ENERGINET

KRIEGERS FLAK II

OFFSHORE SURVEYS OF BIRDS, BATS AND MARINE MAMMALS FOR OFFSHORE WIND FARMS IN DANISH WATERS.

TECHNICAL REPORT MARINE MAMMALS

12-07-2024

KRIEGERS FLAK II (NORTH AND SOUTH)

OFFSHORE SURVEYS OF BIRDS, BATS AND MARINE MAMMALS FOR OFFSHORE WIND FARMS IN DANISH WATERS.

TECHNICAL REPORT MARINE MAMMALS

ENERGINET

PROJECT NAME: KRIEGERS FLAK II
PROJECT NO.: 22003005
DATE: 12-07-2024
VERSION: 1.0
PREPARED BY: WSP AND BIOCONSULT SH
PROJECT MANAGER: JAN NICOLAISEN
REPORT MANAGER: ALEXANDER SCHUBERT AND SANNE KJELLERUP
CHECKED BY: JAN NICOLAISEN AND ANSGAR DIEDERICHS
APPROVED BY: [GODKENDT AF]
APPROVED BY CLIENT: [GODKENDT AF]
DESCRIPTION: TECHNICAL REPORT FOR MARINE MAMMALS

WSP DANMARK

WSP.COM

INDHOLD

Abbreviation	Explanation
CMS	Convention on the Conservation of Migratory Species of Wild Animals
C-POD	Cetacean-Porpoise Detector
CR	Critically endangered
DCE	Danish Center for Environment and Energy
DD	Degree (WGS84 coordinate system)
DP10M	Detection-Positive 10 Minutes
DPD	Detection-Positive Days
EEA	European Environment Agency
EEZ	Exclusive Economic Zone
HELCOM	Helsinki Commission
Ind	Individual
IUCN	International Union for the Conservation of Nature
KF II N	Kriegers Flack II North
KF II S	Kriegers Flack II South
LC	Least Concern
MM	Minute (WGS84 coordinate system)
NOVANA	Nationwide Monitoring and Assessment Programme for the Aquatic and Terrestrial Environments
ODAS	Offshore Data Acquisition Systems
PAM	Passive Acoustic Monitoring
Pre-investigation area	Gross area for Digital Aerial Survey for marine mammals.
SAC	Special Areas of Conservation
SAMBAH	Static Acoustic Monitoring of the Baltic Sea Harbour Porpoise
SCANS	Small Cetacean Abundance survey in the North Sea and adjacent waters
SCI	Sites of Community Importance
SD	Secure Digital
SPL	Sound Pressure Level
TRL	Target Reference Level
VU	Vulnerable

1 SUMMARY

1.1 INTRODUCTION

The pre-investigation area for Kriegers Flak II (North and South) is situated between Møn in Denmark, Falsterbo in Sweden and Rügen in Germany within the Danish, German and Swedish EEZ. The pre-investigation area includes two planned offshore wind farm areas (KF II N and KF II S) within the Danish EEZ. There are already three operating offshore wind farm areas within the pre-investigation area, of which two are located within the Danish EEZ.

1.2 OBJECTIVES AND METHODOLOGIES

The following monitoring methods were used for the present marine mammal monitoring study:

- Abundance and distribution of marine mammals based on bimonthly digital aerial offshore wildlife surveys (HiDef)
- Spatial and seasonal habitat use of harbour porpoises based on Passive Acoustic Monitoring (PAM) with C-PODs

1.2.1 DIGITAL AERIAL SURVEYS

For the assessment of marine mammals in the pre-investigation area for Kriegers Flak II (KF II N and KF II S) digital aerial surveys were conducted using HiDef video technology (www.hidefsurveying.co.uk), explained in detail in WEIß ET AL. (2016). Transect design for the pre-investigation area consisted of 13 transects aligned from north to south. The transects had a total length of 831 km varying between 24 km and 84 km with a distance between each transect line of 5 km. On average, 11.0% of the 3,739 km² pre-investigation area was covered per flight (Table 1.1).

Table 1.1. Overview of the digital aerial surveys carried out in the pre-investigation area between February 2023 and January 2024. Effort is the area covered by the digital aerial flights; coverage is the % area covered relative to the pre-investigation area.

Survey no.	Date	Distance [km]	Effort [km²]	Coverage [%]
1	27.02.23	833	431	11.5
2	04.04.23	787	417	11.1
3	22.06.23	790	421	11.2
4	16.08.23	834	340	09.1
5	18.10.23	796	415	11.1
6	23.12.23	834	445	11.9
		Total: 4,873	**Total: 2,468**	**Average: 11.0**

1.2.2 PASSIVE ACOUSTIC MONITORING

The purpose of the passive acoustic monitoring (PAM) survey was to determine the spatial and seasonal habitat use of harbour porpoise occurring in the pre-investigation areas from KF II N and KF II S during the one-year survey period from February 2023 to January 2024. 16 C-PODs (F-O1 to F-O8 and F-R1 to F-R8) were deployed for PAM of harbour porpoises in the pre-investigation area in the Western Baltic Sea.

1.3 RESULTS

1.3.1 HARBOUR SEALS

Out of the 100 seals that were observed during the digital aerial surveys, 72.0% (72 individuals) could be identified to species level. These 72 seals were divided into 93.1% harbour seals (n=67) and 6.9% grey seals (n=5). Harbour seals were the most dominant seal species. The highest density for all seals combined was observed in autumn. Most seals were observed in the northern part of the pre-investigation area throughout the year with 89.0% of all sightings within one of the two Swedish Sites of Community Importance (SCI) under the Natura 2000 Habitats Directive *Falsterbohalvön* (SE0430095) and *Sydvästskånes utsjövatten* (SE0430187) in which both harbour seal and grey seal are listed as important species respectively.

1.3.2 GREY SEALS

Grey seals were only observed during one digital aerial survey (04.04.23). However, as 28.0% of seals could not be identified to species level, results apply to both seal species. Most seals were observed in the northern part of the pre-investigation area throughout the year with 89.0% of all sightings within one of the two Swedish Sites of Community Importance (SCI) under the Natura 2000 Habitats Directive *Falsterbohalvön* (SE0430095) and *Sydvästskånes utsjövatten* (SE0430187) in which both harbour seal and grey seal are listed as important species respectively.

1.3.3 HARBOUR PORPOISE

Harbour porpoises were observed during all surveys with the highest densities in summer. Overall, from February 2023 to January 2024 74 individuals were identified as harbour porpoises. The proportion of juveniles was 4.3% (n=2) which is relatively low compared to other areas (e.g., the North Sea). Harbour porpoises were distributed all over the pre-investigation area with no clear preference. Most sightings occurred in the middle of the pre-investigation area around and east of Møn.

Furthermore, passive acoustic monitoring with a total of 16 C-POD stations was carried out to determine the habitat usage of the area by harbour porpoises. On average, at least one harbour porpoise contact was recorded at each station on 90.9% of all survey days.

2 INTRODUCTION

In order to accelerate the expansion of Danish offshore wind production, it was decided with the agreement on the Finance Act for 2022 to offer an additional 2 GW of offshore wind for establishment before the end of 2030. In addition, the parties behind the Climate Agreement on Green Power and Heat 2022 of 25 June 2022 (hereinafter Climate Agreement 2022) decided, that areas that can accommodate an additional 4 GW of offshore wind must be offered for establishment before the end of 2030. Most recently, a political agreement was concluded on 30 May 2023, which establishes the framework for the Climate Agreement 2022 with the development of 9 GW of offshore wind, which potentially can be increased to 14 GW or more if the concession winners – i.e. the tenderers who will set up the offshore wind turbines – use the freedom included in the agreement to establish capacity in addition to the tendered minimum capacity of 1 GW per tendered area.

In order to enable the realization of the political agreements on significantly more energy production from offshore wind before the end of 2030, the Danish Energy Agency has drawn up a plan for the establishment of offshore wind farms in three areas in the North Sea, the Kattegat and the Baltic Sea respectively.

The area for Kriegers Flak II Offshore Wind Farm (OWF) consists of two sub-areas: KF II N and KF II S. The areas are located 25-50 km off the coast of South Zealand and Møn. Kriegers Flak II North is located approximately 15 km from the east coast of Møn, while Kriegers Flak II South is located approximately 30 km southeast of Møn (Figure 2-1). The area for the Kriegers Flak II OWF is approximately 175 km², divided into 99 km² for North and 76 km² for South. The Kriegers Flak II OWF will be connected to land via subsea cables making landfall close to Rødvig on South Zealand.

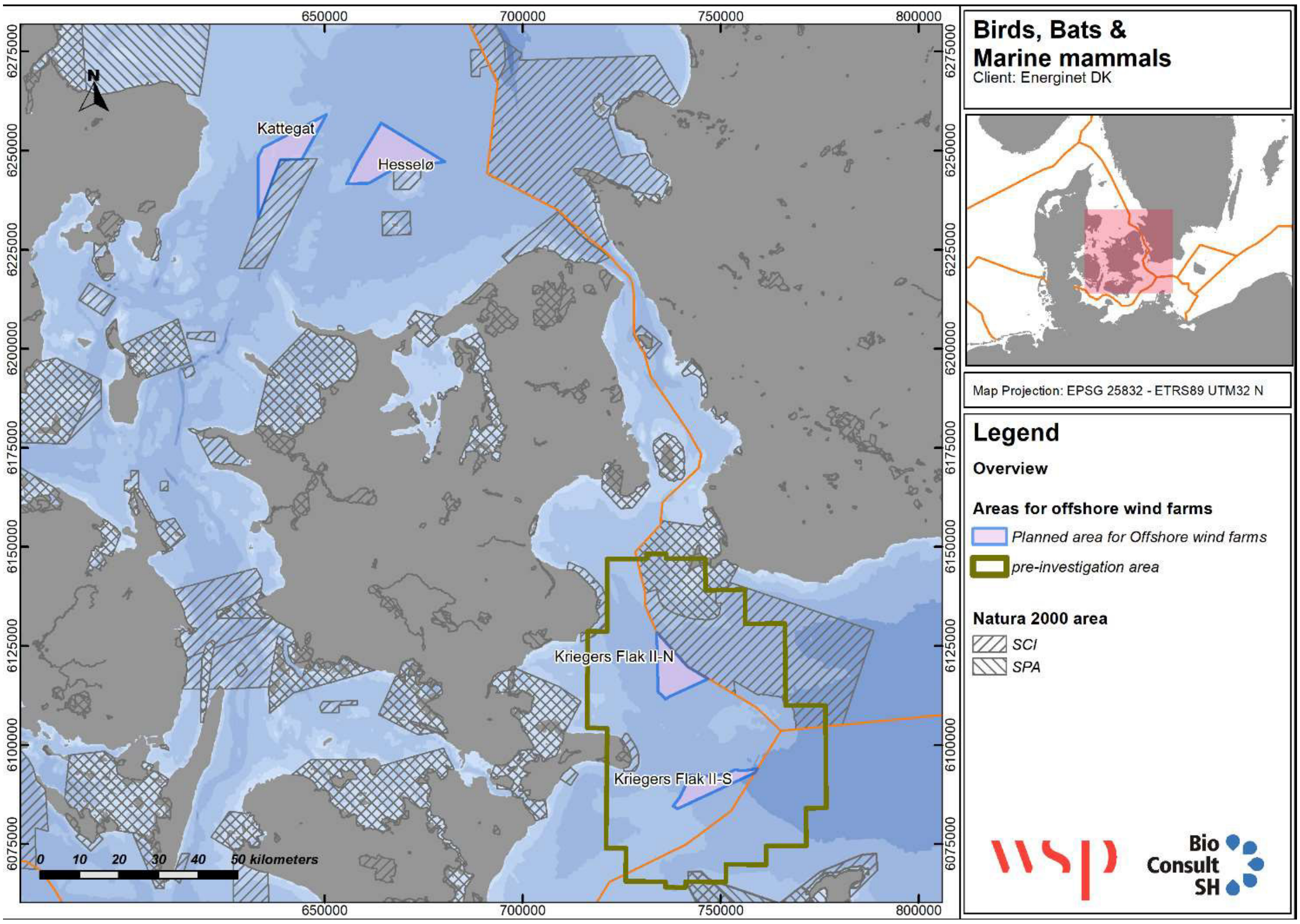

Figure 2-1 **Map showing the location of the investigated offshore wind farm areas Kattegat, Hesselø and Kriegers Flak II (KF II N and KF II S). The present report focuses on Kriegers Flak II (KF II N and KF II S).**

3 EXISTING DATA

The purpose of this section is to give a brief overview on the conservation status and biology of the three marine mammal species, regularly occurring in the pre-investigation area for Kriegers Flak II (KF II N and KF II S), namely the harbour porpoise (*Phocoena phocoena*), the harbour seal (*Phoca vitulina*) and the grey seal (*Halichoerus grypus*). This section is based on publicly available literature (peer-reviewed journals as well as non-peer-reviewed reports) relevant to describe the spatial and seasonal presence of these three marine mammal species in and around the pre-investigation area. Finally, first inferences about the potential importance of the pre-investigation area for each of these three species will be discussed.

3.1 HARBOUR SEALS

3.1.1 BIOLOGY, DISTRIBUTION, ABUNDANCE

Harbour seals (*Phoca vitulina*) are the most widely distributed species of all seals ranging from temperate to polar coastal regions all along the Northern Hemisphere. In the Baltic Sea, distribution is limited to Danish, Swedish, German and Polish waters.

Harbour seals can reach a maximum age of 36 years (HÄRKÖNEN & HEIDE-JØRGENSEN 1990). Adult East Atlantic harbour seals were found to show an asymptotic length of 146 cm in females and 156 cm in males (HÄRKÖNEN & HEIDE-JØRGENSEN 1990). Asymptotic weight was 67 kg in females and in 75 kg in males, but strong fluctuations depending on reproductive status and season were observed (HÄRKÖNEN & HEIDE-JØRGENSEN 1990).

Females reach sexual maturity at an average age of 3.7 years and males about a year later (HÄRKÖNEN & HEIDE-JØRGENSEN 1990). The overall pregnancy rate in 3- to 36-year-old females was 92% (HÄRKÖNEN & HEIDE-JØRGENSEN 1990). Females give birth on land, usually once a year, between May and June after an average pregnancy period, or gestation, of 11 months. Pups are usually weaned after four weeks and are then left to fend for themselves. Pups shed their embryonic lanugo fur before birth. They can swim and dive immediately after birth but depend on undisturbed sites on land for suckling and resting. Mating occurs in the water after pubs are weaned around July. Males perform an underwater display including specific vocalizations and are sought out by females for mating, a so-called lek-system (VAN PARIJS ET AL. 1997). Moulting occurs between July and September, with a peak in August, and during this time animals also depend on undisturbed sites on land. This is because a good blood perfusion to the outer skin layers is necessary for moulting, which makes animals more prone to heat loss. Therefore, increased perfusion occurs on land, preferably with dry fur (DIETZ ET AL. 2015). Because of the reproduction and moulting period, harbour seals are most sensitive to disturbance at haul-out sites during summer months between May and August.

Harbour seals show no migration movements and instead they display high site fidelity to their haul-out sites, from where they make foraging trips into deeper waters. These trips are mostly confined to a radius of less than 50 km from the coast but can occasionally range as far as 100 km or further offshore (e.g. THOMPSON ET AL. 1994; TOLLIT ET AL. 1998; CUNNINGHAM ET AL. 2009; MCCONNELL ET AL. 2012; DIETZ ET AL. 2013).

Harbour seals are opportunistic predators but show mainly benthic feeding and prefer small to medium sized benthic fish species. As such, they are mainly found to feed in areas with a water depth below 100 m (TOLLIT ET AL. 1998). From two studies in the south-western Baltic Sea, 20 fish species were identified from otoliths found in 42 harbour seal samples (scat and digestive tracts). Most prey items were made up of lesser sandeel (*Ammodytes tobianus*, 43%), black gobies (*Gobius niger*, 15%) and Atlantic cod (*Gadus morhua*, 12%) (SCHARFF-OLSEN ET AL. 2019). In relation ANDERSEN ET AL. (2007) also found a minimum of 20 different prey species being consumed by harbour seals from Rødsand lagoon (collected 13 scats and 17 digestive tracts). The dominant species was cod, which was found in the diet (42% and 43% of weight consumed) especially in spring and autumn. In the summer period flounder and plaice made up 52% of the weight consumed (cod only 22%).

Harbour seals have probably been present in the Baltic Sea since the last glaciation. Based on molecular data and satellite telemetry studies, it was suggested to split harbour seals in the Baltic region into four different subpopulations or management units (ANDERSEN & OLSEN 2010; BLANCHET ET AL. 2021): one in the Kalmarsund between Øland and the Swedish mainland, one in the south-western Baltic, one in the Kattegat and one in the Limfjord. As tagging studies have shown, there is no or only limited exchange between colonies separated by more than about 100 km due to generally limited movements (DIETZ ET AL. 2013, 2015), and thus at least partial reproductive isolation between these four subpopulations.

The population in the Skagerrak, Kattegat and the Danish Straits exceeded 17,000 animals, but declined to only about 2,500 in 1930 due to intense hunting (HEIDE-JØRGENSEN & HÄRKÖNEN 1988). Following protection in the area, the population recovered in the 1960s. Two severe morbillivirus epidemics in 1988 and 2002 decreased the population size by about 50% on both occasions (HÄRKÖNEN ET AL. 2006), but the population recovered afterwards. Then, a third epidemic caused by an unknown pathogen in 2007 killed about 3,000 harbour seals. However, the recovery rate in the Kattegat has been low ever since the 2002 epidemic (HELCOM 2013a). Latest estimated population sizes of harbour seals were about 2,000 individuals in the SW Baltic and about 12,500 individuals in the Kattegat (HELCOM 2023a). Harbour seal haul-out sites in the Baltic Sea closest to the planned windfarm area of KF II N and KF II S area are located about 13 km northeast at Falsterbo (Måkläppen) in Sweden, and in Denmark about 25 km west in the Bøgestrøm. The Haul-out site at Måkläppen is also used by grey seals.

HELCOM (2023b) states that the harbour seal populations in the Baltic are currently recognized as two official management units consisting of (a) the Kalmarsund and (b) the southwestern (SW) Baltic Sea and the Kattegat. In addition, HELCOM also assessed a third unofficial unit in (c) the Limfjord.

HELCOM (2023b) states that the harbour seal populations in the Baltic are currently recognized as two official management units consisting of (a) the Kalmarsund and (b) the southwestern (SW) Baltic Sea and the Kattegat. In addition, HELCOM also assessed a third unofficial unit in (c) the Limfjord.

3.1.2 HABITAT USE

As harbour seals show high site fidelity at haul-out sites and aggregate there especially during the lactation and moulting period, estimates of population sizes are based on counts at haul-out sites during the moulting season. Such counts are carried out annually and thus, good knowledge exists on the individual numbers at haul-out sites. In section 5.1.2 location and number of historical haul-out sites are described in further detail. However, much less is known about harbour seal density in the surrounding waters and about harbour seal habitat use there. From tracking studies, it is known that harbour seals usually stay close to shore and make foraging trips that are rarely further than 50 km from their haul-out site (THOMPSON ET AL. 1994; TOLLIT ET AL. 1998; CUNNINGHAM ET AL. 2009; DIETZ ET AL. 2013). Most studies found some seasonal, age- and sex-specific differences in these movement patterns. Juvenile harbour seals seem to have the tendency to travel further distances to up to 200 km to the haul-out site, while adult harbour seals seem to prefer to stay closer to the haul-out sites within the vicinity of 50 km (MCCONNELL ET AL. 2012; DIETZ ET AL. 2015). One reason for these different travel distances may be age depending individual preferences for particular feeding grounds (DIETZ ET AL. 2015).

3.1.3 CONSERVATION STATUS

The status of the global population (LOWRY 2016) and the European population (European Mammal Assessment Team 2007) of the harbour are classified by the IUCN as least concern (LC). The HELCOM Red List (2013a) classified the Southern Baltic population as LC. The red list of Denmark assessed it as LC (Den Danske Rødliste2019; AARHUS UNIVERSITET 2019) and the red list of Sweden lists the Baltic population as vulnerable (VU; 2020). The national red list of Germany lists the harbour seal as being under threat of unknown extent (MEINIG ET AL. 2020). Hunting of harbour seals in Germany is forbidden, as well as in Sweden unless allowed in other parts of the hunting legislation and in Denmark licenses are given to shoot a limited number of individuals each year when seals interfere with fishing gear. Regulation is not allowed between 1st of June and 31st of July and never in seal reserves (HELCOM 2013b).

In EU waters, harbour seals are protected by the EU Habitats Directive and listed in its Annexes II and V (European Commission 2021). They are also covered by the EU Marine Strategy Directive, where distribution, number and bycatch must be reported and evaluated according to descriptor 1. The harbour seal is listed in Appendix II of the Bern Convention (Convention on the Conservation of European Wildlife and Natural Habitats) and in Appendix II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS), also known as the Bonn Convention (CMS SECRETARIAT 2015). For a summary, see Table 3-1.

The Danish Center for Environment and Energy (DCE) assessed the conservation status of the harbour seals in Habitat Directive Article 17 from 2019 (FREDSHAVN ET AL. 2019) as favorable in both Danish marine regions. It also states that while management units in the Wadden Sea and Kattegat are large and long-term viable, management units in the Limfjord and the Baltic Sea are smaller and more vulnerable. In the DCE Marine areas report from 2021 (HANSEN & HØGSLUND 2021) it is said that the population of harbour seals has shown a substantial increase from 1976 to 2020 as a result of the start of protection measures in 1977 and the establishment of a number of seal reserves with no access. Since 2015, the number of harbour seals in Denmark has decreased by 4% each year in all four management units, indicating that the population is approaching or has reached ecological capacity or is pressured by unknown factors, such as a lack of food, disturbances or competition by grey seals (HANSEN & HØGSLUND 2021).

For the SW Baltic population a good status is not achieved (HELCOM 2023a). Thus, the population in the SW Baltic failed to achieve good status with regards to both key indicators ”distribution” as well as ”population trends and abundance” (HELCOM 2023a).

Table 3-1. Listing of the harbour seal in international and regional conservation agreements and international and national Red Lists. LC= Least concern, VU= Vulnerable.

Species	IUCN (2017)	HELCOM Red List	National Red Lists	Natura 2000 (BfN 2015)	Bern Convention	Bonn Convention
Harbour Seal ***Phoca vitulina***	Global: LC European: LC	Southern Baltic: LC Kalmarsund: VU	DE: threat of unknown extent DK: LC SE: VU (Baltic population)	Appendix II und V	Appendix III	Appendix II

3.2 GREY SEALS

3.2.1 BIOLOGY, DISTRIBUTION, ABUNDANCE

The grey seal (*Halichoerus grypus*) is a large seal species with a cold-temperate to sub-artic distribution along the coasts of the North Atlantic. Two subspecies of the grey seal are recognized, which are morphologically and genetically (Boskovic et al. 1996; Graves et al. 2009; Fietz et al. 2013) differentiated: the Atlantic grey seal (*Halichoerus grypus atlantica*) inhabiting the Atlantic and the North Sea, and the Baltic grey seal (*Halichoerus grypus grypus*) inhabiting the Baltic Sea (Berta & Churchill 2012; Fietz et al. 2016; Olsen et al. 2016). The Baltic grey seal is found throughout the Baltic Sea area with main concentrations in the northern and central parts of the Baltic Sea, but the population is expanding in numbers towards the south-western Baltic and Kattegat area (Scharff-Olsen et al. 2019; Galatius et al. 2020). The two sub-species show different breeding periods and differ in their choice of breeding habitat.

Adult male grey seals can reach a body length of up to 2.5 m and a weight of up to 400 kg, female grey seals are smaller with up to 2.1 m body length and a weight up to 250 kg. (Shirihai et al. 2008). Grey seal females reach sexual maturity between 3 and 5 years of age and males between four and six years of age. After a pregnancy of about 11.5 months, grey seal pups are born in winter with a pupping period of February-March in the Baltic and October-December in the northeast Atlantic (Galatius et al. 2020).

Grey seals in the Baltic Sea breed mainly on drift ice, but where this is not possible, as in the southern Baltic Sea in most winters, they also breed on land. Grey seal pups are born with their lanugo coat, which is not waterproof, so pubs are not able to enter the water until they have shed it and attained their adult coat after 2-4 weeks. Nursing lasts about 14 days, during which the females do not feed, and pups undergo substantial weight gain, increasing from a birth weight of about 10 kg to almost 50 kg at the time of weaning. Grey seals therefore highly depend on undisturbed haul-out sites above the high-water line in winter for successful reproduction. Baltic grey seals moult between April and June and during this time, they spend a lot of time hauled out.

Like harbour seals, grey seals are associated with coastal waters, but also make foraging trips at larger distances of the coast with occasional travelling distances of up to 2,000 km (e.g. Thompson et al. 1991, 1996; McConnell et al. 1999; Dietz et al. 2015). Grey seals tagged in the Rødsand lagoon were found to move up to 850 km east into the Baltic (Dietz et al. 2015). Generally, grey seals visit a larger number of haul-out sites than harbour seals and at greater distances (e.g. Thompson et al. 1996).

Grey seals are generalist and opportunist feeders with a wide range of prey (Scharff-Olsen et al. 2019). The fish species consumed include a similar range as that of harbour seals, although grey seals can take larger fish due to their larger size and ability to tear large prey into pieces for consumption. Main contributors to grey seal diet are sand eel (*Ammodytes* spec), flounder (*Platichthys flesus*), herring (*Clupea harengus*) and cod (*Gadus morhua*), depending on location and season (THOMPSON ET AL. 1991, 1996). Additionally, seabirds as well as harbour porpoises and harbour seals may also be preyed upon (JAUNIAUX ET AL. 2014; LEOPOLD 2015; VAN NEER ET AL. 2015; WESTPHAL ET AL. 2023).

The grey seal population in the Baltic Sea suffered from extensive hunting and environmental toxins during the 20th century and was reduced from an original population size of about 80,000 individuals (HELCOM 2023c) to only about 3,000 individuals in the beginning of 1980 (HARDING & HÄRKÖNEN 1999). Following the abandonment of the use of several pollutants and the mitigation of their effects, as well as the introduction of a general culling and hunting ban, the population had increased exponentially since the 1980s (HARDING & HÄRKÖNEN 1999; HÄRKÖNEN ET AL. 2007; HELCOM 2018). In the years 2014–2017, numbers were around 30,000 individuals counted in the Baltic Sea at the haul-outs during the moulting season in late May and early June (ICES 2019), about 38,000 grey seals were counted in 2019, and about 42,000 grey seals were counted in 2021, leading to an estimated population size of about 60,000 animals (HELCOM 2023c).

There are no distinct subpopulations recognized of the Baltic grey seal and it ranges widely within the Baltic Sea, although local differences in their distribution is present. HELCOM (2023c) assessed the grey seal population in the Baltic Sea as a single management unit based on data from 2003-2021. According to this evaluation the grey seal population of the Baltic Sea has failed all four key indicators “trends and abundance”, “distribution”, “nutritional status” and “reproductive status” (HELCOM 2023c).

Even though grey seals in the Baltic Sea show increases in their population size, the population growth rate remained under the threshold values (HELCOM 2023c). Because the population is still growing it was assessed as being below Target Reference Level (TRL) and was evaluated against the threshold of 7% annual increase during exponential growth. With an estimated annual growth rate of about 5.1% (80% support for >=4.7% according to Bayesian analyses) between 2003 and 2021, the population did not reach the growth target. Therefore, the population achieved good status with regards to “abundance” but did not achieve good status with regards to “population trend”.

With regards to “distribution” the Baltic grey seal population achieved good status in the component “area of occupancy” (at sea distribution), but no good status in the components “haul-out sites” and “breeding sites”, because in some subareas some available sites are not occupied (HELCOM 2023c).

Nutritional status of seals is estimated based on blubber thickness of hunted and bycaught seals, which indicates long-term and short-term changes in food supplies and other stressors. Grey seals in the Baltic Sea failed the threshold for good status in the assessment period 2016-2021.

The pregnancy rate in the grey seal population of the Baltic Sea was found to be on average 87% in the period 2016-2021, which is below the threshold value of 90% that would indicate a good status (HELCOM 2023c). Grey seal haul-out sites in the Baltic Sea closest to the planned windfarm area of KF II N and KF II S area are located about 13 km northeast at Falsterbo (Måkläppen) in Sweden, and in Denmark about 15 km west at Stevns. The Haul-out site at Måkläppen is also used by harbour seals.

3.2.2 HABITAT USE

Good knowledge about habitat use of grey seals on the Baltic Sea coastlines exists from observations of the number of animals at haul-out sites, where they are mainly counted during the moulting period (see section5.1.2). Little is known about grey seal density and habitat use offshore. Some information comes from telemetry studies, which show that grey seals undertake longer foraging trips from their haul-out sites than harbour seals do, and they also show much larger dispersal distances. Grey seals in Scotland for example were reported to show movement patterns on two geographical scales: local, short and repeated trips between haul-out sites and discrete offshore areas about 40 km from the coast, similar to harbour seals, and longer distance travels to areas up to 2,100 km away (McConnell et al. 1999). In McConnell et al. (2012), five grey seals in the Rødsand lagoon – one adult and four juveniles – were satellite tracked. These seals also showed similar local movement patterns as well as far distance trips. Two such examples are shown in Figure 3-1. Dietz et al. (2015) tagged five grey seals from Rødsand, five from Falsterbo and one from Ålandsøerne (Figure 3-2). These animals also showed some local movements as well as long distance trips to other haul-out sites. Movement was largely focused on local areas around haul-out sites (Figure 3-2).

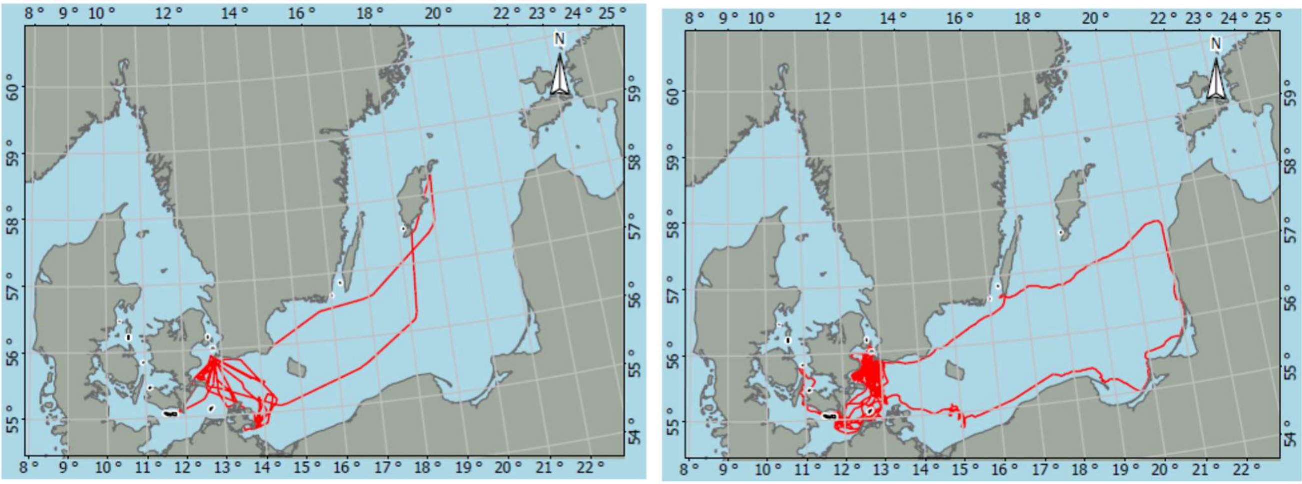

Figure 3-1. Example of tracks from two radio-tracked grey seals, captured and tagged in the Rødsand lagoon. From: McConnel et al. (2012).

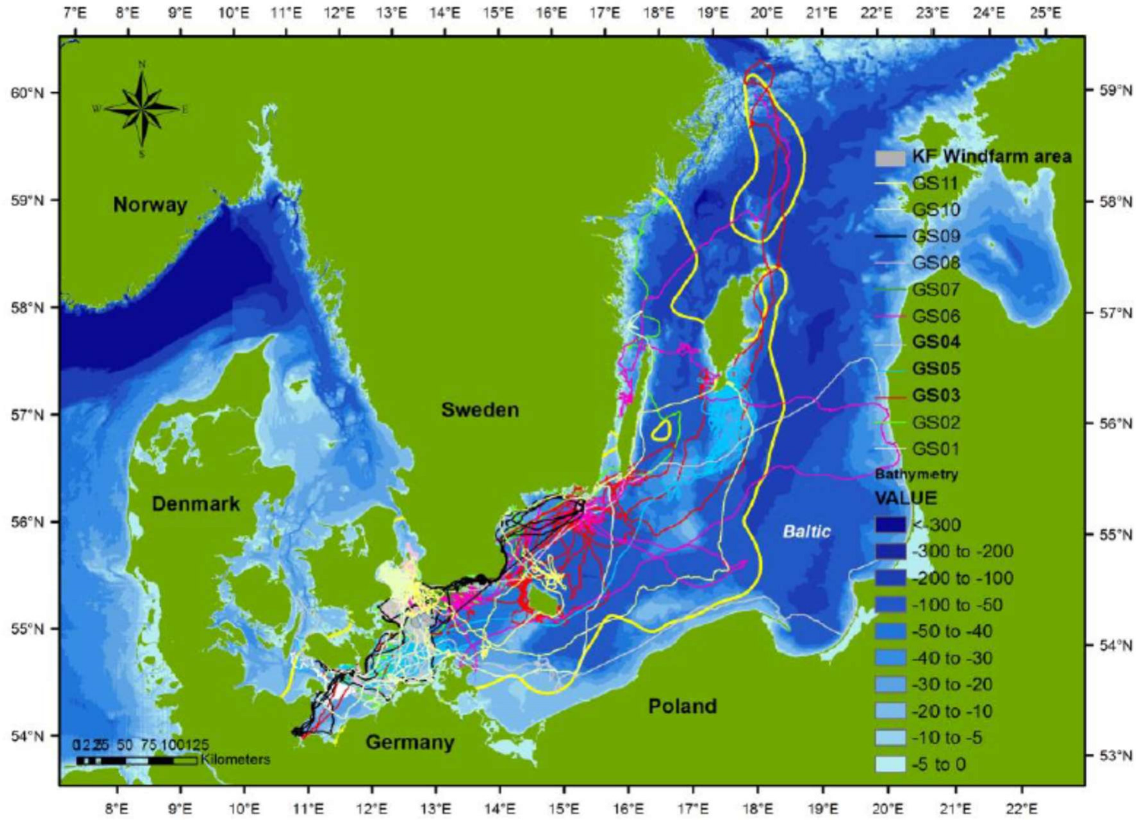

Figure 3-2. Map showing the migration routes and the 95% Kernel ranges (yellow polygon) for 11 grey seals tagged between 2009 and 2012 at Falsterbo (5 seals), Rødsand (5 seals) and at Ålandsøerne (1 seals). From: DIETZ ET AL. (2015).

