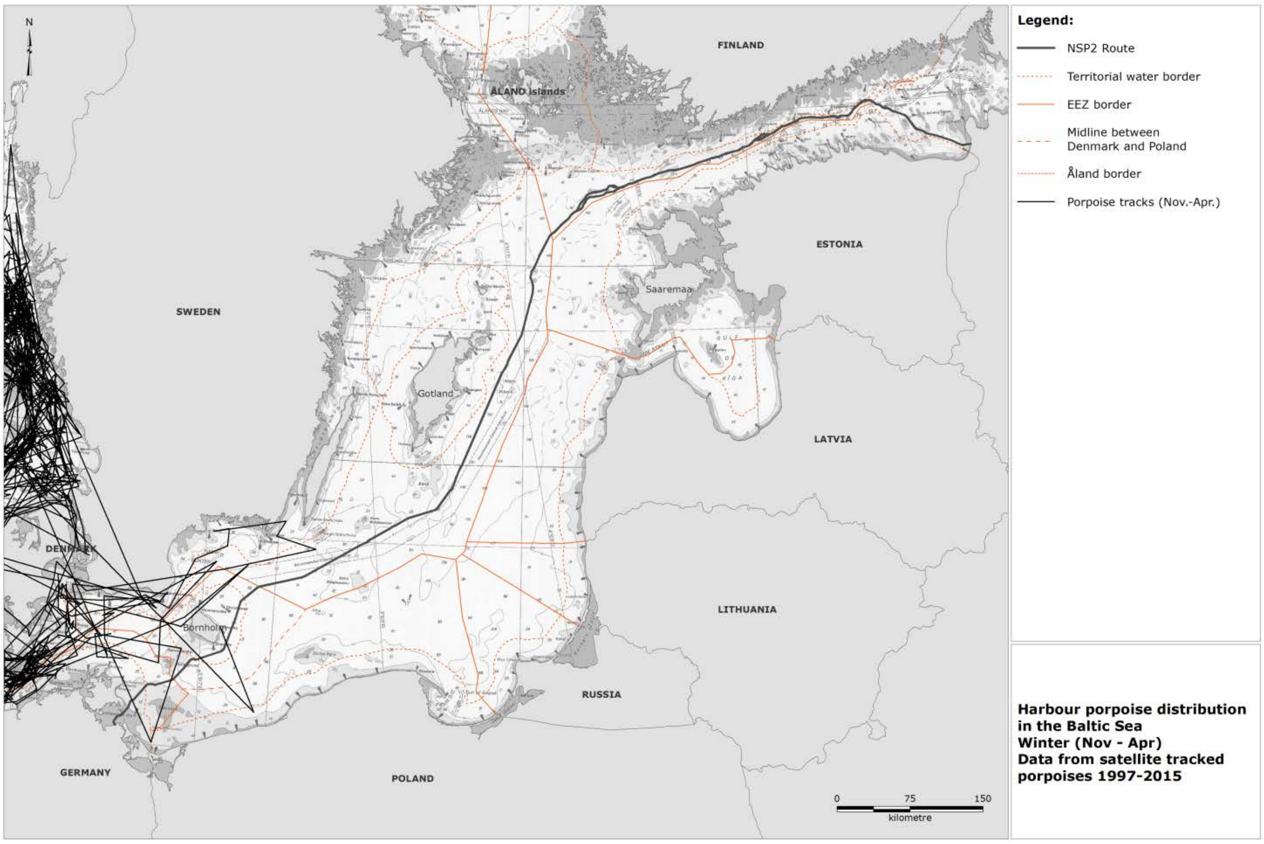

*Figure 2.1.3 Tracks of satellite tagged porpoises during **winter**. Porpoises were tagged in Danish waters (1997-2015). Note that only few animals move past the island Bornholm in southwestern Baltic Sea and only for short periods.*

The border at 13.5^0 E is, however, not the best management border for the porpoise population in the Baltic Proper. Based on acoustic detections at 304 passive acoustic monitoring (PAM)stations deployed across the Baltic covering all Baltic EU countries from Finland to Denmark for two years (2011-2013), the SAMBAH project concluded that the best management border during summer (May-Sept) was a straight line from Listerlandet peninsula in Sweden to Jarosławiec in Poland (Fig. 2.1.4, SAMBAH 2016). During winter no clear management border could be determined since the animals were more dispersed in distribution compared to summer. The distribution during the summer period is of high importance to the population structure since both calving and mating occurs in this season.

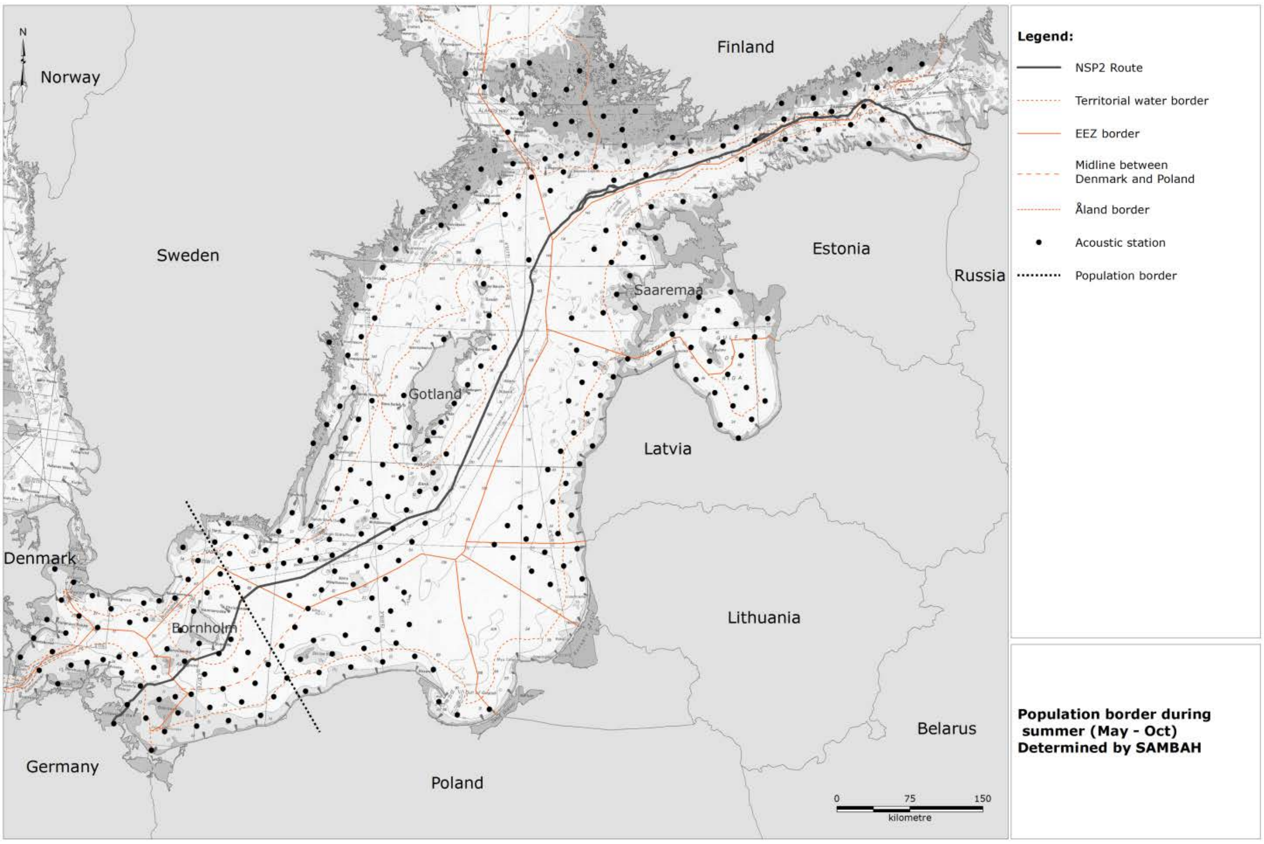

Figure 2.1.4 The best management border for the Baltic Proper harbour porpoise population based on acoustic detections at 304 stations deployed for two years (2011-2013), as determined by the SAMBAH project (www.sambah.org)

2.2 Distribution and abundance

The harbour porpoise is the smallest and also the most numerous cetacean in Europe. 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).

2.2.1 Harbour porpoises in the 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 harbour porpoises in the world (Anon. 2002) and it is listed as “critically endangered” in this sea by the International Union for Conservation of Nature (IUCN). Two visual surveys (albeit with low resolution in coverage) of population size in the Baltic Proper have been conducted and estimated 599 (95% CI 200-3300) animals in 1995 (Hiby & Lovell 1996) and 93 (95% CI 10-460) in 2002 (Berggren et al. 2004), respectively. In 2016, the SAMBAH project (see above)estimated the remaining number of porpoises in the Baltic Proper to be app. 500 (95% CI 80-1,100) (SAMBAH 2016).

The porpoise detections from the SAMBAH project were analysed as Porpoise Positive Seconds per day (PPS) and split into two seasons (Fig. 2.2.1.1 and 2.2.1.2). In the summer period, the data were further divided into the two population groups (i.e. east and west of the estimated population border). During the breeding period in summer, porpoises in the Baltic Proper concentrate around the shallow Midsjö Banks south of Gotland and Öland (Fig. 2.2.1.1). There is a clear drop in density from this area in all directions, confirming the isolation of this population. The proposed Nord Stream 2 pipeline route is passing through the middle of this area over a stretch of at least 100 km in Swedish waters.

During winter the porpoises are more widespread and porpoises were detected as far north as the southwestern Finnish waters (Fig. 2.2.1.2).

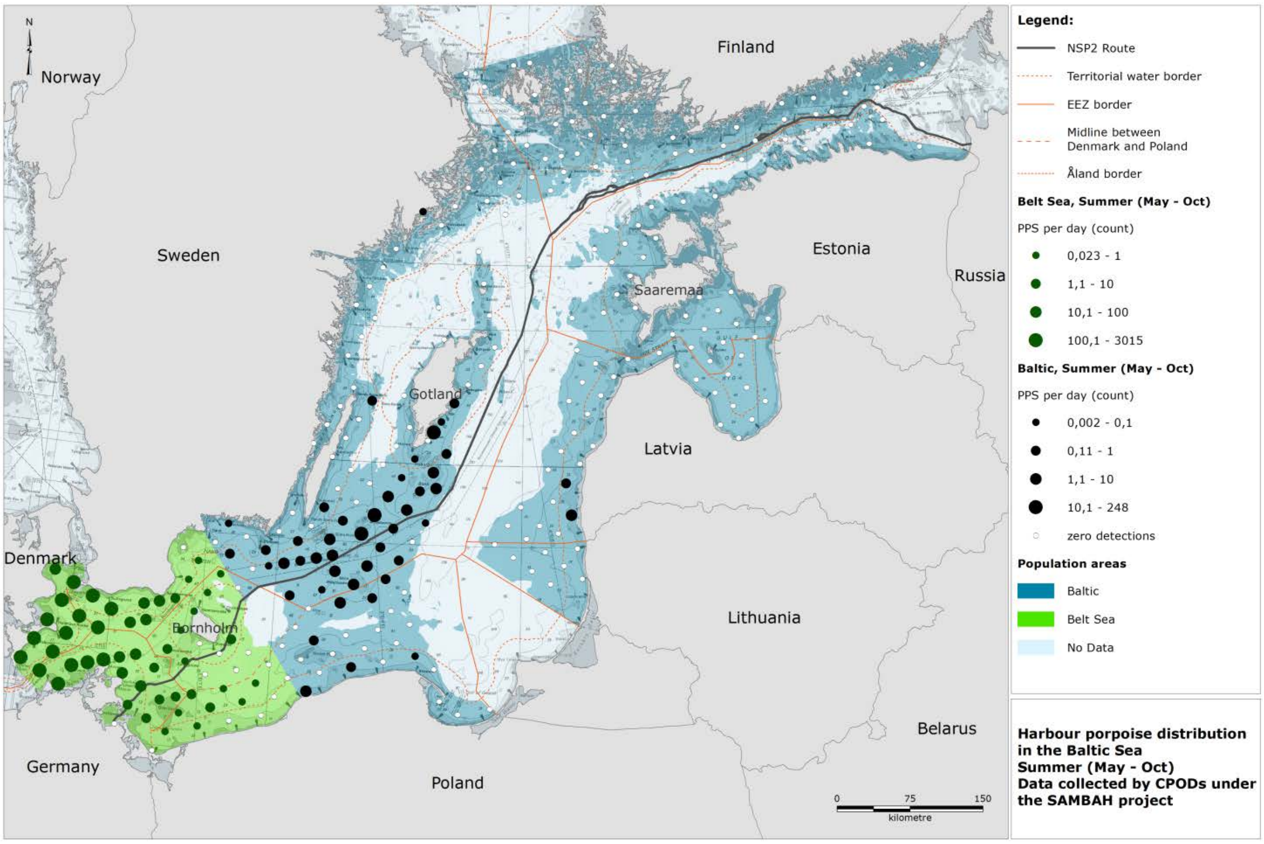

Figure 2.2.1.1 ***Summer*** *distribution of porpoise detections in the Baltic Sea (Data from the SAMBAH project). Each acoustic station is shown with a dot. If porpoises were detected the dot is black and scaled in size to the density of 'porpoise positive seconds per day'. If no porpoise was detected the station is shown with a white dot. Green indicates the area inhabited by part of the Belt Sea population extending to the east and blue is believed to contain the breeding distribution of the remaining Baltic Proper porpoise population.*

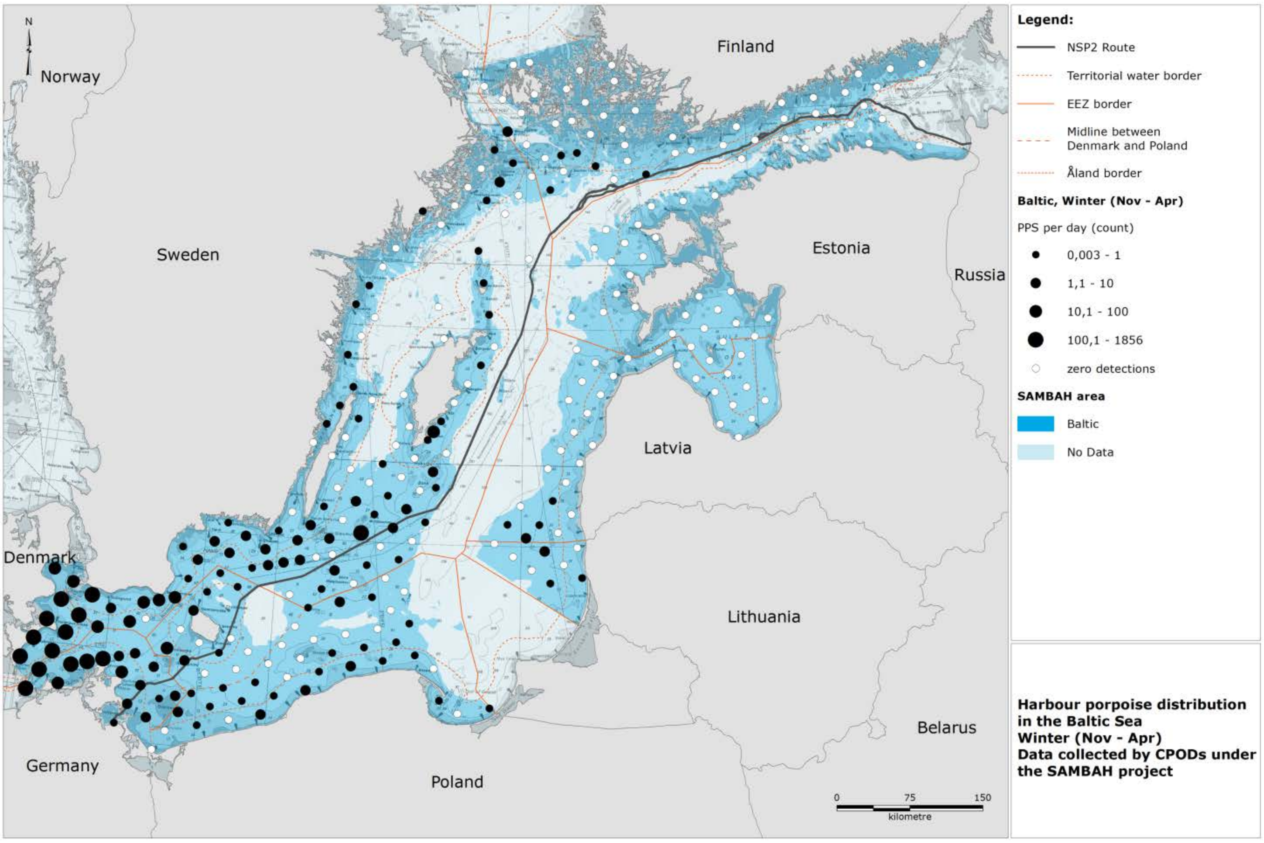

Figure 2.2.1.2 ***Winter*** *distribution of porpoise detections in the Baltic Sea (Data from the SAMBAH project). Each acoustic station is shown with a dot. If porpoises were detected the dot is black and scaled in size to the density of 'porpoise positive seconds per day'. If no porpoise was detected the station is shown with a white dot. The blue area is believed to contain a mixture of the Baltic Proper porpoise population and the Belt Sea porpoise population.*

Predictions of probability of occurrence of harbour porpoises were modelled for each month during the SAMBAH project (Fig. 2.2.1.3). Results resemble the results of the actual data (Fig.2.2.1.1) 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 southwestern 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, and also in Finnish and northern Swedish waters.

