CONSULTING MATERIALS

NJORDR OFFSHORE WIND - A JOINT VENTURE BETWEEN VINDKRAFT VÄRMLAND AND NJORDR

PROJECT NUMBER 30028916

MATERIALS FOR CONSULTATION WITH AUTHORITIES

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Table of contents

Appendices

Project information

Baltic Offshore Beta

Report: Before applying for a permit under the Swedish Exclusive Economic Zone Act (1992:1140) and the Continental Shelf Act (1966:314) – consultation document.

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1 Introduction

1.1 Background

Njordr Offshore Wind - a joint venture between Vindkraft Sweden and Njordr (hereinafter called Njordr Offshore Wind or the Company) is planning an offshore wind farm located about 85 km east of Simrishamn, 85 km southeast of Karlshamn and about 48 km south of the southeast corner of Blekinge (Torhamns Udde). Bornholm is about 63 km away. The wind farm is called Baltic Offshore Beta.

Njordr Offshore Wind intends to apply for a permit under the Swedish Exclusive Economic Zone Act (1992:1140) and the Continental Shelf Act (1966:314) to construct and operate a wind power group station within the specified project area.

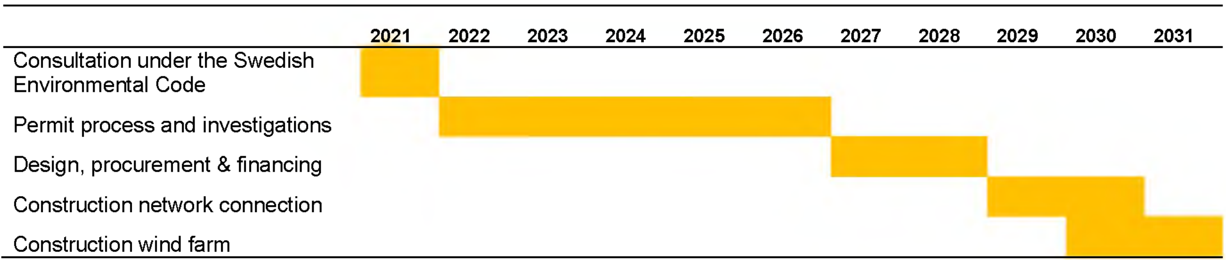
In preparing an application for a permit, Njordr Offshore Wind intends to conduct a consultation process. It is Njordr Offshore Wind's hope that a process involving early consultation will provide the necessary conditions for authorities to provide their views on the approach and scope of the application, the environmental impact statement, and related studies.

The expected output from the wind farm is about 14 TWh per year, which corresponds to the electricity of 2.2 million households, if the electricity consumption is 6,200 kWh/year (Swedish Energy Agency, 2012).

1.2 Preliminary schedule for the application

The timeline for realizing Baltic Offshore Beta is estimated to be just over 10 years. The overall distribution between different project phases up to construction is provided below in the Table 1.

Table 1. Preliminary schedule.



1.3 Consultation process

The planned wind farm is located within Sweden's Exclusive Economic Zone, which means that permits need to be applied for from the government. During the permit application process, the Swedish Environmental Code (EC) shall be applied, and the application shall contain an Environmental Impact Assessment (EIA).

Part of the permit process according to the Environmental Code is to conduct a consultation process according to Chapter 6, Sections 29–32 EC. According to Chapter 6, Sec. 30 of the Environmental Code, consultations about the scope and limitations of the project must be held with the County Administrative Board, regulatory officials, and private individuals who are expected to be particularly affected by the operation, as well as the other governmental authorities, municipalities and the public that may be expected to be impacted by the project. In view of the fact that wind farms are operations which, according to the government's regulations, are always assumed to have a significant impact on the environment, no investigatory consultations are conducted. One step prior to the consultation process is that a consultation document is produced as a basis for the process. According to the Sec. 8 of the Swedish Environmental Assessment Regulation, this consultation document shall contain information regarding:

- The design and scope of the activity
- Location of the activity
- The environmental sensitivity of the areas likely to be affected
- What part of the environment can be assumed to be significantly affected
- The environmental effects which the activity may be presumed to have on its own or as a result of external events, to the extent that such information is available
- Measures planned to prevent, inhibit, mitigate or remedy adverse environmental effects, to the extent that such information is available
- The assessment by the party who intends to conduct the activity as to whether a significant environmental impact can be assumed

In accordance with Chapter 6, Section 32, the County Administrative Board shall work to ensure that the content of the EIA has the scope and degree of detail needed for the approval of the permit.

The Company has planned for the consultation process to be conducted in writing. The consultation is scheduled for autumn 2021.

During the consultation phase, there is an opportunity to provide comments to the Company. The comments are part of the consultation report, which is part of the permit application that is then submitted to the government. A permit is required under the Continental Shelf Act (1966:314) for surveying the seabed and for laying cables for wind farms in public waters and in the Exclusive Economic Zone.

In Figure 1, a schematic diagram of the process according to the Environmental Code is shown.

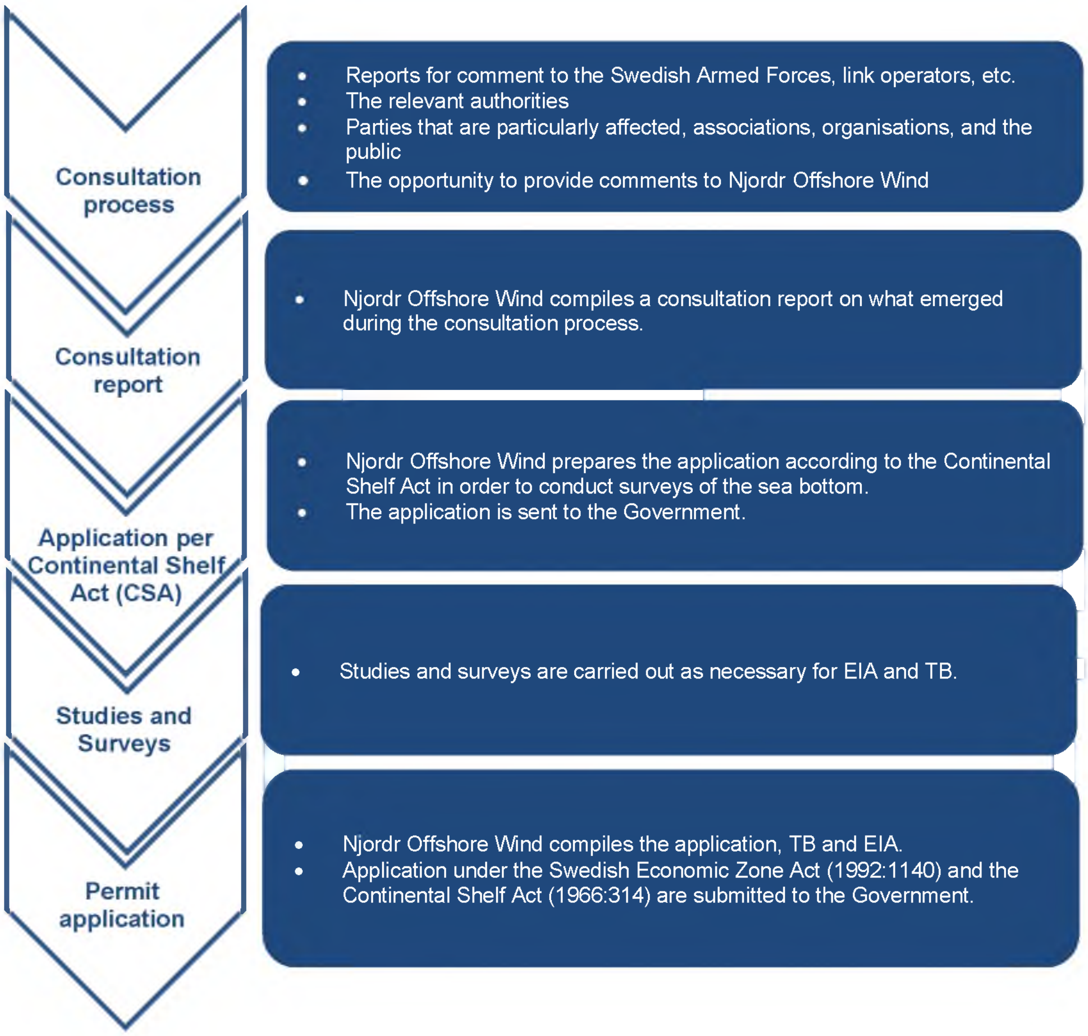


Figure 1. The approval process for the project.

The proposed municipalities, county administrative boards, and authorities that are part of the consultation group can be seen in Table 2.

Table 2. Consultation group.

Government officials	
Swedish National Board of Housing, Building and Planning (Boverket)	Swedish Meteorological and Hydrological Institute (SMHI)
Swedish Energy Markets Inspectorate	State Geological Institute, SGI
Swedish Energy Agency	State maritime and transport history museums
The Swedish Armed Forces	Swedish National Grid
Swedish Institute for the Marine Environment	Geological Survey of Sweden, SGU
Swedish Agency for Marine and Water Management	Swedish University of Agricultural Sciences, the Marine Fisheries Laboratory
Swedish Legal, Financial and Administrative Services Agency	Swedish Transport Administration
Swedish Coast Guard	Swedish Transport Agency
Swedish Civil Aviation Administration	Municipality of Mörbylånga
Blekinge County Administrative Board	Municipality of Karlskrona
Kalmar County Administrative Board	Municipality of Ronneby
County Administrative Board of Scania/Skåne	Municipality of Karlshamn
Swedish Civil Contingencies Agency	Municipality of Sölvesborg
Swedish Museum of Natural History	Municipality of Bromölla
The Swedish National Environmental Protection Agency	Municipality of Kristianstad
Swedish National Heritage Board	Municipality of Simrishamn
Fire and Rescue Services	South Baltic Sea Water Delegation
Swedish Maritime Administration	Östergötland Museum

In addition, the Company will also consult with licensed fishermen, fishing organisations, nature conservation associations, birding associations, tourist agencies, marine rescue companies, diving associations and boat clubs, among other groups.

The public will be invited to consultation through advertising in the appropriate newspapers. The consultation material will be made available through a consultation web portal.

1.4 Transition to a sustainable energy system

Climate change has moved from being a hot issue to an urgent one. The UN International Panel on Climate Change (IPCC) published a new climate report in August 2021. The report states that the Earth's climate is changing rapidly, that sea levels are rising, and various extreme weather events are increasing (IPCC 2021). Researchers are now making it even clearer than before that it is human greenhouse gas emissions that cause climate change. The IPCC Climate Report is in many ways frightening and demonstrates the importance of taking strong action. According to IPCC, it is still possible to reverse the trend. In this case, severe and immediate emission reductions are required.

Wind power is an important and renewable source of energy. Wind as a raw material is environmentally friendly. Wind power does not produce any emissions during operation, and wind provides energy for the production of electricity. Electricity production from wind power meets the Swedish need for electricity consumption and generates most electricity in winter when the demand is greatest.

The Swedish Energy Agency and the Swedish Environmental Protection Agency have developed a national strategy for sustainable hydropower development (Swedish Energy Agency 2021). The aim of the strategy is to contribute to the energy transition by creating the conditions for the future expansion of wind power to take place in a sustainable manner. The strategy has adopted an overall national wind power expansion requirement of 100 TWh by 2040, of which 80 TWh will be on land, which is equivalent to 70% of current electricity consumption.

The strategy takes into account land-based wind power and, in the case of offshore wind power, it is instead managed within the preliminary sea plans of the Swedish Agency for Marine and Water Management, which are now to be decided by the government in 2021.

In general, Sweden has good conditions for offshore wind power, but wind power currently represents a small percentage of overall energy production in Sweden (www.boverket.se). One advantage is that the winds out at sea are often steadier and stronger than on land, enabling larger and more efficient wind farms.

1.5 Administrative information

1.5.1 About the company

Njordr Offshore Wind AB is a joint venture company that was founded in 2021, with headquarters in Karlstad Municipality and the aim of running offshore wind projects, including Baltic Offshore Beta. The Company is owned by Vindkraft Värmland AB and Njordr AS in Norway. Both companies have been handling the development and permit processes for several years for a number of wind power projects in Sweden and Norway.

In addition, there is large amount of expertise in terms of the technical calculations for wind power. Njordr has extensive experience and expertise, including in turbine technology, the planning and construction of wind farms in Sweden and Norway, and extensive experience from offshore operations from Statoil/Equinor. Together, these two companies possess complementary competencies, which together with cutting edge expertise in the relevant fields, ensure that there is comprehensive knowledge from the early analysis stage to the construction and commissioning of offshore wind power.

1.5.2 Application concerns

Njordr Offshore Wind intends to apply for a permit for a wind farm with a maximum of 240 wind turbines within the area described in Figure 2. The wind farm's turbines will have a total height of no more than 330 m above sea level.

The application for a permit for laying marine cable will be submitted separately.

1.5.3 Legislation

A permit must be applied for in accordance with the Swedish Exclusive Economic Zone Act (1992:1140) and the Continental Shelf Act (1966:314).

The operations are covered by Activity Code 40.90 according to the Environmental Assessment Regulation (2013:251). The group station for wind power constitutes a "B" activity according to the regulation, and the operations therefore require a permit according to Chapter 9 of the Environmental Code. In the case of wind power operations, they are of such a nature that they can be assumed to have significant environmental impact according to the Environmental Code.

The underwater work required for the construction of the wind farm is subject to permits according to Chapter 11 of the Environmental Code, a so-called “A-activity”. This type of work is carried out to construct the wind power facility including substations and measuring masts and to lay cables in the water within the group station and on land.

2 Location

2.1 The location process

The proposed location for Baltic Offshore Beta is based on a comprehensive feasibility analysis of the Swedish part of the Baltic Sea with respect to future energy needs, technical and commercial feasibility, environmental conditions, impact on the environment, and other potential counter-interests. The analysis is based on a wide range of choices in order to identify the sites that maximise climate and environmental benefits while minimizing impacts on nature and the environment, as well as possible adverse impacts on human health and the environment.

The analysis is based on a thorough mapping of the potential wind resources and the technical and commercial feasibility. To this, restriction maps in four main categories are added:

- Industrial counter-interests. These include, for example, vessel traffic, professional fishing and aviation. This is based on both national interests available and actual traffic via Automatic Identification System (AIS) data
- Impact on local residents and recreational areas. This is evaluated mainly through analysis of visual effects and sound emission.
- Other environmental counter-interests such as valuable natural habitats, Natura2000, the presence of marine mammals, fish and birds, sensitive bottom fauna or geology.
- Defence and security interests.

An important balance in the selection of offshore wind power locations is the balance between distance to land and depth of the seabed, which are important economic aspects, and the visual impact on coastal landscapes and neighbouring communities. The chosen strategy is that major consideration should be given to the visual impacts. This has meant that a place further from the coast has been chosen with almost no visual impact on the mainland. One consequence of this strategy is that large-scale wind farms are required to bear the costs of connecting to the grid, and technology that largely consists of floating wind turbines.

2.2 Baltic Offshore Beta Wind Farm

Baltic Offshore Beta is located in the southern Baltic Sea about 60 km southeast of Karlskrona. The project area is 570 km^2 large and has a potential for about 3340 MW of installed power with annual production of just over 14 TWh. The assessment is that the area is well-suited for offshore wind power. It has good wind resources with an average wind speed of 9.6 m/s at 160 m altitude (Section 4) and meets all of the criteria mentioned in the selection process described above. It is located outside all types of environments, fauna and fisheries that are identified as national interests. In the case of shipping, the easternmost part of the area is included as a national interest in terms of shipping. This is a deliberate choice after consulting the Swedish Maritime Administration regarding the consideration that should be given to national interests versus actual shipping traffic (AIS data). The AIS data shows that shipping vessels take a more eastern route than the areas of national interest (see Figure 35 Section 5.10). The distance from land (about 50 km to mainland Sweden southeast of Karlskrona, about 60 km northeast of Bornholm, and about 110 km from the north coast of Poland) means that the impact on the surrounding coastal environments is very small, see Figure 2.

Water depth varies between 55 to 80 metres. The planned wind farm is located in the low-oxygen bottom area northeast of Bornholm (see Sections 4.3 and 4.5). The bottom sediment is dominated by post-glacial clay and silt (see Section 4.3)

To strengthen offshore wind power opportunities in the Baltic Sea, Transmission System Operators (TSOs) in Germany, Sweden, Denmark, Finland, Estonia, Latvia and Lithuania have jointly launched the Baltic Offshore Grid Initiative, which will create common plans for electricity networks in the Baltic Sea and between the different countries around the Baltic Sea. Baltic Offshore Beta is strategically well-positioned with potential connections to most countries, Figure 2.

Figure 2. Displays the location and distance of the project area to land. The distance to Simrishamn is 85-90 km. Existing connections to the Baltic states are visible on the eastern side of the area and the existing connection to Poland on the western side.

The location of the project area outside of southeast Sweden means the project will have a major positive impact in terms of meeting the need for renewable energy in electricity price area 4. This is an area that already has difficulties producing its own electricity and where there are limited opportunities for land-based wind power. The demand for electricity is also expected to increase significantly in the coming years. For example, the main scenario from the Swedish Energy Agency shows that between 80–120 TWh of new, renewable energy production is needed by 2045 (Swedish Energy Agency 2018), where the transition of the transportation and industry sectors is of great importance. The winds are more consistent over the sea, which leads to a more even production profile. Figure 3 shows an example of a Baltic Offshore Beta power profile. The figure shows that the power in December and January, when the demand is greatest, is over 1000 MW 70–75% of the time (solid circle in Figure 3), while in the middle of summer it is over 1000 MW only 40–45% of the time (dashed circle in Figure 3). This can be compared to the capacity of the Oskarshamn 3 nuclear reactor, which has a maximum power of 1450 MW.

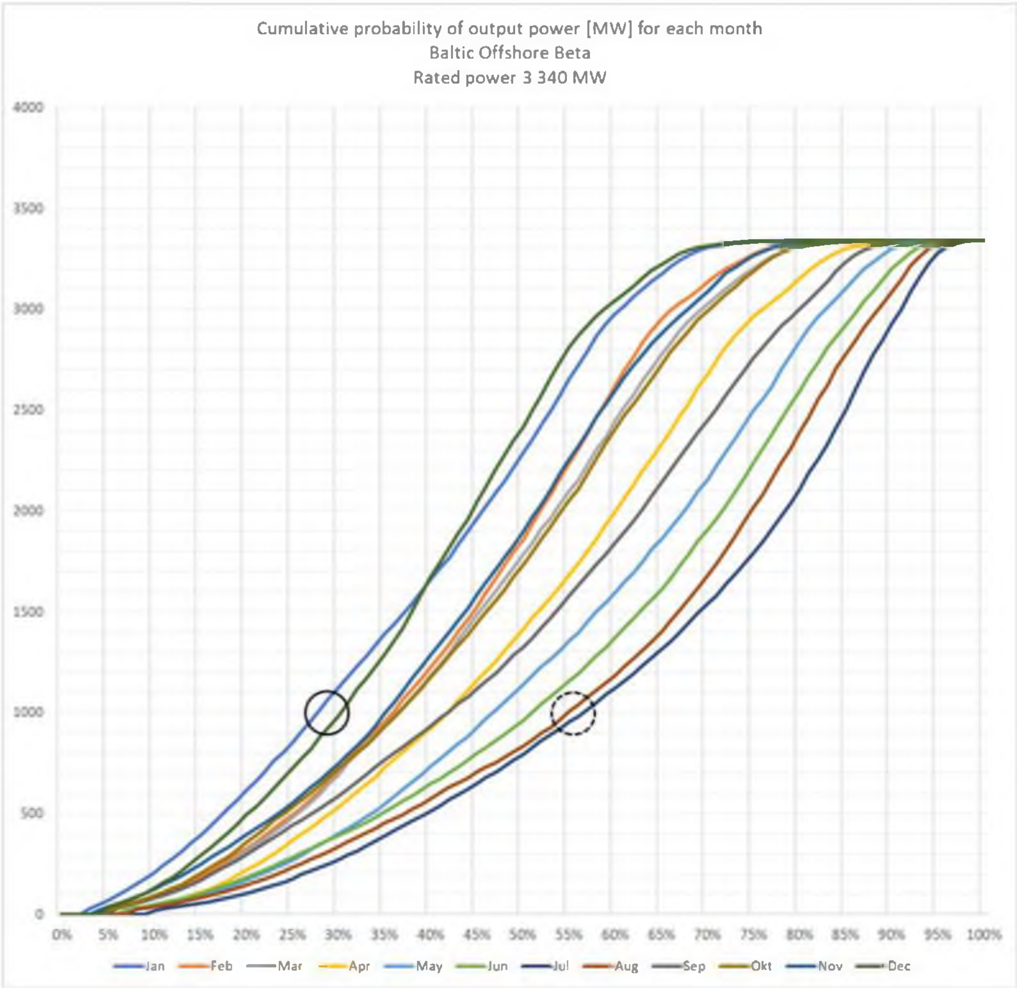


Figure 3. Cumulative distribution of total wind power from the Baltic Offshore Beta wind farm for different months of the year.

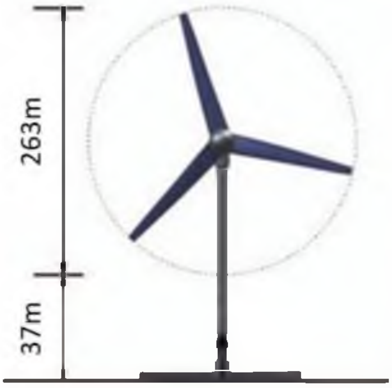
3 Design of the wind farm

The planned Baltic Offshore Beta consists of a maximum of 240 wind turbines with a total installed capacity of approximately 3340 MW and an expected annual production of 14 TWh. The wind turbines are distributed over a total project area of 570 km^2. The individual wind turbines are connected via an internal cable network with functionality to both transmit the energy produced and to facilitate communication. The internal cable network transmits the energy generated to one or more offshore substations (these are often called OSS, offshore substations), where the electricity is converted and transferred to the mainland via one or more connection cables.

In general, an offshore wind farm consists of the same main components as the land-based ones, that is, the tower, the nacelle that houses the line for transferring the power, as well as generators, control systems, and a rotor to capture the energy in the wind. There are two main techniques for constructing foundations for offshore wind turbines. Either the wind turbines are anchored directly to the sea bottom, or floating foundations are used, which are anchored to the bottom with cables. Both technologies are considered to be relevant for Baltic Offshore Beta.