3.2.3 CONSERVATION STATUS

The status of the global population (BOWEN 2016) and the European population (EUROPEAN MAMMAL ASSESSMENT TEAM 2007) of the grey seal are classified by the International Union for the Conservation of Nature (IUCN) as LC, and the status of the Baltic subspecies *Halichoerus grypus grypus* is assessed by the HELCOM Red List (HELCOM 2013a) also as LC. The national Red List of Denmark lists the grey seal as VU (Danske Rødliste 2019; AARHUS UNIVERSITET 2019). The Red List of Germany lists the grey seal as highly threatened in the case of the Baltic grey seal subspecies and as threatened in the case of the Atlantic subspecies (MEINIG ET AL. 2020). The Swedish Red List lists the grey seal as LC (2020). Hunting in Denmark and Germany is forbidden, in Sweden it is allowed but controlled through various regulations and restrictions (HELCOM RED LIST MMEG 2013).

In EU waters, grey seals are protected by the Habitats Directive and listed in its Annexes II and V (European Commission 2021). They are also covered by the EU Marine Strategy Directive, where distribution, number and bycatch must be reported and evaluated according to descriptor 1. Furthermore, grey seals are listed in Appendix III of the Bern Convention, while they are not listed by the Bonn Convention (CMS SECRETARIAT 2015). For a summary, see Table 3-2.

DCE assessed the conservation status of the grey seals in Habitat Directive Article 17 from 2019 (FREDSHAVN ET AL. 2019) as highly unfavorable in both Danish marine regions because breeding activity is assessed to be very far from previous levels. It is also stated, however, that conditions are improving in both regions. In the DCE Marine areas report from 2021 (HANSEN & HØGSLUND 2021) it is stated that the numbers of grey seals in Danish waters have increased over the last ten years. In 2020, 1,098 grey seals were counted in the Danish Baltic Sea. It is expected that the general increase in numbers will continue in all areas in the coming years. However, in the Baltic Sea only six pubs were observed at one out of four surveyed sites in 2020, which is a large decline compared to 2017 and worrying for a species of unfavourable conservation status (HANSEN & HØGSLUND 2021).

Table 3-2. Listing of the grey seal in international and regional conservation agreements and international and national Red Lists. LC= Least concern, VU= vulnerable.

Species	IUCN (2017)	HELCOM Red List	National Red Lists	Natura2000 (BfN 2015)	Bern Convention	Bonn Convention
Grey seal ***Halichoerus grypus***	Global: LC European: LC	LC	DE: highly threatened (Baltic grey seal) DK: VU SE: LC	Appendix II and V	Appendix III	Not listed

3.3 HARBOUR PORPOISES

3.3.1 BIOLOGY, DISTRIBUTION, ABUNDANCE

The harbour porpoise (*Phocoena* phocoena) inhabits temperate to cold waters throughout the northern hemisphere and is the only cetacean species resident in the Baltic Sea (KINZE 1994; BENKE ET AL. 1998). Harbour porpoise habitat use shows seasonal differences. In general, harbour porpoise habitat use is considered to largely depend on prey availability, and was shown to correlate with strong currents and the occurrence of fronts and eddies (e.g., JOHNSTON ET AL. 2005; PIERPOINT 2008), where prey usually concentrates.

Harbour porpoises in Danish waters (North Sea and Baltic Sea combined) may live up to about 23 years, however, fewer than 5% seem to live longer than 12 years (LOCKYER & KINZE 2003). Based on the study of bycaught and stranded individuals in Danish waters, LOCKYER & KINZE (2003) reported both sexes to reach sexual maturity at about three years of age, with corresponding body sizes of about 143 cm in females and 135 cm in males. Ranges of mean body weight of bycaught individuals were 34-47 kg in females and 27-35 kg in males with only little seasonal variation (LOCKYER & KINZE 2003). More recent data from bycaught and stranded harbour porpoises in German waters (North and Baltic Sea), however, showed that female harbour porpoises first show signs of ovulation at a mean age of about 5 years, while average age at death was 5.7 years in the North Sea and only 3.7 years in the Baltic Sea (KESSELRING ET AL. 2017). Newborn calves in the Belt Sea may be seen from April to October. The percentage of calves in the Belt Sea increased from May to June and reached a peak in July and August (LOCKYER & KINZE 2003). The peak in mating seems to occur in July and August (SCHULZE 1996; KOSCHINSKI 2002; LOCKYER & KINZE 2003). The gestation period is about 10 months and the lactation periods spans from 8 to 10 months, such that many harbour porpoise females are pregnant and lactating at the same time (SCHULZE 1996; KOSCHINSKI 2002; LOCKYER & KINZE 2003). The majority of the female harbour porpoises in the Baltic were found to have a reproduction rate between 0.7 and 0.8, so mature females would produce about two calves in three years (KOSCHINSKI 2002).

The most recent published information on harbour porpoise diet in the Baltic Sea is based on stomach content analysis of 339 harbour porpoises stranded and bycaught in the Danish and German Baltic Sea between 1980 and 2011 (ANDREASEN ET AL. 2017). The authors reported the diet of adult harbour porpoises to consist of mainly Atlantic cod (*Gardus morhua*, 36%) and herring (*Clupea harengus*, 34%), but also of gobies (Gobiidae, 25%), eelpout (*Zoarces viviparus*, 7%), sandeels (Ammodytidae, 5%), sprat (*Sprattus sprattus*, 2%), whiting (*Merlangius merlangus*, 2%) and some other fish species (8%; Figure 3-3). Juveniles were found to take a much higher proportion of gobies than adults (25%), which made up almost as much as cod (26%) and substantially more than herring (18%). Whiting (7%) and sprat (6%) were also taken at a slightly higher proportion than for adults, while sandeels made up only about 1% of juvenile diet. Other fish species contributed about 11% to juvenile diet. There was considerable seasonal variation in the diet composition of adults with cod and herring clearly dominating the winter diet (>80%), while eelpout and sandeel only made up a significant proportion of the adult diet in summer. The more diverse juvenile diet also showed seasonal variation, but less so than in adults. These findings are mainly in line with earlier studies that also found cod, herring and gobies to make up the majority of prey items in Baltic harbour porpoises, however, some found a higher proportion of cod (AAREFJORD ET AL. 1995; BENKE ET AL. 1998; LOCKYER & KINZE 2003). The diet of Baltic Sea harbour porpoises was found to be quite similar to that of harbour porpoises from the North Sea, except for sandeels and whiting appearing more important in the North Sea (BENKE ET AL. 1998; SANTOS & PIERCE 2003; LEOPOLD 2015). In summary, harbour porpoises mainly live of pelagic fish species like herring and whiting and of semi-pelagic living cod. However, during the summer and especially for juvenile harbour porpoises, demersal fish species such as gobies and sandeels also play a significant role as prey.

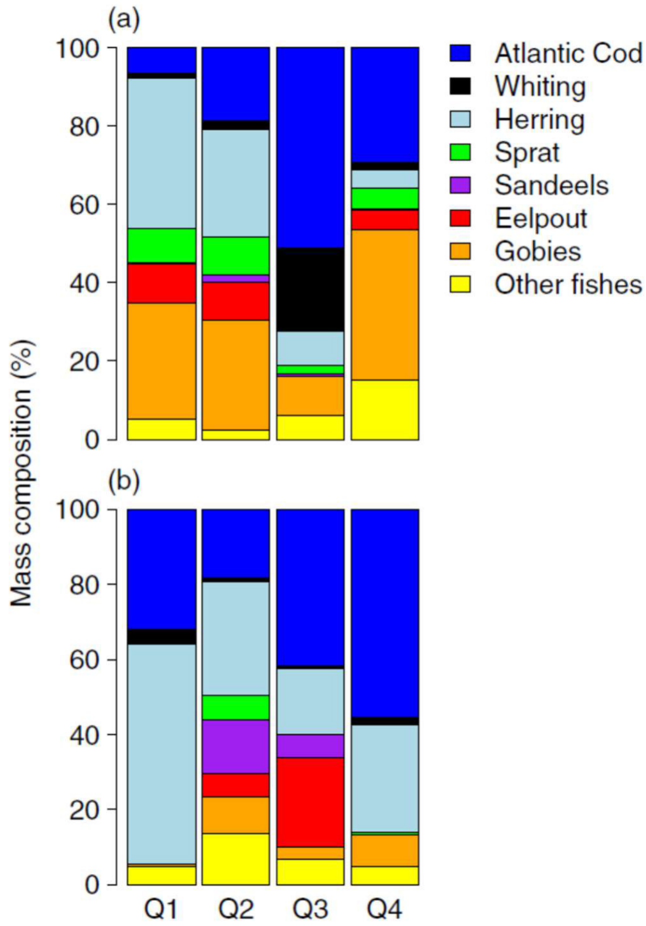

Figure 3-3. Quarterly prey mass composition in the diet of juvenile (a) and adult (b) harbour porpoises in the western Baltic Sea in the period 1980-2011. From: ANDREASEN ET AL. (2017).

According to KOSCHINSKI (2002), many studies and even a crude examination of sighting and stranding data support the general view that the number of harbour porpoises have declined and their distributional range in the Baltic has narrowed extensively. Danish catch statistics reviewed by KINZE (1995) showed that in the Belt Sea region a consistently increased take occurred in the second half of the 19th century when the catch rate doubled in the Little Belt area. This may have led to an overexploitation initiating the decline of the Baltic harbour porpoise population. Mean annual catch rates in the Little Belt finally decreased from 1,195 harbour porpoises between 1871 and 1892 to only about 327 harbour porpoises during the second world war KINZE (1995).

Catch statistics suggest that harbour porpoises in the Baltic Sea used to show strong migration patterns from the Baltic Proper into the Belt and Kattegat area during autumn and back into the Baltic Proper in spring (see KOSCHINSKI 2002 for review). Such strong migration patterns are no longer evident today, possibly because the present population in the Baltic Proper is so much smaller.

Harbour porpoises occurring in the Baltic Sea are thought to belong to three different (sub)populations (Skagerrak/North Sea, Belt Sea and Baltic Proper). Genetic and morphological evidence suggest that harbour porpoises inhabiting the Baltic Proper belong to a different (sub)population than harbour porpoises in the Skagerrak (which probably belong to the North Sea population of harbour porpoises) and harbour porpoises from the Belt Sea (sub)population, inhabiting the Kattegat, Sound, Belt Sea and western Baltic Sea (WIEMANN

ET AL. 2010; BENKE ET AL. 2014; LAH ET AL. 2016; TIEDEMANN ET AL. 2017). Based on survey and acoustic monitoring data, BENKE ET AL. (2014) suggested a management border for the Baltic Proper population around the Darss ridge. SVEEGAARD ET AL. (2015) provide a map with suggested overlapping zones between these populations based on survey and telemetry data. More recently, based on the distribution of harbour porpoise detections in the Baltic region, it was suggested that animals from the Belt Sea and Baltic Proper are separated during the summer from May to October (so including the breeding season) but have overlapping distribution patterns from November to April (CARLÉN ET AL. 2018). The seasonal management border proposed for the Baltic Proper population of harbour porpoises by CARLÉN ET AL. (2018) lies east of the Odra Bank (running from the Swedish mainland north of the island of Bornholm in south-eastern direction at a distance of about 30 km east of the island of Bornholm) and is thus further east than the one suggested by Benke et al. (2014). Figure 3-4 taken from SVEEGAARD ET AL. (2018) shows the suggested management areas for the separate populations as well as their transition areas.

From passive acoustic monitoring data collected during the SAMBAH project, the number of individuals of the Baltic Proper population was estimated at approx. only 500 animals (AMUNDIN ET AL. 2022). Regardless of the special protection status, any disturbance or even removal of animals from this small population can lead to severe consequences for the well-being of this population. The Belt Sea population of harbour porpoises is estimated to consist of about 17,300 individuals (HANSEN & HØGSLUND 2021).

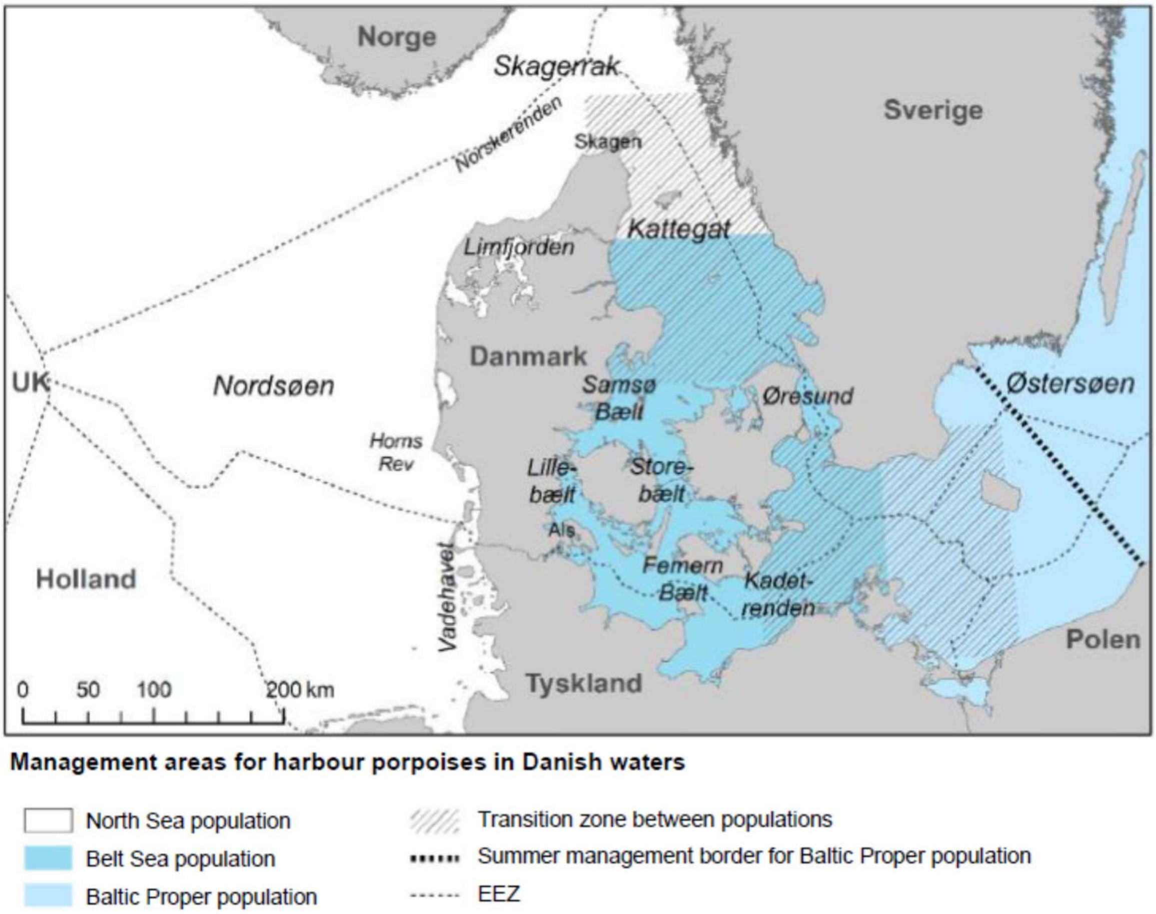

Figure 3-4. Map showing suggested management areas for the three harbour porpoise populations in Danish waters and neighbouring countries. Taken from: SVEEGAARD ET AL. 2018.

3.3.2 HABITAT USE

Information on density and abundance of harbour porpoises in the Baltic Sea exists from different sources: visual and acoustic surveys covering different parts of the Baltic Sea. Because of differences in methodology and in the area covered by these surveys, it is difficult to compare estimates of abundance and densities between the surveys. This is especially the case for visual aerial-based and ship-based surveys.

The first systematic survey for harbour porpoise density in the Baltic Sea was the "Small Cetacean Abundance survey in the North Sea and adjacent waters" (SCANS-I survey) in July 1994 (HAMMOND ET AL. 2002), followed by the SCANS-II survey in July 2005 (HAMMOND ET AL. 2013), SCANS III in 2016 (HAMMOND ET AL. 2017) and SCANS IV in 2022 (SCANS-IV 2023). During the SCANS I, II and III surveys, the Baltic Sea area was covered from the Skagerrak in the north to Rügen in the east with ship-based surveys, during the SCANS IV survey it was covered by aerial surveys. Density and abundance estimates, of harbour porpoises, in the Baltic Sea (covering the Skagerrak, Kattegat and Belt Sea area) based on the 2016 survey were 73,573 individuals with a density of 1.15 Ind./km². Estimates for 2005 and 1994 were lower but considering the large confidence intervals associated with these calculations, no clear changes in abundance could be detected (HAMMOND ET AL. 2017).

The area for which these estimates were calculated also includes the Skagerrak region and is therefore not only focused on the Belt Sea population. However, due to ongoing discussions about different populations of harbour porpoises in the Baltic Sea it is important to define a discrete management unit for each population. This means that the area that is used by animals from one population needs to be carefully defined and abundance estimates need to be calculated for this management unit (in this management area) and their development monitored over time to assess the populations conservation status. Therefore, the SCANS III and IV surveys redefined a porpoise management unit for only the Belt Sea population of harbour porpoises and in-between these large-scale SCANS surveys, two Mini-SCANS surveys were conducted in 2012 and 2020, especially focusing on the Belt Sea population of harbour porpoise (VIQUERAT ET AL. 2014; UNGER ET AL. 2021).

Because of the methodological differences in survey methods and the area that was covered only estimates from 2016 on can be used to assess the Belt Sea population, as it is now defined. The latest 2022 SCANS IV resulted in estimate for the Belt Sea harbour porpoise population of 14,403 individuals (SCANS-IV 2023), which is considerably lower than the 2016 estimate of 42,324 individuals (SCANS III) and from the 2012 Mini-SCANS-I estimate of 40,475 individuals (VISQUERAT ET AL. 2015), but not significantly different from the 2020 Mini-SCANS-II estimate of 17,301 individuals (UNGER ET AL. 2021). The estimated annual decline between 2012 and 2022 is 1.5% (Figure 3-5). However, the variance in the data is very large and power analyses showed that the data would only enable to detect a significant decline of at least 4.4% per year. The authors state, that although a significant decline could thus not be determined, this cannot be interpreted as no decline in abundance (SCANS-IV 2023). A more robust Bayesian approach revealed a strong negative trend of 2.7% per year with a 90.5% probability since 2005 (OWEN ET AL. 2024).

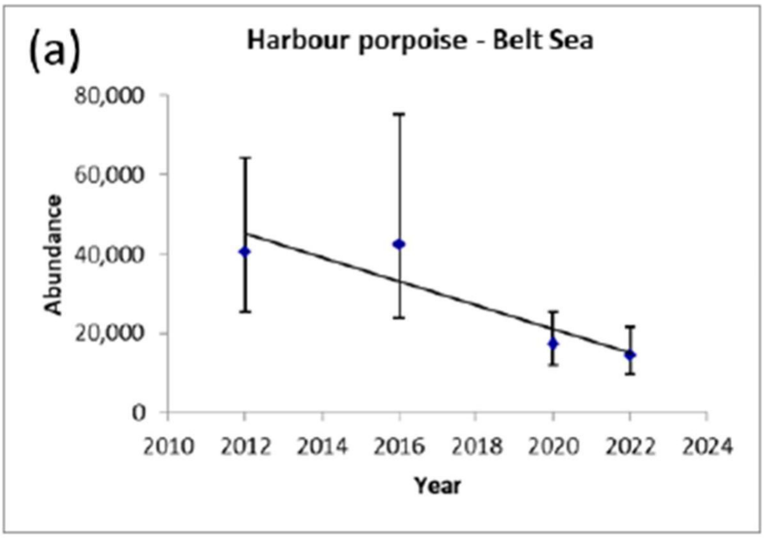

Figure 3-5. Abundance estimates for harbour porpoises of the Belt Sea population with fitted trend line, suggesting an annual decline of 1.5%. Taken from SCANS IV: GILLES ET AL. (2023).

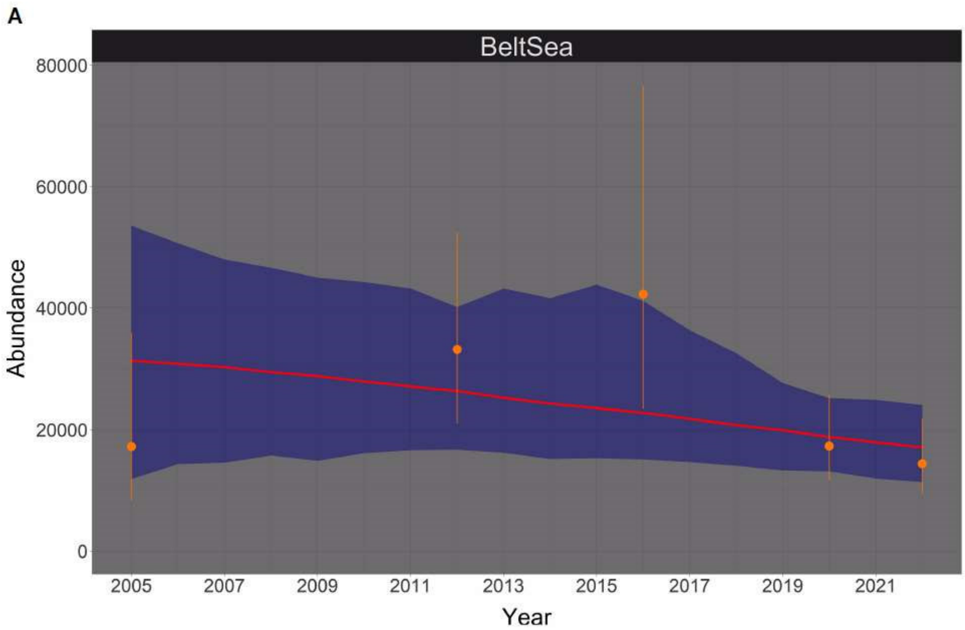

Figure 3-6. Belt Sea harbour porpoise population Bayesian trend, suggesting an annual decline of 2.7%. Taken from: OWEN ET AL. (2024).

National monitoring data, collected in the German part of the Baltic Sea, SCHEIDAT ET AL. (2008) calculated harbour porpoise abundance estimates based on ten aerial surveys (covering between 1,921 km² and 3,400 km and lasting between 2 to 25 days) between 2003 and 2006 during the months March to September. They found harbour porpoise abundance to range from 1,352 harbour porpoises in March-April 2005 to 4,610 harbour porpoises in May 2005, not including one survey in March 2003 yielding an unusual low abundance of only 457 harbour porpoises. For the calculation of harbour porpoise density, they subdivided the study area into three sub-areas (in Figure 3-7). In the west, in sub-area E (Kiel Bight), harbour porpoise density ranged between 0.01 and 0.64 Ind./km² and in the middle, in sub-area F (Mecklenburg Bight), density ranged between 0.04 and 0.35 Ind./km², whereas in the east, in the sub-area G (Pomeranian Bay), the density ranged between 0 to 0.06 Ind./km². Seasonal densities per grid cell corrected for survey effort are shown in Figure 3-8.

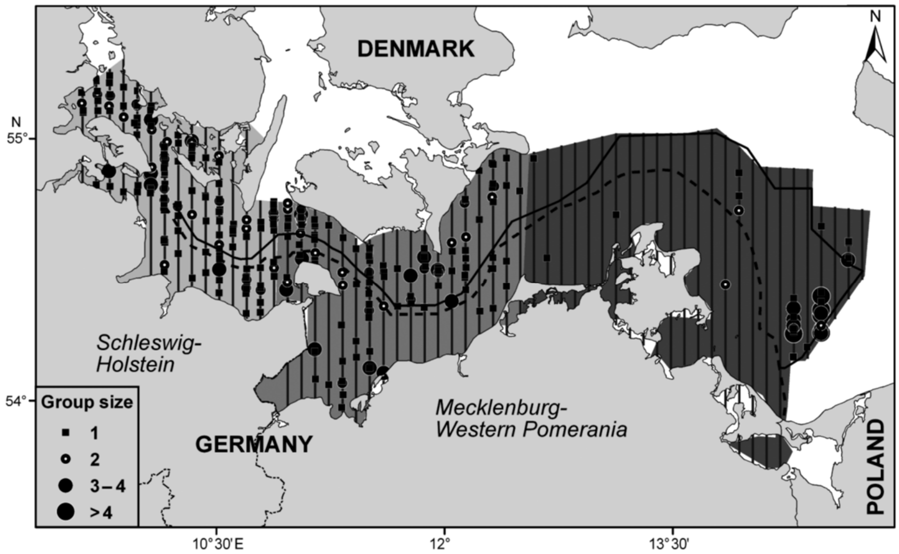

Figure 3-7. Map showing the area in the German Baltic Sea and its division into subareas for calculating harbour porpoise density estimates from aerial surveys between 2003 and 2006. Black squares and points indicate harbour porpoise sightings. From: SCHEIDAT ET AL. (2008).

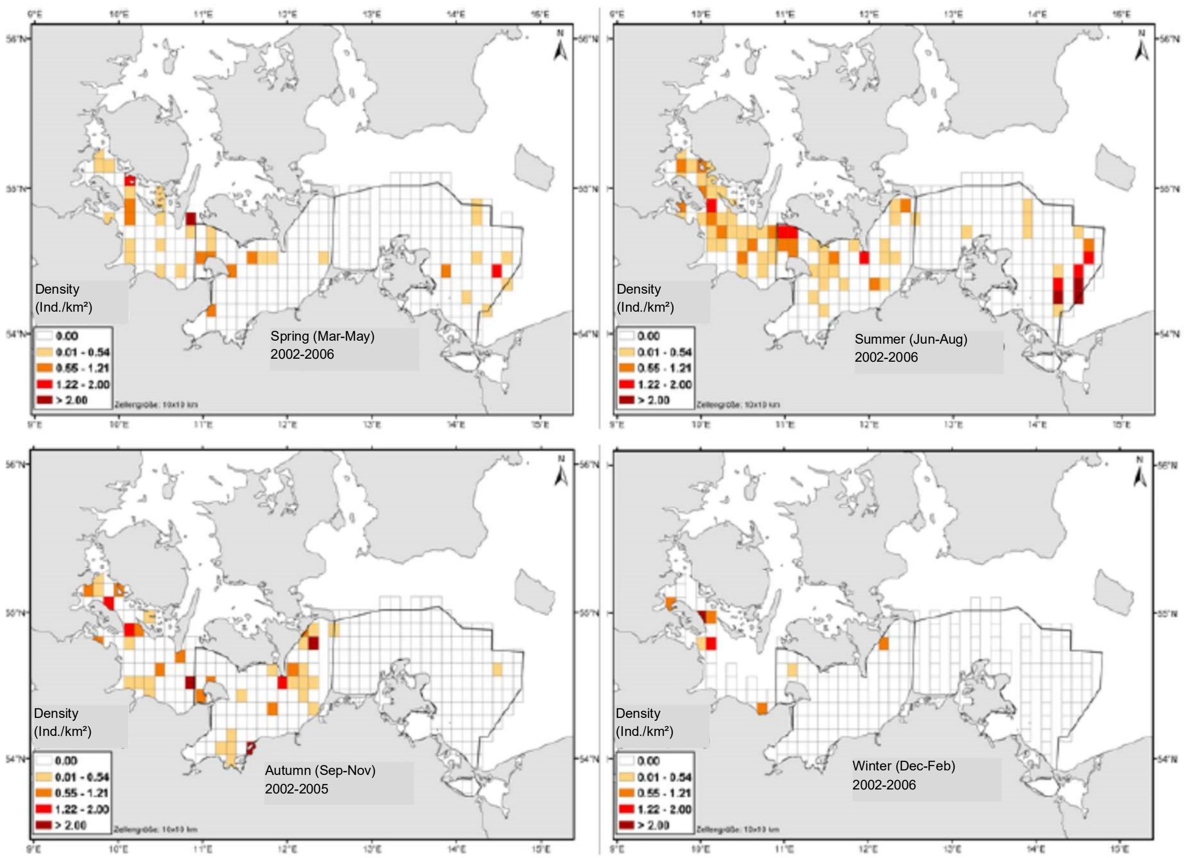

Figure 3-8. Map showing seasonal occurrence of harbour porpoises in the German area of the Baltic Sea based on sightings during aerial surveys between 2002 and 2006. Shown are density estimates per grid cell corrected for survey effort. From: GILLES ET AL. (2007a; b).

Harbour porpoise sightings from ship-based surveys conducted during SCANS-I and II in Polish, Swedish and German waters of the Baltic Proper were so rare that it was not possible to calculate reliable abundance estimates (GILLESPIE ET AL. 2005). Therefore, no more visual surveys were conducted in this region during SCANS III. It was recommended to conduct passive acoustic monitoring in the Baltic Proper instead.

In the year 2011 the SAMBAH project was launched to gain reliable assessments of abundance, distribution and habitat preferences of the harbour porpoise population in the Baltic Proper (SAMBAH 2016). Due to low abundance of harbour porpoises in the Baltic Proper and the generally shy behaviour and thus low visual detectability of harbour porpoises, it was chosen to use the well-established method of passive acoustic monitoring rather than visual surveys to reach this goal. Over a study period of two full years, data were collected at 304 C-POD (Cetacean Porpoise Detectors) positions distributed all over the Baltic Proper between 2011 and 2013. As mentioned in chapter 3.3.1, based on these passive acoustic monitoring data from the SAMBAH study, the number of individuals of the Baltic Proper management unit during summer was estimated at approx. only 500 animals (SAMBAH 2016; AMUNDIN ET AL. 2022).

The distribution of harbour porpoise detections from the SAMBAH project showed a strongly decreasing pattern from the south-west to the north-east during the summer months (Figure 3-9).

Based on these seasonal distribution patterns, it is concluded that in winter, the Baltic Proper population of harbour porpoises shows a widespread distribution across the whole study area mixing with the Belt Sea population. During the summer breeding season, however, the two populations seem to be separated:

The Belt Sea population moves further west and the Baltic Proper population concentrates in the detection hot spot in Swedish waters around the Hoburg and Midsjö banks south of Gotland and east of Øland (area indicated by a red circle in Figure 3-9). A seasonal population management border that lies east of Bornholm was thus proposed (Figure 3-9). Harbour porpoise density estimates based on these detections yielded low numbers with about 0.07 ind./km² in the whole study area during winter and with about 0.63 ind./km² in the south-western part of the study area and about 0.004 ind./km² in the north-eastern part of the study area in summer (SAMBAH 2016).

OWEN ET AL. (2021) recently presented further monitoring data from Swedish waters near the Northern Midsjö Bank south of Øland, hence the area probably used by Baltic Proper harbour porpoises during the breeding season. They found a slight increase in detection rates in their study period 2017-2020 compared to the 2011-2013 SAMBAH study period when analysing detection rates during the seasonal peak in May-October and thus during the breeding season. While this may be indicating the start of population recovery, the rate of increase (2.4%) is still very low relative to what is likely for this harbour porpoise population in the absence of threats (OWEN ET AL. 2021).

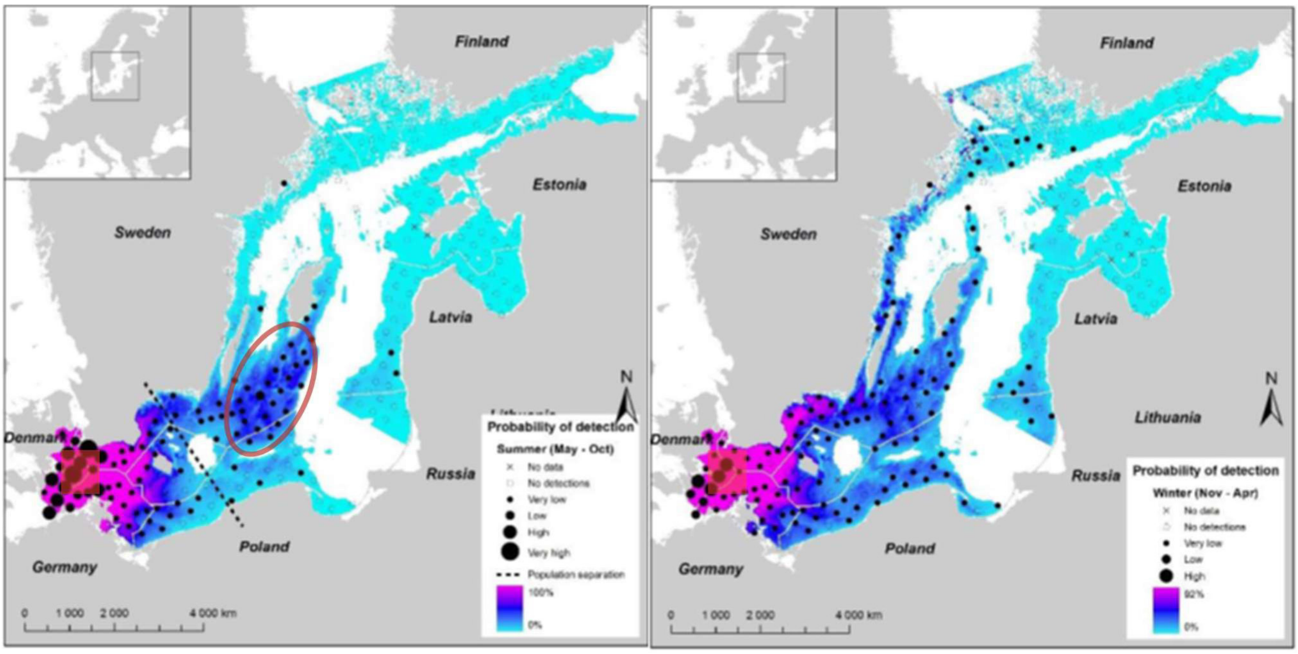

Figure 3-9. Probability of detection of harbour porpoises in the Baltic Sea in summer (May-October) and winter (November-April) as calculated from harbour porpoise detections at 304 C-POD stations deployed during the SAMBAH project between April 2011 and June 2013. The red circle indicates the high-density area around the Hoburg and Midsjö banks, which is suggested to be the breeding area of harbour porpoises from the Baltic Proper population. Taken from: SAMBAH (2016). Approximate pre-investigation area is indicated in red.

MIKKELSEN ET AL. (2016) modelled harbour porpoise distribution patterns in the south-western Baltic Sea using satellite locations from 13 tagged harbour porpoises of the Belt Sea population and comparing it to harbour porpoise detections at C-POD stations in the same area used during the SAMBAH project. As satellite data were only sufficient during summer (June-August) and autumn (September-November), model results were restricted to these two seasons. A summary of C-POD data is shown in Figure 3-10, which clearly shows a decrease in harbour porpoise detections from west to east. These data confirm results from the model calculated from satellite locations of the Belt Sea harbour porpoises that show high habitat suitability in the south-western part of the study area in summer and the western areas in autumn (Figure 3-11) (MIKKELSEN ET AL. 2016).

