Environmental assessment of Plan for Thor offshore wind farm

Marine mammals and birds

Marine mammals and birds; from the Danish report 2

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This report 'Environmental Assessment of Plan for Thor Offshore Wind Farm: Marine mammals and birds is a translation of the chapters 2.8 Havpattedyr and 2.9 Fugle in the Danish original version 'Miljøvurdering af Planen for Thor Havvindmøllepark, delrapport 2: Miljø på havet'.
In case of divergences between the English translation and the original version, the Danish original version is applicable.

1. MARINE MAMMALS

Environmental status

Danish waters and the Danish part of the North Sea are home to three indigenous species of marine mammals: harbour porpoises, common (harbour) seals and grey seals. The harbour porpoise (*Phocoena phocoena*) is the only Annex IV species which is expected to be a regular visitor to the wind farm area.

White-beaked dolphins (*Langenorhyncus albirostris*) and minke whales (*Balaenoptera acutorostrata*) are only found in the deeper parts of the North Sea /10/ and are not discussed further. Killer whales (*Orcinus orca*) have occasionally been seen in the North Sea, but they are regarded as infrequent visitors /10/ and are not discussed further. A survey conducted by the Danish Centre for Environment and Energy (DCE) in 2019 observed no species other than seals and porpoises, which supports the conclusion that the wind farm area does not affect any species but these /21/.

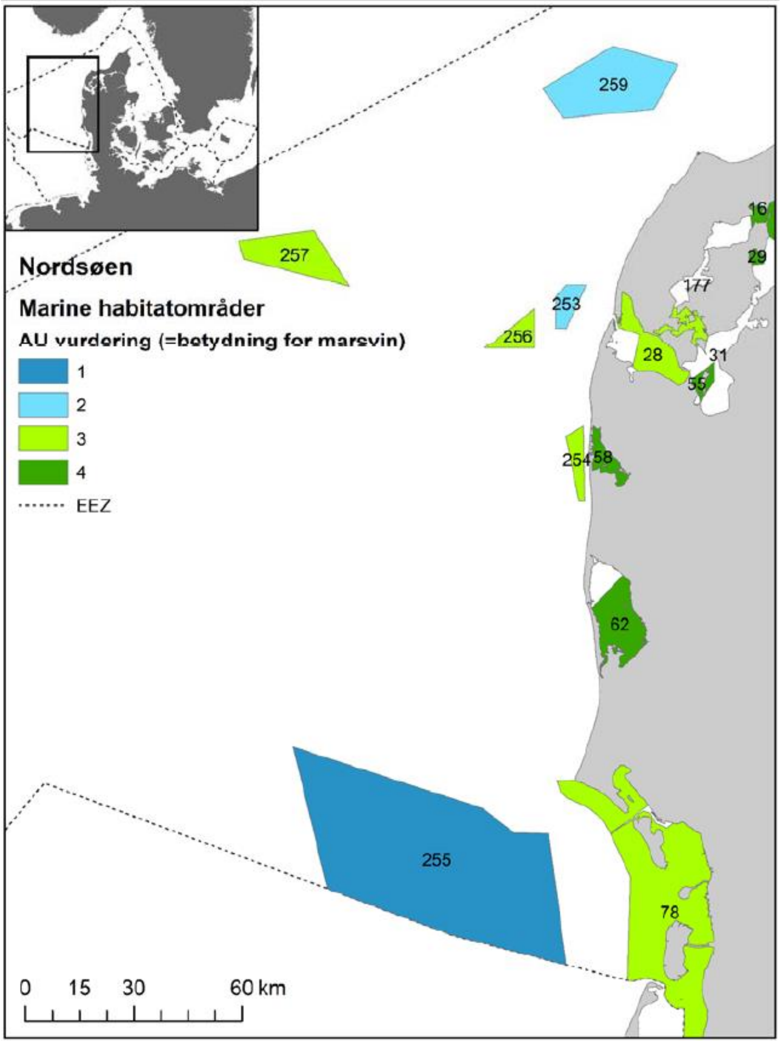
According to the status assessment, the biggest known threat to porpoises and seals comes from accidental by-catch from net fishing, but pollution, underwater noise, heavy ship traffic and reduced food availability can also have a negative effect on these animals.

Harbour porpoise

Harbour porpoises are the most common cetacean in Denmark, and the only species that breeds in Danish waters. Porpoises in Danish waters are divided into three populations – the Baltic population (the waters around Bornholm and further east into the Baltic), the Bælthav population (inner Danish waters, incl. the Bælthav, Øresund, southern Kattegat and western Baltic) and the North Sea population (northern Kattegat, Skagerrak and North Sea). The North Sea population, which is present in the plan area, is estimated at around 345,000 individuals. The animals are mainly found in the eastern, western and southern parts of the North Sea /11/. Porpoises were the subject of a monitoring exercise conducted as part of the NOVANA programme in 2018. The number of porpoises in the whole census area in the southern North Sea (the Danish part of the Wadden Sea region) was estimated at 2,013 individuals (95% confidence interval: 954-3,186) with a density of 0.38 porpoises/km^2 /9/. The SCANS III[1] project also produced density estimates for porpoises of 0.277 individuals/km^2 in the plan area /10/.

Harbour porpoises are not evenly distributed in Danish waters. The species may be present both near the coast and in the open sea but gathers in ‘hot spot’ areas. The nearest identified hot spot area is Horns Rev, to the south of the plan area (habitat area H255), Figure 1-1 and Figure 1-2. The area is considered to be of moderate importance to the population of porpoises, as it is a relatively large area (>20 km^2) with a middling density of porpoises in at least one season /27/. Preliminary figures from the technical survey of marine mammals in connection with the Thor offshore wind farm /50/ show that the distribution of harbour porpoises is in the same order of magnitude as previous studies, albeit slightly higher (0.47 and 0.41 individuals / km^2 for April and June / August, respectively).

[1] SCANS III: Small Cetaceans in European Atlantic waters and the North Sea (2016)



1: Region with a high density of harbour porpoises in at least one season, an area of >20 km^{2,} of major importance to the relevant population.
2: Region with a high density of harbour porpoises, but too small an area (≤20 km2) to have a significant effect on the harbour porpoise population. Or a large area with a middling density of harbour porpoises in at least one season.
3: Region with a middling density of porpoises, but too small an area (≤20 km^2) to have a significant effect on the harbour porpoise population. Or a large area with a low density of harbour porpoises.
4: Small area (≤20 km^2) with a low density of porpoises and therefore little effect on the harbour porpoise population.

Figure 1-1 Figure from /27/. Map of Danish habitat areas in the North Sea with habitat numbers and AU's assessment of the importance of each area to harbour porpoises, on a scale from 1-4.