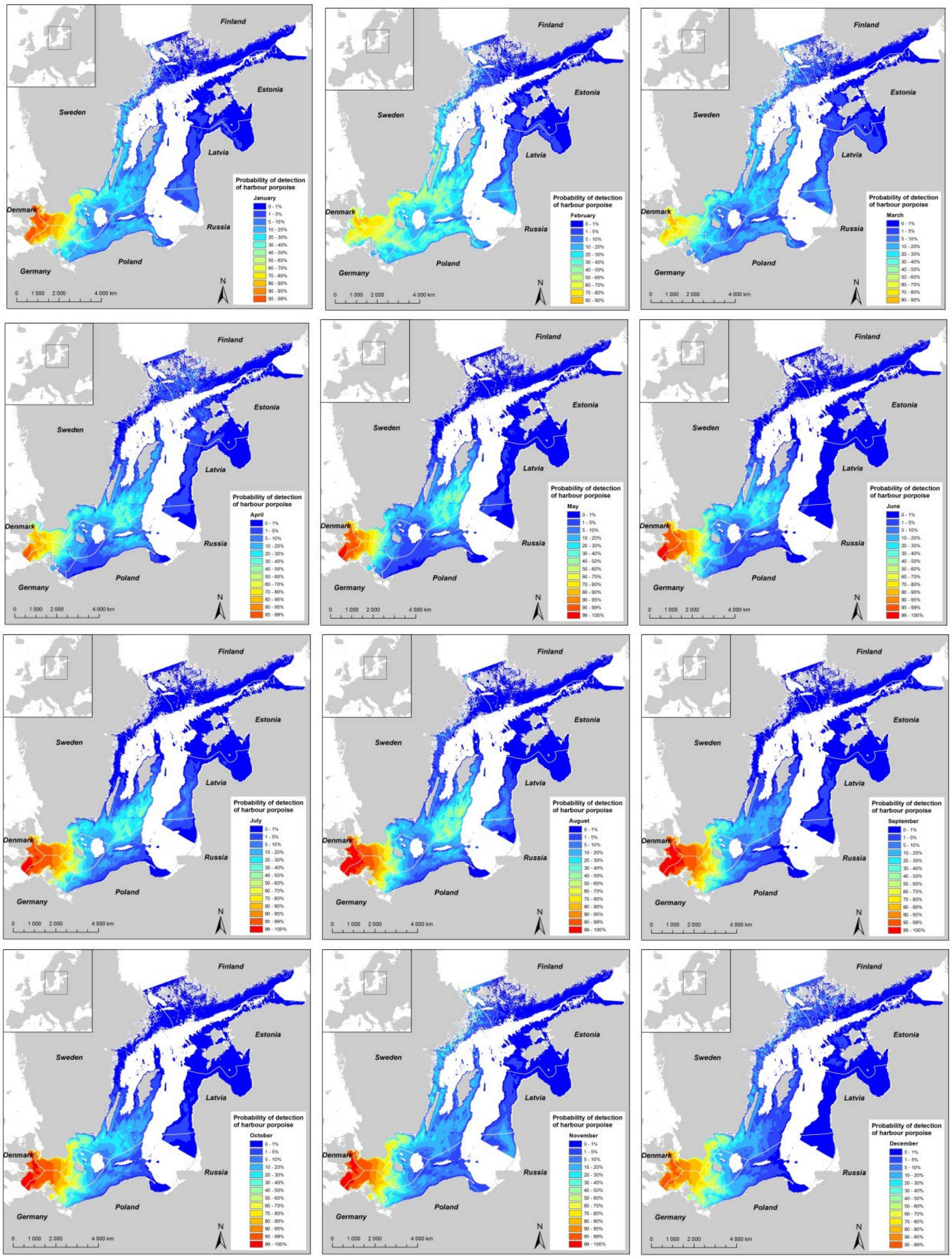

Figure 2.2.1.3 Predicted probability of detection of porpoises in the study area, for each month Jan-Dec (From SAMBAH 2016).

The SAMBAH project also delivered density maps of the porpoise distribution for summer (May-Oct) and winter (Nov-Apr). These illustrate the same seasonal variation in distribution as the predicted probability of detection above (Fig. 2.2.1.4).

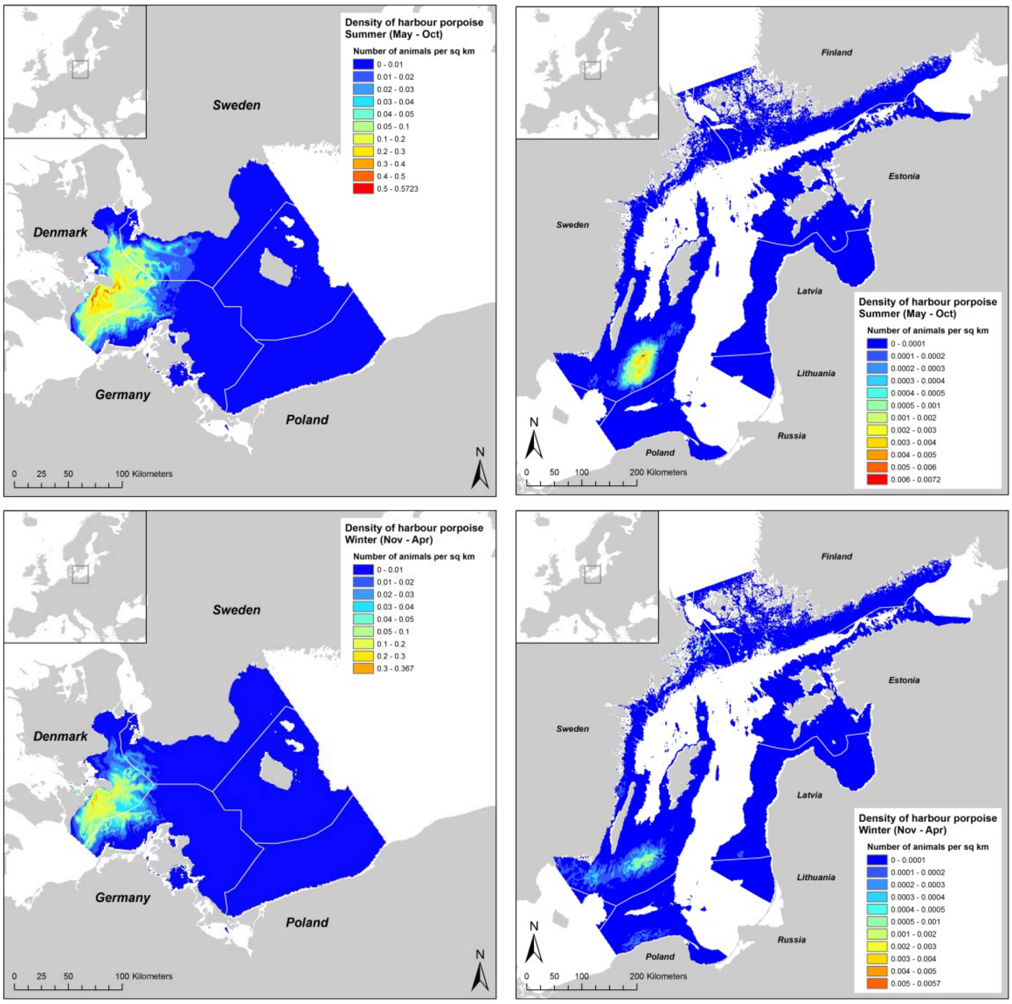

Figure 2.2.1.4. Predicted density of porpoises (in number of animals per km^2) for each season and for the southwestern and northeastern part of the study area, respectively (From SAMBAH 2016).

The Finnish Ministry of Environment in 2000 launched a campaign to collect data on opportunistic sightings og harbour porpoises from the public. During this campaign, observations were recorded in the central Gulf of Finland (near Helsinki) from 2000-2015, where few detections were made during the SAMBAH project 2011-2013 (Figure 2.2.1.5). The higher number of observations in the Helsinki area are believed to be a consequence of the higher human population density resulting in more leasure boats and not a local harbour porpoise hot spot. Thus porpoises are likely found in low densities in most of the Gulf of Finland and Archipelago Sea. During the SAMBAH project, all detections in Finnish waters were recorded during winter and spring (December–May)[1]. No acoustic detections were made during summer, which corresponds well to very few opportunistic observations in the summer of 2011-2013. The opportunistic visual observations were detected from April to January (so basically all year) but the majority (87%) were observed from June to October. This means that a low density of porpoises likely is present all year along the NSP2 route in Finnish, Estonian and likely also Russian waters.

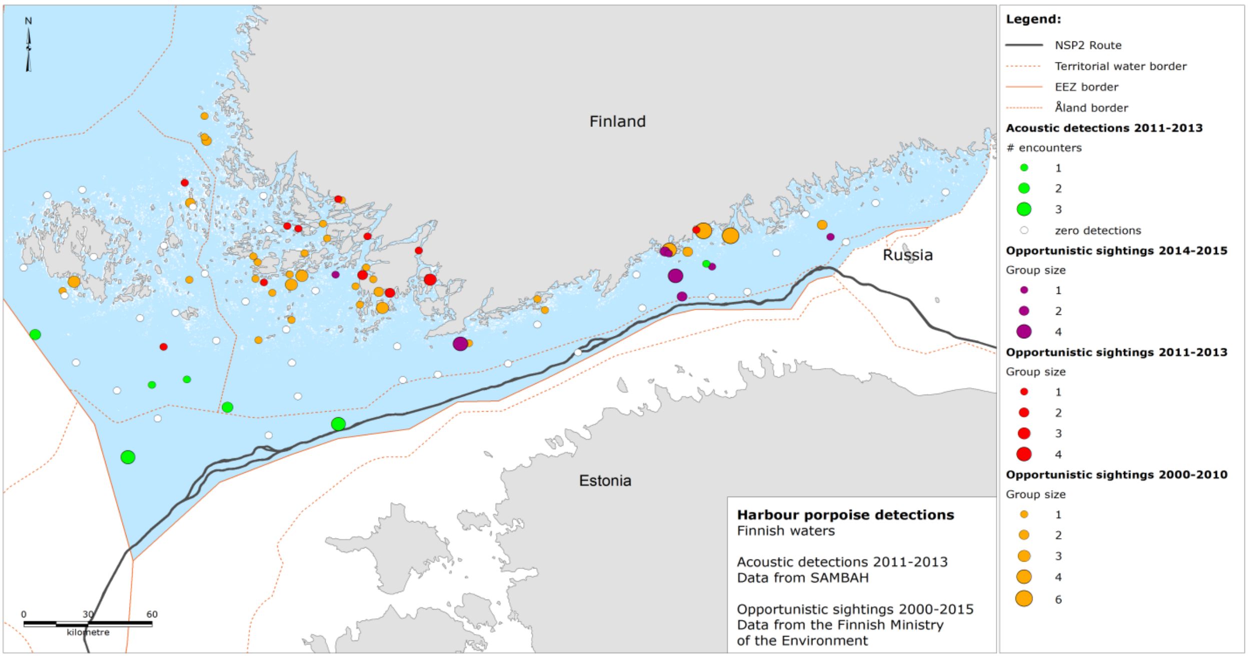

Figure 2.2.1.5 Confirmed opportunistic sightings in Finnish waters 2010-2015 (source: Finnish Ministry of the Environment) and actual acoustic detections during the SAMBAH project 2011-2013[1] in Finnish waters.

Very little is known about harbour porpoises in Russian waters, since Russia did not participate in the SAMBAH project and no other dedicated surveys or official gathering of opportunistic

[1] Note that the displayed acoustic detections from SAMBAH are slightly different from the detections previously presented in figure 2.2.1.1 -2.2.1.2, where only data passing the strict Hel1-filter (implemented to avoid false positive detections) were displayed. In Figure 2.2.1.5, all detections in Finnish waters were visually evaluated and confirmed manually in cpod.exe.

sightings have been performed there. However, in 2011 a Russian organization "Biologists for Nature Conservation" conducted a project with the aim to examine the occurrence of harbour porpoises in Russian waters. The methods were to collect opportunistic harbour porpoise observations from Fishermen and locals (by interviewing them) as well as to localise any remains or bones of cetaceans in Russian museums (Biologists for Nature Conservation 2011). The project conducted 32 interviews in the Leningrad region of which zero had observed a porpoise in the Russian Gulf of Finland. However, the project concluded that "harbour porpoise presence is detected in neighboring countries, and thus we can assume that there are occasional visits of these animals to Russian territorial waters". In addition it was recommended that "passive acoustic monitoring devices should be deployed to confirm this assumption".

2.2.2 Adjacent waters

In 2005, the total number of harbour porpoises in the Northeast Atlantic continental shelf waters was estimated to be 375,358 (95% CI=256,304–549,713) (Hammond et al. 2013). This number includes all populations of porpoises in the North Sea as well as the majority of the spatial extent of the Belt Sea population. The Belt Sea holds high densities of porpoises especially in the Sound, Great Belt, Little Belt and Fehmarn Belt. Based on ship surveys in 1994, 2005 and 2012 the number of porpoises residing in this area was estimated to be 27,923 (CV = 0.46, 1994), 10,614 (CV: 0.28, 2005) and 18,495 animals (CV = 0.27, 2012), respectively (Sveegaard et al. 2013). This corresponds to a decreasing trend in the population, however, these figures are associated with large statistical uncertainties and this trend is therefore not significant on a 5% level.

2.3 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)).

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 begin suckling immediately after parturition and accompany their mother until March the following year and possibly longer, however ss females often give birth every year, thesuckling period will usually end after 12 months at the latest. Females can conceive when they are 3 or 4 years old (Kinze et al. 2003). Changes in food resources may influence the reproduction of porpoises. Calves seem to be sighted throughout their range and areas of high porpoise density may therefore also be considered to be important for reproduction (Hammond et al. 1995; Kinze et al. 2003). Consequently, no specific breeding areas have been identified in the Baltic Sea for harbour porpoises, but the summer concentrations on the Midsjö Banks south of Gotland found in the SAMBAH project should be considered important for reproduction.

2.4 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).

2.5 Feeding

The average daily food intake per adult harbour porpoise is app. 1.75kg consisting mainly of fishes of up to 20-25cm in length with a preference for fatty fishes 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 made up 41% and eelpout 10% of the fish weight eaten (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, and the diet varies both spatially and temporally. In a tagging study, Wisniewska et al (2016) found that harbour porpoises made ca. 550 feeding attemts on small fish (3-10 cm) every hour with a 90% success rate.

2.6 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 use their echolocation almost continuously (Akamatsu, et al., 2006, 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 any great extent.

Harbour porpoise hearing is very sensitive and covers a vast frequency range (Fig. 2.6.1, Andersen 1970, Popov et al. 1986, Kastelein et al. 2002, Kastelein 2010). The hearing abilities of harbour porpoises become increasingly directional with increased frequency. This improves their echolocation capabilities by making them less susceptible to background noise and clutter echoes (i.e. returning echoes from other objects than the intended target (Fig. 2.6.2, Kastelein et al. 2005).

Mammals do not hear equally well over their entire 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 those close to the cut-off frequencies. At higher sound intensities, the loudness of the sound becomes greater than what is predicted from the audiogram towards the lower and upper cut-off frequencies (Moore, 2012). This discrepancy in loudness can be estimated by applying an equal-loudness filter. In humans, filters have been developed for low sounds (A-weighting) and loud sounds (C-weighting). Southall et al. (2007) developed equal-loudness filters equivalent to the C-weighting filters for the different marine mammal groups (M-weighting), but at present there is no common consensus on which method for frequency weighting is the most appropriate (Energistyrelsen 2015).

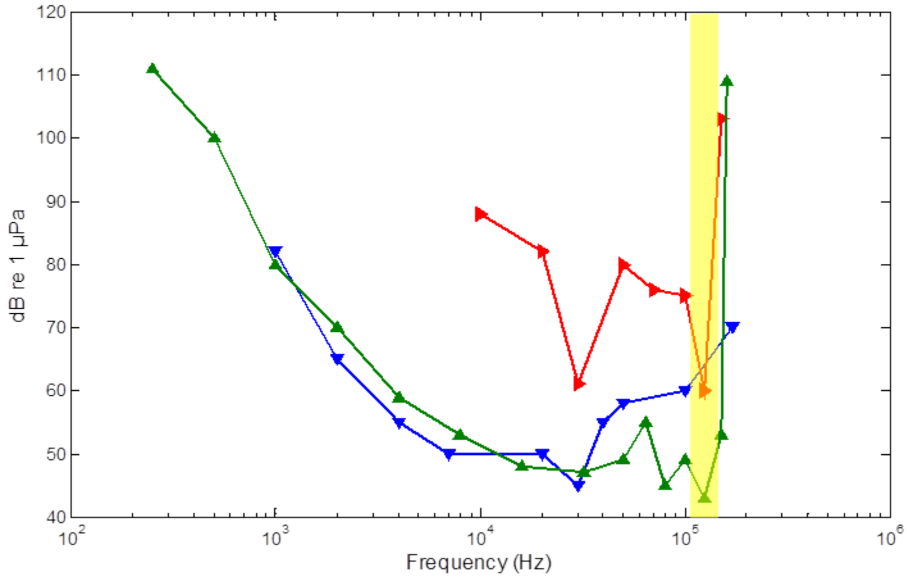

Figure 2.6.1 Audiograms for harbour porpoises modified from Kastelein et al. (2010) (green), Andersen (1970) (blue) and Popov et al. 1986) (red). The audiogram shows the hearing threshold: the porpoise can only detect sound above the threshold for each frequency. The best ability to detect sound is at frequencies with the lowest threshold (the best sensitivity). The audiogram also shows the frequency range of harbour porpoise vocalization (yellow).

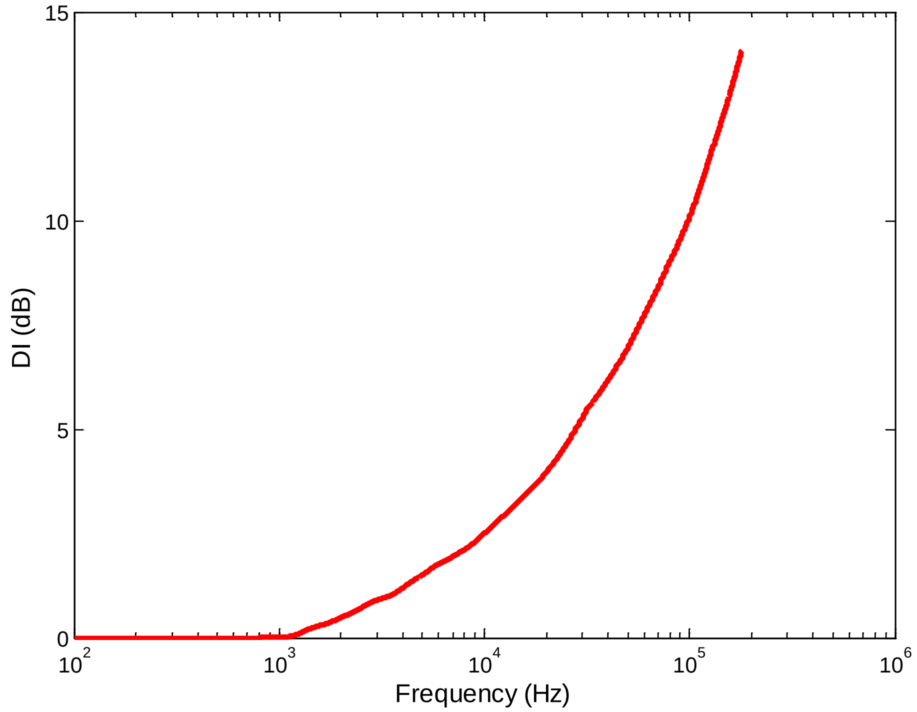

Figure 2.6.2 The directivity index (DI) is a measure of the directional hearing as a function of frequency in the harbour porpoise (modified from Kastelein et al. 2005).

2.7 Vision

Cetaceans have good vision, although especially toothed whales have small eyes in relation to their body size, compared to other mammals. The eyes are completely adapted to vision underwater and under low light conditions.