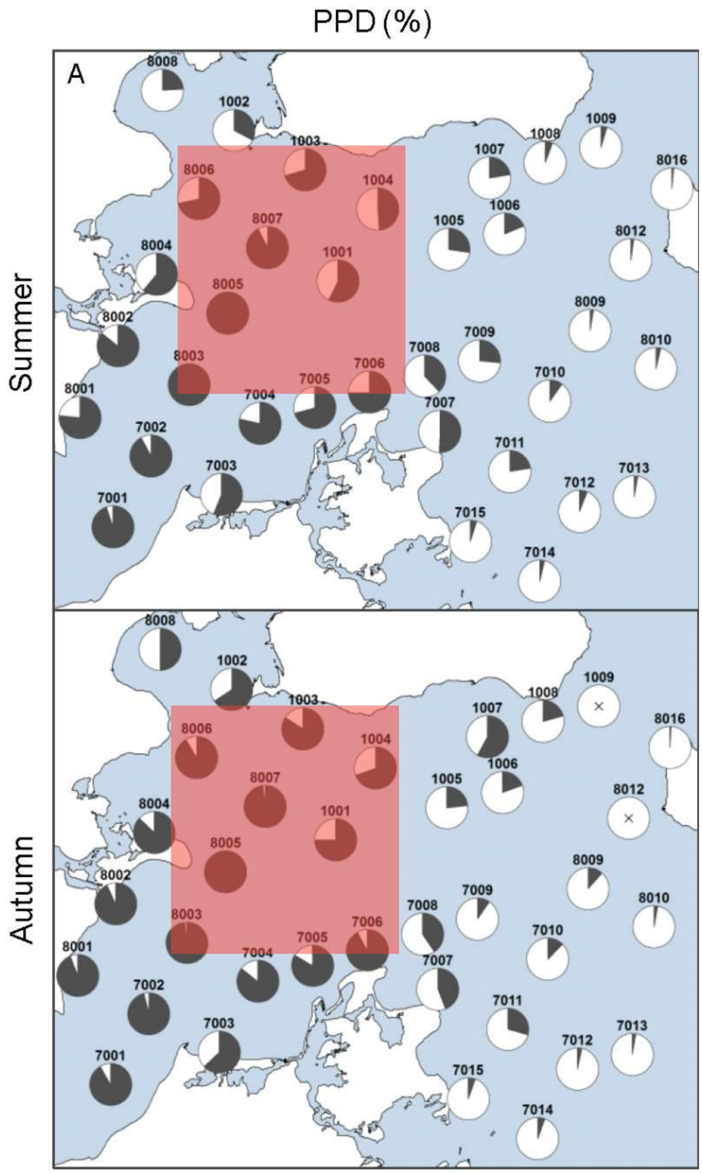

Figure 3-10. Percentage of harbour porpoise positive days (PPD %) by season (summer: June-August, autumn: September-November) at the C-POD stations used during the SAMBAH project between 2011 and 2013. Stations with an x mark indicate that no clicks were recorded at that station. From: MIKKELSEN ET AL. (2016). Approximate pre-investigation area is indicated in red.

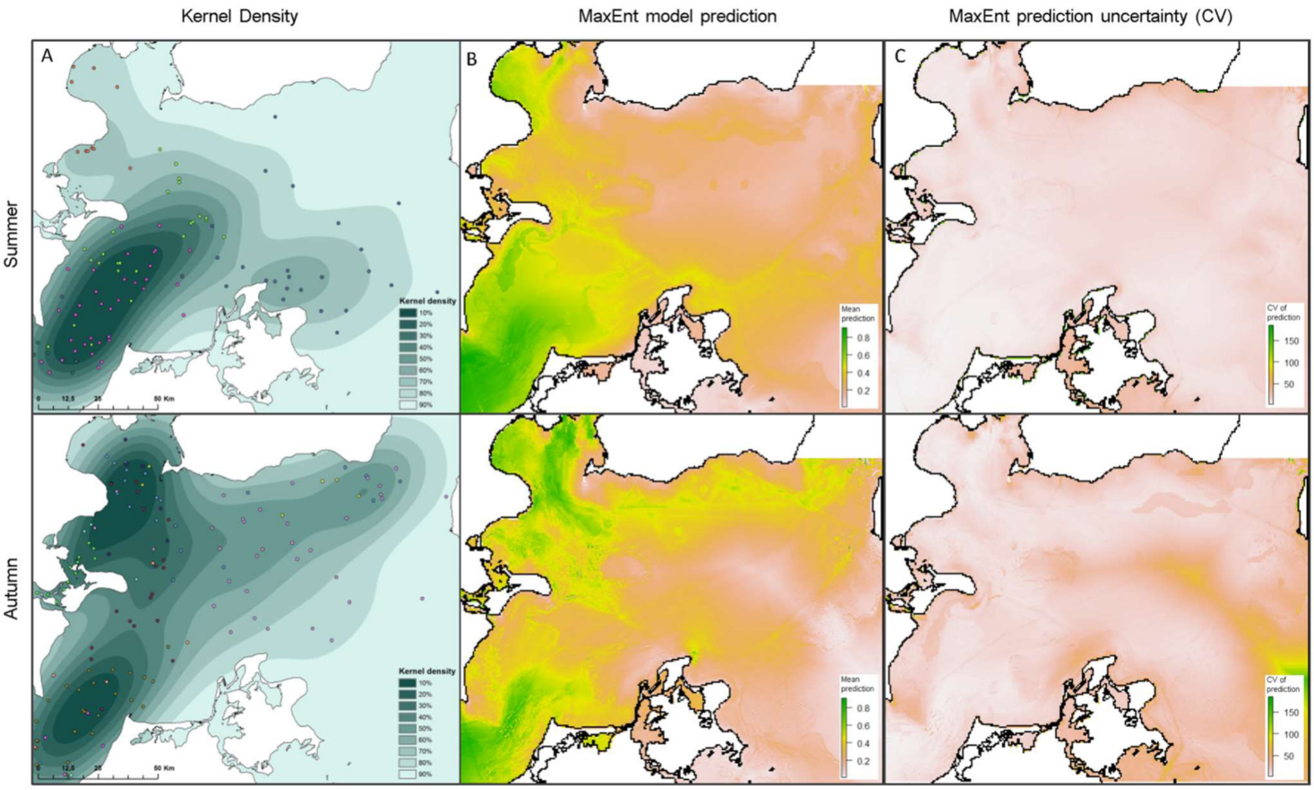

Figure 3-11. Kernel and MaxEnt results. (A) Kernel density results for summer (June-August, top row) and autumn (September-November, bottom row). (B) Mean prediction of the probability of presence of harbour porpoise based on 100 bootstrap models. The scale of the colouring can be interpreted as the relative probability of presence of harbour porpoise given the environment. (C) The uncertainty of the prediction expressed by the coefficient of variation (CV). From: MIKKELSEN ET AL. (2016).

In a recent HOLAS III report (SVEEGAARD ET AL. 2022) data from porpoise telemetry in the Belt Sea, SCANS, SAMBAH and other national data were revisited with the aim to create a map showing the importance of areas in the Baltic Sea for harbour porpoises. Not being solely based on density estimates, which would fail to highlight the areas that may be important for the Baltic Proper population of harbour porpoises, which only consists of about 500 individuals, it was created using several steps: Importance was estimated separately for the Belt Sea population and the Baltic Prober population of harbour porpoises, before joining it for a single map.

Importance of areas in the Baltic Sea for the Belt Sea population was estimated using telemetry data from 2007-2021, separately for summer and winter. With the Kernel Density tool in ArcGIS, contour lines (called isopleths) were created that encompassed 10, 50, 75% and 100% of harbour porpoise locations. The 50% isopleth was then used to identify areas of high importance, the 75% isopleth areas of medium importance, and areas outside these were categorized as being of lower importance. Then seasonal maps were merged, and this map was then compared with data from SCANS III (LACEY ET AL. 2022), the Belt Sea density surface model (period 2002-2016, ITAW / unpublished) and MiniSCANS II (UNGER ET AL. 2021), after which some areas of importance were added to the map in the Kattegat and Little Belt / Kiel Bight, giving the map shown in Figure 3-12.

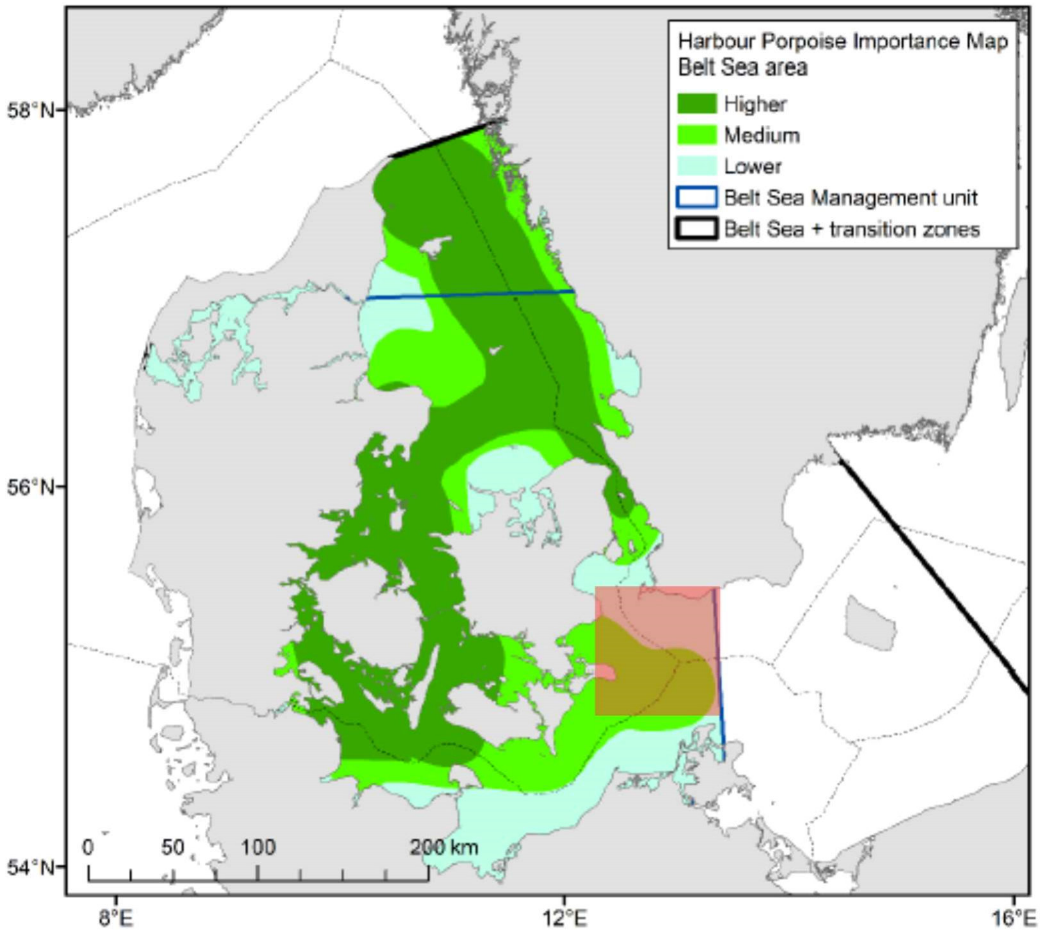

Figure 3-12. Map of the importance of different areas for the Belt Sea population of harbour porpoises. From: SVEEGAARD ET AL. (2022). Approximate pre-investigation area is indicated in red.

The importance map for the Baltic Proper population was based on probability of detection from SAMBAH, also first created separately for winter and summer and then merged. Areas of ≥ 20% probability of detection were chosen to represent areas of higher importance, and areas between 10% - 20% of probability of detection were chosen to present areas of medium importance. A convex hull (smallest polygon containing all the 20% (and then 10%) detection probability areas was drawn to present the area of higher (≥ 20%) and medium (10-20%) importance for harbour porpoises of the Baltic Proper population. An area of high importance was added in Polish waters based on assessment of local PAM data and also an area of medium importance was added in Finnish waters, where national monitoring data indicated regular presence of harbour porpoises. Furthermore, information was added showing in what areas data are deficient, because no or only very little monitoring took place, giving the map shown in Figure 3-13. Note the summer and winter management borders that are also included in Figure 3-13.

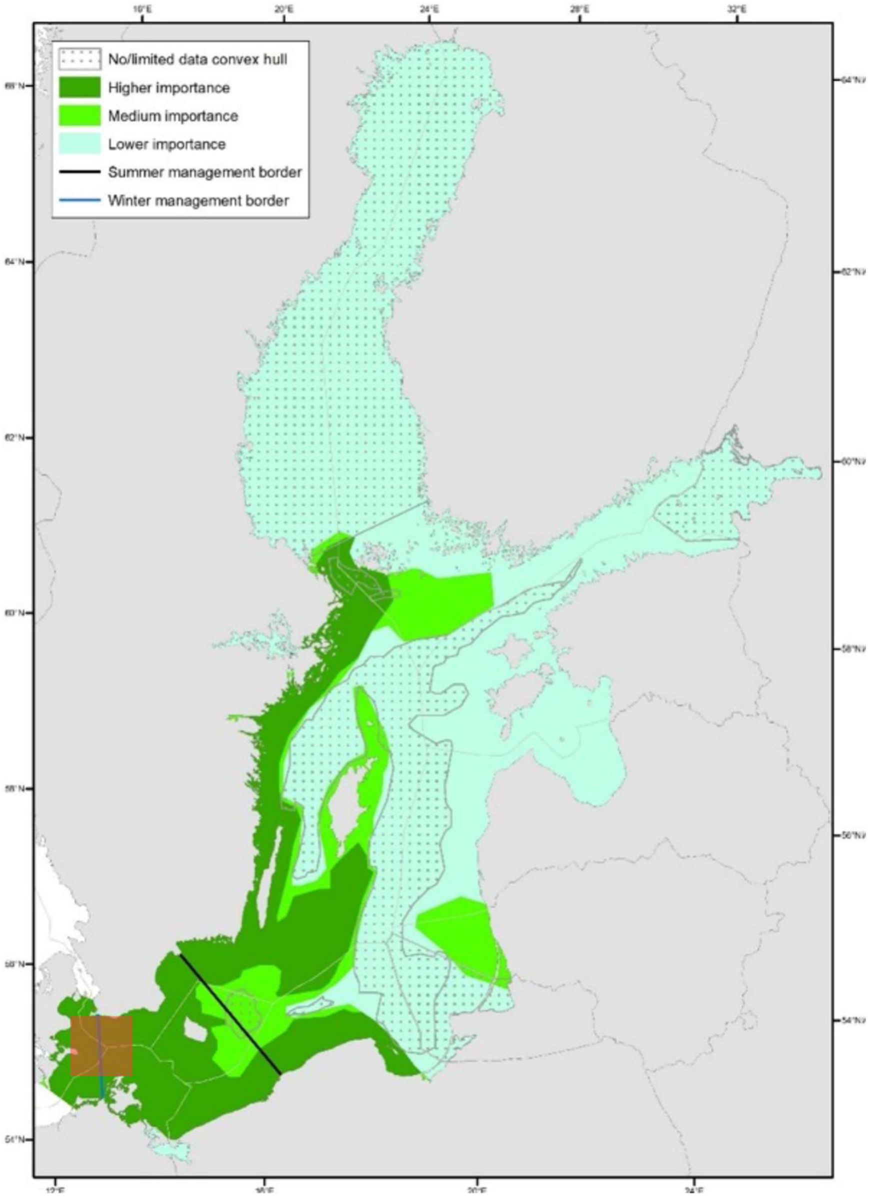

Figure 3-13. Map of the importance of different areas for the Baltic Proper population of harbour porpoises. From: SVEEGAARD ET AL. (2022). Approximate pre-investigation area is indicated in red.

These two maps were finally joined to gain one harbour porpoise importance map for the Baltic Sea, which is shown in Figure 3-14.

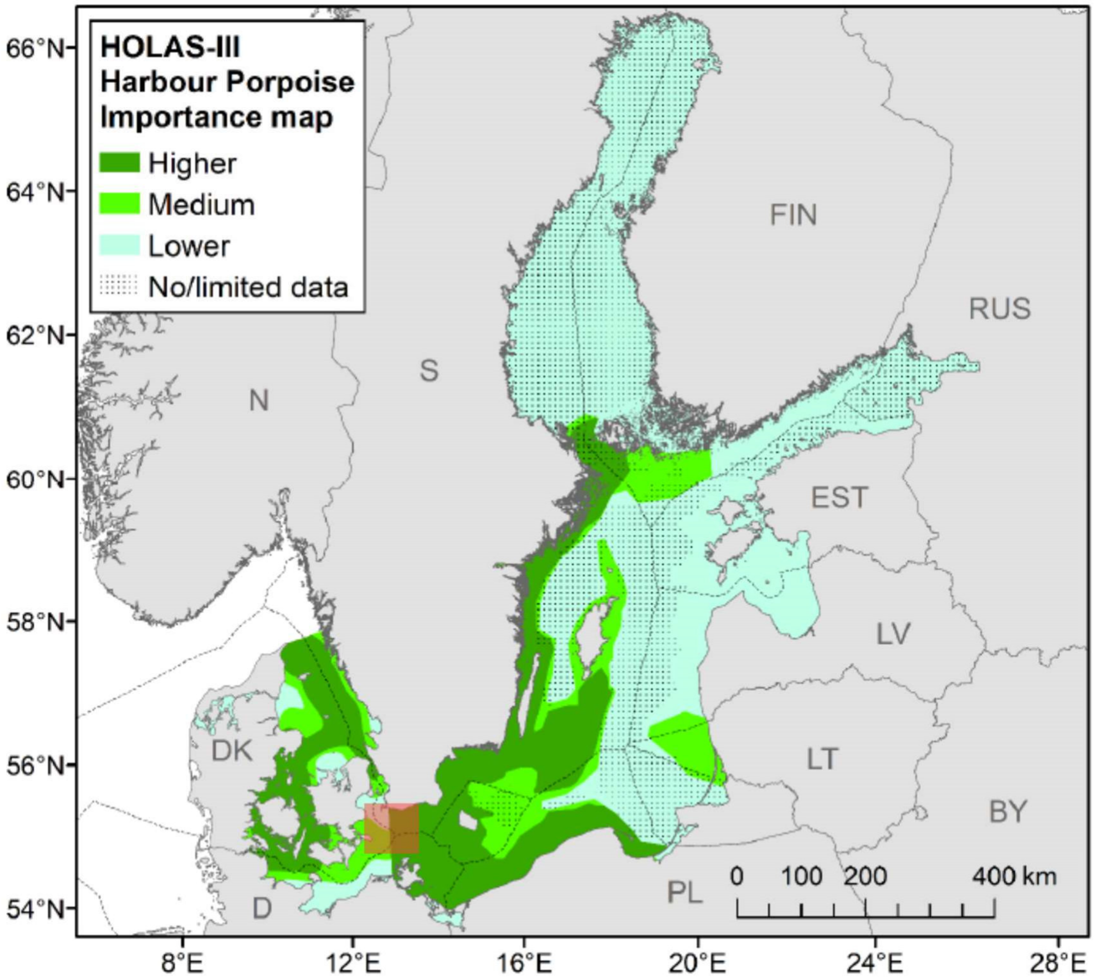

Figure 3-14. HOLAS III map of importance for harbour porpoises within the HELCOM area. From: SVEEGAARD ET AL. (2022). Approximate pre-investigation area is indicated in red.

3.3.3 CONSERVATION STATUS

Whilst the status of the global population (BRAULIK ET AL. 2020) and the European population (SHARPE & BERGGREN 2023) of the harbour porpoise is classified by the IUCN as least concern (LC), the Baltic Proper subpopulation is classified as critically endangered (CR; CARLSTRÖM ET AL. 2023), which is the highest threatened status(SPECIES ACCOUNT BY IUCN SSC CETACEAN SPECIALIST GROUP; REGIONAL ASSESSMENT BY EUROPEAN MAMMAL ASSESSMENT TEAM 2007; HAMMOND ET AL. 2008). The Baltic Sea subpopulation is considered decreasing. The HELCOM Red List lists the Baltic Sea subpopulation as CR and the Belt Sea subpopulation as VU (HELCOM 2013c). The national Danish Red List classified the harbour porpoise as LC (AARHUS UNIVERSITET 2019), the German as highly threatened (MEINIG ET AL. 2020), and the Swedish lists the Baltic Sea subpopulation as CR (2020).

Like all cetacean species, the harbour porpoise is included in Annex II and IV of the EU Habitats Directive (92/43/EEG), meaning that it requires strict protection, including the designation of Special Areas of Conservation (SACs) by the European member states. EU member states are required to maintain a “favorable conservation status” of harbour porpoises. All whale species are also covered by the EU Marine

Strategy Directive, where distribution, number and bycatch must be reported and evaluated according to descriptor 1.

The harbour porpoise is listed in Appendix II of the Bern Convention, meaning that it is strictly protected in member states. The harbour porpoise populations of the North and Baltic Seas are further included in Appendix II of the Bonn Convention (CMS SECRETARIAT 2015). The CMS daughter agreement ASCOBANS (Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas) hosts a recovery plan for the Baltic harbour porpoise and a conservation plan for the harbour porpoise in the Western Baltic, Belt Sea and Kattegat (www.ascobans.org/en/documents/action-plans). Furthermore, the Baltic Sea states have agreed in HELCOM Recommendation 17/2 to protect the harbour porpoise in the Baltic Sea. For summary see Table 3-3.

HELCOM (2023d; e) pre-core indicators both (abundance and distribution) failed for the Baltic Proper harbour porpoise population. Due to a lack of sufficient scientific data, a quantitative evaluation could not be implemented and instead a qualitative expert-based evaluation was conducted based on the SAMBAH results from passive acoustic monitoring (PAM) in 2011-2013 (CARLÉN ET AL. 2018; AMUNDIN ET AL. 2022) and historic records. The qualitative evaluation shows that the abundance and the distribution of the Baltic Proper harbour porpoise population does not achieve good environmental status HELCOM (2023d; e). This is due to the very small population size of only about 500 individuals estimated (CARLÉN ET AL. 2018; AMUNDIN ET AL. 2022) and a decline in abundance and distribution over the last century when the current situation is compared to historic records.

The Danish National Center for Environment and Energy (DCE) assessed the conservation status of the harbour porpoise in Habitat Directive Article 17 from 2019 (FREDSHAVN ET AL. 2019) as follows: The population in the marine Atlantic region is considered as being of favorable conservation status. In the Baltic area the Belt Sea population is considered as having a favorable conservation status whereas the Baltic Proper population has a highly unfavorable conservation status. However, in the DCE Marine areas report from 2021 (HANSEN & HØGSLUND 2021) it is stated that the entire Belt Sea population of harbour porpoises has halved since previous counts in 2012 and 2016 to only about 17,300 individuals. On the other hand, acoustic monitoring in the Flensborg Fjord, Bedgrund and the waters around Als and Lillebælt revealed an increase in acoustic detections of harbour porpoises from 2013 to 2020 (HANSEN & HØGSLUND 2021).

Table 3-3. Listing of the harbour porpoise in international and regional conservation agreements and international and national Red Lists. * The population in the inner Danish waters.

Species	IUCN	HELCOM Red List	National Red Lists	Natura 2000 (BfN 2015)	Bern Convention	Bonn Convention
Harbour Porpoise *Phocoena phocoena*	Global: LC Europe: LC Baltic Sea subpopulation: CR	Baltic Sea: CR Western Baltic*: VU	DE: Highly threatened DK: LC SE: CR (Baltic Sea population)	Appendix II und IV	Appendix II	Appendix II

4 METHODOLOGY

This chapter outlines the data collection methods, and analytical approaches applied for the investigations of marine mammals within and around the pre-investigation area of KF II N and KF II S.

4.1 DIGITAL AERIAL SURVEYS

Digital aerial surveys were used to determine the spatial distribution and seasonal abundance of marine mammals in the pre-investigation area from February 2023 to January 2024.

4.1.1 STUDY DESIGN

For the assessment of marine mammals in the pre-investigation area for KF II N and KF II S digital aerial surveys were conducted using HiDef video technology (www.hidefsurveying.co.uk). Transect design for the pre-investigation area consisted of 13 transects aligned from north to south (Figure 4-1). The transects had a total length of 831 km varying between 24 km and 84 km with a distance between each transect line of 5 km (Table 4.2). On average, 11.0% of the 3,739 km² pre-investigation area was covered per flight (Table 4.1).

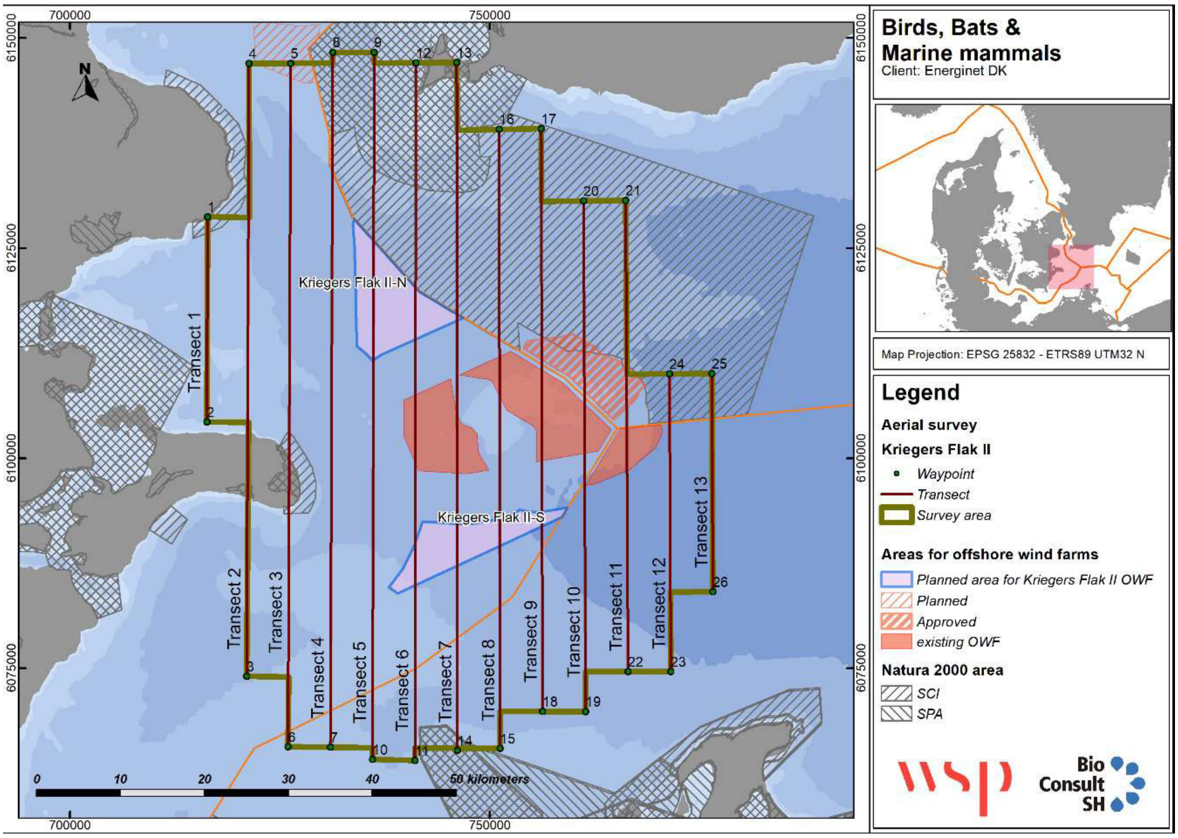

Figure 4-1. Transect design for aerial marine mammals' surveys in the pre-investigation area for KF II N and KF II S.

Table 4.1. Overview of the digital aerial surveys carried out in the pre-investigation area between February 2023 and January 2024. Effort is the area covered by the digital aerial flights; coverage is the % area covered relative to the pre-investigation area.

Survey no.	Date	Distance [km]	Effort [km^2]	Coverage [%]
1	27.02.2023	833	431	11.5
2	04.04.2023	787	417	11.1
3	22.06.2023	790	421	11.2
4	16.08.2023	834	340	09.1
5	18.10.2023	796	415	11.1
6	23.12.2023	834	445	11.9
		Total: 4,873	**Total: 2,468**	**Average: 11.0**

Table 4.2. Waypoints (WP) and Transects coordinates and lengths for aerial marine mammal surveys in the pre-investigation area for Kriegers Flak II N and KF II S.

Transect	Start Transektt	End Transekt	Length [km]
1	WP1: 55.25736°N; 12.40568°E	WP2: 55.03848°N; 12.38576°E	20.5
2	WP3: 54.76499°N; 12.43648°E	WP4: 55.41892°N; 12.49748°E	30.9
3	WP5: 55.41678°N; 12.57595°E	WP6: 54.68753°N; 12.50645°E	37.9
4	WP7: 54.68479°N; 12.58426°E	WP8: 55.42622°N; 12.65561°E	40.7
5	WP9: 55.42399°N; 12.73385°E	WP10: 54.66939°N; 12.6609°E	46.8
6	WP11: 54.66589°N; 12.73898°E	WP12: 55.41029°N; 12.81078°E	49.9
7	WP13: 55.40829°N; 12.88752°E	WP14: 54.67413°N; 12.81805°E	53.1
8	WP15: 54.67378°N; 12.8972°E	WP16: 55.33462°N; 12.95984°E	55.2
9	WP17: 55.33248°N; 13.03839°E	WP18: 54.71077°N; 12.97924°E	57.3
10	WP19: 54.70801°N; 13.05826°E	WP20: 55.25289°N; 13.10999°E	57.3
11	WP21: 55.25074°N; 13.18862°E	WP22: 54.74793°N; 13.14068°E	62.0
12	WP23: 54.74524°N; 13.21973°E	WP24: 55.06281°N; 13.2507°E	62.0
13	WP25: 55.06031°N; 13.32938°E	WP26: 54.82762°N; 13.30673°E	65.9

4.1.2 DATA COLLECTION

The recording of marine mammals was performed using the digital video technology developed by the company HiDef surveying Ltd. (www.hidefsurveying.co.uk), explained in detail in WEIß ET AL. (2016) and summarized in the following paragraphs.

A twin-engine, high-wing propeller-driven aircraft (Partenavia P 68) was used for the acquisition of digital videos, see Figure 4-2. This aircraft is equipped with four high-resolution video camera systems, which take approximately seven images per second and can achieve a resolution of two cm at sea surface. Since the camera system is not directed vertically downwards (depending on the sun position, it can be slightly inclined or even set against the flight direction), interferences arising from solar reflections (glare) can be effectively reduced. The external cameras (indicated by A and D, Figure 4-2) cover a strip of 143 m width while the internal ones cover a width of 129 m each, resulting in 544 m effectively covered. There is however about 20 m distance between each strip to avoid double counting of individuals detected by the cameras. Thus, the total recorded strip of 544 m is distributed over a width of 604 m.

The aircraft flew at an average speed of approx. 220 km/h (120 knots) at an altitude of 549 m. A GPS device (Garmin GPSMap 296) recorded the position every second, which permitted to geographically assign a location to the images and the animals registered on them. The collected data were stored on mobile hard disks for subsequent review and analysis.

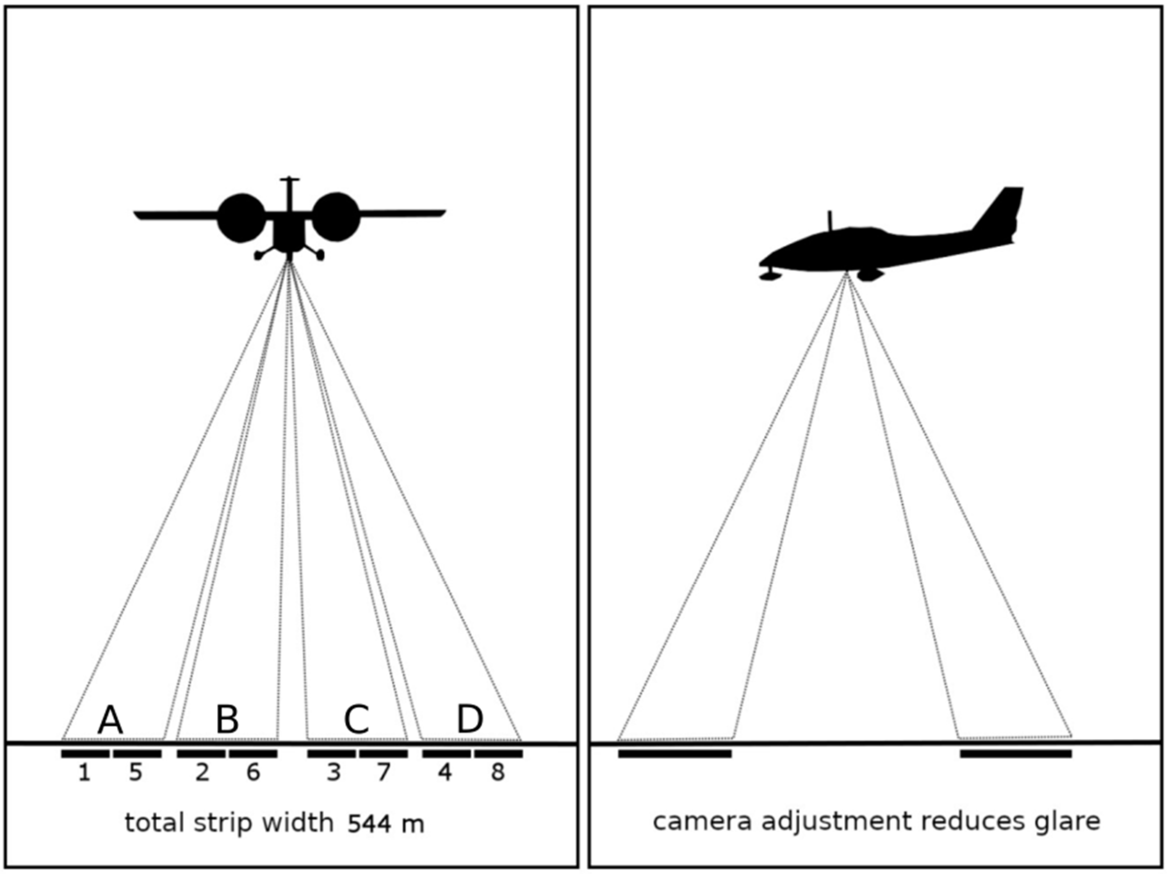

Figure 4-2. The HiDef Camera System. The four cameras (A to D) cover an effective strip width of 544 m of the sea surface at a flight altitude of 549 m (left: frontal view; right: side view). The numbering indicates the camera images as they are used in the evaluation (the images from each camera are divided into two halves).

4.1.3 DATA PROCESSING

To facilitate the detection of objects, the video sequences taken from each camera were split into two halves, so that each half of the picture fitted the width of a large monitor. The video files were then processed using an image capture and management software (StreamPix). First, the images were examined and all the detected objects (marine mammals, ships, etc.) were marked and pre-sorted for subsequent identification. To guarantee a consistent high quality, 20% of each film was randomly selected and processed again by another reviewer. If both reviewers reached a consensus of 90% regarding object identification, discrepancies were rechecked, and the film afterwards approved for further analysis. If the consensus was below 90%, the film was reanalyzed entirely. Sections of the footage that could not be assessed due to backlight or the presence of clouds were not considered for further analysis.