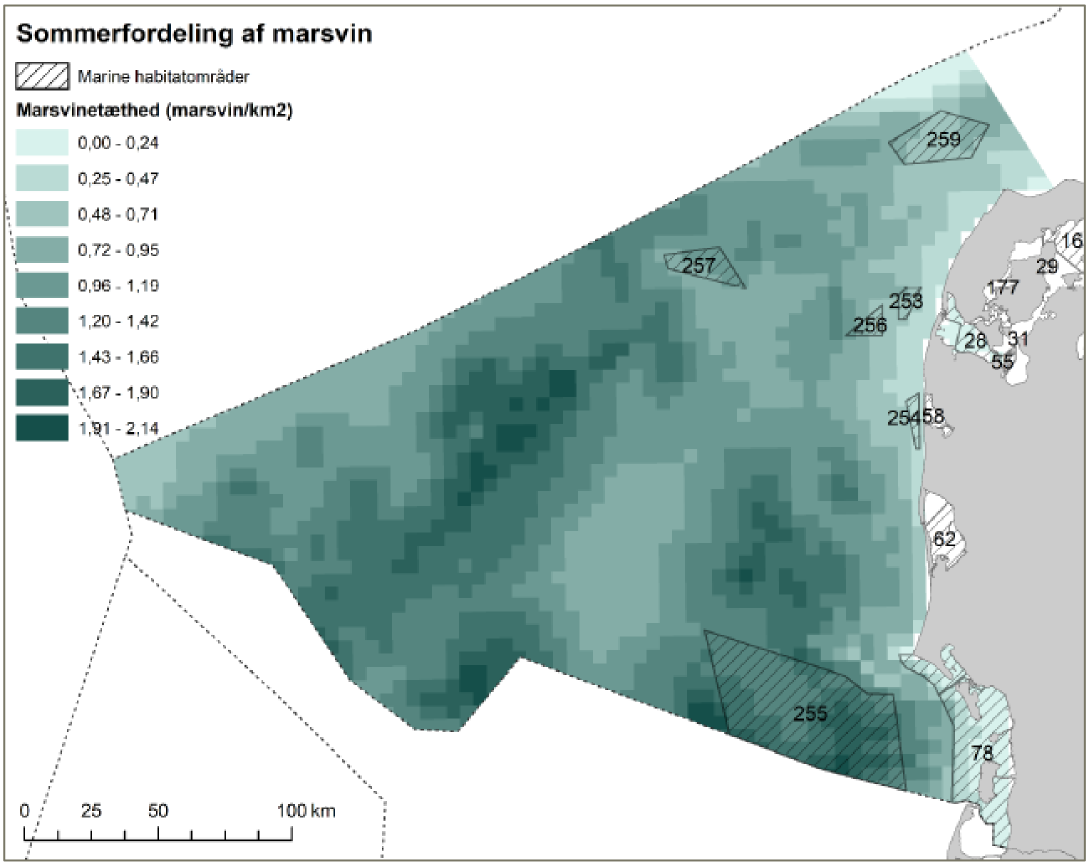


Figure 1-2 Figure from /27/. Modelled absolute density of harbour porpoises in the North Sea during summer (June-August), and existing habitat areas with habitat numbers shown (modified from /54/). Habitat area 255 Horns Rev is a hot spot for harbour porpoises.

With a weight of just over 50 kg and body length of around 1.5 metres, the harbour porpoise is one of the world's smallest cetaceans. Harbour porpoises feed mainly on cod and herring, including sand eels, but they are opportunists and adapt to whatever prey is available. Harbour porpoises navigate and hunt by means of echolocation, which means that they emit clicking sounds to find their food and use their hearing to locate their prey. This enables them to hunt for food in the dark, although they can also see well underwater. Porpoises have a fast metabolism and need to eat often, so they also hunt at night /17/. When foraging, a porpoise is typically submerged for 2-3 minutes. There is generally a good correlation between the availability of food and the presence of porpoises, and the best habitats are assumed to coincide with a good food supply /13/. To the south of the area around Thor is a spawning area for sand eels (see section 2.7 Marine flora and fauna in report 2, in Danish language)), and the likelihood of porpoises using this as a feeding ground is high.

Harbour porpoises' hearing is adapted to life underwater, and communication and foraging take place by means of echolocation. Therefore, harbour porpoises can navigate and search for prey even in complete darkness. Porpoises echo-locate at approx. 125 kHz. The hearing of toothed whales, the group which includes harbour porpoise, is characterised by very high sensitivity (low threshold) to high frequencies, reaching well into the ultrasound band, from approx. 10 kHz to 100-160 kHz /13/. The optimum range for harbour porpoise hearing is shown by the audiogram in Figure 1-3.

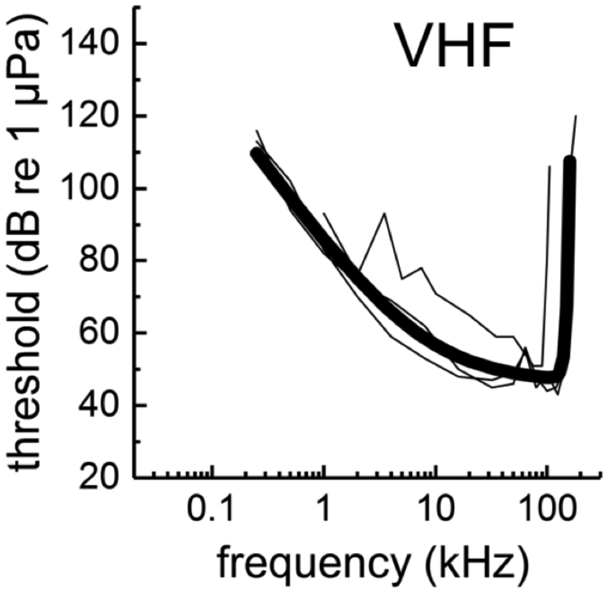


Figure 1-3: Audiogram for harbour porpoise (figure from /15//13/) VHF: very high-frequency. Harbour porpoises are among the mammals using VHF). The audiogram shows the hearing threshold; Harbour porpoises can register sound above the threshold (the thick black line) at each frequency. The best chance of registering sound is at frequencies with the lowest threshold.

No specific breeding areas have been identified in Danish waters, but a high mother/calf ratio in the summer months has been observed along the west coast /17/. The males are sexually mature at 2-3 years and the females at 3-4 years. Harbour porpoise mate from July to August. Pregnancy lasts around 11 months, and the calves are born in June-July. The calves then suckle for five to eight months.

Harbour porpoises are listed in Annexes II and IV of the Habitats Directive 92/43/EEC, list II of the Bonn Convention and Annex A to the CITIES/Washington Convention. Porpoises are also protected under the Danish Order on the Protection of Species (Executive Order no 1466 of 06/12/2018). The porpoise populations in the North Sea, the Skagerrak and the inner Danish waters are considered to be stable and are listed as 'least concern' (LC) on the Danish Red List from 2019[2].

Harbour) seal

The harbour seal is the most widespread species of seal in Danish waters, and is divided into four populations: Western Baltic, Kattegat, Limfjorden and Wadden Sea. The species is seen mainly inshore and usually close to haul out places (seal colonies). Seal colonies are well-known and do not change from year to year. Figure 1-4 shows seal colonies in Danish waters. There are no harbour seal colonies close to the plan area for the offshore windfarm. Harbour seals were given protected status in 1976, when the total Danish population was around 2,000 individuals. The most recent census figures for harbour seals from 2018 indicate a total Danish population of approx. 13,000 animals /9/. The population in the Wadden Sea is spread over the whole coastline and is therefore shared with Germany and the Netherlands. In 2018 the total number of common seals was estimated at 3,400 in the Danish part of the Wadden Sea /9/. Observations of harbour seals made by the DCE in 2019 /21/ and the position of seal colonies (haul out places) indicate that the site for the Thor offshore wind farm is not a core area for common seals.