3.1 Wind turbine, example layout

Due to the relatively long processes involved to realize offshore wind power projects, combined with the relatively rapid development of technology in the wind power industry, it is difficult to accurately predict the turbines that will be constructed. The current schedule indicates that the start of construction for Baltic Offshore Beta is likely to take place at the earliest by 2030 (see Figure 4 and 5). There are already offshore wind turbines with an installed capacity of 15 MW, and according to industry forecasts, 20 MW turbines are likely to exist around the year 2025. We have chosen to base our production analysis on a concept turbine with an installed capacity of 20 MW. Hence, this reflects a somewhat conservative analysis of future technological development. This turbine has a rotor diameter of 263 m and a total height of up to 300 m. Note that the application concerns wind turbines with a total height of up to 330 m, which is also applied to the visual impact analysis.



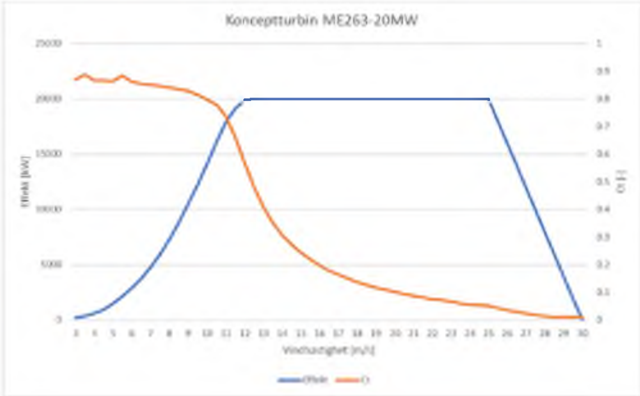


Figure 4 and 5. The figure on the left illustrates the size of the wind turbines in our preliminary production analysis. The graph on the right shows the production curve for an individual turbine. The blue line indicates produced power as a function of wind speed. The red line indicates the thrust coefficient, which is a measure of the axial force of the wind turbine relative to the potential force of the oncoming wind and which is used to calculate the deceleration of the wind reaching the turbines behind it.

Figure 6 shows an example layout based on a layout optimisation with the wind turbine described above. The layout contains 167 turbines and thus has a total installed capacity of 3340 MW. This layout was designed with an expected limitation from the wake-induced loads (turbines generate turbulence in the downstream air which induces fatigue loads for turbines situated downstream). The layout is also designed with safety in mind in terms of clear corridors that are required for e.g., emergency operations, and a safety distance of 1 km from the Nord Stream 1 and 2 gas pipelines that pass through the project area. These requirements result in a design with an optimised structural turbine pattern with an average distance between the wind turbines of approximately 2 km.

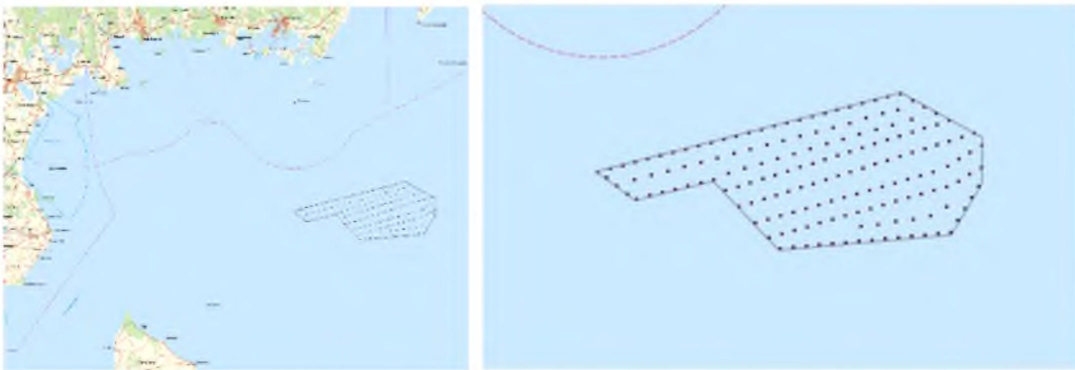


Figure 6. The layout of the wind turbines from the preliminary production analysis.

3.2 Foundation

Offshore wind turbines can be placed on both foundations fixed to the bottom as well as floating foundations, see Figure 7. Bottom foundations can be used down to about 60 m and with today's technology it is likely that floating foundations are a more suitable solution. Floating foundations are a newer technology, which at their present cost involve a relatively expensive solution, and are only competitive in the short term at large depths of water. Future development and significantly higher volumes are expected to drive the costs for floating foundations down.

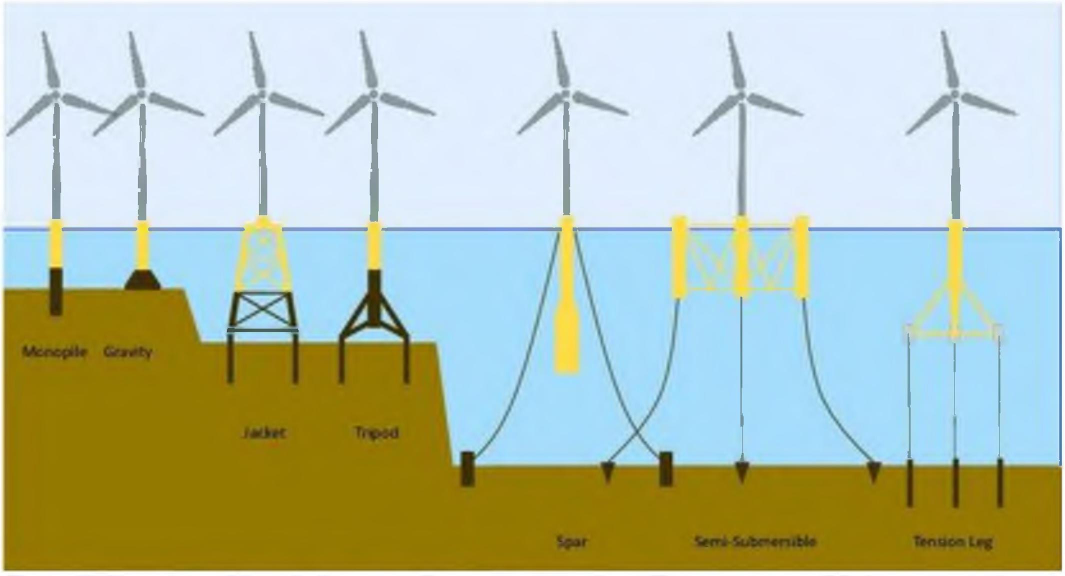


Figure 7. Overview of foundations for offshore wind turbines (Dornhelm et al. 2019).

The bottom foundations consist of four main technologies:

Gravity foundation

A gravity foundation consists of a circular concrete structure filled with ballast that rests on the seabed. The tower is fixed to the foundation and the wind turbine is kept upright by gravity. Gravity foundations are a simple and cost-effective solution suitable for most types of sea bottoms. The downside is that their use is limited to relatively shallow depths of water, 30 m is often mentioned as a maximum depth for the sea floor.

Monopile

Monopile consists of a steel cylinder driven down into the sea bottom by pile driving. Monopile foundations are the most common method for offshore wind power. It is fast and relatively inexpensive to install. The technology is well suited for relatively shallow water depths, up to 30–40 m with today's technology, and seabeds consisting mainly of sand or gravel. There is ongoing research aimed at changing the design to produce monopile solutions that still function down to a depth of 70 m. A disadvantage of the conventional installation of monopiles using pile driving is that this method creates vibrations and sounds that can disturb underwater animals. In those instances, an alternative to a monopile can be the “suction pipe/anchor” where the pipe itself is driven down by a created vacuum in the pipe. This option is suitable for soft bottoms.

Jacket foundation (Truss foundation)

A jacket foundation consists of a truss construction that is anchored to the bottom. This is a stable design that can withstand high loads and is scalable to withstand significantly greater depths than the previous solutions. This solution is also relatively insensitive to the type of bottom, since the method of fastening it to the seabed can be adapted to the conditions.

Tripod

A tripod foundation consists of an upper cylindrical part that is joined to the tower, and a lower three-legged structure the distributes the force to the bottom, see Figure 8. The tripod technology is stable and can handle relatively large sea depths. It also works with most types of solid seabeds. The disadvantage is the cost and the fact that it requires more effort during transportation.

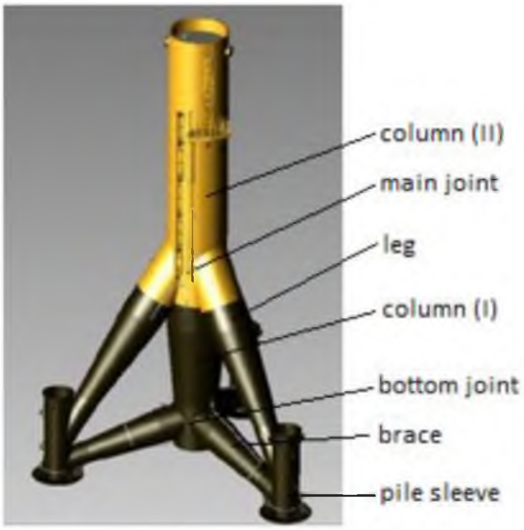


Figure 8. Illustration of tripod foundations (Wijnegaarden, 2013).

For floating foundations, there are currently three main technologies, see below, but floating wind power is under rapid development, and more concepts are likely coming in the future that may become relevant before this project is ready to be implemented.

Spar

The Spar technology is based on a counterweight placed directly below the floating wind turbine, thus stabilizing the structure from lateral movements from both aerodynamic loads and forces from waves and ocean currents. The stabilizing counterweight typically consists of a cylinder filled with ballast. A practical limitation is that the cylinder body is typically the same length as the turbine tower. This means that very deep ports, or another solution, are needed for this assembly.

Semi-submersible

The wind turbines are placed on a floating platform that is anchored to the bottom with slack anchor lines. The floating platform can consist of both a single large floating element or many floating elements (pontoons) assembled with arms to distribute the gravitational force over a larger area, thereby increasing stability.

Tension Leg

The tension leg technology is based on a floating platform where stability is achieved through tension-securing lines attached to the sea bottom. Implemented using the techniques above, which are based on slack lines to keep the turbines in place, the tension leg technology means that the platform needs more buoyancy and that the fastening of the lines needs to withstand greater loads.

All the floating foundations described above are based on being fastened to the sea bottom with wire ropes. The choice of fastening depends on the type of seabed. An overview of the most common methods is provided by Figure 9.

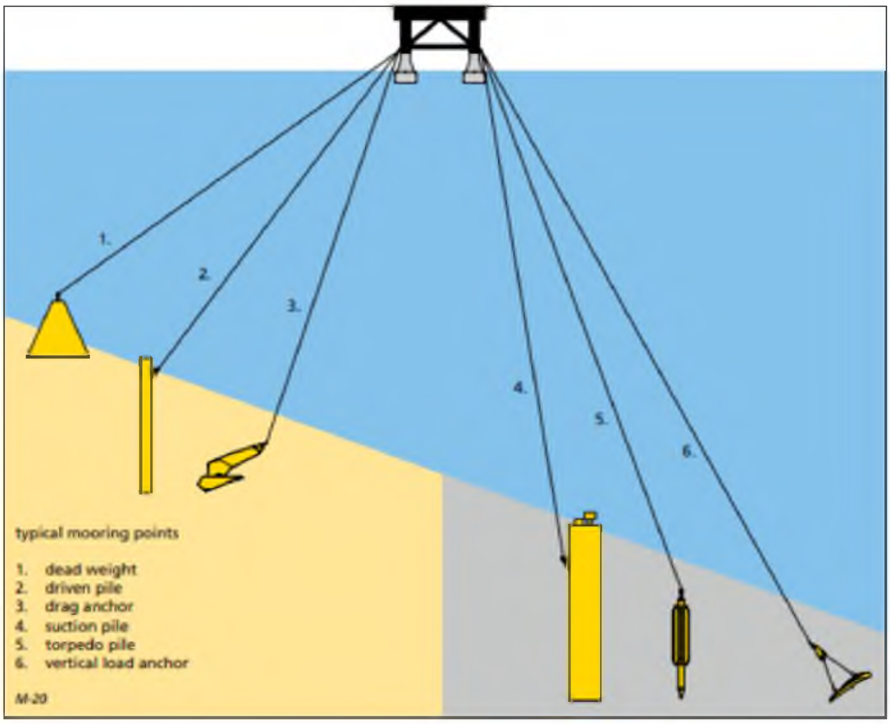


Figure 9. An overview of the most common methods for attaching the platform to the sea bottom.

3.3 Electrical connection

The individual wind turbines are connected to an internal cable network for communication and transmission of generated current. The voltage level in today's internal cable system is usually 33 or 66 kV, but it is likely that higher voltage levels may also be considered for Baltic Offshore Beta. The communication between the wind turbines is important for operational monitoring, load control at the turbine level and at the wind farm level (e.g. to bring the aggregate production of the wind farm toward a certain level).

The internal cable network is connected to one or more substations (OSSs). Here the electricity produced by the wind farm is transformed into high voltage. It is likely that electricity is also converted to high-voltage direct current (HVDC) to reduce electrical losses when transmitting to the mainland (or offshore grid station) via one or more connection cables.

4 Project phases

The time for starting construction of Baltic Offshore Beta is estimated to be just over 10 years. The overall distribution between different project phases up to construction is provided in Table 1 Section 1.2

4.1 Construction

The construction phase of an offshore wind farm consists of preparing foundations, bottom anchorages, and cable routing, as well as the installation of foundations, wind turbines, substations and other electrical infrastructure. Construction work is expected to last at least two years and is sensitive to adverse weather conditions. Normally, construction and installation are not carried out in the entire project area at the same time, but in stages. During installation, a safety zone is established to protect the installation, personnel, and third parties.

The different sub-areas of Baltic Offshore Beta have different technology solutions in terms of floating versus bottom-anchored installation. These different technologies lead to differences in construction and the installation of wind turbines. A brief description of this is given below.

4.1.1 Bottom-anchored wind turbines

Anchoring and foundations

As described in Section 3.2, two types of bottom-anchored foundations are primarily relevant for the Baltic Offshore Beta based on the current technology. Today's monopile and gravitational foundations are currently not considered to be appropriate at sea depths of 60 m. The remaining options using today's technology are the Jacket foundation and Tripod technology, see Figure 10.

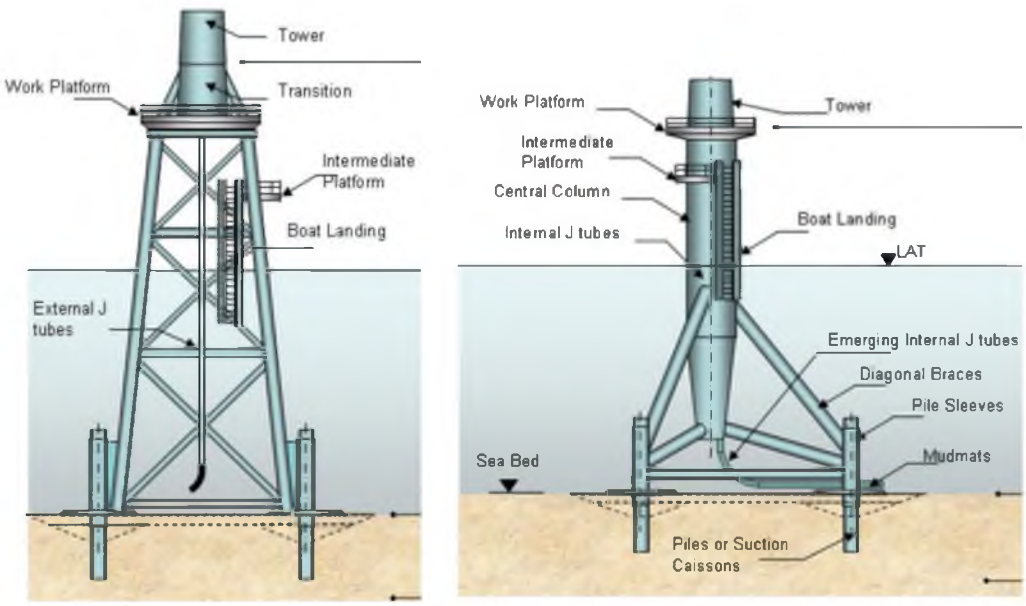


Figure 10. Overview of bottom-anchored foundations with jacket (left) and tripod technology (right). (Wijngaarden 2013)

The jacket foundations and tripod foundations are available in a few different designs, but the attaching them to the sea bottom is usually done either with a suction pipe/anchor (which is a technique based on creating a vacuum in the mounting tube by pumping out water), or steel pipes that are pile-driven or drilled into the seabed. The choice of technology depends on the seabed conditions at the site.

Both types of foundations are assembled on land and transported to construction sites by boat. At the site, the structures are lowered to the sea bottom with a crane and secured using one of the techniques above. Depending on the conditions and the design of the foundation, erosion protection can be provided either before or after installation of the foundation. Erosion protection is used to prevent the bottom around the foundation from eroding and undermining the anchoring. The corrosion protectors usually consist of a lower layer of gravel and an upper layer of mixed-size rock.

Wind power turbine

The most common method for installing offshore bottom-anchored wind turbines is that the main components (tower, nacelle, and composite rotor) are transported to the site by barge and the turbine is assembled on site using cranes.

4.1.2 Floating turbine

The floating approach allows almost all of the assembly to be completed on land. The foundations and wind turbines are assembled in port and are towed out to the project area, where they are connected to the prepared anchoring lines to the bottom.

4.1.3 Offshore substation (OSS)

An OSS is normally installed on its foundation by means of a crane vessel. Depending on how the OSS and its foundation are designed, they can also be floated out or installed using other lifting methods, for example with their own outriggers.

4.1.4 Internal cable network and connection cables

The wind farm's internal cable network and connecting cables are provided from cable vessels. If protection is needed for the anchoring, e.g., cables can be wound, ploughed or buried into the seabed, normally at a depth of about 1.5 meters. Winding is usually applied for softer bottoms, while ploughing and digging is used with harder bottoms. The final depth depends on the geological conditions and the level of protection desired. Where geological conditions do not allow cables to be placed in the seabed, they can be protected by covering them, for example, with stone or pipes. If a cable needs to cross another cable, the cables are usually protected by concrete carpets or stone.

4.2 Operations

Both the turbines and the substations are unstaffed and remotely monitored during normal operations. However, the wind farm is continuously maintained, which requires personnel and materials to be transported to the wind farm by means of smaller service boats, ships, or helicopters. An office will be established on land close to the wind farm for relevant personnel, stored equipment, and materials.

For more extensive work, such as replacing major components, an outrigger vessel, a floating crane, or the equivalent may be used. Cables are inspected if necessary to ensure, for example, that the cable guards at the base of each wind turbine are intact. In the event of cable damage, repairs are completed by lifting the relevant cable section using a cable-laying ship to repair them, after which the cable is placed back on the bottom. To protect the cables from damage, it is inappropriate to run bottom trawls and to anchor inside the wind farm and along the export cable corridor.

4.3 Reduction

The expected lifetime for an offshore wind farm is between 30 and 35 years. After that, the wind farm will be decommissioned, and the area restored. In the case of decommissioning, wind turbines, any floating foundations and substations will be dismantled and transported away from the site.

5 Description of the surrounding environment

5.1 Wind resources

The Company's assessment is that the area is well-suited for offshore wind power. It has good wind resources with an average wind speed of 9.6 m/s at a height of 160 m. Figure 11 shows the frequency distribution of wind speed and direction, average wind speed in different directions, and the proportion of potential energy in different wind directions based on long-term, adjusted, high-resolution simulations of the local wind conditions with the ME-WAM model (Keck R.-E. and Sondell N.). The data below shows that western and southwestern winds constitute the prevailing wind direction. These wind directions also have the highest average wind speed, and thus constitute a large part of the potential wind power in the area.

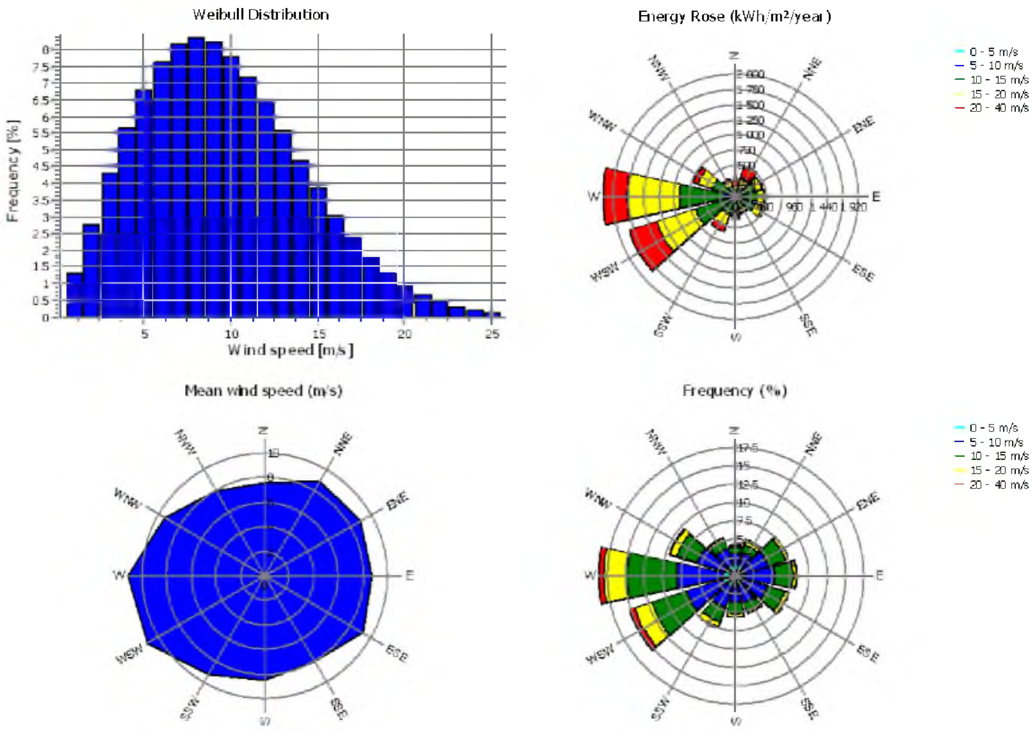


Figure 11. The frequency distribution of wind speed (top left) and wind direction (bottom right), average wind speed in different directions (bottom left), and the proportion of potential energy in different wind directions (top right) based on long-term, adjusted high resolution simulations of the local wind conditions with the ME-WAM model (Keck R.-E. and Sondell N. 2020).

