BALTICA-1 OFFSHORE WIND FARM

ESPOO REPORT

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NON-SPECIALIST SUMMARY

This report on the transboundary environmental impact assessment of the project involving the construction of facilities using wind power to generate electricity, i.e. the Baltica-1 Offshore Wind Farm, implemented by the company Elektrownia Wiatrowa Baltica-1 sp. z o.o., owned by Polska Grupa Energetyczna S.A., fulfils the requirements of the Espoo Convention, which regulates transboundary environmental impact assessment at the international level as well as incorporates the practice and experience regarding such assessment.

In September and October 2023, the Polish party sent written notifications to the potentially affected countries (Sweden, Denmark, Finland, Lithuania, Latvia, and Estonia) in accordance with Article 3(1) of the Espoo Convention, including the information on the planned implementation of the above-mentioned Project entitled Baltica-1 Offshore Wind Farm and the initiation of proceedings to issue a decision on environmental conditions for the Project.

All the countries mentioned above have responded, and the willingness to participate in the process of transboundary environmental impact assessment has been expressed by Sweden, Denmark and Finland.

The construction of the Baltica-1 Offshore Wind Farm is a strategic project from the point of view of Poland's energy security and is a part of the policy of increasing the proportion of electricity from renewable energy sources. The energy policy of Poland provides for the construction of an OWF in the Polish exclusive economic zone (EEZ), with a total capacity of up to 5.9 GW by 2030 and a potential of up to approximately 11 GW in 2040.

It should also be mentioned that the Project is also in line with the directions of activities undertaken by Baltic countries, which confirms their activity in the field of offshore wind energy.

The Project is situated within the EEZ of the Republic of Poland, on the eastern side of the Middle Bank, the sea depth within the Project area is from approximately 16 MBSL to approximately 50 MBSL, at a distance of approximately 75 km north of the coastline, opposite Smołdzino commune and Łeba commune (Pomorskie voivodeship), and approximately 550 m from the EEZ boundaries of Poland and Sweden.

The offshore wind farm consists of three main components, connected functionally and structurally:

- offshore wind turbines – a nacelle with a rotor and a supporting structure (the above-water part, transition elements and underwater part);
- offshore substation or offshore substations comprised of offshore transformer substations and, in the case of the HVDC solution, also offshore converter substations;
- inter-array medium- or high-voltage subsea cable lines together with accessories.

The proposed Project will consist of up to 60 offshore wind turbines, up to 4 offshore substations and inter-array subsea power cable lines with a total length of about 140 km.

To gain the best possible understanding of the current state of the environment, and thus correctly identify possible adverse environmental impacts of the Project, including its transboundary impacts, environmental surveys were carried out in 2022–2024 in the proposed Project area and the area of the anticipated impact.

The surveys covered the following areas:

- geophysical surveys: bathymetric, sonar, magnetometer and seismo-acoustic surveys, ROV inspections, seabed surface sediment sampling, core sampling;
- hydrological and meteorological surveys including sea currents;
- ambient noise;
- physico-chemical parameters of water;
- physico-chemical parameters of sediments;
- phytobenthos;
- zoobenthos;
- chiropterofauna (bats);
- marine mammals;
- avifauna;
- ichthyofauna.

The environmental surveys provide a foundation for describing the baseline condition of the environment and assessing the possible environmental impact of the Project on the environment including transboundary aspects.

As part of the surveys also social conditions for the implementation of the Project were investigated and determined.

The resulting environmental impact assessment of the Project involving the construction of the Baltica-1 Offshore Wind Farm indicated the possibility of transboundary environmental impacts.

The scope of the conducted environmental impact assessment accounted for the requirements of Polish legislation, as well as the expectations of the affected parties expressed in their responses to the notifications in accordance with Article 3 of the Espoo Convention.

A detailed analysis of possible impacts carried out during the Polish environmental impact assessment demonstrated the possibility of transboundary environmental impacts on the following environmental components:

- quality of water and seabed sediments (contamination with petroleum products during breakdowns or collisions of vessels);
- ichthyofauna;
- seabirds;
- marine mammals;
- bats;
- protected areas.

The most significant environmental impacts will be related to noise emissions at the construction stage, particularly during the construction of foundations for wind turbines using the piling method. These impacts may, in particular, affect marine mammals and ichthyofauna. To limit this impact, the Project Owner provided for an application of various mitigation measures to maximally reduce the influence of noise on living organisms including limiting the impacts of transboundary level.

Moreover, the operation of the farm will impact other above-mentioned components of the environment.

ABBREVIATIONS AND DEFINITIONS

AIS	Automatic Identification System; fitted aboard all ships of 300 gross tonnage and upwards. It provides automatic exchange of data, which helps to avoid collisions between ships and to identify ships for the coastal marine vessel traffic service
APV	Applicant Proposed Variant
Baltica-1 OWF	Baltica-1 Offshore Wind Farm
BIAS	Baltic Sea Information on the Acoustic Soundscape
Birds Directive	Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (OJ L 20/7 of 26.01.2010)
BOD_5	5-day biochemical oxygen demand
CDGU	centrally dispatched generating unit
C-POD/F-POD	Continuous Porpoise Detector / Full waveform capture Porpoise Detector
DBBC	Double Big Bubble Curtain – technology designed to reduce the propagation of sound underwater
DPD	detection positive day
DPM	detection positive minute
EEZ	exclusive economic zone
EIA	environmental impact assessment – procedure constituting part of the proceedings for issuing a decision on environmental conditions, which is carried out by an authority competent to issue such decision
EPP2040	Energy Policy of Poland until 2040
Espoo Report	this document containing documentation of the environmental impact assessment pursuant to Article 4 of the Convention on Environmental Impact Assessment in a Transboundary Context, containing the scope of information compliant with Annex II to the aforementioned Convention
EU	European Union
EUROBATS	Agreement on the Conservation of Populations of European Bats
G+	Global Offshore Wind Health and Safety Organisation
GUS	Statistics Poland – Poland's National Statistical Institute [abbreviation from Polish: *Główny Urząd Statystyczny*]
Habitats Directive	Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (OJ L 206 of 22.07.1992)
HDPE	high-density polyethylene
HELCOM	Helsinki Commission – Baltic Marine Environment Protection Commission