[2] Aarhus University, Department of Bioscience, http://bios.au.dk/raadgivning/natur/redlistframe

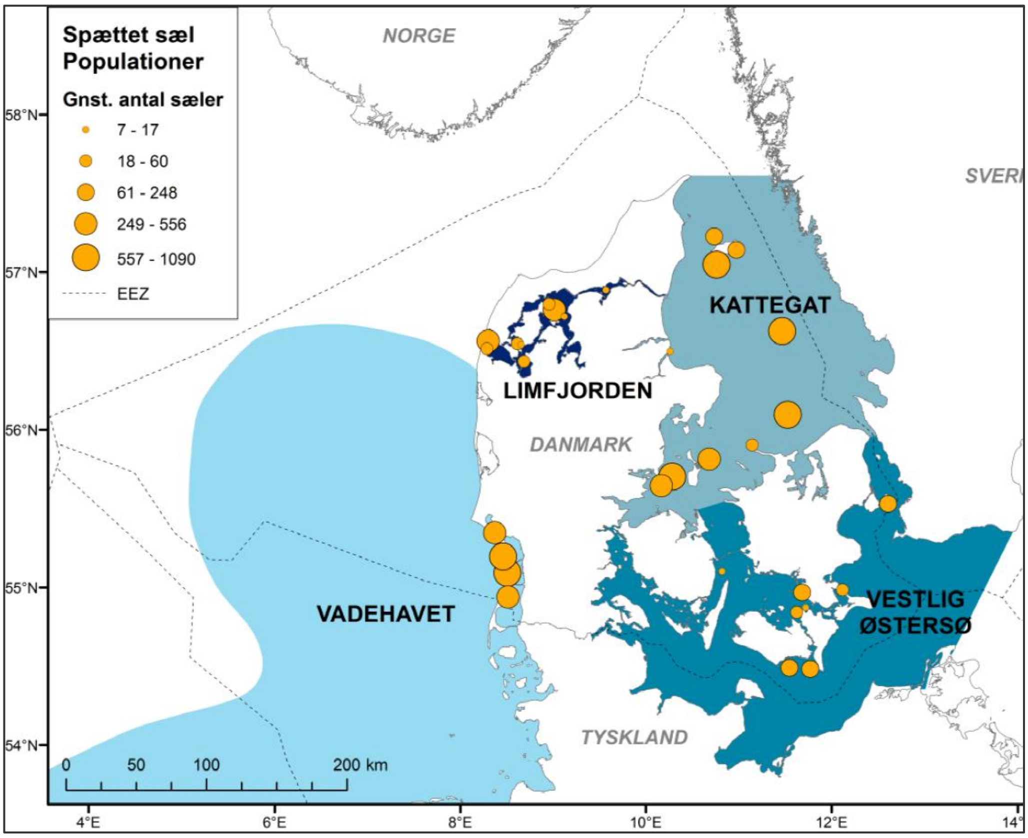


Figure 1-4: Distribution areas for populations (shaded in blue) of harbour seals in the Wadden Sea, Limfjorden, Kattegat and western Baltic. Major harbour seal colonies are marked with yellow circles. The average number of seals at a haul out place is estimated based on counts taken in the moulting season in August 2015 and 2016 /18/ /19/.

Harbour seals can be over 1.5 metres long and weigh more than 100 kg. The males are larger than the females. Their diet is mostly fish, which they hunt mainly by sight, but they also use their whiskers to search for food, which enables them to forage in the dark. Seals are opportunistic and adapt to the fish species available in their feeding grounds.

Seals have amphibious hearing and can hear in both water and air. The optimum frequency range for harbour seals is from a few hundred Hz to approx. 50 kHz (Figure 1-5). The audiogram shows the hearing threshold, which means that the species can only pick up sound above the threshold for each frequency (frequencies above the line). There is not the same data for grey seals, but it is assumed that the same audiogram would apply to them too /13/.

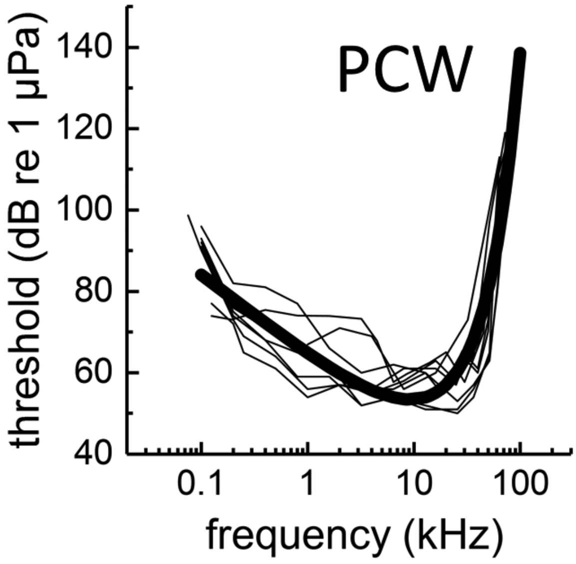


Figure 1-5 Audiogram for harbour seal (from /14/. PCW: Phocid (true seal) in water). The audiogram shows the hearing threshold; seals can register sounds above the threshold (the line) at each frequency. The best chance of registering sound is at frequencies with the lowest threshold.

Seals are considered most sensitive to disturbance in the breeding season, when they are moulting, and when they spend time on land. Harbour seals breed in all parts of the Danish Wadden Sea. The females are sexually mature at 4-5 years and the males at 4-6 years. Seals generally mate in July and August. Pregnancy lasts around 10.5 months, and the pups are born in June-July. The pups then suckle for about a month in June-July, before they are weaned. Moulting takes place in August-September. The species is very settled in terms of seal colonies, but seals may forage many kilometres from their permanent haul out place /18/, though typically under 25 km /19/.

The harbour seal is protected under Annex II to the EU Habitats Directive and the Convention on the Conservation of Migratory Species (the Bonn Convention). The species is also protected under the Danish Order on the Protection of Species (Executive Order no 1466 of 06/12/2018). Harbour seals are listed as ‘least concern’ (LC) on the Danish Red List[3].

Grey seal

There are two separate populations of grey seals in Denmark, one in the North Sea with its main distribution around the UK and in the German and Dutch Wadden Sea areas and the other in the Baltic with its main distribution around Stockholm, Estonia and southern Finland. Census counts of moulting grey seals were launched in 2015, when 164 individuals were counted in the Wadden Sea in April, rising to 173 in 2016, 332 in 2017, then 229 in 2018.

Like harbour seals, grey seals live close to the coast, but swim to a greater extent than harbour seals on longer foraging trips and can thus be observed far out to sea. Satellite tracking of grey seals has shown that the species ranges over many hundreds of kilometres in the Baltic Sea /19/. The species is very settled in terms of haul out places. Figure 1-6 shows haul out places for grey seals.

[3] Aarhus University, Department of Bioscience, https://bios.au.dk/raadgivning/natur/redlistframe/

Observations of grey seals made by the DCE in 2019 /21/ indicate that the plan area for Thor offshore windfarm is not a core area for grey seals.

