Simply Blue Group

HERKULES FLOATING WIND

Consultation document for scoping documentation concerning the construction and operation of a wind farm in the Baltic Sea, Sweden's Economic Zone.

24-11-2022

WIND SWEDEN

ADMINISTRATIVE INFORMATION

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Mapping documents are from the websites of relevant authorities including the Land Survey, County Administrative Boards, Swedish Maritime Administration, Swedish Agency for Marine and Water Management.

HERKULES

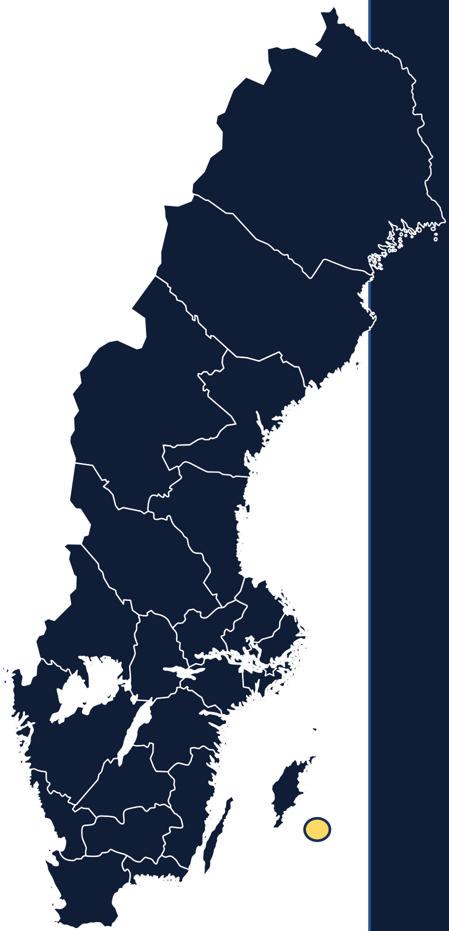
Simply Blue Group (see applicant/company) intends to apply for the necessary permits for the construction of an offshore wind farm under the Swedish Economic Zone Act and the Continental Shelf Act.

The planned wind farm covers an area of approx. 1078 km^2 with maximum 121 wind turbines with a maximum total height of 360m to be sited within the project area. Annual production is expected to be approx 13 TWh.

The planned activities are expected to have a significant environmental impact. Where activities are expected to involve a significant environmental impact, the operator must consult on the scope of the Environmental Impact Assessment. These documents provide the information required for the scoping consultation and have been designed to fulfil the requirements of the Environmental Code.

The project area, located approx 60km south east of Gotland, has been established through a location study based on screening competing interests, electricity requirements, biological and geological conditions. A detailed description of the location process can be found in Chapter 2.1.

The consultation documents are based on available information from mapping, data sources, existing investigations and experience. More detailed surveys of the ground conditions, natural values, bird life, bats, marine mammals and marine archaeology will be carried out within the scope of the forthcoming EIA. Together with the information and comments from the consultation, the surveys will form the basis of the EIA prepared for the permit application and for the final implementation and design of the wind farm.



HERKULES
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1 INTRODUCTION

1.1 Target for wind power and electricity production

At the start of 2022, the EU Parliament voted to agree a strategy for renewable ocean power. The strategy laid out the parliament's recommendations to establish at least 60 GW offshore wind power by 2030 and 300 GW by 2050. This is the same goal proposed by the European Commission in its 2020 strategy. To achieve the 2030 and 2050 climate goals, more rapid expansion of renewable offshore energy is required, while marine areas and coastlines must be sustainably managed, as emphasised in the adopted strategy(Svensk vindenergi, 2022).

Wind power is an important source for Sweden to achieve its energy policy targets. The targets state that Swedish electricity production should be 100 % fossil fuel free by 2040[1] and that there will be no net emissions of greenhouse gases into the atmosphere by 2045 (Energimyndigheten, 2021). This target means that wind power is an important part of the transition to a more ecologically sustainable society. Only by means of streamlined electricity usage and a move to renewable energy sources with environmentally acceptable technology will this target be achieved. In 2021, approx 17 % of the country's electricity production was from wind power, corresponding to 27.4 TWh(Holmström, 2022).

The demand for electricity is expected to increase significantly in the coming years. In the Swedish Energy Agency's long-term scenarios for the energy system, total production from wind power is estimated to be between 64–156 TWh by 2050 of which offshore wind power will provide 34 TWh (Energimyndigheten, 2021).

According to the *Nationella strategin för en hållbar vindkraftsutbyggnad* report, the expansion requirement for wind power is estimated to be at least 100 TWh by 2040 of which offshore wind power is estimated at 20 TWh(Energimyndigheten, 2021).

In the recently presented national maritime plan, an area corresponding to an expansion of approx 20–30 TWh has been put forward. At the same time, the Swedish Energy Agency together with other affected agencies was tasked with highlighting further suitable areas to enable a further 90 TWh offshore electricity production. This will be reported on by March 2023 and the then the proposal will, if possible, be worked into the maritime plan and the Maritime and Water Agency will report their recommendations to the government by December 2024 (Energimyndigheten, 2022).

There are currently three offshore wind farms in the Swedish maritime area: Lillgrund, Bockstigen and Kårehamn. Three further wind farms have permission, Storgrundet, Kriegers Flak and Kattegatt Offshore, but none of these permits have yet been used.

1.1.1 Electricity demand

Sweden has four electricity regions. The different electricity regions have different demands and production which has led to the areas SE1 and SE2 producing more electricity than is used. Areas SE3 and SE4, on the other hand, have an electricity deficit. This means that large quantities of electricity are transported from north to south Sweden. Transporting electricity requires electricity cables and

[1]Government statement by Prime Minister Ulf Kristersson, 18/10/2022.

sometimes there is insufficient capacity in the main network to transfer sufficient electricity to the areas with a deficit. This can mean that electricity consumers in southern Sweden sometimes pay a higher price than they should compared to those living in northern Sweden(Vattenfall, 2021). The project area for Herkules is sited outside of SE3 and SE4 and therefore presents an opportunity to contribute to meeting the ever-increasing demand for renewable energy in a region which even today produces insufficient electricity to meet demand.

1.2 Climate benefits

70% of the world's surface is ocean which means that the ocean is important for regulating the climate. Since 1970, more than 90% of warming has been absorbed by the oceans and since 1990, the rate of warming has doubled. Of the carbon dioxide released since the start of the industrial revolution in the 1800s, the oceans have absorbed around 40% (Naturskyddsföreningen, 2021). To counteract the climate change which is the consequence of the world's oceans warming up, it is necessary to strengthen access to renewable energy and thus reduce carbon dioxide emissions.

One of the Global Goals, *Goal 7*: *Sustainable energy for all,* means that everyone should have access to sustainable, reliable and renewable energy and clean fuel. This is in order to meet other global challenges such as poverty, climate change and inclusive growth. Global demand for energy is simultaneously expected to increase by 37% by 2040. Renewable energy solutions such as wind power are becoming cheaper, more reliable and more efficient by the day. By investing in renewable energy, energy services and electricity can be secured for all without damaging the planet. Target *7.2 Increase global percentage of renewable energy* also includes the proportion of renewable energy increasing significantly by 2030 (Globala målen, 2021a).

Expansion of offshore wind farms involves a large area of ocean which presents questions about the impact on the marine environment. It is important to both conserve biodiversity locally while simultaneously contributing to mitigating climate change. These two interests are connected as the ocean's species and ecosystem are heavily influenced by climate change. Offshore wind power contributes to a reduction in carbon dioxide and other greenhouse gases with the potential to also increase biodiversity through artificial reefs around the foundations (Bergström, o.a., 2022).

Offshore wind power can be linked to Global Goal 14, *Life below water*, which aims to conserve and use marine resources sustainably for sustainable development. A major problem facing oceans today is acidification. This occurs as a result of increased levels of carbon dioxide in the air mentioned earlier. By implementing more wind power, carbon dioxide emissions will fall, which in turn reduces acidification and can be linked to *target 14.3: Minimise ocean acidification* (Globala målen, 2021b).

In order to achieve the global goals in the fight against climate change, wind power must continue to be expanded and developed. Electricity production from wind power must increase from the current 27 TWh to at least 100 TWh according to the Energy Agency's assessment. Since wind farms are becoming ever more important in the work to achieve Sweden's target and the global goals, new wind turbines must be built where there are good wind conditions. There are several advantages to siting wind farms offshore. The best wind conditions are offshore where there are large areas and winds are often stronger and more even than on land.

1.3 Administrative information

1.3.1 Operations

Simply Blue Group intends to apply for permission for an offshore wind farm within Sweden's Economic Zone. The farm encompasses an area of approx 1,078km^2 with up to 121 wind turbines at a maximum height of 360m, wind measurement masts and substations (OSS).

The wind farm will consist of wind turbines constructed on floating foundations which are anchored to the seabed. Aside from turbines, offshore substations, wind measurement masts, internal network cabling on the seabed and export cables to shore will be installed.

1.3.2 Operators

Simply Blue Group (SBG) is a leading developer of sustainable and transformative marine projects. SBG works with offshore projects which enable society to benefit from blue growth through floating offshore wind power, wave energy, sustainable fuels and sustainable aquaculture. All in harmony with the ocean in the fight against the adverse affects of climate change.

SBG was founded in 2011 and its headquarters are in Cork, Ireland. The company has offices in England, Scotland, Spain, Sweden, USA and Canada with a rapidly growing team of more than 90 employees all over the world.

Floating offshore wind power is the dominant market segment in SBG's portfolio. The group has more than 10 GW floating wind projects in development and the company has grown to a position as one of the world's leading floating wind power companies as evidenced by their growing international presence.

The part of SBG working on the production of biofuels produces green hydrogen, green ammonia, biofuels, sustainable aviation fuel, methanol and so on from renewable offshore energy. This biofuel can then be used as "drop in" fuel for aviation, marine transport and chemical production where it is difficult to transition to renewables. At the same time, it enables existing oil and gas infrastructure to be reused to move from fossil-based to sustainable fuel production and storage. This makes it possible to deal with the constraints of the grid infrastructure and variations in renewable energy production that might otherwise affect the robustness and stability of the grid.

SBG has produced a strategy for Carbon Dioxide Removal (CDR) and aims to evaluate methods for reducing emissions through Direct Air Capture (DAC). Captured CO_2 can either be permanently sequestered and stored or fed into the production of biofuels.

Operating DAC and biofuel plants during periods of high wind and low demand creates economic efficiency and sustainable energy production which reduces the risk and dependency on subsidies while enabling projects to support a robust local supply chain.

SBG has many years' experience in aquaculture and an ambition to use marine space in the wind farm for algae farming and other aquaculture. Algae farming has the potential to use CO_2, nitrogen and phosphorous in the sea and produce oxygen. This creates effective artificial habitats which have the potential to support fish populations by providing food and protection. Harvested algae can be used for biofuel production, biodynamic fertilisers and, if water conditions are good, so-called "superfoods".

In order to minimise the environmental impact, utilise the marine area to improve sea water quality and create a basis to transition from fossil fuels to renewable sources, all three business areas are assessed in parallel when SBG develops their wind farms. This creates new economic opportunities for coastal communities and ensures projects co-exist with sustainable fishing, improvements in marine environments and support for local industry through the transition.

1.3.3 Consultant

Wind Sweden AB is the lead consultant with responsibility for leading the project and drawing up the consultation document. Wind Sweden has broad knowledge of the branch and specialist competence within development, implementation and operation of renewable energy production plants. The company also has reliable competence within offshore wind power and is responsible for the development of the Kattegatt Offshore wind farm outside of Falkenberg.

1.4 Scope of consultation and legislation

These consultation documents relate to an assessment of permission for the installation and operation of the Herkules wind farm, including related activities such as substations and the internal cable network. Several different types of permit are required, which are examined by various bodies at different stages. Table 1 following includes a summary of the main permits required for installation, with those intended to be applied for at a later stage and therefore not covered by this consultation specifically highlighted in yellow.

Table 1. Main permits for establishing and operating Herkules. Permits highlighted in yellow are not included in these consultation documents since they are intended to be applied for at a later date.

Activity	Area	Permit	Agency	When
Wind power installation	Economic zone	Permit for the installation and operation of a wind farm in Sweden's economic zone (§5 of the Act on Sweden's Economic Zone (1992:1140).	Government	This consultation with additional application
Internal cable network	Continental shelf	Permit for laying undersea internal cables §3 and § 2 b of the Swedish Continental Shelf Act CSA (1966:314)).	Government	This consultation with additional separate application
Seabed surveys	Continental shelf	Survey permit (§ 3 CSA)	SGU	Separate application in several stages
Export cable	Continental shelf	Permit for laying export cables (§ 3 and § 2 b CSA).	Government	Separate application
Export cable	Territorial waters	Permit for water-related works and required measures onshore (Chap. 11 of the Environmental Code).	Land and Environmental Court of Appeal	Separate application
Grid connection	Connection point to be determined at a later stage	Authorisation for connection to the main grid under Electricity Act.	Energy market inspectorate	Separate application

1.4.1 Authorisation and legislation

Permit for construction and operation of the wind farm

Construction and operation of the planned wind farm and associated facilities, including substations and internal cable networks (ancillary activities require a permit from the government under § 5 of the Act (1992:1140) on Sweden's Exclusive Economic Zone (LSEZ).

In a permit assessment under LSEZ, certain rules in the Environmental Code (1998:808) (EC) apply, including Chapters 2-4 and Chapter 5. §§ 3-5 and § 18 along with relevant regulations in Chapter 6 pursuant to § 6 LSEZ. A specific environmental assessment will be conducted and an Environmental Impact Assessment (EAI) will be produced pursuant to § 6 a LSEZ.

Permit for laying submarine internal cables.

The wind farm will be connected by cables which form the so-called internal cable network within the farm area. Laying submarine cables for the internal cable network on the continental shelf requires a permit under § 3 and § 2 b of the Continental Shelf Act (SFS 1966:314) (CSA) subject to governmental review. The company intends to apply for such a permit in connection with the permit application for the wind farm. In a permit assessment under CSA certain rules in the Environmental Code (EC) apply, including Chapters 2 and Chapter 5. §§ 3-5 EC. For measures involving drilling or blasting, the relevant provisions in Chapter 6 of the EC under § 3 of CSA apply. Where appropriate, a specific environmental assessment will be conducted and an Environmental Impact Assessment (EAI) will be produced.

Survey permit

For preparatory geological and biological seabed surveys a survey permit is required under § 3 CSA. Once permission is granted for the wind farm, further more detailed surveys may need to be conducted in order to design the wind farm in detail. The provisions set out in the EC in the section above on permits for the laying of internal submarine cables apply.

1.4.2 The permit process for the construction and operation of the Herkules wind farm

The permit process for the Herkules wind farm begins with a consultation and investigation stage in which the applicants consult with agencies, organisations, the general public and those with a special interest under Chapter 6. of the EC. During this consultation period, the applicants receive input and information from all stakeholders. This input and the information received then informs which surveys will be conducted, which material is presented and which aspects go into the EIA.

The consultation begins with Gotland County Administrative Board and Region. This is in a written consultation with the proposed consultation group, see Annex 1.

Public consultation is proposed to take the form of a face-to-face meeting where attendees have the opportunity to raise issues and comments. Following the consultation meeting, there will be a further opportunity to submit comments to the operator within 3 weeks. The consultation will be announced in the press, with information on where to find information about the project and how to submit comments.

Following consultation with agencies, organisations, the general public and those with a special interest an EIA will be produced.

The permit process is shown in the schematic below.

Figure 1. Schematic of the permit process. Förstudie – Feasibility studies; Samrådsunderlag – Scoping report; Avgränsnings-samråd och miljöbedömning – Public consultation and impact assessment; MKB och ansökan tas fram –EIA report and permit application development; Tillståndsansökan lämnas in – Submission of the permit application; Handläggning – Processing of the permit; Eventuell komplettering – Any additional documentation; Prövning -Permit examination; Beslut om tillstånd och villkor – Decision on permit and permit conditions; Genomförande av verksamhet och kontrollprogram – Project realisation and monitoring program; Idrifttagande och kontrollprogram – Operation and monitoring program continuation.

1.4.3 Scoping consultation

This consultation document has been prepared as a basis for scoping consultations in accordance with Chapter 6 §§ 29-32 of the EC. Survey consultation in accordance with Chapter 6 §§ 23-25 of the EC has not been conducted as it is only relevant if significant environmental impacts[2] cannot be predicted in advance.

A scoping consultation under the provisions in Chapter 6 § 30 of the EC and consultations will be consulted with the County Council, supervisory authority and individuals likely to be particularly affected by the operations. In addition, consultation will be conducted with other government agencies, municipalities and the public who may be affected by the planned operations.

A scoping consultation aims to inform agencies, individuals and the public, about the planned project's location and give a comprehensive account of the potential environmental impact of the planned activities. Consultation documents will contain information on:

- Design and scope of operations
- Location of operations
- Environmental sensitivities in the affected area
- Aspects of the environment which can be assumed to be significantly affected

[2] According to Section 6 of the Environmental Assessment Act (2017:966) a wind farm requiring a permit must always be assumed to have a significant environmental impact in accordance with Chapter 6 § 20 of the first part of section 2 of the Environmental Code.

- The environmental affects likely to result from the operations or external events, to the extent such information is available.
- The assessment conducted by the applicant as to whether or not the operations have a significant impact on the environment.

The consultation document shall also provide examples of appropriate protection measures. The consultation document shall include information on all aspects of the project, the construction phase, operational phase and decommissioning phase. The purpose of a scoping consultation is also to provide the applicant with guidance from the County Administrative Board which will work to ensure that the content of the forthcoming EIA contains the scope and detail required for an assessment.

1.4.4 Scope of consultation

Substantive limitations

This consultation document relates to the permit application for wind power installation under the LSEZ, including related operations such as substations and internal cable network. Permission for the internal cable network under the CSA, also part of this consultation, is applied for at the same step as the permit under LSEZ.

Further permits are considered separately and are therefore not covered by this consultation document. The power connection point to the overhead network has not yet been determined but will be surveyed at a later stage and coordinated with Svenska kraftnät. The consultation document therefore does not cover the laying of export cables according to §§ 2b - 3 CSA. The consultation also does not cover permits under Chapter 11 of the EC for laying cables in territorial waters or other permits required under the EC or other relevant legislation for onshore measures, for example. Permits required for these will be applied for at a later stage.

Connection of the wind farm to the transmission grid and the construction of an electrical power line in accordance with the Electricity Act (1997:857) is a separate authorisation process, known as a grid concession for a line, and is not covered by this consultation.

Since the project may have an impact across borders, separate consultations will be held with neighbouring countries and information provided in accordance with Chapter 6 of § 33 EC to satisfy the requirements of the provisions on transboundary consultation in the EIA directive and on the Environmental Impact Assessment in a transboundary context under the Espoo Convention. The Swedish Environmental Protection Agency is responsible for conducting the procedure with other countries under the EC and Espoo Convention, see Chapter 6. 33 EC and § 21 Environmental Assessment Regulation (2017:966).

The consultation process is limited to that which includes the construction phase, operational phase and decommissioning phase for the Herkules wind farm and related infrastructure. This includes the wind turbines and their foundations, measuring masts, internal cable network and substations.

This consultation process also gives an overview of what the forthcoming EIA will contain along with which environmental impact will be further investigated.

Geographical scope

The geographical scope for the consultation and environmental assessment is based on the area covered by the project as well as the surrounding area which may be impacted by the operations in the application, i.e.,the survey area. The geographical scope for the survey area varies due to respective factors.

Time limitations

Consultation for the Herkules wind farm will be conducted between autumn 2022 and spring 2023. A comprehensive EIA with related surveys is expected to begin after the consultation.

Definition of the scope of consultation

Stakeholders identified for inclusion in the consultation are listed in Annex 1.

2 LOCATION

According to the code of conduct in Chapter 2 of the Environmental Code, a site must be chosen for an activity or measure that is suitable both in terms of its purpose and in terms of human health and the environment. The location principle (Chapter 2 § 6 environmental code) is extremely important for new installations. It is therefore particularly important to highlight how the location principle has been observed in the environmental impact assessment in a permit evaluation. The location principle (Chapter. 2 § 6 environmental code, involves activities or measures being placed in a location where the end goal of the activity or measure can be achieved with minimum intrusion and nuisance to human health and the environment. Intrusion and nuisance to human health in the location principle means anything which contradicts the aim of the environmental code. Sometimes several locations may be suitable for an activity. In such cases, the best of these locations is chosen (prop. 1997/98:45 part 1, p. 218 ff)., i.e. the location which causes least intrusion or nuisance to human health and the environment (Naturvårdsverket, 2022a).

A recent report from Vindval aimed to investigate the possibility for large scale, sustainable expansion of wind power in Swedish waters in the Baltic Sea while also acting as a guidance document (Isæus, Beltrán, Stensland Isæus, Öhman, & Andresson-Li, 2022). The report is based on both industry preferences, i.e., wind power producers, and the assessed impact on species at the population level. The outcome of the report shows that offshore wind power with floating foundations is broadly possible in all parts of the Baltic Sea. In general, floating foundations are expected to have lower impact on marine organisms than fixed foundations since they located in deeper areas with lower biodiversity. Areas with deep, dead seabeds where the impact is expected to be particularly low, are particularly suitable for wind power developments.

The choice of project area for the Herkules wind farm has been based on a location study. Chapter 2.1.1explains how the location of the operation has been chosen and why.

2.1 Location study

The forthcoming EIA includes a description of the location study and the choice of the design of the farm. It will also include an explanation of alternative.

Along with this consultation document, a location study has been conducted with help of the QGIS programme, in which information on conflicting interests and other available information has been studied.

The area which has been analysed is the Swedish waters in the Baltic Sea between Stockholm and Malmö. The aim of the analysis was to identify areas suitable for development of an offshore wind farm with regards conflicting interests, environmental impact, distance to shore, wind resource, power requirements and technical conditions.

The first step in the location survey was to exclude conflicting interests which could been heavily impacted by an offshore wind farm development and therefore would be avoided if at all possible. In the second step, an area 7 km from the coastline was removed from the available area to maintain distance from the mainland and reduce visual impact. In the third step, areas were identified which were suitable for an offshore wind farm development with sufficient water depth for floating foundations. In the final step, areas were chosen which had sufficient production capacity.

A summary of the different steps can be seen below in Table 2.

Table 2. Summary of location surveys.

Step	Parameters
1	National park
	Nature reserve
	Natura 2000 area
	Armed forces
	Waterways
	National commercial fishing interest
2	Distance from shore
3	Identify areas suitable for floating foundations based on ocean depth
4	Identify areas with sufficiently large production capacity

In order to then choose the final project area, further parameters were investigated to choose the most suitable area. A summary can be seen below in Table 3.

Table 3. Overview of further parameters which influence the choice of location.

Parameter	Explanation
Electricity demand	SE3 and SE4 - electricity is needed in these electricity areas
National interest	Areas of national interest have been avoided
National maritime plan	Recommendations for use of land areas follow
Good wind conditions	At least 8m/s average wind speed
Porpoises	Adaptations have been made in areas frequented by porpoises
Aviation	Areas of conflict have been avoided
Mines and dumped ammunition	Have been avoided
Ice	Areas with high risk of ice have been avoided

2.1.1 Choice of location

The project area for Herkules lies within Sweden's Economic Zone, south east of Gotland covering an area of 1,078km^{2}, see Figure 2.

The fact that the planned operations is located close to the electricity areas SE3 and SE4 is considered a positive aspect since these areas have a power deficit.

The area is judged to have favourable conditions for an offshore wind farm with winds between 9.7m/s and 9.8m/s at 150m above sea level. Ocean depth varies between approx. 107 m and 224 m and the material on the seabed is predominantly hard mud and clay.

No national interests are found in the project area and the planned operations have few conflicting interests.

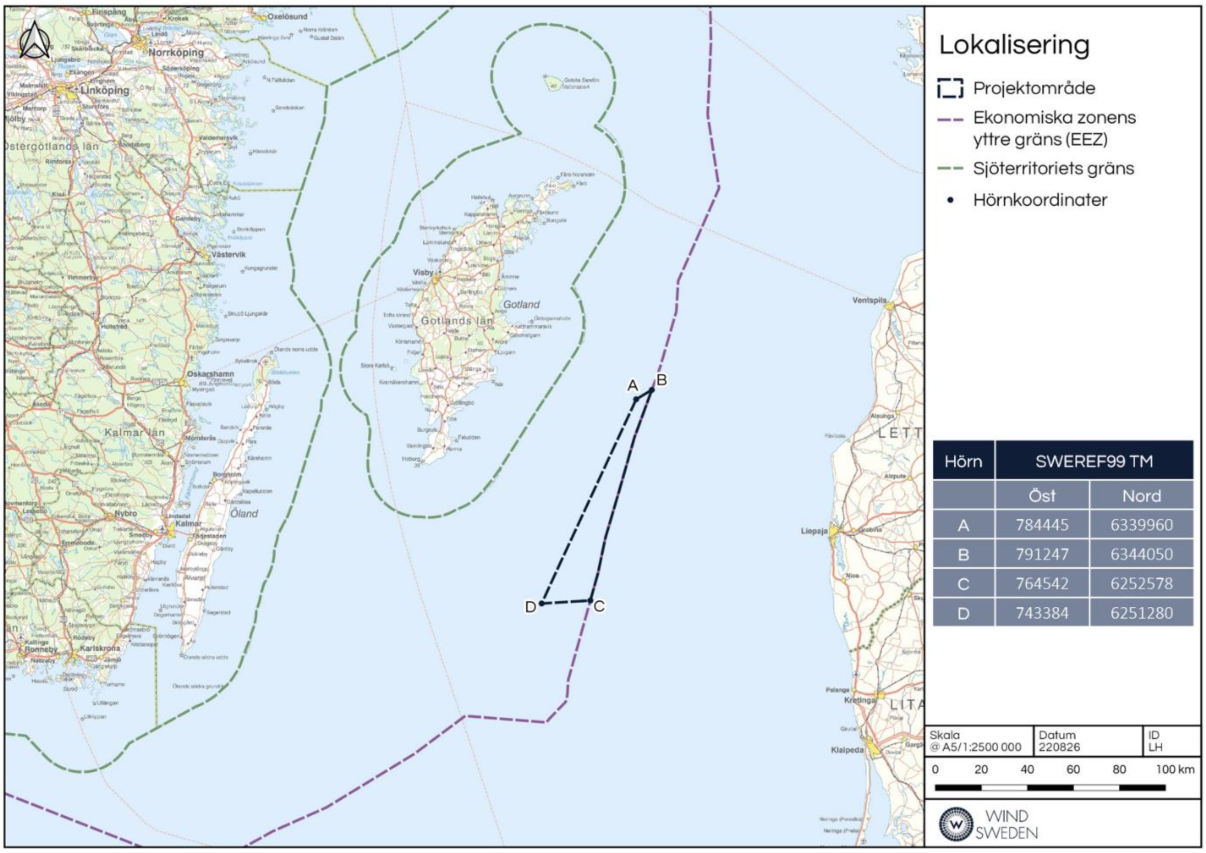

Figure 2. Overview of location and corner coordinates for the project area. Projetkområde – Project area; Ekonomiska zonens yttre gräns (EEZ) – Exclusive economic zone (EEZ); Sjöterritoriets gräns – Territorial waters boarders; Hörnkoordinater – Corner coordinates.