5.2 Marine planning

Marine planning

The Swedish Agency for Marine and Water Management has developed a proposed marine plan for Sweden that will guide authorities, municipalities, and courts in decisions, planning and licensing. Consultation and dialogues on the seabed planning were held until December 2019 when the proposal was submitted to the government, which has since then prepared the proposal.

According to the proposed marine plan (Swedish Agency for Marine and Water Management, 2019), the area for the proposed wind farm lies within the southern Baltic Sea planning area. In the project area, the marine plan specifies its general use with particular regard to high natural values, GN Ö249 (Figure 12). The area contains shipping routes (see Section 4.7.3) and is a commercial fishing area (see Sections 4.7.1 and 4.11).

Figure 12. Proposal for marine plan in the area concerned.

Existing and planned projects in the immediate vicinity

A number of permit processes are in progress for offshore wind power. These currently known areas are described in Figure 13.

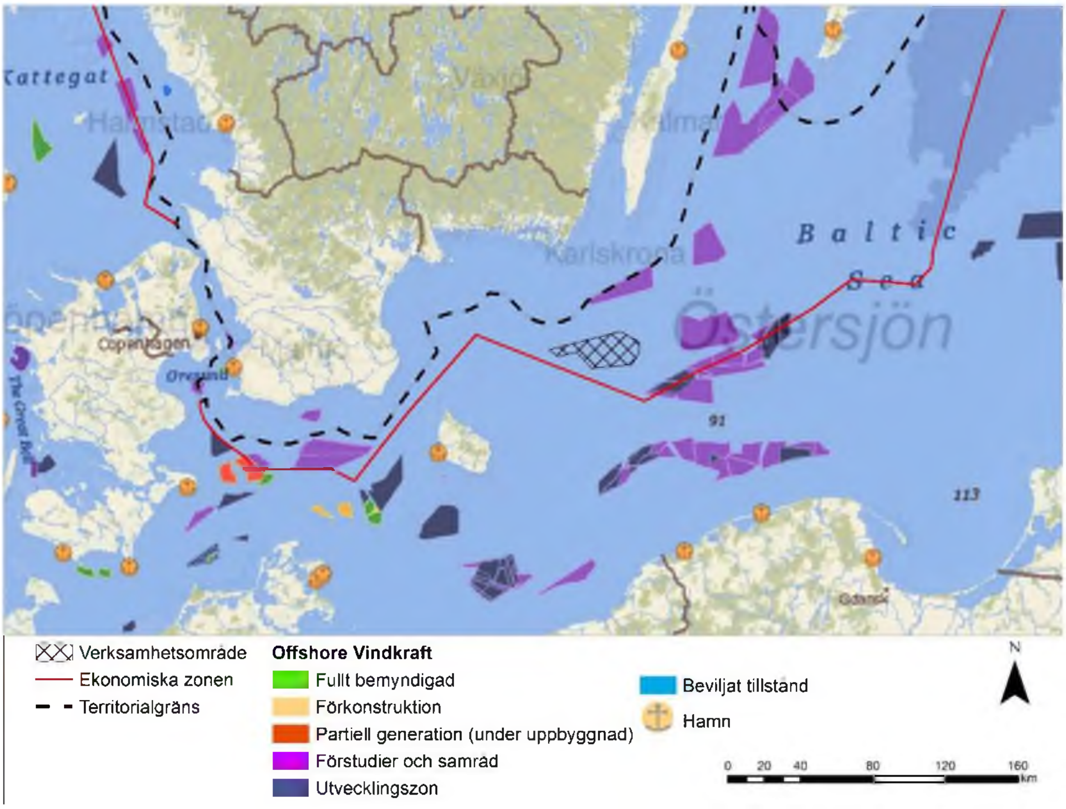


Figure 13. Illustration of the currently known wind farms that are either in a permit process or are being planned.

5.4 Depth and bottom conditions

Bathymetry

Bathymetry describes the physical shape of the undersea terrain. Figure 14 shows the variation of the bottom measured in meters below the water surface. The wind farm area is located in an area where depth varies between 55 and 80 m.

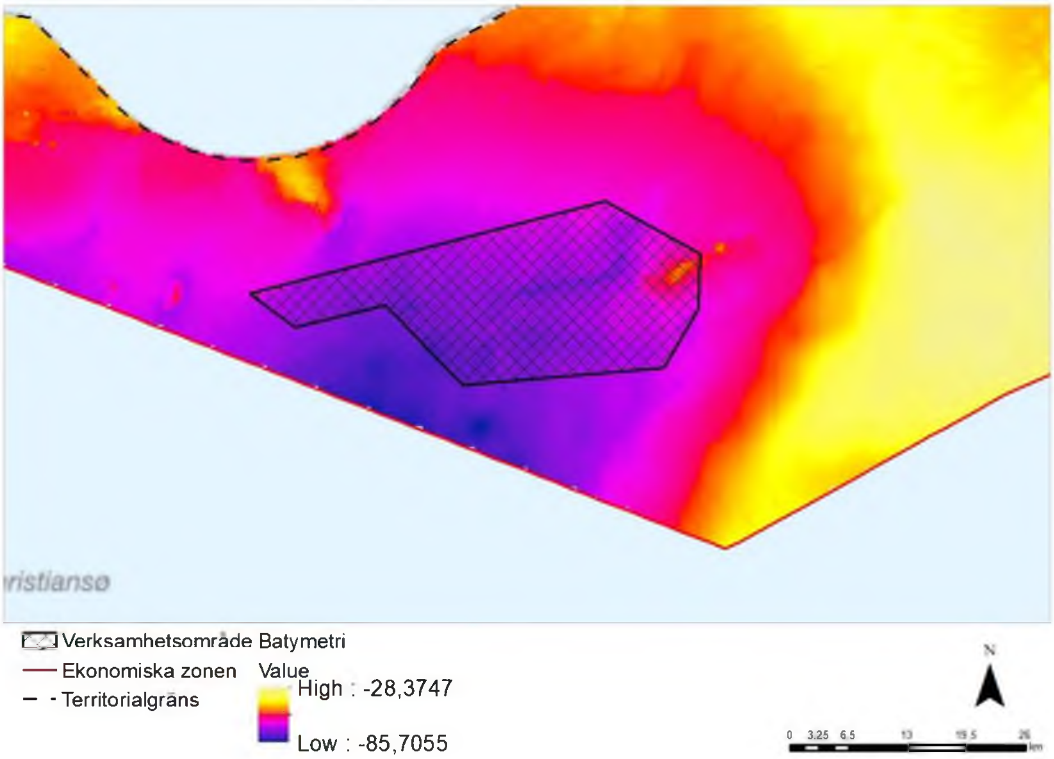


Figure 14. Area bathymetry.

Rock foundation and bottom substrate

The bottom of the planned wind farm area consists of clay, gyttja clay, and clay gyttja, and areas with sand, gravel and rock on sedimentary rock including sandstone and limestone (see Figure 15 and Figure 16).

Figure 15. The rock foundation within the operating area consists of sand and limestone.

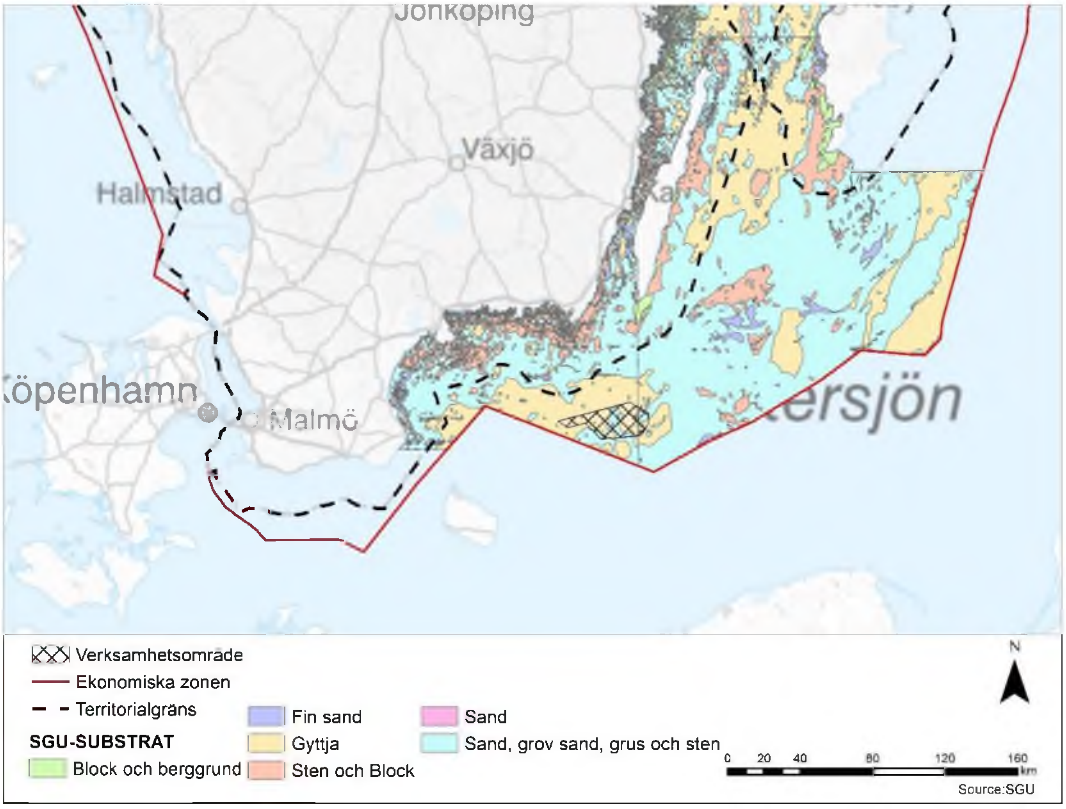


Figure 16. The bottom substrate in the operations area consists of clay and sand.

Sediment conditions

The sediment conditions depend on a number of factors such as water depth, current patterns, the halocline position, and supply of material. Data on sediment conditions are taken from the Nord Stream Project 2 which passes the wind farm area. The conditions of the seabed will be examined prior to the preparation of the permit application.

The area for the wind farm is dominated by marine sediments in the form of sludge, mud and gyttja. The type of sediment includes mixed zones with and without sedimentation (Nord Stream 2, 2016). Within the framework of the Nord Stream Project 2, sediment samples were analysed for their normal physical and chemical conditions (e.g. dry weight, organic content, grain size distribution) and concentration of heavy metals, polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), organochlorine pesticides and nutrients. The location of the sampling site is shown in Figure 17. The surface sediment from the relevant sampling sites is reported in Table 3 and Table 4.

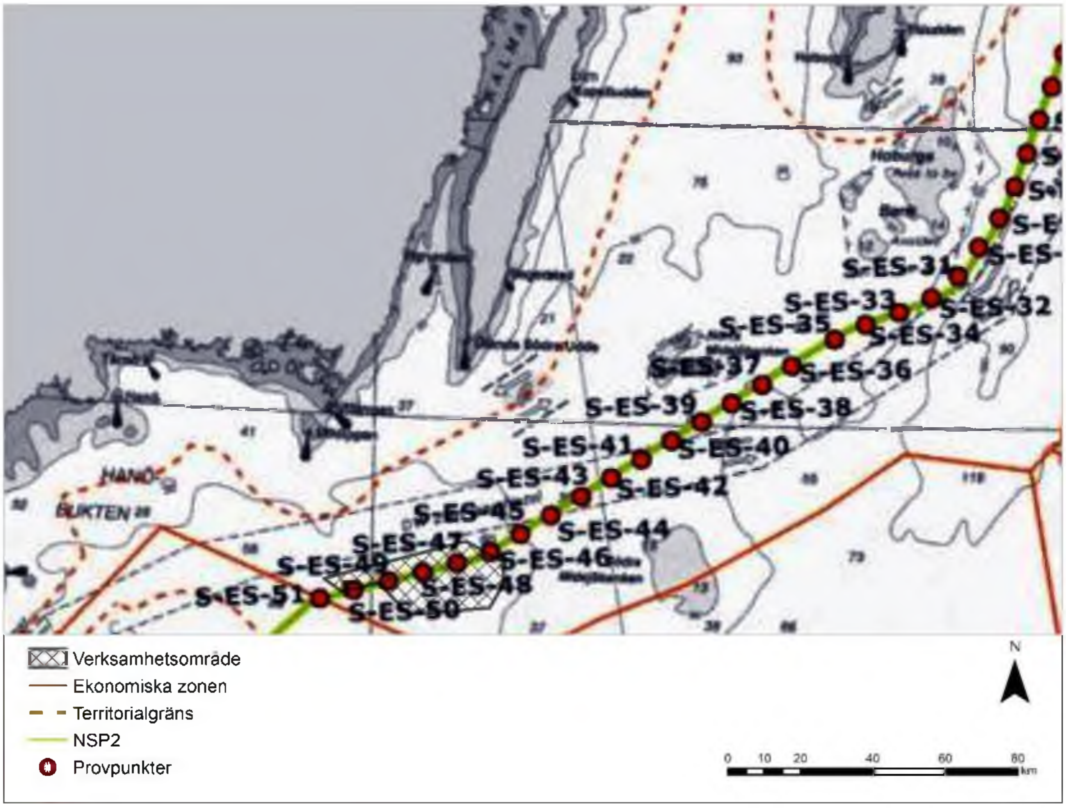


Figure 17. The picture illustrates the location of the operating area in relation to the sediment samples taken in connection with the Nord Stream 2 investigations.

The analyses of pollutants showed nothing unusual in terms of the background levels of metals according to the Swedish Environmental Protection Agency's assessment criteria[1], i.e. no PAHs and PCBs exceeding the EAC[2], organochlorine pesticides that were slightly above or below EAC values, and nutrients indicating a nitrogen-rich sediment (see Table 4). The results show which sediment contaminants are present in a 130 m wide cable corridor but also gives indications of what levels can be found in the surrounding area.

[1] Swedish National Environmental Protection Agency, 1999. Assessment criteria for environmental quality - Coast and Sea, Report no. 4914. p. 134 ISBN: 9162049143
[2] EAC – Environmental assessment concentration levels developed by HELCOM and OSPAR.

Table 3. Summary of sampling results from relevant sampling sites (Nord Stream 2 AG, 2017).

Station	Depth	Description of surface sediment
S_ES_46	56 m	Beige coarse sand with debris in mud. Oxidised surface layer. No smell of hydrogen sulphide. 0-3 cm coarse sand and 2-14 cm grey clay.
S_ES_47	67 m	Dark grey sludge on clay. No oxidised surface. Hydrogen sulphide odour. 0-5 cm dark grey clay and 5-11 cm grey clay.
S_ES_48	72 m	Black, soft clay on hard clay. No oxidized surface. Hydrogen sulphide odour. 0-2 cm black, soft clay and 2-18 cm hard clay.
S_ES_49	78 m	Black, soft clay on clay. No oxidised surface. Hydrogen sulphide odour. 0-3 cm black clay and 3-14 cm dark grey clay.
		Black soft clay. No oxidised surface. Hydrogen sulphide odour. 0-4 cm black soft clay and 4-12 cm dark grey fine sand/clay.
		Black soft clay on grey clay. No oxidised surface. Hydrogen sulphide odour. 0-3 cm soft black clay and 3-10 cm dark grey clay

Table 4. Summary of analysed contamination levels (Nord Stream 2 AG, 2017).

Station	As	Pb	Cd	Cr	Cu	Co	Hg	Ni	V	Zn
	mg/kg TS	mg/kg TS	mg/kg TS	mg/kg TS	mg/kg TS	mg/kg TS	mg/kg TS	mg/kg TS	mg/kg TS	mg/kg TS
S_ES_46	4.97	19.8	0.410	49.40	28.60	16.50	0.042	13.8	26.30	34.7
S_ES_47	5.27	19.8	0.410	49.40	28.60	16.50	0.042	13.8	26.30	34.7
S_ES_48	5.20	19.3	0.190	42.80	23.20	16.10	0.020	39.3	53.80	89.4
S_ES_49	12.70	26.5	0.230	44.20	37.60	17.20	0.023	34.0	49.00	80.2
S_ES_50	18.30	48.2	0.230	44.10	39.00	18.10	0.037	39.9	62.90	107.0
S_ES_51	15.70	32.6	0.330	39.80	35.40	16.00	0.036	39.7	63.30	138.0

Landslides

In the surrounding area, sites for the formation of landslides have been identified by the survey conducted by SGU (Nord Stream 2, 2016). The closest sites with landslides are about 22 km north of the pipeline and are outside the wind farm area (see point K1-K3 in Figure 18).

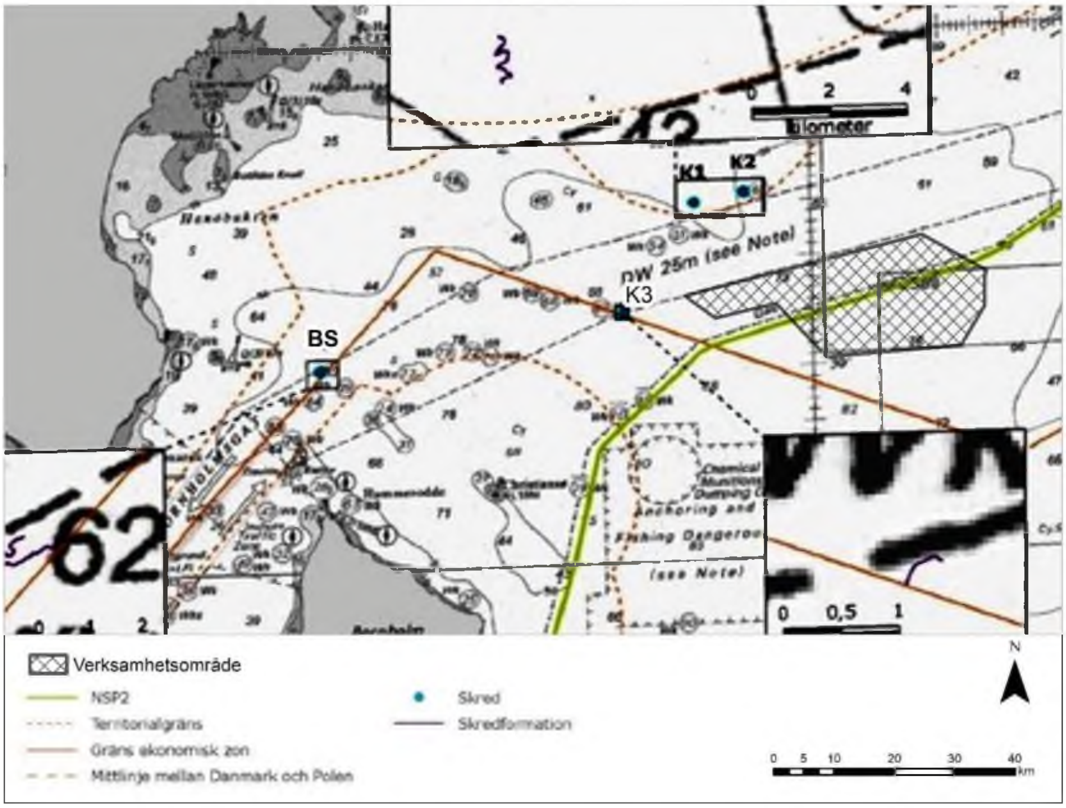


Figure 18. Location and formation of landslides surveyed by SGU (Nord Stream 2, 2016).

Seismic activity

Seismic activity with small-scale earthquakes occurs in the surrounding area, but the area lacks earthquake activity from a global perspective. Macroseismic evidence of significant damage from earthquakes is very rare in the region (Nord Stream 2, 2016). Figure 19 shows the position of seismic events detected in the Swedish Exclusive Economic Zone during the period 2000 to March 2016. The data have been collected from the Swedish National Seismic Network and GEUS Denmark. Earthquakes have occurred about 10 km north-east of the area but not within the area.

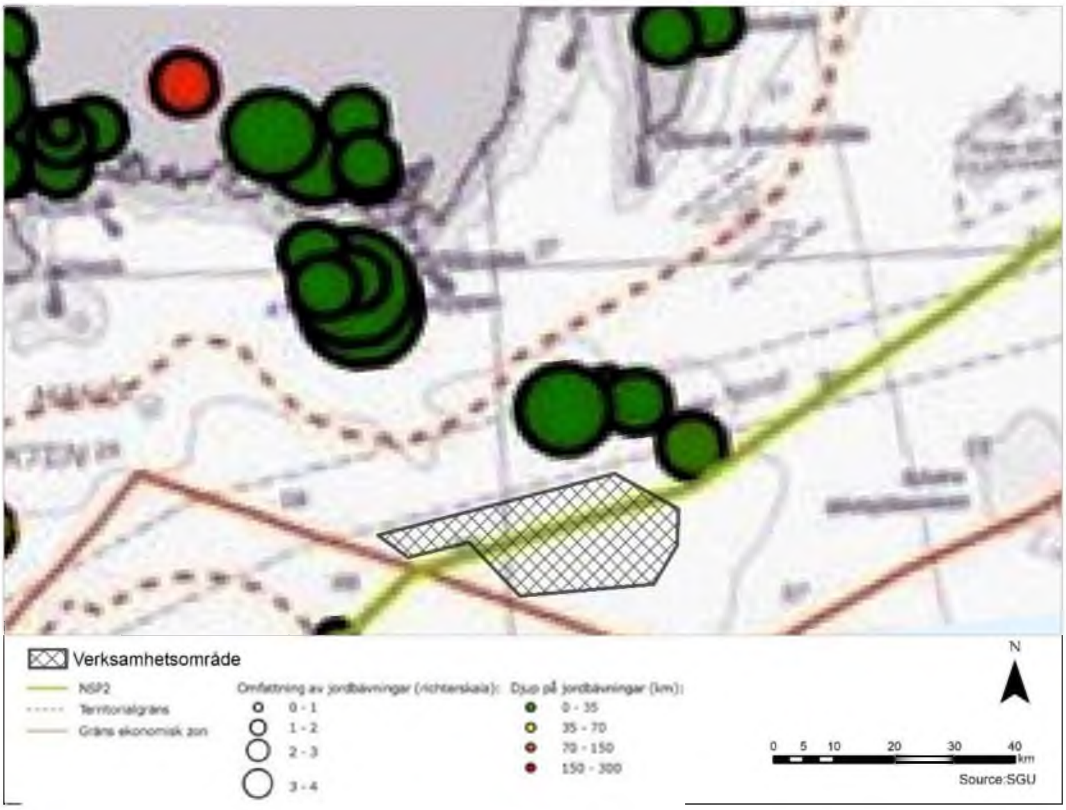


Figure 19. Seismic activity in the Baltic Sea between 2000 and March 2016 (Nord Stream 2, 2016).