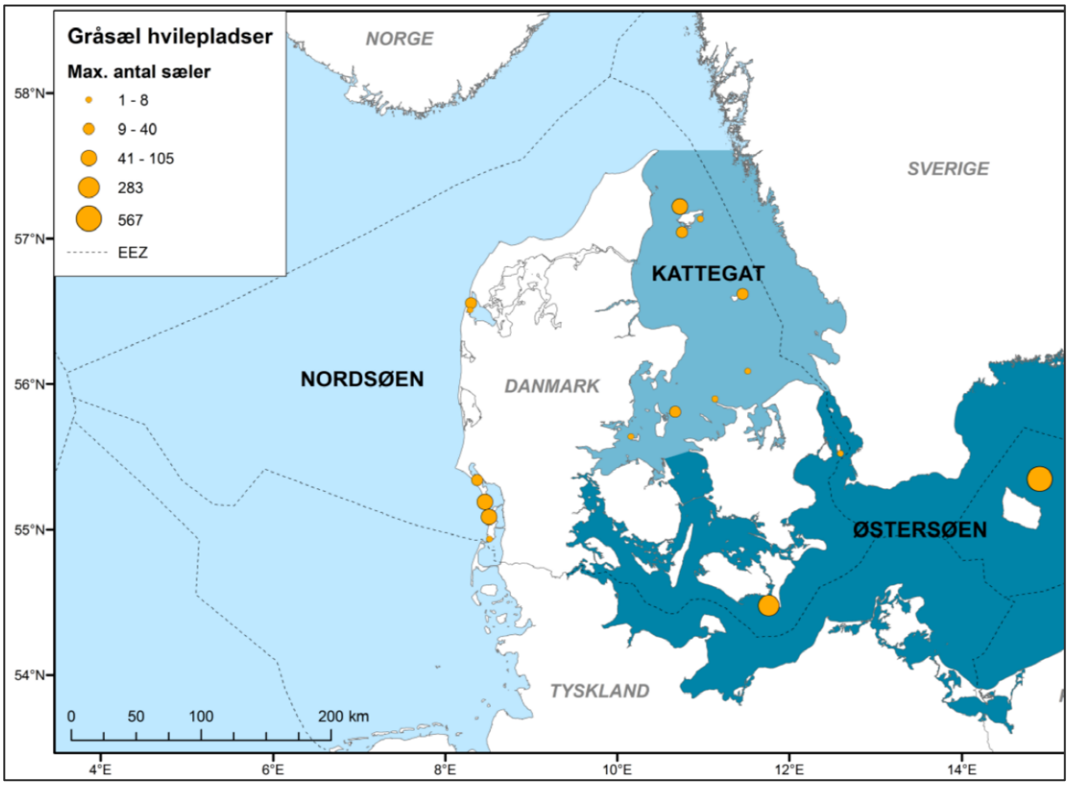


Figure 1-6: Distribution areas for populations of grey seals (shaded in blue) in the North Sea (Nordsøen) and the Baltic (Østersøen), and the overlapping area in the Kattegat. Major haul out sites for grey seals are marked with yellow circles. The average number of seals at a haul out is based upon counts in the moulting period in August 2015 and 2016.

The grey seal is a large animal and the male, which is around 1½-2 times the size of the female, can grow to over two metres and weigh up to 300 kg. Like the harbour seal, they are opportunistic when it comes to food and eat the available fish species.

Grey seal hearing is assumed to be similar to that of the common seal (see Figure 1-5).

Like harbour seals, grey seals are sensitive to human interference in the breeding season, while the pups are suckling and in the moulting season. The females are sexually mature at 4-6 years and the males at around 6 years. Pregnancy lasts around a year. In the North Sea, grey seals give birth from September to October /20/. The young then suckle for 18 days on average, before they are weaned. The females mate around 1 month after giving birth. The moulting season for grey seals in the North Sea starts in March, peaking in April /18/. Most grey seals in Danish waters are therefore just visiting and are assumed to return to their original birthplace when they are ready to breed.

The grey seal is a protected species listed in Annexes II and V to the Habitats Directive and Annex III to the Bonn Convention. In Denmark, the species is also protected under the Order on the Protection of Species (Executive Order no 1466 of 06/12/2018). The grey seal appears as a vulnerable species on the Danish Red List[4]. The conservation status of the species is considered unfavourable because of the population is very small

[4] Aarhus University, Department of Bioscience, https://bios.au.dk/raadgivning/natur/redlistframe/

and fluctuating. The most important locations for seals in Danish waters are subject to reserve provisions, to provide the seals with undisturbed haul out places particularly in the breeding season, during suckling and when they are moulting[5].

Environmental assessment.
The probable effects on marine mammals will depend entirely on the specific project and the number and type of wind turbines, the locations of the individual turbines, foundation methods etc. The environmental assessment therefore deals mainly with the primary potential effects at a general level.

An offshore wind farm could produce the following most significant sources of impact on marine mammals:

- Sediment spill in the construction phase
- Underwater noise from pile-driving and vibration in the construction phase
- Area intake and altered habitat in the operational phase
- Underwater noise and vibrations in the operational phase

There could also be noise and disturbance from other construction works (shipping, excavation work etc.). This impact is expected to be marginal for marine mammals and will not be discussed further in this context.

Sediment spill
Sediment spill will occur in the construction phase as turbine foundations are established and cables laid. Sediment spill could cause an increase in suspended material in the water column, and high concentrations could affect marine mammals. Based on experience from other offshore wind farm projects, such as Vesterhav Nord and Vesterhav Syd /1//2/, the amount of sediment spill is expected to be limited. Despite that spill is expected to be limited, it is worth noting that harbour porpoises communicates and forages with the aid of echolocation. Its behaviour and foraging activity are therefore not dependent on vision. Any reduction in visibility is therefore assessed to have no impact on porpoises.

Studies have shown that vision is not crucial for seals to be able to navigate and find food in the water. As any spill is expected to be limited and temporary, it is unlikely that there will be any visual or behavioural changes that could have a significant impact on seals.

The indirect effect of sediment spill on marine mammals could be in terms of affecting food availability whereby sand eel eggs become buried. The eggs are a likely important food source in the area, however the impact is assessed to be small. The plan for the Thor offshore wind farm only affects the northernmost part of the spawning ground for sand eels, and sediment spill is expected to be limited in extent and short-term. A significant impact on the food supply is thus unlikely (see section 2.7 on Fish report 2, in Danish).

Underwater noise and vibrations in the construction phase
Activities involved in the construction of a planned offshore wind farm will cause underwater noise and vibration of varying frequencies and intensities, which could affect marine mammals. The main construction activity which will generate underwater noise is likely to be related to the establishment of turbine foundations. Here we assume a worst-case scenario in terms of noise, which derives from driving in of monopiles.

[5] Management plan for common and grey seals. https://mst.dk/media/117662/saelforvaltningsplan2005.pdf

The ramming of monopiles for the wind turbines will generate a particularly high level of noise, which could potentially cause permanent hearing loss (PTS), temporary hearing impairment (TTS), and behavioural changes and hence habitat displacement for marine mammals.

More specifically, the effects of noise on marine mammals can be broken down into different zones of impact: audibility, behavioural responses, masking (of other sounds) and physiological damage (temporary or permanent hearing loss (TTS and PTS)[6], and in extreme cases, other physiological damage or death); see Table 1-1. As different groups of animals have different hearing and differing sensitivity to noise, the extent of these zones will be species-specific /28/.

Table 1-1 Possible effects on marine mammals from underwater noise.

Impact	Explanation
Permanent threshold shift - PTS	• Permanent hearing loss. Damage to the sensory organ. The hearing loss is not reversed after exposure. As most species are dependent in their hearing, any hearing loss will reduce their viability and may result in death. The degree of impact will depend on the PTS level, where high PTS levels are more serious than low levels (at which survival is not significantly reduced). Limits for PTS are shown in Table 1-2.
Temporary threshold shift - TTS	• Temporary hearing loss. Hearing will return with time (from seconds to hours), depending in the level of exposure. As the effect is relatively short-lived, the viability of the species is not significantly affected. Limits for TTS are shown in Table 1-2.
Behaviour	• Underwater noise which does not cause TTS or PTS can still affect marine mammals in the form of altered behaviour, which may n turn affect the individual's long-term survival and reproductive success. • Avoidance behaviour can range from panic and flight to confusion. Panic behaviour can have serious effects in the form of by-catch, stranding etc., which may in turn result in death. Flight and confusion behaviour can reduce the time for foraging and suckling pups, in turn reducing the survival chances of these species. • Masking is a situation in which noise from the project prevents other sounds from being picked up and identified. Masking is relevant in the case of continuous noise and coincides in time and falls within roughly the same frequency band. The effect of masking on marine mammals has not been assessed in the scientific literature. • The behavioural response to noise (other than avoidance behaviour) could include altered swimming patterns. The behavioural responses can be hard to predict and hence assess, but they are recognised as an extremely important parameter when it comes to measuring disturbance from underwater noise. • Thresholds for behavioural response are shown in Table 1-2.