The choice of project area for Herkules coincides with a non-restricted area meaning areas with existing site protection (national parks, Natura 2000 sites and nature reserves) are not found within the project area.

Map, Figure 3, includes existing environmental protection as well as restricted areas and unsuitable areas according to Vindval's report *Ecologically sustainable wind power in the Baltic Sea* (Isæus, Beltrán, Stensland Isæus, Öhman, & Andresson-Li, 2022).

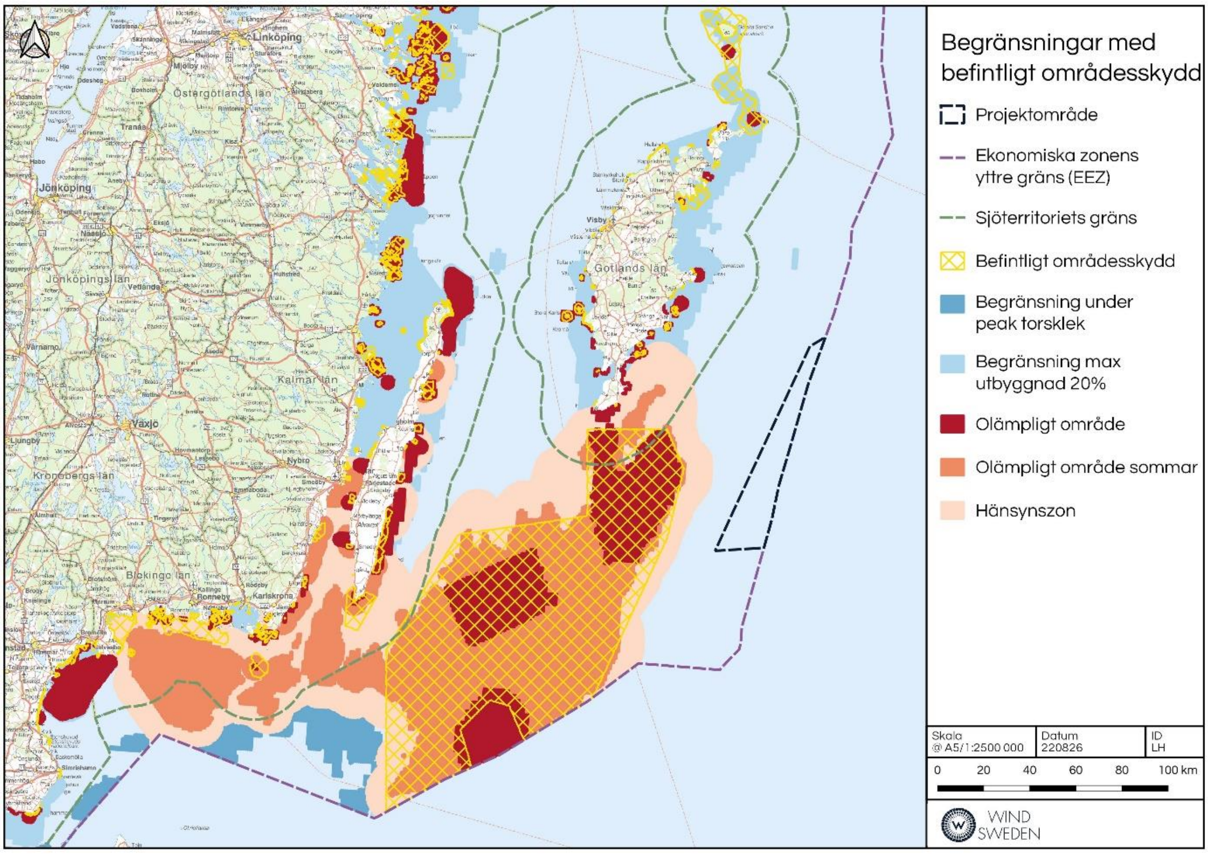

Figure 3. Restricted areas and areas with existing environmental protection (national parks, Natura 2000 areas and nature reserves) (Isæus, Beltrán, Stensland Isæus, Öhman, & Andresson-Li, 2022). Projektområde – Project area; Ekonomiska zonens yttre gräns (EEZ) – Exclusive economic zone (EEZ); Sjöterritoriets gräns – Territorial waters boarders; Befintligt områdesskydd – Existing protection area; Begränsning under peak torsklek – Restricted areas during cod spawning; Begränsning max utby-ggnad 20% - Restricted areas where only 20% of are can be exploited ; Olämpligt område – Invalid area for development; Öleämpligt område sommar – Invalid area for development in summer; Hänsynzon – Area of consideration.

2.2 Zero option

The zero option describes a situation where no wind farm is installed within the planned area. A detailed presentation of the zero option will be included in the forthcoming EIA. This will include the assessed environmental impact as a result of the alternative in the application in relation to the zero option.

3 DESCRIPTION OF OPERATIONS

Offshore wind power is considered to have great potential in respect to electricity production in both Swedish waters and globally. This is because winds at sea are both strong and even. Data from existing wind farms in the North Sea show that 91% of the time it is sufficiently windy to produce renewable energy (Ørsted, u.d.). The development of Herkules wind farm will contribute approximately 12.7 TWh/year of renewable energy.

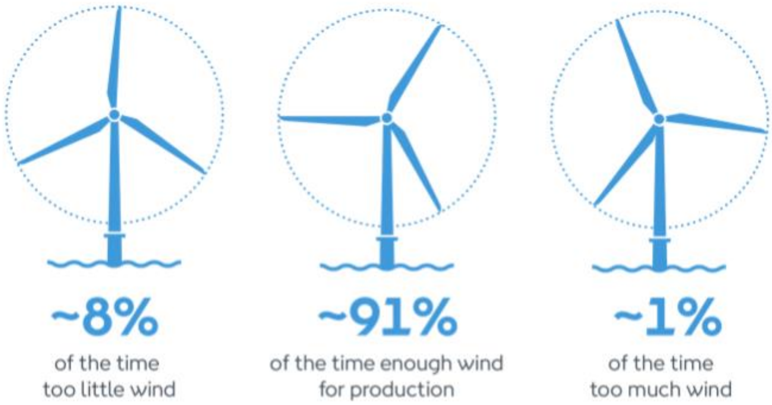

Figure 4. Average values of how often an offshore farm can produce renewable energy. Data based on North Sea wind farms (Ørsted, u.d.).

Construction for the Herkules wind farm will begin following receipt of permits, it is currently difficult to determine which model or height of wind turbines will be optimal at the time of development. This is predominantly due to the constant rapid technological development of wind turbines. Hence the consultation document includes a maximum total height and maximum number of wind turbines for the project area. This also applies to the choice of floating foundation and anchoring methods and therefore several alternative methods are presented in the consultation document. This favours the application of the principle of best available techniques. The forthcoming EIA intends to describe potential environmental impacts based on alternative scenarios which allow for flexibility in the choice of technology.

The company intends to apply for authorisation for construction and operation of a wind farm with free placement of wind turbines within a geographically defined area, as per the usual procedure for offshore wind power. The positions of the wind turbines will be determined before construction with regard to the best technology available at the time.

Based on the project area, an example design has been developed by the company with the maximum number of wind turbines allowed, see Figure 6. An example turbine is used for the example design of the wind farm and calculations, the dimensions of which can be seen in Table 4, chapter 3.2.1. The example design is only to be seen as an idea of how the planned wind farm may look. The final design of the wind farm in terms of wind turbines, positions, rotor size and total height will be determined at a later stage.

3.1 Scope

Herkules is planned to be designed with up to 121 wind turbines which currently gives a total installed capacity of approx. 2.4 GW with an expected annual production of approx. 12.7 TWh.

The wind farm consists of wind turbines with foundations and an internal cable network which connects all of the turbines and their substations (OSS). The wind turbines will be anchored with floating foundations meaning that the wind turbines float and are moored to the seabed.

3.1.1 Accompanying activities

An export cable (marine cable) is a requirement for the wind turbines to be connected to the grid infrastructure. As a result, an export cable will be constructed from the wind farm's substations, either to land or to one of the offshore connection points proposed by Svenska kraftnät on the border between the territorial waters boundary and the SEZ. Should the applicant intend to lay a marine cable towards land, this will be constructed all the way to the beach. At the shoreline, the marine cable will be coupled with a land cable which will continue further to a suitable connection point to the Swedish transmission grid. Alternatively, a connection to another country may be required, such as where the Swedish grid does not have capacity to receive the additional energy.

3.2 Design

3.2.1 Wind turbine

As the permit process for offshore wind assessment takes time, the time from project launch to construction phase can sometimes be as long as 8-10 years. Technological development within wind power, on the other hand, is rapid, meaning it is impossible to know which technology will be the best available on the day the project is realised.

Currently available technology will be further developed both with regards efficiency and height of wind turbines. The current trend is for higher and more efficient turbines and today there are wind turbines with outputs of 15 MW (Vestas, u.d.). If this trend continues at the same pace, we will see turbines with outputs around 20MW within the next decade.

The total height of a wind turbine is determined by the rotor diameter as well as clearance between the water surface and the tip of the rotor blade. Clearance will be between 21 - 35 m for this project. The installed output for wind turbines for the project is expected to be approx. 20 MW. The maximum total height applied for is thus 360 m, see Table 5. An exact number, dimensions and model will be determined in the final contract and detailed projections of the site. Therefore, exact figures cannot be provided at this stage.

Table 4 below lists an alternative design, which can be seen in Figure 6, and a scenario with the maximum dimensions, see Table 5.

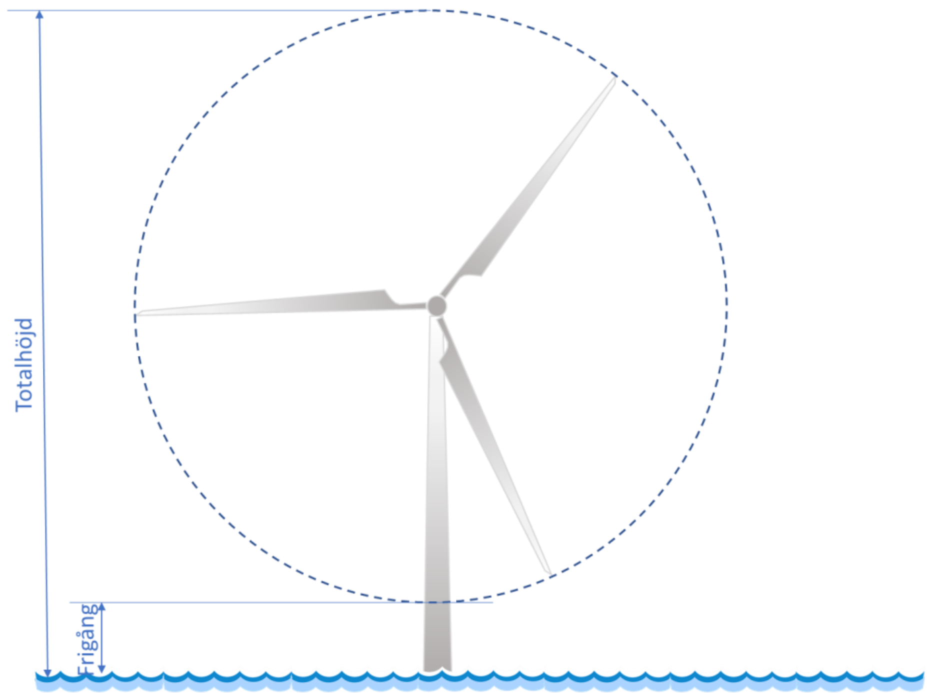

Figure 5. Schematic of example. Frigång – Clearance; Totalhöjd – Total height.

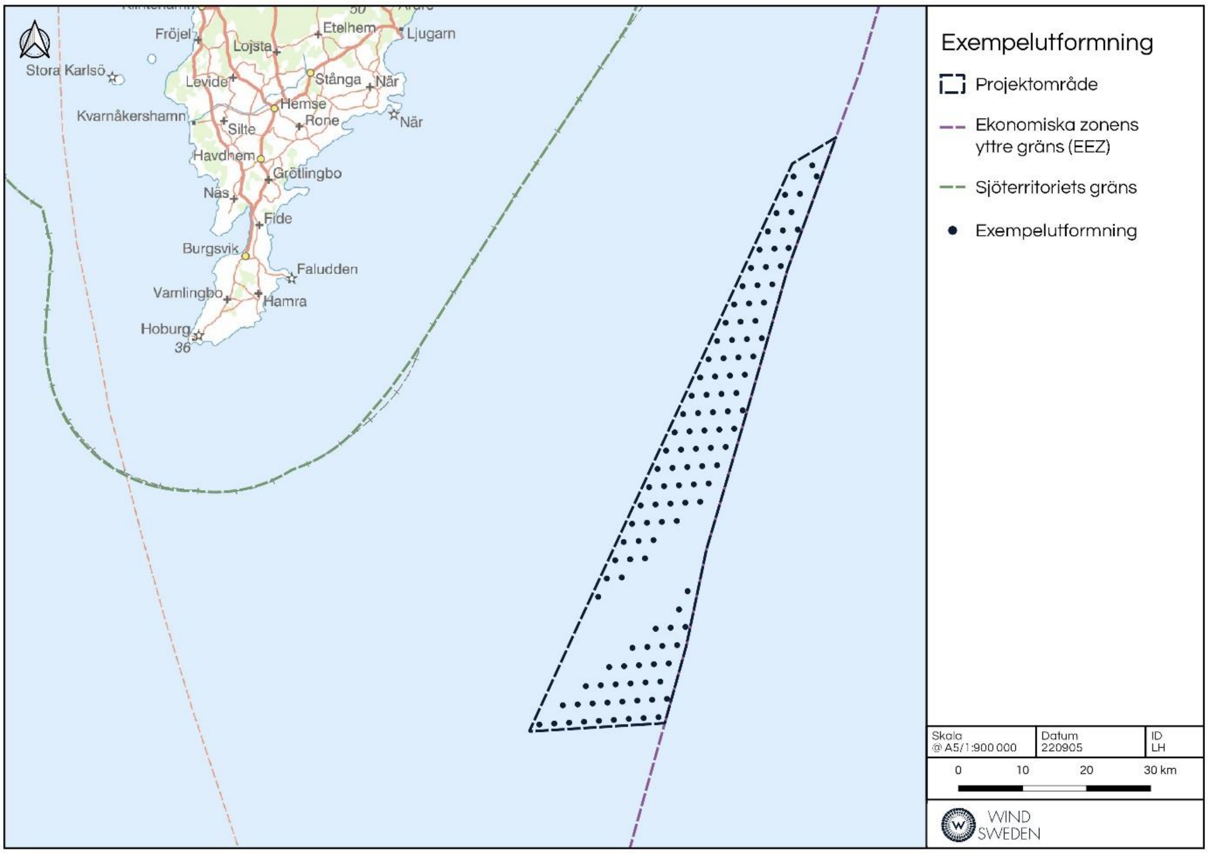

Figure 6. Example design for Herkules based on dimensions in Table 4. Projektområde – Project area; Ekonomiska zonens yttre gräns (EEZ) – Exclusive economic zone (EEZ); Sjöterritoriets gräns – Territorial waters boarders.

Table 4. Example design of wind farm. RD=Rotor diameter.

	Example design
Number of wind turbines	121
Output per wind turbine [MW]	20
Total installed output [MW]	2,420
Clearance [m]	35
Rotor diameter [m]	290
Total height [m]	325
Approximate distance between turbines [RD] Within rows / Between rows	6 / 13
Calculated production capacity [TWh/yr]	12.72

Table 5. Maximum dimensions applied for:

Scope of application	Number of wind turbines	Total height [m]
Maximum	121	360

For this evaluation and the forthcoming EIA, the maximum number of turbines and total height are dimensioned. Further design alternatives within the framework of the maximum number of wind turbines and maximum total height applied for will be surveyed.

The final design will be based on the forthcoming seabed surveys and information received during consultations and will be determined once permission is obtained.

3.2.2 Floating foundations

With regards the depth within the Herkules project area, the installation is intended to use floating foundations. Floating foundations use buoyancy to support the wind turbines and are anchored to the seabed. The choice of which type of floating foundation to use depends on several parameters, including the nature of the seabed, wind conditions and the size of turbines. The design will be analysed at a later step to optimise electricity production and economy as well as minimising the negative impact on the environment.

The main types of floating foundation currently on the market can be categorised into three groups depending on the type of mechanism used for stability. These three are as follows:

Stabilised with ballast

Ballast at the bottom of the floating construction moves the centre of gravity to below the centre of buoyancy. This means the construction stays upright and counters movements which unbalance the construction. An example of floating foundations with this technology is *SPAR.*

Stabilised with buoyancy

In this case, the water surface is the main element for maintaining the construction's stability. Stability is achieved by either having one large pontoon or several smaller pontoons a distance from the centre of the construction. An example of floating foundations with this construction are *barge* and *semi-submersible*. The main difference between these two types is that *semi-submersible* has distributed buoyancy and consists of pontoons connected by arms while *barge* consists of one flat floating element with no space between.

Stabilised through anchoring to the seabed

This technology relies on lines which are anchored to the seabed under tension and that they can thus stabilise the construction. The volume of water displaced by the construction of the wind turbine must be large enough to create extra buoyancy so that the anchoring lines are always under tension. An example of floating foundation which uses this type of mechanism is *Tension Leg Platform (TLP)*(Leimeister, Kolios, & Collu, 2018).

A summary of the advantages and disadvantages for three of the floating foundations named above can be seen below in Table 6.

Table 6. Summary of the advantages and disadvantages of the different types of floating foundation (IRENA, 2016) & (Du, 2021).

Types of floating foundation	Advantages	Disadvantages
SPAR	- Simple design compared to semi-submersible and TLP - Lower installation and anchoring costs than TLP - More stable than semi-submersible due to depth of design	- Requires greater depth (>100m) - Wind turbines cannot be installed in port but rather are installed in situ
Semi-submersible	- Easier to construct and transport than SPAR and TLP - Wind turbines can be installed in port and then the whole construction can be transported to be positioned - Can be used for a broad spectrum of water depths, usually from 40m - Lower installation and anchoring costs compared to TLP	- Least stable of the three different structures - Complex and larger construction compared to the other alternatives
Tension leg platform (TLP)	- The most stable construction of these three types - Smaller structure and therefore lower material costs - Wind turbines can be installed in port and then the whole construction can be transported to be positioned - Can be used for a broad spectrum of water depths, usually from 40m	- Difficult to maintain stability during transport and installation - Depending on the design may need a specially designed vessel for installation - Higher installation and anchoring costs compared to SPAR and semi-submersible - Can be affected by high frequency dynamic loads due to the construction's rigidity.

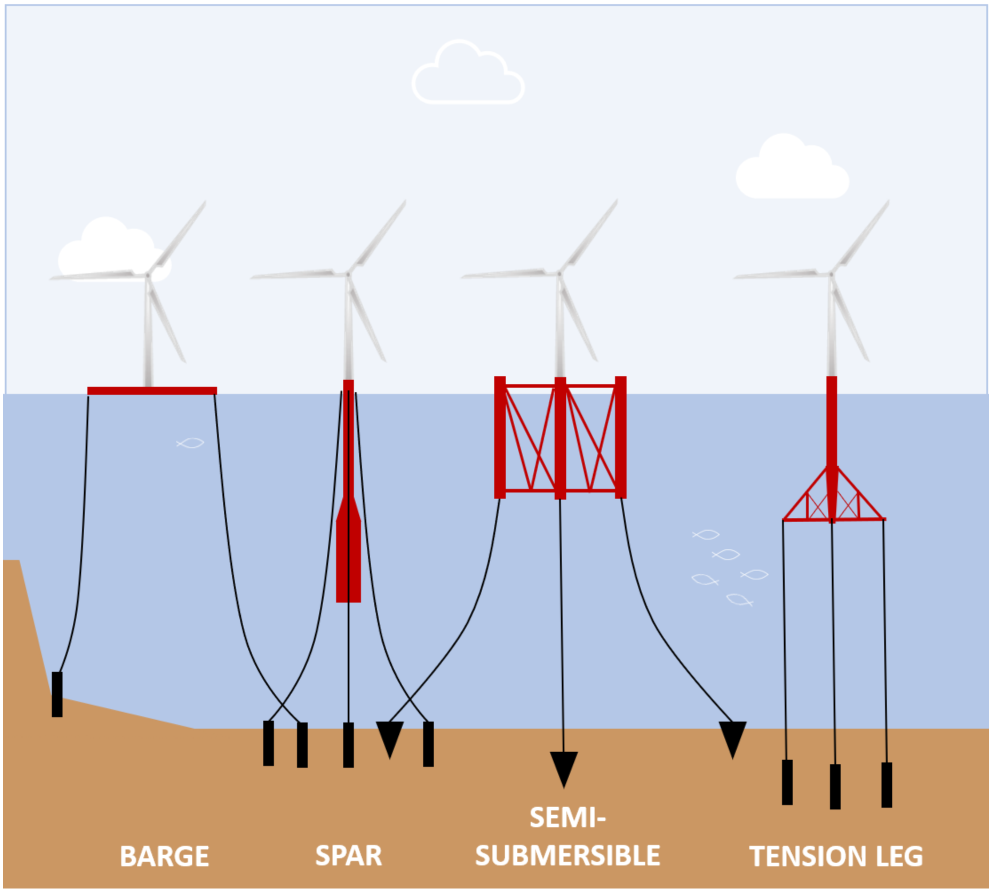

Figure 7. Illustration of the current main models of floating foundations.

3.2.3 Anchoring methods

All of the types of foundation described in Chapter 3.2.2 require anchoring to the seabed. Which type of anchoring method is appropriate depends on the nature of the seabed and sediment in the area and therefore the choice will be based on the seabed survey which will be conducted at a later stage. Tension of the lines between the foundation and anchoring also depends on the type of foundation and anchoring method. Which tension is used affects how much the foundation can move on the surface. The final anchoring method will be determined at a later stage.

A summary of some of the most common current anchoring methods is described below in Table 7.

Table 7. Summary of anchoring methods(Castillo, 2020) & (Vryh of Anchors BV, 2010).

Anchoring method	Information	Advantages	Disadvantages
Gravity anchor (Gravity anchor)	- Made of steel or concrete - Holding force created from the weight of the anchorage and friction against the seabed material - Manages vertical loads through its weight and horizontal loads with friction on the seabed	- Can be installed in a wide range of types of seabed - Can manage both vertical and horizontal loads - Low cost	- Material intensive production - Difficult to remove after decommissioning of a wind farm
Piles (Piles)	- Cylinders - Holding force is created through friction between the cylinders and ground - Piles are buried	- Can be installed in a wide range of types of seabed - Can manage both vertical and horizontal loads	- Generates a lot of underwater noise during installations - Difficult to remove after decommissioning of a wind farm
Suction pile (suction pile)	- Another type of anchoring with piles - Larger diameter compared to piles - The piles are hollow and a pump creates a vacuum to anchor the pile during installation	- Can manage both vertical and horizontal loads - Low installation costs - Easy to remove and can be reused - Low noise during installation compared to piles - Can be removed after decommissioning of a wind farm	- Can be used on a limited range of seabeds Used on clay soils
Drag embedment anchor (drag embedment anchor)	- Made of steel with a triangular construction at the base which forms capacity for anchoring	- Can resist high levels of horizontal movement - High loading capacity in relation to its weight - Can be removed after decommissioning of a wind farm	- Can only handle horizontal loads. There are certain types which can resist vertical movements. - Can be used on a limited range of seabeds Best suited to sandy soils

3.3 Mains grid

The electricity transmission for a wind farm can be divided into several parts. The internal cable network, substations (OSS) and export cable. Electricity is transmitted from each wind turbine to a substation via the internal cable system. The substation transforms the electricity to a higher voltage before it is transmitted further via the export cable. In some cases several substations and export cables are required.

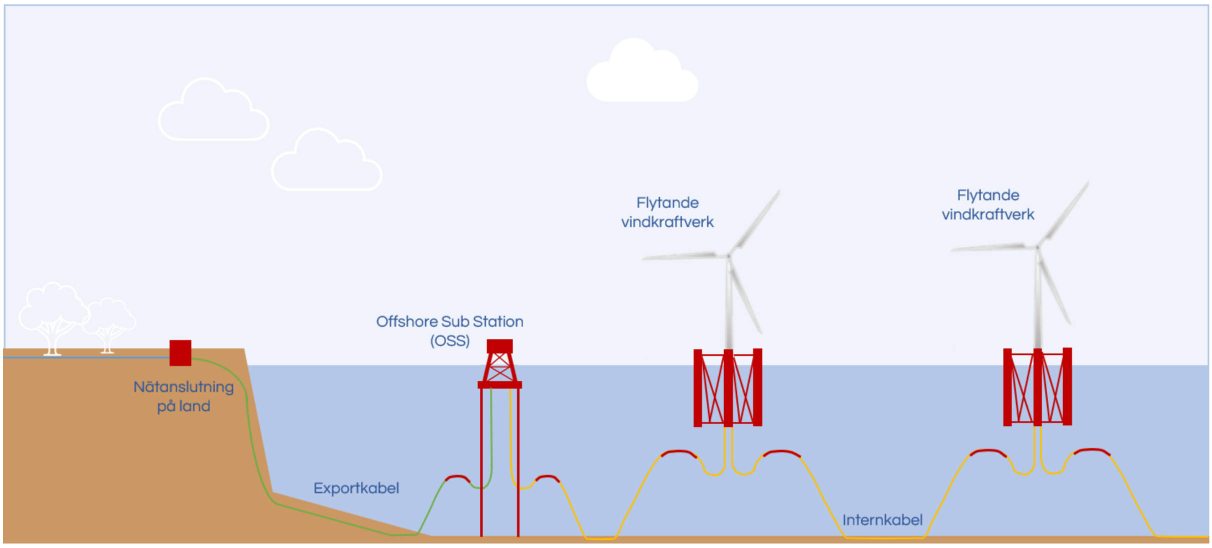

Figure 8. Schematic of the different parts of an offshore wind farm.