The spherical lens makes the eye highly myopic (short-sighted) in air and they are not likely to be able to see objects sharply in air at distances beyond a few meters. Movement, however, e.g. rotating wind turbine wings, should be clearly visible to porpoises, even in air. Porpoises, like other cetaceans and seals, are functionally colour blind (Peich et al. 2001).

2.8 Other senses

Toothed whales have no sense of smell, but taste may play a role, not only in relation to tasting prey, but also in terms of collecting information about the surrounding water.

A magnetic sense, that is the ability to determine the direction of the earth's magnetic field, has only been demonstrated convincingly in a few vertebrates and this ability is very difficult to explore experimentally (Wiltschko and Wiltschko 1996). Until fairly recently it was believed that no mammals had electroreceptive abilities, but it has been conclusively demonstrated that the duckbilled platypus has electroreceptive organs along the edge of the bill and uses these in prey capture (Proske and Gregory 2003). Since then several other mammals have been suspected of possessing electroreceptive capabilities. Recently it was found that the hairless vibrissal crypts on the rostrum of the Guiana dolphin serve as electroreceptors with a sensory detection threshold for weak electric fields of 4.6 μV cm−1 (Czech-Damal et al. 2012). This threshold is comparable to the sensitivity of the electroreceptors in platypuses. Their results show that electroreceptors can evolve from a mechanosensory organ that nearly all mammals possess and shows that the existence of this kind of electroreception is possible in other species, especially those with an aquatic or semi-aquatic lifestyle. It has however, to our knowledge, not been examined in harbour porpoises.

2.9 Disturbance

Harbour porpoises are generally vulnerable to anthropogenic disturbances and threats. The most severe threath is incidental bycatch and subsequent drowning in set nets, followed by anthropogenic noise of various kind, prey deletion due to overfishing, habitat destruction and pollution. Disturbances will be elaborated in the NSP2 assessment report for marine mammals.

2.10 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 Helsinki Commission; protection of the marine environment of the Baltic Sea). The Baltic population of harbor 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, Anon. 2002), 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*".

2.10.1 Natura 2000 sites in the Baltic near the NSP2 pipeline route

Harbour porpoises are listed as part of the selection criteria in one Danish Natura 2000 site in the Baltic Proper, namely Adler Grund and Rønne Banke (Fig. 7) approx. 16 km from the NSP2 route.

The harbour porpoise is, however, listed as population status D (=non-significant population) under site assessment, which means that no particular conservation measures (e.g. a management plan) are obligatory (European Environmental Agency 2016). This seems sensible in the light of the present low density in the area as found by the SAMBAH project. The results show that porpoises clearly are present in the area, but according to the predicted probability (Fig. 2.2.1.3) of porpoise occurrence in the areas surrounding the Natura 2000 site are actually higher. Whether the SAMBAH models will result in further designation of Natura 2000 sites in the Danish waters surrounding Bornholm, is currently being evaluated (Pers. Comm. Marie-Louise Krawack, the Danish Natura Agency, May 2016).

There is currently one designated Natura 2000 site in the Swedish Baltic with harbour porpoises listed as part of the selection criteria, namely Hoburgs Bank (Fig. 2.9.1). However, after the release of the final SAMBAH distribution results, the two responsible counties, Länsstyrelsen Kalmar Län and Länsstyrelsen Gotlands Län, proposed a major Natura 2000 site for harbour porpoises encompassing Hoburgs Bank as well as the newly found high density areas at Midsjöbankerna. The proposal was submitted in April 2016 (Länsstyrelsen Kalmar Län and Länsstyrelsen Gotlands Län 2016) and in December 2016, the Swedish government decided to designate the proposed areas as a Natura 2000 site. 138 km of the NSP2 route is within the proposed area “Hoburgs Bank and Midsjö Bank”. At the same time, 2 smaller Natura 2000 sites in the Baltic Swedish waters were approved (both within 100km of the NSP2 route) namely: Sydvästskånes Utsjövatten and Kiviksbredan.

There are currently no Natura 2000 sites in Finnish waters with harbour porpoises listed as part of the selection criteria.

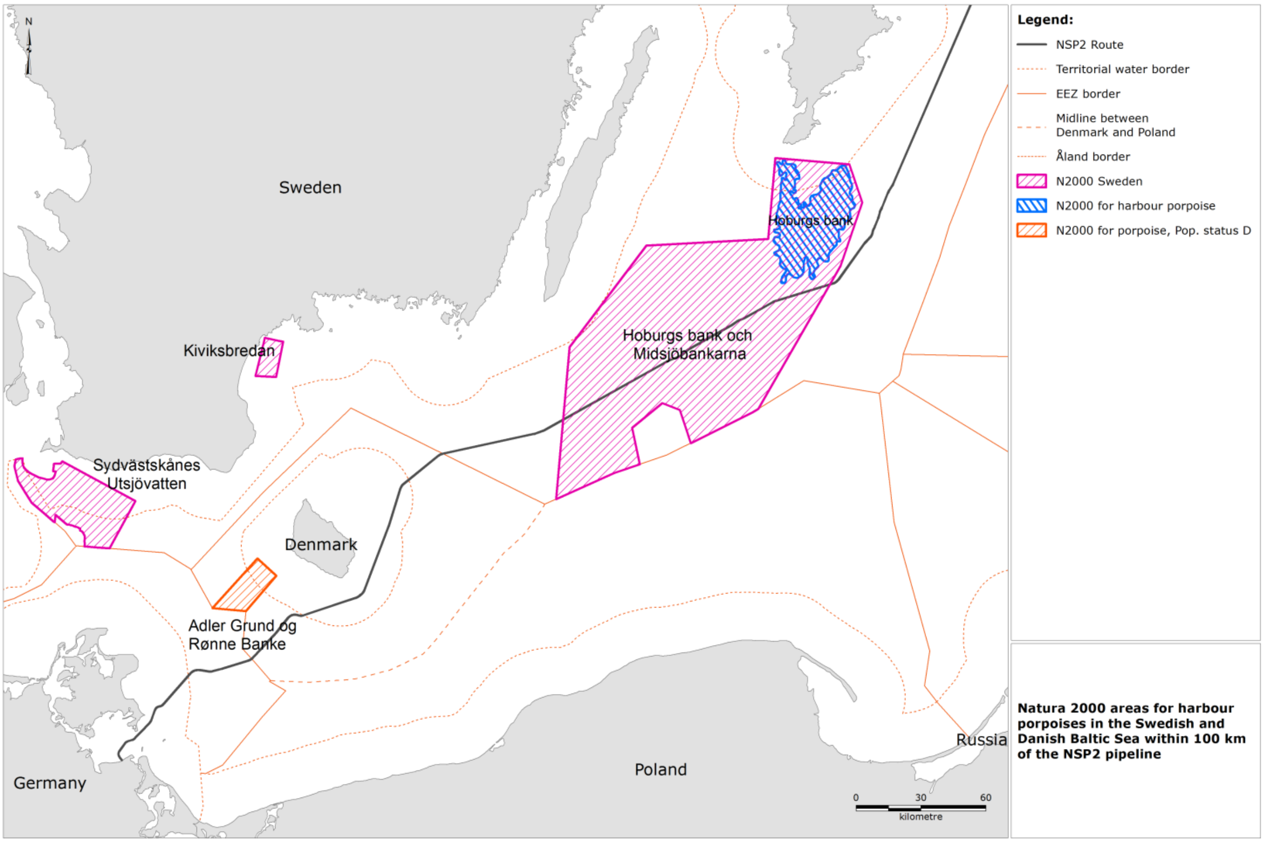

Figure 2.9.1 Map displaying the two designated Natura 2000 sites (N2000) for harbour porpoises relevant for the NSP2 route ("Hoburgs Bank" and "Adler Grund and Rønne Banke") as well as the proposed Natura 2000 site ("Hoburgs Bank and Midsjöbankerna"). Only Swedish and Danish N2000 sites relevant for the NSP2 pipeline route are shown (Länsstyrelsen Kalmar Län and Länsstyrelsen Gotlands Län 2016, European Environmental Agency 2016*).*

3. Harbour seal (*Phoca vitulina*)

3.1 Population structure

Based on molecular data and satellite telemetry, the harbour seals in the Baltic region have been split into three management units or sub-populations, among which there is at least partial reproductive isolation: 1) Kalmarsund (between Øland and the Swedish mainland), 2) the southwestern Baltic (along the southern Danish and Swedish coasts) and 3) Kattegat (Goodman et al. 1998, Härkönen 2006; Olsen et al. 2014). Tagging studies have shown limited movements of harbour seals (e.g. Dietz et al. 2015) and no or limited exchange between colonies separated by more than app. 100 km.

3.2 Distribution and abundance

Harbour seals are found in temperate and arctic waters of the Northern Hemisphere. The harbour seals of southern Scandinavia (Skagerrak, Kattegat, western Baltic, and the Limfjord) have probably been present in low numbers since the end of the last glaciation, however, they were assumably not abundant until a few centuries ago. Once established, the harbour seals became subject to intense hunting; first due to the value of the skin and blubber and later because of the threat they constituted to commercial fisheries. During the 1920s the population was at its lowest. Following protection in the Baltic region in the 1960-70s the populations have recovered. More recently, two severe morbillivirus epidemics in 1988 and 2002 reduced most populations by app. 50% on both occasions (Härkönen et al. 2006).

Haul-out sites (also called colonies) are land localities occupied by seals during periods of mating, giving birth, moulting and resting. Haul-out sites for harbour seals are well known and do not change between years. Annual counts are made during the moult in August in Denmark and Sweden. In the Baltic Sea, harbour seals are only found in Kalmarsund between Øland and the mainland of Sweden and in the southwestern Baltic concentrated around the Rødsand sand bar (7 km west of Gedser in Denmark) and Falsterbo and Saltholm in the Sound. The Kalmarsund population comprises around 1,000 individuals (HELCOM 2015) and the southwestern population around 1,500 individuals (Sveegaard et al. 2015b). There are no observations of harbour seals from the Finnish coast and no known haul-out sites along the coasts in any of the other Baltic countries.

3.2.1 Harbour seals in the Baltic Sea

In the Baltic, harbour seals are mainly found in Danish, Swedish and German waters although occasional visits to other areas may occur. The knowledge on abundance and density of seals is extensive with respect to the locations of the haul out sites, but very limited when it comes to their use of the surrounding waters, especially in the Kalmarsund region. In the western part of the Baltic, harbour seals have been tagged with GPS transmitters at Falsterbo (Sweden, Fig. 3.2.1.1). GPS tracking of seals can provide detailed information on the movement of individual seals and it is clear from the movement of the satellite tracked seals that there is very little chance that a harbour seal would be near the proposed pipeline route at any time.

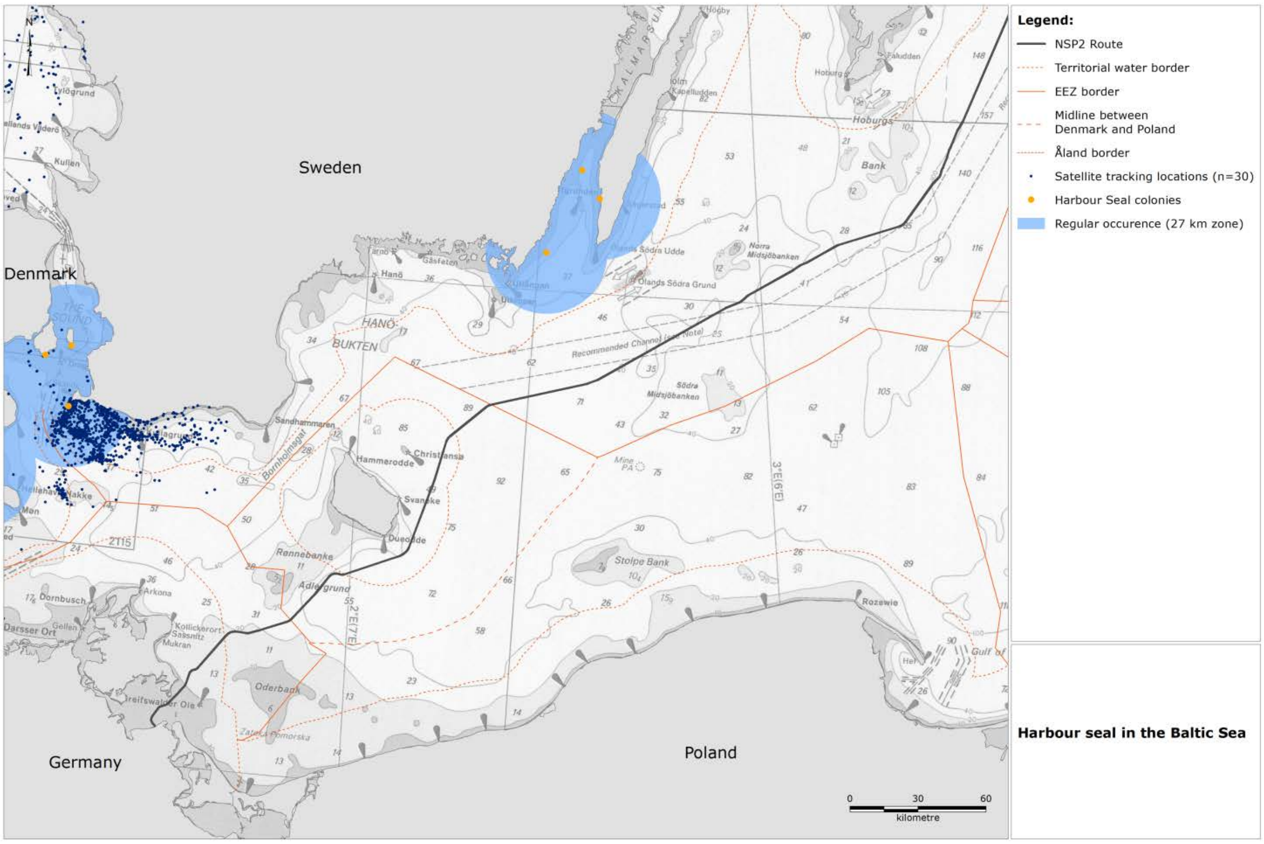

Figure 3.2.1.1 Map of haul-out sites (colonies) in the Baltic used by harbour seals for resting, breeding

and moulting. Only sites used by seal populations in Kalmarsund and the south-western Baltic are included. The zone of regular occurrence (blue areas) is taken as the maximum distance from the tagging site according to figure 3.2.1.2 (Dietz et al. 2015). Dark blue dots indicate positions of tagged seals. Data source: Aarhus University.

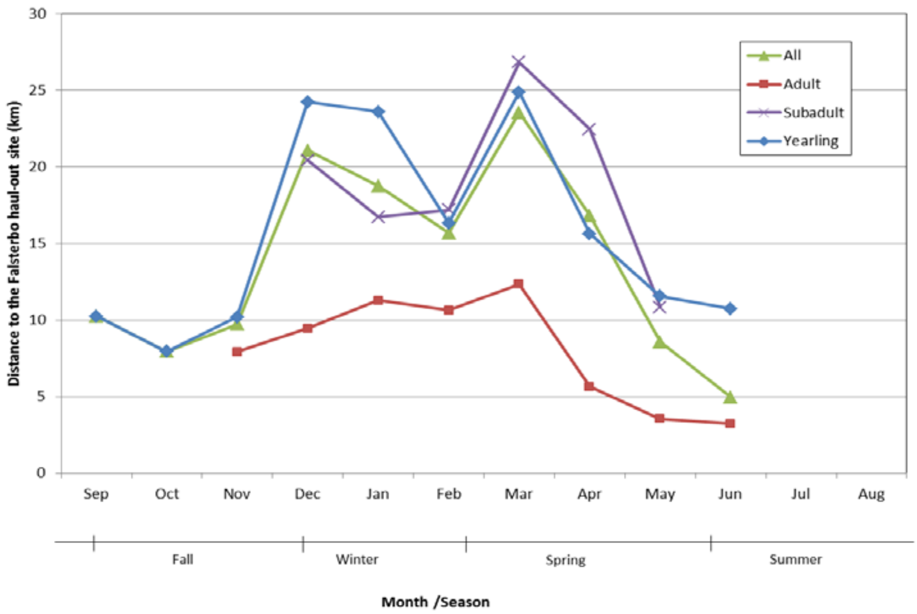

Figure 3.2.1.2 Average distance to the Falsterbo haul-out site (southern Sweden) by the 10 tagged harbour seals. Seals were tagged in 2012 (From Dietz et al. 2015).

3.3 Behaviour and reproduction

The harbour seal is a relatively small seal with an adult weight of app. 65-140 kg. Females are believed to give birth once a year on land in May and June, with a gestation period of 11 months. The pup suckles for about three to four weeks after which it is left to feed for itself. Harbour seal pups shed their embryonic fur (lanugo) before birth and are thus born with the adult fur. In contrast to most other true seals, the pups are able to swim and dive for longer periods immediately after birth. In case the mother and pup are disturbed on land they will flee together into the water, but as they depend on getting back on land again for suckling, disturbances in the breeding season in May-July can severely affect pup survival. Mating occurs immediately after end of suckling and takes place in the water. Little is known of the exact circumstances surrounding the mating. Several studies from Norway, Scotland and California have suggested that males perform an underwater display, which includes vocalisations (Bjørgesæter et al. 2004) and that females seek out the displaying males and decide whether to mate or not (Hanggi and Schusterman 1994; Boness et al. 2006). Moulting occurs in August where seals spend more time on land to develop the new fur. The moult depends on a good blood perfusion to the outer layers of the skin. In order to reduce heat loss from the body, this increased perfusion therefore mainly occurs on land, preferably with dry fur. Thus, also adult seals are vulnerable to disturbances during the summer months.

At sea harbour seals hunt alone or in small groups. Depending on individuals and the area harbour seals stay within 25-100 km from shore, but individuals are occasionally found more than 100 km offshore (Tougaard et al. 2008). They primarily dwell on the same undisturbed islets and sandy beaches year round but may occasionally be seen resting on scattered stones along the shores. Adult harbour seals do not migrate, but they are capable of travelling considerable distances. Localised movements are common whilst searching for food, and short-distance movements also may be associated with seasonal availability of prey and with breeding.

Harbour seals generally forage in areas shallower than 100 m (Tollit et al. 1998; Lesage et al. 1998, Eguchi and Harvey 2005), but have been demonstrated to dive to depths exceeding 400 m (Gjertz et al. 2001). In the south-western Baltic, water depths do not exceed 50 m, and harbour seals tagged in this area regularly dived to the bottom (Dietz et al. 2015). Harbour seals from the Kalmarsund population may potentially forage in deeper waters in the vicinity of their haulouts, but this has not been investigated. Thus, harbour seals may potentially be present at all depths within their range in the areas surrounding the NSP2 route.