This study only examined the effects of impulse noise. The Danish authorities recommend the following limits /28/ (Table 1-2)[7] for hearing damage and behavioural change resulting from impulse noise.

[6] TTS: Temporary threshold shift
PTS Permanent threshold shift

[7] More recent limits for hearing damage and behavioural change resulting from both types of noise are regarded as the latest /26/ (and comments from J. Tougaard, DCE), which are an update to the limits currently recommended by the authorities.

Table 1-2 Estimated threshold levels for behavioural change and PTS in porpoises and seals from impulse noise (see /49/).

Impact type*	Porpoises			Seals		
	PTS (unweighted)	TTS (unweighted)	Behaviour	PTS (unweighted)	TTS (unweighted)	Behaviour
Impulse noise (Piling)	190 dB SELcum	175 dB SELcum	140 dB SEL	200 dB SELcum	176 dB SELcum	142 dB SEL

SEL limits in dB re 1 μPa^{2}s underwater

The spread of underwater noise will depend on the expected sound speed profile for the water column, the depth of water and the geo-acoustic properties of the seabed. From a combination of the threshold levels, the construction activities and a model to calculate the spread of noise, a later environmental impact assessment phase could include a specific evaluation of the impact on marine mammals from the establishment of an offshore wind farm.

Early modelling of underwater noise for the present preliminary survey /49/ shows that porpoises may be expected to suffer PTS up to 16 km away and seals up to around 3 km. For TTS and other disturbance, the range of potential impact will be up to 50 km.

It should be emphasised that these model calculations have been produced *without* any mitigating measures being taken. If mitigating measures are included, the results will be very different. The noise findings highlight the importance of mitigating measures to provide protection for marine mammals. See section on “Mitigating measures and recommendations”.

PTS, TTS and behaviour

As mentioned above, it is expected that, without mitigating measures, there is a risk of permanent hearing damage which could have a serious impact on seals and porpoises. Mitigating measures in the form of bubble curtains, seal scarers and pingers etc. will possibly reduce any major impact. Pile-driving is also expected to be carried out in accordance with the guidelines from the Danish Energy Agency /24/, which call for a soft-start/ramp-up (mitigation) to ensure that marine mammals are outside the risk area for PTS. The environmental impact analyses for Vesterhav Syd and Nord included modelling of the spread of noise from pile-driving including mitigating measures. The results showed that there was no risk of PTS (when mitigating measures were included), but there was a risk of TTS up to 24 km from the piling area /1//2/. As noted in the EIAs, these estimates are conservative, as the limits used are unweighted /24/.

It is also likely that the construction period will see behavioural changes and displacement of porpoises and seals in the area. The results from Vesterhav Syd and Nord showed that there was a risk of impact on behaviour up to 26 km from the piling area /1//2/. The displacement is expected to be temporary (i.e. during the construction period).

The effects of noise could cause behavioural changes, but there is no risk of permanent damage to the animals’ hearing (PTS) and only a small risk of temporary damage (TTS) for porpoises and seals in the area. The impact will be reversible and short-lived.

Studies at other offshore wind farms indicate that animals that leave the area in the construction phase return relatively quickly /25/. Monitoring of marine mammals during the construction and operation of Horns Rev offshore wind farm /22/ shows that effects on seals were only seen from pile-driving and that seals both at sea and on land were generally unaffected by the construction and the operation of the wind farm. It was also shown that the number of porpoises fell slightly during the construction works but rose again after the wind farm went into operation. At Nysted offshore wind farm, however, porpoises took longer to return to the area /22/.

As the site of the Thor offshore wind farm is not a core area for porpoises /12/ and is located more than 70 km away from any known core areas (habitat areas: southern North Sea, Gule Rev and Skagens Gren and Skagerrak /12/), and as the area is well away from any seal colonies (Figure 1-4, Figure 1-5 and Figure 1-6) the likely impact is not considered to be significant.

Underwater noise and vibrations in the operational phase
The operation of offshore wind farms can give rise to emissions of noise and vibrations from the turbines. Studies of existing off shore wind farms: Rødsand /30/, Anholt /32/ and Sprogø /33/, along with Horns Rev /22/ and Egmond aan Zee /31/, indicate that operational underwater noise is limited. Monitoring of these facilities showed that the density of porpoises was at the same level or higher in and around offshore wind farms as before they were built, which indicates that no impact from their operation can be identified. Similar observations at e.g. Horns Rev also conclude that seals are not affected by its operation /22/. All in all, it is therefore assessed that the operation of an offshore wind farm will not have a significant impact on marine mammals living in and around the site.

Area closure and altered habitat in the operational phase
Establishing foundations for wind turbines involves introducing hard substrate, which can cause reef effects over time. Hard substrate attracts bottom fauna and fish, and the latter could potentially increase the food supply for marine mammals. Harbour porpoises are expected to forage for sand eels in the area to the south of the plan area. As the food supply for porpoises will not be immediately removed, and as an artificial reef will be introduced which could potentially increase the volumes of food, the habitat changes are considered to be minor. This is supported by a study showing increased porpoise activity around a restored stone reef /34/, and a study showing that seals may search around the turbine foundations in their hunt for prey /35/.

Mitigating measures and recommendations
For the more detailed planning of the Thor offshore wind farm, it is recommended that mitigating measures be included in connection with the ramming monopiles and other very noisy activities, to avert any significant impact on marine mammals. Apart from the expected requirements from the authorities for the use of soft-start/ramp-up before work starts, noise reduction measures could include bubble curtains, pingers and seal scarers.

2. BIRDS

This section provides a brief description of the major groups of birds in and around the site of the Thor offshore wind farm.

Environmental status
In 2020, a host of data from aerial and ship surveys of the North Sea/Vesterhav from earlier monitoring was collated and processed, including other offshore wind farms etc. and more recent aerial surveys in and around the site of the Thor offshore wind farm /36/. These surveys all concur that the major groups of birds around the Thor site can be confined to divers, gannets, gulls and auks, cf. /1//2//21//36//37//38//39/.

These birds forage at the water surface or are pelagic and are present in varying numbers, reflecting the availability of food which is mainly influenced by hydrographic factors such as currents, wind, depth, waves, salinity etc. (see section on Seabed and water quality, report 2 in Danish)) and also the season. The studies show that the largest numbers of birds may be observed at the end of winter in February and in April, May and October.

Diving ducks, such as common scoter, have not been seen around the site for Thor, but have been recorded in more shallow waters, e.g. close to the coast or further south, near the northern part of Horns Rev, as common scoter have a clear preference for water depths lower than 18 m, as it is generally too energy-intensive to dive deeper for food. As the depths around Thor are around 21-35 m, common scoter and other diving ducks will not be discussed further.

The area of Thor Offshore Wind Farm with a distance of at least 20 km to the coast does not constitute a main migration corridor for waterfowl s /1//2/.

Divers
Divers (red-throated and black-throated divers) are most frequently seen in the winter and at the end of the spring migration, generally with increasing numbers of birds from around February-March, as the great majority of the population is assumed to migrate to Greenland, northern Scandinavia and Siberia, where the divers breed in the summer season. Only a few individuals spend the summer in Danish waters.

The distribution of divers is mainly controlled by differences in salinity, but the availability of food and the depth of water also is a factor, as the density of divers falls in areas of water deeper than 25 m. The depth of water on the eastern and south-eastern part of the site is lowest (up to 30 m), and the area is home to e.g. sand eels (see section on fish below), which are preferred by divers. This could explain why the number of divers is greatest in this part of the site, although the density of divers in the area is relatively low; see Figure 2-2 which shows the highest densities occurring in the spring /36/.