3.3.1 Internal cable network

Within the wind farm area, a number of cables will be laid to connect the wind turbines to each other, the so-called internal cable network. This network is important for communication between wind turbines and transmission of the electricity produced. It is also importance for operational monitoring and load control.

The internal cables have a dynamic part which moves with the floating foundation and therefore needs a high level of flexibility and strength to be able to handle the impact of waves and currents, for example. Usually, the cable is constructed used the "lazy wave" method where buoyancy modules are added to reduce the load on the cable, see Figure 9. Either only dynamic cables or a combination of dynamic and static cables can be used but this requires the addition of a connection point between the two types (Lerch, De-Prada-Gil, & Molins, 2021).

The internal cable network is then connected to one or more offshore substations (OSS). These stations transform the electricity produced by the wind turbines to a high voltage to reduce loss of electricity during transmission via export cables.

The preferred method of protection for the internal cable network, with regard to the static parts, will be by burying them. In those places where this method is unsuitable due to, for example, cables crossing each other or unsuitable seabed material, a different method will be used. Alternative methods for protecting the cables can be to cover them with stones, concrete mattresses, concrete, artificial seaweed mats [3] or sandbags.

[3] Anti-Scour Frond Mattress:

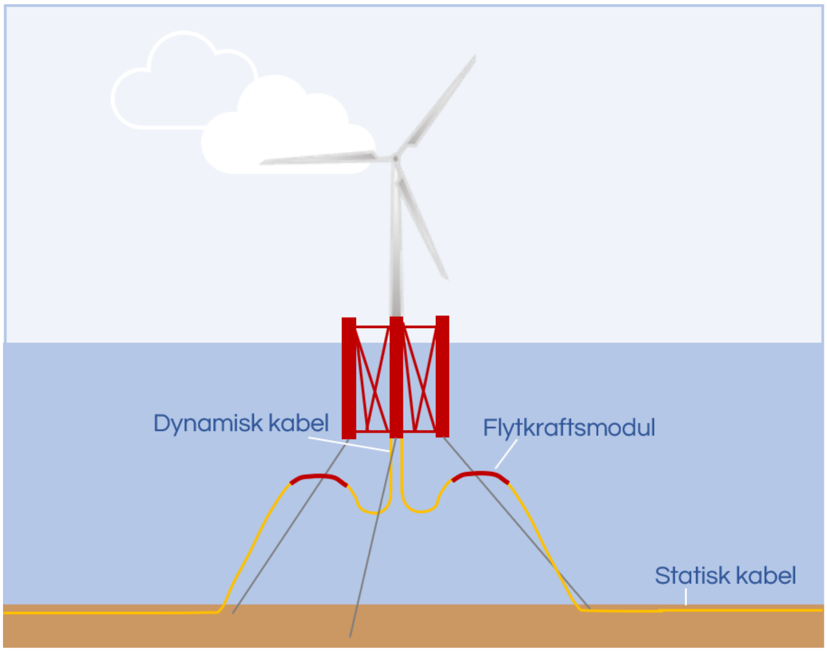

Figure 9. Schematic of the internal cable network

3.3.2 Substation

A substation tower with transformer room is built on the foundation for the substation. Within the transformer room the voltage from the wind farm is increased before it is transmitted via the export cable. This reduces power loss to the transmission grid. The number of substations and their positioning depends on the final placement of the export cable. The export cable's exact route has not yet been determined.

Depending on the actual depth of the location of the substation, it may be appropriate to anchor with either so-called jacket-foundations, see Figure 10, or floating foundations with anchoring, see Chapter 3.2. However, other types of foundation may also be appropriate.

Jacket foundations consist of a stable truss structure of steel tubes/beams anchored to the base. This construction is suitable for deeper waters and high loads.

Jacket foundations are secured to the base with either so-called suction buckets or smaller steel pipes which are bored or piled into the seabed. Suction buckets are steel or concrete cylinders which use a vacuum to suction to the seabed. Some preparation of the seabed may be needed for the installation of substations. Large rocks may need to be moved and depending on the choice of anchoring methods, the seabed may need levelling. The final choice of technology will depend on the seabed situation on site. Erosion protection is usually laid around the foundation consisting of a lower layer of gravel and upper layer of stones of various sizes.

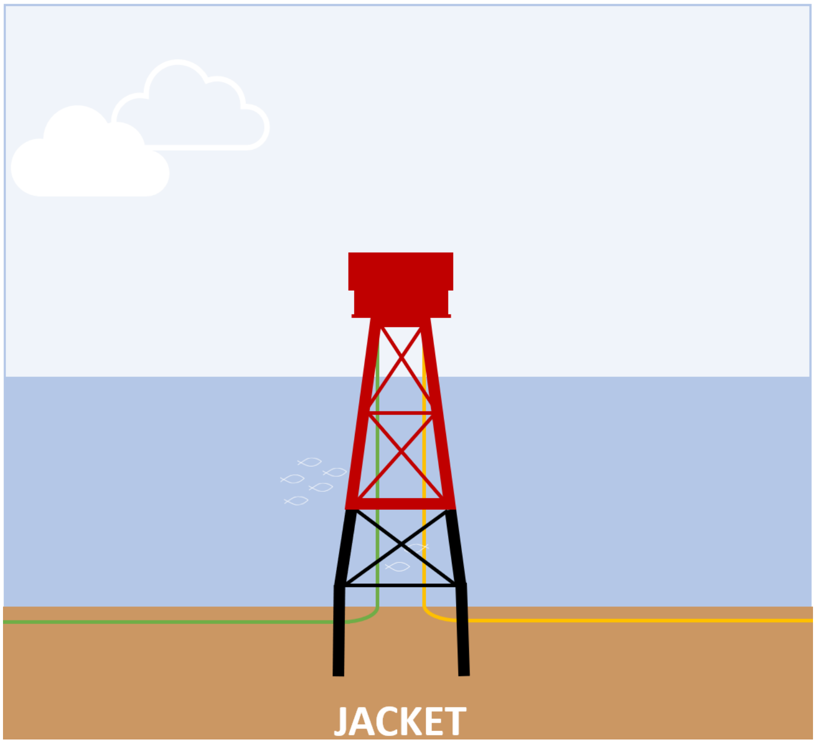

Figure 10. Schematic of a jacket foundation.

3.3.3 Export cables

The electricity produced by a wind farm is transmitted via substations to the transmission grid or regional grid. An export cable (marine cable) will be constructed either leading to land or to one of the offshore connection points proposed by Svenska kraftnät at the boundary or territorial waters and the SEZ. Alternatively, it may be possible for the export cable to lead abroad.

Should the applicant intend to lay a marine cable towards land, this will be constructed all the way to the beach from the SEZ via territorial waters. At the shoreline, the marine cable will be coupled with a land cable which will continue further to a suitable connection point to the Swedish transmission grid or regional network on land.

As with the internal cable network, the export cable must be protected from damage either by burying in trenches or covering with blocks, depending on the seabed conditions.

The exact route and size of the cable will be determined later in the design process, where conflicting interests and technical conditions will be taken into account.

3.3.4 Site for connection to national grid.

On 1st January 2022, the government asked Svenska kraftnät to evaluate how Svenska kraftnät could extend the transmission network to areas within Sweden marine territory where there is potential to connect several power generation plants. Report published 15th June 2022. Grid development will support Sweden to achieve its renewable energy production targets. The government considers that offshore electricity production has the potential to contribute to achieving the target for renewable electricity production by 2040, partly by meeting increased demand for electricity in the future. The government further considers that it is important that the development of offshore wind power occurs in such a way as to ensure the greatest possible benefit as cost effectively as possible and that offshore wind is able to contribute large volumes of electricity and high efficiency.

Svenska kraftnät has proposed that the expansion of the grid within Sweden’s sea territory be organised in calls for tenders for offshore connection points on the border between territorial waters and Sweden’s economic zone. The first round includes a total of six prioritised areas of water for expanding the network: Skåne’s south coast, Halland coast, the south east Baltic Sea, the north Western Sea, the south Bothnian Sea and the Gulf of Bothnia(SvK, 2022).

In terms of Herkules, the onshore connection point for the south east Baltic Sea is probably not the most cost-effective solution and the project will therefore confirm the connection point later in the development phase when Svenska Kraftnät announces new proposed connection points in 2025.

3.4 Facility

The wind farm facility consists of different phases, the first of which is to prepare the site. This includes preparation of the seabed, pre-installation of electricity cables and anchoring systems.

Since the farm will be installed with floating foundations, the installation process will be somewhat different from solid foundations. The majority of the floating foundations on the market currently can be constructed in harbour and then towed out to site to be moored to the pre-installed anchors and cables. However, the development of offshore construction vessels is progressing, which may change how the process looks in the future.

3.5 Operation

Operation of the wind farm and monitoring of substations takes place remotely via an operation centre. Regular maintenance and repairs will need to be carried out during operational times and will involve transporting materials and staff on a service vessel or helicopter. The operation and service centre will be sited onshore near to the wind farm. Floating foundations have the advantage that they can be towed to harbour for repair and maintenance.

3.6 Decommissioning

The lifetime of wind farms is currently expected to be between 30 - 35 years after commissioning. Following that, the farm will be decommissioned and dismantled in the reverse order to installation. That means that the wind farm will be decoupled from cables and anchoring and then towed to harbour for dismantling. In the event that removal of parts of the wind farm and cables leave a greater environmental impact than leaving them in situ, this will be preferred. The dismantling and recovery plan will be developed in consultation with the supervisory authority.

4 AREA DESCRIPTION

The following chapter describes the area intended for the planned Herkules wind farm.

4.1 Wind resources

Wind conditions for the project area have been initially evaluated using available wind data from Global Wind Atlas(Global Wind Atlas, u.d.) and a wind rose produced with available wind data (ERA5). At 150 meters above sea level, average wind speeds are between 9.7m/s and 9.8m/s in the project area. (Global Wind Atlas, u.d.). Prevailing winds are south westerly, see Figure 11.

Before the final design of the wind power development is determined, wind measurements will be taken in the area which will form the basis of the final design of the wind farm.

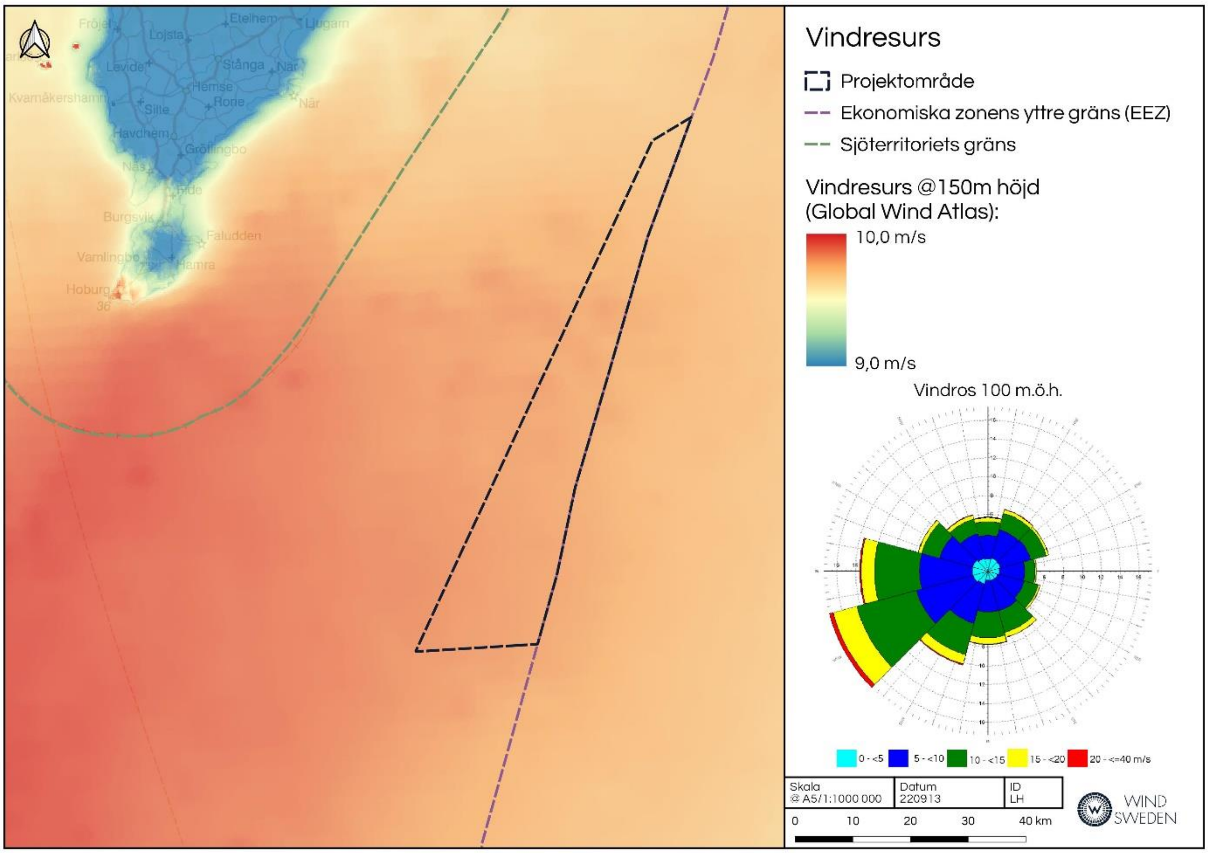

Figure 11. Overview of the wind resources for the project area at 150m above sea level and the prevailing wind direction at 100 metres above sea level (Global Wind Atlas.). Projektområde – Project area; Ekonomiska zonens yttre gräns (EEZ) – Exclusive economic zone (EEZ); Sjöterritoriets gräns – Territorial waters boarders.

4.2 Planning conditions

This chapter describes the planning conditions which influence the project area.

4.2.1 National maritime plan

The Swedish Agency for Marine and Water Management has produced three different marine plans, one for the Gulf of Bothnia, one for the Baltic Sea and one for the Western Sea, with the aim of contributing to a long-term sustainable development. The marine plan is not binding but is intended to be guidance around how the ocean can be used in the best way and act as a guide for national authorities, municipalities and courts in the coming decisions, planning and authorisation process. This will also contribute to creating the conditions for Sweden's future need to generate renewable energy including the expansion of wind power.

In the plans, relatively few areas for energy generation relating to wind power have been identified which are not considered sufficient to achieve the national target. However, the permit application to develop wind power was made in areas which were not identified specifically for that purpose.

The Swedish Energy Agency considers that at least 100 TWh renewable electricity production must be installed in Sweden by 2040-2045 in order to be able to achieve the goal of 100% renewable electricity production. The Agency expects the offshore plan to allow for about 50 TWh of offshore wind power. The areas identified for energy generation in the marine plan, however, only enable a total of between 23 TWh and 31 TWh of annual electricity production possible, depending on what proportion of the areas can be used, considering other interests. Therefore, the Swedish Energy Agency together with other affected agencies was tasked with highlighting further suitable areas to enable a further 90 TWh offshore electricity production. This will be reported on by March 2023 and the then the proposal will, if possible, be worked into the maritime plan and the Maritime and Water Agency will report their recommendations to the government by December 2024 (Energimyndigheten, 2022).

According to the zoning of the marine plan, the planned wind power development Herkules, is located within the Baltic Sea area. Within this area there are good technical conditions for offshore energy generation. However, high natural values have been identified in the marine plan are which may affect future wind power installations. Within the marine plan area, there are also extensive defensive interests which mean that wind power is not suitable in several areas according to the Maritime and Water Agency's evaluation. In the overall assessment for wind power in the Baltic Sea marine plan, these parameters have been taken into account as well as negative effects on long-tailed duck populations.

The Herkules project area is predominantly located within the area of the south east Baltic Sea but the northern point is within the area for the Central Baltic Sea, see Figure 12. The marine plan shows that there are good conditions for energy generation and that the demand for electricity is high due to the high consumption in southern Sweden (Havs- och vattenmyndigheten, 2022a).

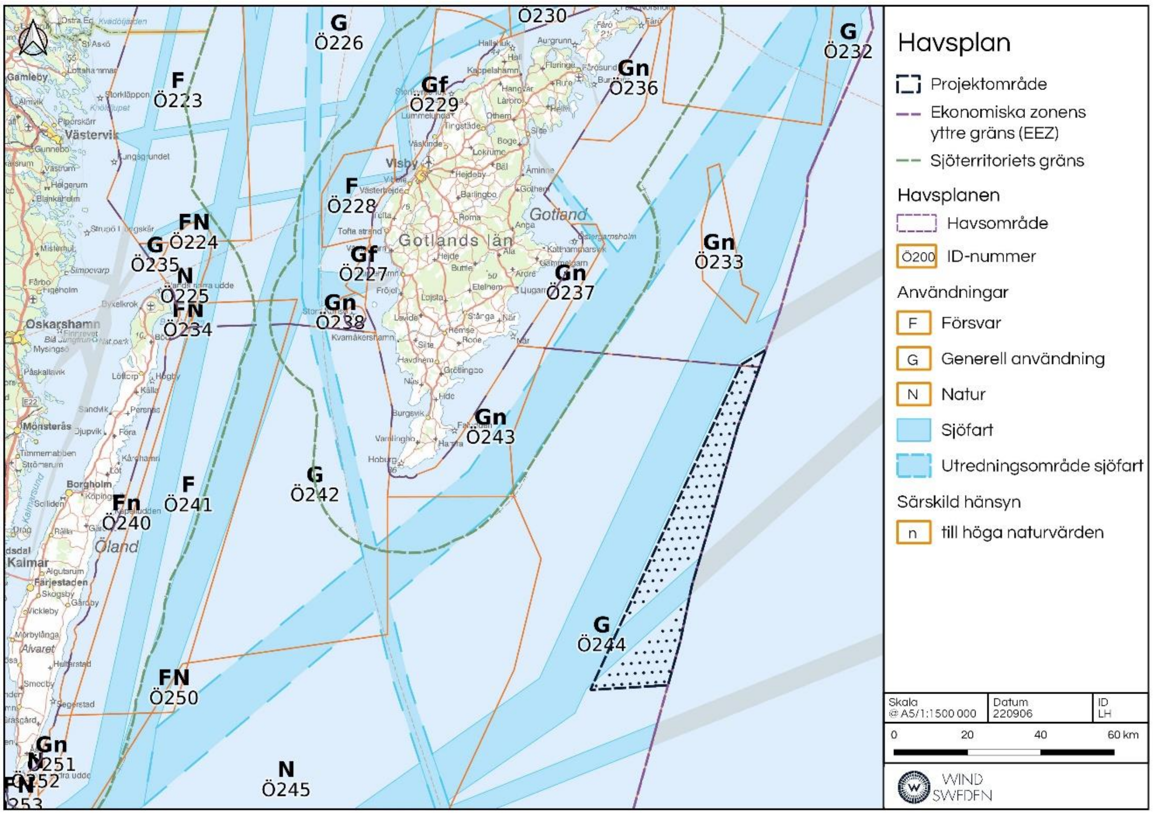

Figure 12. The national marine plan showing which areas that affect the Herkules project area (Maritime and Water Agency, 2022). Projektområde – Project area; Ekonomiska zonens yttre gräns (EEZ) – Exclusive economic zone (EEZ); Sjöterritoriets gräns – Territorial waters boarders; Havsplanen – Maritime plan; Havsområde – Sea area; ID-nummer – ID number; Anvädningar – Uses; Försvar – National Defence; Generel användning – General uses; Natur – Nature; Sjöfart – Ferry routes; Utredningsområde sjöfart – Area considered for the ferry routes; Särskild hänsyn till höga naturvärden – Significant importance for nature.

A run-through of the various areas follows in order to clarify which interests are considered important in the area of the marine plan where the project area is located.

Area **G** Ö232

In the Central Baltic Sea, there are several shipping lanes and several of these pass through the area of Ö232. In addition to shipping, the area also includes general use and commercial fishing. No preference or special adaptation for coexistence is indicated for the area (Havs- och vattenmyndigheten, 2022a).

Area **G** Ö244

In the south east Baltic Sea there is extensive traffic both to foreign and Swedish ports which means that shipping is important in this area. South and east of Gotland, it is predominantly traffic to and from the Gulf of Finland and the Baltic. These connect to the deep-water route, adjacent to the project area, southeast of Gotland in the Swedish economic zone and which is of substantial public interest. In addition to shipping, the area also includes general use, commercial fishing and electricity transmission. When nature and energy generation are in opposition to one another, nature takes precedence in the area according to the assessment of the Maritime and Water Agency (Havs- och vattenmyndigheten, 2022a).

4.2.2 HELCOM, Baltic Sea Action Plan

To protect the Baltic Sea's marine environment, the countries with a Baltic coastline have a shared agreement. Work to improve the Baltic Sea's condition is organised by HELCOM, which consists of representatives from the different countries which are signatories to the Helsinki Convention. This convention is a regional environmental convention which addresses issues such as eutrophication, the spread of environmentally hazardous substances and the protection and conservation of marine biodiversity(Havs- och vattenmyndigheten, u.d.).

HELCOM's work is directed by the Baltic Sea Action Plan (BSAP) which is a programme put forward by representatives within the convention, to restore the good ecological status of the Baltic Sea's marine environment(WISE Marine, u.d.).

In the latest BSAP from 2021, it was raised that HELCOM sees the need to develop offshore wind to be able to achieve the climate goals for 2030 and 2050. They also establish that steps should be taken to expand sustainable with respect for their commitments to biodiversity and a healthy marine environment (HELCOM, 2021).

4.2.3 Marine environmental management and environmental quality standards

The Marine Environment Directive was adopted by the EU in 2008 and into Swedish law in 2010 via the Marine Environment Regulation, which follows the content of the EU Directive. The Marine Environment Directive aims to achieve or maintain a good environmental status in Europe's waters and the directive was introduced into Swedish law through Chapter 5 of the Environmental Code and in the Marine Environment Regulation (2010:1341) and the Marine and Water Agency's regulations HVMFS 2012:18. The Marine Environment Regulation states that marine environmental management shall ensure that good environmental status is maintained or achieved in the North Sea and Baltic Sea. The management includes developing environmental quality standards (EQS) with various indicators to assess whether good environmental status is being maintained or achieved, developing and implementing a programme to monitor compliance with the EQS and describing the measures to be taken to maintain or achieve a good environmental status. 11 Swedish EQS have been determined as a tool to achieve good environmental status.

EQS determines the quality of the water, land, air and environment in general. This is regulated by the environmental code. The standards should protect human health and the environment. There are currently EQS for noise, air and water. The standards can be designed in different ways. Some provide clear limits while others represent target standards to work towards.

EQS for water includes lakes, rivers, coastal waters and ground water. An environmental quality standard for water describes the quality a body of water should have achieved by a certain point in time. The main rule is that all bodies of water should achieve that which the water agency calls *good status* (Vattenmyndigheterna, 2022).

All sea water from the coast to the outer limit of Sweden's economic zone fall under the EQS for sea quality. The current project area for the Herkules wind farm lies in the Baltic Sea proper [4], in the basin of the eastern Gotland Sea outer waters. (Havs- och vattenmyndigheten, 2019a). The current project area lies at its closest, 35km from the territorial waters' outer limit which means that the project has been judged to have little to no impact on the EQS in territorial waters. This will be further investigated in forthcoming EQS following surveys and modelling.

Good environmental status

[4] The Baltic Sea proper is that part of the Baltic Sea reaching from south Åland Sea to the Danish sounds. The North Åland Sea, Gulf of Finland, Bay of Riga are not (in most cases) included.

Good environmental status is the desired condition in the environment and serves as an overarching environmental quality standard for the Baltic Sea. The parameters involved in maintaining or achieving good environmental status in the sea are physical and chemical conditions, habitats and biological conditions. Pressures can include physical disturbance, introduction of nutrients and organic matter, introduction of hazardous substances and biological disturbance.

The description of good environmental status is divided into 11 themed area, descriptors, see Table 8, and are found in Annex 2 of the Marine and Water Agency's regulations (HVMFS) 2012:18 (Havs- och vattenmyndigheten, 2012). Each descriptor is then divided into one or more criteria based on the description of what conditions constitute good environmental status within that descriptor. In turn, each criterion has indicators which are the parameters for measurement/investigation by the environmental monitoring in order to determine whether the conditions in the criterion are met (Havs- och vattenmyndigheten, 2022b).

Table 8 . Good environmental status 11 themes (Havs- och vattenmyndigheten, 2022b).

Themes
1. Biodiversity 2. Non-native species 3. Commercially beneficial fish and shellfish 4. Marine food webs 5. Eutrophication 6. Integrity of the seabed 7. Existing changes in hydrographic conditions 8. Concentrations and effects of hazardous substances 9. Hazardous substances in fish and other marine life 10. Marine debris 11. Underwater noise

The themes which are considered to potentially impact the planned wind farm are:

- Biodiversity
- Integrity of the seabed
- Underwater noise

Each theme in turn has indicators which are measured and investigated in the environmental monitoring programme. Eutrophication, hazardous substances, marine debris, noise, physical loss and physical disturbance to habitats, fish including by-catch and non-native species.

What impact development of an offshore wind farm can have and the scope of the impact will be investigated in the forthcoming EQS.

4.3 Overview of nearby wind farm developments

Where there are nearby wind farms, so-called cumulative effects can occur. Table 9 below lists the planned wind power developments in the water within 50 km from the project area. Of the four total planned projects within this distance, three are located outside of Swedish waters. This area is identified as a development zone in 4C Offshore (4C Offshore). The project located in Swedish water lies 14 km from the outer limit of the Herkules project area and has applied to the Geological Survey of Sweden for an investigation permit (OX2 AB, 2022).