5.5 Hydrography and oxygen conditions

5.5.1 Hydrography

The sea water level along the Swedish coast of the middle Baltic Sea varies generally between +/- 40 cm in wintertime and slightly less in summertime. However, major deviations may occur during the year.

There are a number of forces contributing to the currents in the sea. The driving forces are horizontal density differences, the slope of the sea surface, tides, structures in the water and air pressure differences. There are also decelerating forces, such as friction against the bottom and the coastlines. In the northern hemisphere, the so-called Corioli force affects water toward the east in relation to the direction of movement. The current speed in the middle of the Baltic Sea is about 0.5 m/s. (Östersjön.fi, 2021 a)

The wave climate in the Baltic Sea is considerably calmer than that on the Swedish west coast and the North Sea, which is favourable for wind farms. The wave height is defined as a significant wave height. This is calculated as the average of the highest third at a given time. Significant wave heights of 8 meters have been measured in the Baltic Sea. The single highest wave was measured at 14 meters. (östersjön.fi 2021 a) The conditions in the area in question need to be further investigated.

Every year, the Baltic Sea freezes, and the degree of ice coverage varies from year to year, see Figure 20. During mild winters only the Gulf of Bothnia freezes while almost the entire Baltic Sea freezes under severe winters. The degree of coverage varies from 115,000 km^2 – 345,000 km^2 for the entire Baltic Sea area of 422,000 km^2. The greatest amount of ice coverage occurs during January-March. However, climate change is contributing to shorter winters with ice. (Baltic Sea.fi b)

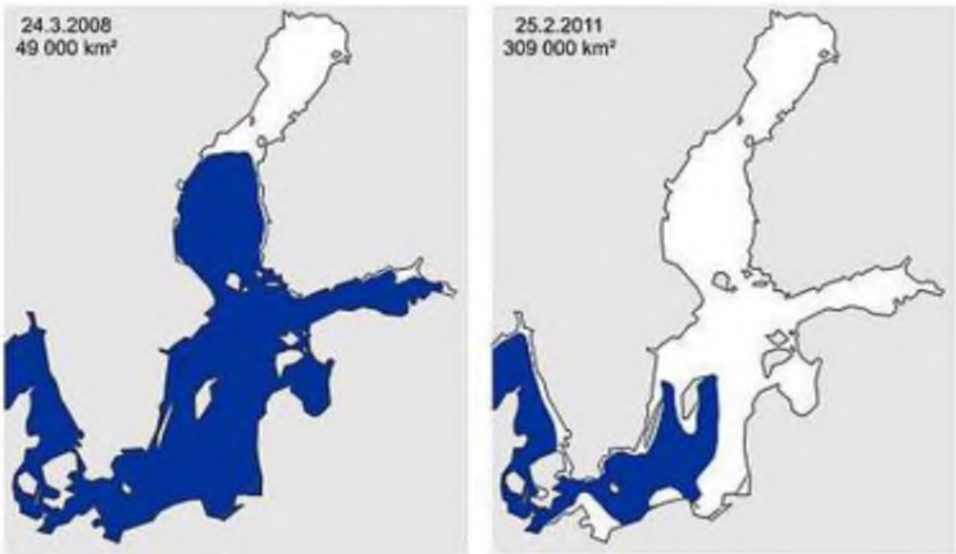


Figure 20. The degree of coverage of the ice is illustrated by white fields. Winter 2007-2008 was mild, while 2010 – 2011 was severe.

5.5.2 Oxygen conditions and sulphur

Since there is no oxygen supply to the water below the halocline, what little oxygen that is available is consumed in breaking down marine organisms that sink to the bottom. In the deep pools, a lack of oxygen is not uncommon, resulting in anaerobic processes that result in the formation of hydrogen sulphide (H_2S). Hydrogen sulphide is toxic to all higher forms of life. The anaerobic conditions also lead to the release of phosphate and silicate from the sediments and which, by means of vertical mixing, can reach shallower water. This process results in elevated levels of phosphorus that contribute to the production of algae blooms and cyanobacteria in surface waters. (HELCOM 2014). Other causes of the oxygen-free sea bottoms are assumed to be a lack of new water flowing in from the Kattegat, an increase in primary production as a result of eutrophication, and a change in fresh water supply.

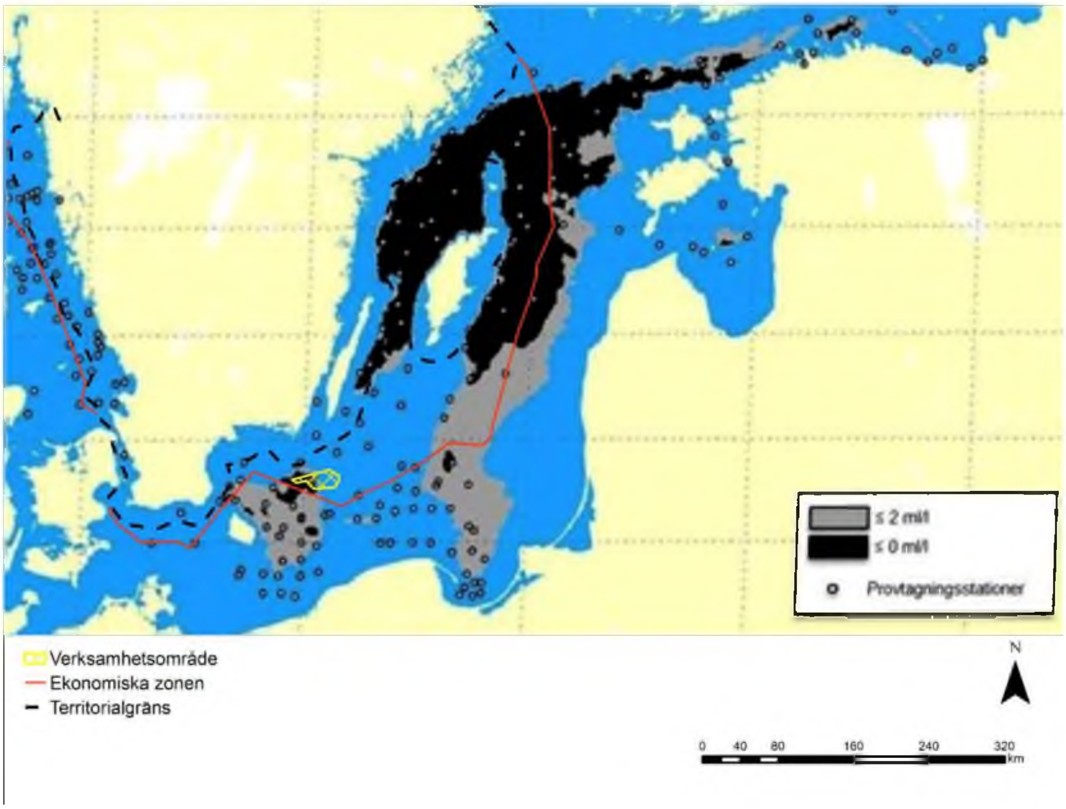


Figure 21. Oxygen mapping from 2010. Swedish Meteorological and Hydrological Institute (SMHI)

During 2010, SMHI conducted a survey of the oxygen concentration in the Baltic Sea, see Figure 21, which shows that oxygen levels remain very low. In large parts, the oxygen content varied between anoxic (<0 mg O_2/l) conditions and oxygen-free (<2 mg O_2/l). In the Proper Baltic, completely oxygen-free bottoms affected by hydrogen sulphide constitute 17% of the total surface area. This corresponds to about 10% of the water volume in the area. About half of the planned area of operations lies within the area that the SMHI survey has shown to be anoxic. Swedish Meteorological and Hydrological Institute (SMHI)

In connection with the Nord Stream 2 permit application, sampling of oxygen conditions was performed along the planned pipeline route. The results from these showed that the oxygen content in the area where operations are planned, sampling sites 47-51, had an oxygen content below 1.1 mg O_2/l which corresponds to oxygen-free conditions. (Nord Stream 2 2016)

5.6 National interests and protected areas

National interests protected under the Environmental Code identified as being in connection with or near the project area are:

- Commercial fisheries (Chapter 3, Section 5)
- Nature conservation, outdoor activities, and cultural environment (Chapter 3, Section 6)
- Shipping, waterways, and maritime passages (Chapter 3, Section 8)
- Wind turbines (Chapter 3, Section 8)
- Swedish Defence Forces (Chap 3, Section 9).
- Special protected areas - Natura 2000 (Chapter 7, Section 28)

5.6.1 Commercial fishing

The aim of maritime planning is to contribute to sustainable commercial fishing. The area of the southern Baltic Sea area that is in the national interest in terms of commercial fishing is shown in Figure 22. In this area, the conditions for the fishing industry are, as far as possible, protected against measures which may significantly impede their operations.

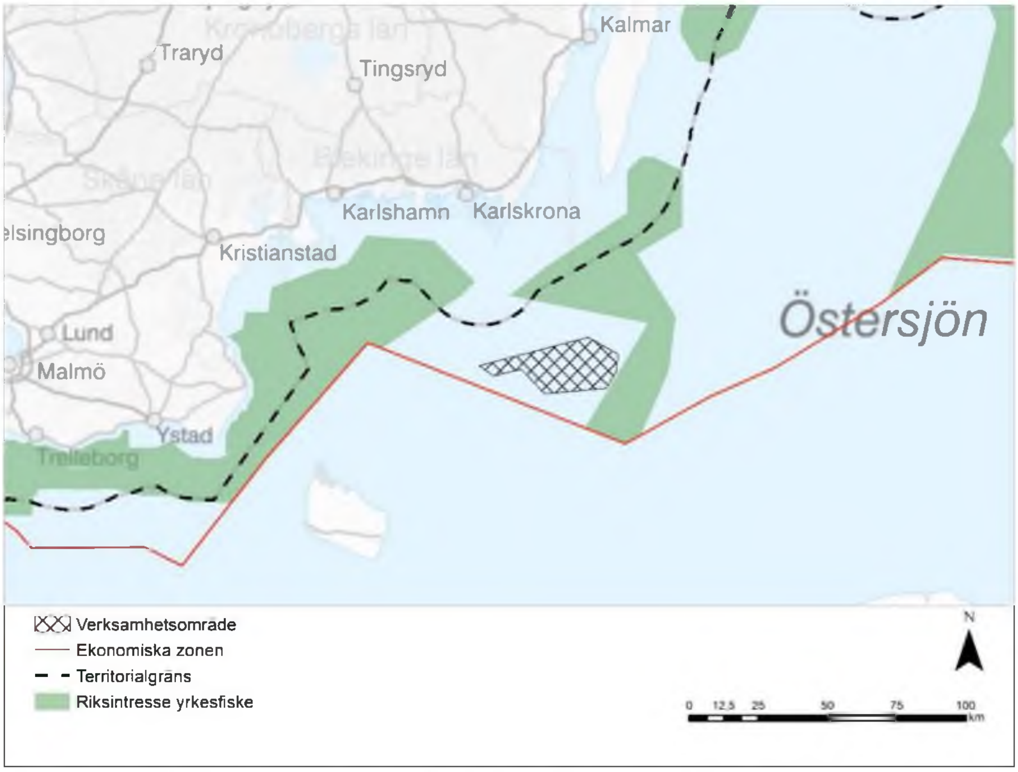


Figure 22. National interest of commercial fishing within the marine plan.

5.6.2 Nature conservation, recreational activities and cultural environment

National interests for nature conservation and recreational activities shall be protected as far as possible from measures which may significantly harm the natural or cultural environment. The closest national interests in terms of nature conservation and recreation are south of Skåne and Öland (see Figure 23 and Figure 24). The closest national interest in terms of the cultural environment lies along the coast and is not investigated further.

Figure 23. National interests for nature conservation.

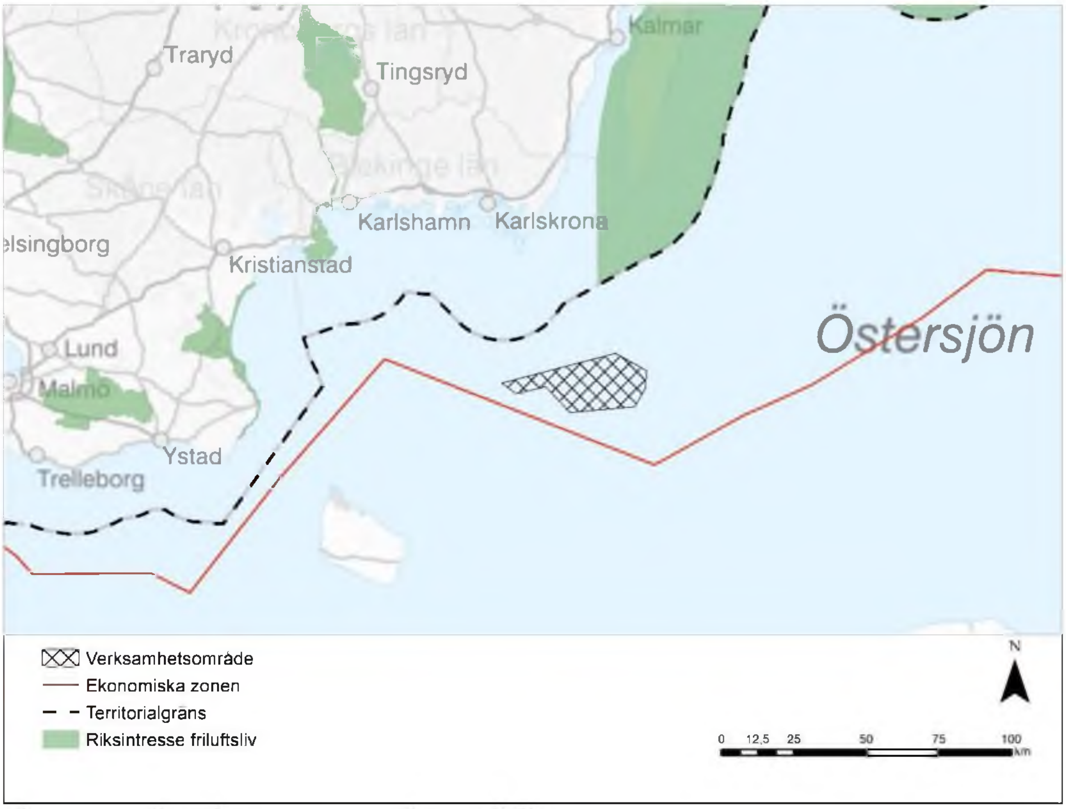


Figure 24. National interest for recreational activities.

5.6.3 Shipping and waterways

The national interest in terms of shipping shall be taken into account during operations and construction, both inside and outside the project area, with the aim of protecting its functioning and, as far as possible, protecting against measures that could significantly impede the creation or exploitation of shipping routes. The routes and the density of the shipping traffic are described in more detail in Section 5.10.

Two main routes to the north of the wind farm area have a high volume of shipping traffic (see Figure 25). The forecast for 2025 is that shipping traffic will increase but not the size of the largest vessels, since the Great Belt has a natural maximum limit on the size of vessels that can travel to and from the Baltic Sea.

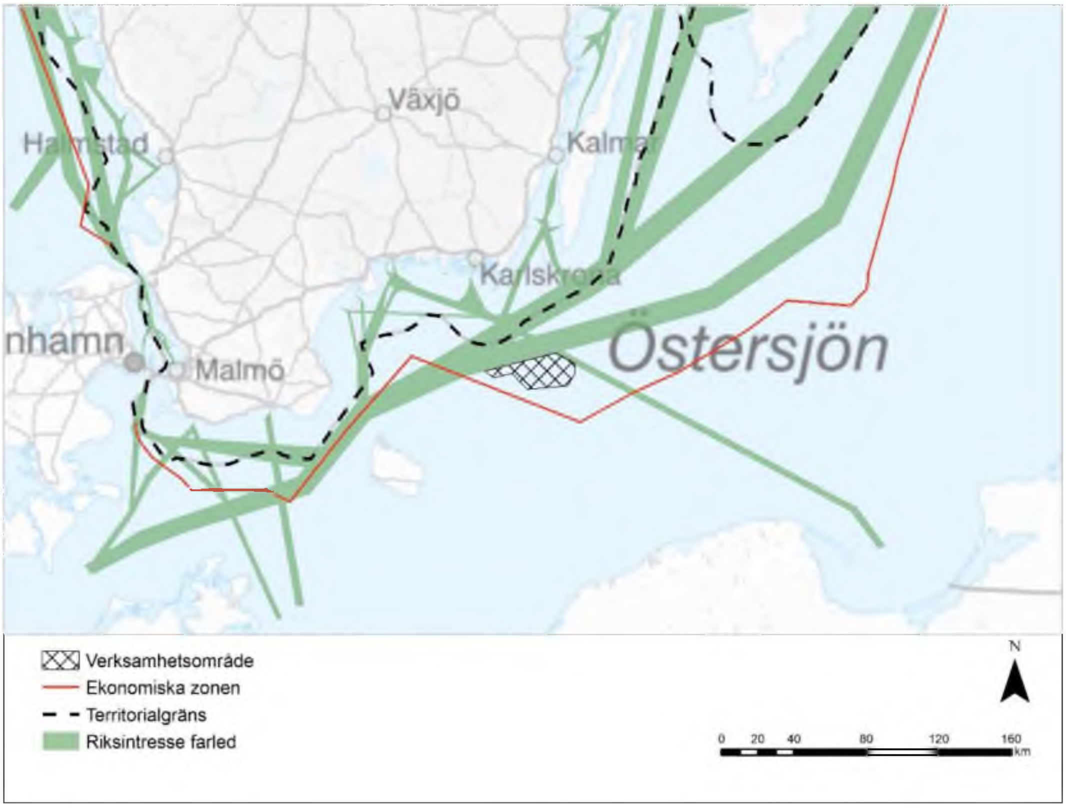


Figure 25. National interest in terms of passageways

5.6.4 Wind turbines

There is no area of national interest in terms of wind farms in the vicinity of the operating area.

5.6.5 Overall national defence

In terms of the national interest of overall national defence, there are different categories of coastal areas and sea areas: restricted areas for high objects, areas with an increased need to be free of obstructions, area with defined heights (MSA areas), areas that impact weather radar, and maritime training areas. This means that these areas should be protected as much as possible against measures that significantly counteract the interests of overall Swedish defence. None of these areas are close to the area of operations under consideration.

North of the area of operations there is an area of national interest in terms of defence in the form of sea training areas (see Figure 26) and the MSA areas, and low-flying areas (see Figure 27).

Clearing obstructions and areas of influence are covered in Section 5.14.

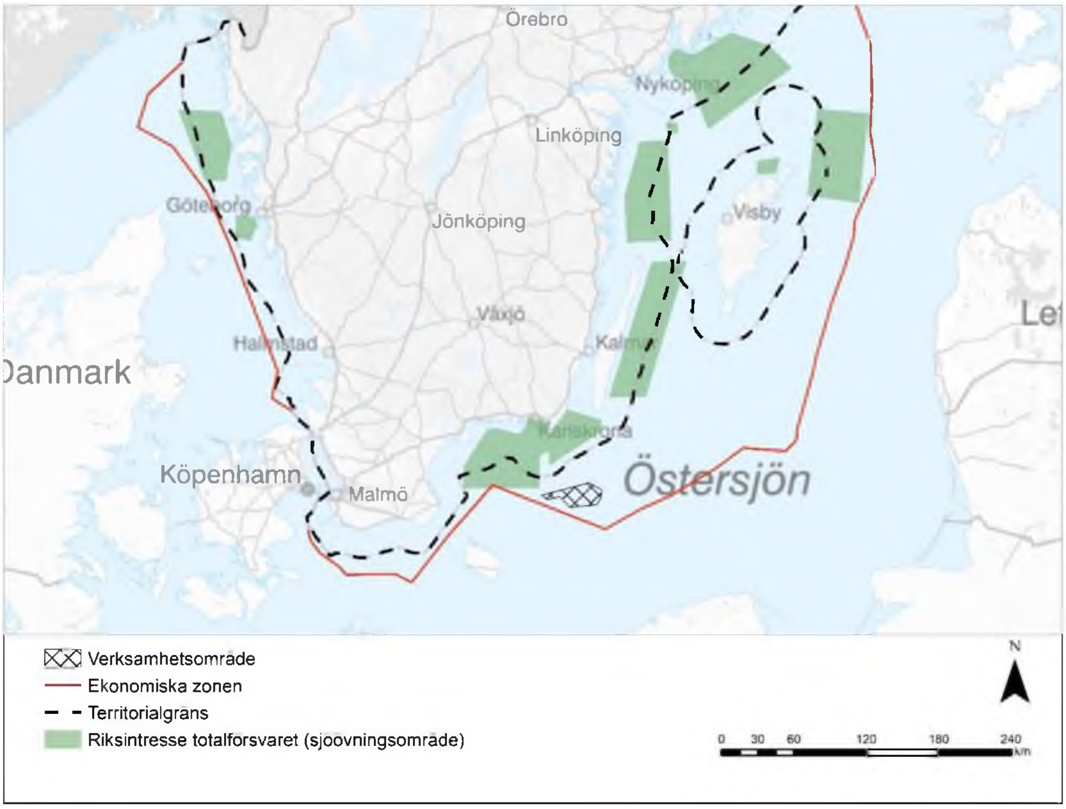


Figure 26. National interests in terms of overall national defence – maritime training areas.