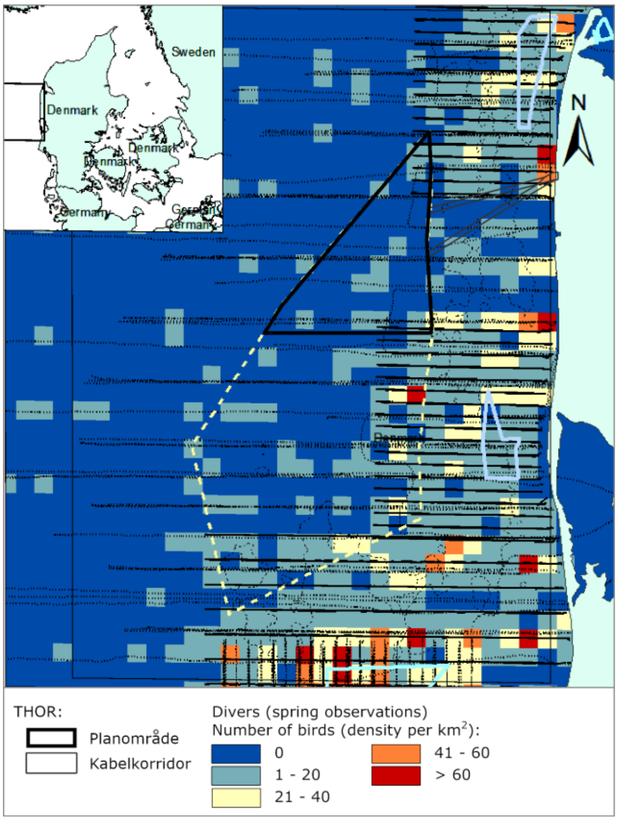


Figure 2-1 Modelled densities (number/km^2) of divers in the spring. (Divers = red-throated and black-throated divers) /36/.

The remainder of the site is less important for divers, as the depths increase to more than 30 m. By far the biggest populations of divers have been observed in the southern and eastern parts of the Danish North Sea, with the largest numbers observed in the waters from Hvide Sande in the north to the boundary with the German EEZ in the south.

Auks

Here, 'auks' cover razorbills and common guillemots. These two species are almost identical in size and plumage and are often recorded simply as 'auks', e.g. when conducting aerial surveys.

Common guillemots are widespread in the North Atlantic and the northern Pacific. Outside the breeding season, the guillemot is a common bird in Danish waters and overwinters in the central and eastern parts of the Kattegat. From the end of July to February, at least 200,000 birds are present in Danish waters. The birds in the western Danish waters and the Kattegat are thought to originate mainly from the Scottish colonies.

Razorbills as a species are distributed all around the North Atlantic. In Denmark, they breed in two locations on Bornholm. In Europe they breed from northern Scandinavia and the Kola Sea in the north to north-west France in the south. There are also populations in the North Sea, including the Danish groups. In the winter season, razorbills are a common sight in Danish waters. The modelled distribution based on censuses taken in the winter is shown in Figure 2-2.

In and around the Thor offshore wind farm, razorbills are present at low to medium densities outside the breeding season. Common guillemots are present at lower densities than razorbills and mainly in deeper sea areas with high salinity and clear water, so there are unlikely to be high densities (> 10 birds/km^2) around the site of Thor /36/. The modelled distribution based on censuses taken in the spring is shown in Figure 2-2.

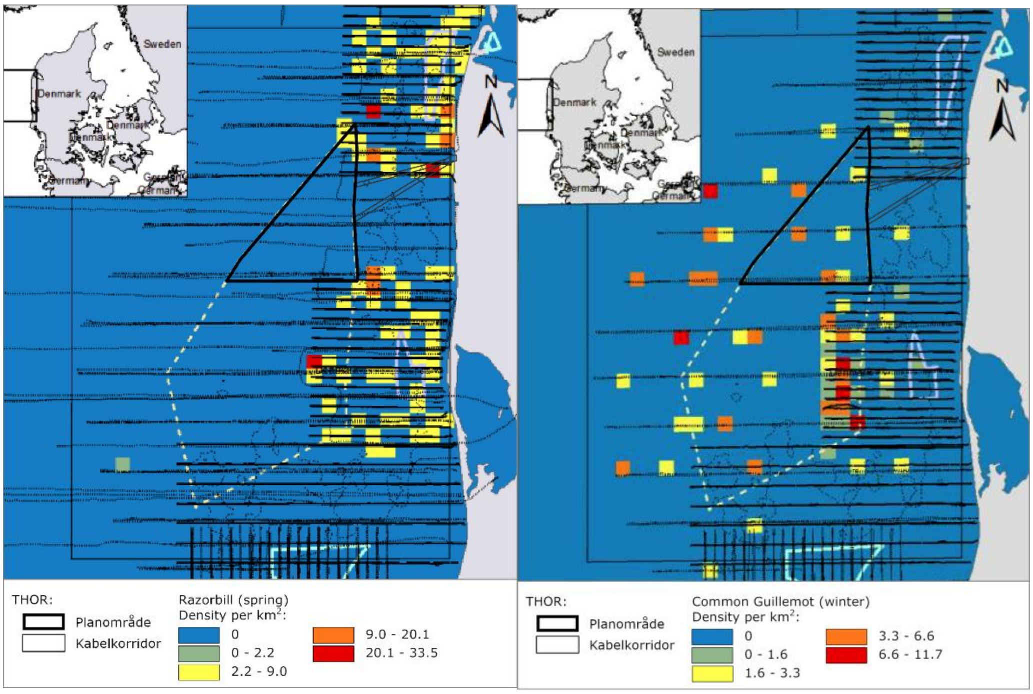


Figure 2-2 Modelled densities (number/km^2) of razorbills - springtime observations (left) and of common guillemots - winter observations (right) /36/.

Note that, within one month's surveys in 2019 there is a wide variation in the numbers of razorbills and common guillemots observed, rising towards the end of October 2019 /38/; see Figure 2-3 .

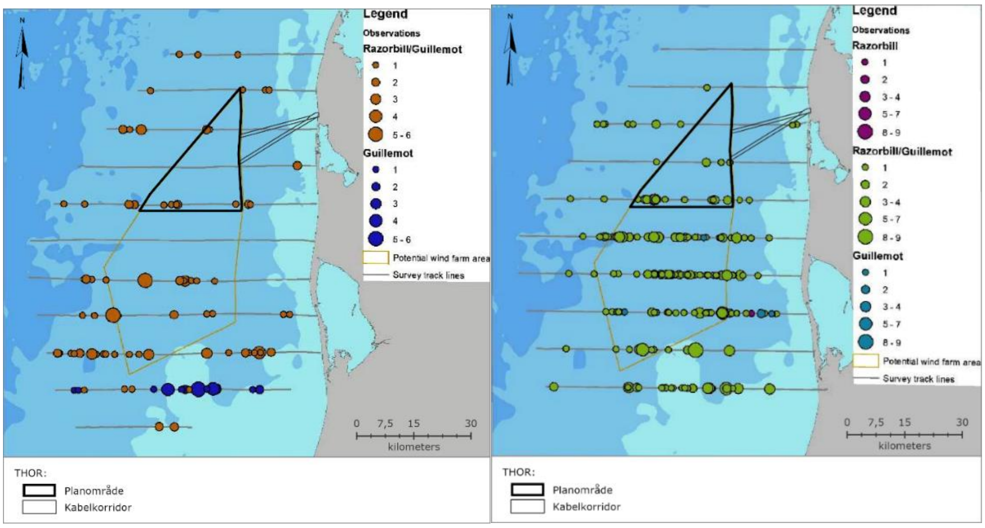


Figure 2-3 Observations of numbers of razorbills and auks (razorbills/common guillemots) at the beginning of October (left) and late October (right) in 2019 in flight transects /38/.