Figure 13shows an overview of known planned offshore wind power development. Wind turbines that have been built, have received permits or are being processed on land are not shown because the distance to land is more than 50 km.

Table 9. Summary of nearby planned offshore wind power developments within 50km of the project area. Distance is from the outer limit of the Herkules project area.

Project	Distance	Operators/Country	Status
Pleione	14 km	OX2/Sverige	Investigation permits according to CSA processed
A (outside of Swedish waters)	40 km	Latvia/Lithuania	Development zone
B (outside of Swedish waters)	47 km	Latvia	Development zone
C (outside of Swedish waters)	45 km	Latvia	Development zone

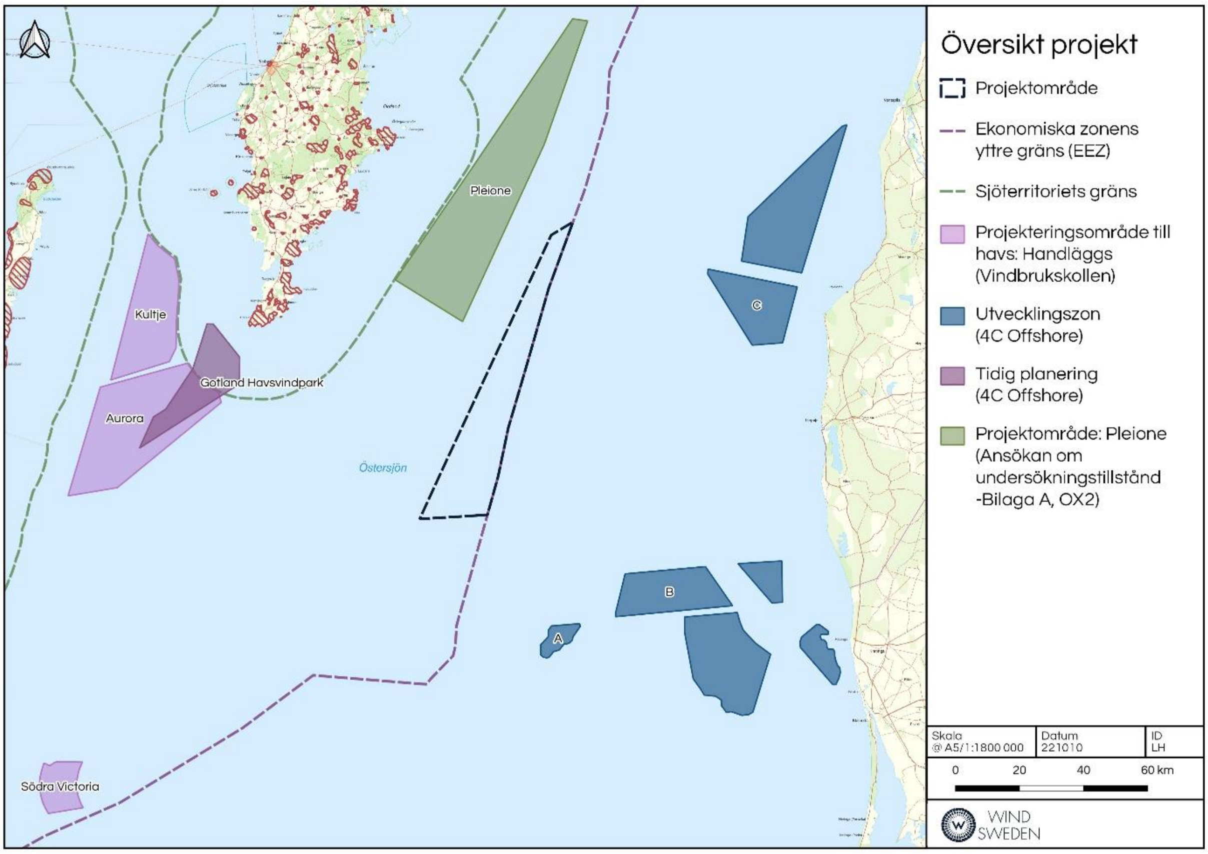

Figure 13. Overview of the nearby wind power developments (Vindbrukskollen), (4C Offshore)& (OX2 AB, 2022). Projektområde – Project area; Ekonomiska zonens yttre gräns (EEZ) – Exclusive economic zone (EEZ); Sjöterritoriets gräns – Territorial waters boarders; Projekteringsområde till havs: Handläggs (Vindbrukskollen) – Offshore windfar Project area (Vindbrukskollen); Utvecklingszon (4C Offshore) – Obszar rozwoju morskich farm wiatrowych (4C Offshore); Tidigt planering – Projekt na wstępnym etapie planowania; Projektområde: Pleione – Projekt Pleione (powolenie na badania dnia morskiego).

4.4 Existing cables and lines

Along the Baltic seabed there are several different cables and lines for telecommunications, electricity transmission and gas. Those lying close to the project areas are the gas lines Nordstream 1 and 2 between Russia and Germany, see Figure 14. The planned Nordstream 2is the line which is closest to the project area, approx 15 km from the project area's outer limit. Two different fibre cables are located within the project area. The east-west cable from Katthammarsvik in Sweden to Lithuania is called BCS

East-West Interlink and the so-called C-Lion1 cable, goes north to south from Finland to Germany. Both cables are fibre cables for telecommunication.

Aside from these cables there are no further cables or lines within or to the project area other than what is known about from accessible material.

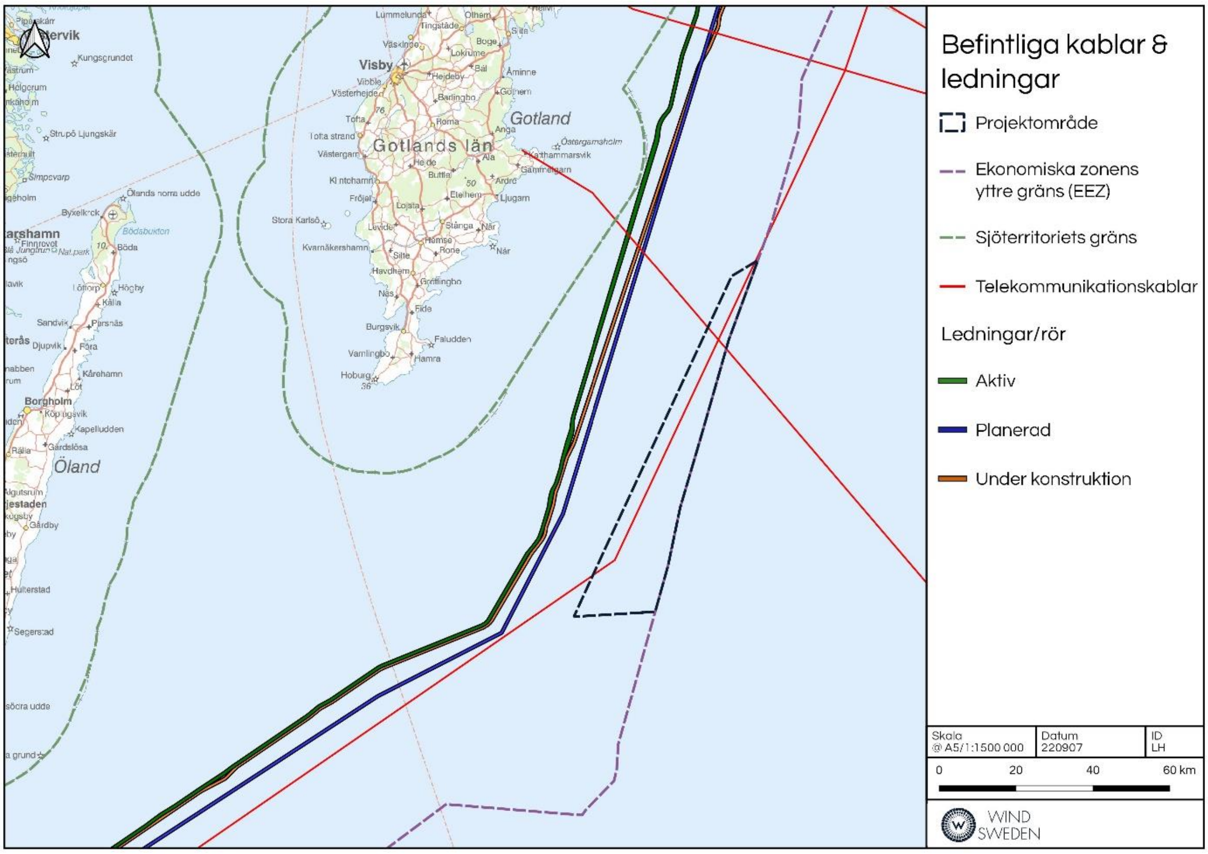

Figure 14. Existing cable and lines/pipes in the vicinity of the project area (EMODnet, 2022a). Projektområde – Project area; Ekonomiska zonens yttre gräns (EEZ) – Exclusive economic zone (EEZ); Sjöterritoriets gräns – Territorial waters boarders; Kablar – Cables; Ledningar/rör – Pipelines-, Aktiv – Active; Planerad – Planned; Under konstruktion – Under construction.

4.5 Depth and marine geology

The ocean depth in the project area varies and lies between 107 m and 224 m, see Figure 15. Since the depth in the project area is over 60m, it is well-suited to a development of a wind farm with floating foundations.

The geology of the area consists predominantly of hard clay and mud which can be seen below in Figure 16.

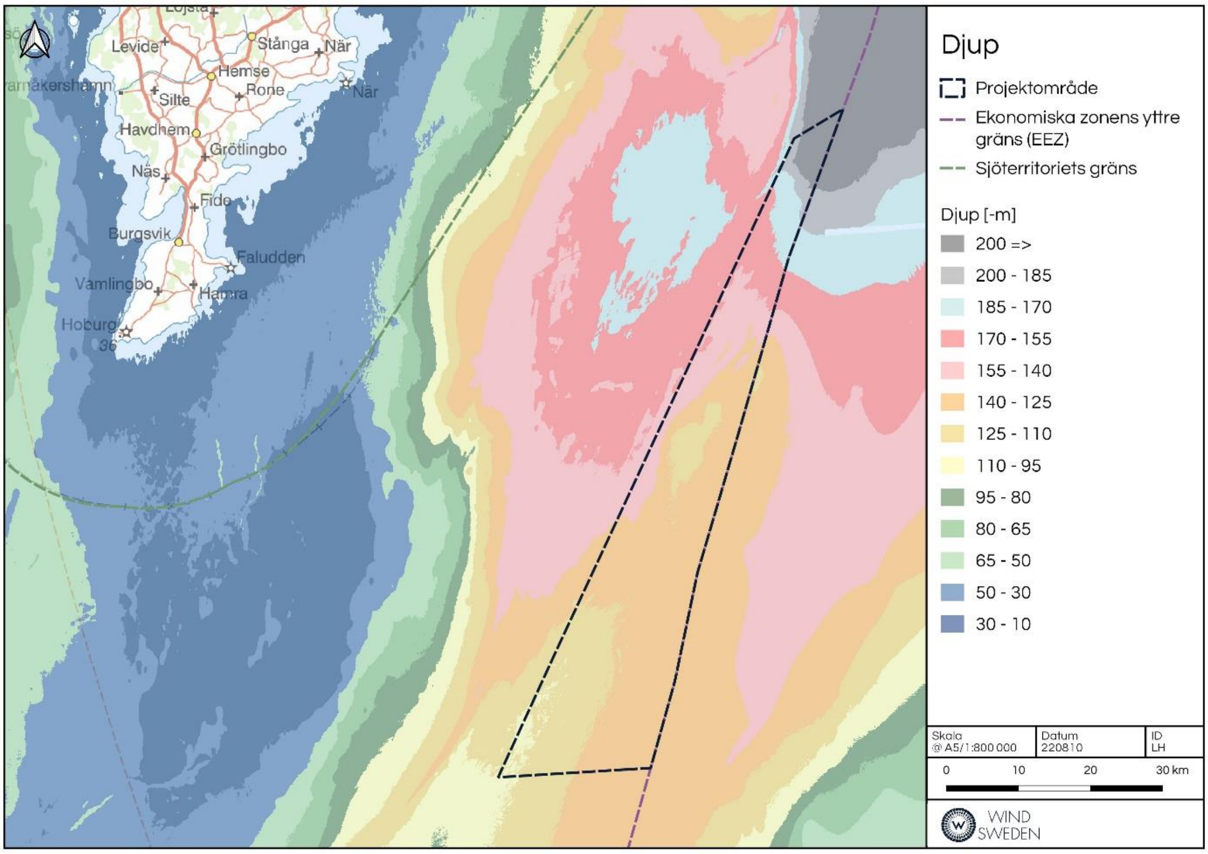

Figure 15. Depth conditions within and around the project area (EMODnet). Projektområde – Project area; Sjöterritoriets gräns – Territorial waters boarders.

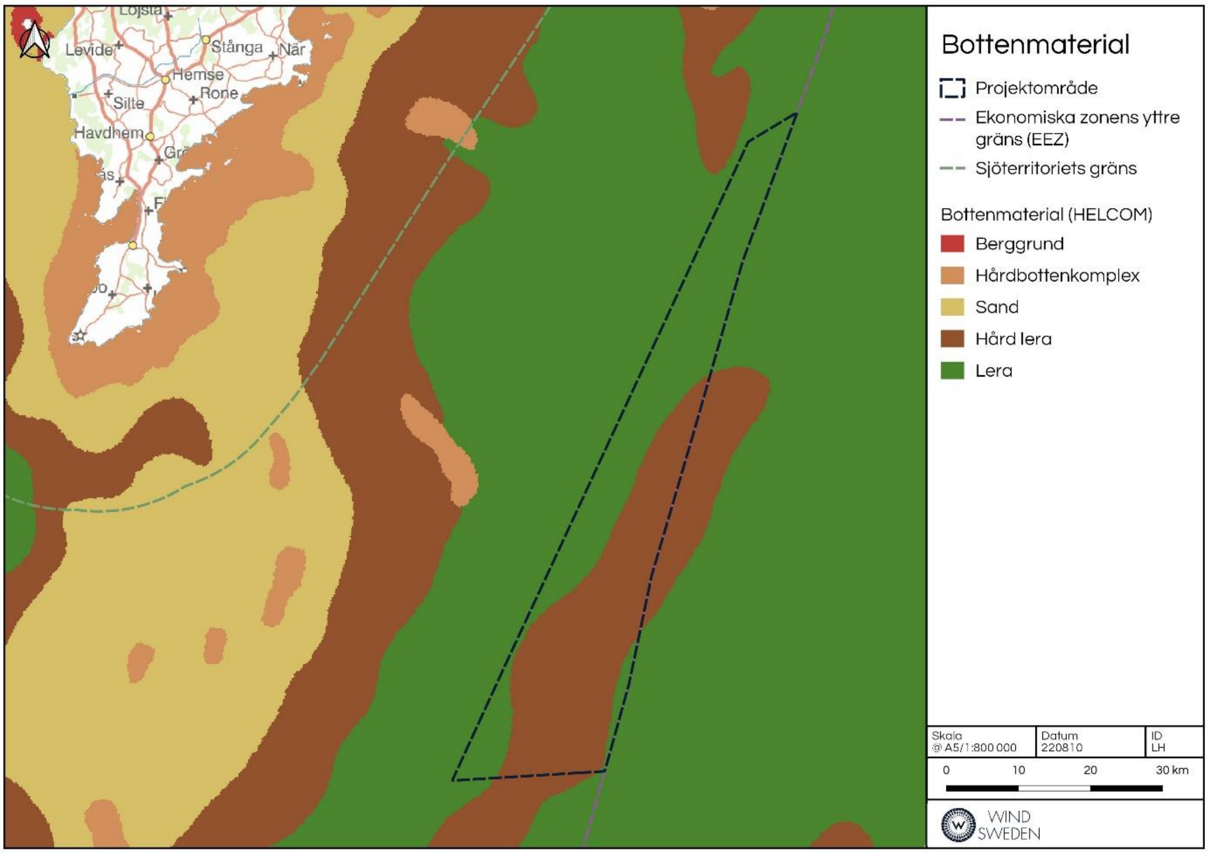

Figure 16. Overview of the seabed material within the project area for Herkules (HELCOM 2008a & SGU). Projektområde – Project area; Sjöterritoriets gräns – Territorial waters boarders; Berggrund – Bedrock; Hårdbottenkomplex – Mixed hard bottom; Sand – Sand; Hård lera – Hard clay; Lera – Clay.

4.6 Oceanographic parameters

The Baltic Sea is a semi-enclosed sea surrounded by nine countries with limited flow to the ocean. Water circulation is dominated by salinity and temperature difference rather than by winds. Surface water salinity, halocline strength [5] and surface water temperature decrease to the north where the impact of winter ice cover increases. Due to the shallow thresholds in the Baltic Sea, the turnover time of the water is around 30 years in the southern Baltic Sea and 40 years in the northern part. This means that the Baltic Sea is heavily affected by drainage from the surrounding land masses (Snoeijs-Leijonmalm, Schubert, & Radziejewska, 2017).

4.6.1 Currents & salinity

Ocean currents are created by differences in water levels, salinity and temperature, the moon and sun's gravitational pull as well as winds. In addition, currents are also influenced by coastlines, seabed topography, the earth's rotation and friction between bodies of water and the seabed. Sea water is always moving and the greatest movements occur horizontally while vertical movements are smaller due to density stratification(SMHI, 2011).

Salinity in the Baltic Sea is heavily impacted by the drainage of fresh water from the surrounding land masses. The average salinity in the Baltic Sea is 7g salt per kg water, which can be compared to the

[5] The divide between two bodies of water with different salinities. Also known as the saltier layer.

average salinity of sea water of 35g. Salinity reduces northwards with around 20g per kg water in the south and 2g in the Gulf of Bothnia(Östersjön.fi, u.d.). The location of the project area for Herkules has salinity of around 7g per kg water (Livet i havet, 2022).

In the Baltic Sea there is no strong permanent system of currents, so it is mainly locally produced currents as a result of wind and other factors which can have an impact on the proposed wind power development. The fresh water which drains into the sea lies in a thin layer and moves over the heavier salt water turning to the right due to the earth's rotation. Gradually, the fresh water mixes with sea water, creating a large-scale coastal current which slowly moves southwards along the coast(SMHI, 2021).

Inflow into the Baltic Sea comes from Skagerrak and Kattegatt. The inflow consists of salty and oxygen-rich water which affects the oxygen conditions in the Baltic Sea. Since the incoming water has a higher salinity, it settles underneath the fresh water. Water is distributed by seabed currents in the Baltic Sea to the east and north, where salinity decreases over time as a result of mixing with the existing water, see Figure 17. This process heavily influences the ecosystem in the Baltic Sea (SMHI, 2012).

Figure 18 shows modelling of the annual average current speeds in the Baltic Sea. Based on this data, the fastest seabed speed is 3.3cm/s. Even though this is not a measured current, but only modelled, it shows that the seabed speeds in the areas are extremely low (HELCOM, 2008b).

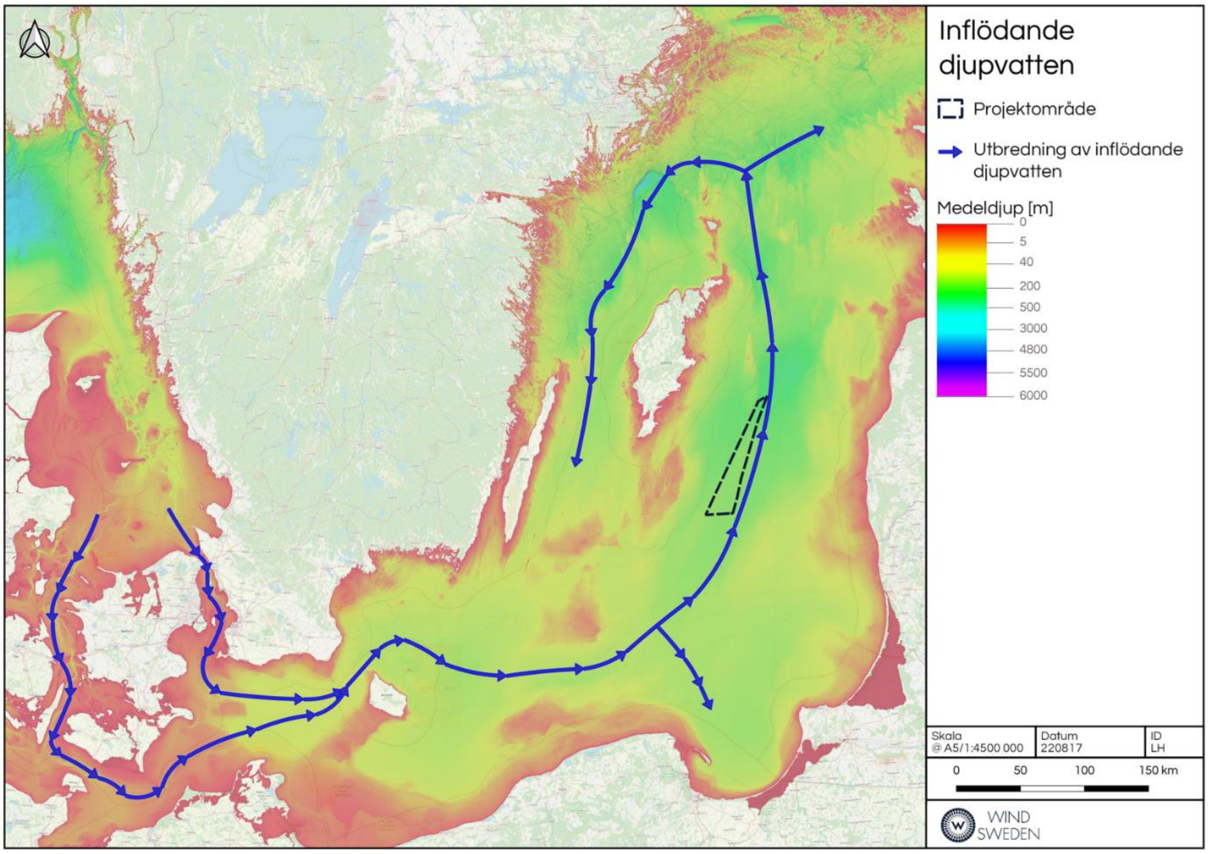

Figure 17. Schematic of the spread of inflowing deep water into the Baltic Sea (SMHI, 2012). Projektområde – Project area; Utbredning av inflödande djupvatten – Inflow of the water.

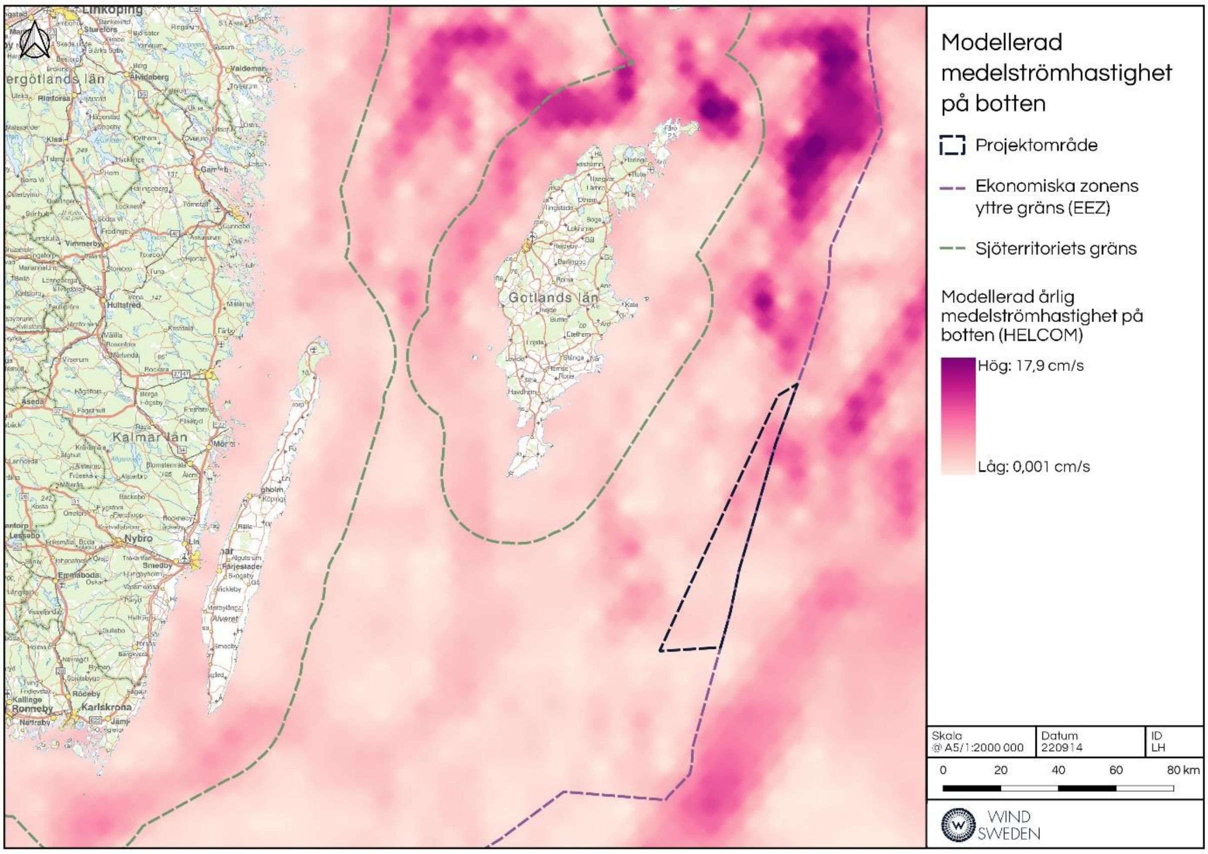

Figure 18. Annual average current speeds in the Baltic Sea (HELCOM, 2008b). Projektområde – Project area; Ekonomiska zonens yttre gräns (EEZ) – Exclusive economic zone (EEZ); Sjöterritoriets gräns – Territorial waters boarders.

4.6.2 Depth of visibility

Data recorded between 2010 - 2022 from measuring station BY10, located approx 8 km east of the outer limit of the project area, shows there the depth of visibility [6]varies during and across years between 3 - 17m. This means that there is limited depth of visibility in large parts of the project area(SMHI, 2022b). The greater the depth of visibility, the deeper sunlight penetrates.