3.4 Feeding

Harbour seals are opportunistic predators. They feed mainly on benthic fish but can catch and eat all bony fish species in the area., which shows they are highly adaptable to changes in prey availability. The diet of seals varies across their distribution. In the southwestern Baltic Sea, 21 fish species have been detected. Lesser sand eel, black goby and Atlantic cod were found in the highest quantities, making up 44.5%, 15.1% and 11.5% of the otoliths, respectively (Andersen et al. 2007). In Kalmarsund, only 5 prey species were detected with European eel being the most important prey (41.7%), followed by Atlantic cod (16.7%), European flounder (16.7%) and European whitefish (16.7%) Söderberg (1975). Also garfish have been found in the diet, but as the head is not eaten the otoliths are lacking and the importance of this species is therefore difficult to estimate. (Andersen et al. 2007).

3.5 Hearing

Seals have ears well adapted to an aquatic life. These adaptations include a cavernous tissue in the middle ear which allows for balancing the increased pressure on the eardrum when the animal dives (Møhl 1967) and also a separate pathway for sound to the middle ear in water. The audiogram of harbour seals shows good underwater hearing in the range from a few hundred Hz to app. 50 kHz (Fig. 3.5, left).

The critical bandwidth of harbour seal hearing decreases with frequency, at least in the range 2.5 kHz to 30 kHz where it has been measured (Fig. 3.5, right) and is comparable to the general pattern in the few marine mammals studied (except porpoises), i.e. about 1/3 octave or smaller in the range of best hearing and broader at the very low frequencies. The critical bandwidth is (among other) a measure of the sensitivity to masking by noise. Noise which falls within the critical bandwidth around a given tone stimulus of constant frequency is able to mask the tone (i.e. cause an elevation of the detection threshold) whereas noise that falls outside the critical bandwidth has no orlittle effect on the detection of the tone. Small critical bandwidths thus indicate low sensitivity to noise interference, whereas broader critical bands indicate higher sensitivity to noise. Critical bands have not been beasured in grey seals or ringed seals, but it is reasonable to expect that they are comparable to what is seen in harbour seals.

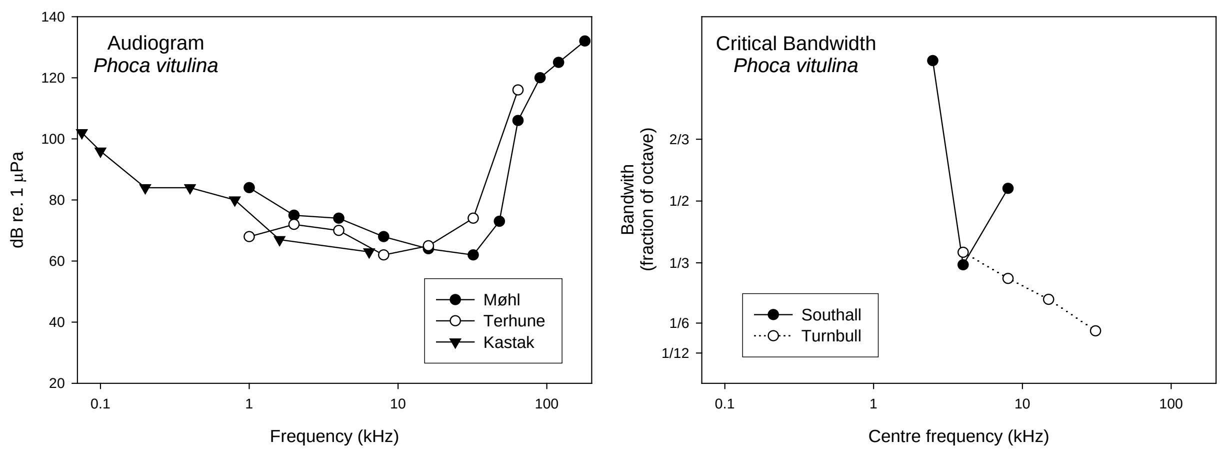

Figure 3.5. Left: audiograms of three harbour seals, showing threshold of hearing under quiet conditions at frequencies in the range from 80 Hz to 150 kHz. Data from Møhl 1968; Terhune and Turnbull 1995; Kastak and Schusterman 1998). Right: critical bandwidth of harbour seals, expressed as fraction of an octave. Data from Southall et al. (2001) and Turnbull and Terhune (1990).

3.6 Vision

Seals have good vision, both in air and water, with variation from species to species in terms of the degree to which the eyes are adapted to water. The lens is adapted to underwater vision and focusing in air is believed to be possible due to the slit-formed pupil (when contracted), which results in a large depth of focus (Fobes and Smock 1981, Hanke et al 2009). As all other pinnipeds (and cetaceans) the harbour seal is considered to be functionally colour blind (Peich *et al.* 2001). They have very few cones in the retina and all of these are of the same (blue) type (Newman and Robinson 2005).

The sensitivity of the eyes is high, enhanced by the presence of a *tapetum lucidum* behind the retina and seals are probably able to orient visually even at great depth (Levenson and Schusterman 1999).

3.7 Touch/vibration

Seals have very well developed whiskers (vibrissae) and the follicles are highly vascularised and surrounded by a large number of attached sensory nerves (Dykes 1975). Behavioural experiments have shown that the whiskers of seals are extraordinarily sensitive to particle movement in the water (Denhardt *et al.* 1998) and it is possible that seals can detect the vortices and eddies left behind in the wake of a swimming fish, even several minutes after the fish has passed (Denhardt *et al.* 2001).

It can thus be conjectured that the whiskers play as large a role as the eyes, if not larger, in terms of locating prey. This is especially true at great depth, at night and when visibility is low.

3.8 Electro- and magnetoreception

In parallel with harbour porpoises, there is no evidence of electroreception or the ability to detect magnetic fields in seals. As for porpoises, the possibility of especially magnetoreception should however not be dismissed.

3.9 Disturbance

Harbour seals on land react to boats by moving into the water when a boat is 50-500 m from a haul-out. The disturbance distance depends on the area. In some areas, the seals habituate to regular traffic and also seem to develop tolerance to noise (Andersen et al. 2012; 2014). During construction and operation of a large wind farm near Rødsand in Denmark the effect on seals was investigated. Only ramming of sheet piles at one of the wind turbine foundations caused measurable effect of the seals on land (Edrén et al. 2010).

3.10 Protection

Harbour seals are protected under the EU Habitats Directive, the Convention for the Protection of Migratory Species (Bonn Convention) as well as they are fully protected under national legislation. Harbour seals are listed as ‘Least concern’ by the World Conservation Union (Lowry 2016). However, the International Union for Conservation of Nature (IUCN) expresses concern for the Kalmar Sound population (IUCN 2007). The harbour seal is listed on the EU Habitats Directive annex II, which means that they should be protected by the designation of special areas of conservation. For seals these areas are primarily placed in connection with important haul outs on land.

3.10.1 Natura 2000 sites in the Baltic near the NSP2 pipeline route

Harbour seals are listed as part of the selection criteria in 20 Swedish Natura 2000 sites. Of these 5 are located in the Baltic within 100 km of the NSP2 pipeline route (Table 3.10.1, Fig. 3.10.1). There are no Natura 2000 sites for harbour seals in Danish Baltic waters within 100 km of the NSP2 pipeline route. Harbour seals do not inhabit the waters of Estonia, Finland and Russia and no Natura 2000 sites are thus designated for them in these waters.

Table 3.10.1 Natura 2000 sites in the Swedish Baltic waters with harbour seal (Phoca vitula) listed as part of the selection criteria. Area size, percentage of area that is marine, population status (according to the Habitats Directive), population size as well as approx. swimming distance to NSP2 pipeline route (km)

(Source: http://natura2000.eea.europa.eu/#)

Site	Site name	Area (ha)	Marine %	Population status	Pop. Size min-max	Approx. swimming distance to NSP2 pipeline (km)
SE0330108	Ottenby NR	2391.4	40	C	10-40	52
SE0330109	Eckelsudde	424.8	88	C	74-74	80
SE0330123	Värnanäs skärgård	1551.9	93	B	142-142	87
SE0330174	Sydöstra Ölands sjömarker	8866.9	68	C	no data	60

SE0410113	Isaks kläpp	124.7	97	C	50-50	68

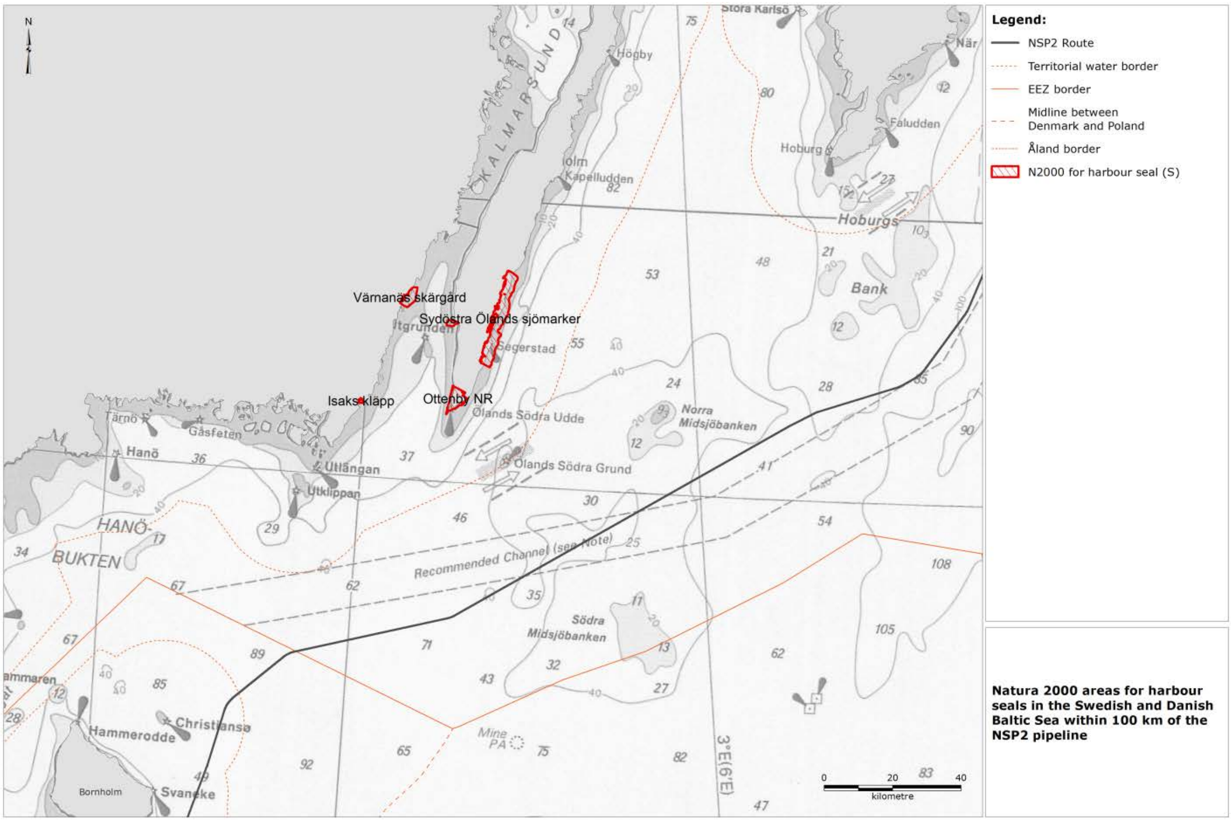

Figure 3.10.1 Map of Natura 2000 sites in the Swedish Baltic waters with harbour seal (Phoca vitula) listed as part of the selection criteria.

4. Ringed seal (*Pusa hispida botnica*)

4.1 Population structure

The Baltic ringed seals form a genetically isolated population that never leaves the Baltic Sea. As they are dependent on the sea ice, they are only rarely seen in the southern Baltic. No genetic difference has been found between three of the breeding areas in the Baltic Sea although satellite tagged individuals from the three areas (Bothnian Bay, Gulf of Finland and Gulf of Riga) seem to form three geographically isolated groups (Härkönen et al. 2008) (Fig. 4.2.1.1).

4.2 General distribution and abundance

The ringed seal has a circumpolar arctic distribution. It is associated with icy waters and is the primary food for polar bears. The world population is at least a few millions and so, the species is not thought to be generally threatened. The isolated ringed seal population in the Baltic Sea and the only two freshwater ringed seal populations in the world living in the Saimaa and Ladoga lakes in Finland and Russia, respectively, are however, considered threatened (Reeves 1998). The Baltic and freshwater ringed seals were isolated from the Arctic waters at the end of the last glaciation app. 9-11,000 years ago.

4.2.1 Ringed seals in the Baltic Sea

The ringed seal has previously been abundant in the Baltic Sea with an estimated population size around 200,000 individuals in the beginning of the last century. The population has since severely declined because of hunting and pollution until the 1970s, at which time only 3,000-5,000 ringed seals remained (Harding and Härkönen 1999). Since 1988 the abundance in the northern breeding area in the Bothnian Bay has increased by 4.8% per year and aerial surveys in 2014 of ringed seals hauled out on the ice in April-May gave an estimate of app. 8,000 hauled-out individuals (HELCOM 2015) there. When correcting for seals in the water the total northern population of ringed seals in the Baltic Sea comprised around 11,500 individuals. However, in the spring of 2015, the ice conditions were exceptionally suitable during population count and a surprisingly high total number of hauled out individuals (17,400) were estimated (Natural Resources Institute Finland 2016). This was almost twice as much as expected and this survey may not be completely comparable with the previous surveys. In this report we will assume that the population is between 11,500 and 17,400 individuals.

Because of unfavourable ice conditions, there are no recent survey data on the ringed seals inhabiting the three southern breeding areas, the Finnish Archipelago Sea, the Gulf of Finland and the Gulf of Riga. A census in 2011 counted 50 individuals in the Gulf of Finland leading to a population estimate of approx. 100 (HELCOM 2016). This area was estimated at 300 individuals in the 1990s (HELCOM 2016) and may thus be in serious decline. The seals are most commonly found within Russian territorial waters, but a small part of the population lives and breeds on the Finnish side close to the Russian border, while some seals also breed near the Uhtja Island in

Estonia. Other Estonian ringed seal localities in the Gulf of Finland are Kolga Bay and Krassi Island (Keskonnaamet 2015).

In the Gulf of Riga, 1,400-1,500 ringed seals were counted in 2011 (Härkönen et al. 2013).

In the Archipelago Sea, the population size according to the 2002-2005 censuses was estimated to be 140-300 individuals in the area (Miettinen et al. 2005). Telemetry data have provided some evidence that the subpopulation in the eastern Gulf of Finland is an isolated population, as are also the Gulf of Riga and the Bay of Bothnia populations. However, one individual has been shown to migrate from the Bay of Bothnia to the Gulf of Riga (Oksanen 2015), so some gene flow between areas may still occur. Warmer climate has reduced winter sea ice cover and populations are now fragmented into smaller areas. This makes the subpopulations increasingly vulnerable (Sundqvist et al. 2012). A genetic study using microsatellite data did not detect separation among subpopulations (Palo et al. 2001). Outside the moulting season ringed seals are less dependent on their haul-out sites or fishing areas as grey seals are, and can move among several locations (Oksanen 2015).

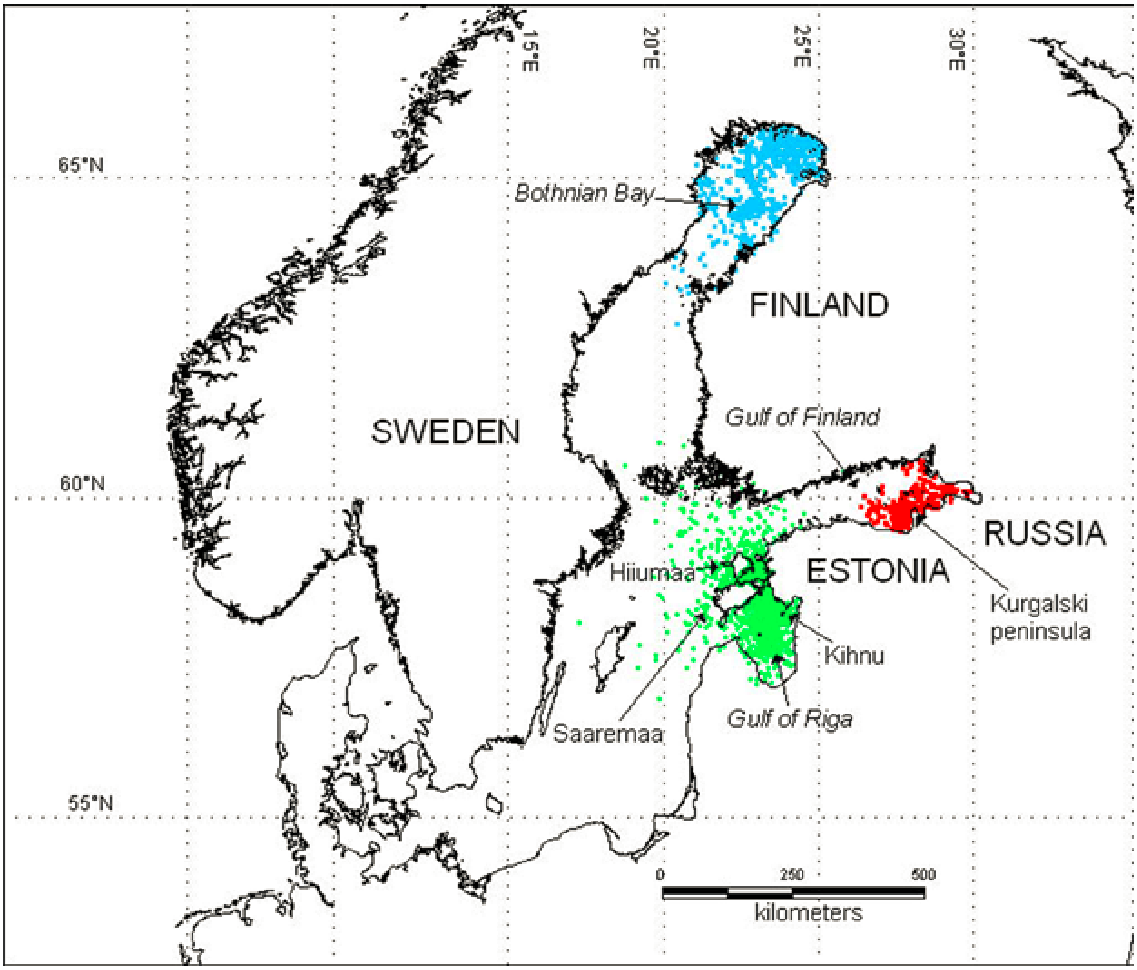

Figure 4.2.1.1 The Baltic Sea with locations from adult ringed seals tagged with Argos satellite transmitters in three geographically isolated groups: the Bothnian Bay (blue, 5 seals, 345 locations), the Gulf of Finland (red, 4 seals, 178 locations), and Estonian coastal waters (green, 10 seals, 812 locations) (from Härkönen et al. 2008).