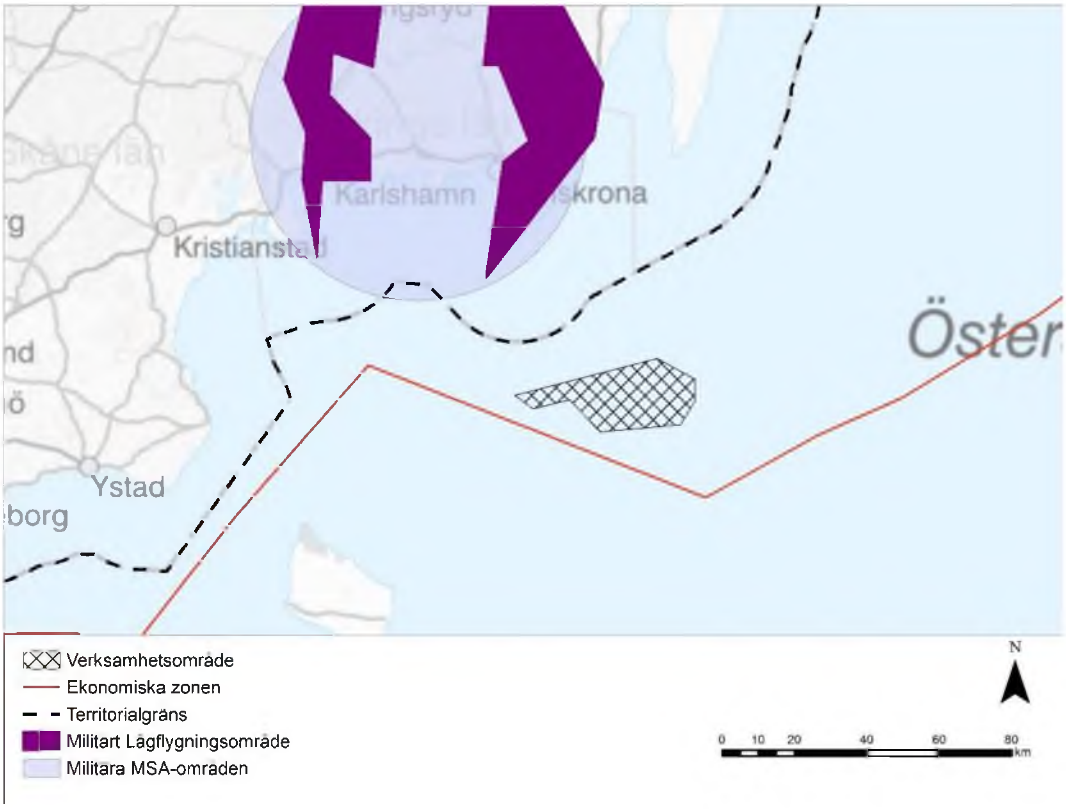


Figure 27. National interest in terms of overall defence – MSA area and low-flying area.

5.6.6 Special protected areas - Natura 2000

Hoburgs Bank and the Midsjö Banks (Midsea Banks)

The area SE0330308, i.e. the Hoburgs bank and the Midsjö Banks, see Figure 28, is protected according to the Species and Habitat Directive and the Bird Directive and is located about 10 km (1 Swedish mile) east of the planned wind farm. The protected habitats are 1170 Reef and 1110 Sand Banks, and species designated within the area are the long-tailed duck, eider duck, black guillemot and porpoise. The deep sea banks are important feeding and breeding areas for fish and seabirds. They are also important overwintering areas for the Baltic Sea population of long-tailed ducks, and constitute the core area for the Baltic Sea population of porpoises. They cover an area of 1 million ha. (Protected nature)

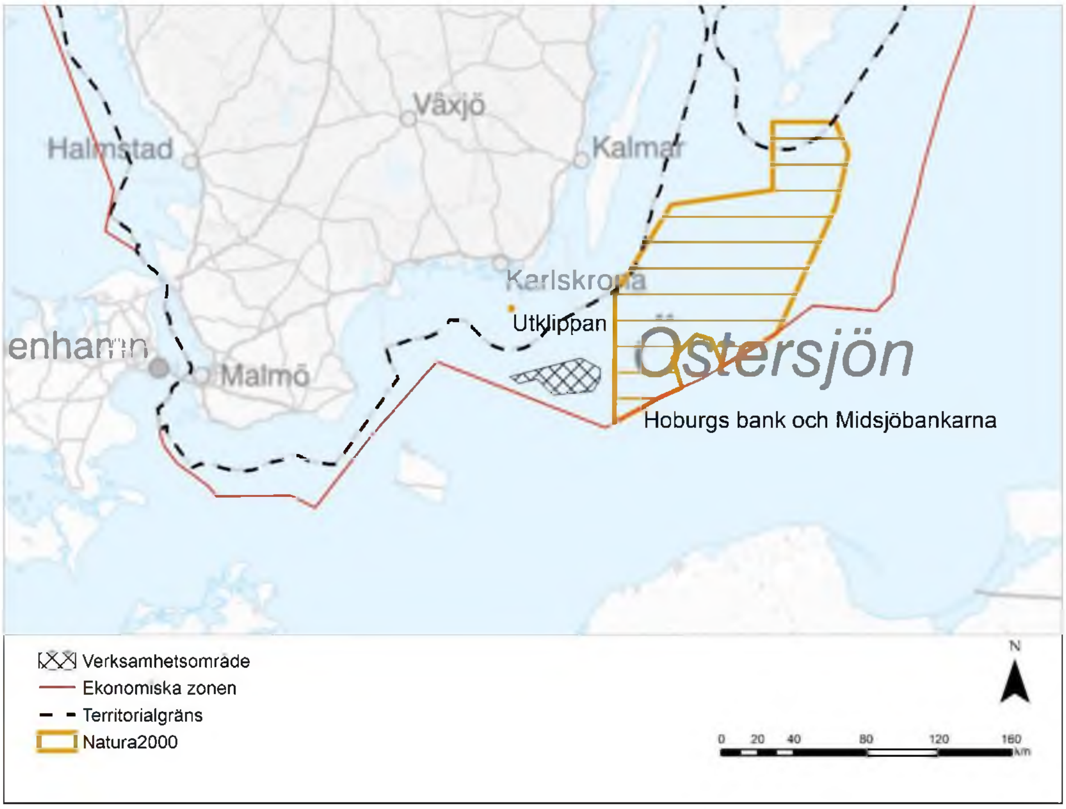


Figure 28. Nearby Natura 2000 areas.

Utklippan (The Cutout)

The area SE0410040 Utklippan, Figure 28, is designated according to the Species and Habitat Directive and the Bird Directive and is 5 km north of the planned area of operations. Utklippen is an important area for migratory birds and seals. Among the protected bird species are the eider duck, long-tailed duck, blue throat, merlin and brent goose. The protected habitat is 620 Skär and small islands in the Baltic Sea. Utklippan and the waters surrounding it are also part of a nature reserve of the same name. (Protected Nature)

The area is far from the planned wind farm, and the values of the area are not considered to be affected, so it will not be investigated further.

5.6.7 UNESCO World Heritage Site

Karlskrona is a well-preserved naval town built in 1680 to meet the need for a fortress in southern Sweden. At the time, it was one of the most modern naval bases in the world and has, in turn, served as a model for other European naval cities. The city is a UNESCO World Heritage Site. (Unesco.se)

Based on the visibility analyses that were conducted, the wind farm cannot be seen from Karlskrona, which is why no further investigation of the impact of the wind farm is necessary.

5.7 Natural environment

5.7.1 Birds

Birds and offshore wind power

Research shows that some species of birds, such as divers, great crested grebe, and fulmars and gannets, completely avoid wind farms. There are also species of birds that largely avoid wind turbines. These include the common scoter, the long-tailed duck, shearwater, razorbill, guillemot, little gull, and the Kentish tern. This behaviour is strongest while the wind farm is in operation. There is also a group of birds that are equally repelled and attracted to the wind farm. These include the eider duck, three-toed seagull, common tern, and the arctic tern. There is also a group of birds that are attracted to wind turbines to varying degrees because they think they are roosting locations. This group includes cormorants and probably seagulls.

Bird life in the Baltic Sea

The Baltic Sea has a rich bird life, and there are a number of locations that are identified as particularly important for feeding in connection with breeding and during the winter season. These are mainly coastal and archipelago environments, but also a number of islands and offshore banks in the central Baltic Sea, see Figure 28. The latter consists of Hoburgs Bank, the North Midsjö Bank, and the South Midsjö Bank, and neighbouring areas. These offer protected environments with a good food supply available at depths of 9–25 meters. These locations are far from the planned area of operations and are not expected to be affected by the facility.

Long-tailed duck

This species is threatened on a global scale, and the Hoburgs Bank, the North and South Midsjö Banks, see Figure 29, are important overwintering sites for the northern and western Siberian populations. The decline of this species has led to it being classified as *Vulnerable* on the IUCN's Red List and *Endangered* on Helcom's Red List (Baltic Marine Environment Protection Commission). On the Swedish Red List, the species is classified *Near Threatened.* For long-term survival, the species is dependent on sea areas within the Swedish Exclusive Economic Zone. The long-tailed duck lives largely on blue mussels, which they swallow whole. Since they can only absorb the soft parts, large quantities of blue mussels of the right size are required. A long-tailed duck of one kilogram is estimated to eat one kilogram of blue mussels per day to achieve its energy balance.

It is not expected that the long-tailed duck will search for food within the area of operations, but its pattern of movement in the area needs to be further investigated.

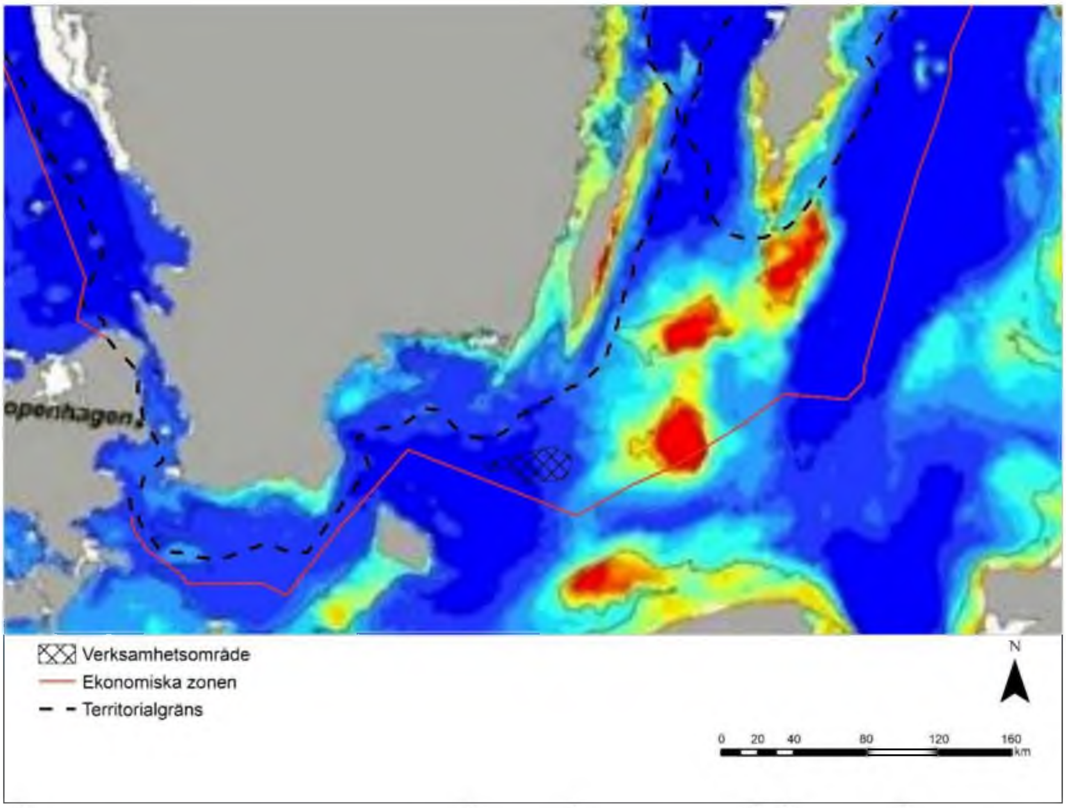


Figure 29. Winter range of long-tailed duck in the Baltic Sea. The density is greatest in the orange areas. From Skov et al. 2011.

Black Guillemot

Just like for the long-tailed duck, Hoburgs Bank, the North and South Midsjö Banks, see Figure 30, are important overwintering places for the black guillemot. It is classified as *Near Threatened* on both Helcom's Red List and the Swedish Red List. Its food consists of crustaceans and small fish caught at a depth of 10 – 30 m.

It is not expected that the black guillemot will search for food within the area of operations, but its pattern of movement in the area needs to be further investigated.

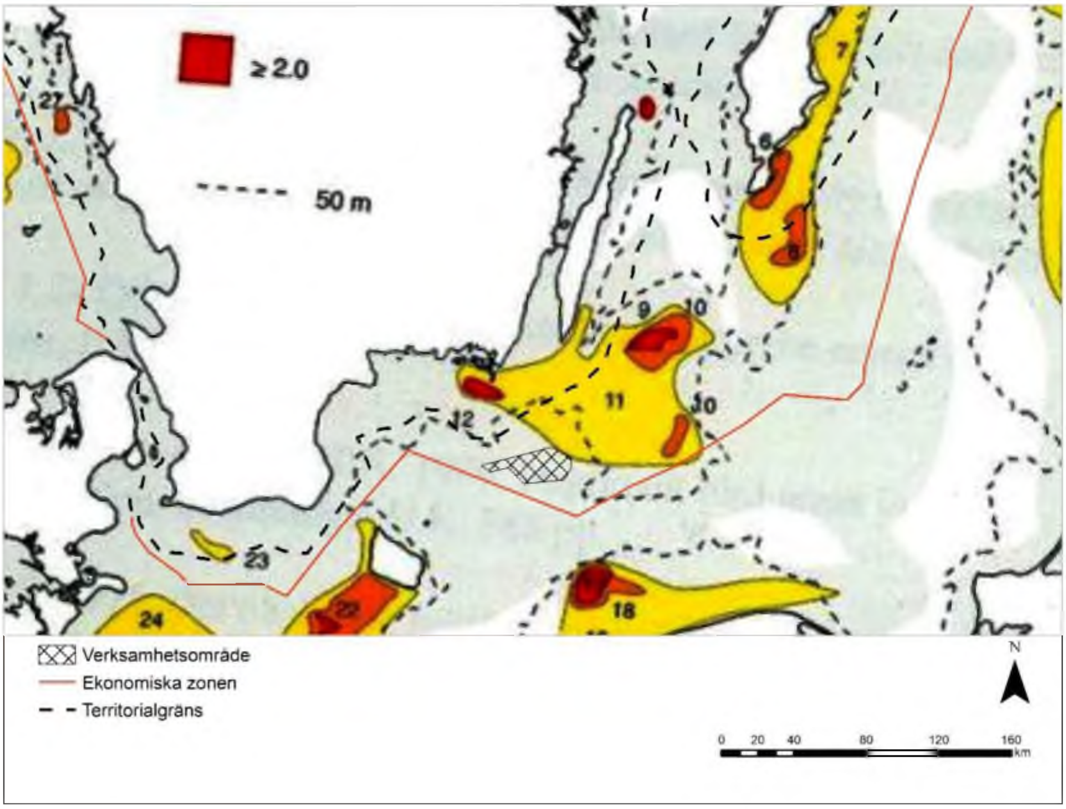


Figure 30. Winter range of black guillemot in the Baltic Sea. The density is highest in orange. From Durnick et al. 1994.

Common guillemot and Razorbill

The Central Baltic Sea is an important feeding area for the common guillemot and the razorbill during both summer and winter. In Sweden, the densest populations outside Gotland are found on Stora and Lilla Karlsö and on Christiansø near Bornholm. Their ability to search for food down to 40 meters means that they are not particularly tied to the offshore banks. When raising their young, their feeding area can reach a radius of 40 km, but usually it is around 20 km. Both species are classified as *Least Concern* (LC) according to the Swedish Red List.

These two species are not expected to search for food within the area of operations, so this is not deemed to need further investigation.

Black-throated loon and red-throated loon

Only a small part of the northern European population of these two species overwinters in the Baltic Sea. This occurs mainly at Rügen and along the Baltic coast. Only a small number of them overwinter at the offshore banks. The black-throated loon is classified on the Swedish Red List as *Least Concern* (LC), while the red-throated loon is classified as *Near threatened* (NT).

These two species are not expected to search for food within the area of operations, so this is not deemed to need further investigation.

Eider duck, black and common scoter.

These three species of divers are mainly located along the coastline and, to a lesser extent, on the offshore banks. Their food consists mainly of mussels. The eider duck is classified *as Endangered* (EN), black scoter as *Vulnerable* (VU), and common scoter as *Least Concern* (LC)

These species are not expected to search for food within the area of operations, so this is not deemed to need further investigation.

Seagulls and terns

A number of seagulls overwinter in the Baltic Sea area, but none are tied to any specific offshore bank. They are usually associated with fish waste from fishing boats.

These species are not expected to search for food within the area of operations, so this is not deemed to need further investigation

5.7.2 Bats

According to the Swedish National Environmental Protection Agency, only two population studies on bats have been carried out for offshore wind power. These have been relatively close to land (within 8 km). However, bats can appear much further away, especially during migration. The main species are migratory species such as dwarf and Nathusius' pipistrelles, but also water and dust bats. The latter two species have only been recorded at sea level, and there is no indication that these would be killed by wind turbines. The conclusion is that special consideration should not be given to these two species. (Swedish National Environmental Protection Agency 2017)

5.7.3 Fish

There are about 100 fish species in the Baltic Sea. Of these, 70 are marine species and they dominate the Baltic Sea. The other 30 – 40 species are freshwater species found in coastal areas and internal archipelagos. The distribution of different fish species is mainly dependent on salinity, while the species composition varies depending on the conditions of their habitat, such as salinity, oxygen content, food availability and temperature. Marine species as well as brackish and freshwater species are well represented in the Baltic Proper area of the Baltic Sea. (Helcom 1)

The fish stocks in the Baltic Proper are mostly made up of the marine pelagic species: cod, herring and sprat. There are also flounder, plaice, sandpike, garpike and whiting. There are also freshwater species such as bream, walleye, pike, perch, and burbot.

There are also several diadrome species (species that live in fresh water and salt water over different periods) such as salmon, eel, smelt, and trout. (Sparholt H 1994)

The results of exploratory fishing, which was carried out during the investigation research for Nord Stream 2, showed that the most common species in the Swedish Exclusive Economic Zone were the marine pelagic species cod, herring and sprat. Only a small number of benthic species such as flounder, plaice and red bullhead were found. There is probably a direct relationship between the species composition and the oxygen content. In the present area under investigation, the oxygen content of previous samples has shown oxygen content that varied between anoxic (<0 mg O_2/l) conditions and oxygen-free (<2 mg O_2/l). It is likely that this area cannot maintain benthic fish populations.

Cod

The Baltic Sea has two populations of cod, one that is west of Bornholm and one this is east of Bornholm, which are genetically different. The population of the cod is strongly affected by commercial fishing and changes in water quality, which has resulted in a drastic reduction in the proportion of individual fish who currently reach spawning maturity. The cod spawn in the deeper parts of the basins where the salinity is higher. For the eastern cod population, spawning takes place in the Bornholm basin, which overlaps the area of operations. For the survival and development of pelagic eggs, a salinity above 11 psu is required to keep eggs floating, as well as an oxygen content above 2 ml/l and a temperature above 1.5 ºC. (Tomkiewiecz, Lehmann, & St John 1998) The species is classified as *Vulnerable* VU on the Red List. The greatest threat to the species is judged to be the high pressure of fishing. (Artfakta)

Herring

Herring mainly lays its eggs on vegetation such as fine-threaded algae, but also on stones and mussels. The roe is sticky and attaches immediately to the bedding. (Swedish Museum of Natural History) The species is classified as *Least Concern* LC on the Red List. (Artfakta)

Sprat

Sprat is found throughout the entire Baltic Sea except at the top of the Gulf of Bothnia. It appears in a large schools along the coastline, but also in pelagic areas. It can usually be found from 10 to 50 meters. Sprat avoids cold surface water and forms overwintering schools in deep water. Spawning takes place on open water from the surface down to 40 meters from February-August. Just like the eggs of cod, the sprat depends on the salt content to keep the eggs afloat. The species is classified as *Least Concern* LC on the Red List. (Artfakta)

5.7.4 Marine mammals

In the Baltic Sea there is a stationary whale species, the porpoise, and the three species of seal: grey seals, ring seals, and harbour seals.

The harbour seal is found around Kalmar Sound with a population of about 2000 individuals. The ring seal is mainly located in the Gulf of Bothnia because it depends on sea ice for reproduction. (Artfakta). Because the populations of ring seals and harbour seals are relatively distant from the planned wind farm, these species will not be addressed in any greater detail.

Porpoise

Porpoises in the waters around Sweden are divided into three genetically and morphologically distinct populations. The population in the Baltic Sea was estimated to consist of 500 individuals based on surveys carried out in 2011 and 2013. This means that it is classified as a Critically Endangered (CR) (HAV a). The harbour porpoise is listed in Appendix 2 and Appendix 4 of the Species and Habitats Directive, which means that individuals of the species must not be caught, killed or disturbed. Nor must its resting areas or breeding grounds in its natural range be disturbed or destroyed.