The next step involved the identification of the previously marked objects (marine mammals). This was done by experienced observers. Often marine mammals can be identified on the images to species level. Due to strong similarities between some species (e.g., harbour seals and grey seals), an identification on species level is not always possible. However, it is usually possible to identify individuals as belonging to a species group formed by two (or few) closely related species. In addition to the identification, other information such as position, age, behavior and swim direction were determined whenever possible. Environmental parameters (air turbidity, sea state, solar reflection, and water turbidity) were recorded every 500 images (approx. covering 4 km). To assure quality control, 20% of the objects identified were re-assessed by a second reviewer. All discrepancies between the first and second identification process were checked again by a third expert. If there was a consensus of at least 90%, the data collected was released for further analysis. If the consensus was below 90%, systematic errors (e.g., problems in determining specific species groups) were corrected and all objects were re-identified.

4.1.4 DATA ANALYSIS

Densities of individuals (individuals/km²) were calculated for all species or species groups. All seal taxa (grey seal, harbour seal and unidentified seal) were evaluated together as seal.

The density per survey and the seasonal densities were calculated for seals and harbour porpoises. In addition, the seasonal distribution was analysed. To illustrate the spatial distribution, a grid was laid across the pre-investigation area, and the grid cells were aligned with the European Environment Agency grid (EEA 2019). The edge length of the single cells consists of squares with 5 km edge lengths. Densities per grid cell are only shown if a minimum survey effort of 0.5 km² was reached.

Certain correction factors are included in the calculation and analysis since marine mammals located more than about 2 m below the water surface may escape detection from the air. Thus, these animals could also be taken into account to determine abundance and densities. To correct for this so-called availability error (BORCHERS 2003), the number of animals sighted can be multiplied by a factor that takes into account the probability of harbour porpoises being present in the upper level of the water column (0-2 m, TEILMANN ET AL. 2013). This likelihood was determined by means of tagged animals in the North- and Baltic Sea while considering seasonal fluctuations (Table 4.3).

The literature does not provide any information about the proportion of seals in the upper 2 m of the water column. Telemetry studies make it clear that the animals mainly remain close to the seafloor and only briefly come to the surface to breathe (ADELUNG ET AL. 2004). Consequently, the density of seals presented here can only be taken as a minimum density and not as an average.

Table 4.3 Seasonal residence probability (%) of harbour porpoise in the top two meters of the water column, separated by month; according to TEILMANN ET AL. (2013).

ID	Month	Residence probability [%] (0-2 m)
1	January	49.2
2	February	42.5
3	March	52.5
4	April	61.5
5	May	57.3

6	June	55.3
7	July	57.0
8	August	51.7
9	September	45.0
10	Oktober	45.3
11	November	46.3
12	December	49.9

4.2 PASSIVE ACOUSTIC MONITORING SURVEY

The purpose of the passive acoustic monitoring (PAM) survey was to determine the spatial and seasonal habitat use of harbour porpoise occurring in the pre-investigation areas from KF II N and KF II S during the one-year survey period from February 2023 to January 2024.

4.2.1 STUDY DESIGN

A total of 16 C-PODs (F-O1 to F-O8 and F-R1 to F-R8) were deployed for PAM of harbour porpoises in the pre-investigation area in the Western Baltic Sea (Figure 4-3; Table 4-4).

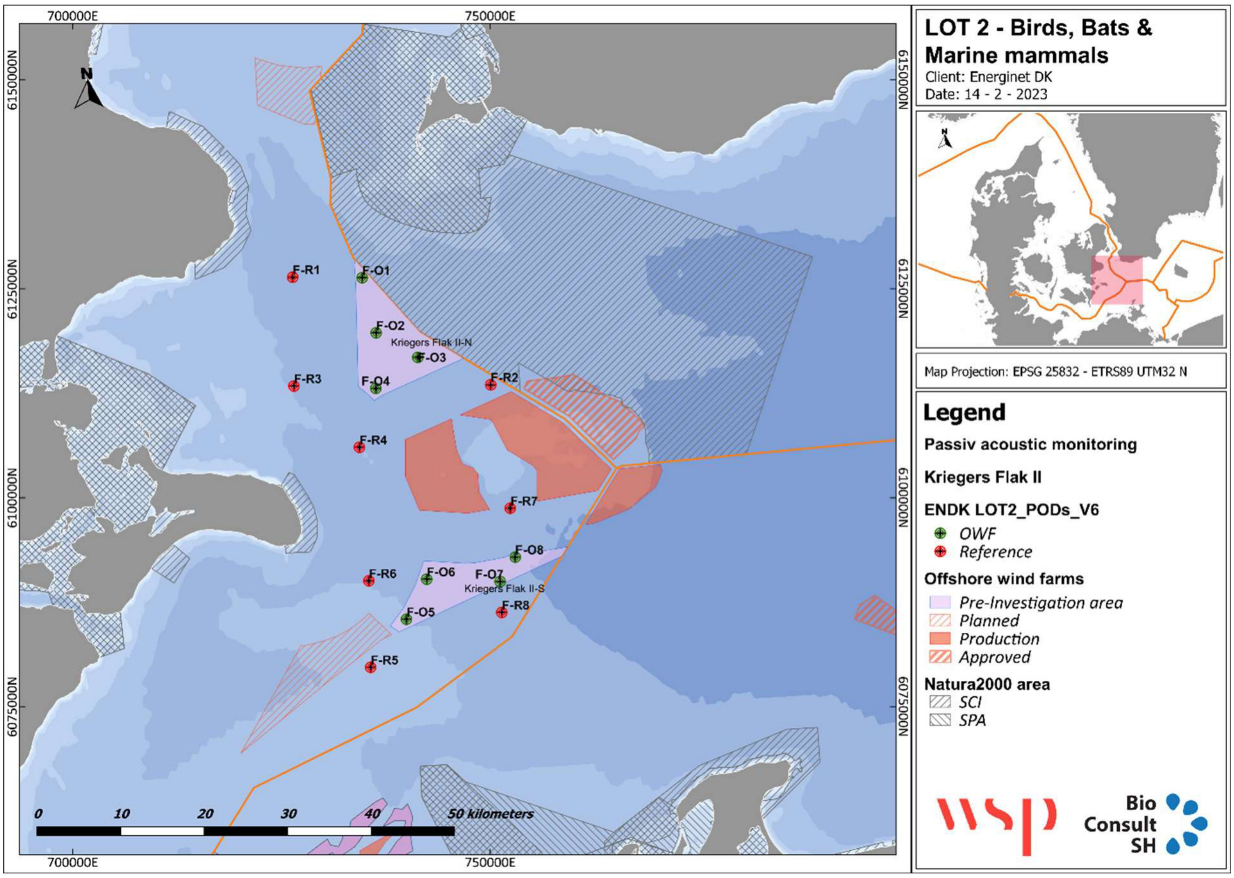

Figure 4-3. C-POD design inside and outside the planned windfarm areas of KF II N and KF II S.

Table 4-4. Geographical positions of the deployed C-PODs. C-PODs were deployed at all stations.

Station	(WGS 84, DD)	(WGS 84, DD)	(WGS 84, DD°MM)	(WGS 84, DD°MM)
F-O1	55.227677	12.690192	55° 13' 39.64'' N	12° 41' 24.69'' E
F-O2	55.167744	12.710919	55° 10' 03.88'' N	12° 42' 39.31'' E
F-O3	55.138938	12.786561	55° 08' 20.18'' N	12° 47' 11.62'' E
F-O4	55.108120	12.704763	55° 06' 29.23'' N	12° 42' 17.15'' E
F-O5	54.858534	12.738946	54° 51' 30.72'' N	12° 44' 20.21'' E
F-O6	54.900388	12.780795	54° 54' 01.40'' N	12° 46' 50.86'' E
F-O7	54.893524	12.917329	54° 53' 36.69'' N	12° 55' 02.38'' E
F-O8	54.918788	12.948089	54° 55' 07.64'' N	12° 56' 53.12'' E
F-R1	55.232059	12.559632	55° 13' 55.41'' N	12° 33' 34.68'' E
F-R2	55.105177	12.920309	55° 06' 18.64'' N	12° 55' 13.11'' E
F-R3	55.115174	12.551529	55° 06' 54.63'' N	12° 33' 05.50'' E
F-R4	55.045845	12.668195	55° 02' 45.04'' N	12° 40' 05.50'' E
F-R5	54.809000	12.667616	54° 48' 32.40'' N	12° 40' 03.42'' E
F-R6	54.901906	12.672705	54° 54' 06.86'' N	12° 40' 21.74'' E
F-R7	54.971533	12.943873	54° 58' 17.52'' N	12° 56' 37.94'' E
F-R8	54.860297	12.917251	54° 51' 37.07'' N	12° 55' 02.10'' E

All 16 C-POD stations were deployed on 7th and 8th of February 2023. The devices were replaced approximately every two months to extract data and change the batteries. The deployment and recording periods of the C-PODs for all monitoring stations are shown in Figure 4-4. There was no data loss at most stations, except at stations F-O8 and F-R4 where data was lost in one deployment period each in spring 2023.

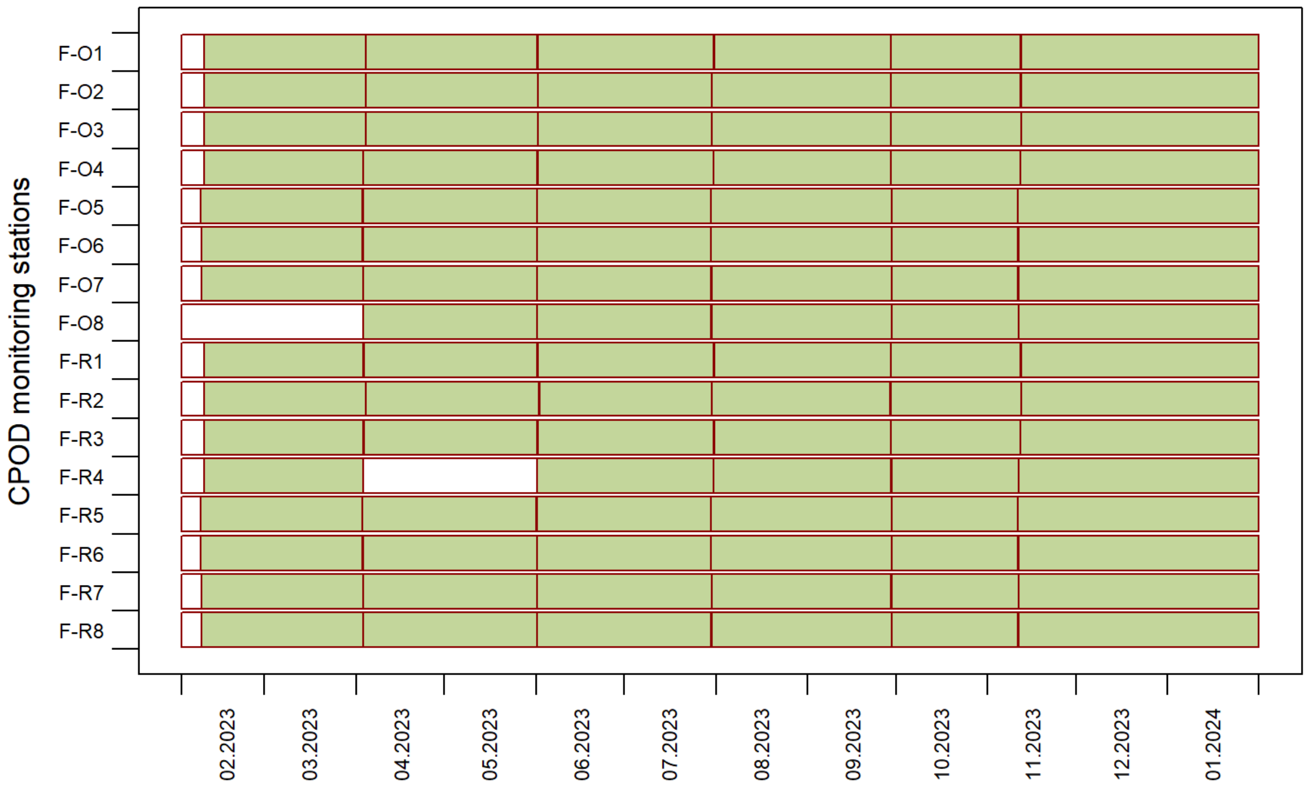

Figure 4-4. Bar chart, indicating the duration of deployment of C-PODs within the pre-investigation area for the survey period (February 2023 to January 2024). Green: C-POD recorded data, white: no data. The x-axis shows the date, the y-axis the C-POD station. Vertical lines indicate the time of exchange/service of the devices.

4.2.2 DATA COLLECTION

THE CETACEAN PORPOISE DETECTOR (C-POD)

C-PODS were used to conduct passive acoustic monitoring of marine mammals. A C-POD (Cetacean Porpoise Detector; Figure 4-5) is a hydrophone, detecting the high-frequency echolocation signals of harbour porpoises up to a distance of about 300 m. Harbour porpoise clicks are directed in a strongly forward direction. They are emitted within a sound beam with a horizontal beam width of 13° and a vertical beam width of 11° (KOBLITZ ET AL. 2012). This means that C-PODs will only be able to detect harbour porpoise presence if these (1) emit click sounds, (2) have their head pointed towards the hydrophone, and (3) are located at a suitable distance from the device. Even though the manufacturer of the C-POD states that these data loggers can record clicks of harbour porpoises up to a range of 400 m (CHELONIA LIMITED 2023), the effective detection radius is smaller. For example, in a field study with the predecessor model, the T-POD (Timing POrpoise Detector) only clicks up to a distance between 22 and 104 m were effectively recorded (KYHN ET AL. 2012), while in another field study a detection range of about 170 m was observed (KOSCHINSKI ET AL. 2003). The respective detection radius depends on the C-POD type, C-POD sensitivity, train classification settings and duration of snapshots, as well as sea state, wind, current speed and sediment type which affect the background noise level.

The recording of harbour porpoise clicks is therefore highly influenced by the animals' activity as well as distance from and angle of approach towards the C-POD. Applying different pre-set filters, the C-POD converts the sound waves into digital data, which are stored on an SD card. A number of different specific click characteristics is additionally saved. The C-PODs were set to a scan limit of 4,096 clicks/min.

Figure 4-5. C-POD (www.chelonia.co.uk/index.html).

C-POD CALIBRATION

All deployed devices were calibrated by the manufacturer (Chelonia Ltd., UK) to the main frequency of porpoise clicks (130 kHz) and set to the same hearing threshold (±3 dB). Calibration is carried out in a specifically designed test tank in a standardized acoustic environment indicating possible differences in the sensitivity of the devices. The sensitivity of the units had been standardized when built by rotating the complete instrument in a sound field and adjusted to achieve a radially averaged, temperature corrected, maximum source pressure level (SPL) reading within 5% of the standard at 130 kHz (60.5 dB). The radial values were taken at 5°-intervals. The calibration and standardization process are described in detail on the manufacturer's website (www.chelonia.co.uk).

C-POD DEPLOYMENT

According to the international guideline for offshore data acquisition systems (ODAS) all C-PODs were marked by a yellow rubber marker buoy as well as a 6 m sparbuoy, equipped with a yellow 3NM flashlight, a radar-reflector and a yellow top-cross (Figure 4-6). Two surface markers are connected via a rope on the sea floor.

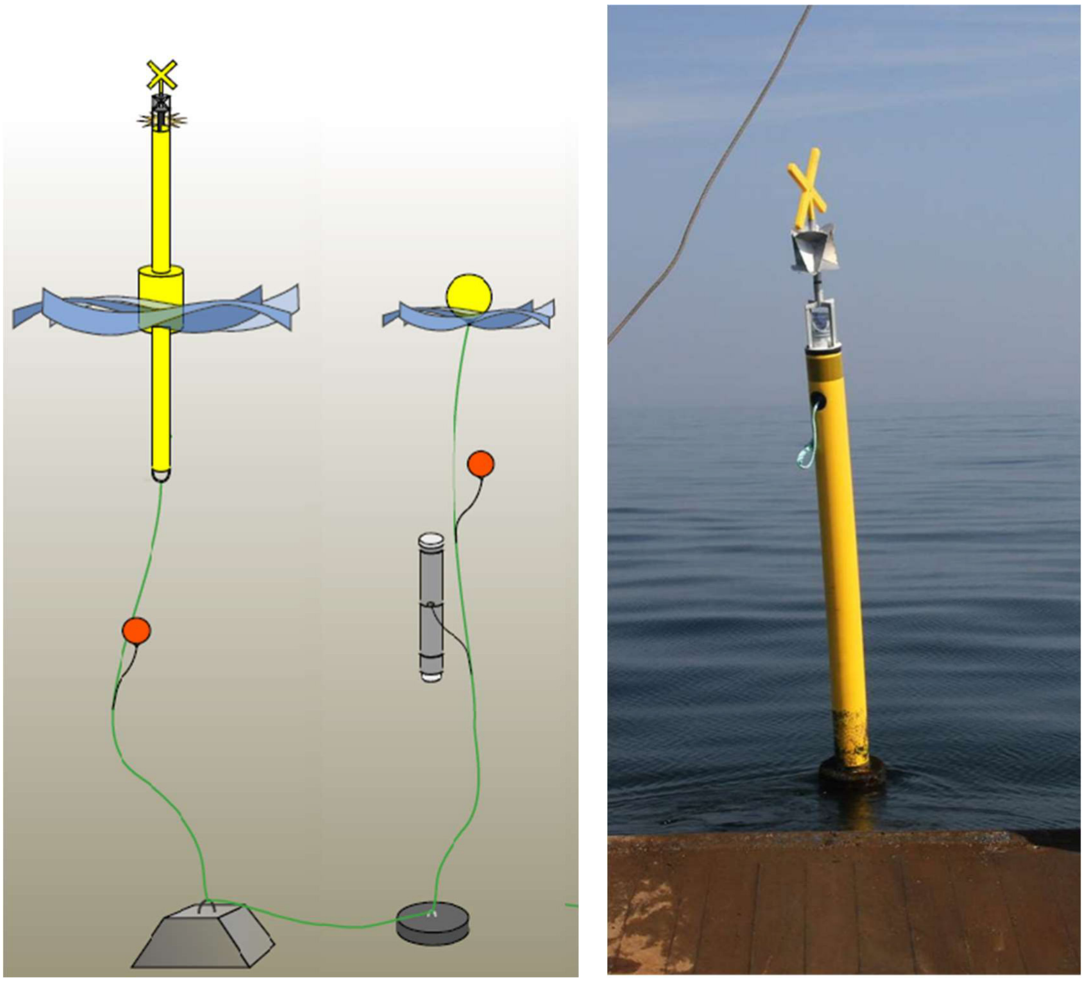

Figure 4-6. C-POD mooring system with spar buoys.

C-PODs were deployed starting February 2023 after the permission from the Danish Maritime Authority for deployment was acquired. The maintenance of C-PODs at sea was done every 6-10 weeks to avoid potential data gaps due to losses or malfunctions as short as possible.

4.2.3 DATA ANALYSIS

MEASUREMENT UNITS

Harbour porpoise-positive time units are pre-defined periods (e.g., days/hours/10-minutes or minutes), which are checked for the occurrence of harbour porpoise click trains. In case the chosen time unit contains at least one harbour porpoise click train, this time unit is rated to be harbour porpoise positive. As the number of recorded click trains largely depends on the behavior of the animals and is very sensitive to possible minor differences in sensitivity between the devices, the parameter "positive time unit" is an indication for harbour porpoise presence. Different studies were able to show a clear relation between absolute harbour porpoise density (determined in aerial surveys) and the detection rate within the same period and area in form of harbour porpoise positive time units (SIEBERT & RYE 2008; KYHN ET AL. 2012; WILLIAMSON ET AL. 2016; JACOBSON ET AL. 2017; SCHUBERT ET AL. 2019). It can therefore be assumed that the higher the detection rate, the more harbour porpoises will have been present in the respective range of the

C-POD on that timeframe. Although it cannot be completely excluded that in case of a high detection rate only few animals stayed in the area covered by a C-POD for a longer period of time. This parameter therefore only serves as a rough indicator for harbour porpoise density per time unit. See formula 1, xt = number of clicks for this time unit.

Formula 1:

$$\text{Harbour porpoise positive time per time unit [\%]} = \frac{\text{N time units with clicks } (x_t > 0)}{\text{N total time unit}} * 100$$

The time unit (from minutes up to months or entire study periods) is chosen depending on the specific question and harbour porpoise presence in the pre-investigation area.

The following analyses are based on DPD/month and DP10M/day (see below), focusing on two main questions:

1. What is the monthly presence of porpoises in the preliminary project area?

2. How do animals utilize the area during a 24-hour day?

%DPD/time unit (% detection-positive days per time unit) gives the percentage of survey days per pre-defined time unit (e. g., month/year/study period, etc.) with at least one harbour porpoise signal. Applying this parameter, no difference is made if only one click train was recorded that day or if every minute hundreds of click trains occurred. The coarse resolution parameter is particularly well-suited for datasets characterized by a limited number of harbor porpoise detections, as observed in the current pre-investigation area. The parameter is standardized to values between 0 and 100 as %DPD/month, taking the number of recording days per month as 100%. In areas with low porpoise abundance, i. e., great parts of the eastern Baltic Sea, the daily presence of harbour porpoises has more explanatory power than the (daily) frequency of occurrences (see %DP10M/day). That is because analyses based on an hourly or even minute-by-minute basis have a high susceptibility to randomness due to very infrequent recording and thus only have a low informative value. To meet highest explanatory goals for areas with low porpoise abundance, the reduced temporal resolution is considered an acceptable limitation in data analysis.

%DP10M/time unit (% detection-positive 10 minutes per time unit): This parameter gives percentages of the number of 10-minute units per pre-defined time unit (e.g., days/month/study period, etc.) with at least one harbour porpoise signal. This parameter is usually used in a resolution per day where it describes within how many of the usually available 144 10-minute units of a 24-hour day at least one harbour porpoise signal was recorded. Thus, it is the most appropriate measure in areas with moderate or high porpoise abundance. This parameter can be used to check for any temporal differences in the presence of harbour porpoises during the course of a 24-hour day. Since the instruments are deployed close to the seabed, regular differences in detections during a day can give valuable information about habitat use.

CALCULATIONS

Seasonality diagrams for each C-POD station were generated based on harbour porpoise detection rates using the software R (package "stats"; version 3.4.0; R CORE TEAM 2017). The phenology is represented by the parameter %DPD/month and %DP10M/d. With the former parameter, each day on which at least one click train was recorded is considered a "detection positive day" (DPD). By this procedure, a day with few click train recordings is treated as equal to a day on which almost continuous (i. e. many) porpoise click trains are recorded. The use of this parameter prevents an overestimation of too large stochastic parameters. The other parameter %DP10M/d provides a finer temporal resolution but is more prone to stochasticity.

The **spatial distribution** of the harbour porpoises is displayed by overlaying the average of detection positive 10-minute units per day (%DP10M/d) as classified circles and the geographical position of the respective C-POD station using the software ArcGIS (Version 10.8).

Dial patterns of harbour porpoises were analysed based on the daytime-phase-length-weighted proportion of %DP10M/t relative to all phases (sum of all four phases day, night, dusk, and dawn = 100 %; dusk and dawn not shown in plots). This was done per C-POD station.

DATA QUALITY

C-PODs record signals in real time allowing to identify click trains due to the temporal resolution. Raw data of C-PODs were processed using the associated software CPOD.exe (Chelonia Ltd., UK). Data was processed in two steps. In a first step, harbour porpoise click trains were extracted from the raw data by means of an algorithm of the CPOD.exe software. In a second step, signals were classified by the KERNO classifier into different categories according to the probable source: harbour porpoise, dolphin, boat sonar or unknown source. The software assigned each click train to one of these classes and gave an estimate of the quality of this classification. Four quality classes are available:

"**high**": these click trains are highly probable harbour porpoise signals.

"**moderate**": short click trains, which are probably harbour porpoise signals.

"**low**": click trains with sound patterns which may be harbour porpoise signals but deviate from the ideal and may therefore originate from other sources.

"**doubtful**": series of click trains which are due to the length or the temporal pattern of rather technical origin. These may still contain harbour porpoise click trains, which were only partly recorded by the hydrophone or from a larger distance or at an unfavourable angle.

For the present analysis, standard filtering was applied according to Chelonia Ltd., including only the two highest quality classes ("high" and "moderate") to decrease the number of incorrectly classified harbour porpoise click trains.

To avoid possible masking effects of too many clicks of unknown sources on the registration of harbour porpoise clicks, the quality of C-POD records was checked. In addition to echolocation sounds of harbour porpoises, C-PODs record all impulse sound events in a frequency band of between 20 kHz and 150 kHz. Among these are the sounds of boat sonars and sediment movement. If a C-POD is deployed in a noisy environment, the pre-set click limit of 4,096 clicks per minute will quickly be exceeded and the C-POD will then record no further data for the rest of this minute. In such a case, harbour porpoise clicks may be missed. However, even if the limit is not reached it cannot be excluded that porpoise clicks may be missed due to masking. A double quality criterion was defined in order to prevent too much data of unknown origin from being included in the further analysis and causing a bias in the outcome: The two criterions were defined based on experience gained in the analysis of different projects in the North Sea and Baltic Sea (ROSE ET AL. 2019). All complete days with C-POD recordings that registered either more than three million clicks (the maximum possible number is > 5.89 million clicks) or had more than 200 minutes reaching the click limit of 4,096 clicks were removed. Furthermore, only whole days with records of 1,440 minutes were included in the evaluation. Duplicate or incomplete records due to e.g. exchanges of C-PODs were excluded.

A total of 113 days of 5,736 possible monitoring days (2.0%) could not be included in the evaluation due to data loss. 5,623 C-POD monitoring days remained for further consideration. About 3,6% of all C-POD monitoring days did not meet the, above described, noise criteria and were therefore discarded. Hence, 5,419 C-POD days remained for further analysis. The dual noise criterion was not applied to sonar analyses, as ship noise was of special interest here.

4.3 SEAL COUNTINGS AT HAUL-OUT SITES

Data from seal counting under the Danish national monitoring programme NOVANA during the moulting and pupping seasons of harbour seals and grey seals, respectively were analyses according to HANSEN & HØGSLUND (2021). In addition to the NOVANA data, also publicly available data for seals from Sweden through the pan-Baltic grey seal moult survey, organised by HELCOM, between late May and early June will be considered. Based on historical (SØNDERGAARD ET AL. 1976) and current distribution of seals (HANSEN & HØGSLUND 2021) and their haul-outs on beaches and sand banks in the Baltic Sea and Kattegat, haul-out sites were selected for further analyses.

These data will be used to study the annual numbers of seals in the vicinity of the proposed offshore windfarm areas Kattegat, Hesselø and Kriegers Flak II, which are included in the ongoing tender for offshore wind (Figure 4-7 and Table 4-5).

For harbour seals May and June haul-out sites count data and for grey seal August haul-out sites count data were used according to HANSEN & HØGSLUND (2021). In contrast to HANSEN & HØGSLUND (2021) data was not corrected for seals at sea during haul-out counts. Therefore, the true abundance may be much higher as 60% of seals may be at sea during counts in some areas (HANSEN & HØGSLUND 2021).

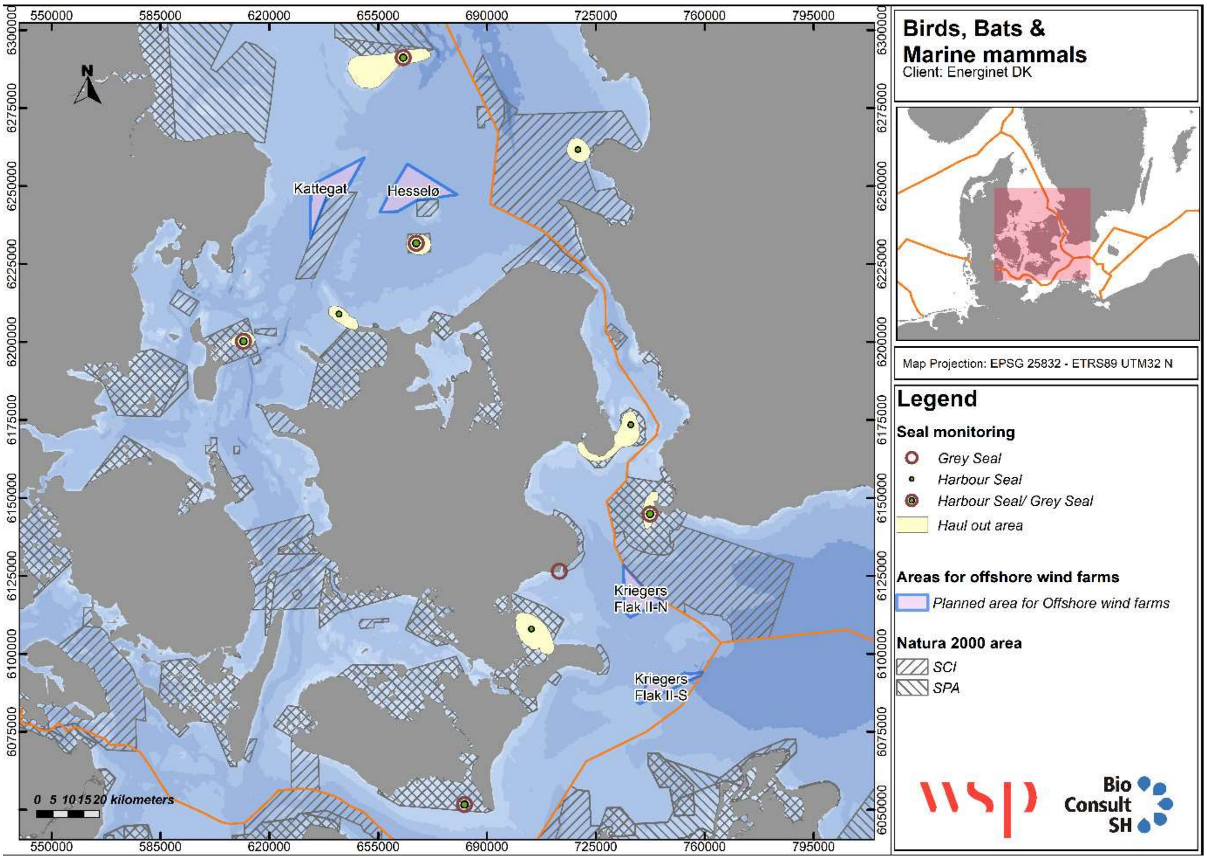

Figure 4-7. Haul-out sites of Harbour Seals and Grey Seals in the vicinity of the windfarm areas Kattegat II, Hesselø Syd, Kriegers Flak II N and Kriegers Flak II S. The distribution of seals and prey on beaches and sandbanks shown is adapted from HANSEN & HØGSLUND (2021) and SØNDERGAARD ET AL. (1976).

Table 4-5. Haul-out sites in Kattegat and around Kriegers Flak from which publicly available data will be analysed.

ID	Name	Type	Lat	Long	Seal Spec.	Natura 2000 EU	Natura 2000 DK
1	Bosserne	Haul out	55.93373151	10.78840203	both	DK00DX155	N55
2	Sjaelland Rev	Haul out	56.00391878	11.28404046	Harbour Seals	DK005X221	N154
3	Hesselø	Haul out	56.19966196	11.69505519	both	DK003X202	N128
4	Anholt	Haul out	56.73561799	11.66533395	both	DK00DX146	N46
5	Hallands Väderö	Haul out	56.44814246	12.5576291	Harbour Seals	SE0420002	
6	Saltholm	Haul out	55.60638302	12.75682771	Harbour Seals	DK002X110	N142
7	Vestamager	Haul out	55.55455963	12.59122218	Harbour Seals	DK002X111	N143
8	Måkläppen	Haul out	55.38954768	12.82751999	both	SE0430095	
9	Stevns Rev	Finding	55.23813505	12.35443397	Grey Seals	DK00VA305	N206
10	Bøgestrøm	Haul out	55.07619534	12.20003145	Harbour Seals	DK006X233	N168
11	Rødsand	Haul out	54.57861100	11.82838900	both	DK006X238	

5 DATA AND RESULTS

During the survey period from February 2023 to January 2024, a total of 181 marine mammals (Figure 5-1 and Table 5-1; 100 seals (67 harbour seals, 5 grey seals, 28 seals), 74 harbour porpoises and 7 unidentified marine mammals) were observed during the six digital aerial surveys. The 7 unidentified marine mammals belong most likely to one of the categories harbour porpoise or unidentified seal.

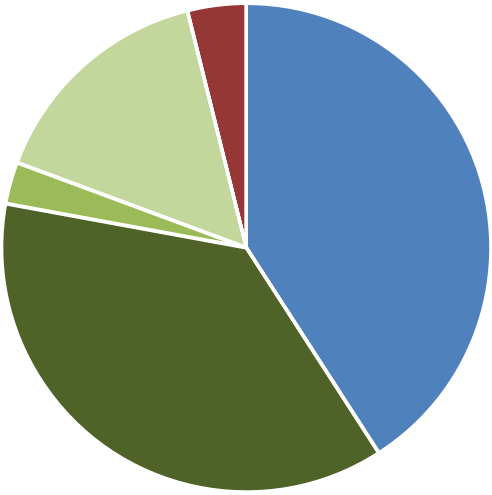

Figure 5-1. Proportion of different marine mammal observations in the pre-investigation area during aerial surveys between February 2023 and January 2024.

Table 5-1. Observations of marine mammals in the pre-investigation area during aerial surveys between February 2023 and January 2024. Harbour seal, grey seal and unidentified seal are summarised under the term seals.

Survey no.	Date	Effort [km²]	Harbour seal [Ind.]	Grey Seal [Ind.]	unidentified seal [Ind.]	Seals (total)	Harbour porpoises [Ind.]	unidentified marine mammal [Ind.]
1	27.02.23	431	1	0	9	10	5	2
2	04.04.23	417	1	5	10	16	9	0
3	22.06.23	421	23	0	4	27	34	0
4	16.08.23	340	1	0	0	1	12	0
5	18.10.23	415	41	0	2	43	10	1
6	23.12.23	445	0	0	3	3	4	4
	Total	**2,468**	**67**	**5**	**28**	**100**	**74**	**7**

Furthermore, passive acoustic monitoring with a total of 16 C-POD stations was carried out to determine the habitat usage of the area by harbour porpoises. On average, at least one harbour porpoise contact was recorded at each station on 90.9% of all survey days.

Details on harbour seals, grey seals and harbour porpoises in the pre-investigation area are described in the following sections.