The fact that the ringed seals breed on ice restricts the population to areas with regularly recurring winter fast ice or dense pack ice, which prevents the species from establishing populations in the southern Baltic Sea. The main dwelling areas for the ringed seal are typically around islands or islets where ice cover is normal during the winter period. The ice cover can occasionally extend down to the Baltic Proper, and ringed seals have on some occasions been observed at the Polish and Danish coasts (pers. comm. Anders Galatius, Iwona Pawliczka). By June, ringed seals leave their usual territory for summer haul-outs on islets and rocks in the deepest waters of the outermost archipelagos and return again in October-November (Miettinen et al. 2005).

Figure 4.2.1.1 and 4.2.1.2 shows the ringed seal distribution in the Baltic Sea relevant to the NSP2 pipeline route. The main breeding areas and resting sites for ringed seals are located in Russian waters for the Gulf of Finland ringed seal breeding areaand in Estonian waters for the Gulf of Riga breeding area. The ringed seals in the Gulf of Finland subgroup inhabit Russian, Finnish and Estonian waters in the Gulf of Finland. While the ringed seals in the Gulf of Riga subgroup mainly inhabit Estonian and Latvian waters, they also move into Finnish and Swedish waters. We have no telemetry data for ringed seals from the Finnish Archipelago Sea area, but it is likely that the range of these seals will also overlap with the construction area. The proposed NSP2 route will be placed very near several ringed seal haul-out sites in the Gulf of Finland and will go through a large part of the habitat with regular ringed seal occurrence.

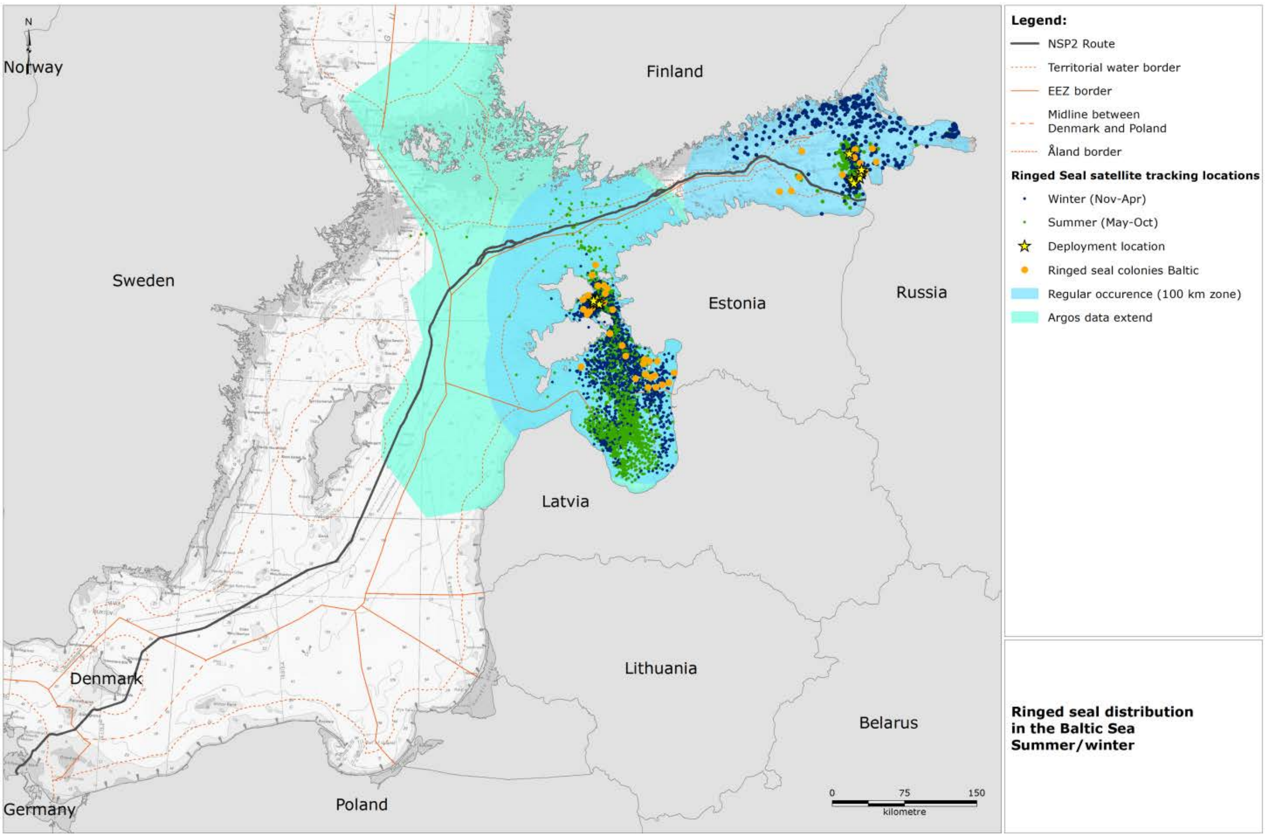

Figure 4.2.1.2 Map of haul-out sites (colonies) used by ringed seals for resting, breeding and moulting. Ringed seal telemetry data (37 tracked individuals, source: Estonian Fund for Nature, Pro Mare) displayed

according to season: green (Summer: May - Oct) and blue (Winter: Nov - Apr). The extent of data from the Argos data in figure 4.2.1.1 are displayed in light green. Regular occurrence is displayed as 100 km zones around each colony. The 100 km zone is calculated as the radii on the ringed seal home ranges found by Oksanen et al (2015). Colony information from Estonian Nature Information System (EELIS) 2016. Note that since only a small proportion of the ringed seal population has been tagged with transmitters, the telemetry data do not show the distribution of the whole population and can only be used as an informative overview of seals in Baltic

4.3 Behaviour and reproduction

The ringed seal breeds close to the ice edge between mid-February and mid-March. It demands sufficient ice and snow cover in order to build a snow burrow above its breathing hole. During peak moulting in the Baltic mosttime is spent on haul-outs (i.e. undisturbed rocks, islets and islands) from mid-April to the beginning of May.

During the winter, seals are usually alone, spread out across the ice fields. They are always wary of predators (hunters) and often aggressive to other ringed seals. When the cracks in the ice begin to freeze, ringed seals use their strong claws to create breathing holes, which they maintain throughout winter in ice up to 2 m thickness. During summer the ringed seals are gregarious, hauling out on rocks and islets.

Härkönen et al. 2008 tagged 19 ringed seals in Northern Baltic waters (see Figure 4.2.1.1), and studied their movement and diving behaviour. Diving behaviour differed between the sexes with males in general diving deeper than females. For ringed seals in the Gulf of Riga and Gulf of Finland dives of females were shallow (<10 m) over the year, but numerous dives were also found in the 20 m–40 m category. Males showed basically the same seasonal pattern as found for females, but they dived deeper. In general, both sexes conducted deeper dives from April to July than during the rest of the year and the maximum dive depth were 110-120 m. This means that ringed seals may be present at all depths in the areas surrounding the NSP2 route.

4.4 Feeding

The Baltic ringed seal feeds on fish such as herring, smelt, whitefish, sculpin, perch and threespined stickleback. They also feed on benthic fauna such as crustaceans (mostly isopods) and bivalves (Kauhala et al. 2011; Suuronen and Lehtonen 2012; Lundström et al. 2014).

4.5 Hearing, Vision, Touch/vibration, Electro- and magnetoreception

The senses of ringed seals have not been studied in detail but are believed to be similar to other true seals. The section on senses of harbour seals above, therefore also applies to the ringed seal.

4.6 Disturbance

Because ringed seals depend on ice and snow cover during reproduction, ice-breaking activities - including noise, loss of breeding areas and visual disturbances can have a detrimental impact on breeding success. A warming of the climate could pose a serious threat to breeding for the southern stocks in the Baltic Sea. The winter of 2006-2007 was very warm, and the limited number of breeding areas threatened the reproduction of the ringed seal populations in the Gulf of Finland, the Archipelago Sea and the Gulf of Riga (Meier et al. 2004).

Seals can also be disturbed by tourism, commercial fishing (e.g. bycatch) and mining activities, although little is known about responses to human presence, underwater noise and airborne noise, but a study in Alaska has demonstrated some tolerance or habituation to industrial noise (Blackwell et al. 2004). Other threats to the Baltic ringed seal are eutrophication, pollution and oil spills. Reproductive failure caused by high levels of organochlorines (i.e., DDT, PCB and HCB) resulted in high prevalence of sterility among adult ringed seals (Helle 1980). These problems seem to be decreasing due to outphasing of organochlorines (Nyman et al. 2002, Routti 2009) and the major threat to ringed seals is now the lack of suitable ice conditions and possibly bycatch, although the magnitude of this is unkown.

4.7 Protection

4.7.1 Protection in EU waters

The ringed seal is listed as a protected species in the EU Habitats Directive (Appendix II and

Appendix V) and the Bern Convention (Appendix III). The Baltic population of ringed seals is listed as ‘least concern’ by the World Conservation Union (Härkönen 2015).

Although far below their historic abundance, the ringed seals in the Bothnian Bay have attained a population abundance above 10,000, which is the limit reference level for ringed seal management units in the Baltic Sea set by HELCOM (HELCOM 2016). However, the observed annual rate of population growth (4.8% since 1988) is far below the intrinsic rate of increase of depleted ringed seal populations (10%) (HELCOM 2016). This means that the population growth rate is impeded by pressures, potentially bycatch, pollution and lack of breeding habitat. In the southern areas (Gulf of Finland, Archipelago Sea and Gulf of Riga), similar positive population trends have not been observed. Indeed, it is believed that the number of animals in the Gulf of Finland is decreasing with the current abundance estimated at about 100 (HELCOM 2016).

On the HELCOM Red List of Baltic species, the ringed seal is listed as ‘vulnerable’ (HELCOM Red List Marine Mammal Expert Group 2013).

4.7.2 Natura 2000 sites in the Baltic near the NSP2 pipeline route

According to European Environment Agency (http://natura2000.eea.europa.eu/) that gathers all information on protected areas related to the Natura 2000 network, Finland and Estonia have 8 and 6 Natura 2000 sites with ringed seals listed as part of the selection criteria, respectively. However, according to sources in the Finnish Ministry of the Environment, ringed seal are in the process of being listed on several existing Natura 2000 sites (P. Blankett, Ministry of the Environment, pers. comm., October 2016). This is however not finalized and thus not included here. One Finnish Natura 2000 site for seals, Saaristomeri, is also in the process of being significantly extended (by two times its size, see extention area on figure 4.2.2). In total, 4 Finnish and 3 Estonian Natura 2000 sites are within 100 km of the NSP2 route and considered relevant here. These are listed in Table 4.7.1 and illustrated in purple in figure 4.7.1.

*Table 4.7.1 Natura 2000 sites in the Finnish and Estonian waters with Ringed seal listed as part of the selection criteria within 100 km of the NSP2 route. Area size, percentage of area that are marine, population size as well as approx. swimming distance to NSP2 pipeline route (km) (Source: http://natura2000.eea.europa.eu/#, except for the area marked with *. Here the source is: http://paikkatieto.ymparisto.fi/natura/tietolomakkeet/FI0408001.pdf).*

Country	SITECODE	SITENAME	Area (ha)	Min. distance to NSP2 (km)	% Marine	Number of ringed seal at location (min-max)
Finland	FI0100078	Pernaja Bay and Pernaja Archipelago	65775	13.1	98.20	no data
	FI0200090	Saaristomeri	49735	27.4	88.60	150-150
		Extension to FI0200090	176117	14.5	>95.00	
	FI0408001*	Eastern Gulf of Finland archipelago and water	95628	23.5	100.00	3-50
Estonia	EE0040002	Väinamere	253457	42.7	82.80	501-1000
	EE0060220	Uhtju	2443	34.6	99.50	1-6

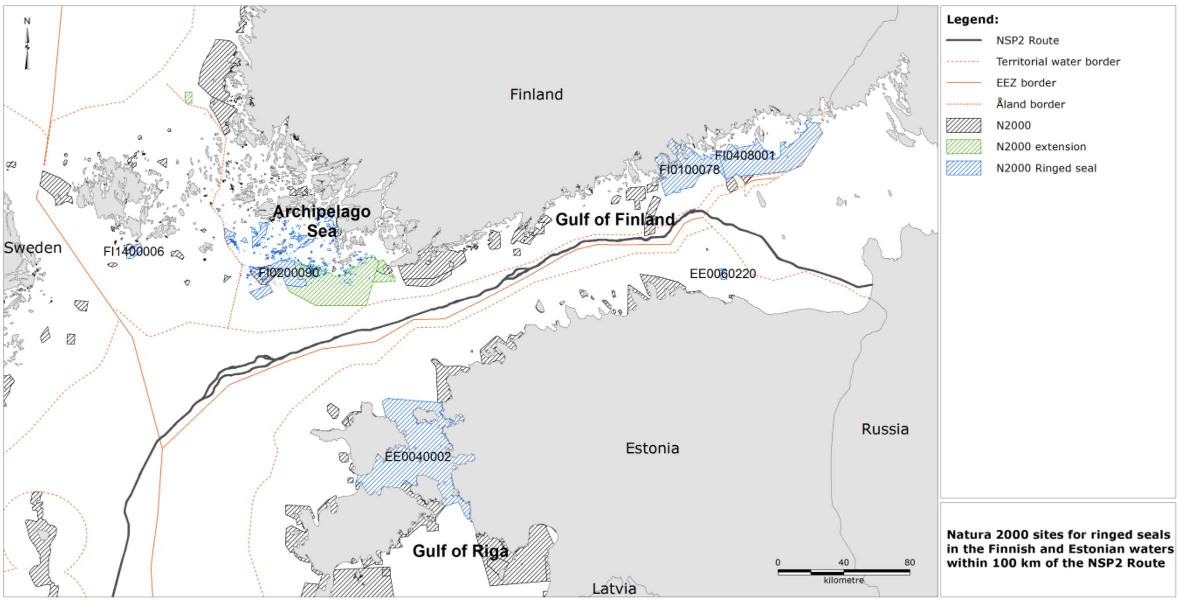

Figure 4.7.1 Map of Natura 2000 sites in the Finnish and Estonian waters with ringed seal listed as part of

the selection criteria within 100 km of the NSP2 route.

There are no Natura 2000 sites in Sweden or Denmark with ringed seals listed as part of the selection criteria.

4.7.3 Protection and marine protected areas in Russian waters

In Russian waters, protected species are listed in the Red Data Book of the Russian Federation (RDBRF). The Red Data Book is a state document established for documenting rare and endangered species of animals, plants and fungi within the territory of the Russian Federation and its continental shelf and marine economic zone. The book has been adopted by Russia and all CIS states (Commonwealth of Independent States) to enact a common agreement on rare and endangered species protection. Russia are currently using a version from 1998 (Iliashenko & Iliashenko 2000), but the Red Data Book for species is planned to be updated in 2018 (according to ASCOBANS). The Red Data Book is implemented on both state and regional level.

The Baltic ringed seal conservation status has been classified as follows (categories in the Red Data Books are from the Rambøll document: W-PE-EBS-PRU-REP-809-Q41501EN-02_Book4):

- The Red Data Book of the Russian Federation, category index 2 – decreasing in number, subspecies
- The Leningrad Region Red Data Book, category index 2 - endangered (EN), subspecies
- The Saint Petersburg Red Data Book, category index 1 - critically endangered (CR), subspecies
- The IUCN Red List of Threatened Species, Least Concern (LC), subspecies (www.iucnredlist.org, accessed 30.12.2016)

It is conspicuous that the categories of the Red Data Books all list the ringed seal as having a problematic status, while the IUCN assessment is positive. The differences in these conservation statuses may be because the IUCN monitors the situation in the Baltic Sea as a whole, while the Red Data Book of the Russian Federation concerns the entire territory of Russia and the Leningrad Region Red Data Book concerns only the Gulf of Finland. Also, all the assessments of the Red

Data Books are more than 10 years old, while the IUCN assessments were updated in 2015.

Ringed seals are included in several marine protected areas in the Russian part of the Gulf of Finland, namely Ramsar sites, Baltic Sea Protected Areas and nature reserves (see Figure 4.7.2). The NSP2 route crosses one of the protected sites and several others are located close to the route.

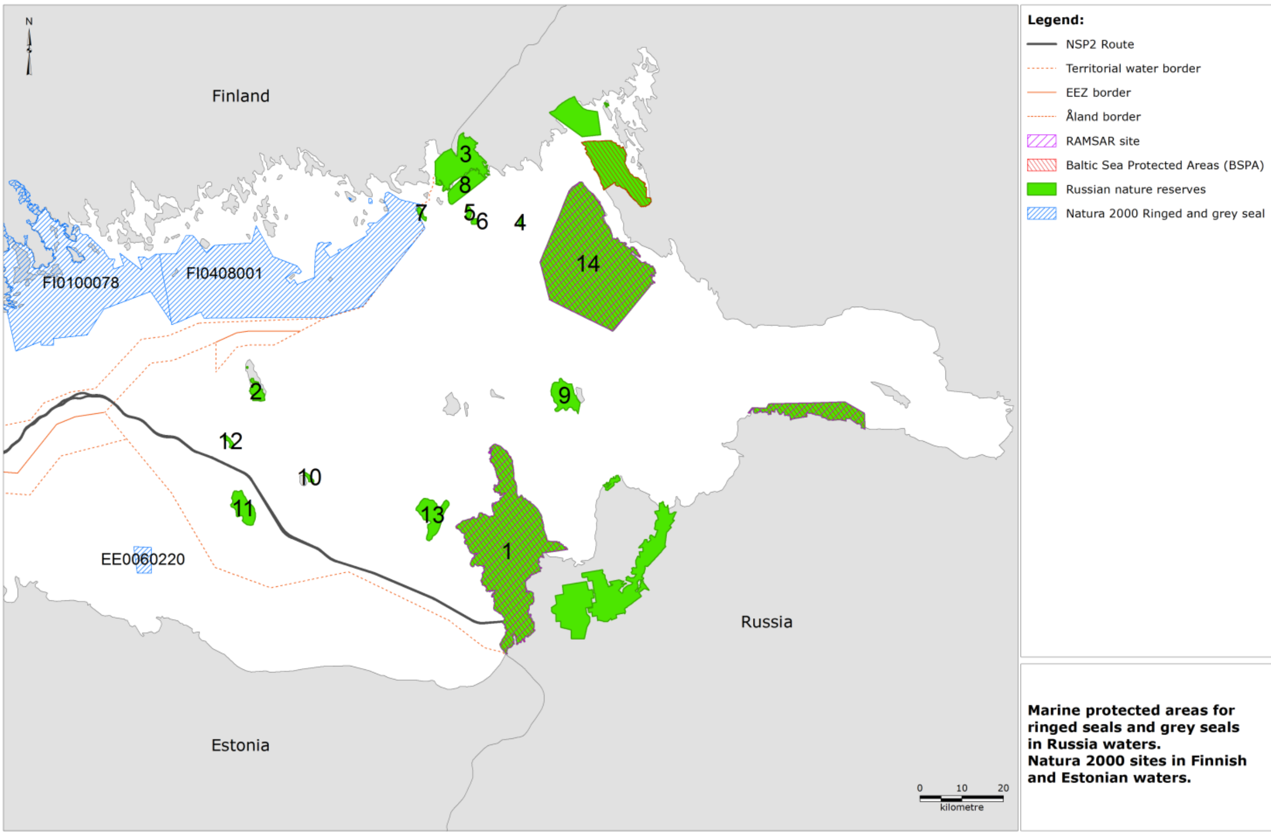

Figure 4.7.2 Map of Marine Protected Areas (MPAs) and Nature reserves in Russian waters and Natura 2000 (N2000) for seals in Estonian and Finnish waters. Numbers refer to names of nature reserves: 1) Kurgalskyi, 2) Suursaari, 3)Prigranichnyi, 4)Hally Cliff, 5) Bolshoy Fiskar, 6)Bolshoy Fiskar, 7) Kopytin, 8) Long Rock, 9) Seskar, 10) Bolshoy Tyuters, 11) Malyi Tyuters, 12) Virginy islands, 13) Virgund cliff, 14) Berezovye islands.