HSD	Hydro Sound Damper
HVAC	high voltage alternating current transmission line
HVDC	high-voltage direct current transmission line
IMO	International Maritime Organization
MASL	metres above sea level
MW	megawatt - unit of power in the International System of Units (SI)
non-CDGU	non-centrally dispatched generating unit
NRS	noise reduction system
OnSS	onshore substation
OSS	offshore substation
OWF	offshore wind farm
PAHs	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
PSzW	permit for the construction and use of the artificial islands, installations and devices in the Polish Sea Areas in accordance with the Act of 21 March 1991 on the sea areas of the Republic of Poland and maritime administration (consolidated text: Journal of Laws of 2023, item 960).
PTS	permanent threshold shift
RAV	Reasonable Alternative Variant
RES	renewable energy sources
ROV	remotely operated vehicle
SDF	Standard Data Form for the Natura 2000 sites
SEL	Sound Exposure Level
SIPAM	Spatial Information System of the Maritime Administration
SPL	Sound Pressure Level
SPRAS	Baltic Acoustic Spring Survey – a type of standardised survey cruise conducted by all Baltic countries in spring to provide data for estimating stocks of pelagic species
TOC	total organic carbon
TTS	temporary threshold shift

1 Introduction

1.1 Information about the document

The content of this Report was developed based on the Polish environmental impact assessment of the Investment. The Polish assessment was conducted in compliance with the procedure specified in the Polish Act of 3 October 2008 o*n the provision of information on the environment and its protection, public participation in environmental protection and environmental impact assessments*, which is a transposition of the Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 *on the assessment of the effects of certain public and private projects on the environment* (hereinafter referred to as the EIA Directive).

The national EIA Report contains all the necessary elements specified in Polish and European regulations, in particular:

1) a description of the investment, including information on the location, design, size, and other important features of the investment;
2) a description of the potential environmental impact of the investment;
3) a description of the features of the investment and the measures envisaged to avoid, prevent, or minimise any significant adverse impact on the environment or to offset this impact if possible;
4) a description of the alternative solutions considered by the Investor that are appropriate for the undertaking and its specific features, as well as an indication of the main reasons for choosing a given variant, taking into account the environmental impact of the investment;
5) all other pieces of information necessary to reliably determine the possible impact of the investment on the environment;
6) a summary in non-technical language.

The assessment of the potential significant impact on the environment was made in relation to all elements of the environment specified in Article 3 of the EIA Directive.

At all stages of the work related to conducting the environmental impact assessment, the Project Owner shall provide all interested parties with access to information on the activities undertaken. All significant decisions made in the matter shall be made public. Additionally, in line with the national procedure, an EIA Report on the investment is to be assessed by the relevant administrative bodies, and in the further course of the proceedings, it will be subject to consultations, in which the possibility of submitting comments and obtaining explanations by all interested groups of society will be ensured.

This report on the transboundary environmental impact assessment of the Project involving the construction of facilities using wind power to generate electricity entitled Baltica-1 OWF fulfils the requirements of the Espoo Convention, which regulates transboundary environmental impact assessment at the international level. Pursuant to Article 4 of the Convention, the Party of Origin shall furnish the Affected Party with the environmental impact assessment documentation. As for the Project covered by this report, the Party of Origin is Poland, while the Affected Parties are the countries that may be affected by the proposed activity and have expressed their intention to participate in the transboundary environmental impact assessment. In this case, these are: Sweden, Denmark, and Finland.

Sections 2–6 hereof present basic information about the Project involving the construction of the Baltica-1 OWF, such as a description of the Project, the legal framework and mechanisms of the Espoo process, as well as a section on risk assessment and the assessment methods applied. The main part of this report is the environmental impact assessment in a transboundary context, addressed in Section 7. The assessment sections are divided according to the environmental or socio-economic components likely to be the receptors of the Project impacts. This section contains the results of the environmental impact assessment for each receptor along with information on the resulting transboundary environmental impacts for the Swedish, Danish and Finnish parties. A separate section is devoted to the assessment prepared with regard to Natura 2000 sites, their subjects of protection and the legal principles of their conservation applicable in this respect. The results of the assessment are summarised in the conclusions in Section 11. The findings of the report and the results of the Espoo procedure form an integral part of the environmental impact assessment for the proposed Project.

1.2 Project description and justification for its implementation

The construction of the Baltica-1 OWF is a strategic project from Poland's energy security perspective, at the same time constituting the implementation of measures aimed at increasing the proportion of electricity from renewable energy sources. The energy policy provides for the construction of an OWF in the Polish exclusive economic zone (EEZ), with a total capacity of up to 5.9 GW by 2030 and a potential of up to approximately 11 GW in 2040.

An important rationale for the Project is the possibility of generating electricity using a natural source and avoiding atmospheric emissions. With a conservative assumption of the use of 40% capacity and 35 years of operation, the 900 MW OWF could generate 110.38 TWh/397.35 PJ of electricity, thus avoiding the emission of over 40 million Mg CO_2, over 540 thousand Mg SO_2, over 72 thousand Mg of nitrogen oxides and nearly 1.3 million Mg of particulate matter from lignite-fired power plants, assuming the emissions indicated by the European Environment Agency[1].