5.1 SEALS

5.1.1 DIGITAL AERIAL SURVEYS

Out of the 100 seals that were observed during the digital aerial surveys, 72.0% could be identified to species level (Figure 5-2 and Table 5-1). These 72 seals were divided into 93.1% harbour seals (n=67) and 6.9% grey seals (n=5). In order to consider that 28.0% of the observed seals could not be identified to species level (n=28), all overserved seals will in the following be analysed together as seals when relevant.

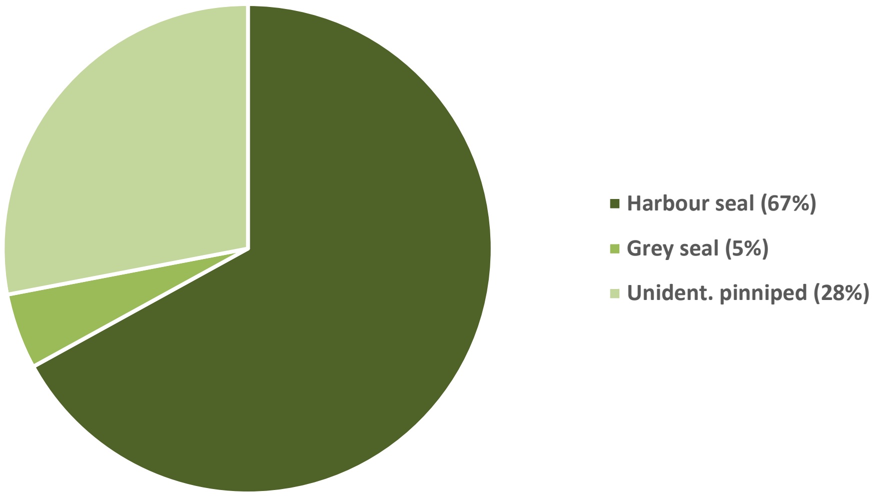

Figure 5-2. Proportion of harbour seal, grey seal and unidentified seals observations in the pre-investigation area during aerial surveys between February 2023 and January 2024.

SEASONAL DISTRIBUTION

While grey seals were only observed during the digital aerial survey on 04.04.23, harbour seals were observed during 5 out of 6 surveys (except December 2023). For the surveys in June, August, and October harbour seals were the most dominant species with more than 85% of all individuals belonging to this species. In contrast, during the aerial surveys in February and April 90% and 63% of the individuals were unidentified seals. In general, highest density for all seals combined was observed in autumn with 0.104 Ind./km² (October 2023; Table 5-2 and Figure 5-3). The two surveys in summer showed a high variability in densities; with the second highest density of 0.064 Ind./km² in June 2023 and the lowest density of 0.003 Ind./km² in August 2023. Densities in winter (February 2023) and spring (April 2023) were in the same order of magnitude with densities between 0.02 Ind./km² and 0.04 Ind./km², while the December survey showed similar numbers as in August 2023.

Table 5-2. Seal densities in the pre-investigation area during aerial surveys between February 2023 and January 2024. Harbour seal, grey seal and unidentified seal. All observed seals are summarised under the term seals.

Survey no.	Date	Effort [km²]	Harbour seal [Ind./km²]	Grey Seal [Ind./km²]	unidentified seal [Ind./km²]	Seals [Ind./km²]
1	27.02.23	431	0.002	0	0.021	0.023
2	04.04.23	417	0.002	0.012	0.024	0.038
3	22.06.23	421	0.055	0	0.010	0.064
4	16.08.23	340	0.003	0	0	0.003
5	18.10.23	415	0.099	0	0.005	0.104
6	23.12.23	445	0	0	3	3
	Total	**2,468**	**0.027**	**0.002**	**0.011**	**0.041**

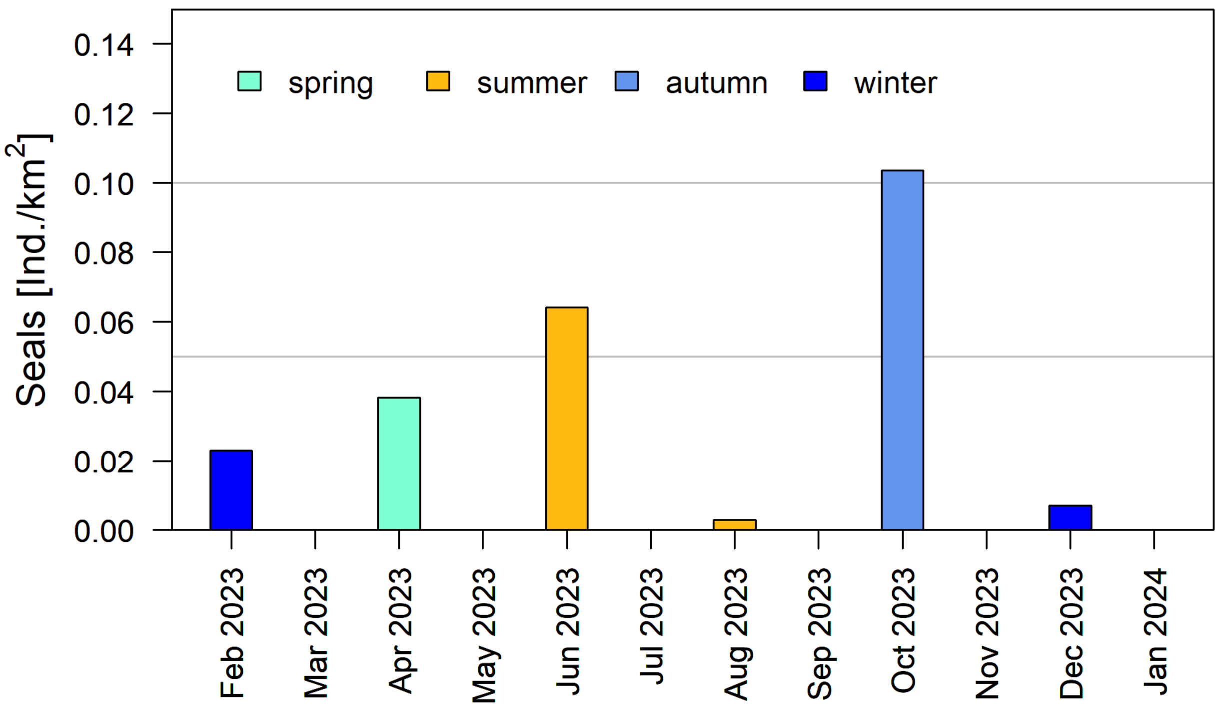

Figure 5-3. Mean seal density (Ind./km²) per month (harbour seal, grey seal and unidentified seals) in the study period (February 2023 – January 2024). In months without a bar, no surveys were carried out. The seasons are colour coded.

SPATIAL DISTRIBUTION

Most seals were observed in the northern part of the pre-investigation area throughout the year. With 89.0% of all sightings within one of the two Swedish Sites of Community Importance (SCI) under the Natura 2000 Habitats Directive *Falsterbohalvön* (SE0430095) and *Sydvästskånes utsjövatten* (SE0430187); in which both harbour seal and grey seal are listed as important species. Only 9 individual sightings occurred in the western or southern part of the pre-investigation area (Figure 5-4 and in the Appendix Figure 9-1). While most observations consisted of individual sightings, two groups of 41 and 17 harbour seals were observed at the Måkläppen/Falsterbo area during the survey on 18.10.2023 and 22.06.2023, respectively. Therefore, densities above 4 Ind./km² were observed in the respective grid cell in summer and autumn, while densities were below 1 Ind./km² in all other grid cells (Figure 5-4).

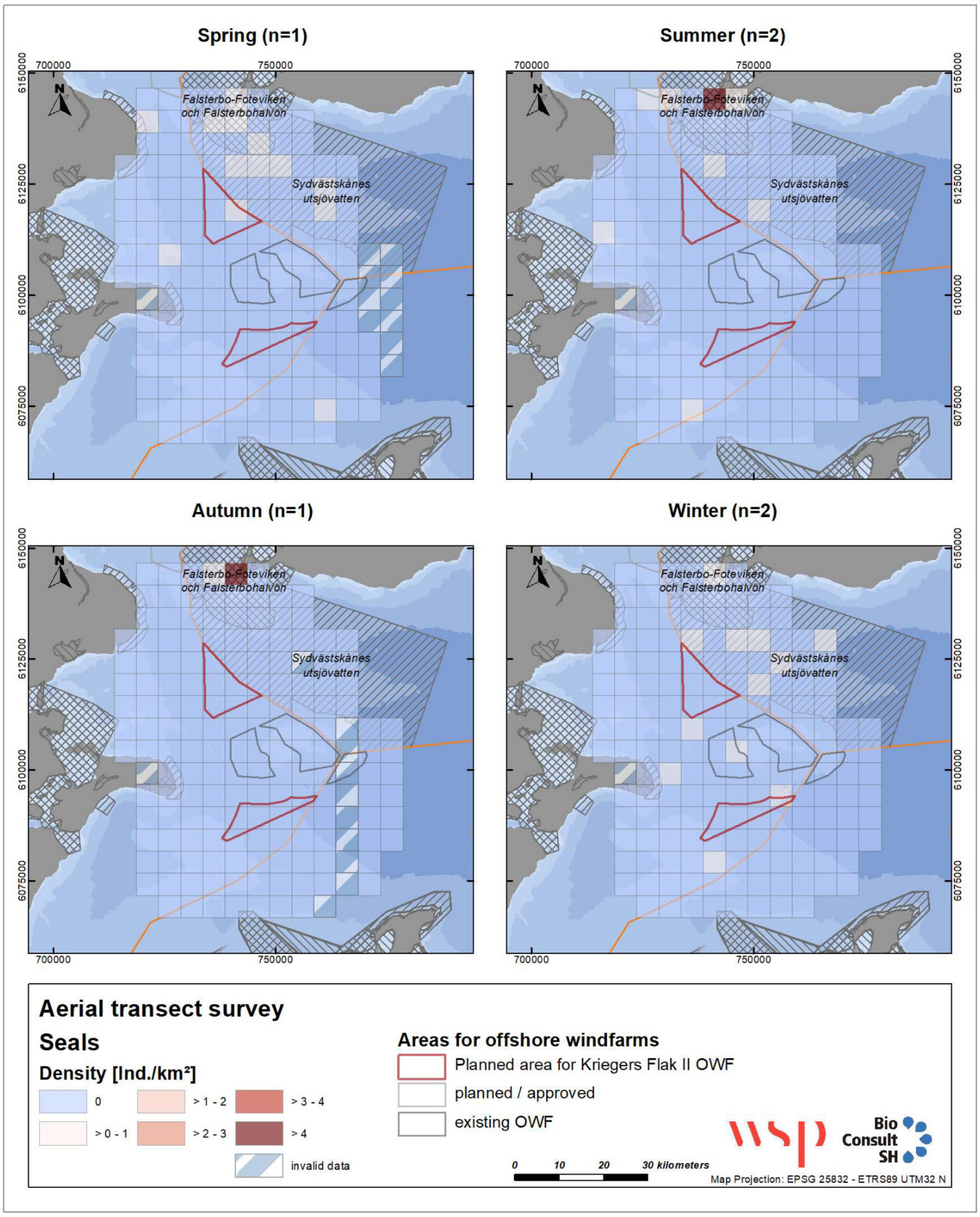

Figure 5-4. Spatial distribution of seals during digital aerial surveys between February 2023 and January 2024. The number (n) of digital aerial surveys taken into account to calculate seasonal densities is given in the title of the respective panel.

5.1.2 SEAL COUNTINGS AT HAUL-OUT SITES

HARBOUR SEALS

Within the Kattegat and southwestern Baltic area eight haul-out sites are taken into account in the analysis for harbour seals (Figure 5-6). Four of the eight haul-out sites contribute with about 90% of all harbour seals counted during the different monitoring programs. The haul-out site at Hesselø was the most important haul-out site for harbour seals with about 42% of all counted seals between 2013 and 2023, followed by Anholt (27%), Bosserne (12%) and Hallands Väderö (9%). The haul-out sites Måkläppen (5%), Saltholm (3%)

as well as Sjællands Rev (0.8%), Bøgestrøm (0.8%) and Rødsand (0.1%) were much less frequent visited by harbour seals (Figure 5-5). Out of these haul-out sites only Måkläppen and Bøgestrøm, which account to approximately 5% of harbour seals in the Kattegat/Western Baltic area, are within the regular foraging distance to the planned windfarm areas. However, exchange to some extent between haul-out sites is possible and not totally understood. Therefore, a general overview of the wider population area is important.

Figure 5-5. Composition (percentage of total counted individuals) of the harbour seal haul-out sites to the abundance in the Kattegat and southwestern Baltic area between 2013 and 2023.

Counts of harbour seals at the different haul-out sites in the years 2013, 2018 and 2023 show a similar distribution of harbour seals counted at the different haul-out sites despite the interannual variation (Figure 5-6).

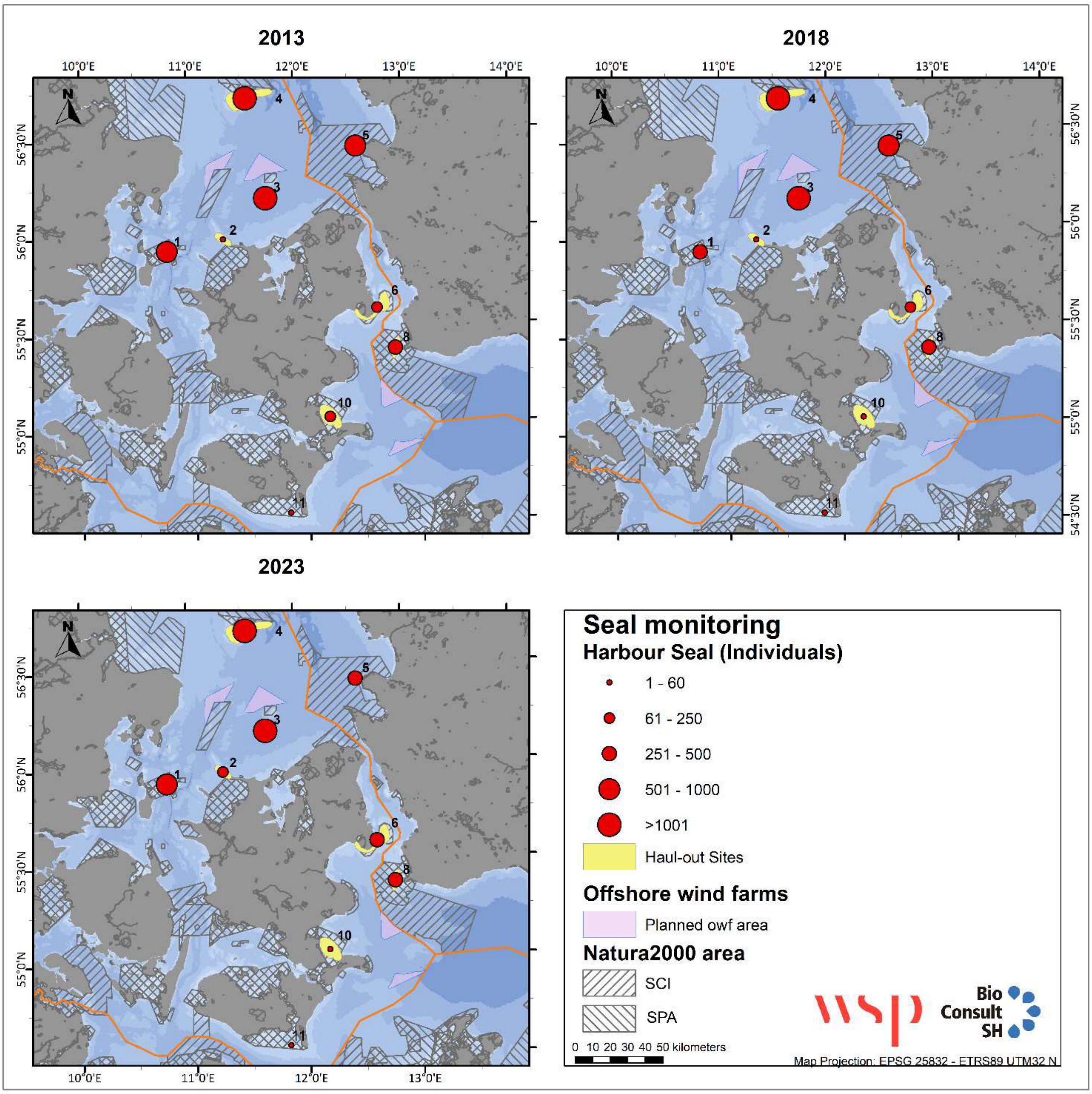

Figure 5-6. Counts of harbour seals at haul-out sites in the Kattegat and southwestern Baltic area between in 2013, 2018 and 2023.

The abundance at the 8 haul-out sites has overall decreased over the last 10 years, with about 9,600 harbour seals in 2013 to about 5,900 harbour seals in 2023 (Figure 5-7). However, especially in the last 6 years, there has been also a high interannual variability within the data. In 2013 Anholt was the haul-out site with the highest counts of harbour seals whereas most harbour seals have been counted at the haul-out site at Hesselø since 2014 with Anholt having second most of the counts until 2023. The other haul-out sites showed an even higher variability with counts below 1,500 individuals.

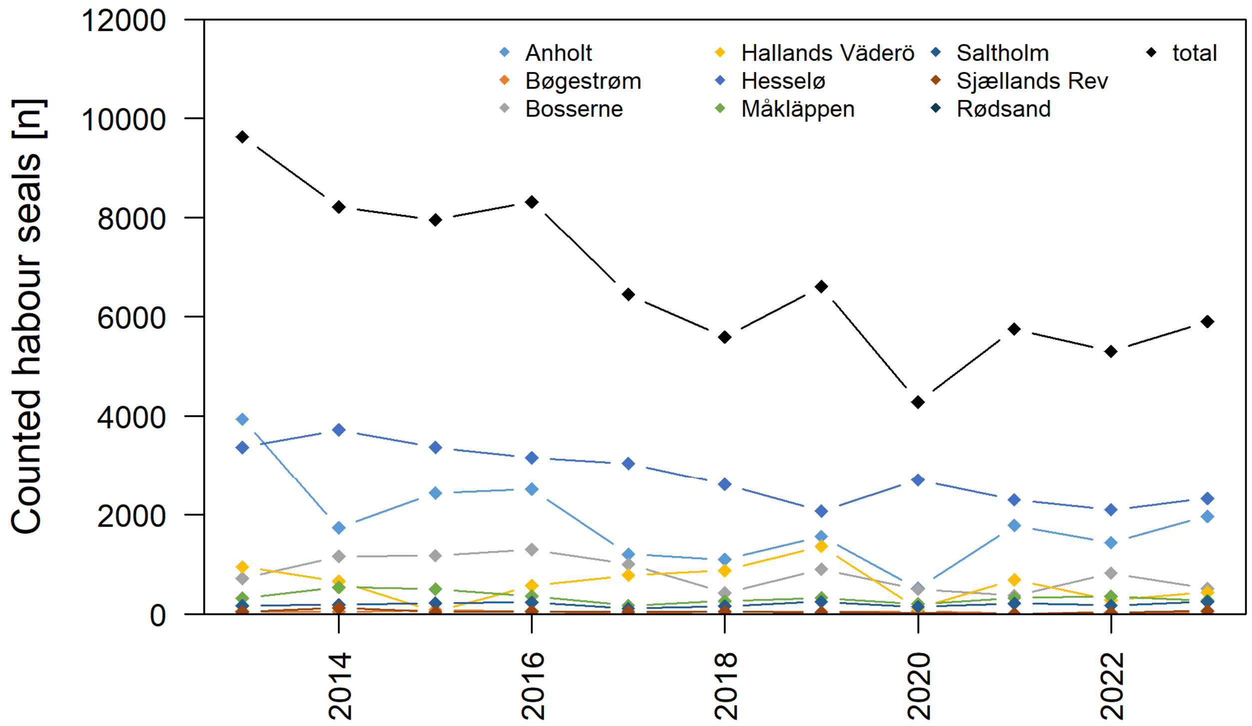

Figure 5-7. Development of the harbour seal abundance at certain haul-out sites in the Kattegat and southwestern Baltic area between 2013 and 2023.

GREY SEALS

Within the Kattegat and southwestern Baltic area four haul-out sites are taken into account in the analysis for grey seals, of which the vast majority of grey seals reside on one of the haul-out sites. Måkläppen contributed to about 93% of all grey seals counted during the different monitoring programs (Figure 5-8). The other 4 haul-out sites, Anholt, Hesselø, Bosserne and Rødsand contributed to about 1%-3% (Figure 5-9).

The abundance at the four haul-out sites has increased over the last 10 years, with about 572 grey seals in 2013 to about 3,500 grey seals in 2023 (Figure 5-10). The highest count was achieved in 2022, with about 7,200 individuals. However, there has been a high interannual variability within the data in relation to the haul-out site at Måkläppen. All other haul-out sites have not influenced the overall grey seal abundance.

Counts of grey seals at the different haul-out sites in the years 2013, 2018 and 2023 show that the distribution of grey seals was spread wider over different haul-out sites over the years (Figure 5-8). Out of these haul-out sites only Måkläppen, which is the most important grey seals haul-out site in the Kattegat/Western Baltic area, are within regular foraging distance to the planned windfarm areas. Therefore, it is not only important for the Western Baltic, but also for a wider region.

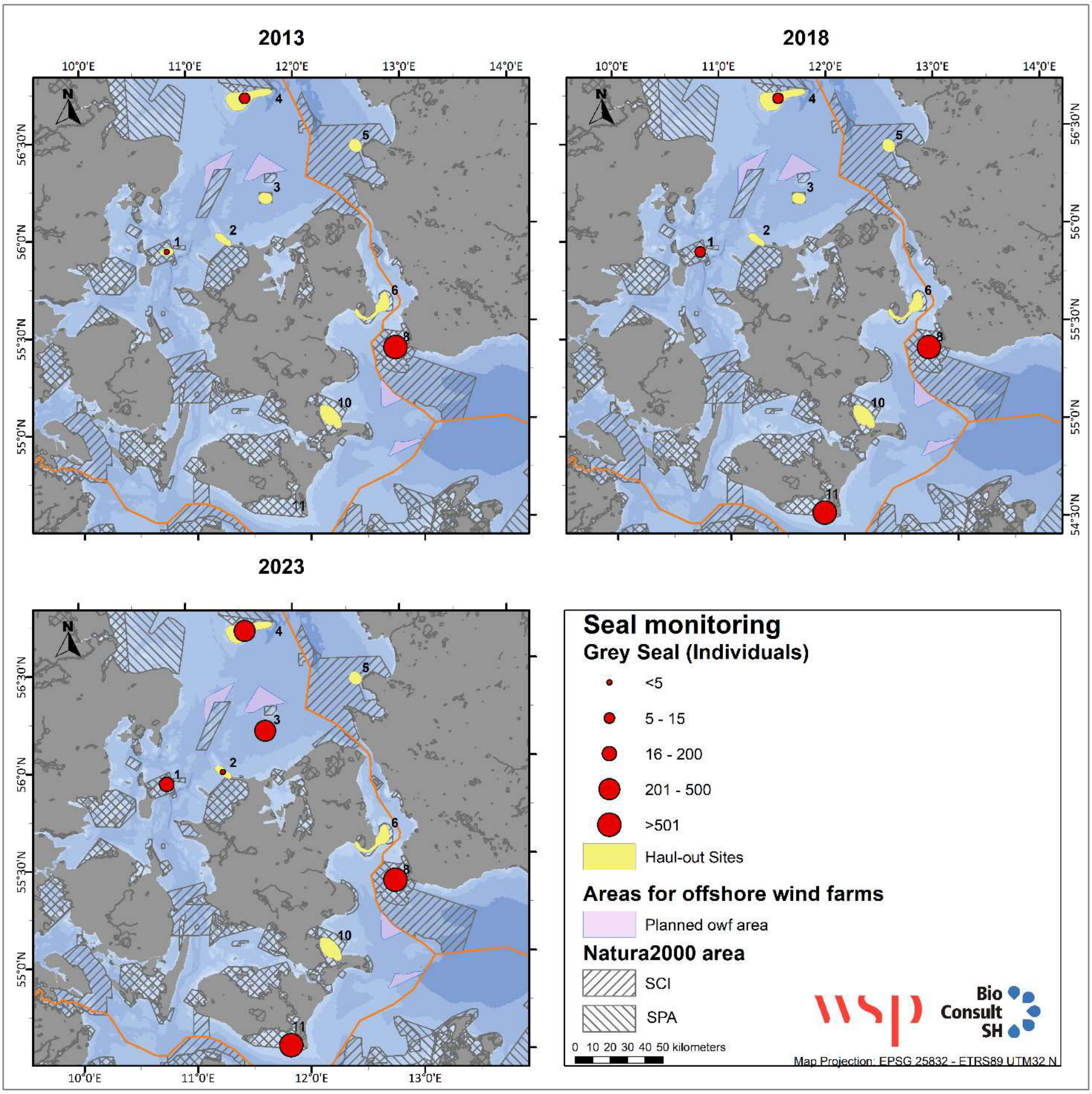

Figure 5-8. Counts of grey seals at haul-out sites in the Kattegat and southwestern Baltic area between in 2013, 2018 and 2023.

Figure 5-9. Composition (percentage of total counted individuals) of the grey seal haul-out sites to the abundance in the Kattegat and southwestern Baltic area between 2013 and 2023.

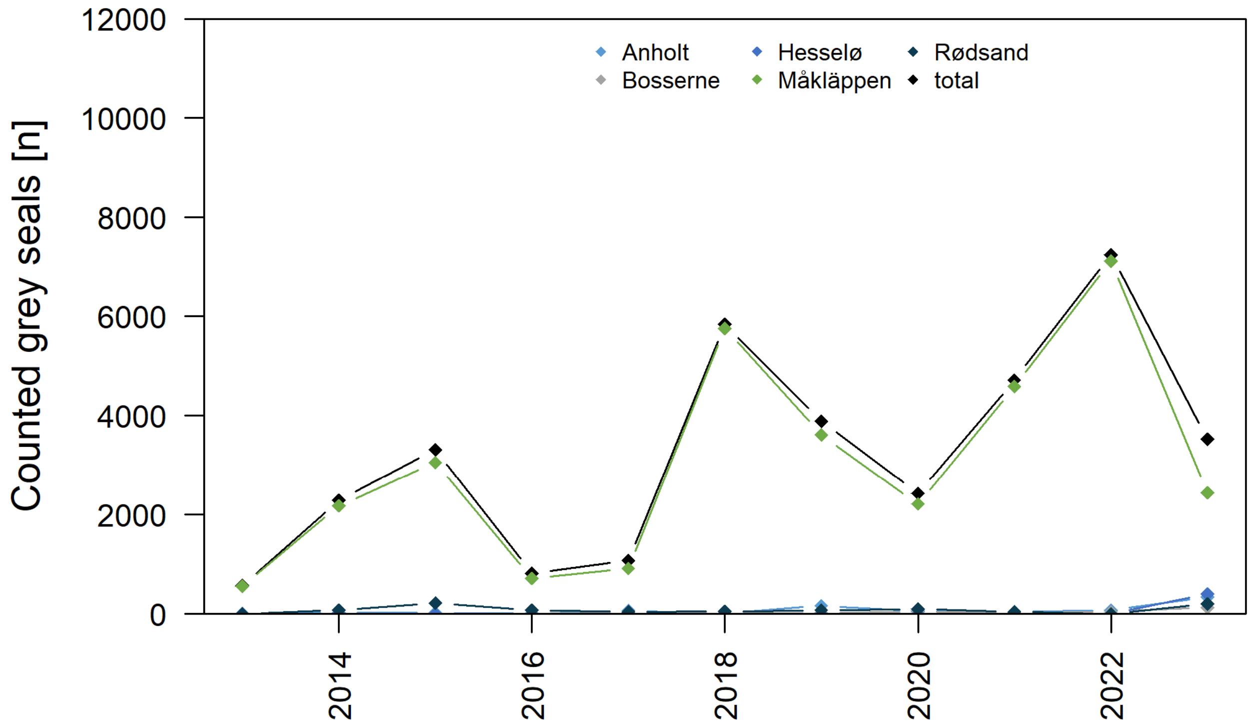

Figure 5-10. Development of the grey seal abundance at certain haul-out sites in the Kattegat and southwestern Baltic area between 2013 and 2023.

5.2 HARBOUR PORPOISES

The harbour porpoise was with 74 individual sightings the most abundant marine mammal species during the 6 digital aerial surveys between February 2023 and January 2024. Detection rates were relatively high, ranging from 75.7%DPD/t to 98.9%DPD/t among stations, with a mean value of 90.9%DPD/t across all stations.

5.2.1 DIGITAL AERIAL SURVEYS

SEASONAL DISTRIBUTION

Harbour porpoises were observed during all 6 surveys. The highest densities were observed in the summer, with 0.146 Ind./km² and 0.068 Ind./km² for June and August (Table 5-3 and Figure 5-11). The density during the autumn survey (October 2023) was in the same order of magnitude compared to the August survey, while the winter (February and December 2023) and spring (April 2023) surveys observed densities about half as high or lower. Two aerial surveys were conducted during the calving period from mid-May until September. During one of these surveys (June 2023) 2 juveniles were observed, which results in a proportion of juveniles of 4.3% during the summer (Table 5-3 and Figure 5-12).

Table 5-3. Harbour porpoise densities in the pre-investigation area during aerial surveys between February 2023 and January 2024.

Survey no.	Date	Effort [km²]	Harbour porpoise [Ind.]	Juveniles [Ind.]	Harbour porpoise [Ind./km²]
1	27.02.23	431	5	0	0.027
2	04.04.23	417	9	0	0.035
3	22.06.23	421	34	2	0.146
4	16.08.23	340	12	0	0.068
5	18.10.23	415	10	0	0.053
6	23.12.23	445	4	0	0.018
	Total	**2,468**	**74**	**2**	**0.057**

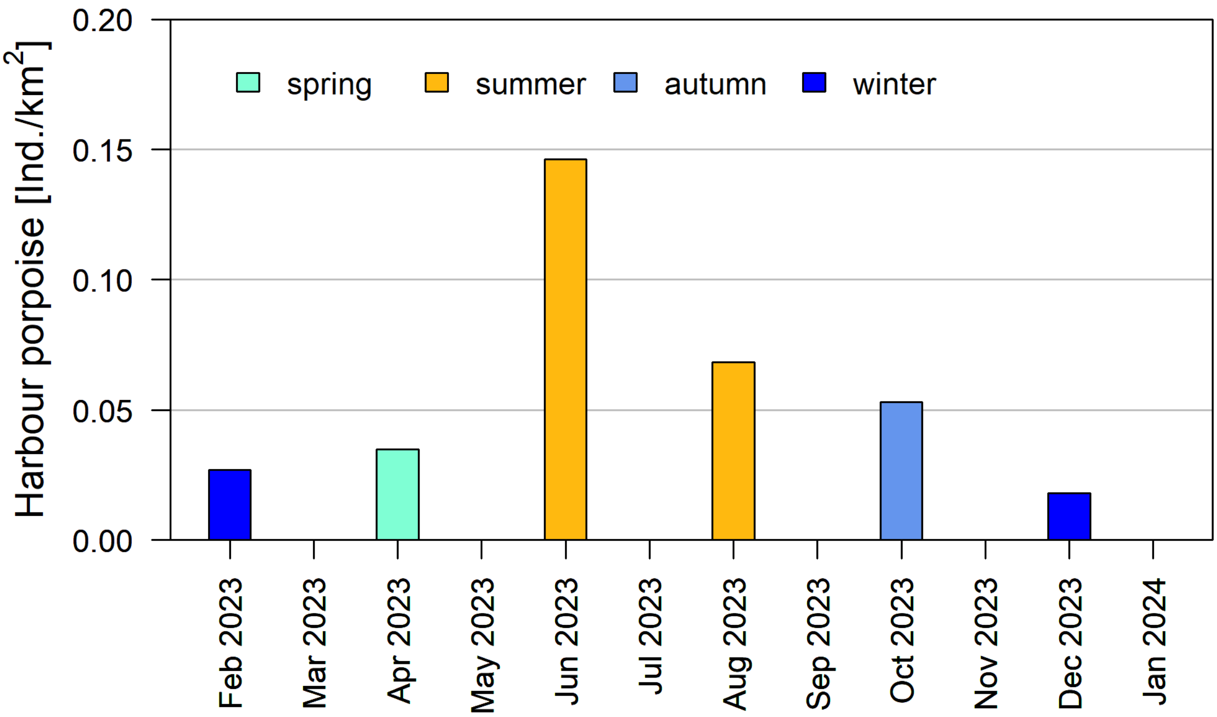

Figure 5-11. Mean harbour porpoises' density (Ind./km²) per month in the study period (February 2023 – January 2024). In months without a bar, no surveys were carried out. The seasons are colour coded.

SPATIAL DISTRIBUTION

Harbour porpoises were distributed all over the pre-investigation area with no clear preference. However, most sightings occurred in the central part of the pre-investigation area in the north-south direction in the vicinity of the operational Kriegers Flak windfarm area and in the central to western part of the pre-investigation area in the west-east direction, around Møn (Figure 5-12, Figure 5-13 and in the Appendix). This was in particular true for summer observations. Most harbour porpoises were more widely distributed in the pre-investigation area for the summer counts. In contrast to the distribution of seals, 83.8% of all sightings were observed outside the two Swedish Sites of Community Importance (SCI) under the Natura 2000 Habitats Directive including the areas *Falsterbohalvön* (SE0430095) and *Sydvästskånes utsjövatten* (SE0430187). In total only 9 harbour porposies were observed in *Sydvästskånes utsjövatten* (SE0430187), where harbour porpoises are listed as important species.

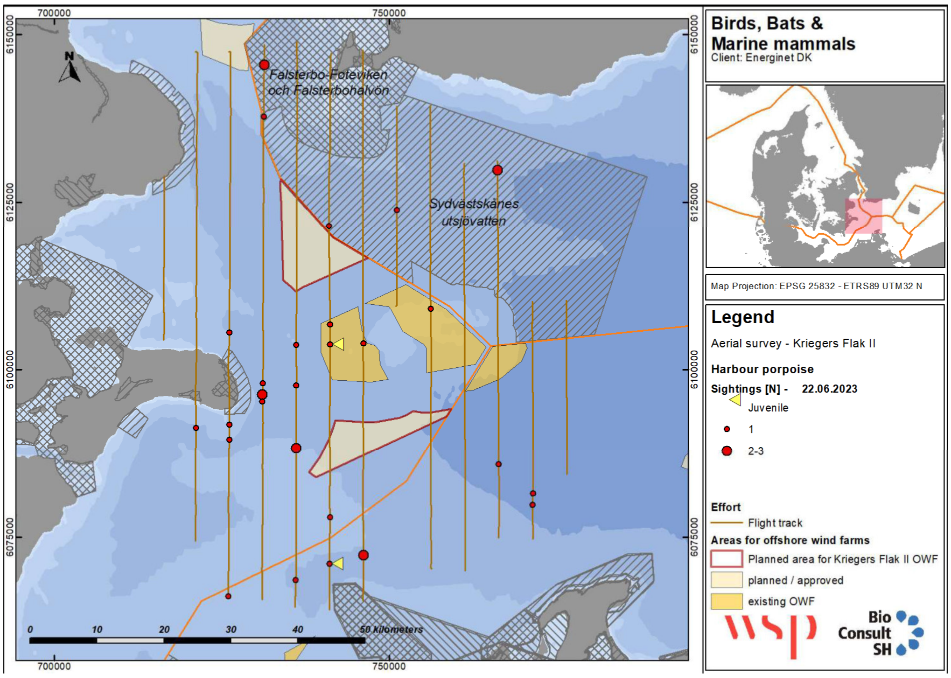

Figure 5-12. Harbour porpoise observations in the pre-investigation area during the digital aerial survey on 22.06.2023.