Northern gannets

Northern gannets breed only in the North Atlantic, most of them in large colonies. In Denmark, the northern gannet is a frequent autumn migrant in the North Sea and the

Kattegat, but is relatively dispersed in and around the Thor site, as can be seen in Figure 2-4 based on aerial surveys in 2018-2019 /36//38//39/.

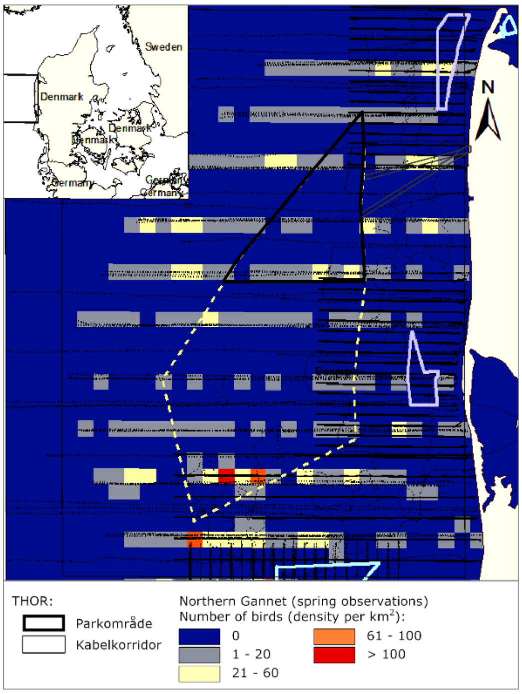


Figure 2-4 Modelled densities (number/km^2) of northern gannets – springtime observations /36/.

It is new for northern gannets to be seen in the eastern North Sea along the west coast of Jutland (and in the Kattegat). The species is closely associated with areas deeper than 20 m with high salinity. The occurrence of the species is probably governed by the available food, e.g. large herring and mackerel. Hence, records generally show, that northern gannets spend little time in any one place /36/.

Gulls

Several different species of gull have been recorded in the area around the survey site, including common gulls, herring gulls, lesser and great black-backed gulls and kittiwakes. The gulls are generally relatively evenly distributed within the survey area, but one species, the common gull, demonstrates preference for the northeast, bordering the site of the Thor offshore wind farm. The occurrence and distribution of gulls is typically linked to the presence of fishing vessels, although less so in the case of lesser black-backed gulls. Figure 2-5 shows the scattered observations from October 2019.

Gulls also include black-legged kittiwake, which breed in a few colonies in Denmark, in Bulbjerg and around the port of Hirtshals. Kittiwakes can be seen in the summertime along the west coast of Jutland in large flocks of young, non-breeding birds. These are British and Norwegian birds which seek out shallower waters and sandbanks along the coast to moult. Outside the breeding season, kittiwakes normally stay far out to sea, but heavy storms may drive large flocks inshore. There are few observations in the area of Thor offshore wind farm, see Figure 2-5 /38/.

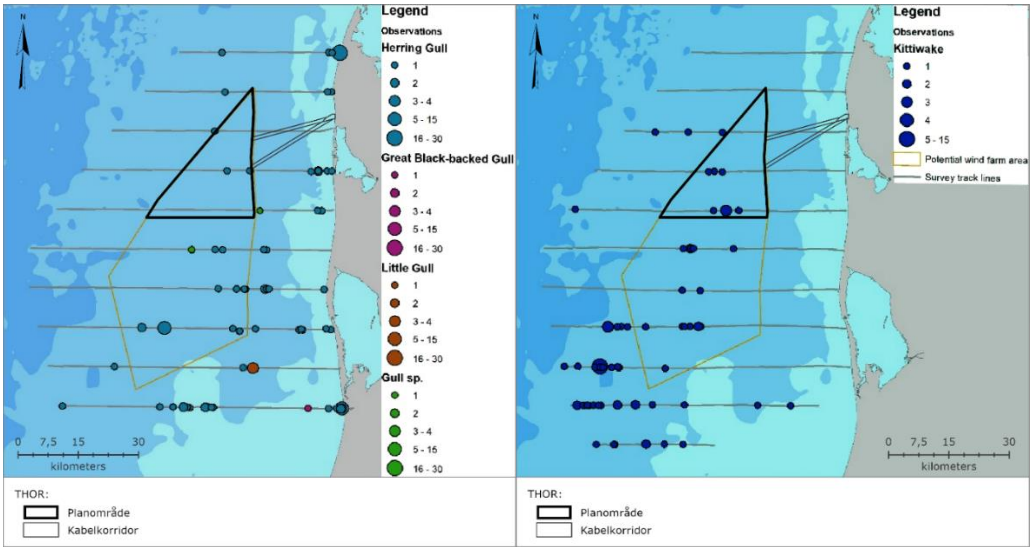


Figure 2-5 Observations of numbers of gulls – herring gulls, great black-backed gulls, little gulls (left side), and numbers of kittiwakes (right side) from aerial surveys in flight transects during October 2019 /38/.

Environmental assessment.

A possible offshore wind farm could generally affect resting and migrating birds as follows:

- Loss of and changes to habitats – resting birds
- Disturbance and displacement – staging birds
- Collision risk – staging and migrating birds
- Barrier effect – migrating birds

The extent of the impact depends on the specific turbine site, the size and layout of the offshore wind farm, the sensitivity of the individual species of birds and the importance of the specific area to the respective species. This section sets out the potential effects on staging and migrating birds at an overall level.

Staging birds

Loss of and changes to habitats

The activities in the construction phase will be limited to a few years and restricted to the local area where the wind farm is to be built.

Gulls and northern gannets are very flexible in their diet and feeding grounds, and as the number of recorded individuals within the geographical area where the construction activities are planned to take place represents just a small part of the bio-geographical population (less than 1%), the impact from the loss of or change to habitats is assessed to be insignificant.

Seabirds such as divers, gannets and auks typically forage for fish or crustaceans, whose presence is generally governed by currents and tidal conditions, so the birds are not expected to show any specific geographical preferences. Installing turbine foundations and laying cables could potentially have a negative effect on the fishing activities of divers and auks, for example, as visibility will be reduced by suspended sediment. The increase in suspension will however be very local and short-term and will fall within the natural variation in the area (see report 2, section 2.12; in Danish). Both divers and auks are common in areas of relatively high turbidity, and the effect of the construction activities on their foraging for fish is insignificant.

The eastern part of the site is of some importance to divers, although the density of birds is well below what may be found in the area around Horns Rev, for example. Divers generally display limited tolerance towards the activities in the construction phase. As any loss of habitats in the construction phase will be short-term and local, the impact on the divers is assessed to be insignificant.

Habitat loss during operation will be restricted to the area taken up by the turbine foundations and scour protection. That means that the availability of fish on which divers and auks etc. depend is not expected to be affected, as only a very modest area will actually be lost. The turbine foundations may be expected to have a positive impact from the formation of artificial reefs, which will bring positive changes in the composition and total biomass of the bottom fauna and fish populations. Changes to and loss of habitats are therefore not expected to have a significant impact on the birds, whatever their species and wherever a future offshore wind farm is located within the site for Thor. In the eastern part of the plan area are habitats (see Figure 2-6 used by divers, which are sensitive to wind turbines and react to these at some distance, as described below.