The above indicators for the Project in question will be an important element of Poland's compliance with international regulations and commitments at global and regional levels. This action will, therefore, contribute to avoiding impacts which due to their effects influence the environmental conditions of other countries.

Among the above-mentioned regulations, the following should be noted in particular:

- United Nations Framework Convention on Climate Change, signed in 1992 in Rio de Janeiro, ratified by Poland in 1994, aimed at stabilising greenhouse gas concentrations in the atmosphere at a level that does not cause dangerous changes in the climate system;
- Kyoto Protocol – the regulatory mechanism of the Convention, adopted in 1997, establishing a timeframe for reducing greenhouse gas emissions. The Protocol entered into force in 2005; in Poland, it was ratified in 2002;
- Paris Agreement, developed in 2015, with a long-term goal to hold the increase in the global average temperature to below 2°C by the end of the 21st century. The Agreement was adopted in October 2016, also by Poland.

[1]*European Environment Agency (EEA), Air pollution from electricity-generating large combustion plants, EEA Technical report, No 4/2008; available at: https://www.eea.europa.eu/publications/technical_report_2008_4*

The proposed Project consisting in the generation of electricity from a renewable energy source, i.e. wind, in maritime areas, complies with the objectives of the above regulations and Poland's energy policy, contributing to the reduction of adverse environmental impact and greenhouse gas emissions from the power sector. It is consistent with the 2030 framework for climate and energy policy (Climate and Energy Package) of the EU, the main objectives of which are:

- reduction of greenhouse gas emissions by 40% relative to the emission level from 1990;
- ensuring at least 32% share of the energy generated by renewable sources (the original target of at least 27% was corrected in 2018);
- improvement of energy efficiency by at least 32.5% (the original target of at least 27% was corrected in 2018).

The proposed Project, through the production of energy from a renewable source and the simultaneous reduction of CO_2 emissions, covers directly two of the three objectives of the European Union in this respect.

The Baltica-1 OWF is also in line with the objective of the EU long-term strategy adopted in November 2018 'Climate neutrality by 2050'[2], i.e. achieving zero level of greenhouse gas emissions by 2050, and with the idea of the European Green Deal[3].

According to expert estimates, electricity from wind farms will be the cheapest source of electricity for the European economy. The costs of energy from this source will be cheaper by as much as several dozen per cent than from gas power.

[2] *https://ec.europa.eu/clima/policies/strategies/2050_pl*

[3] *https://commission.europa.eu/system/files/2020-04/political-guidelines-next-commission_en_0.pdf*

2 Espoo Convention

2.1 Espoo Convention

'The Convention on Environmental Impact Assessment in a Transboundary Context of 25 February 1991' (Espoo Convention) specifies the obligations of contracting parties to assess the environmental impact of specific activities at an early stage of project planning. It also imposes a general obligation on states to notify and consult one another on all major projects under consideration that may have significant adverse environmental effects in a transboundary context. For the purpose of the Espoo Convention, a transboundary impact means 'any impact, not exclusively of a global nature, within an area under the jurisdiction of a Party caused by a proposed activity the physical origin of which is situated wholly or in part within the area under the jurisdiction of another Party'. The Party of Origin means the contracting party or parties to the convention under whose jurisdiction a proposed activity is envisaged to take place. In this case, it is Poland. The Affected Party means the contracting party or contracting parties to the convention likely to be affected by the transboundary impact of proposed activities. As regards the Baltica-1 OWF project, these are Denmark, Sweden and Finland. The Convention requires the Parties of Origin to inform the Affected Parties, in line with the provisions of the Convention, of a proposed activity that is likely to cause a significant adverse transboundary impact.

2.2 Espoo consultation process

The consultation process provided for in Articles 3–6 of the Espoo Convention is coordinated by the Espoo Coordination Points within each Party of Origin. The consultation process consists of the following main stages:

- Notification in accordance with Article 3: For a proposed activity listed in Appendix I that is likely to cause a significant adverse transboundary impact, the Party of Origin shall, for the purposes of ensuring adequate and effective consultations under Article 5, notify any Party which it considers may be an Affected Party as early as possible and no later than when informing its own public about that proposed activity.
- Preparation of environmental impact assessment documentation (Espoo Report) in accordance with Article 4: The Party of Origin shall furnish the Affected Party, as appropriate through a joint body where one exists, with the environmental impact assessment documentation. The concerned Parties shall arrange for the distribution of the documentation to the authorities and the public of the Affected Party in the areas likely to be affected and for the submission of comments to the competent authority of the Party of Origin, either directly to this authority or, where appropriate, through the Party of Origin within a reasonable time before the final decision is taken on the proposed activity.
- Consultation in accordance with Article 5: The Party of Origin shall, after the completion of the environmental impact assessment documentation, without undue delay, enter into consultations with the Affected Party concerning, inter alia, the potential transboundary impact of the proposed activity and measures to reduce or eliminate its impact. The consultations may relate to: (a) possible alternatives to the proposed activity, including the no-action alternative and possible measures to mitigate the significant adverse transboundary impact and to monitor the effects of such measures at the expense of the Party of Origin; (b) other forms of possible mutual assistance in reducing any significant adverse transboundary impact of the proposed activity; and (c) any other appropriate matters relating to the proposed

activity. The Parties shall agree, at the commencement of such consultations, on a reasonable timeframe for the duration of the consultation period. Any such consultations may be conducted through an appropriate joint body, where one exists.