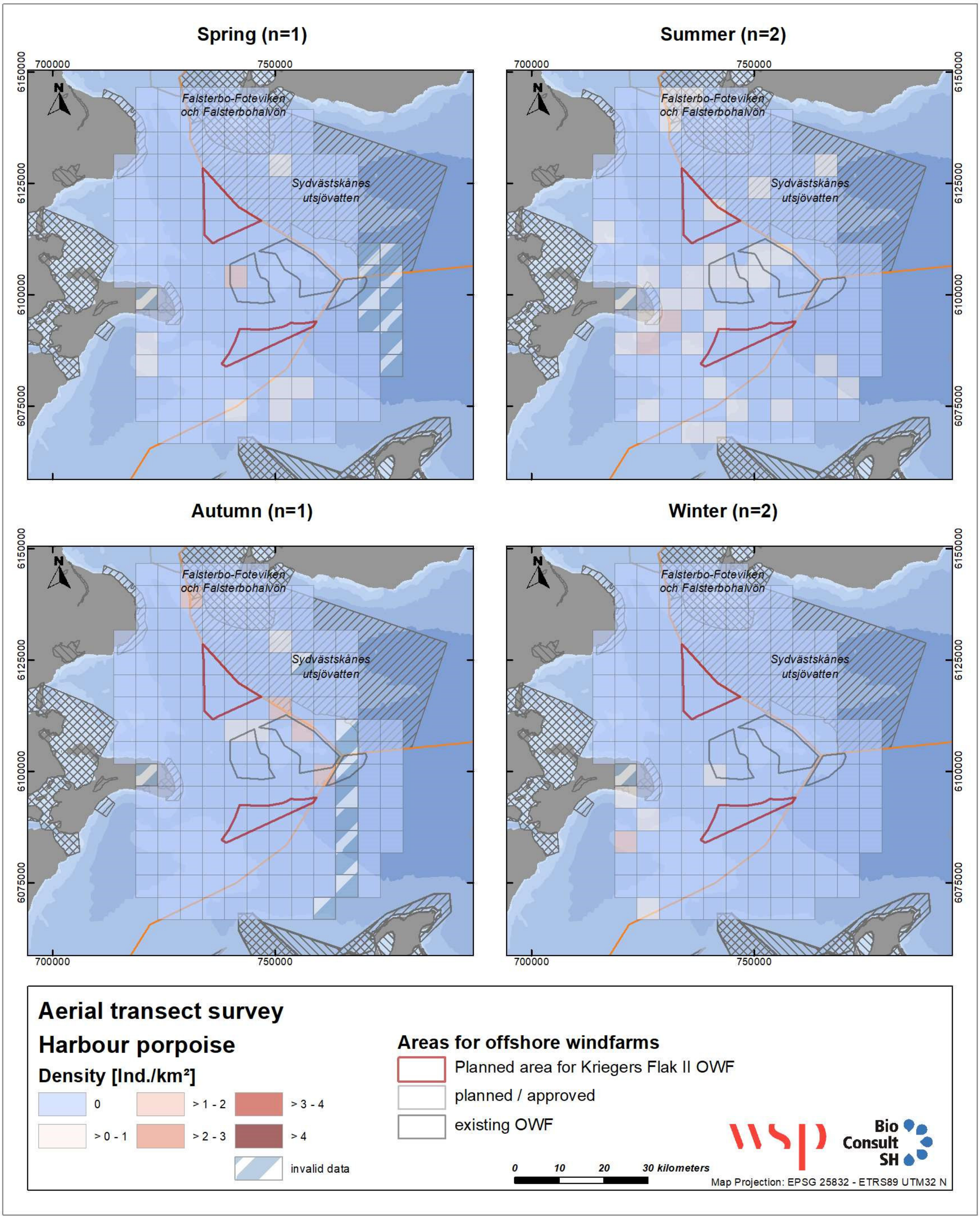

Figure 5-13. Spatial distribution of harbour porpoises during digital aerial surveys between February 2023 and January 2024. The number (n) of digital aerial surveys taken into account to calculate seasonal densities is given in the title of the respective panel.

5.2.2 PASSIVE ACOUSTIC MONITORING

PHENOLOGY/ SEASONALITY

During the survey period (February 2023 – January 2024), harbour porpoises were detected almost daily at all 16 C-POD stations. Detection rates (expressed as %DPD/t) were relatively high, ranging from 75.7% at station F-R4 to 98.9% at station F-O7, with a mean value of 90.9% across all stations (Figure 5-14 and Table 5-4). This suggests that harbour porpoises are generally present all year-round within the pre-investigation area.

Mean Detection Positive 10-Minutes per day (%DP10M/d), showed detection rates on a daily scale at a very fine temporal resolution of 10-minutes block per day, varied between stations. Therefore, the pre-investigation area showed a heterogenous spatial distribution of harbour porpoise presence, which may be driven by habitat preference (Figure 5-15 and Table 5-4). Mean %DP10M/d was highest at station F-O8 (24.1%), followed by station F-O7 (19.2%) and lowest at both stations F-R3 and F-R4 (3.8%). In general, most of the stations with relatively higher %DP10M/d were located towards the north, closer to KF II N, while most of those located towards the south, closer to KF II S, had relatively lower %DP10M/d (Figure 5-15).

Table 5-4. Harbour porpoise detection rates at different temporal resolution, Detection Positive Days over the entire survey period (DPD/t) and mean Detection Positive 10-Minutes per day (DP10M/d), at the 16 C-POD stations deployed within the pre-investigation area. %DPD/t and mean %DP10M/d were calculated over all available recording days. t refers to the entire survey period (February 2023 to January 2024). d refers to a day.

C-POD	Days with positive detections	Days deployed	DPD/t [%]	DP10M/d [%]
F-O1	275	343	80.2	11.1
F-O2	298	342	87.1	12.0
F-O3	307	340	90.3	13.5
F-O4	322	345	93.3	18.5
F-O5	334	342	97.7	10.1
F-O6	332	342	97.1	12.4
F-O7	345	349	98.9	19.2
F-O8	285	290	98.3	24.1
F-R1	295	352	83.8	9.9
F-R2	299	352	84.9	9.4
F-R3	265	345	76.8	3.8
F-R4	221	292	75.7	3.8
F-R5	336	344	97.7	9.0
F-R6	332	337	98.5	12.0
F-R7	336	352	95.5	16.6
F-R8	345	352	98.0	11.6

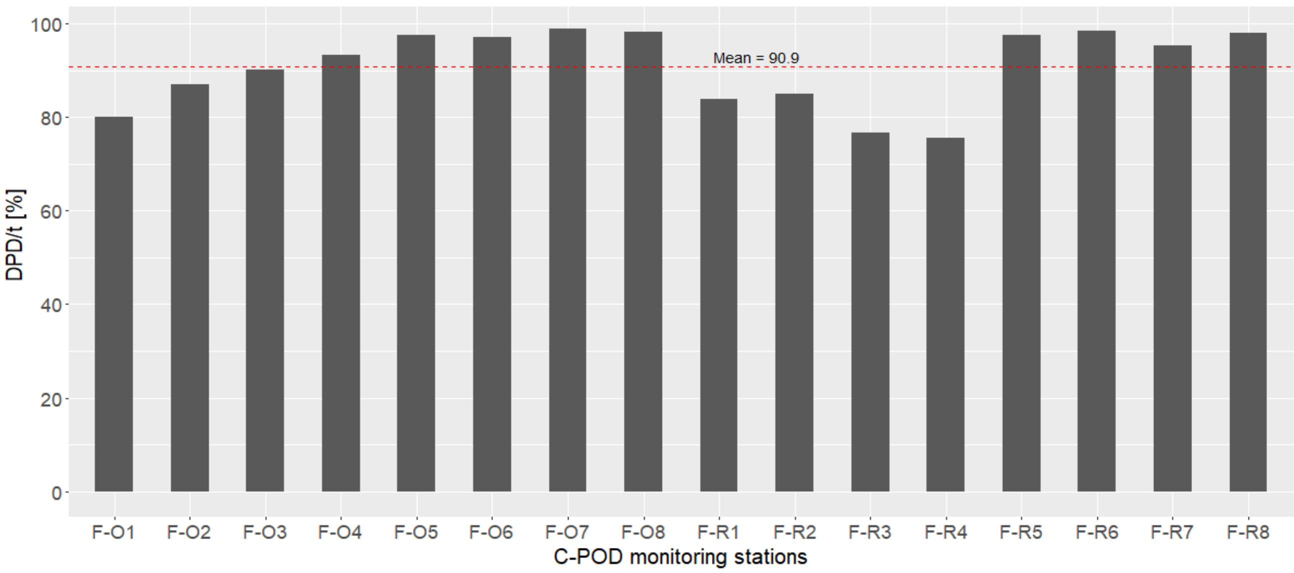

Figure 5-14. The proportion of days with positive harbour porpoise detections over the entire survey period (February 2023 – January 2024), expressed as Detection Positive Days (DPD/t), at the 16 C-POD stations deployed within the pre-investigation area. The red dashed line shows the mean value across all stations.

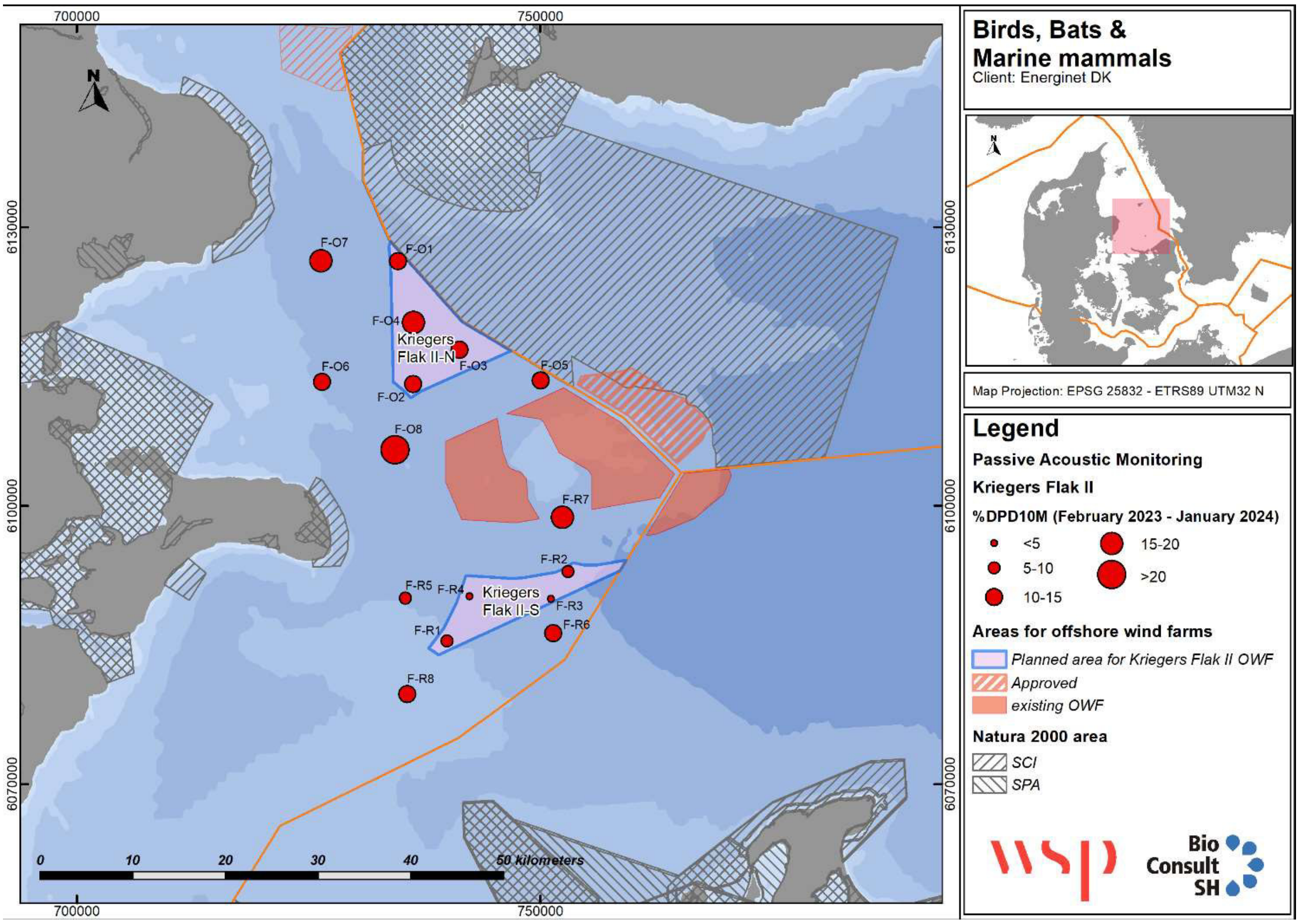

Figure 5-15. Harbour porpoise detection rates, expressed as mean Detection Positive 10-Minutes per day (%DP10M/d), at the 16 C-POD stations deployed within the investigation area for the entire survey period (February 2023 – January 2024).

Monthly mean %DP10M/d (averaged over all 16 stations) showed the temporal variation (seasonal trend) in harbour porpoise presence within the entire pre-investigation area across the survey period (Figure 5-16). In general, detection rates in the winter months (December – February) were much lower compared to spring (March – May), summer (June – August) and autumn (September – October). A bimodal pattern can be observed, with a first peak in detection rates occurring either in spring or early summer and a second peak in autumn. The timing and magnitude of both the spring/summer peak and autumn peak differ slightly between C-POD stations (Figure 5-17 - Figure 5-24). Additionally, stations that were located close together showed similar phenology. At stations F-O1 and F-O2, for example, a small peak in detection rates can be observed in late spring/early summer (May and June 2023, respectively) with a second stronger peak in autumn (October and November 2023, respectively; Figure 5-17). A similar pattern can be seen at stations F-O7 and F-O8, but both the spring/summer and autumn peaks were similar in magnitude and were much stronger than that of other stations (Figure 5-20). In contrast, there were no apparent seasonal variation at stations F-R3 and F-R4 where detection rates were constantly low throughout most of the survey period (Figure 5-22).

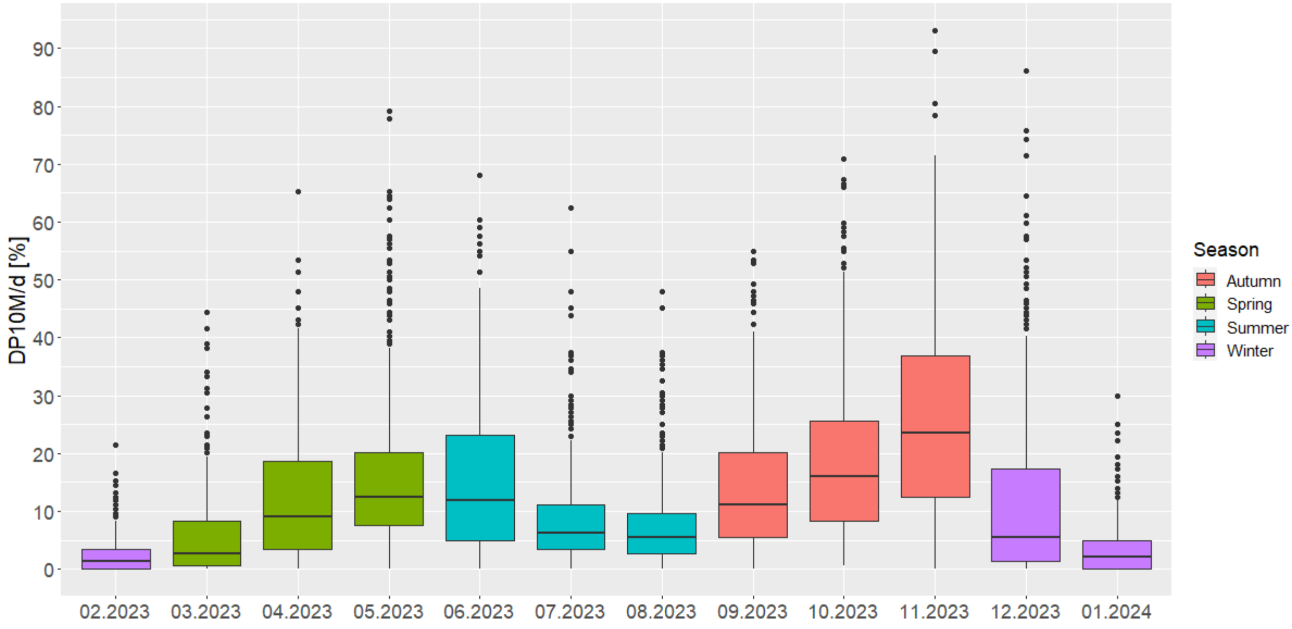

Figure 5-16. Mean monthly Detection Positive 10-Minutes per day (% DP10M/d) averaged over all 16 C-POD stations.

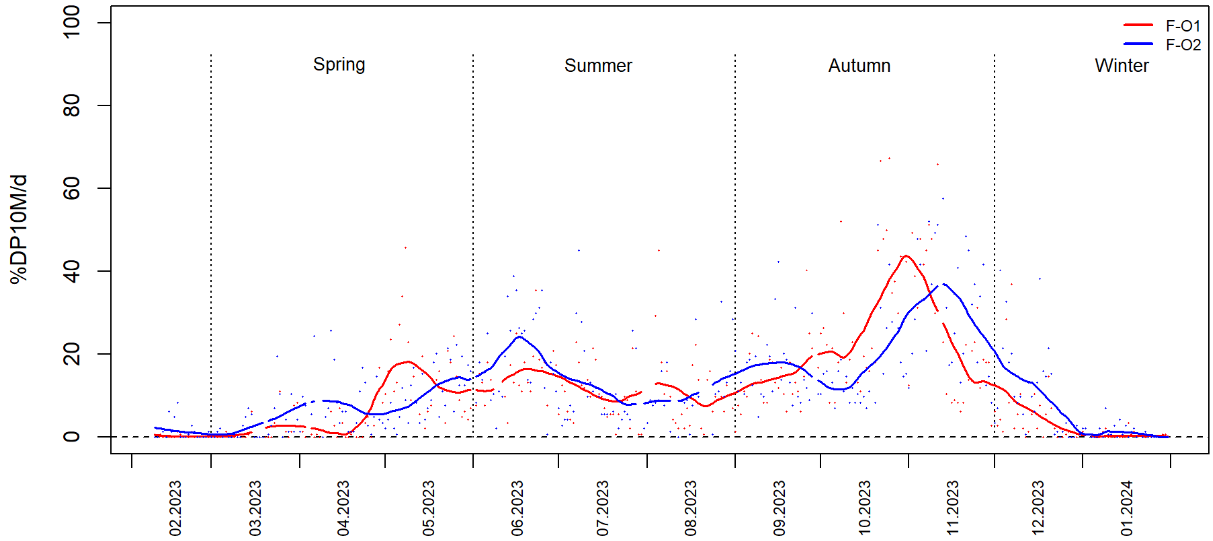

Figure 5-17. Phenology of Detection Positive 10-Minutes per day (%DP10M/d) at stations F-O1 and F-O2 across the entire survey period (February 2023 – January 2024). Gaps in the loess regression curves represent periods with no data.

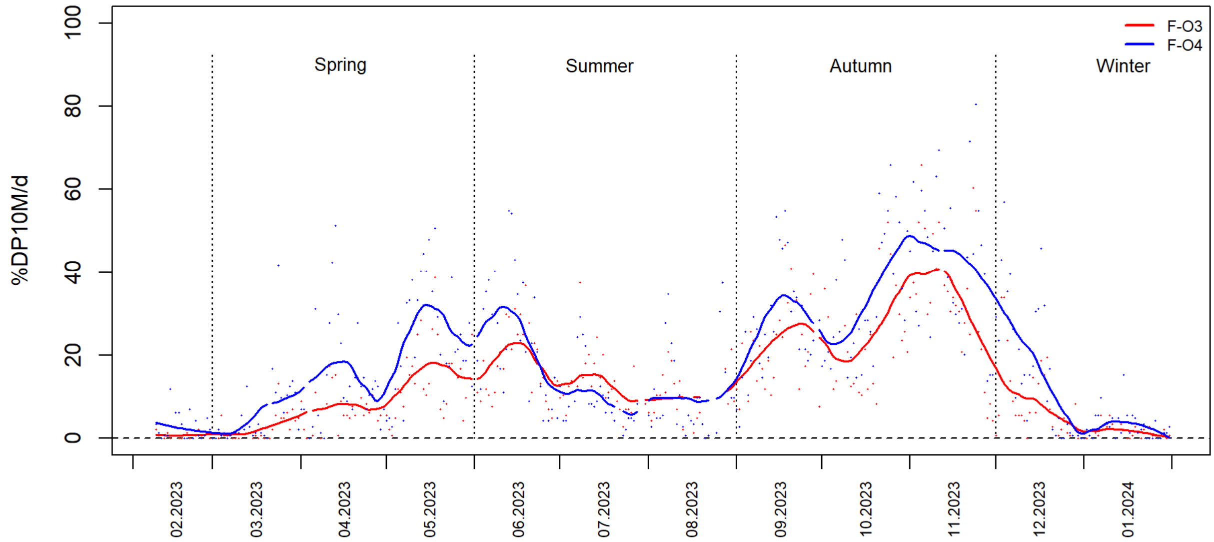

Figure 5-18. Phenology of Detection Positive 10-Minutes per day (%DP10M/d) at stations F-O3 and F-O4 across the entire survey period (February 2023 – January 2024). Gaps in the loess regression curves represent periods with no data.

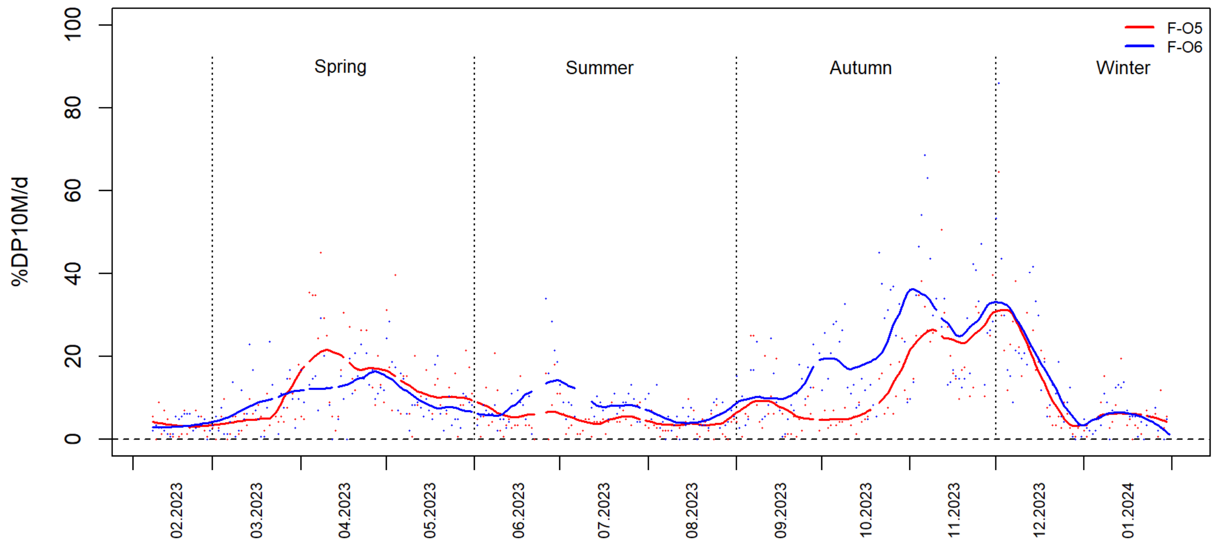

Figure 5-19. Phenology of Detection Positive 10-Minutes per day (%DP10M/d) at stations F-O5 and F-O6 across the entire survey period (February 2023 – January 2024). Gaps in the loess regression curves represent periods with no data.

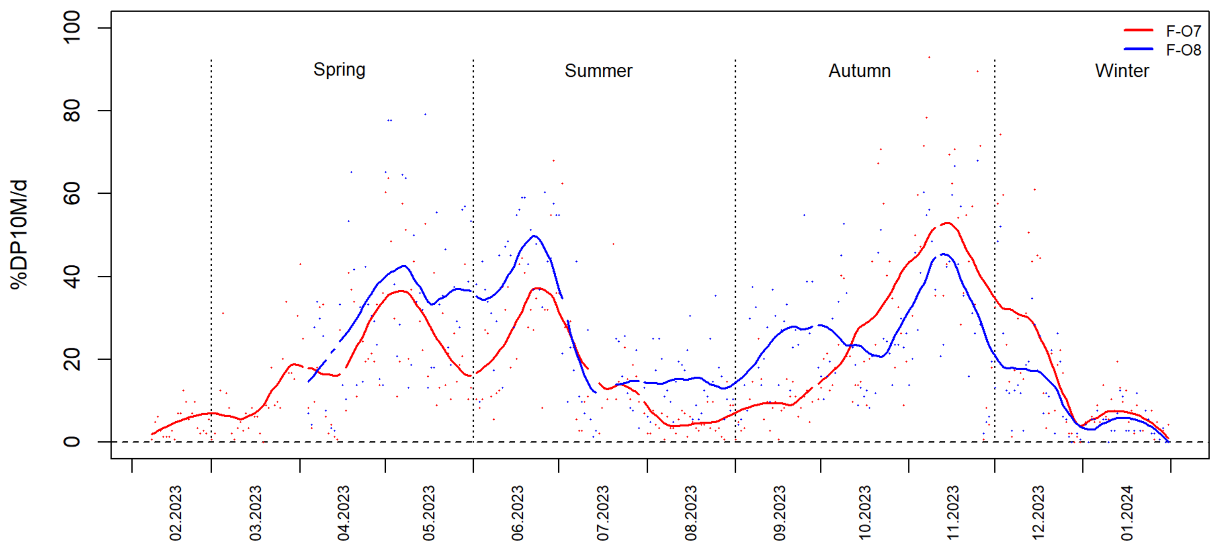

Figure 5-20. Phenology of Detection Positive 10-Minutes per day (%DP10M/d) at stations F-O7 and F-O8 across the entire survey period (February 2023 – January 2024). Gaps in the loess regression curves represent periods with no data (e.g. F-O8 in spring 2023).

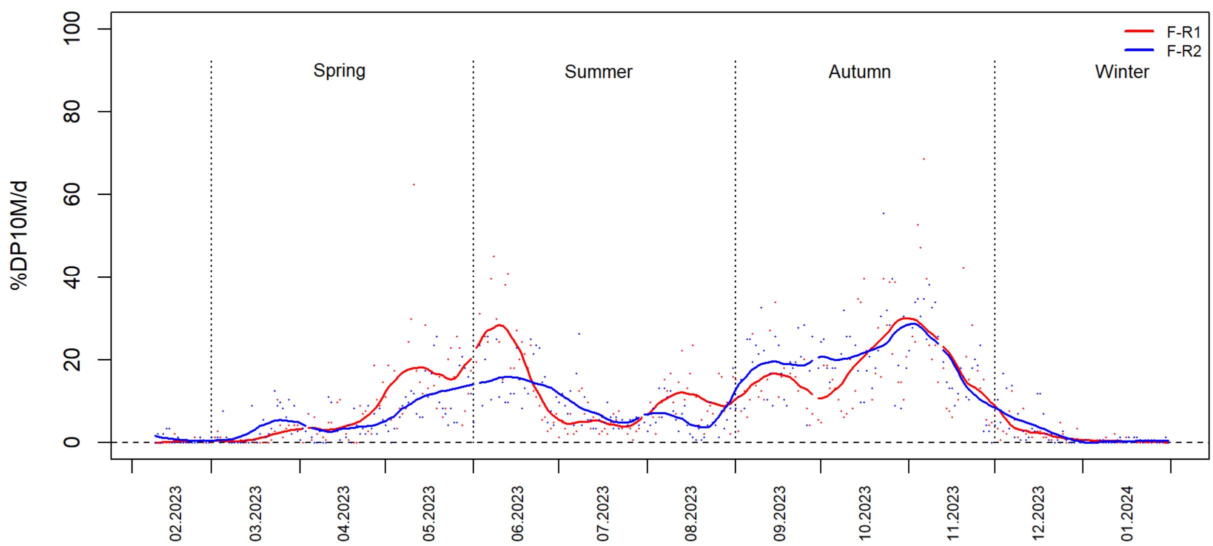

Figure 5-21. Phenology of Detection Positive 10-Minutes per day (%DP10M/d) at stations F-R1 and F-R2 across the entire survey period (February 2023 – January 2024). Gaps in the loess regression curves represent periods with no data.

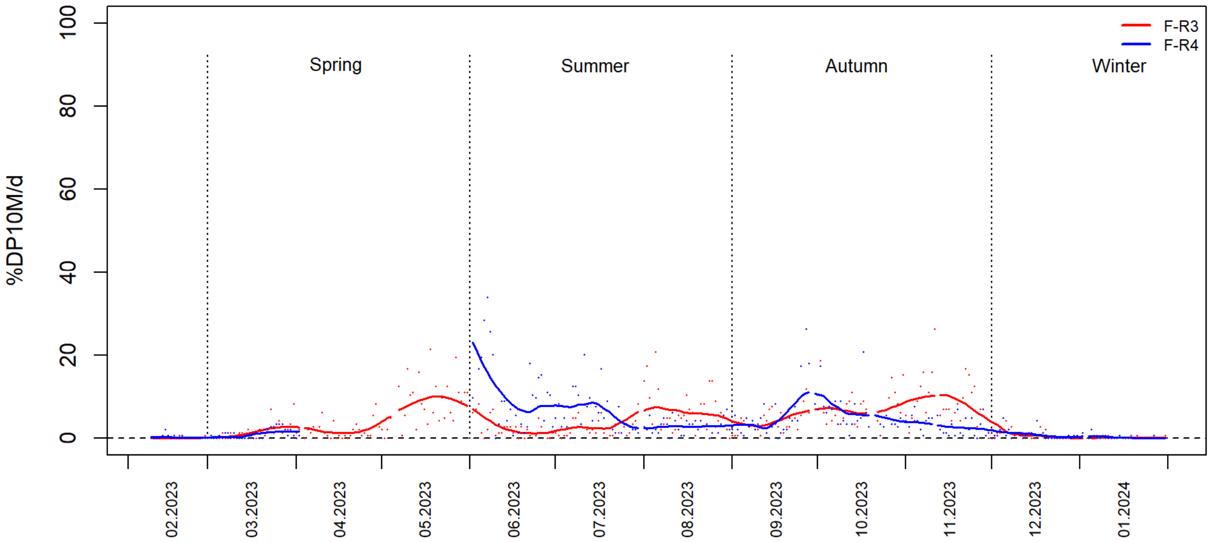

Figure 5-22. Phenology of Detection Positive 10-Minutes per day (%DP10M/d) at stations F-R3 and F-R4 across the entire survey period (February 2023 – January 2024). Gaps in the loess regression curves represent periods with no data (e.g. F-R4 in spring 2023).

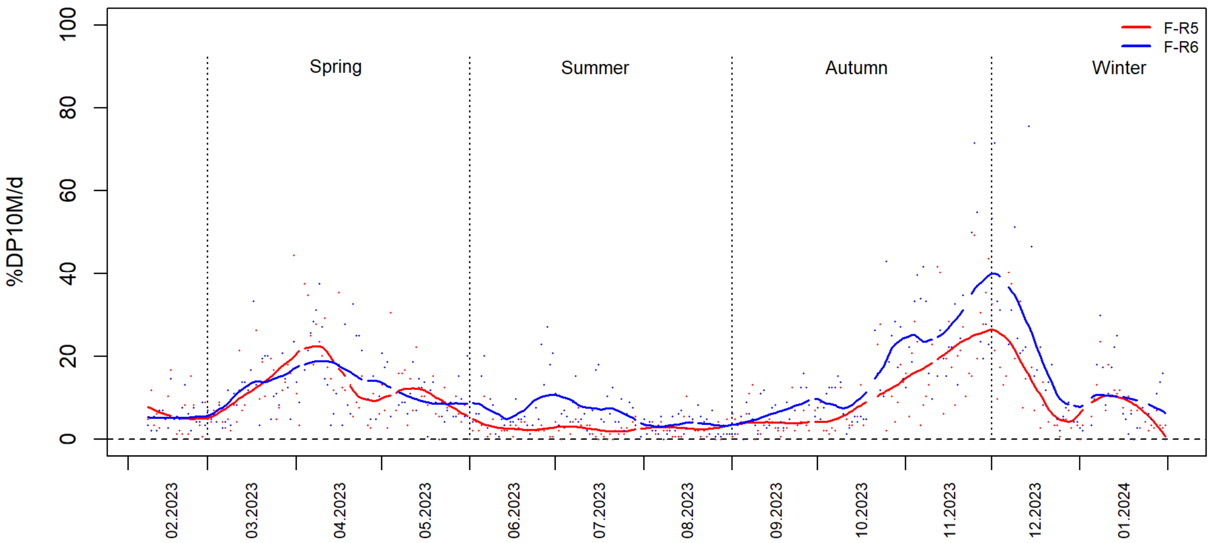

Figure 5-23. Phenology of Detection Positive 10-Minutes per day (%DP10M/d) at stations F-R5 and F-R6 across the entire survey period (February 2023 – January 2024). Gaps in the loess regression curves represent periods with no data.