The range of the species in the Baltic Sea is well studied and its presence is concentrated in Swedish waters. Hanö Bay, Midsjö Banks, Hoburgs Bank and the area around Öland are described as very important. The Midsjö Banks and Hoburgs Bank are Natura 2000 areas within which the harbour porpoise is a designated protected species. Important areas in the Hanö Bay are well away from the area of the planned wind farm Figure 31. (Carlström, J & Carlén, I. 2016)

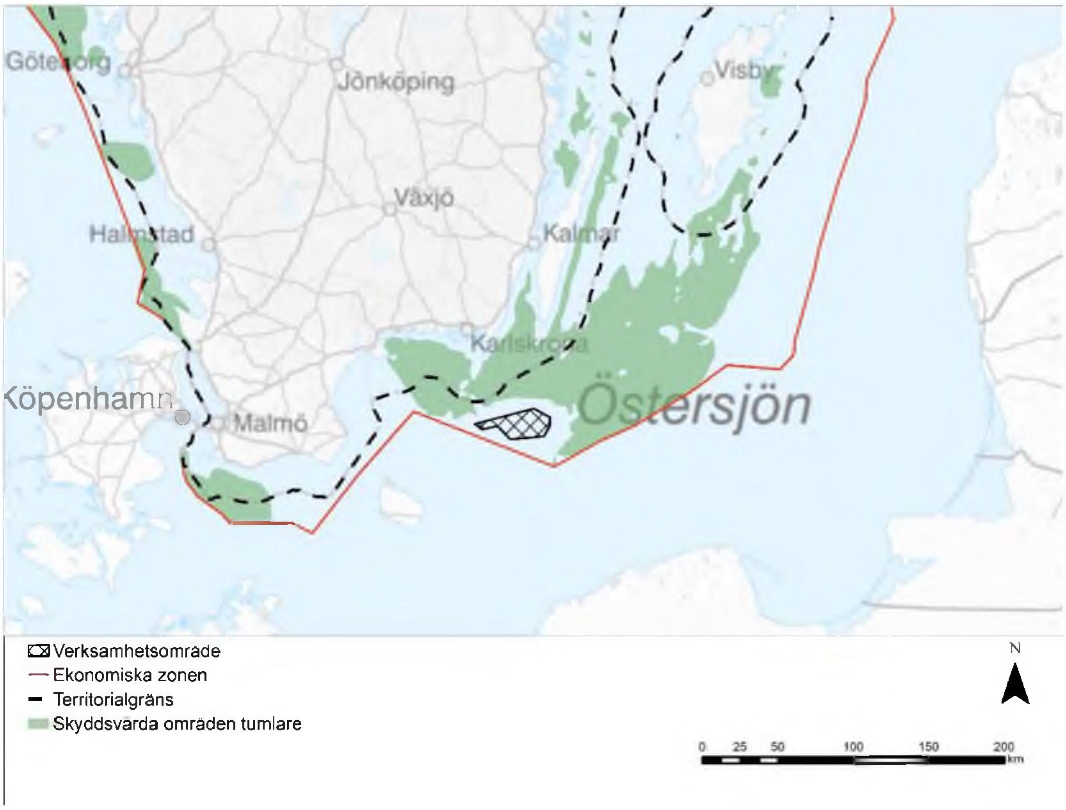


Figure 31. The picture shows important areas for porpoises in the western Baltic Sea and how they vary during the year.

Grey seal

This is the largest and most common seal species in the Baltic Sea. It is also present in the North Atlantic. Despite the large range and well-separated populations, there are no subspecies or different breeds. The Baltic Sea population has been heavily affected by hunting and environmental toxins. In 1906, the Baltic Sea population was estimated to be between 88,000 – 100,000. Today there are approximately 12,000 grey seals in the Baltic Sea. In Sweden, their range is located along the entire coast. The species is mobile and can move over long distances to reach mating areas or to search for food. The pups, i.e. their young, are usually born on pack ice but also on rock islets. The species is classified as *Least Concern* LC on the Red List. (Artfakta) The grey seal has excellent hearing and can perceive sound in the frequency range between a few hundred Hz and about 50 Hz.

Grey seals have not been recoded in the wind power project area, but it is not unlikely that they can occur there, see Figure 32.

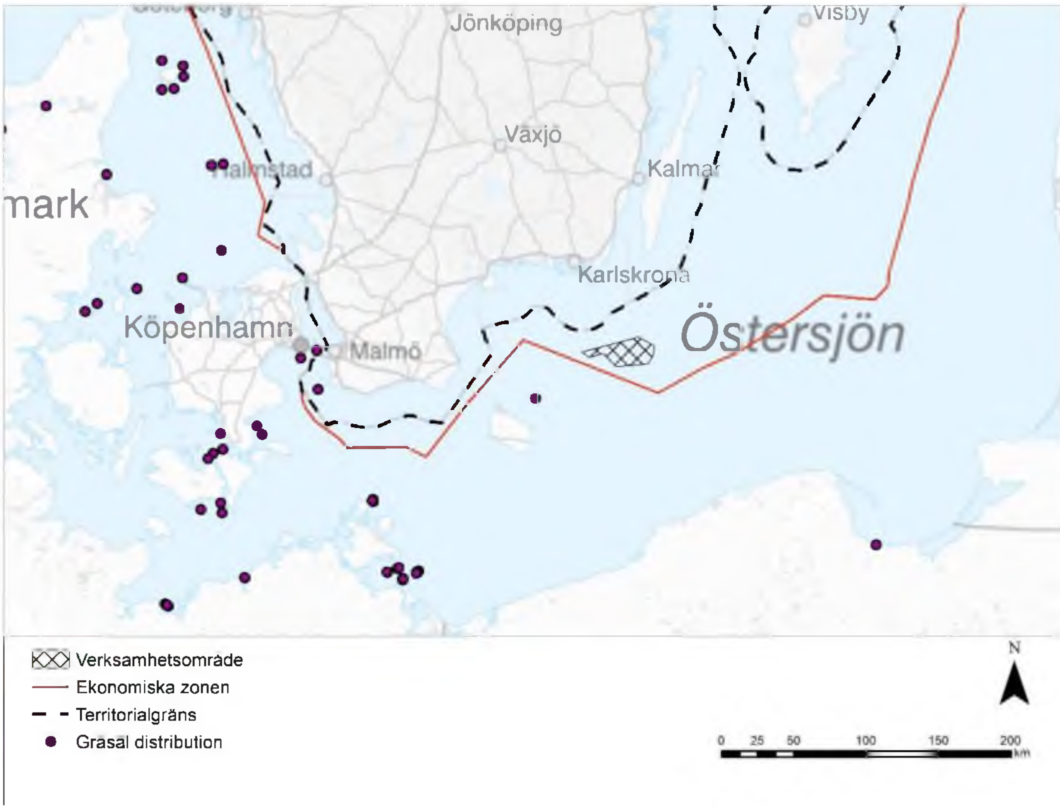


Figure 32. Observation points for the grey seal with transmitter.

5.7.5 Benthic environment

A benthic environment depends on a number of factors to maintain life. Among these are oxygen content, salinity and light, which are factors that in different combinations, are crucial for life at the sea bottom.

The Baltic Sea has a large number of marine algae that decline in number along with the salinity as you head north. However, no benthic flora can live at depths greater than 35 meters within the Swedish Exclusive Economic Zone, which is why this will not be discussed further.

Also the bottom fauna is generally absent or few in numbers below the permanent halocline at about 60 meters depth due to the low oxygen content. This could be confirmed in connection with the investigatory work for the Nord Stream Project 2 (Nord Stream 2 2016)

5.8 Outdoor activities and recreation

In and around the project area, it can be expected that sailboats will pass through and there may also be small-scale recreational fishing.

5.9 Marine archaeology

According to the Swedish National Heritage Board, there are no recorded archaeological finds near the area of operations (brown stars in Figure 33), but there may still be unknown remains to be found. Within the Nord Stream Project 2, a geophysical reconnaissance survey was conducted from November 2015 to February 2016. One of its aims was to identify potential cultural heritage objects along the proposed route (see green line I Figure 33). The data from the survey was submitted for analysis to the Swedish Maritime Museums (SMM), an expert body approved by the regulatory authorities.

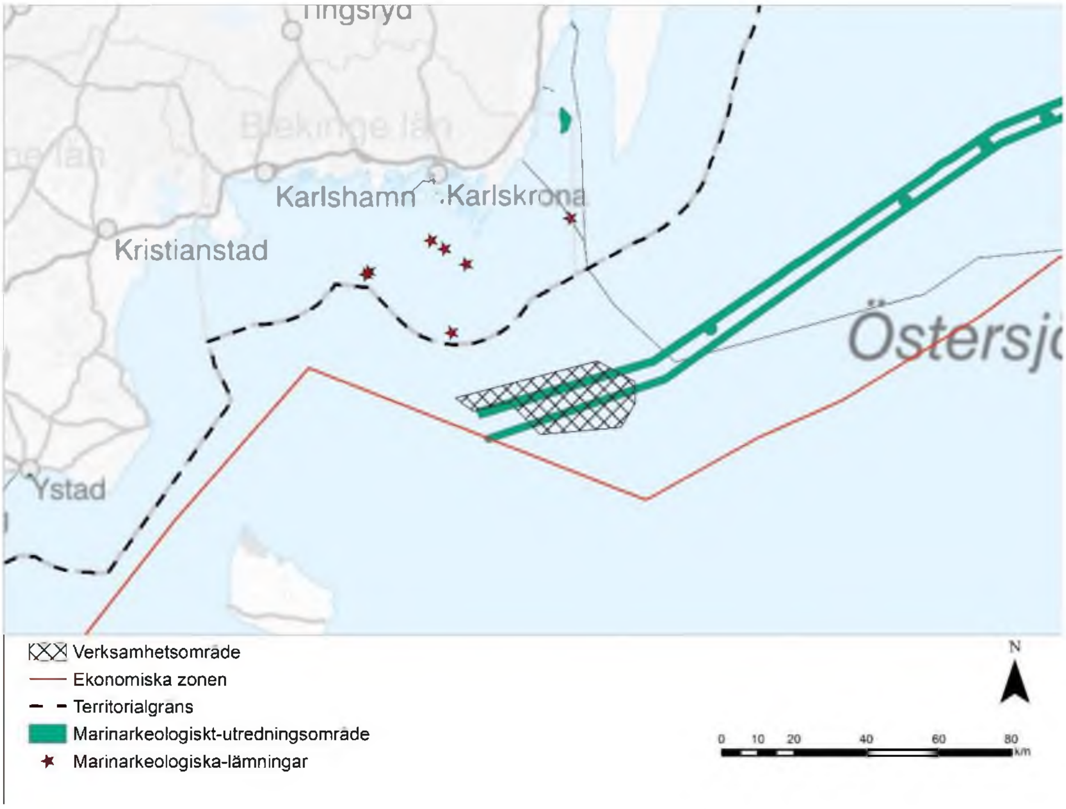


Figure 33. Marine archaeological remains (RAÄ) and the marine archaeological investigation area of the Nord Stream Project 2.

In Figure 34, registered shipwrecks are marked with black dots. Shipwrecks are considered ancient remains if the ship sank before 1850, but this also applies to wrecks that have sunk after that year, if they are particularly interesting (www.vrak.se). Shipwrecks are protected under the Swedish Historic Environment Act.

According to the Nord Stream Project 2 survey, a couple of wrecks and objects related to one of the wrecks were identified (the two black dots within the operating area in Figure 34). The recommended distance between operations and the objects found is 50 m according to SMM.

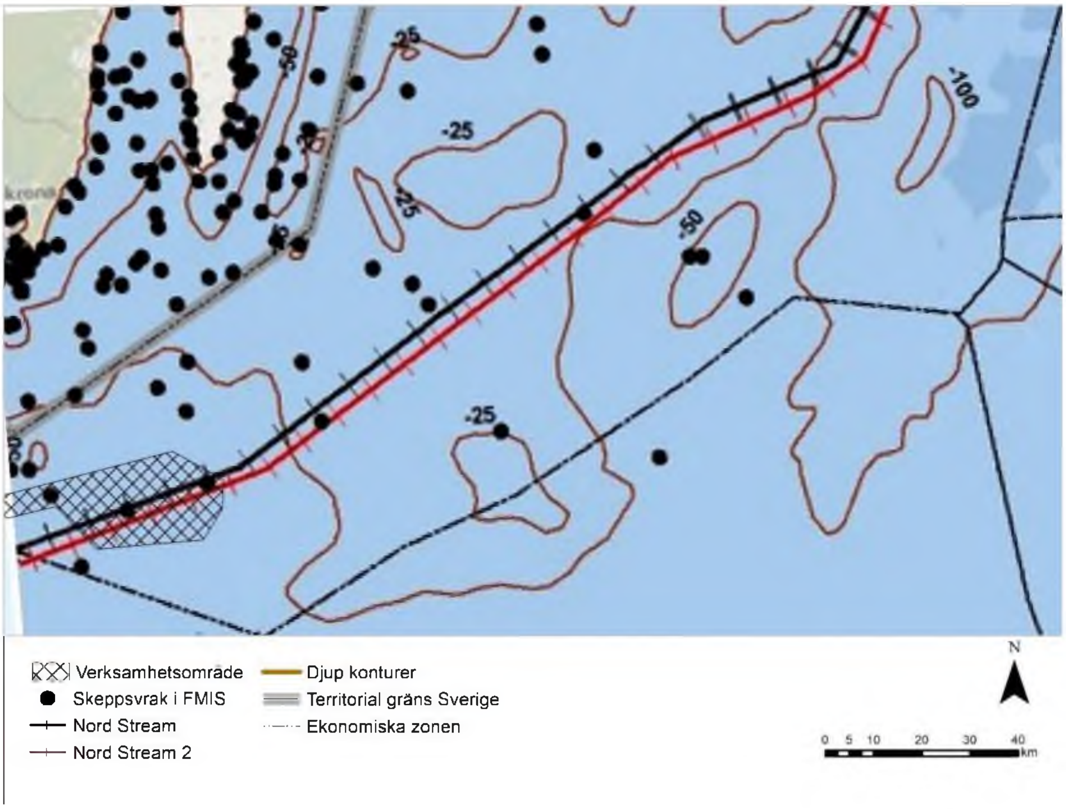


Figure 34. Cut out from the figure with registered shipwrecks in FMIS (Swedish Maritime History Museum, 2016).

5.10 Shipping routes and maritime traffic

There are two main shipping routes north of the operating area (see Figure 35). The route closest to the operating area is the main route for deep-water vessels that sit deeper than 12 m. The route north of this is considered the main route through the Baltic Sea and is mainly used by ships that do not sit deeper than 12 m.

Using an automatic vessel identification system (AIS system), a density map can be produced showing the traffic pattern in a given area. Figure 35 shows the traffic pattern for all types of vessels in 2020 (EMODnet). In the main route, a high number of vessels passed north of the operating area, but a smaller number of vessels passed through the route for deep-water vessels.

According to forecasts in the Nord Stream Project 2 (Nord Stream 2, 2016), vessel traffic in the shipping route closest to the area of operations is expected to increase by 26%. It has the highest proportion of tankers compared to the other shipping routes, and vessels over 200 m account for about 40% of the traffic. The main shipping route is expected to increase by around 44 – 49%, dominated by cargo vessels of less than 200 m. According to forecasts beyond 2025, the increasing trend in the number of larger vessels will continue. Only tankers transporting liquids showed a marginal decrease in frequency in the larger vessel segment. The forecast for 2025 is that shipping traffic will increase but not the size of the largest vessels, since the Great Belt creates a maximum limit on the size of vessels that can travel to and from the Baltic Sea.

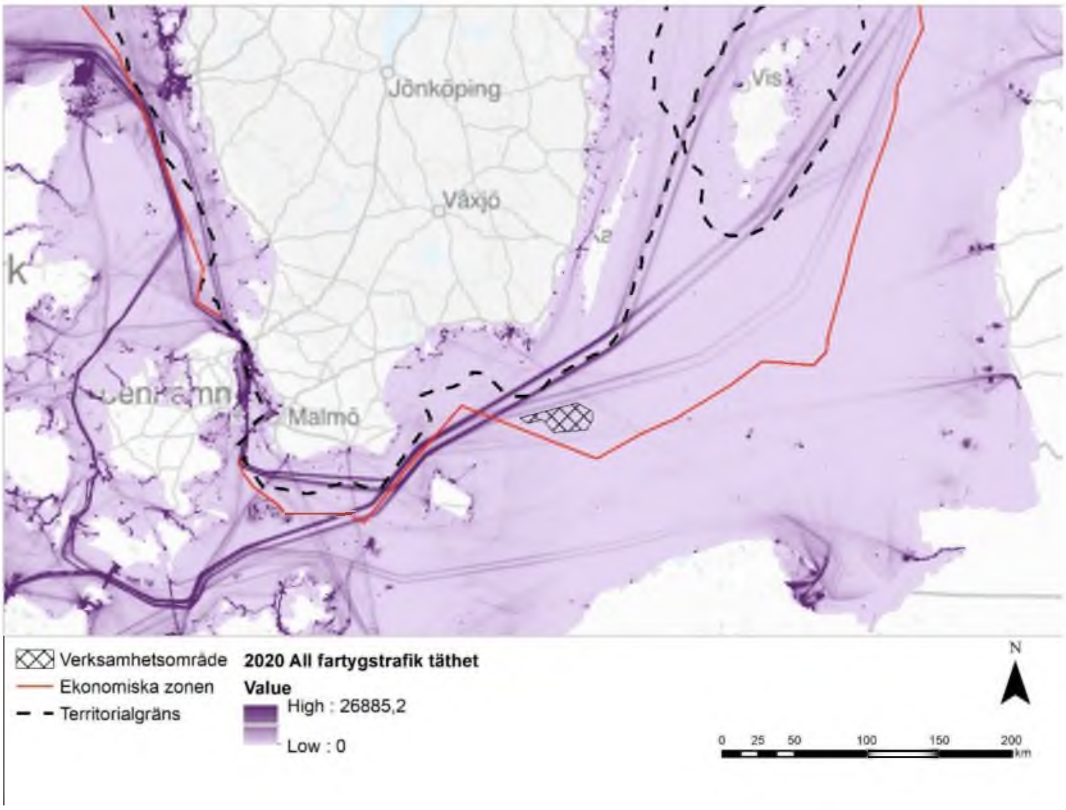


Figure 35. Main shipping routes and the density of shipping traffic in the Swedish Exclusive Economic Zone 2020 (EMODnet). High density corresponds to about 26,885 vessel passages throughout the year.

5.11 Commercial fishing

Commercial fishing in the Baltic Sea has a major impact on fish stocks and is currently highly regulated. In order to ensure that fishing is sustainable, the stocks are continuously monitored over time. It is one part of the work toward the environmental objective of 'Balanced seas and a living coast and archipelago'. In order to highlight the effects of fishing, SLU (Swedish University of Agricultural Sciences), on behalf of the Swedish Agency for Marine and Water Management, has produced the stock-based indicator "Sustainable use of fish and shellfish stocks on the coast and at sea". The indicator indicates whether the fish and shellfish stocks are sustainable in the long term or not, or whether more information is needed to make an assessment. The classification uses three categories: Sustainable use, Unsustainable use and Assessment not possible.

During 2020, Swedish fishing has mainly focused on herring, sprat and whitefish (vendace), while it has previously been focused on cod. In 2020 and 2021, all target fishing for cod has been banned because of the very poor state of the species in the Baltic Sea. (Swedish Agency for Marine and Water Management, 2021) In the investigation area for the wind farm, there is also a ban on fishing for cod, see Figure 36.

Figure 36. The planned location of the wind farm in relation to areas where fishing for cod is prohibited.

Under the Nord Stream Project 2 environmental monitoring programme, a fish species survey was conducted in 2014 showing that the composition of the fish population was similar to what was observed during the 2010 survey carried out in the same programme. This survey was strongly dominated by cod, herring, and sprat, both in terms of biomass and number, and which are also the most commercially important species and account for around 90-95% of the total commercial catch in the Baltic Sea. In general, the size of cod and herring stocks has decreased. In order to protect spawning grounds for cod, since the mid-1990s, a central part of the most important spawning area in the deep waters around Bornholm and an area south of the Hoburgs bank has been closed for all fishing during the most intensive spawning period (May 1 to October 31).

The main fishing areas are located in the western Baltic Sea, in particular north and east of Bornholm (see Figure 37). In the wind farm area, bottom trawling is carried out on a medium scale and some net fishing is carried out in the southern part (2010-2014).

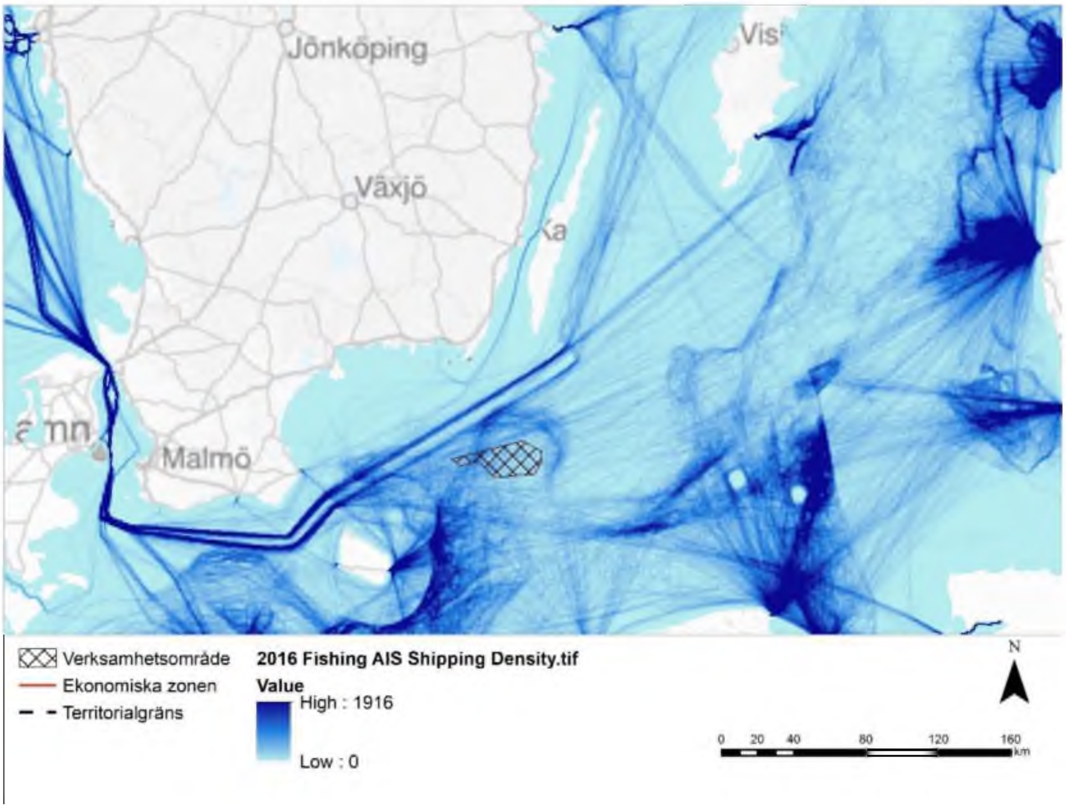


Figure 37. The figure shows the movement patterns for fishing boats during 2016. The boats are equipped with Automatic Identification System (AIS) to track their routes.