- The final decision in accordance with Article 6: The Parties shall ensure that, in the final decision on the proposed activity, due account is taken of the outcome of the environmental impact assessment, including the environmental impact assessment documentation, as well as the comments thereon received pursuant to Article 3 and Article 4, and the outcome of the consultations as referred to in Article 5. The Party of Origin shall provide to the Affected Party the final decision on the proposed activity along with the reasons and considerations on which it was based. If additional information on the significant transboundary impact of a proposed activity, which was not available at the time a decision was made with respect to that activity and which could have materially affected the decision, becomes available to a concerned Party before work on that activity commences, that Party shall immediately inform the other concerned Party or Parties. If one of the concerned Parties so requests, consultations shall be held as to whether the decision needs to be revised.

The consultation process and the content of the environmental impact assessment documentation for the Baltica-1 OWF project account for the recommendations issued by the United Nations Economic Commission for Europe (UNECE, 1996) and the European Commission (European Commission, 2013).

The consultation process was initiated in September and October 2023, when the Polish party sent written notifications to the countries situated on the Baltic Sea, in accordance with Article 3(1) of the Espoo Convention.

The countries notified are:

- Sweden;
- Denmark;
- Finland;
- Lithuania;
- Latvia;
- Estonia.

All the countries mentioned above have responded, and the willingness to participate in the process of transboundary environmental impact assessment has been expressed by Sweden, Denmark and Finland.

The responses received are listed in Table 2.1.

Table 2.1. List of responses of the notified parties

Country	Entity	Date
Denmark	Centre for Renewable Energy / Offshore Wind Energy Department	03.10.2023
	Environmental Protection Agency	06.10.2023
Finland	Centre for Economic Development, Transport and the Environment of Southwest Finland (Varsinais-Suomi)	16.11.2023
	Centre for Economic Development, Transport and the Environment of Southwest Finland (Varsinais-Suomi)	17.11.2023
	Finnish Environment Institute	04.12.2023
	Finnish Meteorological Institute	06.11.2023
	Finnish Transport and Communications Agency Traficom	13.11.2023

Country	**Entity**	**Date**
	Finnish Transport Infrastructure Agency	17.11.2023
	Finnish Wildlife Agency	17.11.2023
	Government of Åland	14.11.2023
	Finnish Ministry of Transport and Communications	13.11.2023
Estonia	Ministry of Climate	17.10.2013
Lithuania	Ministry of the Environment	05.10.2023
Latvia	State Environmental Service	13.10.2023
Sweden	Swedish Environmental Protection Agency	11.10.2023
	Environmental Protection Authority	20.10.2023
	South Baltic Water District Authority	09.10.2023
	BirdLife Sverige – national Swedish bird association	06.10.2023
	Swedish Agency for Marine and Water Management	27.09.2023
	Kalmar County Administrative Board	06.10.2023
	Swedish Geotechnical Institute	20.09.2023
	Swedish Transport Administration	05.10.2023
	Blekinge County Council	29.09.2023
	Geological Survey of Sweden	19.09.2023
	Swedish Pelagic Federation	06.10.2023
	Skåne County Administrative Board	06.10.2023

3 PROJECT DESCRIPTION

The Baltica-1 OWF is a Project with a maximum nominal capacity of 900 MW, which will be situated in the Polish EEZ.

The main elements of the Project will be:

- offshore wind turbines;
- offshore substation or offshore substations comprised of offshore transformer substations and, in the case of the HVDC solution, also offshore converter substations;
- medium- or high-voltage inter-array subsea cable lines together with accessories.

The environmental impact assessment concerns the three main phases of the Project: construction, operation and decommissioning.

3.1 PROJECT LOCATION

The proposed Baltica-1 OWF is situated within the EEZ of the Republic of Poland, on the eastern side of the Middle Bank, with the sea depth in the Project area ranging from approximately 16 MBSL to approximately 50 MBSL, at a distance of approximately 75 km north of the coastline, opposite Smołdzino commune and Łeba commune (Pomorskie voivodeship), and approximately 550 m from the boundary between the EEZ of Poland and Sweden [Figure 3.1].

The Baltica-1 OWF Area covers a surface area of 85.53 km^2.