5. Grey seal(*Halichoerus grypus grypus*)

5.1 Population structure

There are three separate populations of grey seal in the world. One of them is the Baltic grey seal, which is found in the Baltic Proper, in the Bothnian Sea and in the Gulf of Finland, the other two live in the Northeast and Northwest Atlantic. In the Gulf of Finland, the grey seal is by far the most abundant seal species in the Baltic, although fewer haulout sites have been registered than for ringed seals (Figures 4.2.1.2 and 5.2.1.1).

Graves et al. (2009) and Fietz et al. (2016) found clear genetic differentiation between the Baltic and North Sea grey seals. Also some differentialtion was found between the three main breeding areas in the Bothnian Bay, Gulf of Riga and northern Baltic Proper, suggesting limited genetic exchange.

5.2 General distribution and abundance

The grey seal is only found in the North Atlantic. In the Northeast Atlantic, grey seals are centered around the British Isles, ranging from Iceland, eastward along the coast of France, and north along the Norwegian coast and the Kola Peninsula. The Northwest Atlantic population is found from the northeastern United States to Cape Chidley at the northern tip of Labrador (60° N), with the largest concentration around Sable Island, off the Nova Scotia coast. The Baltic Sea population is concentrated in the central Baltic area, bounded by Sweden, Finland and Estonia (NAMMCO 2007)

5.2.1 Grey seals in the Baltic Sea

The grey seal is currently the most abundant seal species in the Baltic. App. 100 years ago the grey seal population had a size of 80-100,000 individuals while in the 1970s it was down to about 4,000 because of hunting and pollution (Harding and Härkönen 1999). Abundance based on photo-identification in 2000 revealed an estimate of 15,600 individuals while an aerial survey in 2004 found 17,640 grey seals on land (Hiby et al. 2006). With an annual population increase of 7.9% and correction for seals in the water which are not counted during the survey, it is believed that the total population in the Baltic in 2014 was above 40,000, based on 32,200 counted seals

(HELCOM 2015).

The Baltic grey seals are distributed from the northernmost part of the Bothnian Bay to the southwestern waters of the Baltic Proper. Generally, during the breeding period, the seals dwell on drift ice in the Gulf of Riga, the Gulf of Finland, the Northern Baltic Proper and the Bothnian Bay or on the rocks in the north-western Baltic.

Satellite tracking of grey seals has showed that this species moves over long distances in the Baltic Sea and most tagged grey seals from the southern Baltic Sea have moved far into the Baltic Proper (Fig. 5.2.1.1, Dietz et al. 2015). A tagged female from Rødsand in the Danish Baltic was observed with a pup in Estonia and observed back at Rødsand a month later. This indicates seasonal migrations that are closely related with the requirements for feeding and suitable breeding habitats, where grey seals travelled up to 380 km from the tagging site (Dietz et al. 2015). Typically, however, they feed more locally, foraging just offshore and adopting a regular pattern of travelling between local feeding sites and preferred haul-outs (Sjöberg and Ball 2000, Oksanen et al. 2014).

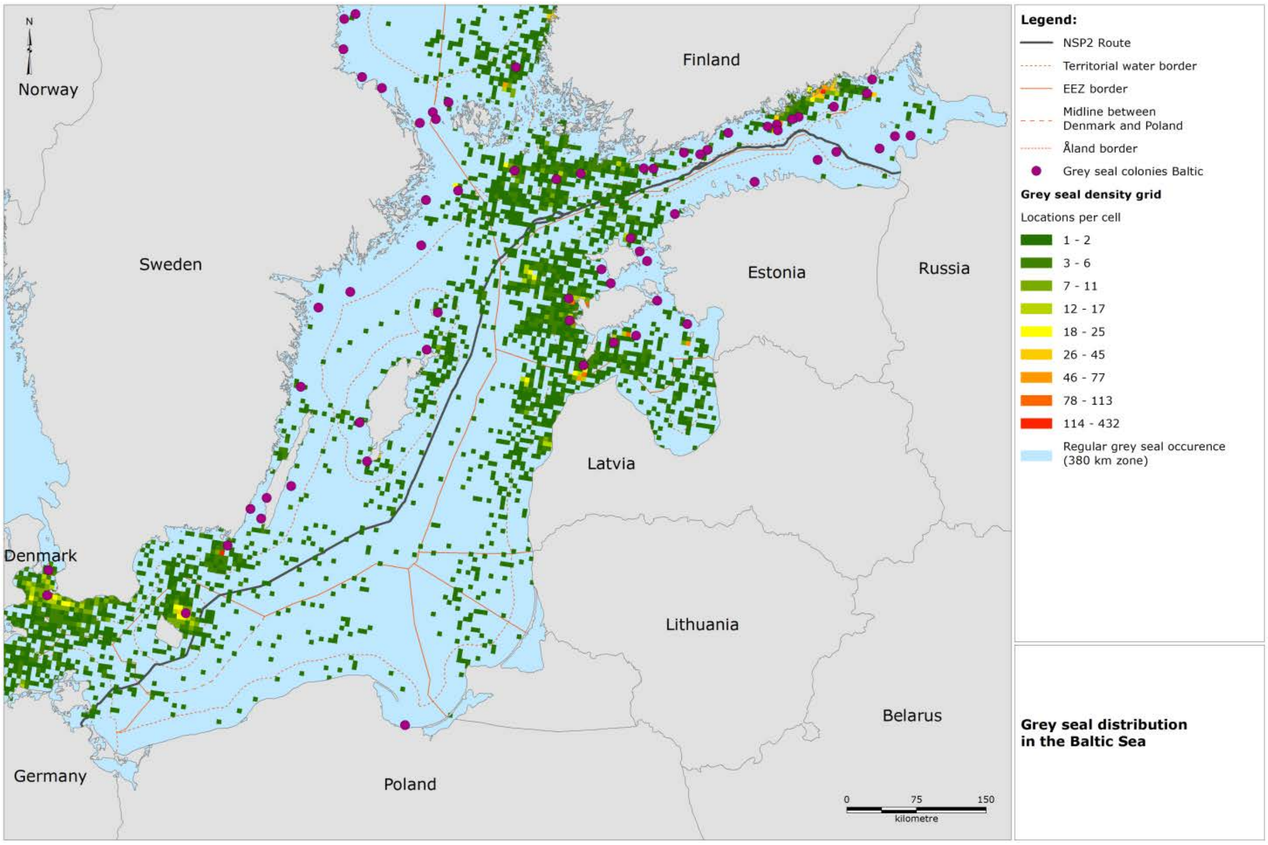

Figure 5.2.1.1 Map of haulout sites (colonies) used by grey seals for resting, breeding and moulting, zone of regular occurrence and density grid.The zone of regular occurrence is taken as the maximum distance from tagging site according to figure 5.2.1.2. Grey seal density grids are displayed as number of locations from GPS tracked grey seal per grid cell. Data source: HELCOM BALSAM Seal Database. Note that the distribution grid does not show the distribution of the whole population and is biased by the sites where seals have been tagged. Thus, it can be used only as an informative overview of seals in Baltic.

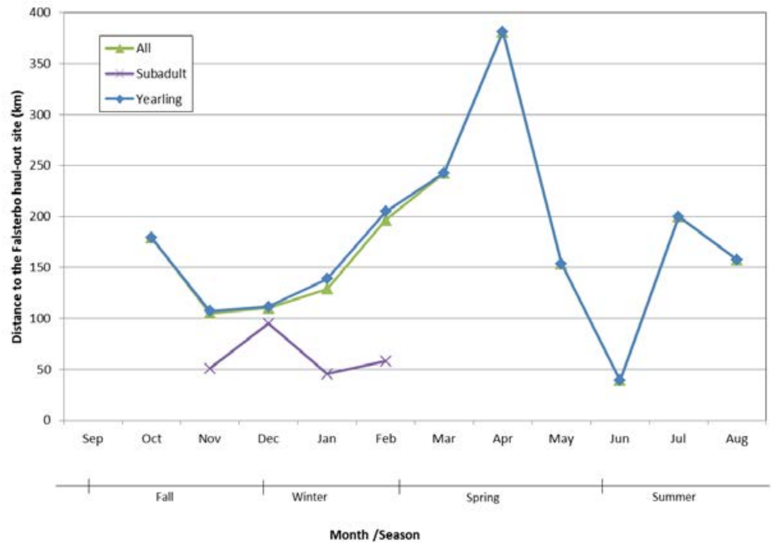

Figure 5.2.1.2 Distance travelled by month from the Falsterbo (southern Sweden) haul-out site where 11 grey seals were tagged in 2009-2012 (From Dietz et al. 2015).

In the Danish part of the Baltic, the number of grey seals has increased considerably over the last decade (Fig. 5.2.1.3). The grey seal colony in closest vicinity of the NSP2 line is at Christiansø (also called Ertholmene) in Danish waters near Bornholm. This colony is at present the largest of the Danish grey seal colonies and from 2011 to 2014, 33- 99% of all observed grey seals in Denmark were counted here.

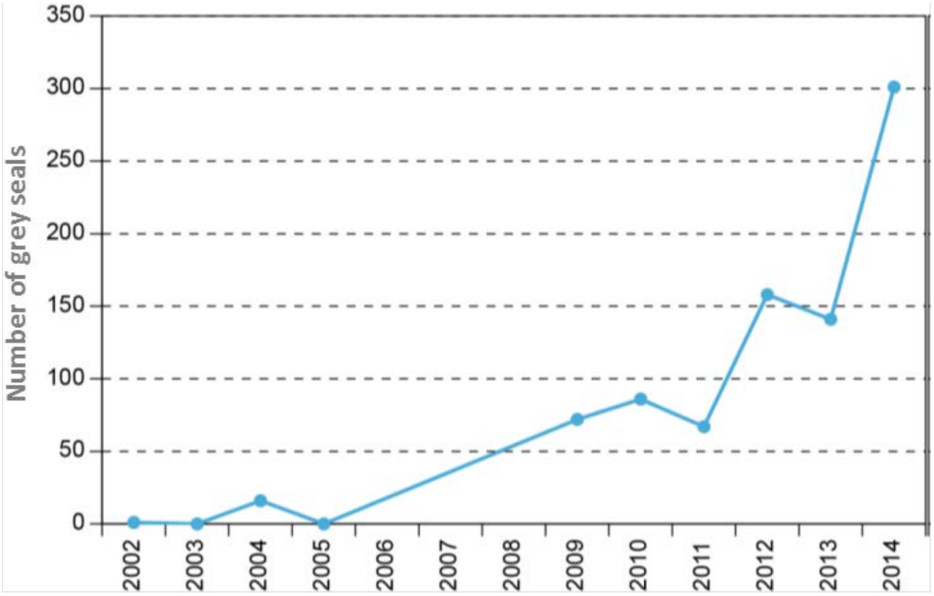

Figure 5.2.1.3 Number of grey seals counted during their moulting period (May-June) in the Danish part of the Baltic Sea 2002-2014 (From Sveegaard et al. 2015b).

5.3 Behaviour and reproduction

Grey seals feed in cold, open waters and breed in a variety of habitats where disturbance is minimal, such as rocky shores, sandbars, sea ice and islands. Birth takes place on pack ice between February and March or sometimes even in April depending on the ice-conditions. Some grey seals, however, also pup at uninhabited islets, most notably in Estonia and in the Stockholm Archipelago as well as a few seals in Denmark (Rødsand sand bar). This is seen as a consequence of global warming and the resulting lack of winter ice in some areas and also as the grey seals' potential to adapt to a changing environment. Males follow the female closely after she has given birth waiting to mate as soon as nursing has ended.

Grey seals are gregarious and gather for breeding, moulting and hauling out. They primarily haul out in coastal areas - in winter on drift ice close to open water and during summer preferably on uninhabited islands, outer islets and rocks. During the moulting period, they dwell on rocks and islets and sometimes on the last drift ice in the Bothnian Bay. Grey seals often share their localities with the harbour seal in areas where both species live. This is e.g. the case at Falsterbo and Rødsand, some of the southernmost localities for grey seals in the Baltic Sea.

Although dives exceeding 400 m have been recorded, most diving is at depths shallower than 120 m, with males tending to dive somewhat deeper (Beck et al. 2003). In the North Sea, grey seals have been observed to alternate long foraging trips with local, repeated trips and forage at depths between 50 and 90 m (McConnell et al. 1999). In a study of seals tagged in the southwestern Baltic, dive depths were mostly shallower than 30 m, although some dives deeper than 50 m were recorded (Dietz et al. 2015). Only slight seasonal variations in dive patterns were oberserved. Thus, harbour seals may potentially be present at all depths within their range in the areas surrounding the NSP2 route.

5.4 Feeding

Grey seals dive alone or in small groups and feed on many species of fish. Throughout the Baltic Sea the main prey is herring. In samples collected at Gotland, 9 fish species were identified from one study of 41 samples. 530 otoliths were recovered with the most abundant prey items being Atlantic herring, sprat and Atlantic cod which made up 32.6%, 31.3% and 24.5% of otoliths, respectively. In the Swedish central Baltic Sea, 32 fish species have been identified. Atlantic herring were most abundant (70.4% of recovered otoliths), followed by sprat (9.4%). In the Baltic Proper also sprat, common whitefish, freshwater cyprinids, gobies and flounder are important while a series of other species, covering most fish species living in the Baltic, contribute in lower amounts (Lundström et al. 2007).

5.5 Hearing, Vision, Touch/vibration, Electro- and magnetoreception

The senses of grey seals have not been studied in details but it is believed to be similar to other true seals. The section on senses of harbour seals, therefore also applies to the grey seal.

5.6 Disturbance

Grey seal populations can be disturbed by tourism, commercial fishing and mining activities, although little is known about responses to human presence, underwater noise and airborne noise.

The grey seal populations in the Baltic Sea are vulnerable to the effects of disturbance by ice-breaking activities, with a possible impact on breeding success. The Baltic Sea is relatively polluted, and fertility rates of seals in the Baltic were low in the 1980s where around 50% of females were sterile (Murphy et al. 2015). Grey seals show a high incidence of reproductive abnormalities and sterility (REF). The abnormalities could be the result of the effect of PCB, DDT or perhaps organochlorines, as high levels of these have been recorded.

5.7 Protection

5.7.1 Protection in EU waters

The grey seal is a protected species listed in Appendix II and Appendix V of the EC Habitats Directive and Appendix III of the Bern Convention. The Baltic grey seal population is also listed as ‘Least concern’ by the World Conservation Union (Härkönen 2016). A limited number of grey seals are hunted under quotas in Finland (Finnish Ministry of Agriculture and Forestry 2007) and Sweden (Havs- och Vattenmyndigheten 2012). The actual number of shot seals have always been far below the quota, the highest number shot in Sweden in any one year was 132 in 2008, in Finland it was 632 in 2009 (Finnish Ministry of Agriculture and Forestry 2007, HELCOM 2014). Estonia and Denmark have opened small quotas to protect fisheries (Naturstyrelsen 2014, http://news.err.ee/v/environment/e9a79e47-7cea-40e6-975d-2be201b91822).

5.7.2 Natura 2000 sites in the Baltic near the NSP2 pipeline route

Grey seals are listed as part of the selection criteria in 38 Swedish Natura 2000 sites. Of these 12 sites are located in the Baltic Sea within 100 km of the NSP2 pipeline route, within a common foraging range (Table 5.7.1, Fig. 5.7.1). In Denmark, grey seals are listed as part of the selection criteria in 16 Natura 2000 sites and one of these, Ertholmene (mentioned above), is located in the Baltic Sea within 100 km of the NSP2 pipeline route (Table 5.7.1, Fig. 5.7.1).