Disturbance and displacement
The presence of vessels etc. in the construction phase could potentially impact bird species that are sensitive to disturbances of this kind. During construction the displacement effect resulting from disturbances in the work area itself will be confined to small areas, as work will not be done on the whole site at the same time. All in all, the impact on birds from the displacement effect in the construction phase is not considered to be significant, as only a few birds will be affected for a relatively short period and are generally expected to return to the area when the disturbance is over.

During operation, the physical installation of the offshore wind farm will constitute a disruptive element for the birds. The sensitivity to and degree of disturbance from an offshore wind turbine will vary from one species to another, but for some it may mean avoiding the area altogether and thus being displaced. Factors such as season, age of the birds and local conditions also have an influence on how many birds are displaced, as well as some kind of habituation can be expected during operational for several species.

Divers are especially sensitive to the presence of wind turbines and may be affected within a buffer zone extending for several kilometres around a future offshore wind farm. For a species like the red-throated diver, individual studies have found a statistically significant reduction in the density of birds as much as 12 km from the turbines, although it is uncertain whether this displacement is due to the presence of the turbines themselves. Other studies have shown no change in the density of birds just 500 metres from an offshore wind farm /36/. Overall, there is limited understanding of the processes behind displacement, including whether the displacement is due to behavioural changes or altered availability of food.

Studies before and after the installation of Horns Rev 2 offshore wind farm documented a significant negative impact on the distribution of divers within a radius of up to 5-6 km. With this in mind, it has been calculated how many divers can be expected to be disturbed and displaced as a result of an upcoming Thor Offshore Wind Farm
, assuming a 5.5 km buffer zone; see Figure 2-6 and Table 2-1 /36/.

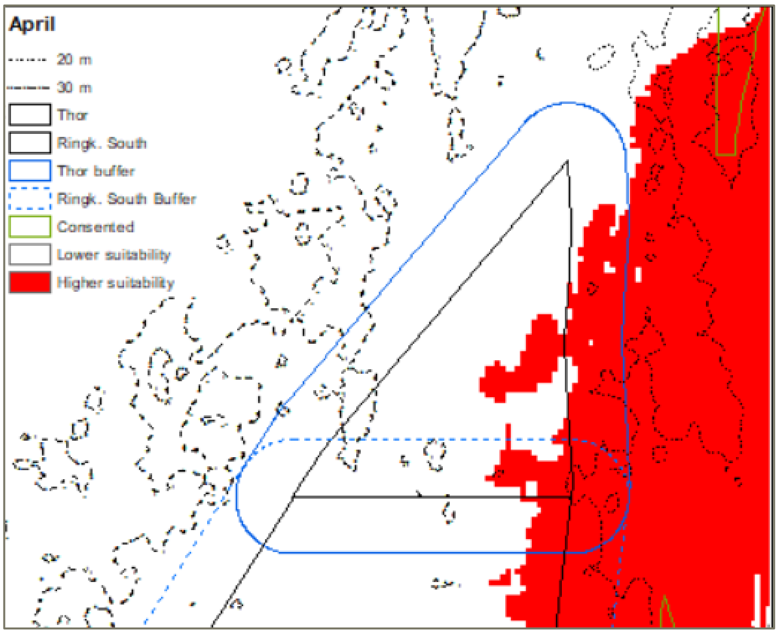


Figure 2-6 Areas with modelled high habitat suitability for staging divers (red-throated and black-throated divers) in April, when most birds can be observed. The site of the Thor wind farm can be seen in the centre, with displacement zones conservatively set at 5.5 km /36/.

Table 2-1 Estimated number of divers expected to be displaced from the Thor plan area, in relation to suitable habitats, proportion of the Danish population in the North Sea and the total bio-geographical population. The most divers are displaced in April (marked in bold) /36/.

Thor wind farm - area (km^2)	Jan	Feb	Mar 440	Apr	May
Area with high habitat suitability within Thor, and extent of displacement (km^2)	263	152	7	243	129
Number of displaced birds	88	68	37	**123**	56
Number of displaced birds as % of total in the Danish part of the North Sea	0.72	0.54	0.38	**0.77**	0.61
Displaced birds as % of total bio-geographical population (wpe.wetlands.org)	0.014	0.011	0.006	**0.020**	0.009

It can be seen from the table that the displacement of divers from the construction of Thor offshore wind farm affects less than 1% of the total population in the Danish part of the North Sea, and is very limited in relation to the overall bio-geographical population. The displacement is highest in April, when the birds are on their way north to their breeding grounds. As the displacement of divers relates mainly to the eastern part of the Thor site, the impact could be reduced by locating a future offshore wind farm in a more westerly part of the area. It should be noted that there are ither areas, e.g. to the south of Thor offshore wind farm, where divers are present in greater numbers.

Collision risk

Vessels and cranes could pose a collision risk for staging birds and birds making local movements between different feeding grounds, as they could collide with construction vessels. The likelihood of collision in such situations must however be considered very small, as the birds may be expected to fly around the vessels to avoid collision, so the impact of collisions in the construction phase is not assessed to be significant.

Recent findings from monitoring detailed movements of e.g. northern gannets and large gulls such as great black-backed gulls, herring gulls and lesser black-backed gulls have shown that these birds can react very close to the wind farms, to the individual turbines and to the rotor blades. This significantly reduces the risk, with a very small number of recorded collisions /40//41/. Auks generally fly close to the surface of the water, so the risk of collision is low.

Overall, the risk of collision for staging birds from an offshore wind farm during operation is expected to be reduced the smaller the total area of the wind farm and the greater the distance between the turbines.

Migrating birds
Barrier effect
The barrier effect relates to changes to preferred migration routes, i.e. where, instead of flying through the wind farm, the birds take alternative routes which may cause increased energy consumption. As a future offshore wind farm will be situated at least 20 km to the west of any land, the number of migrating birds is expected to be limited, as many of these birds make their south-north migration predominantly closer to the coast. A Thor offshore wind farm is not therefore expected to give rise to any significant barrier effect for migrating seabirds wherever it is placed. Positioning the turbines on a north-south axis parallel with the coast and hence parallel with the preferred migration routes of most species of birds will help to reduce any potential impact /1/.

Collision risk
As the site of Thor offshore wind farm at a distance of at least 20 km from the coast is not in an actual migration corridor for water birds, the risk of collision with structures in the construction phase is not considered significant wherever the wind farm is located within in the area.

During operation there is some risk of collision with the turbines, but most species of birds avoid this by taking evasive action, which birds approaching a wind farm can do at three levels:

- By changing course from a long way off, in order to avoid the offshore wind farm,
- By adjusting their course in the horizontal and/or vertical plane, to avoid individual turbines.
- By making last-minute (emergency) manoeuvres, to avoid being hit by a rotor blade.

The extent and nature of the avoidance reactions will vary between the different groups of birds, but the water birds examined here are expected to be able to avoid the turbines. The risk of collision is therefore expected to be low, based among other things on studies of Vesterhav Nord and Syd /1//2/. These studies also show that the estimated number of collisions will be low, at a level with no real effect on the populations of the species in question.

The relative position of the turbines can help to reduce the risk of collision, e.g. by placing them in a linear pattern as at Vesterhav Syd and Nord.

Mitigating measures and recommendations

- A more westerly position on the wind farm site is considered likely to reduce the impact on divers and probably also on auks.
- The turbines could be placed on a north-south axis, to further reduce the risk of collision for any migratory birds.

- The forthcoming EIA should include more detailed calculations and assessments of the collision risk for resting/migrating bords, including auks and kittiwakes as well as gannets, including whether these birds could be at increased risk of collision with offshore wind turbines in periods of stormy weather.

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