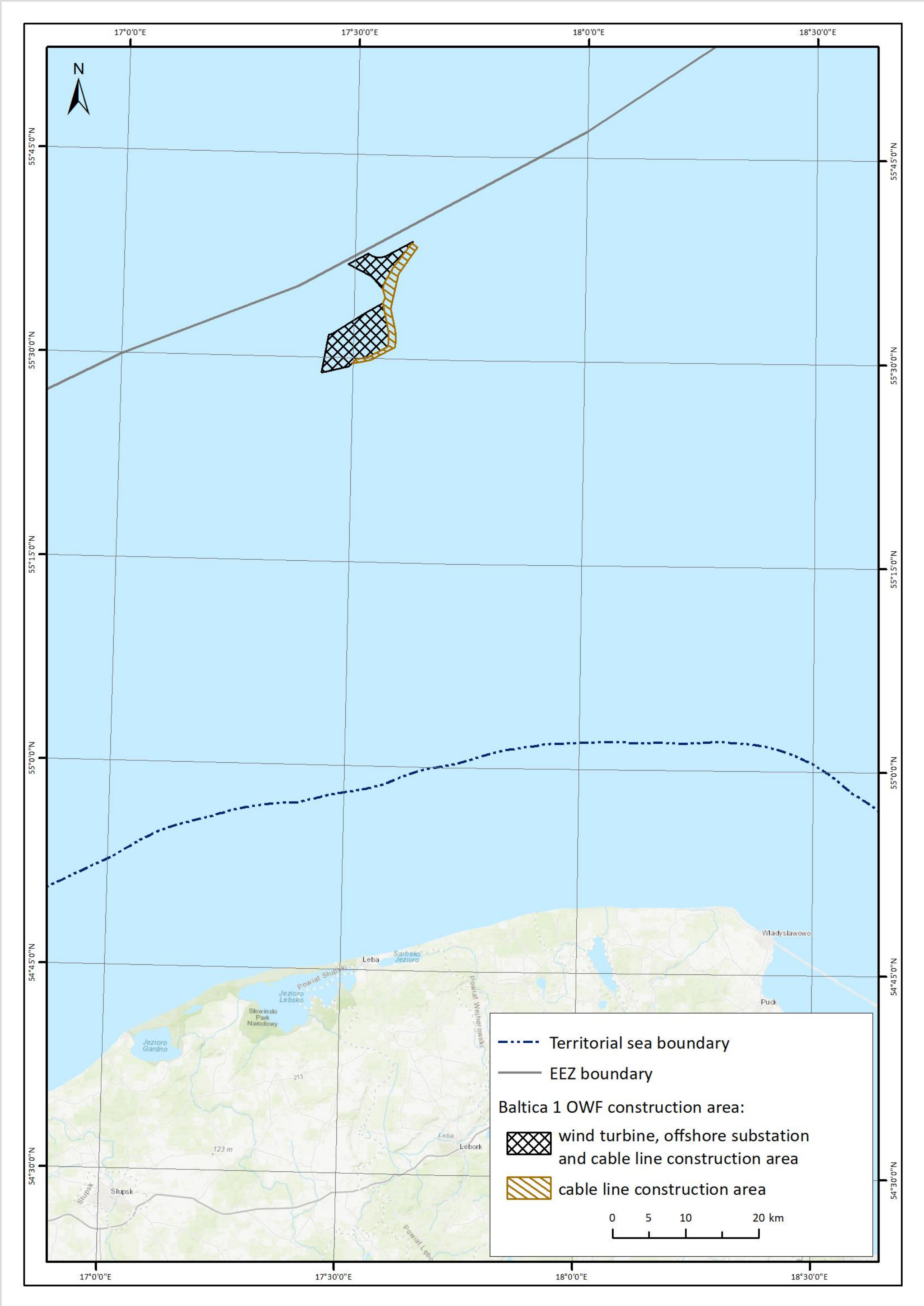

Figure 3.1. Location of the proposed Project, the Baltica-1 OWF

3.2 MARINE ENVIRONMENT SURVEYS

3.2.1 Survey purpose and type

Environmental surveys intended for the proposed Project in the Baltica-1 OWF Area were conducted for a period of one year, from 1 December 2022 to 30 November 2023. With regard to the porpoise activity surveys, it should be noted that these were carried out from January 2023 to February 2024 because a permit from the Swedish party was required for the surveys, the issuance of which postponed the surveys.

The surveys covered the Baltic Sea area designated for the construction of the Baltica-1 wind farm, as well as the buffer established by the Polish authorities, guided by the precautionary principle. The buffer width depended on the environmental component surveyed – for abiotic components, bats, phytobenthos and macrozoobenthos it was 1 NM wide, whereas for ichthyofauna, avifauna and marine mammals it was 4 km wide. Additionally, surveys of marine mammals were carried out in the adjacent area constituting a buffer from the Baltica-1 construction area, with a width of approximately 40 km (both in the Polish and Swedish waters), while seabird surveys were conducted from vessels along transects in the reference area located north of the B1 OWF within the Swedish EEZ.

The surveys covered abiotic and biotic components. The surveys included measurements and observations in the marine environment. The surveys were carried out during cruises of research vessels and observation flights within the Project area and in the area of its potential impact.

The surveys, measurements and observations were complemented by an analysis of available literature data, including archival maps and survey results made available by the Project Owner or other entities, as well as the results of other environmental impact assessments, in particular similar projects planned or implemented in the Baltic Sea, the data and information from which may have been relevant to this assessment.

The surveys also identified the social conditions for the implementation of the Project.

The scope of the surveys was as follows:

- geophysical surveys: bathymetric, sonar, magnetometer and seismo-acoustic surveys, ROV inspections, seabed sediment sampling, core sampling;
- hydrological and meteorological surveys including sea currents;
- ambient noise;
- physico-chemical parameters of water;
- physico-chemical parameters of seabed sediments;
- phytobenthos;
- macrozoobenthos;
- chiropterofauna (bats);
- marine mammals;
- avifauna;
- ichthyofauna.

The environmental surveys provided a foundation for describing the baseline condition of the environment and assessing the possible impact of the Project on the environment.

The environmental survey results provided a comprehensive set of data of sufficient representativeness, temporal and spatial resolution required and enabling the performance of environmental impact assessment of the Project.

The periods and frequency of the surveys conducted for the individual components of the environment resulted from their character and temporal variability and accounted for the phenological periods of animate nature components as well as the commonly used survey methodologies. To the extent carried out, the surveys are also consistent with practices applied in other projects of this type. The spatial extents of the surveys conducted for individual elements were based on the assumed extent of the potential impact of the Project on such components in each phase of implementation.

In addition, it should be noted that the spatial extent of the surveys accounted for the position of the national authority issuing the scoping opinion, inter alia, in the context of the spatial extent of the geophysical, macrozoobenthos and ichthyofauna surveys, and was determined by national considerations rather than a transboundary context. However, the extent was established broadly enough to slightly overlap with areas under the Swedish jurisdiction. The surveys were conducted in accordance with the ruling of the national authority but respecting the integrity of the area under the Swedish jurisdiction, where the surveys were not carried out. Nevertheless, the surveys provided information and knowledge on the components analysed to the extent necessary to perform an environmental impact assessment of the Project, taking into account the territories of other countries. For the small part of the survey area on the Swedish side, where objective limitations concerning the legal basis for the physical survey methods were encountered, analyses of the state of the environment were conducted using commonly applied methods such as extrapolation of the results of surveys carried out in an area available for the surveys, being a continuation of the area on the Swedish side, using data obtained from the European Marine Observation and Data Network (EMODnet). Verification of environmental documentation for other projects was also carried out, thus employing all objectively available survey methods.