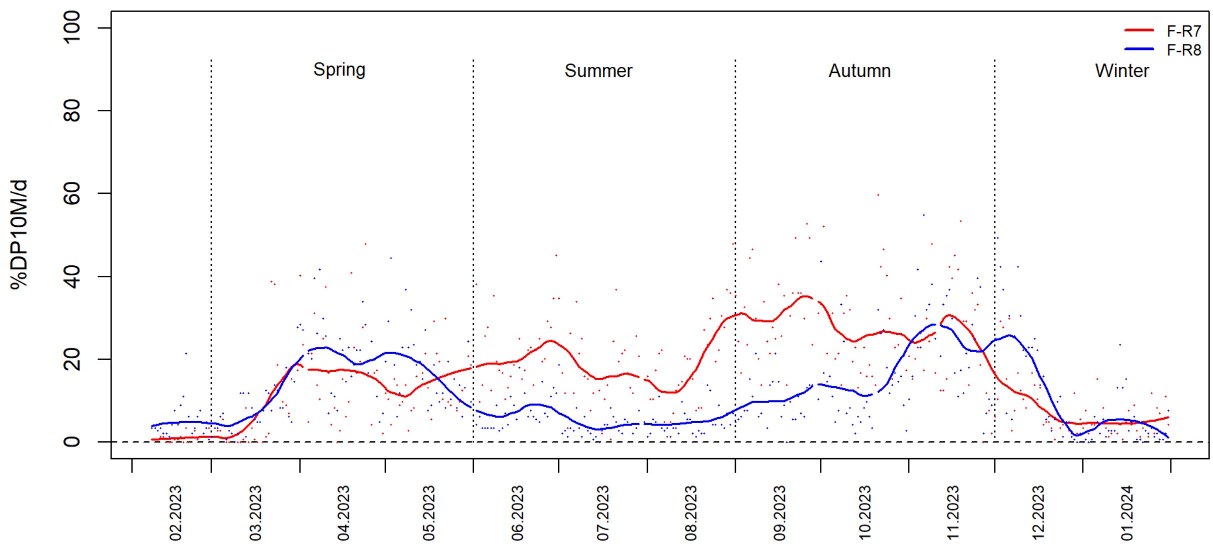

Figure 5-24. Phenology of Detection Positive 10-Minutes per day (%DP10M/d) at stations F-R7 and F-R8 across the entire survey period (February 2023 – January 2024). Gaps in the loess regression curves represent periods with no data.

Diel pattern analysis revealed differences in daylight and nighttime activity of harbour porpoises at each C-POD station (Figure 5-25). Harbour porpoises were detected more frequently during daylight hours at 6 stations (F-O4, F-O5, F-R3, F-R5, F-R6 and F-R8), while nighttime activity prevailed at the remaining 10 C-POD stations (F-O1, F-O2, F-O3, F-O6, F-O7, F-O8, F-R1, F-R2, F-R4 and F-R7).

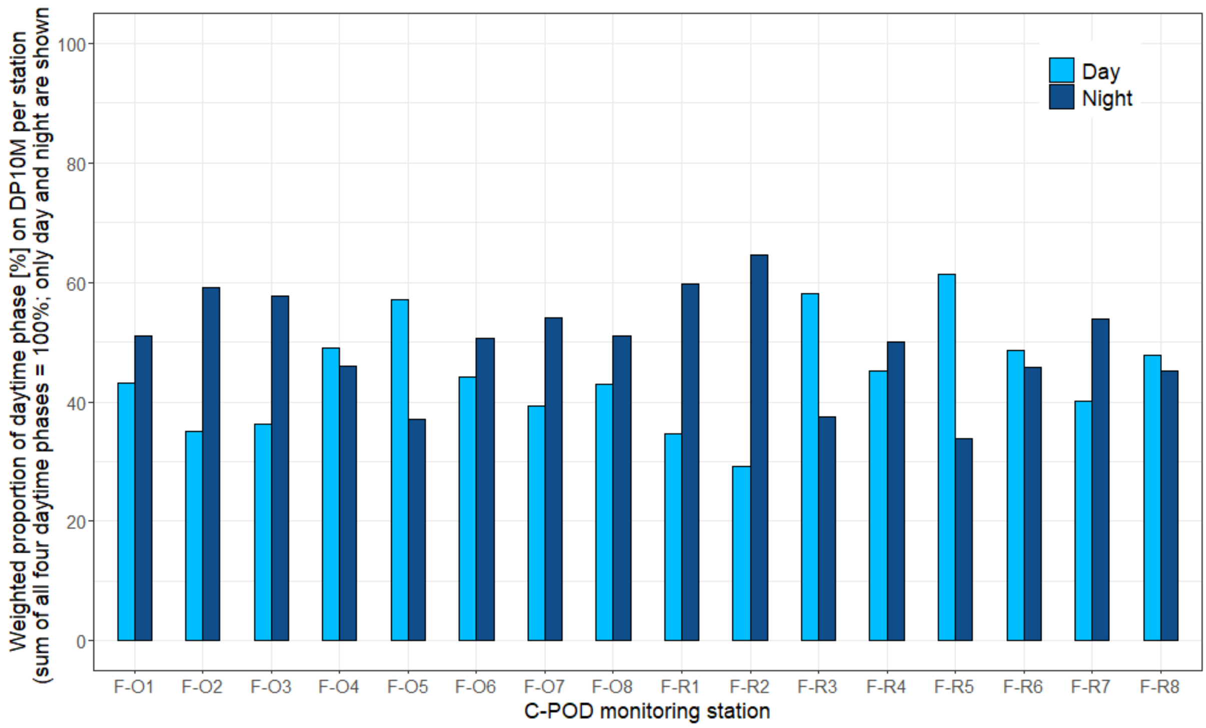

Figure 5-25. Diel pattern of harbour porpoise detection rates at the 16 C-POD stations deployed within the pre-investigation area. Each 24-hour period is divided into four phases (Day, Night, Dusk, Dawn) during analysis. Only Day and Night phases are shown (Dusk and Dawn phases are not considered). A weighing

factor based on daylength proportion is applied due to different lengths of phases at different dates throughout the year. Sum of all phases equals to 100% but is not reached here since Dusk and Dawn phases are not shown.

6 CONCLUSION

This report provides a comprehensive and detailed baseline study for marine mammals in the pre-investigation area for the planned KF II N and KF II S OWF.

Three marine mammal species regularly occur within the pre-investigation area of KF II N and KF II S. These are the harbour seal, the grey seal and, as the only cetacean species occurring in the Baltic Sea, the harbour porpoise. The basis of this study is comprised by digital aerial surveys for all marine mammal species and passive acoustic monitoring using C-PODs to monitor harbour porpoises in more detail, as well as data from the national seal monitoring programs from Denmark and Sweden. In addition, existing data from peer-reviewed literature and other monitoring programs have been considered.

6.1 HARBOUR SEALS

Harbour seal haul-out sites in the Baltic Sea closest to the planned windfarm area of KF II N and KF II S are located about 13 km northeast at Falsterbo (Måkläppen) in Sweden, and about 25 km to the west in Bøgestrøm (Denmark). Måkläppen is by far the most important haul-out site in this part of the Baltic Sea. At these distances, the planned windfarm area is within regular foraging trip distance (e.g. THOMPSON ET AL. 1994; TOLLIT ET AL. 1998; CUNNINGHAM ET AL. 2009; DIETZ ET AL. 2013). This is also shown by the results of the digital aerial surveys, where most seals were observed in the northern part of the pre-investigation area throughout the year with 90.5% of all sightings within one of the two Swedish Sites of Community Importance (SCI) under the Natura 2000 Habitats Directive *Falsterbohalvön* (SE0430095) and *Sydvästskånes utsjövatten* (SE0430187), in which harbour seals are listed as important species, respectively. While the harbour seal counts decrease over the past 10 years, it has to be considered that the population may be approaching or has reached ecological capacity (HANSEN & HØGSLUND 2021) with about 2,000 individuals in the SW Baltic and about 12,500 individuals in the Kattegat (HELCOM 2023a).

6.2 GREY SEALS

The only grey seal haul-out sites in the Baltic Sea close to the planned windfarm area of KF II N and KF II S is located about 13 km northeast at Falsterbo (Måkläppen) in Sweden. At Stevns Rev in Denmark about 16 km west, findings have also occurred. However, the population of the south-western Baltic grey seal management unit is dominated by Måkläppen. At this distance, the planned windfarm area is within regular foraging trip distance (e.g. THOMPSON ET AL. 1991, 1996; MCCONNELL ET AL. 1999; DIETZ ET AL. 2015). This is also shown by the results of the digital aerial surveys, where most seals were observed in the northern part of the pre-investigation area throughout the year with 90.5% of all sightings within one of the two Swedish Sites of Community Importance (SCI) under the Natura 2000 Habitats Directive *Falsterbohalvön* (SE0430095) and *Sydvästskånes utsjövatten* (SE0430187), in which grey seals are listed as important species respectively. In contrast to the harbour seal counts, grey seal counts have increased over the past 10 years (HANSEN & HØGSLUND 2021) with an estimated population size of about 60,000 animals for the Baltic Sea (HELCOM 2023c).

6.3 HARBOUR PORPOISES

Harbour porpoises in the pre-investigation area of KF II N and KF II S area are attributed to the Belt Sea population as the area is located in the western part of the transition zone according to SVEEGAARD ET AL. (2018) and occurrence of individuals from the Baltic Proper population is not very likely. Harbour porpoises were most frequently abundant in the beginning of summer and in autumn. In summer, 2 juveniles were observed, which results in a proportion of juveniles of 4.3%, indicating that the pre-investigation area is used for breeding, but to a smaller extent compared to other areas. For example a proportion of juveniles of 6.4% was observed for a larger study area consisting of the Western Baltic Sea and the Kattegat (UNGER ET AL. 2021) and a proportion of juveniles of 9.1% was observed for the Skagerrak both in 2020 (HANSEN & HØGSLUND 2021). Within the pre-investigation area, harbour porpoise showed no clear preference, but most sightings occurred in the middle of the pre-investigation area around and east from Møn. Only few observations occurred within the Sites of Community Importance (SCI) under the Natura 2000 Habitats Directive *Sydvästskånes utsjövatten* (SE0430187), where harbour porpoises are listed as an important species. Recent studies showed a decrease of the Belt Sea population (SCANS-IV 2023; OWEN ET AL. 2024), which is currently estimated to be about 14,000 to 17,000 individuals (HANSEN & HØGSLUND 2021; SCANS-IV 2023). However, these negative trends are not significant and may be biased by different methods used and a small sample size (SCANS-IV 2023).

7 DATA AND KNOWLEDGE GAPS

In this study, aerial survey data was collected during 6 digital aerial surveys. The advantage of digital aerial data collection is that densities of marine mammals can be assessed quickly and with a uniform collection effort on a large spatial scale, e.g. compared to ship-based surveys and observer-based aerial surveys (ŽYDELIS ET AL. 2019). This method is considered as a “snap-shot”-method since the distribution of marine mammals is only observed during the specific time frame of a flight and not continuously. Therefore, the results only show the abundance on the specific survey date and during daylight hours.

Studies comparing C-POD PAM results to visual observations at the same time (KYHN ET AL. 2012; WILLIAMSON ET AL. 2016; JACOBSON ET AL. 2017; SCHUBERT ET AL. 2018) showed that the results of PAM roughly correspond to absolute densities. Based on a comparison of telemetric data of harbour porpoises and C-POD recordings in the Baltic Sea around the island of Rügen, Germany, a study of MIKKELSEN et al. (2016) showed that both datasets correlated. The more tagged animals being present in an area the higher were the detection rates recorded in this area. One of the advantages of PAM is the very high temporal resolution. Therefore, even short-term patterns can be investigated. Furthermore, C-PODs are capable of continuously recording data, a major advantage in comparison to other survey methods like aerial or ship-based surveys. This produces large quantities of data, allowing for robust statistical analyses. Furthermore, C-PODs also record harbour porpoises at night, whereas aerial and ship-based surveys are limited to daylight hours. A disadvantage of the PAM method is the small spatial coverage. The detection range of a C-POD reaches only up to about appr. 300 meters, and it depends on the direction into which the harbour porpoise click was sent out by the animal. Only deployment of several C-PODs at different locations, like in the present study, allows for analysis of the spatial distribution of harbour porpoises.

A literature research on existing data (see chapter 3) and an analyses of the count data at seal haul-out sides in the vicinity of the planned windfarm area, gives a good general overview of abundance and distribution on the three marine mammal species present in the area and complements the data from February 2023 to January 2024 in the pre-investigation area. However, it also reveals that temporal and geographical resolution of data is important, but often a limiting factor. A focus on the pre-investigation area in combination with existing results, as it has been shown in this report, is therefore crucial and an upcoming additional study period from February 2024 to January 2025 will decrease the impact of annual variability.

8 REFERENCES

Aarefjord, H., A. J. Bjorge, C. Kinze & I. Lindstedt (1995) Diet of the harbour porpoise (*Phocoena phocoena*) in Scandinavian waters. in Biology of the Phocoenids. A collection of papers (auts. Bjorge, A. & G. P. Donovan), in Report of the International Whaling Commission / no. 16, publ. The International Whaling Commission, Cambridge (GBR), pp. 211–222.

Aarhus Universitet (2019) Den danske rødliste. https://ecos.au.dk/forskningraadgivning/temasider/redlist/roedliste-2019 (2019).

Adelung, D., N. Liebsch & R. P. Wilson (2004) Telemetrische Untersuchungen zur räumlichen und zeitlichen Nutzung des schleswig-holsteinischen Wattenmeeres und des angrenzenden Seegebietes durch Seehunde (*Phoca vitulina*) in Hinblick auf die Errichtung von Offshore-Windparks. Endbericht, Tönning, MINOS-Endbericht: Marine Warmblüter in Nord-und Ostsee: Grundlagen zur Bewertung von Windkraftanlagen im Offshore-Bereich. Teilprojekt 6. Landesamt für den Nationalpark Schleswig-Holsteinisches Wattenmeer, pp. 335–418.

Amundin, M., J. Carlström, L. Thomas, I. Carlén, J. Teilmann, J. Tougaard, O. Loisa, L. A. Kyhn, S. Sveegaard, M. L. Burt, I. Pawliczka, R. Koza, B. Arciszewski, A. Galatius, J. Laaksonlaita, J. MacAuley, A. J. Wright, A. Gallus, M. Dähne, A. Acevedo-Gutiérrez, H. Benke, J. Koblitz, N. Tregenza, D. Wennerberg, K. Brundiers, M. Kosecka, C. Tiberi Ljungqvist, I. Jussi, M. Jabbusch, S. Lyytinen, A. Šaškov & P. Blankett (2022) Estimating the abundance of the critically endangered Baltic Proper harbour porpoise (*Phocoena phocoena*) population using passive acoustic monitoring. Ecology and Evolution (2, vol. 12).

Andersen, L. W. & M. T. Olsen (2010) Distribution and population structure of North Atlantic harbour seals (*Phoca vitulina*). NAMMCO Scientific Publications (vol. 8), pp. 15–36.

Andersen, S. M., J. Teilmann, P. B. Harders, E. H. Hansen & D. Hjøllund (2007) Diet of harbour seals and great cormorants in Limfjord, Denmark: interspecific competition and interaction with fishery. ICES Journal of Marine Science (6, vol. 64), pp. 1235–1245.

Andreasen, H., S. D. Ross, U. Siebert, N. G. Andersen, K. Ronnenberg & A. Gilles (2017) Diet composition and food consumption rate of harbor porpoises (*Phocoena phocoena*) in the western Baltic Sea. Marine Mammal Science.

Benke, H., S. Bräger, M. Dähne, A. Gallus, S. Hansen, C. G. Honnef, M. Jabbusch, J. C. Koblitz, K. Krügel, A. Liebschner, I. Narberhaus & U. K. Verfuß (2014) Baltic Sea harbour porpoise populations: status and conservation needs derived from recent survey results. Marine Ecology Progress Series (vol. 495), pp. 275–290.

Benke, H., U. Siebert, R. Lick, B. Bandomir & R. Weiss (1998) The current status of harbour porpoises (Phocoena phocoena) in German waters. Arch. Fish. Mar. Res. (2, vol. 46), pp. 97–123.

Berta, A. & M. Churchill (2012) Pinniped taxonomy: Review of currently recognized species and subspecies, and evidence used for their description. Mammal Review (3, vol. 42), pp. 207–234.

Blanchet, M.-A., C. Vincent, J. N. Womble, S. M. Steingass & G. Desportes (2021) Harbour Seals: Population Structure, Status, and Threats in a Rapidly Changing Environment. Oceans (1, vol. 2), pp. 41–63.

Borchers, D. L. (2003) Estimation with incomplete detection at distance zero “g(0) < 1.” International workshops. Advanced techniques and recent developments in distance sampling. Centre for Research into Ecological and Environmental Modelling, St. Andrews, Scotland, p. 102-109.

Boskovic, R., K. M. Kovacs, M. O. Hammill & B. N. White (1996) Geographic distribution of mitochondrial DNA in grey seals (Halichoerus grypus). Canadian Journal of Zoology (vol. 74), pp. 1787–1796.

Bowen, D. (2016) IUCN Red List of Threatened Species - Grey seal (Halichoerus grypus). https://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T9660A45226042.en (2016).

Braulik, G., G. Minton, M. Amano & A. Bjørge (2020) *Phocoena phocoena*. in In: The IUCN Red List of Threatened Species 2020: e.T17027A50369903. www.iucnredlist.org. https://dx.doi.org/10.2305/IUCN.UK.2020-2.RLTS.T17027A50369903.en. Downloaded on 16 October 2020. (aut. IUCN (2020).).

Carlén, I., L. Thomas, J. Carlström, M. Amundin, J. Teilmann, N. Tregenza, J. Tougaard, J. C. Koblitz, S. Sveegaard, D. Wennerberg, O. Loisa, M. Dähne, K. Brundiers, M. Kosecka, L. A. Kyhn, C. T. Ljungqvist, I. Pawliczka, R. Koza, B. Arciszewski, A. Galatius, M. Jabbusch, J. Laaksonlaita, J. Niemi, S. Lyytinen, A. Gallus, H. Benke, P. Blankett, K. E. Skóra & A. Acevedo-Gutiérrez (2018) Basin-scale distribution of harbour porpoises in the Baltic Sea provides basis for effective conservation actions. Biological Conservation (vol. 226), pp. 42–53.

Carlström, J., I. Carlén, M. Dähne & P. S. Hammond (2023) Phocoena phocoena (Baltic Sea subpopulation). The IUCN Red List of Threatened Species 2023.

Chelonia Limited (2023) The C-POD. https://www.chelonia.co.uk/cpod_home_page.htm (2023).

CMS Secretariat (2015) Convention on the Conservation of Migratory Species of Wild Animals – Appendix I and II. Bonn, Bonner Konvention.

Cunningham, L., J. M. Baxter, I. L. Boyd, C. D. Duck, M. Lonergan, S. E. Moss & B. McConnell (2009) Harbour seal movements and haul-out patterns: implications for monitoring and management. Aquatic Conservation: Marine and Freshwater Ecosystems (4, vol. 19), pp. 398–407.

Dietz, R., A. Galatius, L. Mikkelsen, J. Nabe-Nielsen, F. F. Rigét, H. Schack, H. Skov, S. Sveegaard, J. Teilmann & F. Thomsen (2015) Marine Mammals - Investigations and preparation of environmental impact assessment for Kriegers Flak Offshore Wind Farm. Final Version, p. 208.

Dietz, R., J. Teilmann, S. M. Andersen, F. Rigét & M. T. Olsen (2013) Movements and site fidelity of harbour seals (*Phoca vitulina*) in Kattegat, Denmark, with implications for the epidemiology of the phocine distemper virus. ICES Journal of Marine Science (1, vol. 70), pp. 186–195.

EEA (2019) EEA reference grid. https://data.europa.eu/euodp/de/data/dataset/data_eea-reference-grids-1 (12.1.2019), Stand: 12.01.2019.

European Commission (2021) Guidance document on the strict protection of animal species of Community interest under the Habitats Directive. Final, Brussels (BEL).

European Mammal Assessment team (2007) *Halichoerus grypus*. The IUCN Red List of Threatened Species 2007. https://www.iucnredlist.org/species/9660/13006007 (2007), e.T9660A13006007.

Fietz, K., A. Galatius, J. Teilmann, R. Dietz, A. K. Frie, A. Klimova, P. J. Palsbøll, L. F. Jensen, J. A. Graves, J. I. Hoffman & M. T. Olsen (2016) Shift of grey seal subspecies boundaries in response to climate, culling and conservation. Molecular Ecology (17, vol. 25), pp. 4097–4112.

Fietz, K., J. A. Graves & M. T. Olsen (2013) Control Control Control: A Reassessment and Comparison of GenBank and Chromatogram mtDNA Sequence Variation in Baltic Grey Seals (*Halochoerus grypus*). PLOS ONE (8, vol. 8), pp. 1–7.

Fredshavn, J., B. Nygaard, R. Ejrnæs, C. Damgaard, O. R. Therkildsen, M. Elmeros, L. Sander Johansson, A. Baisner Alnøe, K. Dahl, E. Haar Nielsen, H. Buur Pedersen, S. Sveegaard, A. Galatius & J. Teilmann (2019) Bevaringsstatus for naturtyper og arter. p. 10.

Galatius, A., J. Teilmann, M. Dähne, M. Ahola, L. Westphal, L. A. Kyhn, I. Pawliczka, M. T. Olsen & R. Dietz (2020) Grey seal *Halichoerus grypus* recolonisation of the southern Baltic Sea, Danish Straits and Kattegat. Wildlife Biology (4, vol. 2020).

Gilles, A., H. Herr, K. Lehnert, M. Scheidat, K. Kaschner, J. Sundermeyer, U. Westerberg & U. Siebert (2007a) Forschungsverbund MINOS Plus - Weiterführende Arbeiten an Seevögeln und Meeressäugern zur Bewertung von Offshore - Windkraftanlagen. Teilvorhaben 2 - "Erfassung der Dichte und Verteilungsmuster von Schweinswalen (*Phocoena phocoena*) in der deutschen Nord- und Ostsee." Schlussbericht, Büsum (DEU), pp. 94–160.

Gilles, A., H. Herr, K. Lehnert, M. Scheidat, K. Kaschner, J. Sundermeyer, U. Westerberg & U. Siebert (2007b) Erfassung der Dichte und Verteilungsmuster von Schweinswalen (*Phocoena phocoena*) in der deutschen Nord- und Ostsee. in MINOS 2 - Weiterführende Arbeiten an

Seevögeln und Meeressäugern zur Bewertung von Offshore - Windkraftanlagen (MINOS plus), Endbericht, Büsum (DEU), p. 160.
Gillespie, D., P. Berggren, S. Brown, I. Kuklik, C. Lacey, T. Lewis, J. Matthews, R. McLanaghan, A. Moscrop & N. Tregenza (2005) Relative abundance of harbour porpoises (*Phocoena phocoena*) from acoustic and visual surveys of the Baltic Sea and adjacent waters during 2001 and 2002. Journal of Cetacean Research and Management (1, vol. 7), pp. 51–57.
Graves, J. A., A. Helyar, M. Biuw, M. Jüssi, I. Jüssi & O. Karlsson (2009) Microsatellite and mtDNA analysis of the population structure of grey seals (*Halichoerus grypus*) from three breeding areas in the Baltic Sea. Conservation Genetics (1, vol. 10), pp. 59–68.
Hammond, P. S., G. Bearzi, A. Bjørge, K. Forney, L. Karczmarski, T. Kasuya, W. F. Perrin, M. D. Scott, J. Y. Wang, R. S. Wells & B. Wilson (2008) Phocoena phocoena (Baltic Sea subpopulation). The IUCN Red List of Threatened Species 2008.
Hammond, P. S., P. Berggren, H. Benke, D. L. Borchers, A. Collet, M. P. Heide-Jørgensen, S. Heimlich, A. R. Hiby, M. F. Leopold & N. Øien (2002) Abundance of harbour porpoise and other cetaceans in the North Sea and adjacent waters. Journal of Applied Ecology (2, vol. 39), pp. 361–376.
Hammond, P. S., C. Lacey, A. Gilles, S. Viquerat, P. Börjesson, H. Herr, K. MacLeod, V. Ridoux, M. B. Santos, M. Scheidat, J. Teilmann, J. Vingada & N. Øien (2017) Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys. p. 40.
Hammond, P. S., K. Macleod, P. Berggren, D. L. Borchers, L. Burt, A. Cañadas, G. Desportes, G. P. Donovan, A. Gilles, D. Gillespie, J. Gordon, L. Hiby, I. Kuklik, R. Leaper, K. Lehnert, L. Mardik, P. Lovell, N. Øien, C. G. M. Paxton, V. Ridoux, E. Rogan, Samarra Filipa, M. Scheidat, M. Sequeira, U. Siebert, H. Skov, R. Swift, M. L. Tasker, J. Teilmann, O. Van Canneyt & J. A. Vázquez (2013) Cetacean abundance and distribution in European Atlantic shelf waters to inform conservation and management. Biological Conservation (vol. 164), pp. 107–122.
Hansen, J. W. & S. Høgslund (2021) Marine områder 2020. NOVANA. no. 475, Videnskabelig rapport fra DCE, Aarhus (DNK), p. 192.
Harding, K. C. & T. Härkönen (1999) Development in the Baltic grey seal (*Halichoerus grypus*) and ringed seal (*Phoca hispida*) populations during the 20th century. Ambio (vol. 28), pp. 619–627.
Härkönen, T., S. Brasseur, J. Teilmann, C. Vincent, R. Dietz, K. Abt & P. Reijnders (2007) Status of grey seals along mainland Europe from the Southwestern Baltic to France. NAMMCO Scientific Publications (0, vol. 6), pp. 57–68.
Härkönen, T., R. Dietz, P. Reijnders, J. Teilmann, K. Harding, A. Hall, S. Brasseur, U. Siebert, S. J. Goodman, P. D. Jepson, T. D. Rasmussen & P. Thompson (2006) A review of the 1988 and 2002 phocine distemper virus epidemics in European harbour seals. Diseases of Aquatic Organisms (vol. 68), pp. 115–130.
Härkönen, T. & M.-P. Heide-Jørgensen (1990) Comparative life histories of East Atlantic and other harbour seal populations. Ophelia (3, vol. 32), pp. 211–235.
Heide-Jørgensen, M. P. & T. J. Härkönen (1988) REBUILDING SEAL STOCKS IN THE KATTEGAT-SKAGERRAK. Marine Mammal Science (vol. 4.3), pp. 231–246.
HELCOM (2013a) HELCOM red list of Baltic Sea species in danger of becoming extinct. no. 140, in Baltic Sea Environment Proceedings.
HELCOM (2013b) Species information sheet *Phoca vitulina vitulina*.
HELCOM (2013c) Species Information sheet: *Phocoena phocoena*. https://helcom.fi/baltic-sea-trends/biodiversity/red-list-of-baltic-species/red-list-of-marine-mammals/ (2013).
HELCOM (2018) Distribution of Baltic seals. Key message. HELCOM core indicator report, p. 28.
HELCOM (2023a) Population trends and abundance of seals – Harbour seals. (ed. HELCOM).
HELCOM (2023b) Distribution of Baltic Harbour seals. (ed. HELCOM).
HELCOM (2023c) Distribution of Baltic grey seals. (ed. HELCOM).
HELCOM (2023d) Distribution of harbour porpoises. (ed. HELCOM).
HELCOM (2023e) Abundance and population trends of harbour porpoises. (ed. HELCOM).

HELCOM Red List MMEG (2013) Red List of Marine Mammals. (aut. HELCOM Red List Marine Mammal Expert Group). https://helcom.fi/baltic-sea-trends/biodiversity/red-list-of-baltic-species/red-list-of-marine-mammals/.

ICES (2019) Working Group on Marine Mammal Ecology (WGMME). (auts. Galatius, A., A. Gilles, M. Aloha, M. Authier, S. Brasseur, A. Carlsson, J. Carlsröm, F. Chaudry, R. M. Culloch, P. Evans, S. Geelhoed, K. Lehnert, K. Lundström, G. Pierce, E. Rogan, B. Santos & A. Van Neer; ed. ICES). no. 1:22, ICES Scientific Reports, Kopenhagen (DNK).

Jacobson, E. K., K. A. Forney & J. Barlow (2017) Using paired visual and passive acoustic surveys to estimate passive acoustic detection parameters for harbor porpoise abundance estimates. The Journal of the Acoustical Society of America (1, vol. 141), pp. 219–230.

Jauniaux, T., M.-M. Garigliany, P. Loos, J.-L. Bourgain, T. Bouveroux, F. Coignoul, J. Haelters, J. Karpouzopoulos, S. Pezeril & D. Desmecht (2014) Bite injuries of grey seals (*Halichoerus grypus*) on harbour porpoises (*Phocoena phocoena*). PLOS ONE (12, vol. 9), p. e108993.

Johnston, D. W., A. J. Westgate & A. J. Read (2005) Effects of fine-scale oceanographic features on the distribution and movements of harbour porpoises *Phocoena phocoena* in the Bay of Fundy. Marine Ecology Progress Series (vol. 295), pp. 279–293.

Kesselring, T., S. Viquerat, R. Brehm & U. Siebert (2017) Coming of age: - Do female harbour porpoises (*Phocoena phocoena*) from the North Sea and Baltic Sea have sufficient time to reproduce in a human influenced environment? PLOS ONE (10, vol. 12), p. e0186951.

Kinze, C. C. (1994) Schweinswal oder Kleintümmler (auch Braunfisch). (eds. Niethammer, J. & F. Krapp). in Handbuch der Säugetiere Europas, vol. Band 6: Meeressäuger. out of, publ. Aula-Verlag, Wiesbaden, pp. 242–264.

Kinze, C. C. (1995) Exploitation of harbour porpoises (*Phocoena phocoena*) in Danish waters: a historical review. in DONOVAN, G. P. (Hrsg.) (1995): Biology of the Phocoenids. A collection of papers. Reihe: Report of the International Whaling Commission (Special Issue 16), Cambridge (GBR), 552 Seiten.

Koblitz, J. C., M. Wahlberg, P. Stilz, P. T. Madsen, K. Beedholm & H.-U. Schnitzler (2012) Asymmetry and dynamics of a narrow sonar beam in an echolocating harbor porpoise. The Journal of the Acoustical Society of America (3, vol. 131), pp. 2315–2324.

Koschinski, S. (2002) Current knowledge on harbour porpoises (*Phocoena phocoena*) in the Baltic Sea. Ophelia (3, vol. 55), pp. 167–197.

Koschinski, S., B. M. Culik, O. Damsgaard Henriksen, N. Tregenza, G. Ellis, C. Jansen & G. Kathe (2003) Behavioural reactions of free-ranging porpoises and seals to the noise of a simulated 2 MW windpower generator. Marine Ecology Progress Series (vol. 265), pp. 263–273.

Kyhn, L. A., J. Tougaard, L. Thomas, L. R. Duve, J. Stenback, M. Amundin, G. Desportes & J. Teilmann (2012) From echolocation clicks to animal density - Acoustic sampling of harbor porpoises with static dataloggers. The Journal of the Acoustical Society of America (1, vol. 131), pp. 550–560.

Lacey, C., A. Gilles, P. Börjesson, H. Herr, K. Macleod, V. Ridoux, M. B. Santos, M. Scheidat, J. Teilmann, S. Sveegaard, J. Vingada, S. Viquerat, N. Øien & P. S. Hammond (2022) Modelled density surfaces of cetaceans in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys. SCANS-III project report 2.

Lah, L., D. Trense, H. Benke, P. Berggren, Þ. Gunnlaugsson, C. Lockyer, A. Öztürk, B. Öztürk, I. Pawliczka, A. Roos, U. Siebert, K. Skóra, G. Víkingsson & R. Tiedemann (2016) Spatially explicit analysis of genome-wide SNPs detects subtle population structure in a mobile marine mammal, the Harbor Porpoise. PLOS ONE (10, vol. 11), p. e0162792.

Leopold, M. F. (2015) Eat and be eaten: porpoise diet studies. PhD-Thesis, Wageningen University, Wageningen (NDL), pp. 239.

Lockyer, C. & C. Kinze (2003) Status, ecology and life history of harbour porpoise (*Phocoena phocoena*), in Danish waters. NAMMCO Scientific Publications (vol. 5), pp. 143–175.

Lowry, L. (2016) IUCN Red List of Threatened Species - Harbor seal (Phoca vitulina). https://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T17013A45229114.en (2016).

McConnell, B. J., M. A. Fedak, P. Lovell & P. S. Hammond (1999) Movements and foraging areas of grey seals in the North Sea. Journal of Applied Ecology (vol. 36), pp. 573–590.
McConnell, B., M. Lonergan & R. Dietz (2012) Interactions between seals and offshore wind farms. p. 41.
Meinig, H., P. Boye, M. Dähne, R. Hutterer & J. Lang (2020) Rote Liste und Gesamtartenliste der Säugetiere (Mammalia) Deutschlands. Naturschutz und Biologische Vielfalt (2, vol. 170), p. 73.
Mikkelsen, L., F. F. Rigét, L. A. Kyhn, S. Sveegaard, R. Dietz, J. Tougaard, J. A. K. Carlström, I. Carlén, J. C. Koblitz & J. Teilmann (2016) Comparing distribution of harbour porpoises (*Phocoena phocoena*) derived from satellite telemetry and passive acoustic monitoring. PLOS ONE (7, vol. 11), p. e0158788.
Van Neer, A., L. F. Jensen & U. Siebert (2015) Grey seal (Halichoerus grypus) predation on harbour seals (Phoca vitulina) on the island of Helgoland, Germany. Journal of Sea Research (vol. 97), pp. 1–4.
Olsen, M. T., A. Galatius, V. Biard, K. Gregersen & C. C. Kinze (2016) The forgotten type specimen of the grey seal [*Halichoerus grypus* (Fabricius, 1791)] from the island of Amager, Denmark. Zoological Journal of the Linnean Society (3, vol. 178), pp. 713–720.
Owen, K., A. Gilles, M. Authier, J. Carlström, M. Genu, L. A. Kyhn, D. A. Nachtsheim, N. C. Ramírez-Martínez, U. Siebert, M. Sköld, J. Teilmann, B. Unger & S. Sveegaard (2024) A negative trend in abundance and an exceeded mortality limit call for conservation action for the Vulnerable Belt Sea harbour porpoise population. Frontiers in Marine Science (1289808, vol. 11).
Owen, K., M. Sköld & J. Carlström (2021) An increase in detection rates of the critically endangered Baltic Proper harbor porpoise in Swedish waters in recent years. Conservation Science and Practice (8, vol. 3).
Van Parijs, S. M., P. M. Thompson, D. J. Tollit & A. MacKay (1997) Distribution and activity of male harbour seals during the mating season. Animal Behaviour (vol. 54), pp. 35–43.
Pierpoint, C. (2008) Harbour porpoise (*Phocoena phocoena*) foraging strategy at a high energy, near-shore site in south-west Wales, UK. Journal of the Marine Biological Association of the UK (6, vol. 88), pp. 1167–1173.
R Core Team (2017) R: A language and environment for statistical computing. publ. R Foundation for Statistical Computing, Vienna, Austria.
Rose, A., M. J. Brandt, R. Vilela, A. Diederichs, A. Schubert, V. Kosarev, G. Nehls, M. Volkenandt, V. Wahl, A. Michalik, H. Wendeln, A. Freund, C. Ketzer, B. Limmer, M. Laczny & W. Piper (2019) Effects of noise-mitigated offshore pile driving on harbour porpoise abundance in the German Bight 2014-2016 (Gescha 2). (eds. BioConsult SH, IBL Umweltplanung & Institut für Angewandte Ökosystemforschung). Final Report, Husum (DEU), prepared for Arbeitsgemeinschaft OffshoreWind e.V., p. 193.
SAMBAH (2016) Final Report. Covering the project activities from 01/01/2010 to 30/09/2015. no. LIFE08 NAT/S/000261, Final Report, Kolmården, Sweden, p. 77.
Santos, M. B. & G. J. Pierce (2003) The diet of harbour porpoise (*Phocoena phocoena*) in the northeast Atlantic. Oceanography and Marine Biology: an Annual Review (vol. 41), pp. 355–390.
SCANS-IV (2023) Estimates of cetacean abundance in European Atlantic waters in summer 2022 from the SCANS-IV aerial and shipboard surveys. (auts. Gilles, A., M. Authier, N. C. Ramirez-Martinez, H. Araújo, A. Blanchard, J. Carlström, C. Eira, G. Dorémus, C. Fernández-Maldonado, S. C. V. Geelhoed, L. Kyhn, S. Laran, D. Nachtsheim, S. Panigada, R. Pigeault, M. Sequeira, S. Sveegaard, N. L. Taylor, K. Owen, C. Saavedra, J. A. Vázquez Bonales & P. S. Hammond). Final report published 29 September 2023, p. 64.
Scharff-Olsen, C. H., A. Galatius, J. Teilmann, R. Dietz, S. M. Andersen, S. Jarnit, A.-M. Kroner, A. B. Botnen, K. Lundström, P. R. Møller & M. T. Olsen (2019) Diet of seals in the Baltic Sea region: a synthesis of published and new data from 1968 to 2013. ICES Journal of Marine Science (1, vol. 76), pp. 284–297.