Table 5.7.1 Natura 2000 sites in the Swedish Baltic waters with grey seal (Halichoerus grypus) listed as part of the selection criteria. Area size, percentage of area that are marine, population status (according to the Habitats Directive), population size as well as approx. swimming distance to NSP2 pipeline route (km) (Source: http://natura2000.eea.europa.eu/#)

Site	Site name	Area (ha)	Marine %	Population status	Pop. Size (min-max)	Approx. swimming distance to NSP2 pipeline route (km)
DK007X079	Ertholmene	1256	100	C	no data	16
SE0110088	Bullerö-Bytta	14314.5	91	C	30-30	91
SE0110092	Stora Nassa	2948.7	90	C	no data	90
SE0110096	Svenska Högarna	2667.1	96	C	no data	77
SE0110111	Huvudskär	2076.5	96	C	no data	98
SE0110124	Svenska Björn	3980.2	100	A	1300-1300	87
SE0330108	Ottenby NR	2391.4	40	C	10-40	52
SE0330109	Eckelsudde	424.8	88	C	9-9	80
SE0330123	Värnanäs skärgård	1551.9	93	C	10-10	87
SE0330174	Sydöstra Ölands sjömarker	8866.9	68	C	no data	60
SE0340010	Näsrevet	95	88	C	10-10	96
SE0340097	Gotska Sandön-Salvorev	60494.7	94	C	50-50	26
SE0410040	Utklippan	117.6	90	C	no data	46

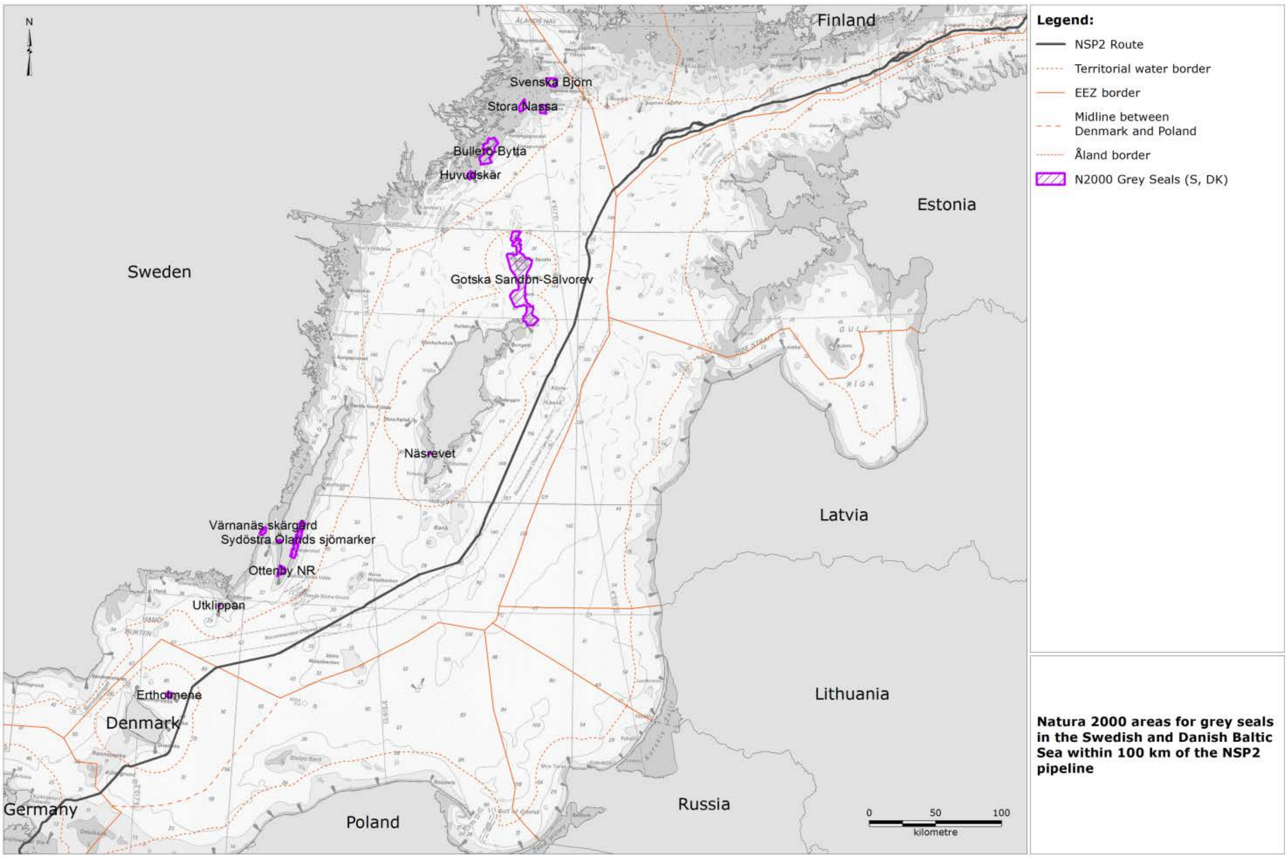

Figure 5.7.1 Map of Natura 2000 sites in the Swedish and Danish Baltic waters with grey seal listed as part of the selection criteria.

Grey seals are listed as part of the selection criteria in 33 Finnish and 19 Estonian Natura 2000 sites. Of these 15 Finnish and 9 Estonian areas are located within 100 km of the NSP2 pipeline route (Table 5.7.2, Fig. 4.7.1).

*Table 5.7.2 Natura 2000 sites in Finnish and Estonian waters with grey seal listed as part of the selection criteria within 100 km of the NSP2 route (22 sites in total). Area size, percentage of area that are marine, population size as well as approx. swimming distance to NSP2 pipeline route (km) (Source: http://natura2000.eea.europa.eu/#, except for the areas marked with * and **. Here the source is * = http://paikkatieto.ymparisto.fi/natura/tietolomakkeet/FI0408001.pdf and ** = P. Blankett, Ministry of the Environment, pers. comm.)*

Country	SITECODE	SITENAME	Area (ha)	Min. distance (km)	Grey seal Pop size (min-max)	% Marine
Finland	FI0100005	Tammisaari and Hanko Archipelago and Pohjanpitäjänlahti marine protected area	52630	17.8	0 - 40	94.50
	FI0100077	Söderskär and Långören archipelago	18219	12.5	100 -300	99.20
	FI0100078	Pernaja Bay and Pernaja Archipelago	65775	13.1	0-20	98.20
	FI0100089	Kallbådan islet andwater area	1520	8.1	0-140	99.90
	FI0200090	Saaristomeri	49735	27.4	1900-2300	88.60
		Extension to FI0200090	176117	14.5	no data	>95.00
	FI0408001*	Eastern Gulf of Finland archipelago and water	95628	23.5	0-20	100.00
	FI1400006	Björkör	5286	87.2	10-10	100.00
	FI1400007	Sandskär	13	77.2	2-2	100.00
	FI1400040	Klåvskär	2458	71.3	10-10	100.00
	FI1400054	Mörskär	803	49.5	no data	100.00
	FI1400055	Karlbybådar	1	55.7	no data	100.00
	FI1400057	Örskär - Fjällskär	6	75.8	1-5	100.00
	FI1400058	Lågskär	1059	90.2	5	100.00
Estonia	EE0010154	Krassi	80	30.7	20	99.10
	EE0010171	Kolga lahe	2449	30.3	6-10	89.20
	EE0040001	Väinamere	272715	42.7	10-1000	82.40
	EE0040002	Väinamere	253457	42.7	10-1000	82.80
	EE0040141	Klaasrahu	2688	66.1	50-200	100.00
	EE0040476	Tagamõisa	13552	80.5	no data	62.40
	EE0040496	Vilsandi	18328	92.0	251-500	70.00
	EE0040499	Raudrahu	2443	81.9	10-100	100.00
	EE0060220	Uhtju	2443	34.6	11-50	99.50

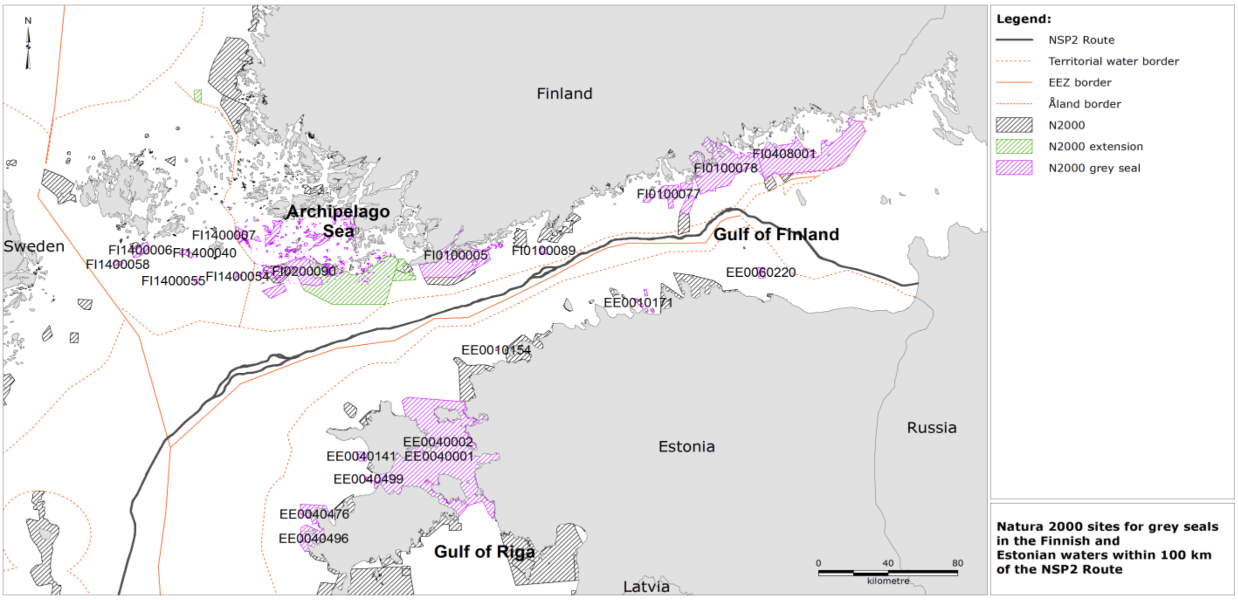

Figure 5.7.2 Map of Natura 2000 sites in the Finnish and Estonian waters with grey seal listed as part of the selection criteria within 100 km of the NSP2 route.

5.7.3 Protection and marine protected areas in Russian waters

In Russian waters, protected species are listed in the Red Data Book of the Russian Federation (RDBRF). The Red Data Book is a state document established for documenting rare and endangered species of animals, plants and fungi within the territory of the Russian Federation and its continental shelf and marine economic zone. The book has been adopted by Russia and all CIS states (Commonwealth of Independent States) to enact a common agreement on rare and endangered species protection. Russia are currently using a version from 1998 (Iliashenko & Iliashenko 2000), but the Red Data Book for species is (according to ASCOBANS) planned to be updated in 2018. The Red Data Book is implemented on both state and regional level.

The Baltic grey seal conservation status (categories in the Red Data Books are from the Rambøll document: W-PE-EBS-PRU-REP-809-Q41501EN-02_Book4):

- The Red Data Book of the Russian Federation category index 1 – abundance of subspecies has decreased to critical levels, bringing a danger of extinction in the near future
- The Leningrad Region Red Data Book, category index 2 - endangered (EN), subspecies

- The Saint Petersburg Red Data Book, category index 3 - vulnerable (VU), subspecies
- The IUCN Red List of Threatened Species, Least Concern (LC), subspecies (www.iucnredlist.org, accessed 30.12.2016)

It is conspicuous that the categories of the Red Data Books all list the grey seal as having a problematic status, while the IUCN assessment is positive. The differences in these conservation statuses may as for the ringed seal be because the IUCN monitors the situation in the Baltic Sea as a whole, while the Red Data Book of the Russian Federation monitors the entire territory of Russia and the Leningrad Region Red Data Book monitors the Gulf of Finland. However, since the Baltic grey seals represent one integrated population which has experienced solid positive population trends in all areas of the Baltic in the last decades, the assessments seem outdated. All Red Data Book assessments are more than 10 years old, while the IUCN were updated in 2015.

Grey seals are included in several marine protected areas in the Russian part of the Gulf of Finland, namely Ramsar sites, Baltic Sea Protected Areas and nature reserves (see Figure 4.7.3). The NSP2 route crosses one of these protected sites and several others are located close to the route.

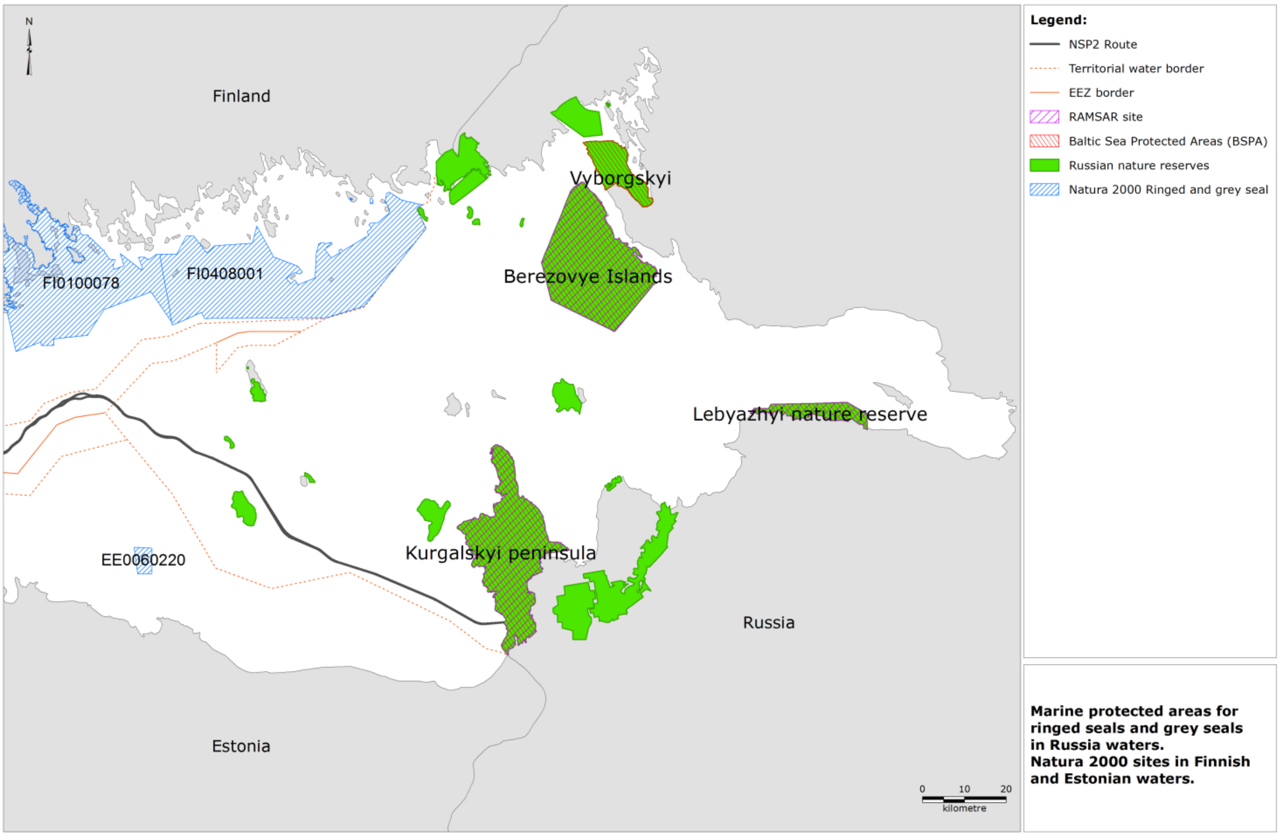

Figure 5.7.3 Map of Marine Protected Areas (MPAs) and Nature reserves in Russian waters and Natura 2000 (N2000) for seals in Estonian and Finnish waters.

6. Critical periods for Baltic Sea mammals

The most vulnerable periods for seals in the Baltic Sea are primarily during their moulting, breeding and lactation periods. Harbour porpoises are also vulnerable in the breeding period, but the calves may be vulnerable throughout the first year and especially in the first period after leaving their mother (Table 6.1).

Table 6.1 Critical periods for harbour porpoise, harbour seal, ringed seal and grey seal and countries around the Baltic Sea. Countries are defined as "Countries in which the species distribution overlaps with the NSP2 route and potential impact area.

Species	Breeding and lactation period	Moulting period	Countries
Harbour porpoise	All year (nursing persists throughout the following year)	-	Sweden, Denmark, Germany, Finland, Poland
Harbour seal	May - July	August	Sweden
Ringed seal	February - March	April - May	Russia, Finland, Estonia, Sweden
Grey seal	February – March/April	May - June	Finland, Estonia, Sweden, Denmark, Germany, Poland, Russia

7. Conclusion

Four species of marine mammals are living in the Baltic Sea: harbour porpoise, harbour seal, ringed seal and grey seal.

The harbour porpoise is found in all waters intersected by the NSP2 route. The densities are however very low especially in Finnish, Estonian and Russian waters. The highest density of the endangered Baltic Sea harbour porpoise population is found around the Midsjö Banks south of Gotland. According to the results of the recently finished EU LIFE+ SAMBAH project, this area is considered a hot spot and the most important area during the breeding season for porpoises, and it was therefore in December 2016 appointed a Swedish Natura2000 site. The proposed pipeline route is crossing in the middle of this area over a stretch of at least 100 km in Swedish waters.

According to the data presented there is very little chance that a harbour seal would be near the proposed pipeline route at any time.

The proposed pipeline route will be positioned relatively near (<100 km) several haul-out sites for ringed seals (Russian waters) and grey seals (Russian and Finnish waters) in the Gulf of Finland and enter a large area with regular occurrence in Russian, Finnish and Estonian waters. This involves the ringed seals occupying the Gulf of Finland and Gulf of Riga, while the ringed seals in Bothnian Bay are further away. Several Natura 2000 sites with ringed seal as part of the protection basis are located near the proposed NSP2 pipeline route.

Despite that grey seals have only been tagged with transmitters in some areas, the tracking locations are spread all over the Baltic Sea. Grey seal colonies, Natura 2000 sites and ice breeding locations in the Gulf of Finland are located within 20 km of the planned pipeline route. The proposed route will also cross within 20 km of the Danish haul-out and Natura2000 site near Bornholm. At the landfall? in Germany a conservation area for grey seals is intersected. This area contains the only island in the German Baltic Sea where grey seals are regularly seen on land.

8. References

92/43/EEC (1992) Council Directive 92/43/EEC of 21 May 1992 on the Conservation of natural habitats and of wild fauna and flora.

Akamatsu, T., Dietz, R., Miller, L. A., Naito, Y., Siebert, U., Teilmann, J., Tougaard, J., Wang, D., and Wang, K. (2007). Comparison of echolocation behavior between coastal oceanic and riverine porpoises. Deep-Sea Research Part II 54: 290–297

Andersen SM, Teilmann J, Harders PB, Hansen EH, Hjollund D (2007) Diet of harbour seals and great cormorants in Limfjord, Denmark: interspecific competition and interaction with fishery. Ices Journal of Marine Science 64, 1235-1245.

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.

Andersen, S.M., Teilmann, J., Dietz, R., Schmidt, N.M. and Miller, L.A. (2014) Disturbance-induced responses of VHF and Satellite tagged harbour seals. Aquatic conservation: Marine and Freshwater Ecosystems 24: 712-723, DOI: 10.1002/aqc.2393

Andersen, S.M., Teilmann, J., Dietz, R., Schmidt, N.M., and Miller, L.A. (2012) Behavioural responses of harbour seals to human-induced disturbances. Aquatic conservation: Marine and Freshwater Ecosystems 22: 113-121. DOI: 10.1002/aqc.1244

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

Beck, C.A., Bowen, W.D., McMillan, J.I. and Iverson, S.J. 2003b. Sex differences in the diving behaviour of a size-dimorphic capital breeder: the grey seal. Animal Behavior 64: 1-13.

Berggren, P. Hiby, L., Lovell, P. and Scheidat. M. 2004. Abundance of harbour porpoises in the Baltic Sea from aerial surveys conducted in summer 2002. 16pp. Paper SC/56/SM7 submitted to the Scientific Committee of the International Whaling Commission. Available from www.iwcoffice.org.

Biologists for Nature Conservation. 2011. Inventories of harbour porpoise Phocaena phocaena phocaena presence in Russian territorial waters of the Baltic Sea. AC19/Doc.6-03

Bjørgesæter, A., Ugland, K. I., and Bjørge, A. (2004). Geographic variation and acoustic structure of the underwater vocalization of harbor seal (Phoca vitulina) in Norway, Sweden and Scotland. J.Acoust.Soc.Am. 116, 2459-2468.