3.2.2 Survey methodology

Briefly discussed below are the methodologies used during the surveys concerning the environmental elements significant from the point of view of potential impacts of the Baltica-1 OWF. A full description of the methodologies is provided in Appendix 1 to the national EIA Report for the Project under discussion.

3.2.2.1 Abiotic components – geophysical surveys

The geophysical surveys were aimed at identifying the relief and structure of the seabed within and around the Baltica-1 OWF development area. All surveys were conducted in accordance with currently applicable Polish and European technical standards.

The geophysical surveys included: bathymetric, sonar, magnetometer and seismo-acoustic surveys, ROV inspection, seabed surface sediment sampling, as well as core sampling.

The bathymetric surveys with a multibeam echosounder, side-scan sonar surveys, magnetometer surveys, single-channel seismic surveys and seismo-acoustic surveys with a sediment profiler were carried out in the survey area along survey profiles delineated with a 50 m spacing and along transverse survey lines (crosslines) established with a spacing of 500 m.

Bathymetric and sonar surveys were carried out along survey lines delineated parallel to one another so as to cover the entire seabed within the survey area. Moreover, in order to identify any potential objects lying on the seabed, a visual inspection using a Falcon ROV was carried out at pre-determined points.

A reflection seismic survey that uses a single-channel set of receivers (streamer) and an acoustic wave induction source with a broad frequency band (sparker) was conducted to obtain a two-dimensional image for the purpose of determining the geological structure to a depth of approximately 45 m.

The surveys using a multi-channel methodology were carried out to obtain a two-dimensional image used for identifying the geological structure of the medium in the upper part of the subsurface zone, at least up to the depth of the wind turbine foundations.

The multi-channel seismic surveys were carried out along the determined survey profiles running at 200 m intervals from one another and along transverse survey lines (crosslines) running at 2000 m intervals.

The single-channel and multi-channel surveys were carried out with the involvement of Marine Mammal Observers and a passive acoustic monitoring (PAM) operator on board a vessel, in accordance with the guidelines of the British Joint Nature Conservation Committee.

Objects of anthropogenic or unknown origin present on the seabed were identified on the basis of previously gathered and processed bathymetric, sonar and magnetometer data. Selected objects were visually inspected with a Falcon ROV. The purpose of the ROV inspection was to confirm or verify the type of contact, which cannot be unambiguously determined on the basis of the other data. Moreover, the nature of such objects, their role in the marine environment and possible threats to the Project resulting from the presence of these objects (especially wrecks and contaminants such as unexploded ordnance, duds, and chemical warfare agents) were verified, as well as their potential value in terms of cultural heritage and archaeology.

Surface sediment sampling was carried out to identify the sediments forming the seabed surface and indicate the areas with potential clastic deposits. Surface sediment samples were collected using a Van Veen grab sampler.

A macroscopic description, particle size distribution analysis and an analysis of physicochemical parameters were carried out at the laboratory. The description included the identification of fractions (taking into account additional components such as shell fragments, wood fragments, etc.), as well as the determination of colour, carbonate content (on a 4-point scale) and consistency (in the case of fine-grained soils). The particle size distribution analysis was conducted in the form of a sieve analysis in the case of coarse-grained sediments (sands, gravels) as well as a hydrometric analysis in the case of fine-grained sediments (sands with silt, silts and clays).

To confirm the arrangement of shallow sediment layers and to identify the presence of potential aggregate deposits, core samples were collected using a VKG 3-6-9 vibrocorer. Cores with a length of up to 6 m were sampled. The minimum yield length required for sampling acceptance was 4.5 m. The macroscopic description of the samples included the determination of the primary and secondary fractions along with a determination of carbonate and organic matter content (where possible). During the macroscopic description, geological layers were identified (using lithological and genetic criteria) and soil colour was determined. The determination of particle size distribution of coarse-grained soils was conducted by dry sieving. Laboratory shakers were used for the analysis. Granular soils with more than 10% of grains passing the 0.063 mm sieve were referred for full hydrometric analysis (with sieve analysis). Determination of particle size distribution of fine-grained soils (containing more than 10% of the fine fraction: silt and clay) was carried out using a combined sieve and sedimentation analysis with the use of the hydrometric method.

3.2.2.2 Abiotic components – hydrological and meteorological surveys including sea currents

The following parameters were measured within the survey area as part of the surveys of hydrological and meteorological conditions, including sea currents:

- air humidity;
- atmospheric pressure;
- wind speed;
- wind direction;
- air temperature;
- water flow velocity;
- water flow direction;
- wave height and period;
- thickness of the water column;
- electrical conductivity of water;
- water turbidity;
- water temperature.

The research was being conducted continuously from the end of November 2023 to the end of November 2024.

The survey system in the survey area comprised five survey points.

The locations of the survey equipment within the survey area were selected in such a way so as to make the values of physical parameters measured as representative as possible for the area surveyed. When selecting the indicated locations, the relief of the seabed was taken into account, which slopes significantly towards the south and east in this area, and consequently, has large variations in water depth.

The survey equipment within the survey area was located at survey points with water depths from approx. 19 to approx. 47 m.