5.12 Risk areas for mines and other ammunition remains

The Baltic Sea is probably the only sea in the world with the highest concentration of mines, munitions and chemical weapons on the bottom. Much of it comes from the time of and after the two World Wars, and it is still dangerous to touch objects found on the sea bottom or in the water. (Swedish Energy Agency, 2019)

According to the Baltic Marine Environment Protection Commission (Helsinki Commission), one of the largest dumping sites is located outside Bornholm, where over 11,000 tons of chemical weapons have been dumped, largely mustard gas. The idea that weapons may also have been thrown overboard during the trip to the dumping sites east of Bornholm and southeast of Gotland cannot be ruled out. In addition, the weapons were often packed in wooden boxes that easily float, enabling them to drift over long distances with the winds and currents before they sank. The weapons were also further spread by trawling fishermen who may have inadvertently carried ammunition and containers over the seabed in their nets. (https://www.havet.nu/ammunition-och-kemiska-stridsmedel). The wind farm area is located northeast of the munitions dumping area but partly within the area where chemical weapons have been found (see Figure 38).

There is also a military training area for submarines east of Bornholm and south of the wind farm area.

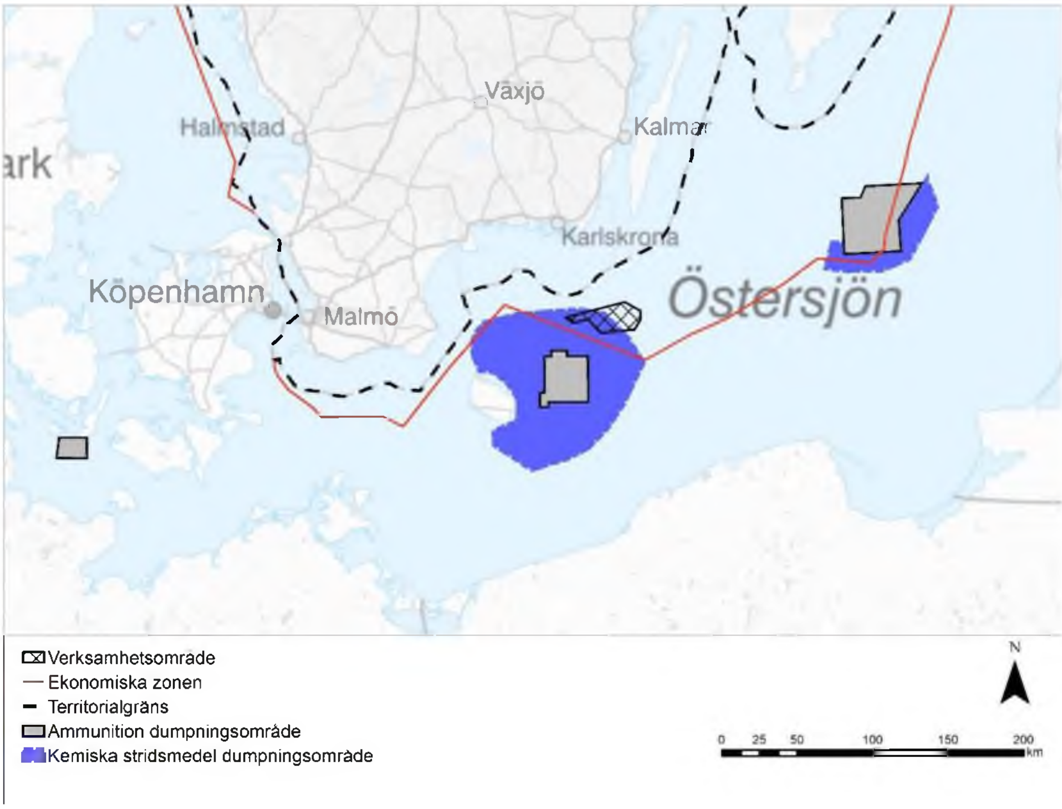


Figure 38. Dumping areas with ammunition and chemical weapons.

5.13 Wires and cables

The identified wires and cables in the area are shown in Figure 39.

At the bottom of the Baltic Sea between Karlshamn and Poland, there is a 254 km long direct current power line, the Swe-Pol link. The area of operations includes a 1,172 km long telecommunications cable and the 1,220 km long Nord Stream 2 gas pipeline, consisting of two parallel steel pipes.

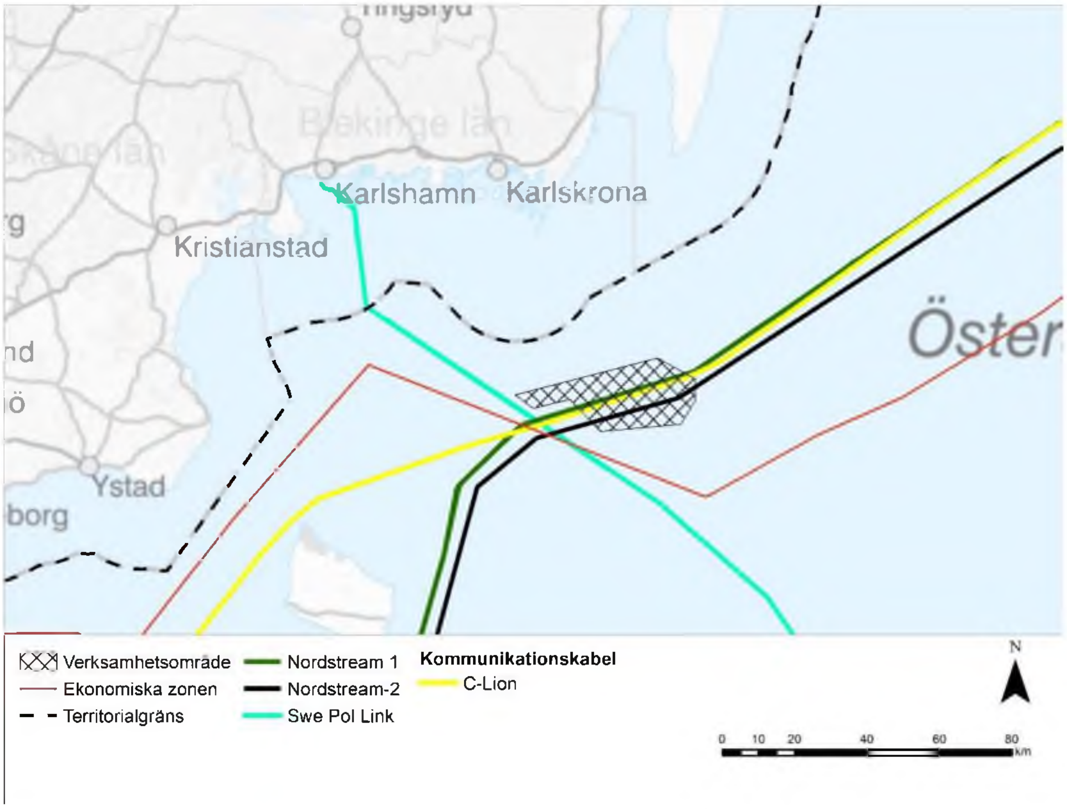


Figure 39. Cables and wires.

5.14 Air traffic and obstruction lights

The planned area of operations is far away from areas with a special need to be free of obstructions and areas that can influence weather radar, see Figure 40. The wind farm is also planned to be designed in such a way that corridors are formed that allow, for example, rescue helicopters to operate.

Notification of a flight obstruction will be issued in advance of the construction of the wind farm.

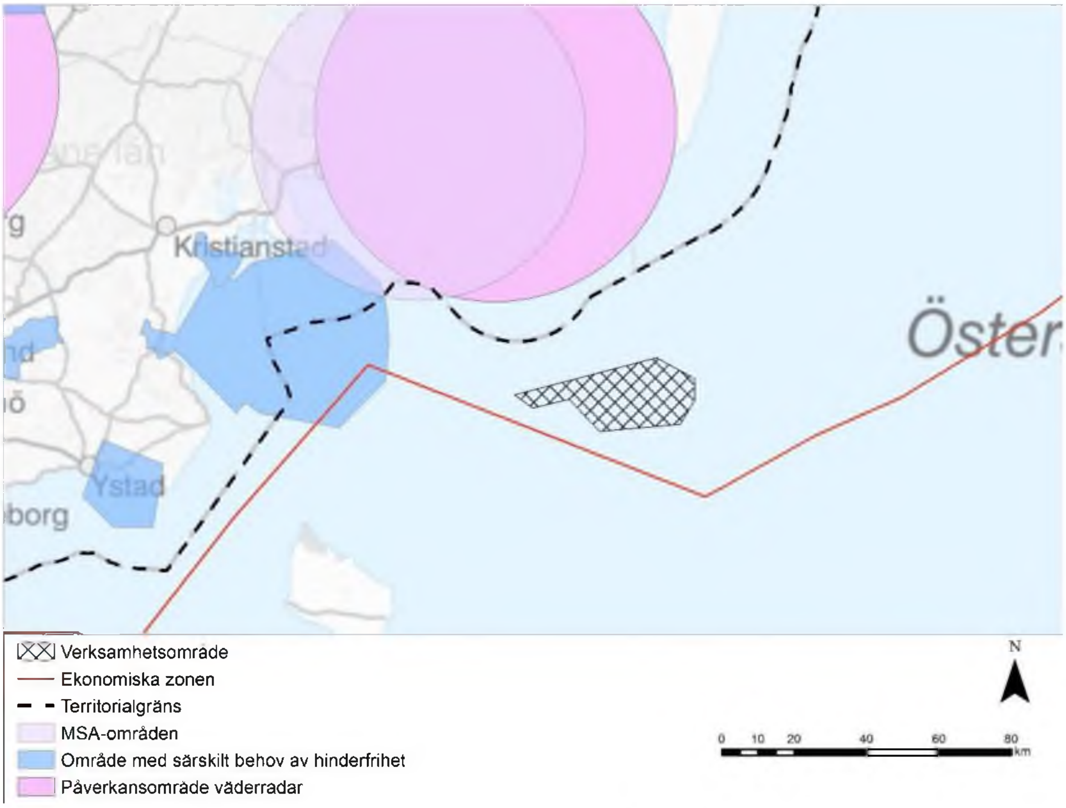


Figure 40. Areas with a special need to be free of obstructions and the area that can impact weather radar.

According to the Swedish Transport Agency's regulations and general recommendations (TSFS 2020:88) on marking objects that may pose a danger to air traffic and on registering flight obstructions, wind turbines higher than 150 m must be marked with white paint and fitted with high-intensity, white flashing obstruction lights on top of the nacelle. For Baltic Offshore Beta, this regulation means that all turbines need to be equipped with white flashing obstruction lights. The option available in the current regulations to reduce the impact on landscape images is to control the light intensity based on background light, see Table 5. A future possibility discussed is the possibility of controlling the obstruction lights based on transponder signals, i.e. that they light up when an aircraft is in the vicinity. This is already technically possible, and its availability is a matter of legislation.

Table 5. The Swedish Transport Agency's guidelines for controlling the light intensity of obstruction lights on wind turbines.

1	2	3	4	5	6	7
Typ av ljus	Färg	Signaltyp (blinknings-intervall)	**Styrka i maxpunkt (cd) mot given bakgrundluminans** (För blinkande ljus gäller effektiv styrka) (a)			**Ljusför-delning-tabell**
			Dager: över 500 cd/m²	Skymning/Gryning: 50-500 cd/m²	Mörker: under 50 cd/m²	
Låg-intensivt typ B	Röd	Fast	32 cd (b)	32 cd	32 cd	2
Medel-intensivt typ B	Röd	Blinkande (20-60 bpm)	2 000 (b)	2 000	2 000	3
Hög-intensivt typ B	Vit	Blinkande (40-60 bpm)	100 000	20 000	2 000	3

a) För blinkande ljus ska intensiteten vara effektiv intensitet i enlighet med Aerodrome Design Manual (Doc 9157), Part 4.

b) Om ett föremål är markerat med färg och framträder tydligt mot omgivningen behöver inte låg- och medelintensiva ljus vara tända när bakgrundslunimansen överstiger 500 cd/m².

In addition to flight obstruction lights on the nacelle, light markers are also needed for vessel traffic and on high towers, as well as a light in the middle of the tower is needed for increased safety during helicopter flights in the park. In Figure 41 below, the different types of flight safety light markings are shown, (upper left image), vessel safety (upper right image) and how the combination of both aspects can be distributed across the wind farm. Note that according to today's rules, all wind turbines in Baltic Offshore Beta will be equipped with white flight-obstruction lights, but the figure below gives an indication of the other light indicators that may be relevant.

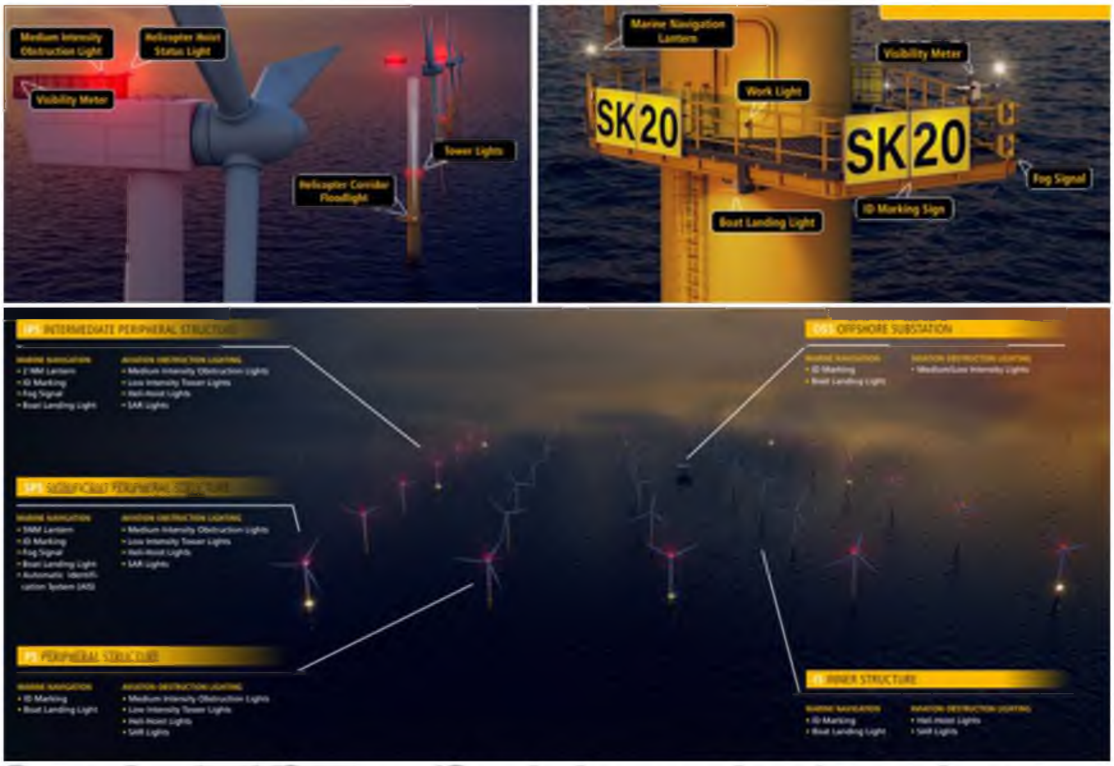


Figure 41. Illustration of different types of flight safety lights (upper left image), vessel safety (upper right image) and how the combination of both aspects might be distributed across the wind farm. Images from Sabik Offshore.

6 Possible impacts and effects

6.1 Marine planning

The marine plan states that special consideration should be given to high natural values in the area, and that interesting shipping routes and commercial fishing should be taken into account during planning. The impact on these interests is explained below.

6.2 Sediments and contaminants

During the construction phase, sediment may be released and can spread into the water (turbidity). If the sediments are contaminated, this can contribute to an increase in the spread of pollution to the surrounding area. Assuming that construction takes place using a jacket foundation or a tripod foundation, local temporary turbidity in the water can be expected mainly during pile driving or drilling. The largest distribution of sediment occurs during strong currents caused by rough weather, when however, construction and anchoring do not take place since these activities are considered risky.

Previous investigations of the bottom sediments indicate that there are no significant levels of contaminants at risk of spreading during construction. This will be examined in more detail when preparing the permit application.

6.3 Commercial fishing

The areas of national interest in terms of fisheries largely coincide with or border the shallow areas, which are the most interesting areas for the expansion of wind power. These are spawning and nursery areas for fish, and at the same time, are the best fishing areas. Fishermen claim that their operations will be disturbed by wind turbines located at depths of less than 25 meters. The area of operations is 55 m to 80 m deep and should therefore not interfere with commercial fishing. Moreover, not much fishing is carried out in the area.

Wind farms with large turbines (3 MW or more) require distances that are so large between the individual turbines that they do not technically pose any major obstacle to certain types of fishing, apart from the limitations that the cables may entail. However, drift nets and trawlers cannot be used inside a wind farm. The reason for this is that it is not always possible to cover or bury cables.

6.4 Shipping routes and maritime traffic

The wind farm may pose a safety risk for shipping along established shipping routes. The development of offshore wind power may have an impact in terms of the fact that markings for shipping traffic are obscured or the visibility is impaired, which makes navigation difficult and makes it more difficult to see other vessels. The project area lies between the shipping routes that are in the national interest, and is therefore not considered to affect maritime traffic. According to AIS data, maritime traffic also runs outside area the national interest in terms of shipping (see Figure 35).

Construction of the wind farm may cause temporary minor disturbances when construction vessels cross ship routes but may be avoided by establishing temporary safety areas around construction vessels.

6.5 Landscape view

The visual effects of Baltic Offshore Beta have been analysed via line-of-sight analyses and by photomontages from selected locations on Bornholm, Öland and along the coast of Skåne and Blekinge.

The effect of the earth's curvature on visibility

The sight analyses below show the theoretical possibility of the wind turbines being in full line of sight. It only takes into account the obscuring effect of the earth's curvature. The picture on the left in Figure 42 shows how far an obstruction light planned 180 m above sea level is visible on the horizon at different terrain heights at the observation site, and the picture on the right shows the same information for the tip of the top blade of the wind turbines at 330 m above sea level. This is 30 m higher than in our example layout to incorporate the next generation of technological development. It is worth noting when interpreting the sight analyses that the nearest areas on the mainland, the islands of Öland or Bornholm are more than 50 km from the wind farm.

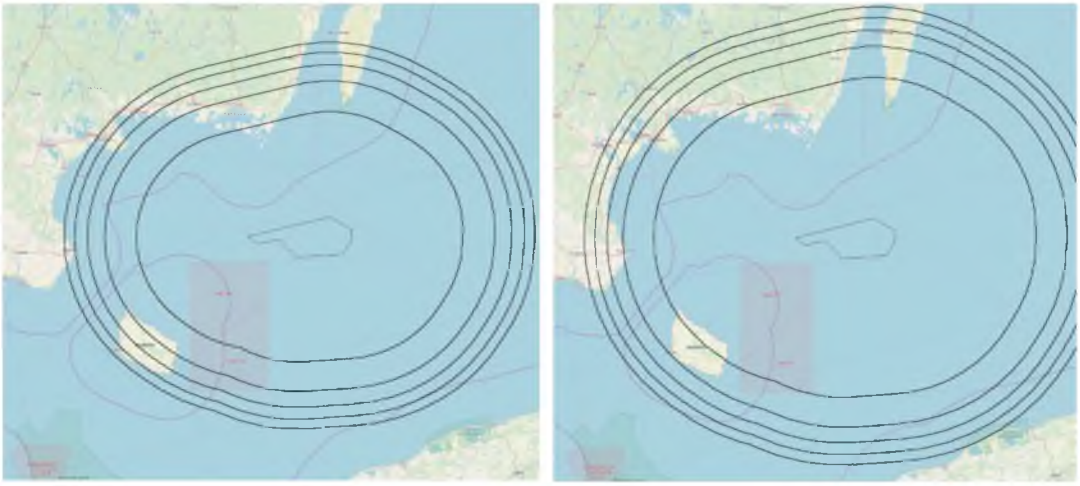


Figure 42. The black lines indicate the theoretical possibility of seeing the nacelle at 180 m height (on left) or the upper tip of the blade (at 330 m height) with a completely clear view before it disappears below the horizon due to the curvature of the earth. The different lines in the figures represent visibility at sea level (innermost line), and in turn from the centre at 30 m, 60 m, 90 m and 120 m terrain height respectively.

Expected reduction in visibility

The Baltic Offshore Beta visualisations have been created with the commercial WindPRO calculation program. This tool does not have an automatic function to include the effect of reduced visibility at large distances. Since this effect is very important in order to get a realistic picture of how much the Baltic Offshore Beta project is visible from the shore, a digital filter has been applied. This filter has been calibrated so that the visibility and colour reproduction of the turbines correspond to the conditions of the photo session, which involved relatively clear weather but with high cirrus clouds toward the southeast from a rainy area further south (some mist was present), see Appendix 1 for more detailed description.

Visualisations

The visual impact of Baltic Offshore Beta from the mainland has been analysed using a high-resolution photomontage from the locations indicated by the map in Figure 43. The photomontage contains corrections to take into account the two effects described above.

A brief description of the observations sites follows below

- Observation point A is located at sea level in the harbour of Sveneke on the northern part of Bornholm's eastern coast. The nearest distance to a turbine is approximately 63 km.
- Observation point B is at "Helligdomskipper", which is one of Bornholm's most visited attractions. It is a group of rock formations on the northeast coast of Bornholm. The photos are taken from a 20 m high cliff in the centre of the area. The nearest distance to a turbine is approximately 65 km.
- Observation point C is a 70 m high cliff on the northern tip of Bornholm. The nearest distance to a turbine is approximately 70 km.
- Observation point D is located at sea level on the shores of Tobisviken just north of Simrishamn. The nearest distance to a turbine is approximately 85 km.
- Observation point E is the peak of Stenshuvud National Park at 90 m height. The nearest distance to a turbine is approximately 90 km.
- Observation point F is the harbour in Nogersund, east of the city of Kristianstad. The nearest distance to a turbine is approximately 73 km.
- Observation point G is the harbour in Torhamn, southeast of Karlskrona. The nearest distance to a turbine is approximately 47 km.
- Observation point H is on the south cape of Öland at sea level. The nearest distance to a turbine is approximately 55 km.

This document presents a few images from the visual analysis as an overview.

Figure 44 displays the analysis from observation point C, which is the nearest point with high terrain. Stenshuvud is slightly higher, but is 20 km further from the wind farm, and visibility is judged to be even more limited than from observation point C. In addition, the visibility from the other points at Bornholm, A and B, is considered to be lower due to the lower terrain at those points. Figure 45, shows how much of the wind farm can theoretically be seen over the sea's curvature.