Scheidat, M., A. Gilles, K. Kock & U. Siebert (2008) Harbour porpoise *Phocoena phocoena* abundance in the southwestern Baltic Sea. Endangered Species Research (vol. 5), pp. 215–223.
Schubert, A., F. Bils, N. Gries, A. Rose, R. Vílela & A. Diederichs (2019) Nord Stream 2 Projekt. Monitoring von Schweinswalen in der Pommerschen Bucht. (ed. BioConsult SH). Jahresbericht, Husum (DEU), Erstellt für Nord Stream 2 AG, p. 53.
Schubert, A., A. Rose, A. Diederichs & G. Nehls (2018) A comparison of high-resolution digital aerial surveys and passive acoustic monitoring. Vortrag zur 32th Annual Conference of the European Cetacean Society, La Spezia, Italien.
Schulze, G. (1996) Die Schweinswale. in Neue Brehm Bücherei, Magdeburg.
Sharpe, M. & P. Berggren (2023) https://www.iucnredlist.org/species/17027/219010660 (2023).
Shirihai, H., B. Jarrett, D. Erdmann, C. Ludy & M. Weymann (2008) Meeressäuger. Alle 129 Arten weltweit. publ. Frankh-Kosmos Verlags-GmbH & Co., Stuttgart, pp. 384.
Siebert, U. & J. H. Rye (2008) Correlation between aerial surveys and acoustic monitoring. Marine mammals and seabirds in front of offshore wind energy. Teubner Verlag, Wiebaden, pp. 37–39.
Søndergaard, N.-O., A. Holm Joensen & E. Bøgebjerg Hansen (1976) Sælernes forekomst og sæljagten i Danmark. in Danske Vildtundersøgelser, vol. 26 out of, publ. Vildtbiologisk Station, pp. 79.
Species account by IUCN SSC Cetacean Specialist Group; regional assessment by European Mammal Assessment team (2007) *Phocoena phocoena*. The IUCN Red List of Threatened Species 2007. https://www.iucnredlist.org/species/17027/6734714 (2007), e.T17027A6734714.
Sveegaard, S., I. Carlén, J. Carlström, M. Dähne, A. Gilles, O. Loisa, K. Owen & I. Pawliczka (2022) HOLAS-III Harbour Porpoise importance map. Methodology. no. No. 240, Technical Report, p. 20.
Sveegaard, S., A. Galatius, R. Dietz, L. Kyhn, J. C. Koblitz, M. Amundin, J. Nabe-Nielsen, M.-H. S. Sinding, L. W. Andersen & J. Teilmann (2015) Defining management units for cetaceans by combining genetics, morphology, acoustics and satellite tracking. Global Ecology and Conservation (vol. 3), pp. 839–850.
Sveegaard, S., J. Nabe-Nielsen & J. Teilmann (2018) Marsvins udbredelse og status for de marine habitatområder is danske farvande. no. 284, Aarhus (DNK), p. 36.
Teilmann, J., C. T. Christiansen, S. Kjellerup, R. Dietz & G. Nachman (2013) Geographic, seasonal, and diurnal surface behavior of harbor porpoises. Marine Mammal Science, pp. 1–17.
Thompson, P. M., P. S. Hammond, K. S. Nicholas & M. A. Fedak (1991) Movements, diving and foraging behavior of grey seals (*Haliochoerus grypus*). Journal of Zoology (vol. 224), pp. 223–232.
Thompson, P. M., B. J. Mcconnell, D. J. Tollit, A. Mackay, C. Hunter & P. A. Racey (1996) Comparative Distribution, Movements and Diet of Harbour and Grey Seals from Moray Firth, N. E. Scotland. The Journal of Applied Ecology (6, vol. 33), p. 1572.
Thompson, P. M., D. Miller, R. Cooper & P. S. Hammond (1994) Changes in the distribution and activity of female harbour seals during the breeding season: implications for their lactation and mating patterns. Journal of Animal Ecology (vol. 63), pp. 24–30.
Tiedemann, R., L. Lah & M. Autenrieth (2017) Individuenspezifische genetische Populationszuordnung baltischer Schweinswale mittels hochauflösender Single Nucleotide Polymorphisms (SNPs)-Technologie. Abschlussbericht, Potsdam (DEU), Abschlußbericht zur Vorlage beimBundesamt für Naturschutz FKZ: 3514824600), p. 29.
Tollit, D. J., A. D. Black, P. M. Thompson, A. Mackay, H. M. Corpe, B. Wilson, S. M. . Parijs, K. Grellier & S. Parlane (1998) Variations in harbour seal *Phoca vitulina* diet and dive-depths in relation to foraging habitat. Journal of Zoology (2, vol. 244), pp. 209–222.
Unger, B., D. Nachtsheim, N. Ramírez Martínez, U. Siebert, S. Sveegaard, L. Kyhn, J. D. Balle, J. Teilmann, J. Carlström, K. Owen & A. Gilles (2021) MiniSCANS-II: Aerial survey for harbour porpoises in the western Baltic Sea, Belt Sea, the Sound and Kattegat in 2020. Joint survey by Denmark, Germany andSweden. Final report to Danish Environmental Protection

Agency, German Federal Agency for Nature Conservation and Swedish Agency for Marine and Water Management, p. 28.
Viquerat, S., H. Herr, A. Gilles, V. Peschko, U. Siebert, S. Sveegaard & J. Teilmann (2014) Abundance of harbour porpoises (*Phocoena phocoena*) in the western Baltic, Belt Seas and Kattegat. Marine Biology (4, vol. 161), pp. 745–754.
Visquerat, S., A. Gilles, Herr & U. Siebert (2015) Monitoring von marinen Säugetieren 2014 in der deutschen Nord- und Ostsee. In: Bericht an Bundesamt für Naturschutz, pp. 2–58. p. 83.
Weiß, F., H. Büttger, J. Baer, J. Welcker & G. Nehls (2016) Erfassung von Seevögeln und Meeressäugetieren mit dem HiDef Kamerasystem aus der Luft. Seevögel (2, vol. 37), pp. 14–21.
Westphal, L., L. Klemens, F. Reif, A. Van Neer & M. Dähne (2023) First evidence of grey seal predation on marine mammals in the German Baltic Sea. Journal of Sea Research (vol. 192), p. 102350.
Wiemann, A., L. W. Andersen, P. Berggren, U. Siebert, H. Benke, J. Teilmann, C. Lockyer, I. Pawliczka, K. Skóra, A. Roos, T. Lyrholm, K. B. Paulus, V. Ketmaier & R. Tiedemann (2010) Mitochondrial Control Region and microsatellite analyses on harbour porpoise (*Phocoena phocoena*) unravel population differentiation in the Baltic Sea and adjacent waters. Conservation Genetics (1, vol. 11), pp. 195–211.
Williamson, L. D., K. L. Brookes, B. E. Scott, I. M. Graham, G. Bradbury, P. S. Hammond & P. M. Thompson (2016) Echolocation detections and digital video surveys provide reliable estimates of the relative density of harbour porpoises. Methods in Ecology and Evolution (vol. 7), pp. 762–769.
Žydelis, R., M. Dorsch, S. Heinänen, G. Nehls & F. Weiss (2019) Comparison of digital video surveys with visual aerial surveys for bird monitoring at sea. Journal of Ornithology (2, vol. 160), pp. 567–580.
(2020) The Swedish Red List 2020.

9 APPENDIX

SEALS – AERIAL SURVEYS SIGHTINGS

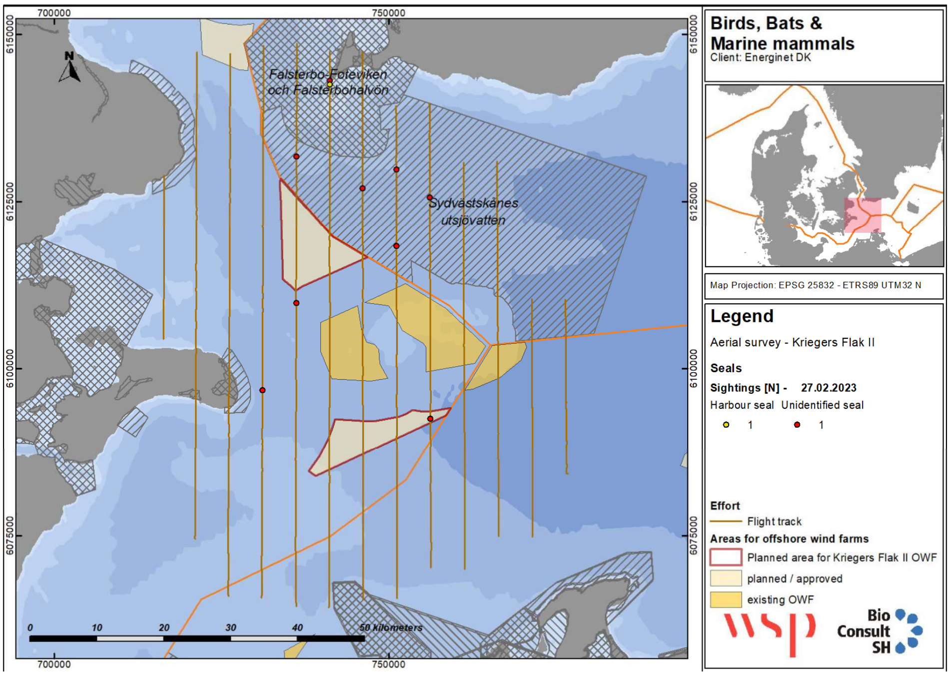

Figure 9-1. Seal observations in the pre-investigation area during the digital aerial survey on 27.02.2023.

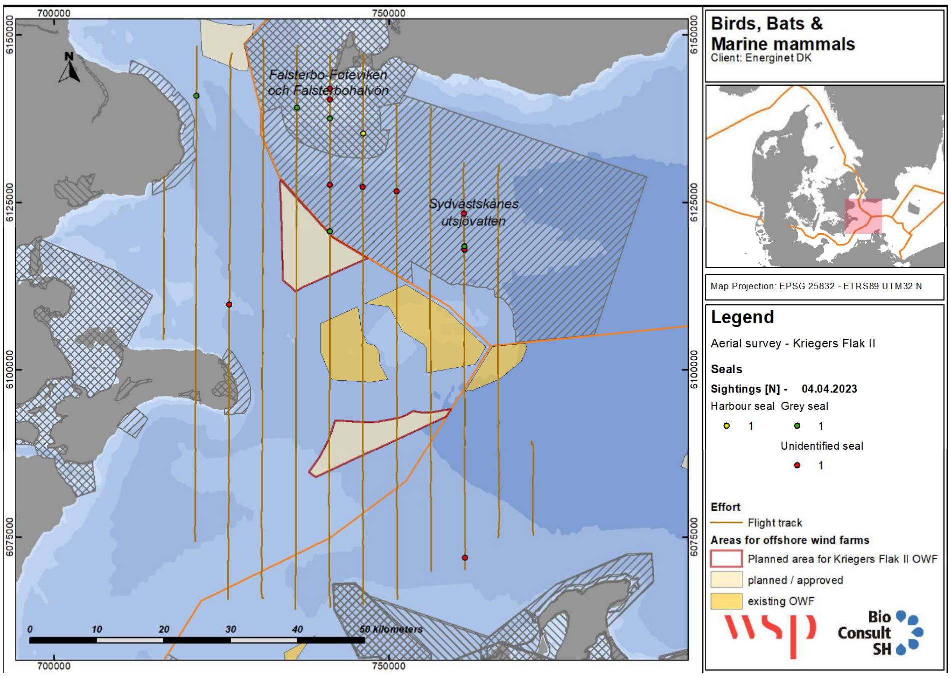

Figure 9-2. Seal observations in the pre-investigation area during the digital aerial survey on 04.04.2023.

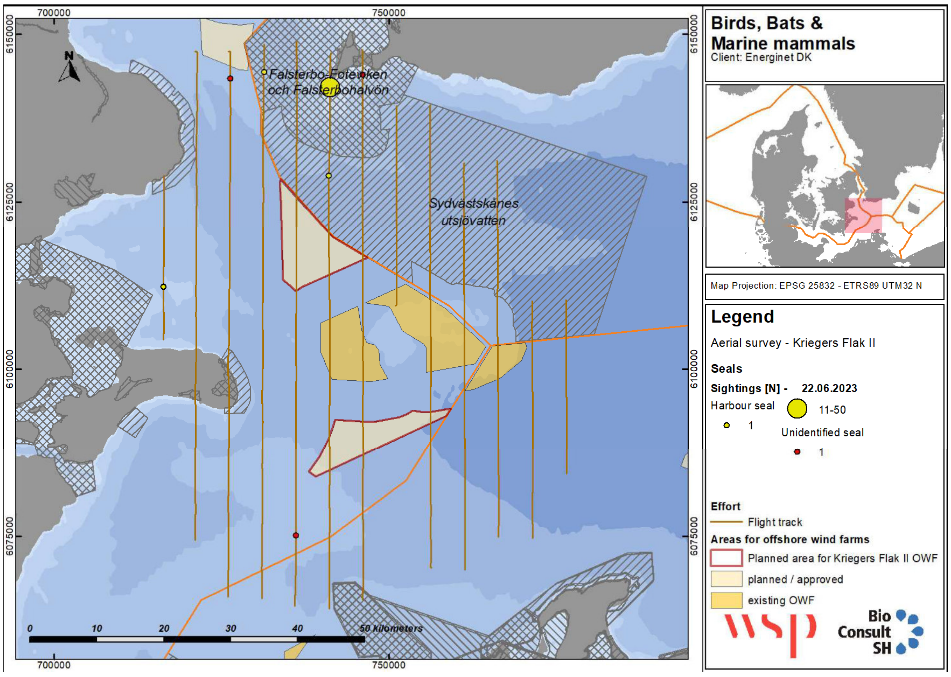

Figure 9-3. Seal observations in the pre-investigation area during the digital aerial survey on 22.06.2023.

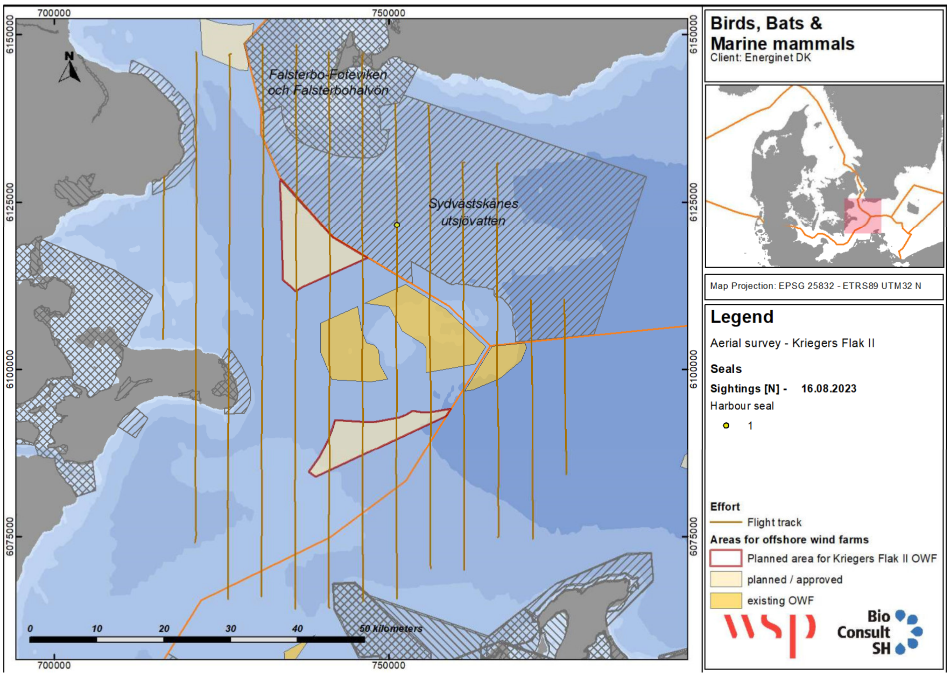

Figure 9-4. Seal observations in the pre-investigation area during the digital aerial survey on 16.08.2023.

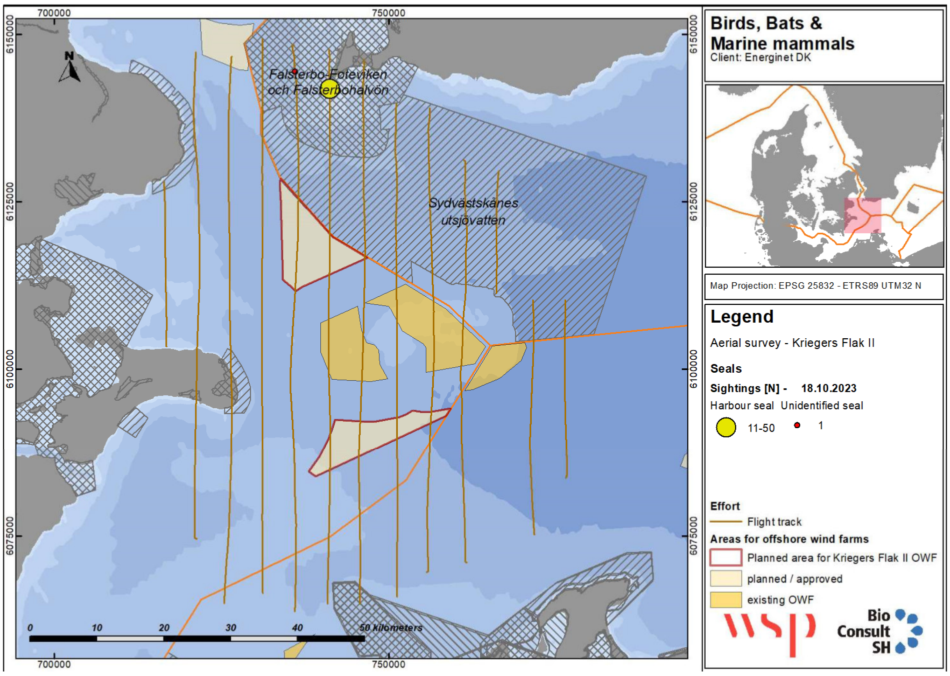

Figure 9-5. Seal observations in the pre-investigation area during the digital aerial survey on 18.10.2023.

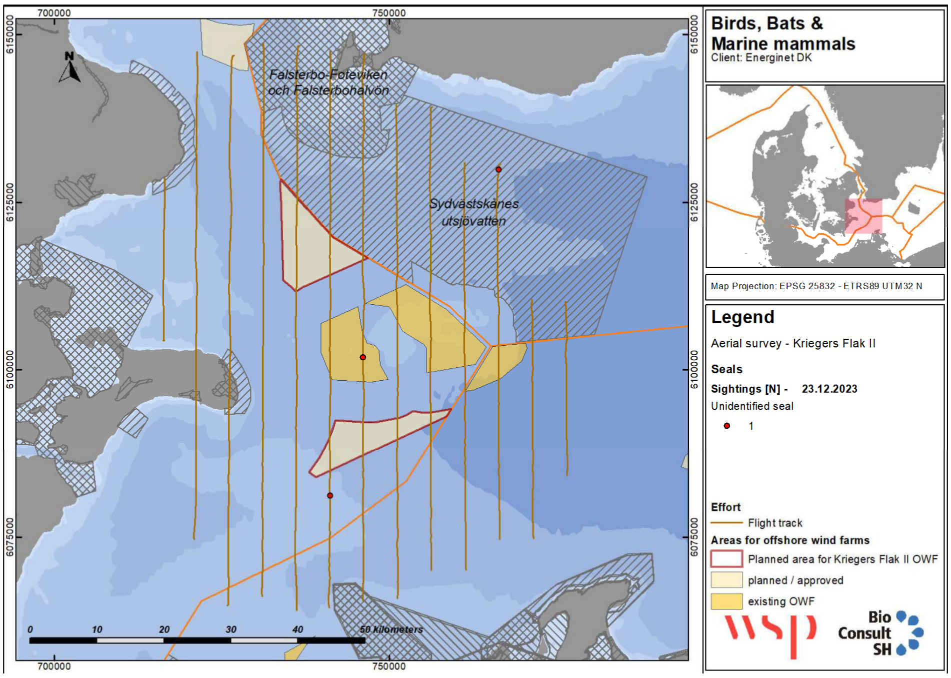

Figure 9-6. Seal observations in the pre-investigation area during the digital aerial survey on 23.12.2023.

HARBOUR PORPOISE – AERIAL SURVEYS SIGHTINGS

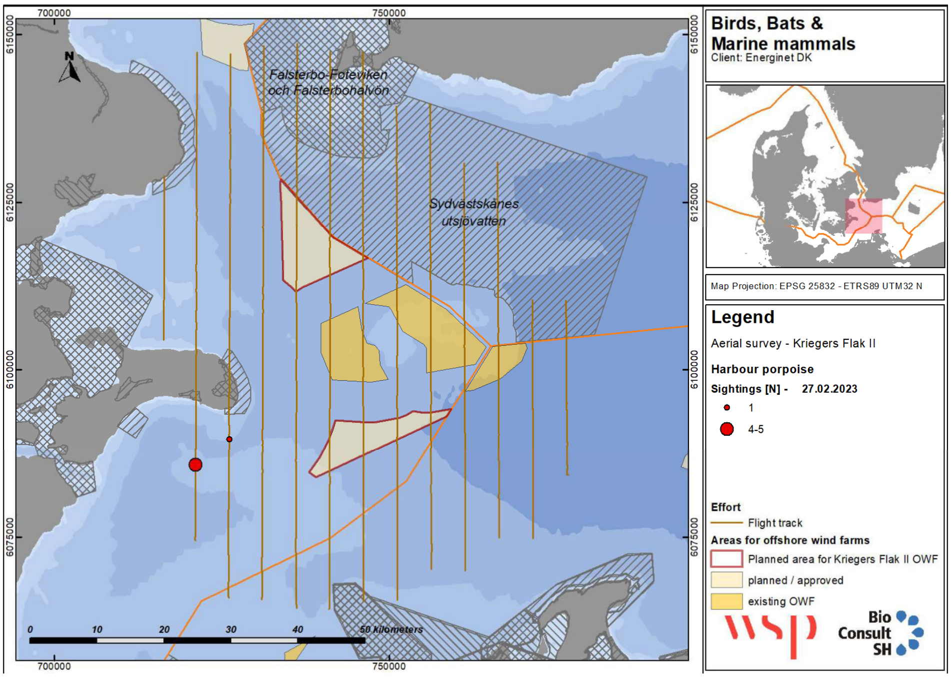

Figure 9-7. Harbour porpoise observations in the pre-investigation area during the digital aerial survey on 27.02.2023.

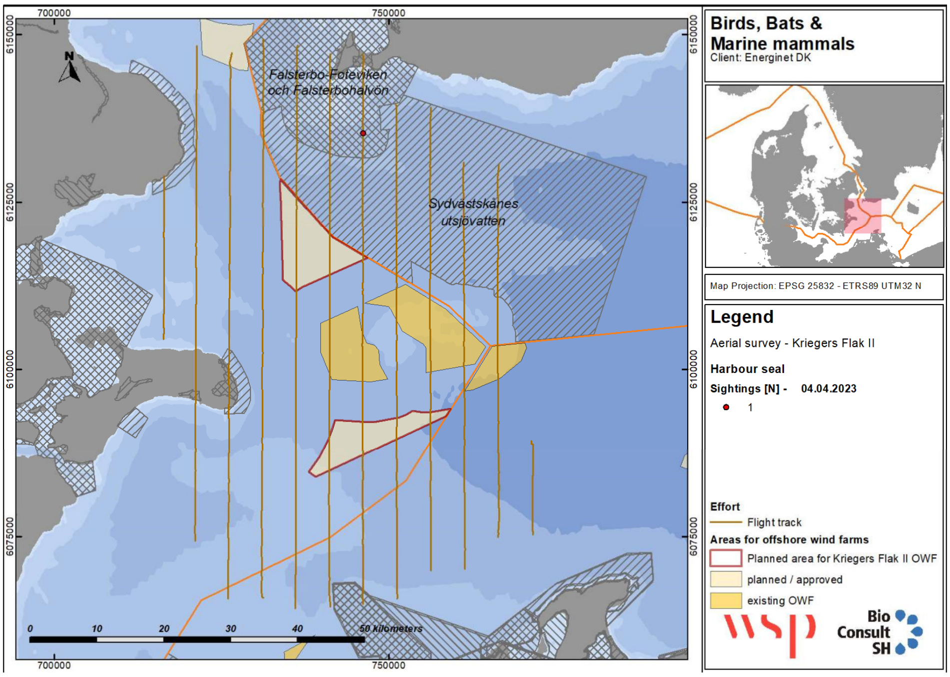

Figure 9-8. Harbour porpoise observations in the pre-investigation area during the digital aerial survey on 04.04.2023.

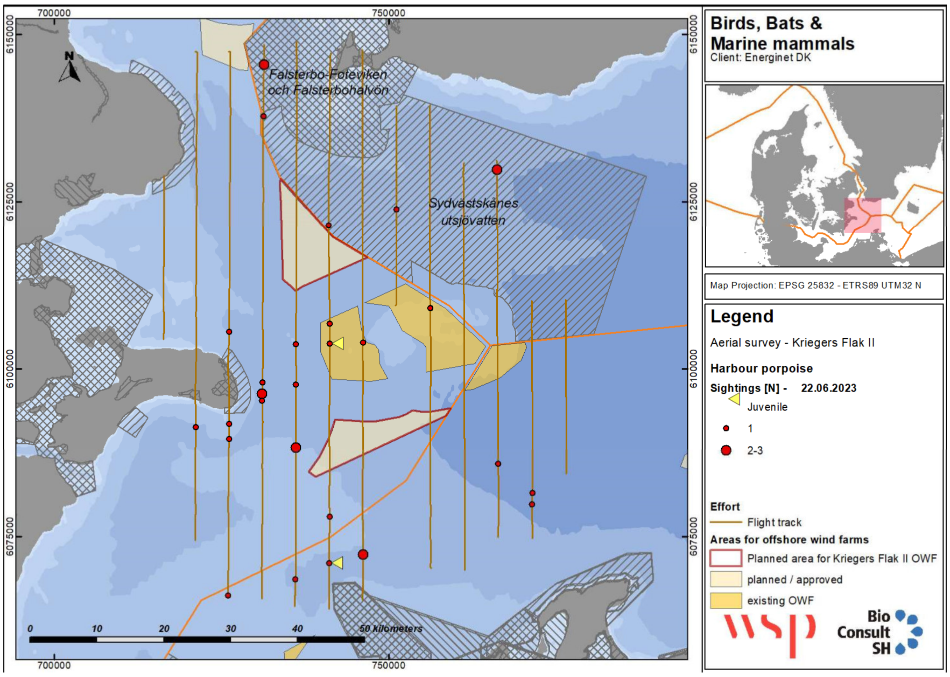

Figure 9-9. Harbour porpoise observations in the pre-investigation area during the digital aerial survey on 22.06.2023.

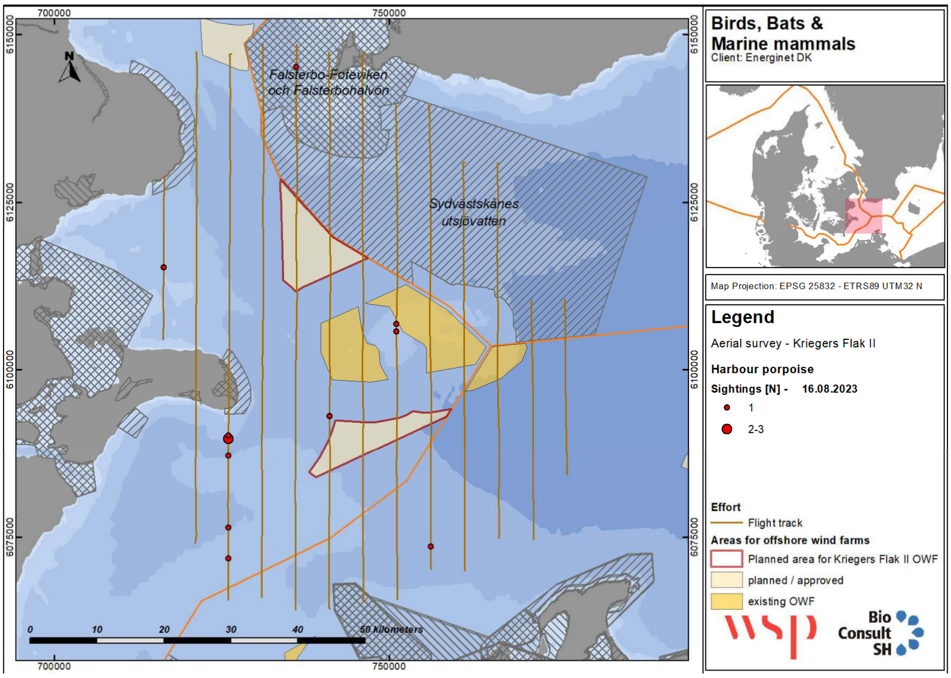

Figure 9-10. Harbour porpoise observations in the pre-investigation area during the digital aerial survey on 16.08.2023.

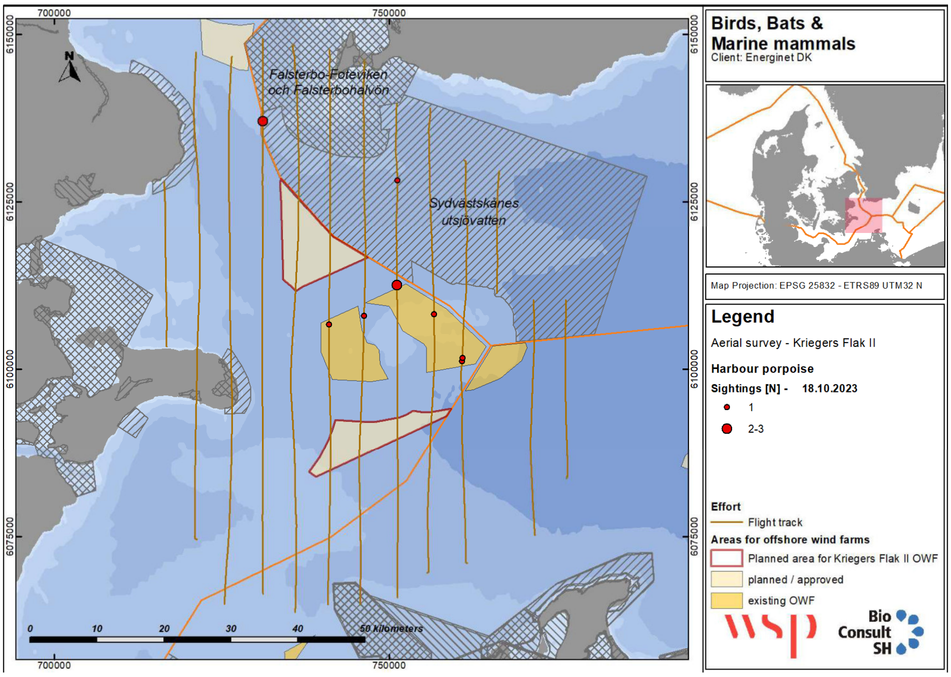

Figure 9-11. Harbour porpoise observations in the pre-investigation area during the digital aerial survey on 18.10.2023

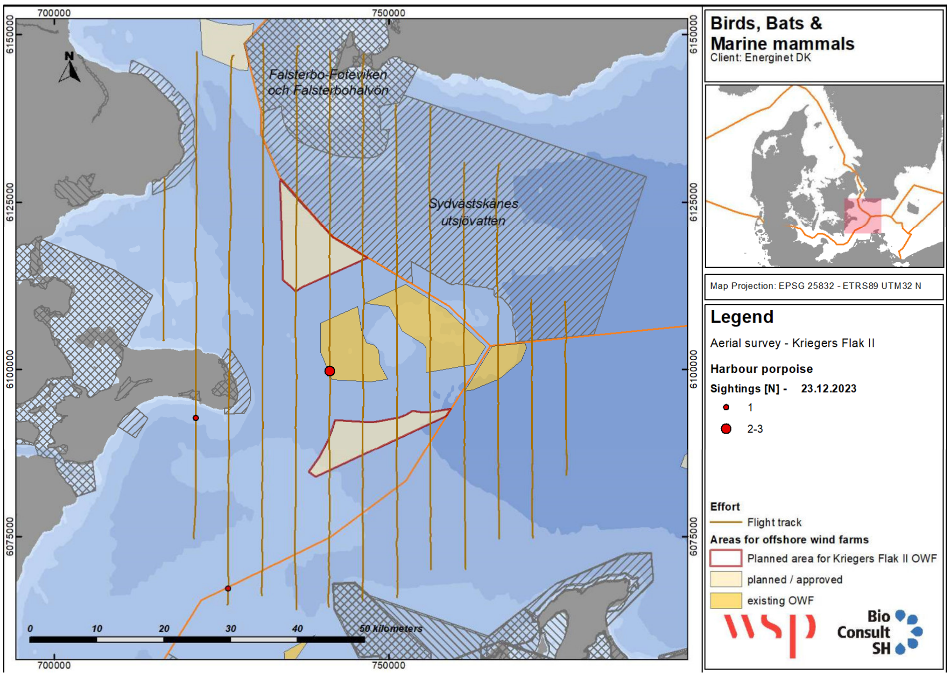

Figure 9-12. Harbour porpoise observations in the pre-investigation area during the digital aerial survey on 23.12.2023