Additionally, the hydrological and meteorological monitoring including sea currents involved hydrological monitoring at survey stations designated for water and seabed sediment sampling.

The meteorological and hydro-physical data acquired were quantitatively and qualitatively assessed and verified to ensure their correctness and to eliminate any other erroneous values. Afterwards, they were subjected to a preliminary statistical analysis and interpretation of the results, followed by a substantive analysis and expert interpretation.

3.2.2.3 Abiotic components – surveys of physico-chemical properties of water

The objective of physico-chemical surveys was to obtain the overall characteristics of the seawater hydro-chemical indicators. For this purpose, measurements and analyses of the following indicators were carried out: oxygen conditions [dissolved oxygen, five-day oxygen demand (BOD_5)], total organic carbon (TOC), acidification (pH) and alkalinity, nutrients [ammoniacal nitrogen, nitrate nitrogen, total nitrogen, mineral nitrogen (DIN), phosphates, total phosphorus], and suspended solids. Also, the analyses of the content of substances particularly harmful to the environment, such as mercury, nickel, lead, cadmium, arsenic, total chromium, chromium (VI), aluminium, phenols, cyanides, mineral oils, polycyclic aromatic hydrocarbons (16 PAHs), polychlorinated biphenyls (7 PCB congeners: 28, 52, 101, 118, 138, 153, 180), as well as the measurements of the radioactivity of caesium (^{137}Cs) and strontium (^{90}Sr) isotopes were carried out.

Water samples were collected from a representative number of points (36 survey stations), from the near-surface and near-seabed water layers, 6 times a year in the survey area.

Some of the laboratory analyses (dissolved oxygen, BOD_5, pH, alkalinity, ammoniacal nitrogen and total suspended solids) were carried out immediately after water sampling, at the laboratory located on board the vessel from which the samples were collected. The remaining tests were performed at the stationary laboratory.

In all campaigns, measurements of temperature, electrical conductivity, pressure and turbidity were carried out at all survey stations during water sampling.

3.2.2.4 Abiotic components – seabed sediments surveys

The monitoring of seabed sediment properties included analyses of the physico-chemical indices selected for the survey, as well as macroscopic description and sieve or hydrometric (depending on the type of soil) particle size distribution analyses.

Physico-chemical analyses were performed for samples collected at 118 survey stations situated within the survey area. Sediment samples for physico-chemical tests were collected in an evenly distributed measurement grid (1 sample per 1 km^2) from the sediment layer, using a grab sampler (van Veen grab sampler).

In order to obtain comprehensive characteristics of the physico-chemical properties of sediments from the proposed Baltica-1 OWF area, the following physico-chemical indicators were selected for testing: moisture content, loss on ignition (LOI), total organic carbon (TOC), content of metals (Pb, Cu, Zn, Ni, Cd, Cr, As, Hg) and their labile form, polycyclic aromatic hydrocarbons (16 PAHs), polychlorinated biphenyls (7 PCB congeners: 28, 52, 101, 118, 138, 153, 180), mineral oils, radioactivity of ^{137}Cs, organic tin compounds (TBT, DBT, MBT) and twice a year (due to seasonal changes) the content of nutrients (total nitrogen and total phosphorus).

Additionally, out of the total number of seabed sediment samples collected as part of the winter sampling campaign, 25 seabed sediment samples from the survey area were analysed for the content of mineral oils, butyltin compounds, i.e. tributyltin (TBT), dibutyltin (DBT) and monobutyltin (MBT) as well as for ^{137}Cs radioactivity.

3.2.2.5 Abiotic components – ambient noise

Data on ambient noise were collected in the period from December 2022 to February 2024, in accordance with the international standards and guidelines regarding best practices in conducting surveys on the underwater noise field. The fundamental element of the monitoring surveys was the recording of underwater noise with the use of an autonomous SM4M Submersible sound recorder (Wildlife Acoustics, USA) equipped with an omnidirectional ultrasound hydrophone HTI-96.

The SM4M survey device was deployed in the water column, approximately 5 m above the seabed. The survey in question generally recorded underwater ambient noise in the frequency range from 2 Hz to 96 kHz, whereas acoustic data in the frequency range of individual 1/3-octave bandwidths with centre frequencies from 20 Hz to 20 kHz were analysed in detail. This is compliant with the latest recommendations of the EU Technical Group on Underwater Noise (EU TG-Noise) [HELCOM, 2021]. This scope covers the majority of noises of anthropogenic origin caused by human activity at sea, including above all the noise from vessels, sounds emitted by the devices for seismo-acoustic surveys, and noise generated during the process of piling and during underwater explosions.

3.2.2.6 Biotic components – phytobenthos

In order to identify phytobenthos assemblages within and around the Baltica-1 OWF Area, a video inspection was performed by means of an underwater ROV along two transects in selected areas of potential plant occurrence.

In effect, phytobenthos was found to be absent, hence no phytobenthos samples were collected for further quantitative and qualitative analyses.

3.2.2.7 Biotic components – macrozoobenthos

Macrozoobenthos surveys within and around the Baltica-1 OWF Area involved collecting macrozoobenthos samples on the soft bottom (mainly sandy and sandy-gravelly seabed) using a Van Veen grab sampler as well as collecting periphytic fauna and associated fauna complex on the hard (stony) bottom using a Cougar ROV equipped with a pipe for collecting zoobenthos from a specified surface. A total of 168 macrozoobenthos samples were collected in the survey area within the soft bottom, and 2 samples within the hard bottom.

The macrozoobenthos samples collected underwent laboratory analyses which included:

- qualitative analysis of the species composition;
- abundance analysis, involving counts of individuals of all the taxa identified except for the species of Gymnolaemata, Thecostraca and Hydrozoa;
- analysis of the biomass expressed as grams of wet weight per square metre;
- measurement of bivalve lengths in 0.5 cm ranges and biomasses in individual intervals.