4.6.3 Oxygen-free seabeds

Oxygen is required for more life to thrive in the sea. Surface water is oxygenated through plant photosynthesis and exchange with the atmosphere. To oxygenate the deeper water, either a vertical mixing with the oxygen-rich surface water is needed or oxygen-rich water is added horizontally. In the Baltic Sea proper, there is stratification of the bodies of water due to the varying salinities, saltier water deeper and fresh water closest to the surface which make vertical mixing difficult. In addition, there are several deep wells in the Baltic Sea which light doesn't penetrate and where salty water gathers. In these environments it is too dark for plants and no photosynthesis can occur so the oxygen which is present is consumed by the decomposition of organic matter. This leads to the formation of oxygen-free or oxygen-poor seabeds. Oxygen-free seabeds are a widespread problem in the Baltic Sea proper and it is calculated that at depths below 80 m no life exists on the beds seeFigure 19 (Havet.nu, u.d.)

[6] One measure of the water transparency.

From measuring station BY10, located approx 8 km east of the limit of the project area, the average oxygen content was calculated at 0.59m/l at 125 m depth and 7.9 ml/l at 5 m depth during the period from January 2015 to July 2022 (SMHI, 2022b).

The project area is located only within an area identified as having oxygen free seabeds.

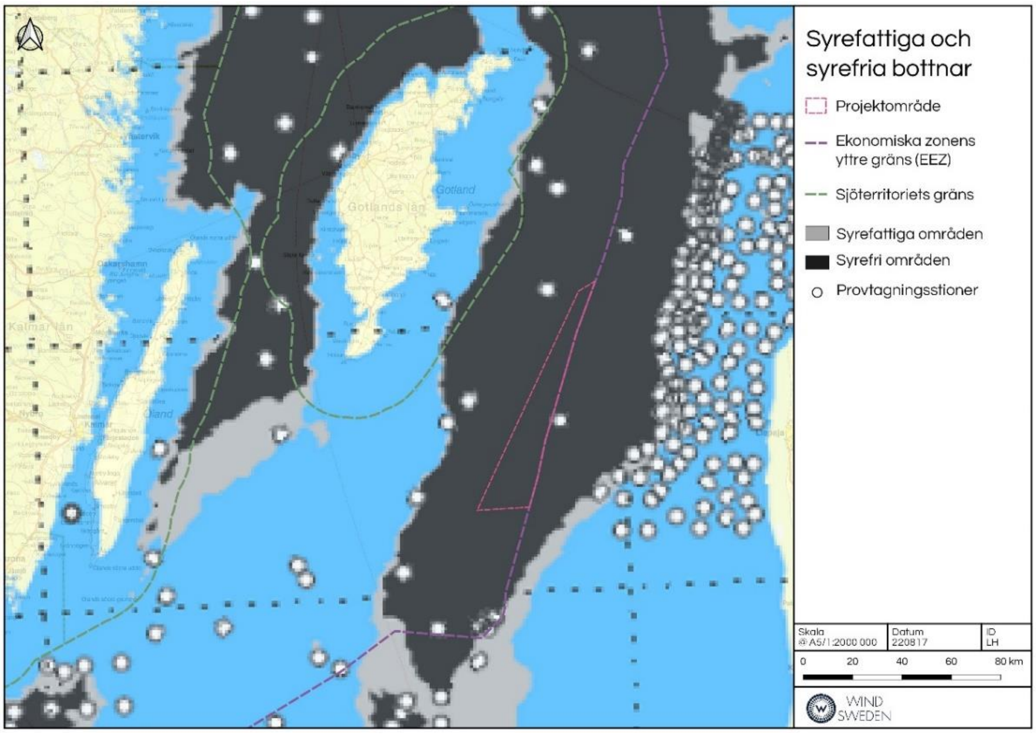

Figure 19. Map of oxygen situation in the Baltic Sea deep water. Black areas show oxygen-free seabeds. Map based on data from 2021(Sveriges miljömål, 2021). Projektområde – Project area; Ekonomiska zonens yttre gräns (EEZ) – Exclusive economic zone (EEZ); Sjöterritoriets gräns – Territorial waters boarders.

4.6.4 Waves

One measure used to report the height of waves is the significant wave height. This parameter is determined from all waves during a 30-minute period from which the average height of the highest third of waves in the interval is calculated. This definition corresponds with what a sailor would observe when assessing the height of waves (SMHI, 2022a). From the Södra Östersjön Buoy measuring station, the average value for significant wave height for the period from June 2005 to April 2011 was 1.24m. The average maximum wave height for the same period was 1.99 m with the max value during the same period being 11.2 m(SMHI, u.d.).

4.6.5 Ice

The Baltic Sea usually starts to freeze in November in the Gulf of Bothnia and the inner Gulf of Finland. That is followed by freezing in Kvarken, southern parts of the Gulf of Bothnia and along the coast in the Bothnian Sea. The extent of freezing varies. In a normal winter, the entire Gulf of Bothnia, Kvarken, almost all of the Bothnian Sea, the Archipelago Sea and even some of the Baltic Sea freeze. A mild winter means that the Gulf of Bothnia doesn't freeze at all and the Gulf of Finland only partially (Meteorologiska Institutet , 2022).

As the climate warms up, this leads to less sea ice. More location specific conditions for ice formation around the wind turbine development will be studied further.

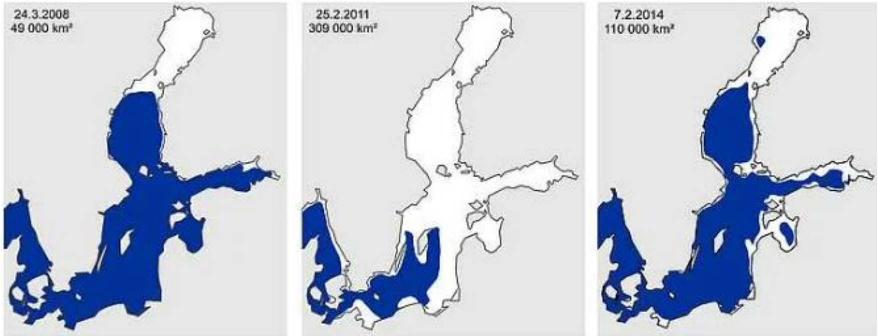

Figure 20. The maximum extent of ice on three different occasions(Meteorologiska Institutet , 2022).

4.7 National Interest

Chapters 3 and 4 of the Environmental Code (EC) set out the provisions for land and water management. With support of Chapter 3 of the Environmental Code, the national authorities highlight areas of national interest such as nature conservation, cultural heritage, energy production and outdoor recreation. National interests under Chapter 4 are written into the Environmental Code directly.

When an area is designated a national interest, it is protected from measures which could seriously damage its purpose or value. The level of protection is regulated by the Environmental Code which is used as guidance in the event of two conflicting interests.

4.7.1 Chapter 3 Environmental Code

The national interests under Chapter 3 EC located in or near to the project area can be seen in Figure 21. No national interests from Chapter 3 EC are located within the project areas boundaries. The shipping lane Gedser - Svenska Björn runs along the project area's western side, which is a deep shipping route identified in the marine plan as being of public interest of significant value (see Chapter 4.2.1). In addition to shipping, the nearest national interest is commercial fishing at sea. At its closest, this lies approx 3 km from the limit of the project area.

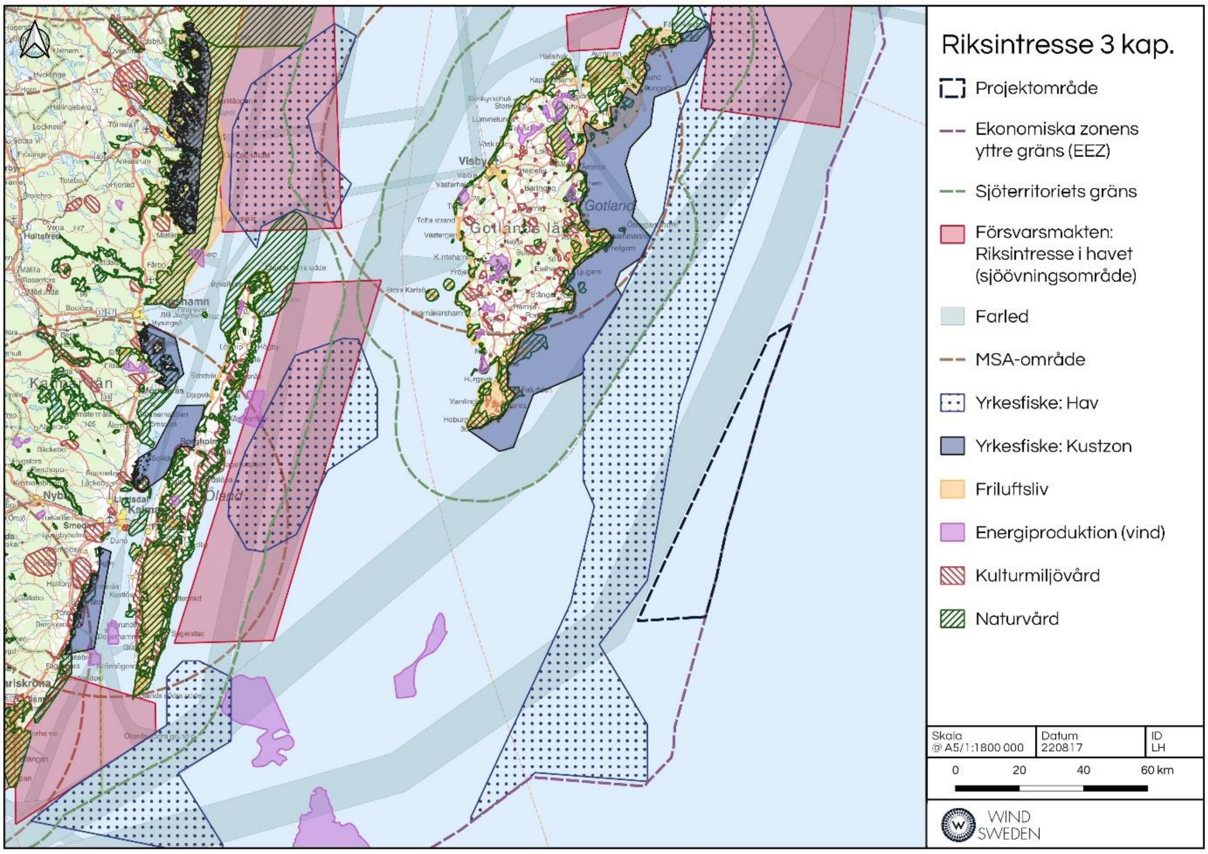

Figure 21. Nearby conflicting interests from Chapter 3 of the Environmental Code. Projektområde – Project area; Ekonomiska zonens yttre gräns (EEZ) – Exclusive economic zone (EEZ); Sjöterritoriets gräns – Territorial waters boarders; Försvarsmakten (Sjöövningsområde) – National Defence (Naval exercise area; Farled – Ferry routes; MSA – område –Minimum Safe Altitude area (MSA); Yrkesfiske: Hav – Commercial fishery, open sea; Yrkesfiske: Kustzon – Commercial fishery, coastline; Friluftsliv – Outdoor recreation; Energiproduktion (vind) – Energy production (vindfarms); Kulturmiljövärd – Cuture heritage protection areas; Naturvård – Nature protection areas.

Airports

MSA area (minimum safety altitude) determines the area within which there are determined heights for the highest permitted objects in the area around an airport. In this area, no fixed installations higher than the determined MSA for the area permitted.

Several MSA areas for nearby airports are located north west and west of the project area. No MSA areas infringe on the project area.

Shipping routes

The project area is located adjacent to the national interest shipping lane, see Figure 21.

- Gedser – Svenska Björn, shipping lane class 0, protected height 65m, protected depth 19 m (Trafikverket, u.d.).

Attention must be paid to existing shipping lanes when locating and designing a wind farm. It is advisable to have a safety distance between the shipping lanes and the nearest wind turbines and any such distance will be determined according to the local conditions.

According to available material, there are no lighthouses within the project area.

The Swedish Maritime Administration will be part of the consultation group for the project.

4.7.2 Chapter 4 Environmental Code

The areas identified as national interests for outdoor recreation are of great importance for people outdoor lives and within these areas, municipalities should consider outdoor recreation in the overview and detailed planning.

The project area for Herkules doesn't adjoin any national interests from Chapter 4 EC. The nearest national interest from Chapter 4 EC, which concerns outdoor recreation, is around Gotland approx 33km from the limit of the project area. This national interest is also found along the mainland coast along with the national interest of unbroken coastline, see Figure 22.

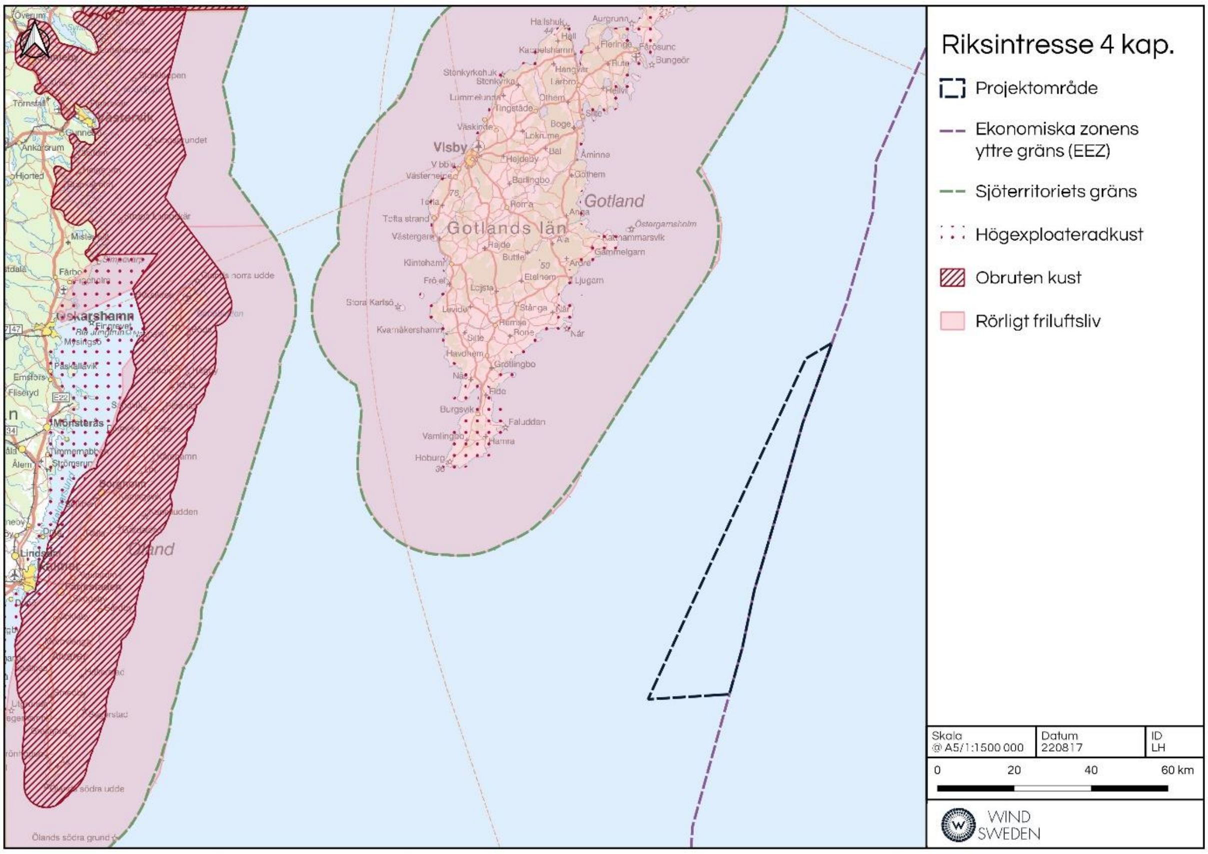

Figure 22. Nearby conflicting interests from Chapter 4 Environmental Code. Projektområde – Project area; Ekonomiska zonens yttre gräns (EEZ) – Exclusive economic zone (EEZ); Sjöterritoriets gräns – Territorial waters boarders; Högexploateradkust – Highly exploited coastline; Obruten kust – Unexploited coast; Rörligt friluftsliv – Outdoor recreation area.

4.8 Protected areas

Within the scope of Chapter 7 of the Environmental Code, land and water areas can be protected with different types of designation such as nature reserves, Natura 2000 areas, national parks and specific animal or plant protected areas. The following chapter describe those which lie in the project area for Herkules.

4.8.1 Natura 2000

Natura 2000 is a network of protected areas across all of the EU member states. The basis for the network is two EU directives, the Birds Directive and Habitats Directive. Natura 2000 areas contribute to the conservation of biodiversity at an EU level. Natura 2000 areas constitute both protected areas under Chapter 7 of the Environmental Code and national interests under Chapter 4 of the Environmental Code.

A Natura 2000 area has been identified within an area 50 km from the project limit. Brief information on the area can be seen below in Table 10 and a description regarding its natural value follows.

Table 10. Summary of Natura 2000 area within 50km of the project area limit. SCI= Species & habitats directive, SPA= Birds directive

Name	Distance to project area limit	Natura 2000
Hoburgs bank and Midsjöbankarna.	22 km	SCI / SPA

Hoburgs bank and Midsjöbankarna.

The Natura 2000 area, Hoburgs Bank and Midsjöbankarna is a large area of 10,511 km^2 which covers both the species and habitats directive as well as the birds directive. The priority conservation values for this Natura 2000 site are porpoise, long-tailed duck and black guillemot. These species use all or part of the site, as well as the reefs and sandbanks present in the area and the species and biodiversity typical of these two habitats.

The Natura 2000 area includes two shallow offshore areas, the North Midsjöbank and Hoburgs Bank. The South Midsjöbank located outside of the Natura 2000 area is also closely connected to the protected species despite not being included. The elevations of the outer banks create areas with conditions similar to those of the coast. The advantage is that these areas are largely unaffected by factors which impact coastal areas. Organisms which previously existed in coastal areas may therefore use them as refuge. In the area around the banks, water turnover is high and environmental pollutants, eutrophication and human impacts are lower and further out to sea compared to the coast, meaning the area has very good conditions for many plant and animal species(Länsstyrelsen Gotlands- och Kalmars län, 2021).

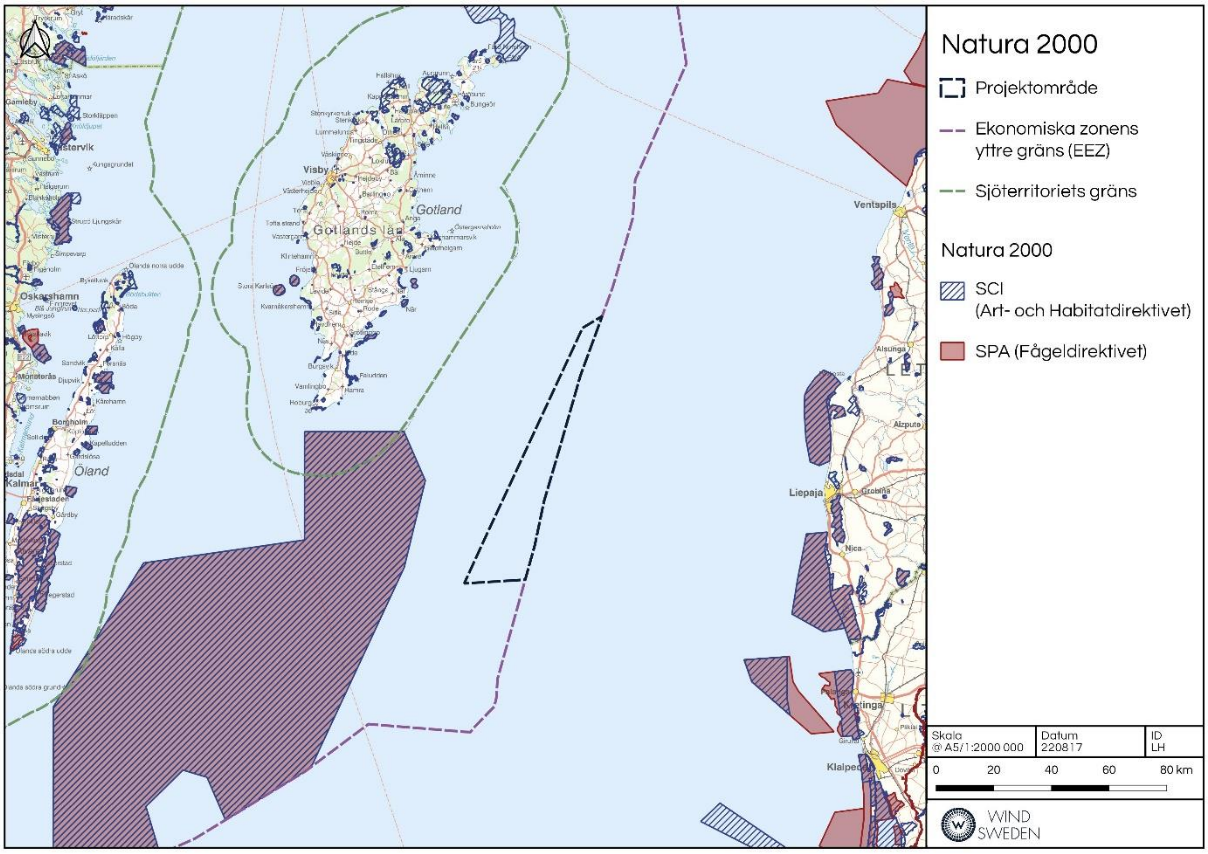

Figure 23. Natura 2000 areas near to Herkules. Projektområde – Project area; Ekonomiska zonens yttre gräns (EEZ) – Exclusive economic zone (EEZ); Sjöterritoriets gräns – Territorial waters boarders; Natura 2000 (Art- och Habitatdirektivet) – Natura 2000 SPI; Natura 2000 SPA.

4.8.2 Other protected areas

Within the project area there are no other protected areas as shown in Figure 24. In addition to the Natura 2000 areas presented in the previous chapter, there are two areas within 50km of the project area limit identified as *Ecologically or Biologically Significant Marine Areas (*EBSA) of HELCOM (see Chapter. 4.2.2). The area west of the project area, approx 21 km from the project area limit called *Southern Gotland Harbour Porpoise Area,* coincides to a great extent with the Natura 2000 area Hoburgs bank and Midsjöbankarna. Within this EBSA area there are also two *Marine Protected Areas* (MPA), Hoburgs Bank and North Midsjöbank, identified by HELCOM. Why these areas have been identified is described in the previous Chapter 4.8.1.

South east of the project area lies another EBSA area, approx 26 km from the project area's limit called *Southeastern Baltic Sea Shallows.* The area is identified by HELCOM due to its unique combination of specific topography, protected brackish coastal environments, specific hydrological conditions and a variety of benthic substrata [7]. The combination of these parameters has enabled the formation of unique conditions for local species and species compositions. The offshore bank, which of the EBSA areas is closest to the project areas, acts as a refuge for the migratory species from short-term hypoxia[8] in the deeper parts of the Gotland Basin. Within the area there are several Natura 2000 areas along the

[7] Substrate on the seabed where plants or animals live.
[8] The medical term which means that body tissue suffers from a lack of oxygen.

Lithuanian and Latvian coast. These areas coincide almost entirely with the MPA area found within the EBSA area(Convention on Biological Diversity, 2019).

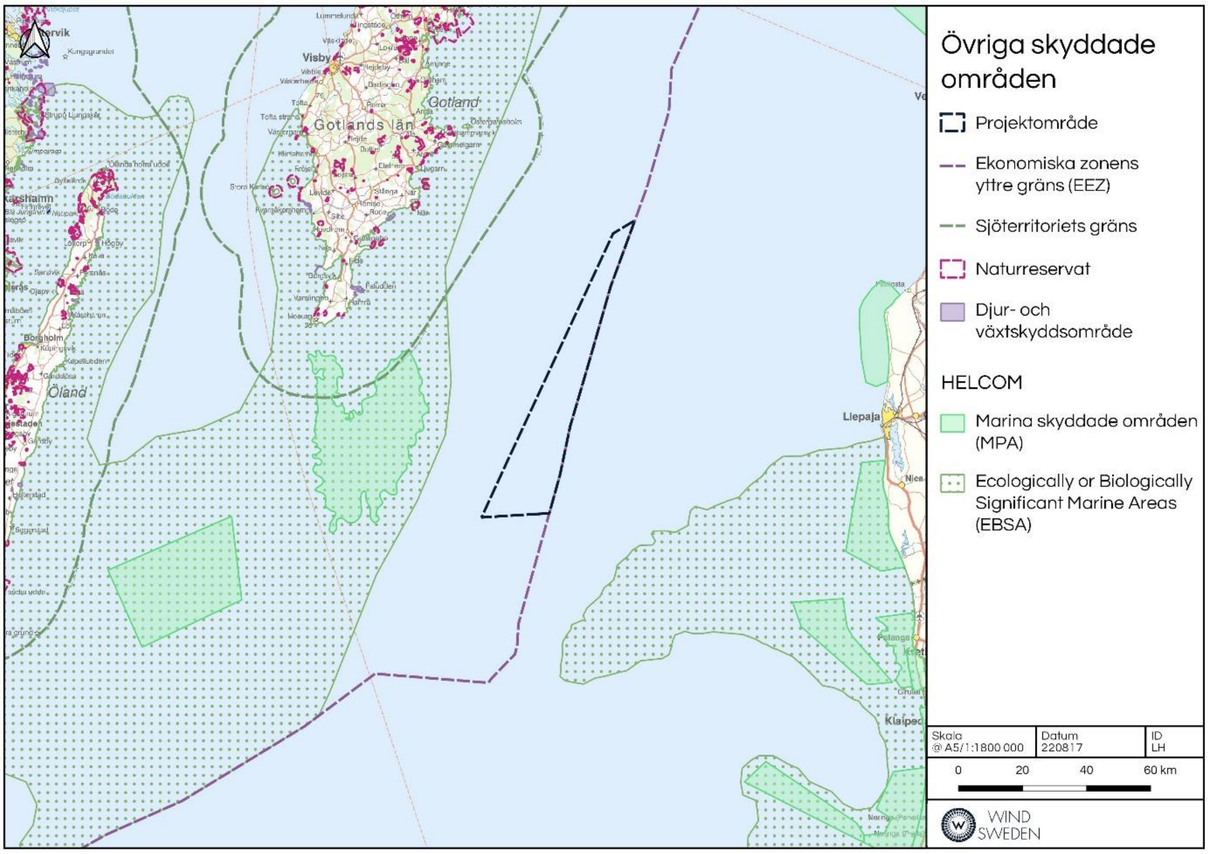

Figure 24. Other protected areas in the vicinity of the Herkules wind farm project. Projektområde – Project area; Ekonomiska zonens yttre gräns (EEZ) – Exclusive economic zone (EEZ); Sjöterritoriets gräns – Territorial waters boarders; Naturreservat – Nature reserve; Nationalpark – National Park; Djur- och växtskyddsområde – Fauna and flora protected area; MPA – Marine Protected area.