Figure 46 shows the analysis from Observation point G, which is the observation point closest to the wind farm (about 47 km). The visualisation is reproduced both with 55 mm lenses and 300 mm lenses to show that even with telephoto lenses, it is relatively difficult to see the turbines at this distance. Figure 47, shows how much of the wind farm can theoretically be seen over the sea's curvature.

Appendix 1 contains Figure 44 and Figure 46 in a full-page format with instructions for a suitable distance from the eyes to obtain a correct understanding of how the turbines are perceived at the site. Note also that from observation points D and F all turbines fall below the horizon line due to the sea curvature.

More full-resolution visualisations and animations will be available on the consultation portal.

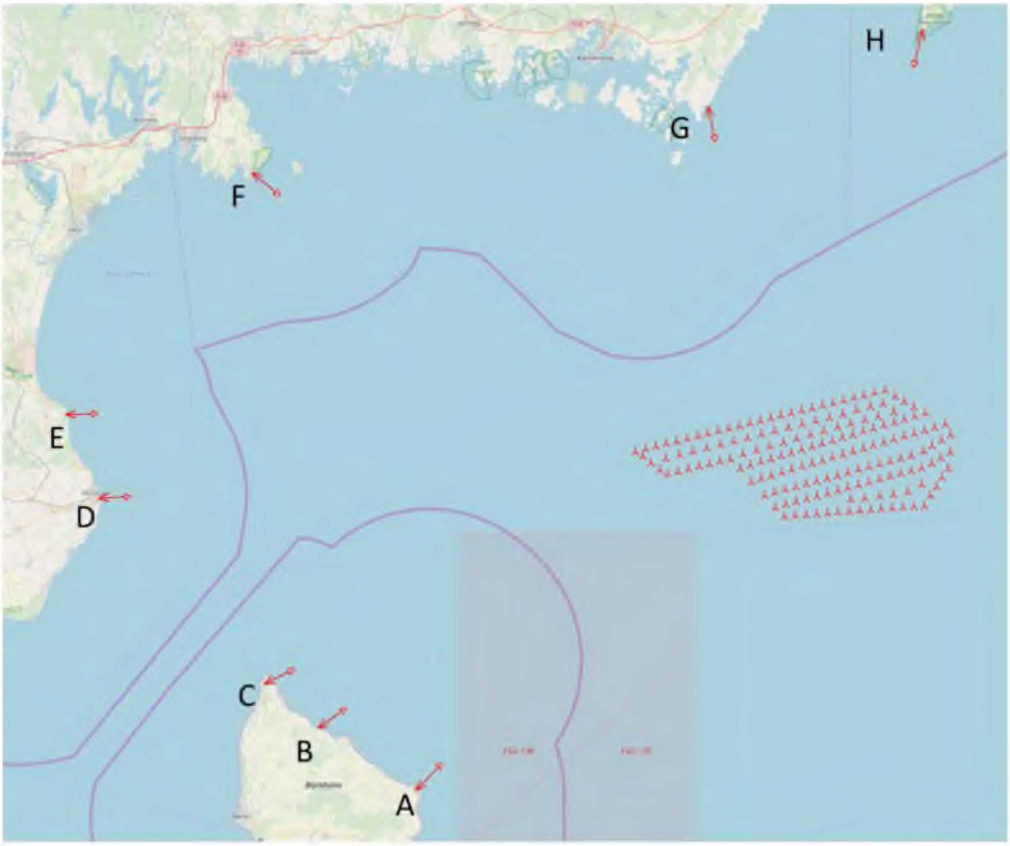


Figure 43. Map showing the locations selected for photo analysis of project's visibility from the shore, see description of locations on previous page.

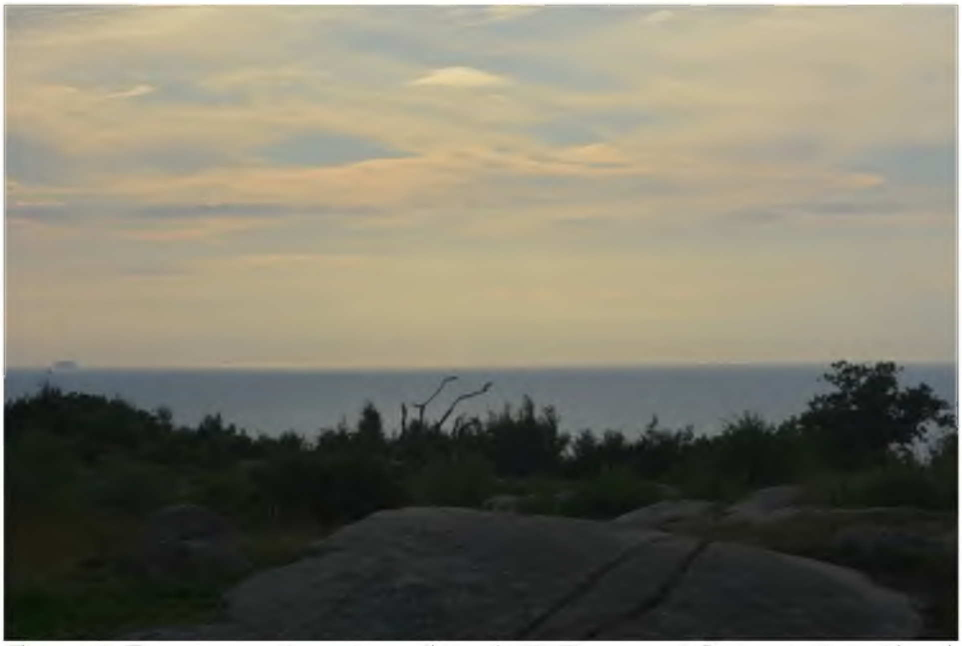


Figure 44. Photomontage from observation point C. The nearest distance to the turbines is about 70 km. Shot with 105 mm lens.

Figure 45. Visual analysis based on the same photo as Figure 44. In this analysis, the turbines are represented by red circles and drawn in front of the sea, although they are actually obscured behind the sea's curvature. This analysis shows that the closest turbines in the left part of the picture project are sticking up about 200 m from the sea (the part above the horizon), but due to reduced visibility it is very difficult to see the turbines in Figure 44.

Figure 46. Photomontage from observation point G. The nearest distance to the turbines is about 47 km. The top photo is taken with a 55 mm lens. The white dashed line shows the area reproduced on the bottom image, which shows photos with a 300 mm lens. Even at this relatively high magnification, the turbines are relatively difficult to see at this large distance.

Figure 47. Visual analysis based on the same photo as the lower image in Figure 46. In this analysis, the turbines are represented by red circles and drawn in front of the sea, although they are actually obscured behind the sea's curvature. This analysis shows that the closest turbines in the left part of the picture project are sticking up about 200 m from the sea (the part above the horizon), but due to reduced visibility it is very difficult to see the turbines in Figure 46.

6.6 Sound emissions

There are several calculation models available for wind power noise. The Swedish Environmental Protection Agency recommends either the Swedish calculation model for wind power or Nord2000. The Swedish calculation model is relatively simple, while Nord2000 is a much more advanced calculation model and requires special software. For offshore wind power only Nord2000 is recommended.

The future sound emissions from Baltic Offshore Beta have been analysed using NORD2000 in the calculation programme called WindPRO (EMD International a). There are many different settings, but the most important ones are that terrain hardness is set to G (water), which then provides limited sound damping and weather conditions are set to clear night, leading to temperature inversion and reduced sound damping.

The results with NORD2000 have also been compared with the results based on the Danish guidelines for sound dispersion for offshore wind power, where an additional correction for multiple reflections from the sea surface is also included. This calculation is also made with the calculation programme WindPRO (EMD International b).

The sound emission calculations have been based on a source sound of 115 dB(a). Figure 48 below is the estimated sound dispersion using the Danish model. From the outer turbines to the calculated 40 dB(a) line, the distance is 2–3 km. The corresponding distance to the 35 dB(a) line is 3–4.5 km. Although this distance is greater than the corresponding calculation on land, this leads to the conclusion that only persons travelling near the wind turbines will be able to hear the wind turbines. They will not be heard from a nearby onshore area that is at least about 50 km from the nearest turbine.

When comparing the NORD2000 calculation shown in Figure 49, the 40 dB(a) line extends 2–2.5 km from the turbines, and the 35 dB(a) line extends 3–4 km from the turbines. Hence, the Danish model shows a 500 m wider sound dispersion.

Details of the sound calculations are described in Appendix 2.

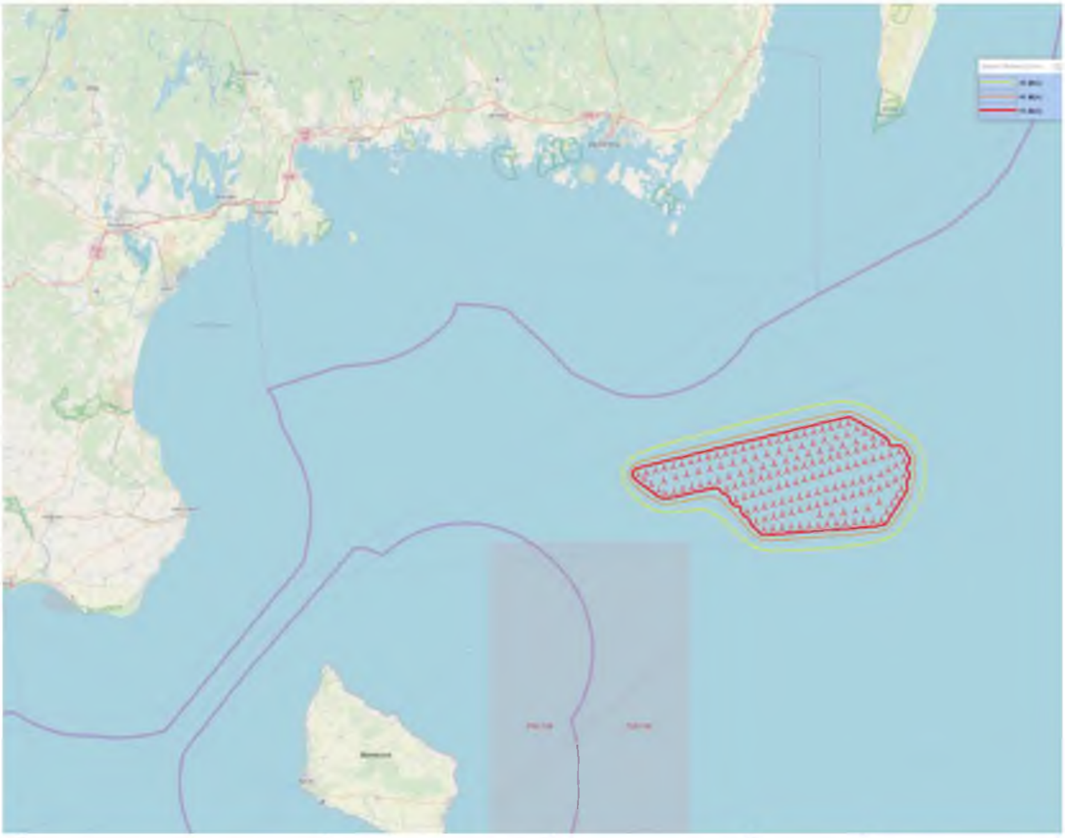


Figure 48. Calculated sound dispersion around Baltic Offshore Beta with the Danish model, based on the example layout of 167 wind turbines and a source sound of 115 dB(a).

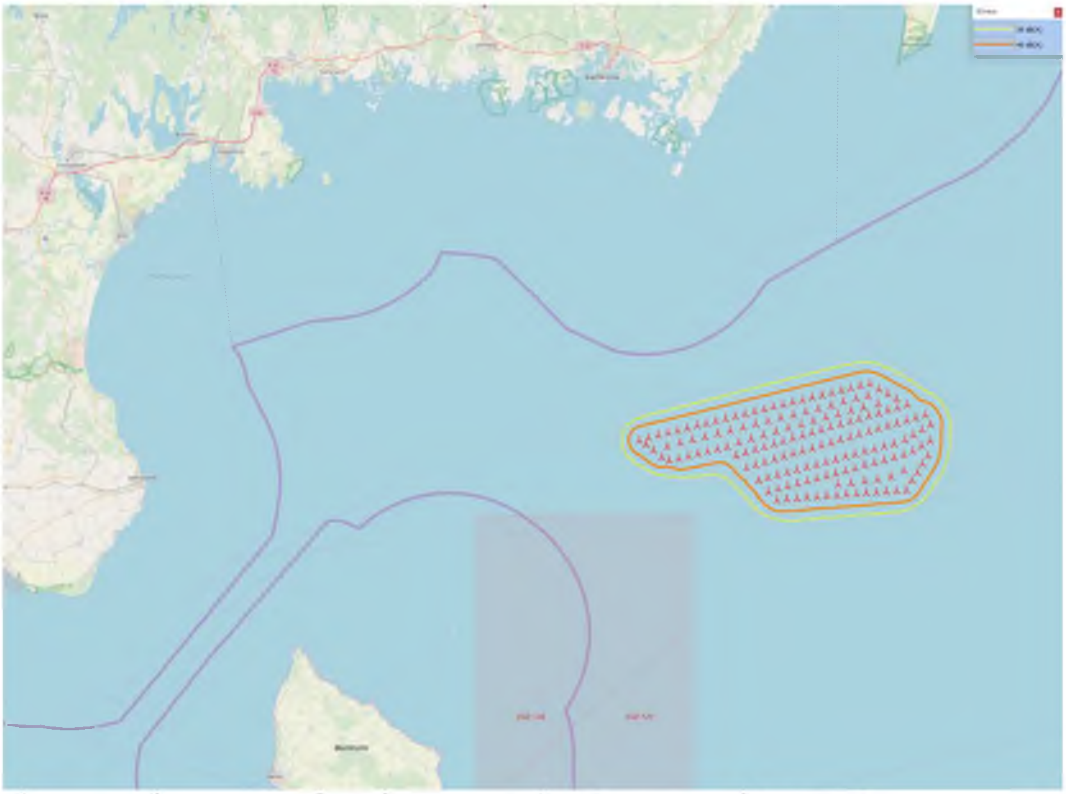


Figure 49. Estimated sound dispersion around Baltic Offshore Beta with NORD2000, based on the example layout with 167 wind turbines and a source sound of 115 dB(a).

6.7 Natural environment

6.7.1 Birds and bats

The proximity to bird-rich areas may involve a risk of affecting seabirds such as the long-tailed duck and the black guillemot. The flight paths of birds may also coincide with the location of the wind farm. An impact study on bird life will be carried out within the framework of the permit application. The same applies to migratory bats.

6.7.2 Fish and benthic environment

The behaviour of fish and the composition of fishing stocks have been shown to be impacted by wind farms. For example, the speed at which fish move has changed in relation to the power output of the wind turbines. Further studies have shown that the incidence of younger fish has decreased. In many cases it has also been possible to demonstrate positive effects in the form of a reef effect. This presupposes, however, that the benthic environment is habitable. The bottom fauna will be sampled when completing the permit application.

6.7.3 Marine mammals

Noise from wind turbines can have a negative impact on porpoises. It has been shown that the impact occurs mainly during construction in connection with pile driving and other noise-generating activities (see 5.7.3). An investigation of underwater noise will be carried out during the permit application process.

Porpoises have good hearing and use sound to locate food and for navigation. They are sensitive to noise, and the effects of noise can be divided into two categories: behavioural effects and physiological effects. The level of impact increases with increasing noise levels. Usually, the effects are that animals withdraw further from the source of the noise at lower levels, while higher noise levels can affect reproduction, their range, and, in the worst case, lead to death.

In Germany, the Federal Ministry of Environment, Nature Conservation, Building and Nuclear Safety (BMUP) has developed a concept for protecting porpoises from sound exposure when designing offshore wind farms in the southern North Sea. Based on the knowledge of how porpoises are affected by noise from underwater pile driving, BMUP has established a double threshold value for the sound exposure level (SEL), which must not exceed 160 dB re 1 re µPa^2 s, or $SPL_{peak\text{-}peak}$ shall not exceed 190 dB re 1 re µPa at a distance of 750 meters from the pile driving source. The first value obtained is the one to be applied. Since there is good knowledge regarding the range of the harbour porpoise in Swedish waters, this model is considered useful in assessing the impact of the construction and operation of wind turbines in Sweden.

During pile driving work for wind turbines, it has been observed that the number of porpoises decreases, or the porpoises disappear within a radius of 20 km or more. The density of porpoises increases within a radius of 50 km. The conclusion is that the porpoises moved 50 km from the disturbing noise. However, during the operating phase, the density of porpoises recovered to the same level as before the construction work. The recovery time associated with pile driving decreases as the distance from the source of the noise increases. At a distance of 2.6 km from the pile driving, the recovery time was 24–72 hours, while at 17.8 km, it was 10–23 hours. (Carlström, J. 2014)

6.8 Outdoor activities and recreation

Effects on recreational and outdoor activities can be expected during the construction stage as a result of the presence of, among other things, ships within the working area, which may interfere with activities such as fishing and sailing in the area.

6.9 Marine archaeology

Surveys and inventories carried out within the framework of NSP2 show that wrecks and other marine archaeological objects have been identified in the operating area, and that they may be affected by the construction of the foundations.

Prior to the work on the permit application, bottom surveys will be carried out in the project area to avoid damaging valuable remains that may be interesting.

6.10 Risk areas for mines and ammunition

The western part of the operating area is in a dumping area where chemical weapons have been found at the bottom. Removing munitions can affect nearby fish due to high sound levels and the leakage of harmful substances. (See also Section 6.9).

6.11 Wires and cables

When setting up the wind farm, measures need to be taken to ensure that no cables are damaged. Work on the seabed in the vicinity of existing cables may also mean that maintenance work on these during the construction period can only be carried out to a limited extent or not at all.

6.12 Cumulative effects

Ongoing work will determine if there are other permitted activities in connection with the wind farm that may have cumulative effects on any environmental aspects.

The cumulative effects will be analysed in terms of the parameters that are relevant and possible to assess. For example, studies of birds, bats, marine mammals and shipping will include the cumulative effects of the wind farm. The studies will take into account existing and planned conditions and activities that are deemed relevant, based on the known impact they may cause. Primarily, the impact from other planned wind farms and existing and forecast water traffic is considered to be relevant.

7 Continued work

7.1 Investigations and inventories

The Company plans on conducting several studies in order to obtain the necessary data to be able to produce an EIA for the project. The planned studies that will be developed within the framework of an EIA are described below. We are happy to receive your feedback on selected studies and their scope.

- Based on the results of the studies planned, mainly in relation to fishing stocks and marine mammals, underwater sound calculations may be required.
- The movement patterns of seabirds searching for food and moving between different areas need to be investigated more closely. The main concern is the long-tailed duck and black guillemot.
- Flight paths for birds and bats will also be investigated.

- In order to assess the environment at the sea bottom for the EIA, different samples from the bottom are needed to determine the infauna (bottom animals that are buried in the seabed) and epifauna (bottom animals that live on top of the seabed), sediment composition, grain size and oxygenation. Sediment samples are drawn using a clamshell scoop, and infauna samples are taken using a cylinder sampler, called a "Haps-corer". In addition, model data for sea currents and salinity in the area will be produced.
- An application for electrical connection has been submitted to the Swedish National Grid, which is conducting a preliminary study on connection possibilities. As soon as advance notice has been given regarding the appropriate connection point, a technical feasibility study will be launched. The electrical connection will probably include laying cable to a land-based grid station. This will be investigated in a separate consultation and authorisation process.
- In connection with studies of the sea bottom, a survey of any undetonated explosives will be carried out with a magnetometer (MAG).
- Grain-size analysis complemented by video-based studies with drop-down video (DDV).

Planned studies according to given environmental permit

Based on the environmental permit, the following studies are planned:

- Based on the permit, the planned turbine locations and corridors for internal cable networks will be investigated in more detail in terms of geophysics and geoengineering. Geophysical surveys will be conducted to identify potential obstacles and evaluate the seabed in the layout area. Investigations will be carried out using echo sounders and sonar equipment. In addition, seismic surveys will be carried out to gain more knowledge of what is beneath the surface of the seabed and to gain a clearer picture of the area. Finally, geotechnical drilling samples at the relevant turbine positions may be taken.
- Marine archaeological investigations will be carried out in parallel with the geophysical investigation of potential turbine sites and cable corridors. When marine archaeological remains are found, they will be reported, and no construction will take place closer than 100 m from the finding. The same applies to an unexploded ordnance (UXO) study to look for undetonated ammunition at the seabed of the sea. This will be done in detail before any work is carried out on the bottom. This mapping is done with a magnetometer.
- The wind conditions at the site will be investigated by constructing one or more measuring masts or alternatively by taking measurements using laser-based equipment (LIDAR) to increase the accuracy of the production and load calculations.

7.2 Alternative

Zero alternative

The environmental effects of the zero alternative in relation to the implementation of the proposed wind farm will be analysed and presented in the environmental impact assessment.

7.3 Environmental Impact Assessment

The future environmental impact assessment, EIA, shall be prepared in accordance with Chapter 6, Sections 35-36 of the Swedish Environmental Code and Sections 15-19 of the Swedish Environmental Assessment Regulation. The aim of the environmental assessment is to integrate environmental aspects into the project planning and decision-making so that sustainable development can be supported.

According to Chapter 6, Sections 35-36 of the Environmental Code and Sections 15-19 of the Swedish Environmental Assessment Regulation, an EIA shall identify and describe the direct and indirect effects of a planned activity or measure on humans, animals, plants, soil, water, air, climate, landscape and cultural environment and conserving the land, water and the physical environment in general. Furthermore, the aim is also to enable an overall assessment of the effects on human health and the environment. In summary, the EIA will contain the following information:

- Presentation of the Company and the operations
- Background and conditions for the operations
- Environmental effects of activities such as electricity production, sound, landscape image and obstruction lighting, birds, marine mammals, fish, bottom flora and fauna, shipping, marine archaeology and cumulative effects
- The possible impact of the activity on environmental quality standards
- Non-technical summary
- Consultation report
- Report on the expertise of those involved in the preparation of the EIA
- Reference list

Comments on other issues that should be highlighted in the EIA are welcomed during the consultation process

7.4 Other permits

Permits will be applied for according to the Continental Shelf Act in order to carry out bottom surveys within the area where the wind farm is planned.

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