Blackwell, S. B., Lawson, J. W., Williams, M. T. (2004). Tolerance by ringed seals (Phoca hispida) to impact pipe-driving and construction sounds at an oil production island. The Journal of the Acoustical Society of America 115, 2346-2357.

Boness, D. J., Bowen, W. D., Buhleier, B. M., and Marshall, G. J. (2006). Mating tactics and mating system of an aquatic-mating pinniped: the harbor seal, Phoca vitulina. Behav.Ecol.Sociobiol. 61, 119-130.

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.

Bullock, T. H. and Heiligenberg, W. (1986). Electroreception Wiley & Sons.

Czech-Damal NU, Liebschner A, Miersch L, Klauer G, Hanke FD, Marshall C, Dehnhardt G, Hanke W. 2012. Electroreception in the Guiana dolphin (Sotalia guianensis). Proceedings of the Royal Society B (2012) 279, 663–668

Denhardt, G., Mauck, B., and Bleckmann, H. (1998). Seal whiskers detect water movements. Nature 394, 235-236.

Denhardt, G., Mauck, B., Hanke, W., and Bleckmann, H. (2001). Hydrodynamic trail-following in harbor seals (Phoca vitulina). Science 293, 102-104.

Dietz, Rune; Galatius, Anders; Mikkelsen, Lonnie; Nabe-Nielsen, Jacob; Riget, Frank Farsø; Schack, Henriette; Skov, Henrik; Sveegaard, Signe; Teilmann, Jonas; Thomsen, Frank (2015) Marine mammals - Investigations and preparation of environmental impact assessment for Kriegers Flak Offshore Wind Farm. Energinet.dk, 2015. 208 pp. http://www.ens.dk/sites/ens.dk/files/supply/renewable-energy/wind-power/offshore-wind-power/new-offshore-wind-tenders/kriegers_flak_offshore_wind_farm_eia_marine_mammals_technical_report.pdf

Dykes, R. (1975). Afferent fibers from mystacial Vibrissae of cats and seals. J.Neurophysiol. 38, 650-662.

Edrén, S. M. C., Andersen, S. M., Teilmann, J., Carstensen, J., Harders, P.B., Dietz, R. & Miller, L. (2010). The effect of a large Danish offshore wind farm on harbour and grey seal haul-out behaviour. Marine Mammal Science 26(3): 614–634.

Eguchi, T., & Harvey, J. (2005). ving behavior of the Pacific harbor seal (Phoca vitulina richardii) in Monterey Bay, California. Marine Mammal Science, 21, 283-295.

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.

European Environmental Agency. 2016. NATURA 2000 - STANDARD DATA FORM for site DK00VA261, sitename: Adler Grund og Rønne Banke. Assessed on 18.05.2016: http://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=DK00VA261

Fietz, K.; Galatius, Anders; Frie, A.K.; Teilmann, Jonas; Dietz, Rune; Klimova, A; Jensen, L F; Graves, J.A.; Hall, A.; McConnell, Bernie; Hoffman, J.; Gilbert, M T P; Olsen, M. T. 2016. Grey seals in Europe: Divided by climate and culling – reunited by conservation. In press: Molecular Ecology, 2016.

Finnish Ministry of Agriculture and Forestry 2007. Management plan for the Finnish seal populations in the Baltic Sea. http://mmm.fi/documents/1410837/1721042/4b_Hylkeen_enkku_nettiin.pdf/aeb2abf7-d6f0-422e-8a6a-94ba8403df31

Fobes, J. L. and Smock, C. C. (1981). Sensory capacities of marine mammals. Psychol.Bull. 89(2), 288-307.

Gjertz, I., Lydersen, C., Wiig, Ø. (2001). Distribution and diving of harbour seals (Phoca vitulina) in Svalbard. Polar Biology **24,** 209-214.

Jüssi M, Ahola M, Verevkin M, Loisa O. 2016. Marine Mammals, p 219-220 in Raateoja M & Setälä O (Eds) The Gulf of Finland Assessment. Reports of the Finnish Environment Institute nr 27, Helsinki, Finland

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

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

Graves JA, Helyar A, Biuw M, Jussi M, Jussi I et al. (2009). Microsatellite and mtDNA analysis of the population structure of grey seals (Halichoerus grypus) from three breeding areas in the Baltic Sea. Conservation Genetics 10: 59-68. doi:10.1007/s10592-008-9517-1

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). The IUCN Red List of Threatened Species 2016: e.T17031A98831650. Downloaded on 08 November 2016

Hammond, PS, Macleod, K, Berggren, P, Borchers, DL, Burt, ML, Cañadas, A, Desportes, G, Donovan, GP, Gilles, A, Gillespie, D, Gordon, J, Hedley, S, Hiby, L, Kuklik, I, Leaper, R, Lehnert, K, Leopold, M, Lovell, P, Øien, N, Paxton, C, Ridoux, V, Rogan, E, Samarra, F, Scheidat, M, Sequeira, M, Siebert, U, Skov, H, Swift, R, Tasker, ML, Teilmann, J, Van Canneyt, O Vázquez, JA. (2013). Cetacean abundance and distribution in European Atlantic shelf waters to inform conservation and management. Biological Conservation 164: 107-122

Hanggi, E. B. and Schusterman, R. J. (1994). Underwater acoustic displays and individual variation in male harbour seals, Phoca vitulina. Anim.Behav. 48, 1275-1283.

Hanke FD, Hanke W, Scholtyssek C, Dehnhardt G. 2009. Basic mechanisms in pinniped vision. Experimental Brain Research 199: 299–311

Havs- och vattenmyndigheten 2012. Nationell förvaltningsplan för gråsäl (Halichoerus grypus) i Östersjön.¬http://www.rktl.fi/www/uploads/pdf/Hylkeet/forvaltningsplan_grasal_sverige_2012.pdf

Harding KC and Härkönen TJ. 1999. Development in the Baltic grey seal (Halichoerus grypus) and ringed seal (Phoca hispida) populations during the 20th century. Ambio 28: 619-627.

Härkönen , T. 2015. Pusa hispida ssp. botnica. The IUCN Red List of Threatened Species 2015: e.T41673A66991604. http://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T41673A66991604.en. Downloaded on 08 November 2016.

Härkönen , T. 2016. Halichoerus grypus (Baltic Sea subpopulation). The IUCN Red List of Threatened Species 2016: e.T74491261A74491289. http://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T74491261A74491289.en. Downloaded on 08 November 2016.

Härkönen T, Galatius A, Bräger S, Karlsson O, Ahola M. 2013. Population Growth Rage, abundance and distribution of marine mammals. HELCOM Core Indicator of Biodiversity, HELCOM, Helsinki

Härkönen T, Jüssi M, Jüssi I, Verevkin M, Dmitrieva L, et al. (2008). Seasonal Activity Budget of Adult Baltic Ringed Seals. PLoS ONE 3(4): e2006. doi:10.1371/journal.pone.0002006

Härkönen T, Stenman O, Jüssi M, Jüssi I, Sagitov R, et al. (1998) Population size and distribution of the Baltic ringed seal (Phoca hispida botnica). NAMMCO Scientific Publications. 1: 167–

180.

Härkönen, T., 2006, "Populationsinventeringar av knubbsäl i Kalmarsund", (Eds: Naturhistoriska Riksmuseet i Stockholm, Miljögiftgruppen).

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

HELCOM 2014. Registered mortality of seals. HELCOM.

HELCOM 2015. Core indicator report - Population trends and abundance of seals. Available at: http://helcom.fi/Pages/search.aspx?k=seal%20monitoring

HELCOM 2016. Population trends and abundance of seals HELCOM core indicator report. Online. http://www.helcom.fi/Core%20Indicators/Population%20trends%20and%20abundance%20of%20seals_HELCOM%20core%20indicator%20report%202016_web%20version.pdf

HELCOM Red List Marine Mammal Expert Group. 2013. Phoca hispida botnica Species Information Sheet, HELCOM; Helsinki. http://helcom.fi/Red%20List%20Species%20Information%20Sheet/HELCOM%20Red%20List%20Phoca%20hispida%20botnica.pdf

Helle E (1980) Lowered reproductivite capacity in female ringed seals (Pusa hispida) in the Bothnian Bay, northern Baltic Sea, with special reference to uterine occlusions. Annales Zoologici Fennici 17:147–158

Hiby, L. and P. Lovell. 1996. Baltic/North Sea aerial surveys - final report. 11 pp.

Hiby, L., Lundberg, T., Karlsson, O., Watkins, J., Jüssi, M., Jüssi, J. and Helander, B. 2006. Estimtes of the size of the Balic grey seal population based on photo-identification data. NAMMCO Sci. Publ. 6, 163-176

IUCN 2007. Phoca vitulina (Common Seal, Harbor Seal, Harbour Seal). IUCN 2007 http://www.iucnredlist.org/details/17013/1

IUCN 2015. http://www.iucnredlist.org/details/41673/0. Accessed on the 1.9.2016.

Kastak, D. and Schusterman, R. J. (1998). Low-frequency amphibious hearing in pinnipeds: Methods, measurements, noise, and ecology. J.Acoust.Soc.Am. 103, 2216-2228.

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., Hoek, L., de Jong, C. A., & Wensveen, P. J. (2010). The effect of signal duration on the underwater detection thresholds of a harbor por-poise (Phocoena phocoena) for single frequency-modulated tonal signals between 0.25 and 160 kHz. Journal of the Acoustical Society of America, 128, 3211-3222.

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.

Kauhala K, Kunnasranta M, Valtonen M (2011) Hallien ravinto Suomen merialueella 2001-2007 - alustava selvitys. Suomen Riista 57, 73-83.

Keskonnaamet 2015. Viigerhülge (Phoca hispida) kaitse tegevuskava. Estonian Environmental Board, Tallinn. 41 pp.

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.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.

Länsstyrelsen Kalmar Län and Länsstyrelsen Gotlands Län. 2016. Samråd kring förslag till utvidgning av Natura 2000-områdena Hoburgs bank och Norra Midsjöbanken med viktiga områden för tumlare. Remiss 2016-04-25. Lst Gotland dnr 511-3419-15, Lst Kalmar dnr

511-3380-14: http://www.lansstyrelsen.se/Kalmar/sv/djur-och-natur/skyddad-natur/natura2000/Documents/remiss_Natura2000_Hoburgs_bank_och_Midsjobankarna.pdf

Lesage, V., Hammill, M., & Kovacs, K. (1999). Functional classification of harbor seal (Phoca vitulina) dives using depth profiles, swimming velocity, and an index of foraging success. Canadian Journal of Zoology-Revue Canadienne de Zoologie, 77, 74-87.

Levenson, D. H. and Schusterman, R. J. (1999). Dark adaptation and visual sensitivity in shallow and deep-diving pinnipeds. Mar.Mamm.Sci. 15, 1303-1313.

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 Scentific Publication 5: 143-176

Lowry, L. 2016. Phoca vitulina. The IUCN Red List of Threatened Species 2016: e.T17013A45229114. http://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T17013A45229114.en. Downloaded 8 November 2016.

Lundström K, Bergenius M, Aho T, Lunneryd SG (2014) Födeval hos vikaresäl i Bottenviken:. Aqua reports 2014:1.

Lundström, K., Hjerne, O., Alexandersson, K. and Karlsson, O. 2007. Estimation of grey seal (Halichoerus grypus) diet composition in the Baltic Sea. NAMMCO Scientific Publications 6: 177-196.

McConnell, B., Fedak, M., Lovell, P., & Hammond, P. (1999). Movements and foraging areas of grey seals in the North Sea. Journal of Applied Ecology, 36, 573-590.

Meier, H. E. M., Döscher, R. and Halkka, A., (2004). Simulated distributions of Baltic sea-ice in warming climate and consequences for the winter habitat of the Baltic ringed seal, Ambio 33: 4-5, 249-256.

Miettinen, M, Halkka, A., Högmander, J., Keränen, S., Mäkinen, A., Nordström, M., Nummelin, J. & Soikkeli, M. (2005). The ringed seal in the Archipelago Sea, SW Finland: population size and surveys techniques. International conference on Baltic seals, 15–18 February Helsinki, Finland.

Møhl, B. (1967). Seal Ears. Science 157, 99.

Møhl, B. (1968). Auditory sensitivity of the common seal in air and water. J.Aud.Res 8, 27-38.

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.

Murphy, S., Barber, JL., Learmonth, JA., Read, FL., Deaville, R., Perkins, MW., Brownlow, A., Davison, N., Penrose, R., Pierce, GJ, Law, RJ., Jepson, PD. 2015. Reproductive Failure in UK Harbour Porpoises Phocoena phocoena: Legacy of Pollutant Exposure? PLoS ONE 10(7): e0131085. doi:10.1371/journal.pone.0131085

NAMMCO 2007. Grey seals in the North Atlantic and the Baltic. Edited by: Tore Haug, Mike Hammill and Droplaug Ólafsdóttir. NAMMCO Scientific Publications Vol 6: 227 pp. http://septentrio.uit.no/index.php/NAMMCOSP/issue/view/239

Natural Resources Institute Finland. 2016. Date accessed 01.09.2016. https://www.luke.fi/tietoa-luonnonvaroista/riista/hylkeet/.

Naturstyrelsen 2014. Forslag om midlertidig ordning til regulering af gråsæl. J.nr. NST-303-00130.¬http://naturstyrelsen.dk/media/nst/9498479/notat_om_regulering_af_gr_s_l.pdf

Nyman M, Koistinen J, Fant ML, Vartiainen T, Helle E 2002. Current levels of DDT, PCB and trace elements in the Baltic ringed seals (Phoca hispida baltica) and grey seals (Halichoerus grypus). Environmental Pollution 119:399–412

Oksanen, S. 2015: Spatial ecology of the grey seal and ringed seal in the Baltic Sea – seeking solutions to the coexistence of seals and fisheries. Publication of the University of Eastern Finland. Dissertations in Forestry and Natural Sciences No 188.

Oksanen S M, Ahola M P, Lehtonen E, Kunnasranta M (2014). Using movement data of Baltic grey seals to examine foraging-site fidelity: implications for seal-fishery conflict mitigationMarine Ecology Progress Series 507: 297-308

Oksanen SN, Niemi M, Ahola MP, Kunnasranta M (2015). Identifying foraging habitats of Baltic ringed seals using movement data. Movement Ecology 3:33

Olsen, M.T., Andersen, L.W., Dietz, R., Teilmann, J., Härkönen, T. and Siegismund, H.R. (2014). Integrating genetic data and population viability analyses for the identification of harbour seal (Phoca vitulina) populations and management units. Molecular Ecology 23, 815–831. doi: 10.1111/mec.12644

Palo, J.U., Mäkinen, H.S., Helle, E.,Stenman, O. & Väinölä, R. 2001: Microsatellite variation in ringed seasl (Phoca hispida): genetic structure and history of hte Baltic Sea population.- Heredity 86:609-617.

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.

Popov, V. V., Supin, A. Y., Wang, D., and Wang, K. (2006). Nonconstant quality of auditory filters in the porpoises, Phocoena phocoena and Neophocoena phocaenoides (Cetacea, Phocoenidae). J.Acoust.Soc.Am. 119, 3173-3180.

Proske, U. and Gregory, E. (2003). Electrolocation in the platypus – some speculations. Comparative Biochemistry and Physiology - Part A: Molecular & Integrative Physiology 136, 821-825.

Reeves, R, R, (1998). Distrubution abundance and biology of ringed seals (Phoca hispida): an overview. NAMMCO Scientific Publications, 1, 9-45.

Routti H. 2009. Biotransformation and endocrine disruptive effects of contaminants in ringed seals- implications for monitoring and risk assessment. PhD Dissertation, University of Turku.

SAMBAH. 2016. Static Acoustic Monitoring of the Baltic Sea Harbour Porpoise (SAMBAH). Final report under the LIFE+ project LIFE08 NAT/S/000261. Kolmårdens Djurpark AB, SE-618 92 Kolmården, Sweden. 81pp.

Sjöberg, M. & J.P. Ball 2000. Grey seal, Halichoerus grypus, habitat selection around haul-out sites in the Baltic Sea: bathymetry or centralplace foraging? Canadian Journal of Zoology 78: 1661-1667.

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.

Söderberg S (1975) Feeding habits and commercial damage of seals in the Baltic. Proceedings from the Symposium on the seal in the Baltic, 66-78.

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., Schusterman, R. J., and Kastak, D. (2001). Masking in three pinnipeds: underwater, low-frequency critical ratios. J.Acoust.Soc.Am. 108, 1322-1326.

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.

Sundqvist, L., Härkönen, T., Svensson, C.J. & Harding, K.C. 2012: Linking climate trends to population dynamics in the Baltic ringed seal: impacts of historical and future winter temperatures – Ambio 41:865-872.

Suuronen P, Lehtonen E (2012) The role of salmonids in the diet of grey and ringed seals in the Bothnian Bay, northern Baltic Sea. Fisheries Research 125, 283-288.

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. and Teilmann, J. 2015b: Havpattedyr - Sæler og Marsvin. In: Marine områder 2014. NOVANA. Aarhus Universitet, DCE – Nationalt Center for Miljø og Energi, 142 s. - Videnskabelig rapport fra DCE - Nationalt Center for Miljø og Energi nr. 167. http://dce2.au.dk/pub/SR167.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, Galatius A. 2013. Abundance survey of harbour porpoises in Kattegat, Belt Seas and the Western Baltic, July 2012. Note from DCE - Danish Centre for Environment and Energy, 11 pp.

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. & Lowry, N. (1996) Status of the Harbour Porpoise (Phocoena phocoena) in Danish waters. - Rep. int. Whal. Commn. 46: 619-625.

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., 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.

Terhune, J. M. and Turnbull, S. D. (1995). Variation in the psychometric functions and hearing thresholds of a harbour seal. In: Sensory systems of aquatic mammals (eds. Kastelein, R. A., Thomas, J. A., and Nachtigall, P. E.), pp. 81-93. De Spil, Woerden, Netherlands.

Tollit, D., Black, A., Thompson, P., Mackay, A., Corpe, H., Wilson, B., et al. (1998). Variations in harbour seal Phoca vitulina diet and dive-depths in relation to foraging habitat. Journal of Zoology, 244, 209-222.

Tougaard, J., Teilmann, J. & Tougaard, S. (2008) Harbour seal spatial distribution estimated from Argos satellite telemetry – overcoming positioning errors. Endangered Species Research, 4, 113-122.

Turnbull, S. D. and Terhune, J. M. (1990). White noise and pure tone masking of pure tone thresholds of a harbor seal listening in air and under water. Can. J. Zool. 68, 2090-2097.

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.

Wiltschko, R. and Wiltschko, W. (1996). Magnetorception: Why is conditioning so seldom succesful? Naturwissenschaften 83, 241-247.

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.