4.9 Natural environment

The Baltic Sea's brackish water conditions give it specific conditions with a mixture of both fresh and salt water species. The sea is species-poor and therefore especially sensitive as the marine ecosystem is easily impacted if one species disappears. It is especially sensitive if one of the key species disappears which can lead to major changes in the ecosystem's foundations(Baltic Eye, 2022). Habitats in the Baltic Sea are driven by four main factors: salinity, oxygen content, light and seabed conditions.

The composition of the ecosystem is also influenced by factors such as currents, winds, waves, temperature and seabed substrate.

4.9.1 Demersal plants and animals

The depth within the project area varies between approx 107m to 224m and the seabeds beds within the project area consist predominantly of hard clay and mud as seen in Figure 16.

According to information from Sweden's environmental goals,(Sveriges miljömål, 2022)the project area largely includes oxygen-poor seabeds which provide poor conditions for many organisms, see Figure 19.

The photic zone, i.e., the depth to which light penetrates into the water, is around 30 m below the surface at open sea in winter. The limited light conditions mean that the deeper parts of the project area support no life at all, see Figure 25.

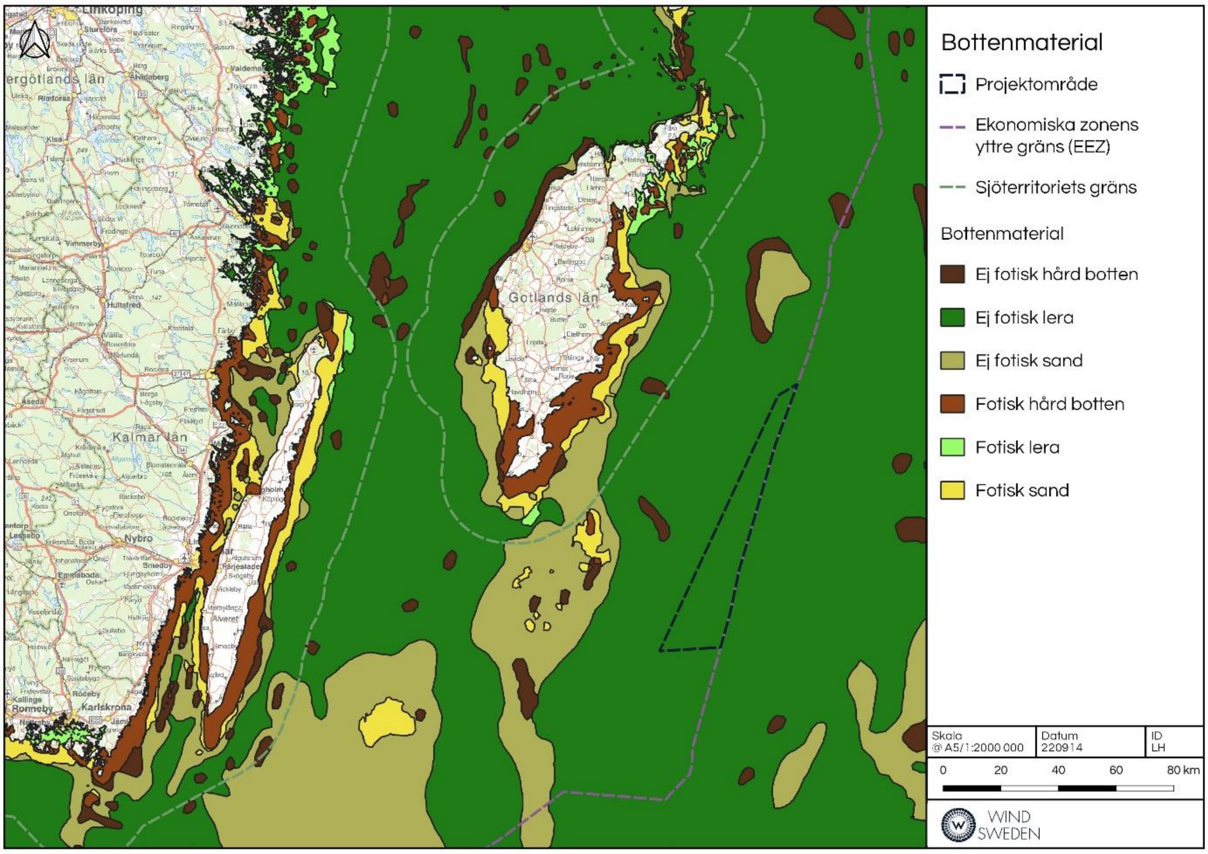

Figure 25. Overview of the Baltic Sea benthic biotope complex. Data is based on a combination of geological sediment data and light penetration data (HELCOM, 2010). Projektområde – Project area; Ekonomiska zonens yttre gräns (EEZ) – Exclusive economic zone (EEZ); Sjöterritoriets gräns – Territorial waters boarders; Bottenmaterial – Bottom material; Ej fotisk hård botten – Aphotic with hard bottom; Ej fotisk lera – Aphotic clay bottom; Ej fotisk sand – Aphotic sandy bottom; Fotisk lera – Photic clay; Fotisk sand – Photic sandy bottom.

According to measurements from the nearest measuring station, BY10, the depth of visibility throughout the year varies between 3-17 m. This means that there is limited depth of visibility in large parts of the project area.

On these oxygen-free seabeds, large demersal animals such as fish, mussels and annelids are seldom or never found. However, investigations of the seabed east of Gotland in 2020, found zooplankton and annelids on the apparently dead oxygen-free seabed of the Baltic Sea (Havet.nu, u.d.).

The location specific environment and seabed conditions within the project area have not yet been investigated, rather investigations of the seabed conditions will be conducted as part of the further work on an Environmental Impact Assessment, see Chapter 0.

4.9.2 Marine mammals

The Baltic Sea is home to marine mammals such as porpoises, common seals, grey seals and ringed seals.

Porpoises

The Baltic Sea has a population of porpoises which migrates between southern Skåne and the northern Gulf of Bothnia and one of the most important areas for porpoises is found in Hanö Bay. The species is on the Red List and classes as vulnerable (VU) according to the species data bank's national red list. In a 2016 study by the SAMBAH project, the number of porpoises in the Baltic Sea population was estimated to be 500 (SAMBAH, 2016), see Figure 26.

Modelling has identified areas in need of protection in the Baltic Sea (Carlström, J & Carlén, I, 2016), see Figure 27. This figure shows important areas during summer and associated zones of consideration. This figure shows that the project area is not within the area of specific importance for the Baltic Sea population during the summer reproductive period or its zone of consideration.

The porpoises use other areas of the Baltic Sea during different periods of the year. Between March-May and February-April, two coastal areas around Gotland are important areas for porpoises. Based on a combination of acoustic investigations (SAMBAH project) and Kernal density[9] from previous studies, the presence of porpoises in the project area is low(Havs- och vattenmyndigheten, 2018).

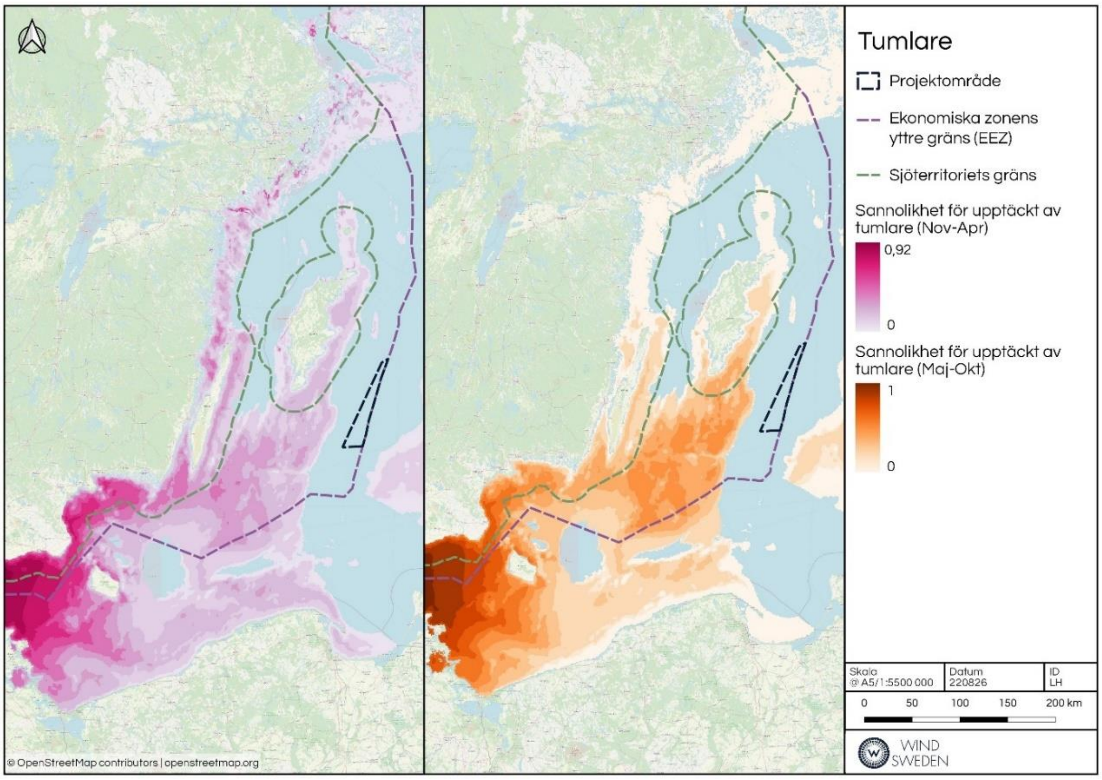

Figure 26. The probability of finding porpoises in the Baltic Sea at different times of year (HELCOM, 2016 & HELCOM, 2017). Projektområde – Project area; Ekonomiska zonens yttre gräns (EEZ) – Exclusive economic zone (EEZ); Sjöterritoriets gräns – Territorial waters boarders; Sannolikhet för upptäkt av tumlare (Nov-Apr) – Probability for harbour porpoise presence (Nov – Apr); Sannolikhet för upptäkt av tumlare (Maj-Okt) - Probability for harbour porpoise presence (May – Oct).

[9]A method of estimating probability density based on a limited data set.

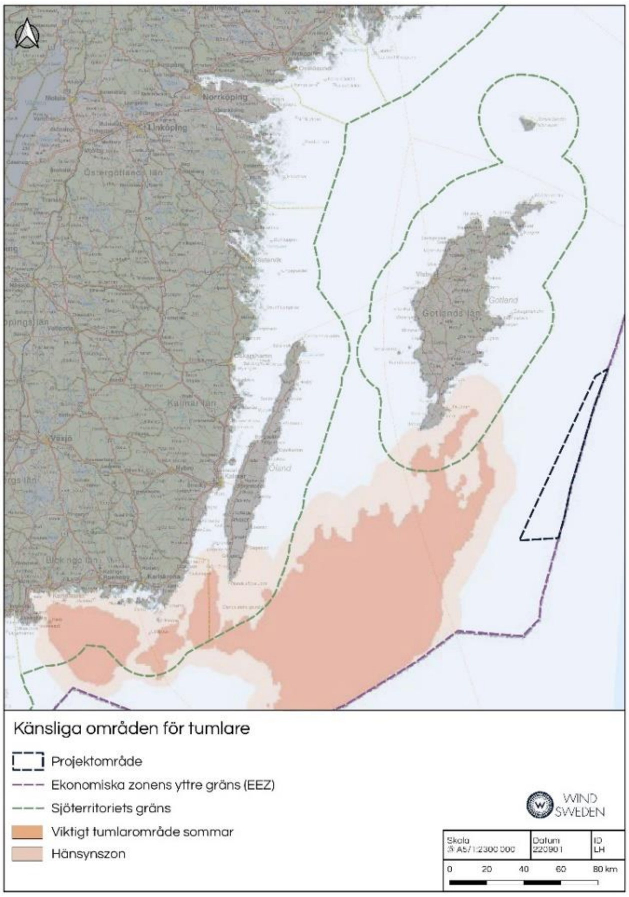

Figure 27. Sensitive areas for Baltic Sea porpoises (Isæus, Beltrán, Stensland Isæus, Öhman, & Andresson-Li, Ekologiskt hållbar vindkraft i Östersjön, Rapport 7055, 2022). Projektområde – Project area; Ekonomiska zonens yttre gräns (EEZ) – Exclusive economic zone (EEZ); Sjöterritoriets gräns – Territorial waters boarders; Viktigt tumlareområde sommar – Important areas for harbour porpoise, summer; Hänsynzon – Consideration areas.

Seals

The grey seal is the most common seal in Sweden and is mostly found in the Baltic Sea. There are estimated to be between 37,000 and 50,000 grey seals in the Baltic Sea. Areas with grey seals are found from the Falsterbo peninsula in Skåne to Haparanda in North Bothnia with the majority of grey seals being found in the archipelagos of Stockholm and Södermanland, though there are also large population in the Sea of Bothnia and North Kvarken as well as along the south coast. The grey seal is listed as of least concern according to the Swedish Red List. The greatest threat to grey seals is climate change which reduces the pack ice in the Baltic Sea, environmental pollutants and by-catch in commercial fishing (Isæus, Beltrán, Stensland Isæus, Öhman, & Andresson-Li, 2022). Based on the national environmental monitoring programme of seal colonies, the occurrence of seals in the project area is low(Havs- och vattenmyndigheten, 2018).

In 2019, the number of ringed seals was estimated as 22,000 animals (Havs- och vattenmyndigheten, 2019b) with most found in the Gulf of Bothnia. The ringed seal is considered of least concern in the Swedish Red List. Based on the national environmental monitoring programme of seal colonies, no ringed seals were found in the project area in 2018(Havs- och vattenmyndigheten, 2018).

Common seals are predominantly found along the west coast but also in the Baltic Sea, in the Kalmar Sound. The population in the Kalmar Sound is classed as vulnerable (VU) in the red list. In 2005, it was estimated to be maximum 477 animals. Based on the national environmental monitoring programme of seal colonies, no common seals are found in the project area(Havs- och vattenmyndigheten, 2018).

4.9.3 Fish

A variety of fresh and salt water fish species are found in the Baltic Sea. The number of fish species in the Baltic Sea is around 80(Baltic Eye, 2022). Cod, haddock, herring and sprats are among the species found in the Baltic Sea. One of the key species in the Baltic Sea is cod.

According to data from HELCOM, there is no cod spawning within the project area(HELCOM, 2021)and the occurrence of cod is considered to be low. The occurrence of spawning grounds for the most important species for commercial fishing within the project area is mostly considered to be low. However, there are small areas within the project area where the assessment is high (Havs- och vattenmyndigheten, 2018). The occurrence of herring and sprats within the project are is rather lower than cod and sprats are considered to spawn throughout the project area(HELCOM, 2021).

A survey of the occurrence of different fish species will be conducted together with the Environmental Impact Assessment, see Chapter0.

4.9.4 Birds

Various bird species are found in different marine areas in different ways during the year depending on whether they are overwintering, resting or foraging. There are often migration routes near the coast. The bird species found in the Baltic Sea during summer and/or winter can be divided into three groups based on the type of food they consume. The Baltic Sea's bird species can be broadly divided into three groups: those which live on plants in shallow water, those that feed on fish and other animals in the body of water and those which eat mussels and other seabed animals(Larsson, 2012). Fish-eating birds can in turn be divided into two groups: flying birds which look for and capture their food on or near to the surface such as terns and gulls, and those which mainly swim and deep dive for fish such as ducks, guillemots, skuas, dippers and cormorants. The bird types which mostly eat seabed plants are for example, eider, velvet scoter, common scoter and long-tailed ducks

Together with the project *Marina skyddsvärden runt Gotland och Öland* led by the Gotland County Administrative Board in 2018, the Administrative Board produced a report (Larsson, 2018)with the aim of summarising and interpreting the bird distribution and use of the offshore banks as well as sea and coastal areas around Gotland and Öland.

Several bird species use the sea areas around Gotland and Öland. The closest area surveyed in relation to the project area for Herkules is Hoburgs Bank. This area, together with the north and south Midsjöbankerna are the most important overwintering areas for the rapidly declining populations of long-tailed ducks but is also important for black guillemots(Larsson, 2018).

The project summary lists a number of areas which should be high priority for protection of long-tailed ducks and black guillemots. The project area doesn't cover any of these areas but they lie closer to the coast in shallower waters than the planned wind farm(Larsson, 2018).

The occurrence of overwintering sea birds within the planned project area is low(Havs- och vattenmyndigheten, 2018)and according to documents from HELCOM, no red list bird species are found in the project area.

A survey of the occurrence of birds will be conducted together with the Environmental Impact Assessment, see Chapter0.

4.9.5 Bats

19 different species of bat can be found in Sweden, of which 12 are red-listed(Artdatabanken, 2022). All of the 19 species are strictly protected and bat surveys are therefore required for all types of development which may have an impact. Sweden has a long tradition of mapping the occurrence of bats and development of wind power has increased knowledge of bats in the context of the surveys conducted(De Jong, Gyltje Blank, Ebenhard, & Ahlén, 2020). Several bat species are found on Gotland.

At sea, most bats fly at heights lower than 40 m and they like to use wind turbines as resting sites. Bats fly over sea only in relatively light winds, rarely at wind speeds above 10m/s. Most activity takes place at wind speeds below 5 m/s. However, it varies between species. Larger species tolerate stronger winds but all bats prefer light winds. In addition, very good weather is required for foraging at sea and intensive and prolonged foraging usually takes place in calm or very light winds when waves are insignificant or there is still water. These are the same conditions in which insects thrive in large quantities higher up around wind turbines (Ahlén, Bach, Baagø, & Pettersson, 2007).

A survey of the occurrence of bats will be conducted together with the Environmental Impact Assessment, see Chapter 0.

4.10 Fishing

Commercial fishing in Sweden takes place along the coast and also at sea. From this, fishing can be categorised into a number of groups including pelagic (species which live in the open sea) and demersal species(Bergenius, o.a., 2018). Since there is oxygen-free seabed in the project area (see Chapter4.6.3) the fishing in the area concerns pelagic fishing.

In recent years, Swedish fishing in the Baltic Sea has mostly been focused on herring and sprat (Havs- och vattenmyndigheten, 2022d).

There is no identified national interest for commercial fishing within the project area for Herkules. The nearest area identified is located approx 3 km from the project area's limit. Within the area, the presence of fishing vessels is restricted, as illustrated below in Figure 28 and Figure 29.

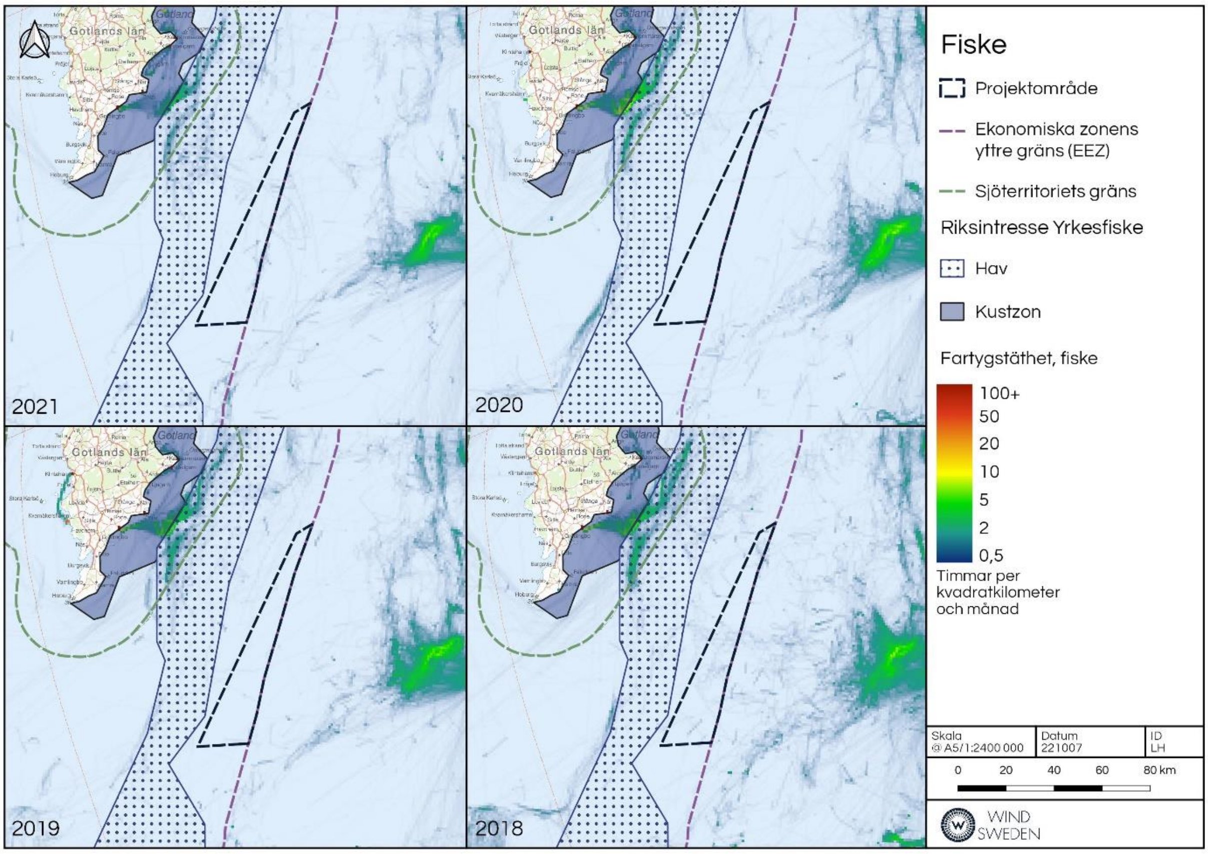

Figure 28. Vessel density for commercial fishing in the project area and vicinity 2018-2021 (EMODnet, 2022b). Projektområde – Project area; Ekonomiska zonens yttre gräns (EEZ) – Exclusive economic zone (EEZ); Sjöterritoriets gräns – Territorial waters boarders; Riksintresse Yrkesfiske – National interest for commercial fishing; Hav – Open sea; Kustzon – Coastline.

Some commercial fishing takes place in the project area mostly of pelagic fish with trawls, see Figure 29. The pelagic fishing takes place most of the year but species and locations vary depending on a variety of factors such as fish biology and migratory patterns (Swedish Pelagic Federation Producentorganisation, 2022). A consultation will take place regarding international fishing within the framework of the Espoo consultation.

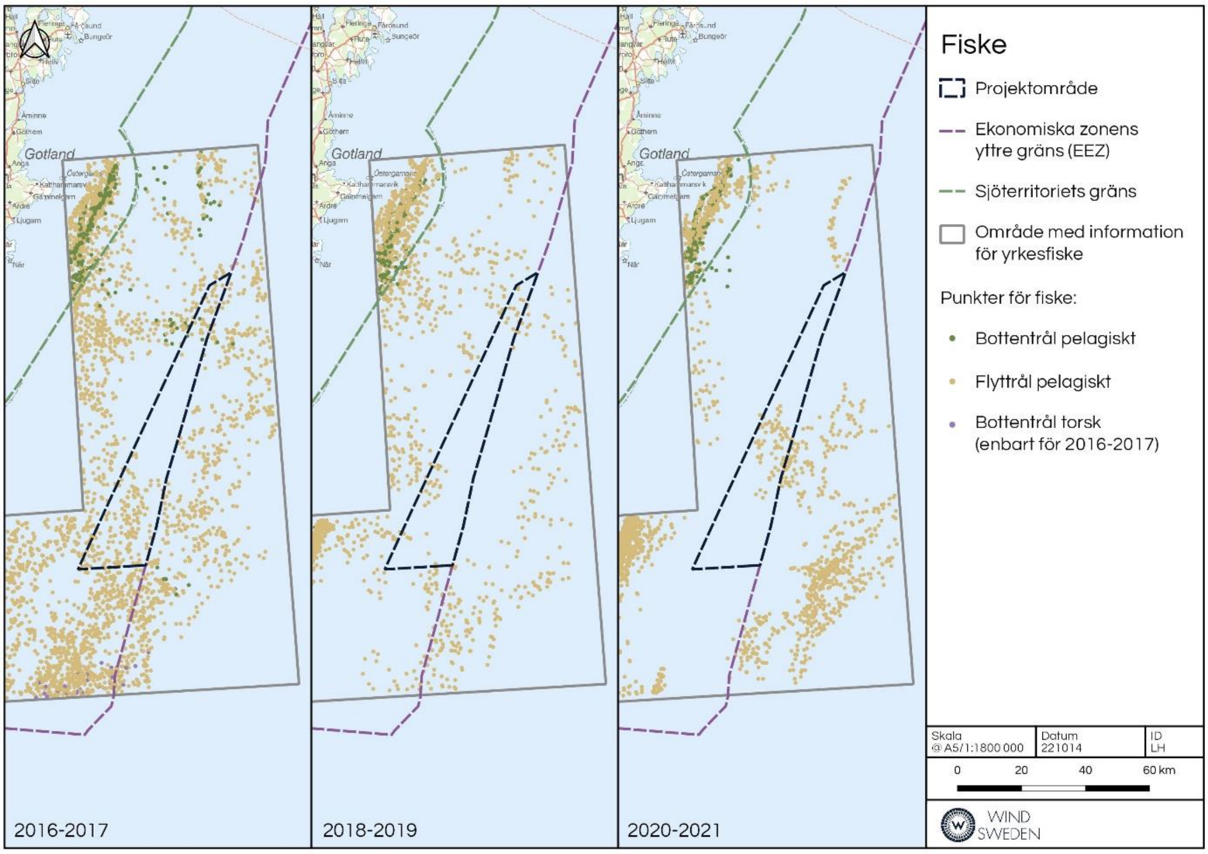

Figure 29. Location of Swedish fishing between 2016-2021(Havs och vattenmyndigheten, 2022e). Projektområde – Project area; Ekonomiska zonens yttre gräns (EEZ) – Exclusive economic zone (EEZ); Sjöterritoriets gräns – Territorial waters boarders; Punkter för fiske – Fishing points; Bottentrål pelagiskt – Pelagic bottom trawl; Flyttrål pelagisk – Pelagic floating trawl; Bottentrål torsk – Bottom trawl, cod.

4.11 Marine culture value

Section 2 Chapter 1 § p. 8 Cultural Environment Act (1988:950) states that shipwrecks constitute ancient monuments provided that the sinking occurred before 1850. A shipwreck from 1850 or later may be declared an ancient monument by the County Administrative Board if there are special reasons relating to its cultural and historical value(Riksantikvarieämbetet, 2014).

Swedish jurisdiction[10]can apply in the whole of the Swedish marine territory, i.e., in both the area known as inner waters and territorial waters. The law on Sweden’s marine territory (1966:374), states that territorial waters extend 12 nautical miles (M) i.e., around 22km from the baseline. Within this area the Cultural Environment Act applies in its entirety. In addition, the UN’s Convention on the Law of the Sea of 1982, gives coastal states the right to establish a so-called contiguous zone outside of the territorial waters. This zone, also calculated from the baseline, can be up to 24 m wide. The coastal states which have established such a zone have the right to protect archaeological and historical finds and remains found inside this limit. Such a zone was established in Sweden in 2017 (2017:1272), Law on the Swedish territorial waters and maritime zones.

[10]Jurisdiction or judicial power, to administer justice and to judge. The jurisdiction is limited to a geographic area or to certain people or a certain subject matter.

A search for known cultural-historical remains has been carried out in the Swedish National Heritage Board's database (Riksantikvarieämbetet, 2022), see Figure 30, which showed that there were no known remains within the project area.

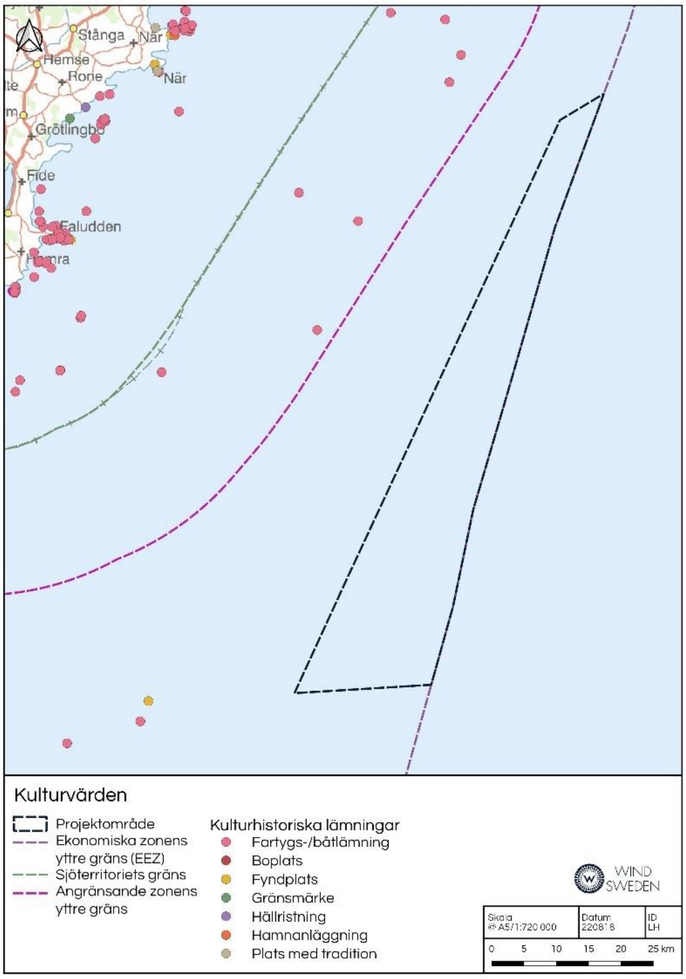

Figure 30. Cultural value within and near the project area. Projektområde – Project area; Ekonomiska zonens yttre gräns (EEZ) – Exclusive economic zone (EEZ); Sjöterritoriets gräns – Territorial waters boarders; Fartygs/båtlämning – Ship/boat abandonment; Boplats – Remains of the houses; Fyndplats – Remains.

Before a large area of the ocean or a sea ca be exploited, the affected seabeds are surveyed with regard to existing water depth, presence of flora and fauna, seabed conditions and more. Along with these surveys, a search for remains can also be conducted. The most suitable method is sonar mapping (Side Scan Sonar) from a boat. The County Administrative Board can decide that such a survey is required under the Law on Cultural Monuments (KML) but this can also be done within the framework of an Environmental Impact Assessment (EIA)(Riksantikvarieämbetet, 2017).

4.12 Outdoor recreation and leisure

An offshore wind farm may have a certain impact on outdoor recreation and leisure. The impact may consist on physical intrusion and encroachment on areas of high value for outdoor recreation and leisure. The farm also changes the landscape and a changed value of experience from the surrounding areas. How the value of experiences changes depends on the individual's opinion of offshore wind power and isn't always considered negatively.

The closest areas for active outdoor recreation include the whole of Gotland and the associated waters, see Figure 31. The national interest of outdoor recreation also exists along the mainland coast and encompasses all of Öland and the surrounding waters. The national interest of outdoor recreation also exists along the Gotland and Öland coastline as well as the mainland coast, see Figure 31.

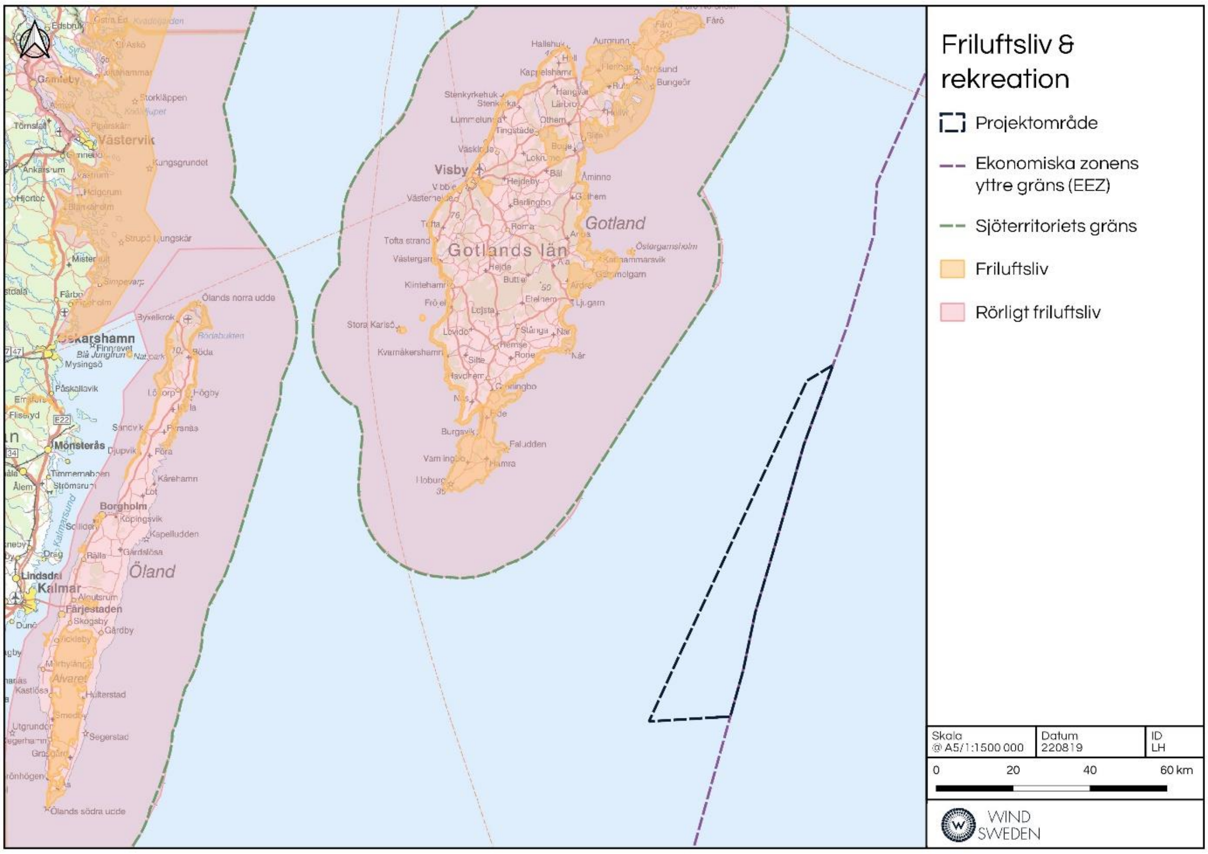

Figure 31. Overview of the national interest for outdoor recreation and activities. Projektområde – Project area; Ekonomiska zonens yttre gräns (EEZ) – Exclusive economic zone (EEZ); Sjöteritoriets gräns – Territorial waters boarders.

4.13 Mines and dumped ammunition

Mines, ammunition and chemical weapons can be found in the Baltic Sea, and it may have the highest concentrations of these in any of the world's seas. Most of the munitions are from the period during and after the World Wars(Transportstyrelsen, 2022).

Within the Herkules project area there are no known munitions, see Figure 32. The adjacent area to the south of the project area is identified as an area where chemical weaponry was dumped.

To investigate any un-detonated ammunition and mines (UXO) on the seabed within the affected area for Herkules, inventories will be carried out. These results will be used to ensure appropriate preventa-tive measures are taken before design and construction work begins.

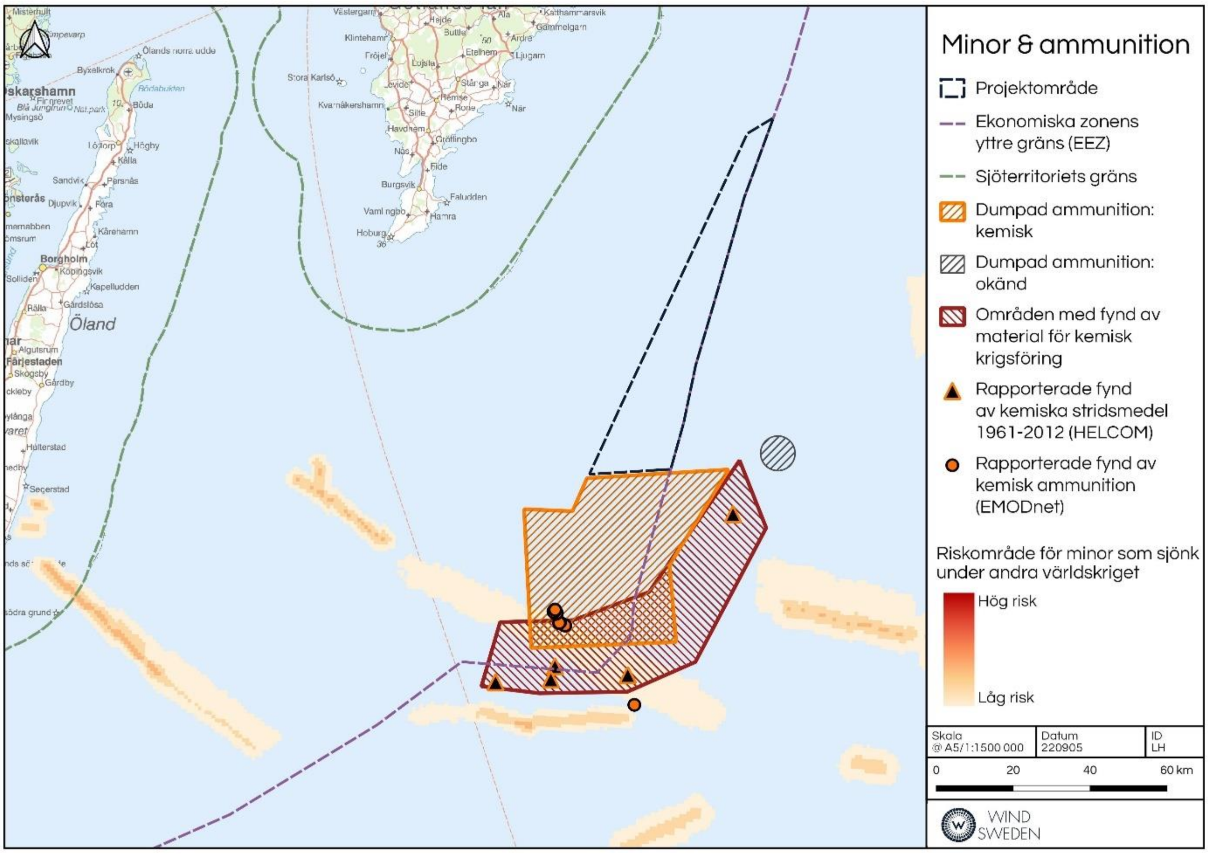

Figure 32. Overview of the area with risk of mines and dumped ammunition. Projektområde – Project area; Ekonomiska zonens yttre gräns (EEZ) – Exclusive economic zone (EEZ); Sjöterritoriets gräns – Territorial waters boarders; Dumpad ammunition, kemisk – Dumped chemical ammunition; Dumpad ammunition, okänd – Unknown dumped ammunition; Områden med fynd av material för kemisk krigföring – Areas of chemical warfare material finds; Rapporterade fynd av kemiska stridsmedel 1961 – 2012 – Reported finds of chemical warfare agents 1961 – 2012; Rapporterade fynd av kemiska ammunition – Reported finds of chemical munitions; Riskområde för minor som sjönk under andra världskriget – Risk area for mines sunk during the IIWW.

4.14 Landscape

Due to their size and constant movement of the rotor bales, wind turbines have a visually dominant impact on the landscape. Developments are towards even taller wind turbines which are visible across a wide area. Wind farm developments change the landscape and affect people's experiences of their surroundings and local identity. Certain landscapes may be especially sensitive to wind power, while wind turbines may add value to other landscapes (Boverket, 2009). The planned wind power development Herkules will involve the landscape changes from an undisturbed horizon to a horizon with a man-made development.

The experience of the landscape is largely subjective, driven by individual experiences, knowledge, attitude and use of the landscape. Visualisation is an important part of determining the impact on the landscape in the forthcoming EIA.

4.14.1 Obstruction marking

Aviation Obstruction Lighting

The wind turbines will be fitted with obstruction markings in accordance with the Swedish Transport Agency's regulations and general guidance on marking objects which may pose a danger to aviation, currently TSFS 2020:88. Current regulations include the following: A wind turbine over 150 m above land or sea level (including rotors) must be painted white and equipped with a high intensity white flashing light at the top of the motor housing (nacelle). If the nacelle is over 150 m above sea level, the tower must also be marked with at least three low intensity lights from half way up to the nacelle. In a wind farm, the wind turbines at the edge of the farm must be marked as above as a minimum. Other wind turbines within the wind farm will be painted white and as a minimum equipped with low intensity lights on the turbine's highest fixed point.

The white lights must be illuminated to maximum strength during daytime. During this time the maximum intensity for the high intensity lights is 100,000 candela (cd). At dusk the light strength can be reduced to 20,000 cd and during hours of darkness, the regulations permit a reduction to 2,000 cd i.e., 2% of the daytime light intensity.

Marine Obstruction Lighting

Offshore wind turbines must be equipped with maritime safety devices, such as obstruction lights. This is in accordance with international recommendations from the marine organisation *International Association of Marine Aids to Navigation and Lighthouse Authorities* (IALA), *Guideline -G1162*. In addition, this is regulated at a national level in *Transportstyrelsens föreskrifter och allmänna råd om utmärkning till sjöss med sjösäkerhetsanordningar (SSA)*, TSFS 2017:66.

The wind farms design, size and location will determine which type and how many safety devices are required. Markings are categorised in two groups, *Significant Peripheral Structures* (SPS) and *Intermediate Peripheral Structures* (IPS). These markings are placed on the wind turbine tower, usually 6-15 m above surface level.

For the example design for the project, an obstruction lighting analysis has been conducted to see how obstruction lighting looks for aviation and marine traffic since this impacts how the development will be experienced, see Figure 33.

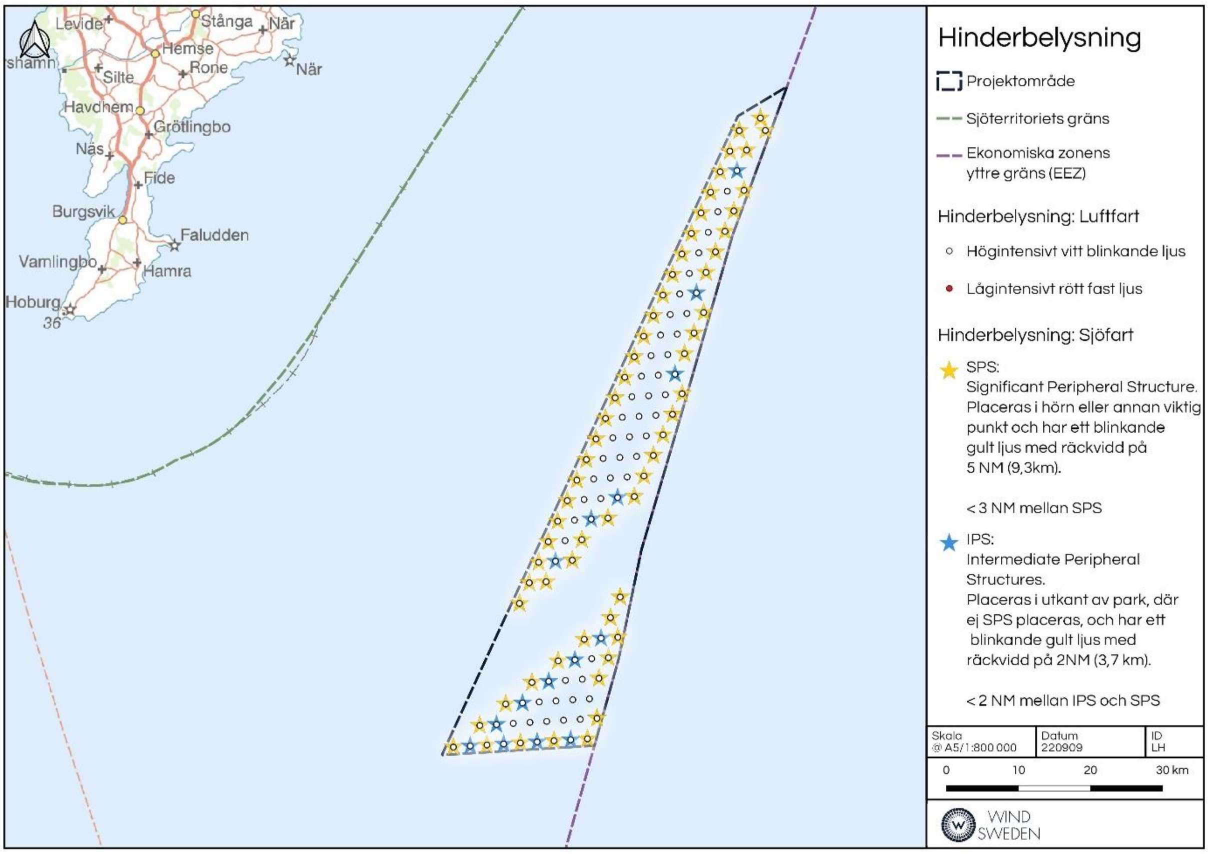

Figure 33. Proposals for how the obstruction lighting may look for the example design with 121 turbines for both aviation and marine traffic. Projektområde – Project area; Ekonomiska zonens yttre gräns (EEZ) – Exclusive economic zone (EEZ); Sjöterritoriets gräns – Territorial waters boarders; Hinderbelysning: Luftfart – Obstacle lighting: Aviation; High intensity white flashing light; Lågintensivt rött fast ljus - Low-intensity red solid light.

4.14.2 Visibility

The visibility of the example design of Herkules has been analysed with the aid of a sightline analysis. This analysis shows the theoretical distance from which the wind turbines can be seen from the sea surface before they disappear under the horizon due to the curvature of the earth. Figure 34 shows how far it is theoretically possible to see the tops of the blades in their highest position (the blue and purple lines) as well as the obstruction lighting for aviation (at hub height, orange line) at the sea surface in perfect visibility considering the curvature of the earth. The blue line shows the maximum total height which is envisaged for the project (360m) and the purple and orange line show how it theoretically appears based on the dimensions of the example design.

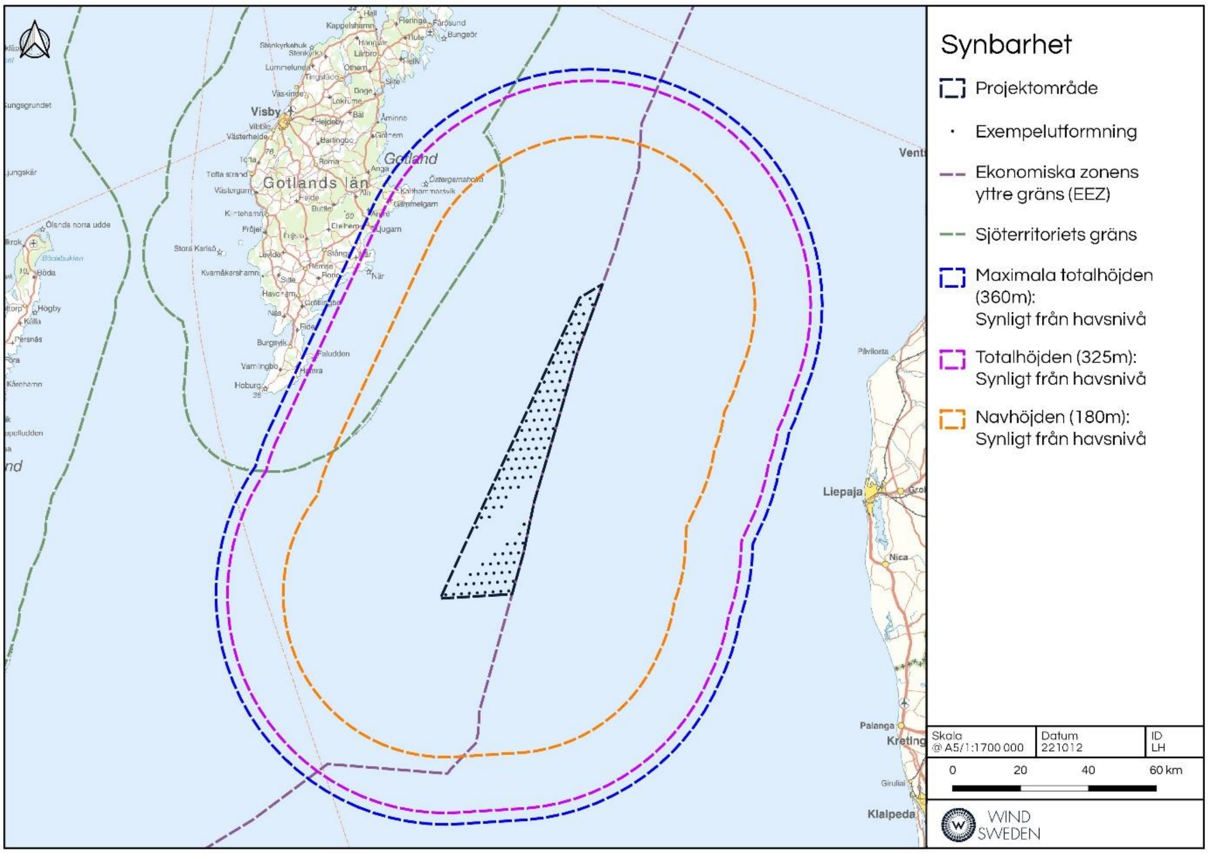

Figure 34. The lines show the distance the wind turbines are still visible from the sea surface for the example design (Chapter 3.2.1). The blue and purple lines show from how far away the top of the blades in their highest position are visible and the orange line shows from how far away the obstruction lighting is visible from the sea surface for aviation (hub height). Projektområde – Project area; Ekonomiska zonens yttre gräns (EEZ) – Exclusive economic zone (EEZ); Sjöterritoriets gräns – Territorial waters boarders.

5 IMPACT FACTORS

The environmental impact and individual and public interest differ across the three project phases: construction phase, operation phase and decommissioning phase, in terms of both scope and time, see Table 11. Some of the impact factors are not relevant to all parts of the project phases. These impact factors can, in turn, lead to the impact and environmental effects reviewed in Chapter 0below.

An important aspect when looking at the impact of an activity is the duration of the impact and severity of the specific impact for the respective species' population. An impact for a long period of time, for example 30-40 years of operation, is considered more significant for population development than a temporary impact for 1-2 years unless the latter is very large (Isæus, Beltrán, Stensland Isæus, Öhman, & Andresson-Li, 2022).

*Table 11. Impact factors in the three project phases Large **X**: high impact, small x: low impact, no x: no impact.*

Impact factors	Construction phase	Operational phase	Decommissioning phase
WIND FARM, MEASURING STATIONS, OSS AND INTERNAL CABLE NETWORK			
Sound (underwater sound, operational sound, noise)	X	x	X
Turbidity	X	x	X
Landscape	x	X	x
Increase traffic (vessels)	X	x	X
Collision risk	x	X	x
Habitat loss	x	x	x
New habitats	x	X	
Electromagnetic field	x	X	
Climate (emissions to the air)	X	x	X
Shadows		X	

*Table12 Possible impact factors of downstream activities for the three project phases for export cable. Large **X**: high impact, small x: low impact, no x: no impact.*

Impact factors	Construction phase	Operational phase	Decommissioning phase
ACCOMPANYING ACTIVITIES - EXPORT CABLE			
Sound (underwater sound, operational sound, noise)	x		x
Turbidity	X		X
Increase traffic (vessels)	X		X
Habitat loss	x	x	x
New habitats	x	X	
Electromagnetic field		X	
Climate (emissions to the air)	x		x

5.1 Sound, underwater sound, operational sound, noise

During the three project phases, different types of noise will occur but the greatest impact of noise will be in the construction phase. The groups of species most impacted by the predominantly high intensity submarine noise are fish and marine mammals (Vindval, 2022). The vessels used during all three phases for construction, operation and decommissioning also emit noise.

Noise is also emitted by the site surveys conducted during the planning phase as surveys and data collection are conducted to apply for and receive the required permits and to identify the final design of the wind farm.

In the construction phase, anchoring the floating foundations and substations emits noise as well as the construction of the internal cable network. The scope of the noise depends on the final choice of anchoring method.

In the operational phase, the wind turbines emit a swishing noise created when the rotor blades cut through the air. The scope of the noise depends on the rotor blades' size and design, the rotation speed and the surrounding wind conditions. The motor housing itself also emits a sound. The wind turbine's rotation also gives rise to a low frequency noise which is the consequence of vibrations in the tower or noise from the motor housing. The noise varied with the wind speed.

In the decommissioning phase, the scope of the noise emitted is similar to the construction phase.

5.2 Turbidity

Due to the anchoring of foundations and substations, installation of cables and decommissioning of the wind farm, some disturbance of sediment can occur. The scope of the turbidity depends on the choice of anchoring method, type of seabed substrate, salinity, water temperature and the areas currents(Naturvårdsverket, 2009).

In the operational phase, the chains anchoring the wind turbines may cause some disturbance and distribution of sediment. The scope of turbidity in the operational phase depends on changes in water conditions and anchoring method.

The effect of turbidity is also related to the occurrence of any pollutants in the seabed sediment.

5.3 Landscape

In the construction and decommissioning phases, vessels will be seen in the wind farm area, as well as the transport route used to transport to and from the shore. In the operational phase, the wind turbines will visibly change the landscape, which varies with the total height of the wind turbines and the distance from the beholder to the various turbines.

5.4 Increased shipping

There will be increased shipping during the three different phases. The increase will be greatest during the construction and decommissioning phases. In the operational phase, service vessels will travel between land and the wind farm.

5.5 Collision risk

The wind farm and its substations and wind turbines create a collision risk for vessels, birds and bats.

5.6 Habitat loss

Some habitat loss will occur in the construction and decommissioning phases. Habitat loss on the seabed will be both temporary and permanent. The extent of this depends on the anchoring method and choice of method for laying cables.

Above the water surface there may be some habitat loss for birds. The extent of this depends on which species are found in and around the project area.

5.7 New habitats

New habitats will arise within the wind farm in the operational phase in the form of hard surfaces. These new habitats consist of the anchorages fixing the wind turbines to the seabed, cable protection on the seabed, substations and the wind turbine floating foundations.

5.8 Electromagnetic field

In the operational phase an electromagnetic field will be created by the internal cable network. The electromagnetic field is formed by the generation and transmission of electricity. The electromagnetic impact decreases with distance from the cables.

5.9 Climate, emissions to the air

During all three phases there will be increased emissions to the air from the vessels and machines used. The greatest increase will be in the construction and decommissioning phase as many work boats and machines will be used. The amount of emissions can be regulated through choice of fuel.

In operation, the wind farm will contribute to renewable and emission-free electricity which will replace other electricity produced from fossil fuels.

5.10 Shadows

In the operational phase there will be both fixed and mobile shadows from the wind turbine's tower and rotor blade. The scope of the shadows depends on the position of the sun in relation to the wind turbine and varies throughout the day. The scope of the shadow also depends on the weather and is lower when it is cloudy. The intensity of the shadow is reduced with distance from the tower. At most, the shadows will penetrate to a depth corresponding to the photic zone, i.e., the depth to which sunlight penetrates below the surface, approx 30m.

6 PROTECTIVE MEASURES

In all three phases of establishing an offshore wind farm disturbances and impacts on the surrounding area can arise. The impact can be both direct and indirect and varies in nature and scope depending on the phase of the development. The conditions in the relevant area also determine the scope of environmental impact(Havs- och Vattenmyndigheten, 2022c).

During the introductory work in the authorisation process for an offshore wind farm a comprehensive location survey is conducted with the aim of finding the optimal site for the development. The location survey takes into consideration to conflicting interests and existing natural values as well as the presence of sensitive species. This survey is a protective measure in itself, since it considers the environmental sensitivity on the basis of existing evidence.

In addition, different technical solutions regarding choice of foundation and construction methods result in different scopes of environmental impact.

In order to reduce the negative impact, a number of protective methods and precautions can be used. This may involve technical solutions or regulating the time of year or day when certain types of work can be carried out.

To reduce the negative impact on fish spawning, sensitive periods of time can be avoided and the same can be done to adapt the time of the work to porpoise mating and calving periods. Times when certain work can be conducted can be regulated in the conditions of authorisation.

In the event the construction period causes extensive underwater noise, noise protecting methods can be used in the form of bubble curtains or *hydro sound dampers* (HSD) or a combination of these. A so-called *ramp up* can also be used, where the pile driving intensity is gradually increased allowing fish and porpoises to the opportunity to leave the area before the noise increases (Naturvårdsverket, 2012).

Sediment dispersal can occur with anchoring and decommissioning of the floating foundations. Sediment dispersal depends on the mooring method as well as the character of the seabed and presence of any environmental pollutants. Sediment dispersal can also occur due to the laying and removal of the external cable network. Sediment dispersal shouldn't occur in the important fish breeding areas in breeding season. Should there be a risk of comprehensive turbidity there are methods to reduce the dispersal.

Use of vessels in the construction phase can be planned in such a way that the number of transports is reduced and thus minimised.

The applications for establishing the Herkules wind farm will include proposals for appropriate protective measure adapted to the scope and conditions of the activity seeking authorisation.

Following receipt of authorisation, a control program will be established and conducted to facilitate the final design of measures to reduce the negative impact on the environment.

7 POTENTIAL ENVIRONMENTAL IMPACTS.

Impact and environmental effects occur in the three different phases of establishing a wind farm. The scope of the impact differs between the three phases in terms of time and space. The scope of environmental effects also depends on the choice of technical solutions, protective measures and working methods for mooring and construction.

The planned wind farm will be constructed in the deeper parts of the Baltic Sea with oxygen-poor seabeds and both flora and fauna are generally poorer in deep environments than shallow. Marine species which live in the deep hard seabeds are especially lacking in the Baltic Sea due to the low salt content. According to the report *Ekologisk hållbar vindkraft i Östersjön,* it is good from a sustainability perspective that wind farms tend to be built in areas with deep water as a wind farm sited in a deep area causes less disturbance to the benthic environment. The report also includes an assessment of the oxygen-free areas which are the most suitable locations to build floating wind power in the Baltic Sea from an environmental perspective(Isæus, Beltrán, Stensland Isæus, C Öhman, & Andresson-Li, 2022).

Below is an overview of the impact on various interests as initially assessed based on existing information. Under the relevant heading, only those factors are described that are initially considered to have a potential impact on the respective interest, others are omitted. The impact of the activity will be investigated within the framework of the forthcoming EIA and a more thorough description and assessment of the environmental effects will also be conducted within this. The statement below includes the different technical alternatives being investigated for consideration. The forthcoming environmental impact assessment will be based on a worst-case scenario for each technical alternative investigated.

The environmental effect of accompanying activities and the export cable are difficult to assess currently, since the placement, dimensions and laying method are not yet determined. A cable will be laid on or in the seabed and may have some environmental impact, mostly for a limited time during the construction phase. The marine environment may be affected by the dispersal of sediment and in some cases there may be a risk of environmental pollutants being released. Where an assessment can be made, from existing knowledge and experience, this is described under the relevant heading below.

7.1 National interest

There is no national interest within the project area for Herkules. The national interest for shipping lanes borders the eastern limit of the project area and a national interest for commercial fishing is found close to the project area. These are initially assessed as not being impacted by the development.

There is not considered to be an impact on the possibility fo exercising the national interest for outdoor recreation covering Gotland and its surrounding waters as a result of the planned wind farm Herkules. However, the area's landscape value should be highlighted in the forthcoming landscape analysis.

The national interest for cultural heritage on land is not considered to be impacted by the establishment of the wind farm Herkules since the visibility from land will be extremely limited.

7.2 Protected areas

The outer limit of the project area for Herkules lies approx 22 km from the edge of the Natura 2000 area Hoburgs bank and Midsjöbankarna. Wind Sweden makes the assessment that the planned wind farm

Herkules will not cause any significant impact to the environment in the Natura 2000 area, nor according to the points below. This is due to the large distance, which means that no Natura 2000 authorisation is required.

- High noise which can cause strong behavioural reactions or temporary/permanent hearing damage in porpoises.
- Continual noise which disturbs porpoises, such as from construction work, increased marine traffic which generates noise.
- Increased vessel traffic and routes which cross important overwintering areas, foraging of breeding areas for porpoises, long-tailed ducks and black guillemots.
- Offshore wind farms which create avoidance effects on long-tailed ducks during the operational phase.
- Cable laying, such as for connecting offshore wind power, which can damage reefs and sandbanks.

7.3 Natural environment

7.3.1 Demersal plants and animals

The project area is found within a deep area, below the photic zone and also in an area consisting of oxygen-poor seabeds. This creates poor conditions for rich biological seabed life. The seabeds predominantly consist of clay of different hardness. The depth of visibility is limited and the penetration of the sun to the seabed is zero due to the depth of the project area.

Some physical disturbance may arise during the construction phase due to the turbine and substation mooring work and cable laying. The disturbance consists of turbidity, noise and the impact on the seabed substrate. Turbidity may arise in the construction phase and can spread to a limited area around the substations, anchors and cables. An impact on the immediate vicinity may also be seen through some coverage of seabeds in connection with mooring and cable laying as well as construction of substations. The impact on the different existing species depends on their normal exposure to turbidity. After construction, the seabeds will be recolonised relatively comprehensively, as any coverage is judged to be limited(Sveriges Lantbruksuniversitet, 2020). Some disturbance of seabed-living animals may occur due to the noise of construction works.

In the operational phase, hard surfaces from the different parts of the wind farm can lead to the establishment of species which live on hard seabeds. The low frequency noise emitted during the operational phase is not judged to have a negative impact on seabed life(Vindval, 2022). The impact of the electromagnetic field from cables, is judged to be non-existent during the operational phase. According to existing studies, there is no evidence that this magnetic field should have a negative impact on organisms at population level(Vindval, 2022).

In the decommissioning phase, physical disturbances will arise corresponding to those in the construction phase.

A final assessment of the impact on seabed plants and animals in the different phases will be conducted following the forthcoming investigations and EIA.

The methodology for laying export cables is still unclear but the cables will need to be laid either on or in the seabed which will cause turbidity. The extent of the turbidity and how far the particles spread depends on the actual seabed substrate, current conditions and the choice of laying method. The smaller the particles on the seabed, such as clay, the greater the turbidity. Smaller particles spread further than the is the same measure is carried out on a sand or stone seabed. The size of the particles determines the length of time before they settle on the seabed again and therefore the spread and thickness of the subsequent sediment deposits. Some coverage of the seabed may also occur. New habitats may arise if the cable is laid on the seabed and protected with stones or blocks.

7.3.2 Marine mammals

In the construction phase, along with the arising high noise, there may be a risk of negative impacts on porpoises and seals. Sudden, high noises can lead to behavioural changes and hearing damage should the animals be in the vicinity of the construction area. If protective measures are taken and particular attention is paid to important times of year for porpoises, these negative risks can be avoided.

In the operational phase, the wind farm can have a positive effect on seals and porpoises where the establishment leads to a greater occurrence of hard seabed species and fish, The noise emitted during operation does not appear to adversely affect either seals or porpoises(Vindval, 2022). Altogether the impact during the operational phase is judged as low (Isæus, Beltrán, Stensland Isæus, Öhman, & Andresson-Li, 2022).

In the decommissioning phase, the effects are judged to correspond to those during the construction phase.

A final assessment of the impact on marine mammals in the different phases will be conducted following the forthcoming investigations and EIA.

The export cable will be laid by a cable laying vessel which will generate noise from the vessel and the equipment used for laying on the seabed. As cable laying is judged to be quite quick and the total time the vessel will be in a specific area is limited, the impact from noise related to the presence of vessels is initially judged to be low.

7.3.3 Fish

In the construction phase, underwater noise will arise due to the laying of cables and mooring foundations and construction of substations. The size of the disturbance depends on which mooring and construction methods are chosen. Increased presence of boats and work vessels will also generate noise. This noise may cause escape responses in fish(Vindval, 2012). Fish may also be negatively impacted by turbidity and the suspended material which occurs with work on soft seabeds. The size of the disturbance depends on the nature of the seabed, current speeds, mooring and construction methods, protective measures and the amount and species of fish present in the area at the time. Which time of the year work is carried out is also a decisive factor in the impact on fish.

The noise emitted by the wind turbines in the operational phase arises when the rotors spin. This noise does not appear to adversely affect fish to the extent that it would inhibit fish behaviour (Vindval, 2022). If more species of hard seabed species arise on the structures of the wind farm, this could lead to a positive impact on fish. Studies of cod show that their presence increases near wind farms which is probably due to the increased availability of food and possibly protection. Regulation of commercial fishing often occurs with the establishment of wind farms which also brings about areas of sea where fish are protected from commercial fishing. During the operational phase, no significant negative impact on fish is expected as the effects of the addition of artificial facilities bring about several positive effects. Studies around Lillgrund wind farm showed that the site attracted fish to the area and that any negative effects of the cables and noise was insignificant(Bergström, Sundqvist, & Bergström, 2012). It is noted, however, that these results were based on a wind farm with fixed seabed foundations.

During the decommissioning phase, an impact corresponding to that in the construction phase may arise.

A final assessment of the impact on fish in the different phases will be conducted following the forthcoming investigations and EIA.

The impact factors on fish from the export cable may arise in connection with laying as turbidity and noise may arise. In relation to the operational phase, the main impact is the generation of electromagnetic fields in the vicinity of the cables. An electromagnetic field is generated around the export cable as it is around the internal cable network.

7.3.4 Birds

The impact on birds in the construction phase is considered to be low. In relation to the wind farm's total life span, the period of time is relatively short. However, consideration must be paid to birds during the important breeding season.

During the operational phase, the establishment of an offshore wind farm can cause a loss of habitat and displacement of birds. The farm's presence can also cause barrier effects for migratory and foraging birds. When birds have to detour around wind farms, there is greater energy loss. Offshore wind farms can also create a collision risk for birds if they fly too close to the rotor blade(Isæus, Beltrán, Stensland Isæus, Öhman, & Andresson-Li, 2022).

The impact on birds in the decommissioning phase is judged to correspond to that of the construction phase.

A study of the presence of birds will be carried out within the framework of the forthcoming EIA.

7.3.5 Bats

If there are migrating or hunting bats in the project area, they may be affected by the establishment of a wind farm.

To determine the impact on bats which may occur during the three different project phases, a survey of the presence of bats will be conducted within the framework of the forthcoming EIA.

7.4 Fishing

The project area does not include any identified national interest for commercial fishing and the nearest identified area for this is situation approx 3 km west of the project areas outer limit. According to known information about the area, even the presence of fishing vessels is limited, see Figure 28.

During the construction and decommissioning phase, the accessibility of the area for fishing will be limited.

Any pelagic fishing currently carried out in the project area may need to be restricted during the operational phase in the area where turbines, substations and moorings will be located. Since pelagic fishing and angling do not impact the seabed cables, some fishing can continue to take place within the project area.

Based on currently available information, the impact on commercial fishing will not be significant. Through dialogue with commercial fishing during the consultation process, the impact on commercial fishing will be further investigated for the different phases of the project.

The export cable will be laid either on or in the seabed and thus protected from the impact of commercial fishing. Depending on the fishing methods used within the area of the export cable, some impact on commercial fishing may arise within a very limited area.

7.5 Marine culture value

In connection with the forthcoming investigations ahead of the EIA, a marine archaeological survey will be conducted. If this survey reveals the presence of remains this will be handled according to current legislation, alternatively these areas will be exempted from any establishment which may adversely affect the marine cultural value.

For the export cable, a similar study as for the wind farm will be conducted.

7.6 Outdoor recreation and leisure

In the construction phase, some impact may arise due to the transports to the project area. The amount of vessel traffic will increase and disturbance from that will depend on the time of year. In general, there is more vessel traffic at sea due to outdoor recreation and increased boating activities. During the construction phase there may be barriers and safety distances preventing recreational boats from visiting the area.

In the operational phase the wind farm will be accessible to visitors in recreational boats. However, Herkules is located in an area of little recreational boating activity since it is a long way from the coast and the impact during the operational phase on outdoor recreation is therefore judged to be low or insignificant.

During the decommissioning phase, an impact corresponding to that in the construction phase may arise.

7.7 Mines and dumped ammunition

There is currently no known ordnance within the project boundaries. However, the project s adjacent to an area where dumped chemical weapons have been found. There is an increased likelihood of finding ordnance within the project area as the dumped material doesn’t always remain inside the identified area. Chemical weapons can consist of mustard gas and arsenic which may begin to leak and contaminate the water and seabed sediment.

To assess the actual impact of ordnance on the surroundings in planning, a survey of the presence of ordnance will be conducted within the framework of the forthcoming EIA.

7.8 Landscape

Experience of the landscape is largely subjective, driven by individual experiences, knowledge, attitude and use of the landscape. The lie of sight analysis presented in Figure 34 shows the theoretical visibility at sea level with respect to obstruction lighting and the highest point of the rotor blades. Obstruction lighting on the surface will not be visible on Gotland. However, the tips of the turbine blades will be visible from certain locations along the south east coast of Gotland.

The planned wind power development Herkules will involve the landscape changes from an undisturbed horizon to a horizon with a mobile man-made development. Of course, visibility will be high for recreational boats passing close to the wind farm.

Visualisation and animations are an important part of determining the impact on the landscape in the forthcoming EIA.

7.9 Cumulative effects

Cumulative effects means those effects which arise when the impact from several sources interact with each other. For the assessment of cumulative effects, already licensed activities within and around the project area as well as the wind farm's accompanying activities are included. Licensed and current activities include shipping, wind power and commercial fishing. The current environmental status of the represented or surrounding body of water will also be included in the assessment.

Which phase of the project other wind power projects in the vicinity are at is also of importance in assessing the cumulative effects, as well as when the accompanying activities will be carried out in relation to the construction of the wind farm. If two close farms carry out turbidity and/or noise creating work in the construction or decommissioning phase at the same time, the cumulative effects will be greater than if they are at different phases of their respective projects. Currently, with the existing information available, the cumulative effect of other wind farms is very limited due to the large distances. As far as is reasonable based on the phase of the projects, the cumulative effects of planned wind power projects in the vicinity will be assessed in the forthcoming EIA.

Preventative protective measures reduce the risk of extensive cumulative effects. Even the soundscape can be affected if there are two close wind farms which must also be included in the assessment.

The cumulative effects on fish, birds and commercial fishing during the operational phase will be surveyed in the forthcoming surveys and investigations conducted in connection with the EIA.

Cumulative effects with regards the export cable will be considered in the forthcoming EIA.

8 PLANNED INVESTIGATIONS

Comprehensive investigations and surveys will be conducted to establish the evidence required to complete an EIA for the project. The investigations and surveys currently planned are described below.

8.1 Seabed investigations

Seabed investigations will be conducted for the project area. The aim is to gather information on the conditions for establishing a wind farm in the area. The evidence will then be used to determine the design of the wind farm and what is appropriate for the area.

In addition, the evidence will be used to determine the topography and sediment conditions of the seabed. Sediment samples can be taken to establish the grain size, composition and oxygen content of the seabed in order to map out the area. This can then be used to assess the conditions for seabed vegetation and fauna. The survey will also form the basis of a survey of the marine archaeology and any presence of ordnance.

8.2 Natural environment

To map the natural environment within the project area, investigations of seabed flora and fauna, fish and invertebrates, marine mammals, birds and bats must be conducted. With the aid of this information, an assessment can then be made of the possibility of life and any risk of spreading environmental hazardous substances.

8.3 Cultural heritage

To map remains within the project area, marine geological surveys must be conducted. Evidence from the geophysical investigations can also be used as evidence for this survey.

8.4 Other surveys

Other surveys and investigations which may be relevant are listed below:

- Noise survey
- Fishing survey (Commercial fishing)
- Aviation risk analysis
- Marine traffic risk analysis
- Landscape analysis
- Natura 2000 survey
- Survey of any cumulative effects
- Survey of the impact of environmental quality standards
- Visualisations and animations
- Meteorological investigation
- Investigate the water quality in the area (lack of oxygen in the area?)
- Survey of presence of remaining ordnance, UXO, in the area
- Current modelling and distribution calculations
- Weather measurements, including wind and waves

9 RISKS AND SAFETY

There are risks in establishing a large-scale offshore wind-farm which involve high safety requirements. Safety is therefore prioritised across all phases. The different risks which can arise can be categorised into different groups such as risk to human health and environmental risk.

Risk to human health can occur in connection to work which emits high noise, handling electrical equipment or heavy lifting. The environmental risks which can occur include the negative impact which can arise from establishing an offshore wind farm. This can include oil or other chemical release, distribution of seabed sediment and high levels of submarine noise which can impact marine life. In addition to these risks, the project area will be investigated for ammunition and other ordnance which may cause a specific risk. This will be mapped in the geophysical investigations.

Risks related to the location of the area with regards to shipping may arise.

10 LOCAL BENEFIT

10.1 Socio-economic benefits

The benefit of wind power is about much more than just energy and the environment. There is the possibility of positive effects both within business and civil society. For example, the socio-economic benefit in the form of employment opportunities, high levels of education and the resulting increased attractiveness. Therefore, it is important that decision makers see the whole picture and have the opportunity to evaluate all the benefits which can arise in relation to intrusion and protective measures. The cost-benefit balance for different target groups/bodies is an important aspect to consider in decision making.

10.1.1 Employment

Employment may be created within the wind power branch from two main areas. Construction of wind power strengthens the manufacturing industry and creates jobs. Interaction between the different parts, for example by sharing skills between companies, is strengthened if the domestic wind power market develops well. Offshore wind power has been shown to be more labour intensive than onshore wind power. This applies throughout the life cycle i.e., planning construction, installation and operation and maintenance. In addition to increased demand for goods and services within the region of the wind power development, this creates a direct increase in the number of employment opportunities.

10.1.2 Technical learning

Supporting offshore wind power creates a positive dissemination of technical learning. As the market for offshore wind is international, the knowledge gained by constructing offshore wind farms can be shared between and within countries. On a global level, Sweden can help other countries to reduce their emissions by sharing knowledge on renewable electricity production. In the long term as market players learn more about the technology, costs also decrease which in turn contributes to greater socio-economic stability.

10.1.3 Infrastructure

Often, infrastructure is expanded and improved in areas where wind power is established. New roads, port expansion, electricity grid and fibre arranged in conjunction with the development bring positive external effect such as increased communication and transport opportunities in the local community(Blom, Eriksson, Hillman, & Zandén Kjellén, 2020).

10.1.4 Calculations

The socio-economic calculation is based on a wind farm close to shore with a total of 50 wind turbines and an output of 10MW.

Planning phase

A positive annual financial contribution is made to the local and regional community as a whole, a large share of which is also passed onto the state. At the local level, this depends on how many people live in the municipality (tax base) during the planning phase. If planning takes seven years, this would give an overall effect of around 43 Mkr in total and approx 10.8 Mkr to the local community. The annual overall employment effect during planning in the report’s calculations is 14 full time jobs when direct and indirect jobs are included.

Construction

The opportunities for the local community to benefit from revenue during construction are, in our view, significant as ‘accompanying works’ covered by the supplier’s commitment must take place on site and should be deliverable by existing and start-up businesses - such as electrical work, security and, not least, continual boat servicing. If preliminary work/construction were to last three years, this would have a total impact of just over 100 million SEK, of which just over 25 million SEK would be directed to the local community. The annual overall employment effect during preliminary work in the report’s calculations is 95 full time jobs when direct and indirect jobs are included.

Operation and maintenance

As the facilities for operation and maintenance must be nearby to be able to implement measure quickly while maintaining continuous service, the opportunity for the local community to benefit from the social values created is very large. Several sources expect as much as 90 % of the total value for operation and maintenance to benefit the local area. This means that people affected probably live in the local community, that the boat service is always accessible, that monitoring is continuous. The annual overall employment effect with regards operation and maintenance is calculated as 62 full time jobs when direct and indirect jobs are included(IUC Sverige AB, 2020).

11 SCHEDULE

Consultation will be conducted between autumn 2022 and spring 2023. After that the investigations and surveys which will form the basis of the environmental assessment as part of the forthcoming EIA will begin.

12 PRELIMINARY CONTENT OF THE ENVIRONMENTAL IMPACT ASSESSMENT

On conclusion of the consultation process, an environmental impact assessment (EIA) will be carried out as a part of the environmental assessment process. The EIA forms a central document in which all environmental aspects are analysed and assessed, both direct and indirect environmental consequences during construction, operation and decommissioning. In addition, the EIA will contain data on the site location, design, scope and other properties which may be significant for the environmental assessment. To prevent, hinder and counter negative environmental effects of the activity, the planned measures to be applied will be presented in the EIA.

Below is a summary list of content proposed for inclusion in the EIA.

- Non-technical summary
- Introduction and background
- Location
    - Alternative location and implementation
    - Zero option
- National maritime plan
    - What this looks like for the project area
- Environmental quality standards
- Geology
    - Types of sediment and sediment processes
    - Presence of hazardous substance in sediment
    - Diffusion models
- Underwater noise generated by the activity
- Impact on current conditions caused by the activity
- Any impact from electromagnetic radiation
- Potential impact on types of nature and species identified in the nearby Natura 2000 area
- Current description of the marine biology within the project area
    - Indirect and direct impact on existing species such as fish, birds and marine mammals.
- Impact on conflicting interests such as commercial fishing and outdoor recreation
- Cumulative environmental impact of other activities
- Protective and precautionary measures to minimise negative environmental impact
- Proposed content of the control programme
- Choice of technique and method for preliminary investigations and civil engineering works
- Restoration after decommissioning
- Schedule
    - For the project
    - Any time restrictions during ecologically sensitive periods

In addition to the above, the EIA will include the consultation report and technical description. The layout of the forthcoming EIA is proposed to follow the same structure as this consultation document.

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