3.2.2.8 Biotic components – ichthyofauna

The ichthyofauna surveys were conducted in a one-year-long cycle and included 4 survey campaigns covering all seasons of the year.

In the survey area, ichthyoplankton samples were collected at 8 sampling stations (area coverage density was 1 station per 38 km^2). Samples were collected from 5 m above the seabed to the surface level, using a 300 µm mesh Bongo net equipped with a depth gauge to control the depth of the gear immersion. The hauls were carried out at a vessel speed of approximately 2–3 kt. The volume of water filtered during the haul was measured using a flowmeter. The biological material collected was preserved in a 4% formaldehyde solution. Salinity and temperature were also measured throughout the water column at each sampling station.

The ichthyoplankton samples collected were examined under a stereo microscope at a laboratory. All ichthyoplankton components were analysed in terms of quantity and quality.

The analysis of the density and characteristics of the pelagic fish community within the survey area was conducted using complementary hydroacoustic survey methods and pelagic control hauls.

To determine the pelagic fish areal biomass distribution and density, an acoustic method was used in compliance with the international standards adopted by the Baltic International Fish Survey Working

Group (WGBIFS) of the International Council for the Exploration of the Sea (ICES), included in the Manual for the International Baltic Acoustic Survey (IBAS) [ICES 2017]. For the purpose of acoustic monitoring of fish in the water column, a SIMRAD EK80 survey echosounder with a transducer operating at 38 kHz was used. The grid of hydroacoustic transects was designed in such a way so as to cover the survey area (the total length of the transects was 132 km), which allowed the correct interpolation and interpretation of the inventory results for the survey area. EchoView software from Myriax was used to analyse the echo-integration results.

Pelagic control hauls were carried out in order to determine the species composition as well as the proportion of fish in individual length classes, and afterwards, following the biological analysis, to determine the biomass of fish of individual species. The hauls were conducted after recording fish concentrations along the hydroacoustic transect. For each haul, salinity, temperature and seawater oxygen concentration were measured throughout the water column.

The procedure of catch handling involved:

- sorting fish into individual species;
- determining the catch weight for each fish species;
- measuring the total length (LT, *longitudo totalis*) of each fish species.
- ichthyological analyses of the target fish species predominant in the catch.

The procedure of ichthyological analysis involved:

- conducting measurements of individual lengths and weights (with accuracy up to 1 g);
- determining sex and sexual maturity (gonad maturity stages) according to the revised 9-stage Maier’s scale;
- assessing fish stomach fullness (the 5-point scale adopted in Polish ichthyological surveys was used: 0 – empty stomachs, 1 – 1/4 full stomachs, 2 – 1/2 full stomachs, 3 – 3/4 full stomachs, 4 – full or distended stomachs);
- collecting otoliths to determine the age of a given fish – fish ages were determined after the cruise at the NMFRI laboratory.

The ichthyological analysis focused on commercial species – herring and sprat.

Demersal fish catches were conducted with gillnet sets, including multi-mesh gillnets and nets used in commercial fishing. Within the survey area, 10 survey stations were established for the deployment of the nets. Salinity and temperature measurements were conducted throughout the water column at the net deployment site.

The deployment duration of a single survey set was a minimum of 12 hours, including dusk and dawn hours, which are of particular significance for daily migrations of demersal fish. At each survey station, surveys were conducted twice.

The procedure of catch handling involved:

- taking fish out from multi-mesh survey nets;
- sorting fish into individual species;
- determining the catch weight of each fish species (separately from each net type);
- measuring the lengths of individual fish species (separately from each net type);
- ichthyological analyses of the target fish species predominant in the catch.

The procedure of ichthyological analysis involved:

- conducting measurements of individual lengths and weights (with accuracy up to 1 g);
- determining sex and sexual maturity (gonad maturity stages) according to the revised 9-stage Maier's scale;
- assessing fish stomach fullness (the 5-point scale adopted in Polish ichthyological surveys was used: 0 – empty stomachs, 1 – 1/4 full stomachs, 2 – 1/2 full stomachs, 3 – 3/4 full stomachs, 4 – full or distended stomachs);
- collecting otoliths to determine the age of a given fish – fish ages were determined after the cruise at the NMFRI laboratory.

Herring concentration surveys were carried out using survey nets including nets used in commercial herring fishing and multi-mesh nets (herring gillnets). In order to capture the relationship between the presence of herring and foraging birds, the survey comprised 12 cruises in March, April, August, September, October and November. Originally, 2 cruises were to take place in each of these months, but in October, the weather conditions only allowed for 1 survey series. Consequently, an additional cruise was organised in November. The dates of the cruises coincided with the dates of the avifauna surveys. The analyses were conducted at 7 survey stations located at the observation transects along which bird counts were conducted from vessels.

The procedure of catch handling involved:

- sorting fish into individual species;
- determining the catch weight for each fish species;
- measuring the total length (LT, *longitudo totalis*) of each fish species.

Furthermore, an ichthyological analysis of herring was performed to determine gonad maturity stages and possible spawning activity.

3.2.2.9 Biotic components – marine mammals

The marine mammal monitoring was being conducted in the period from December 2022 to February 2024. The spatial extent of the monitoring was the survey area comprising the Baltica-1 wind turbine, OSSs and cable line construction area (Area A) and the cable line construction area (Area B), together with a zone with a width of not less than 40 km from the boundary of Area A. Figure 3.2 and Figure 3.3 illustrate the extent of the surveys as well as the location of survey points and observation transects.

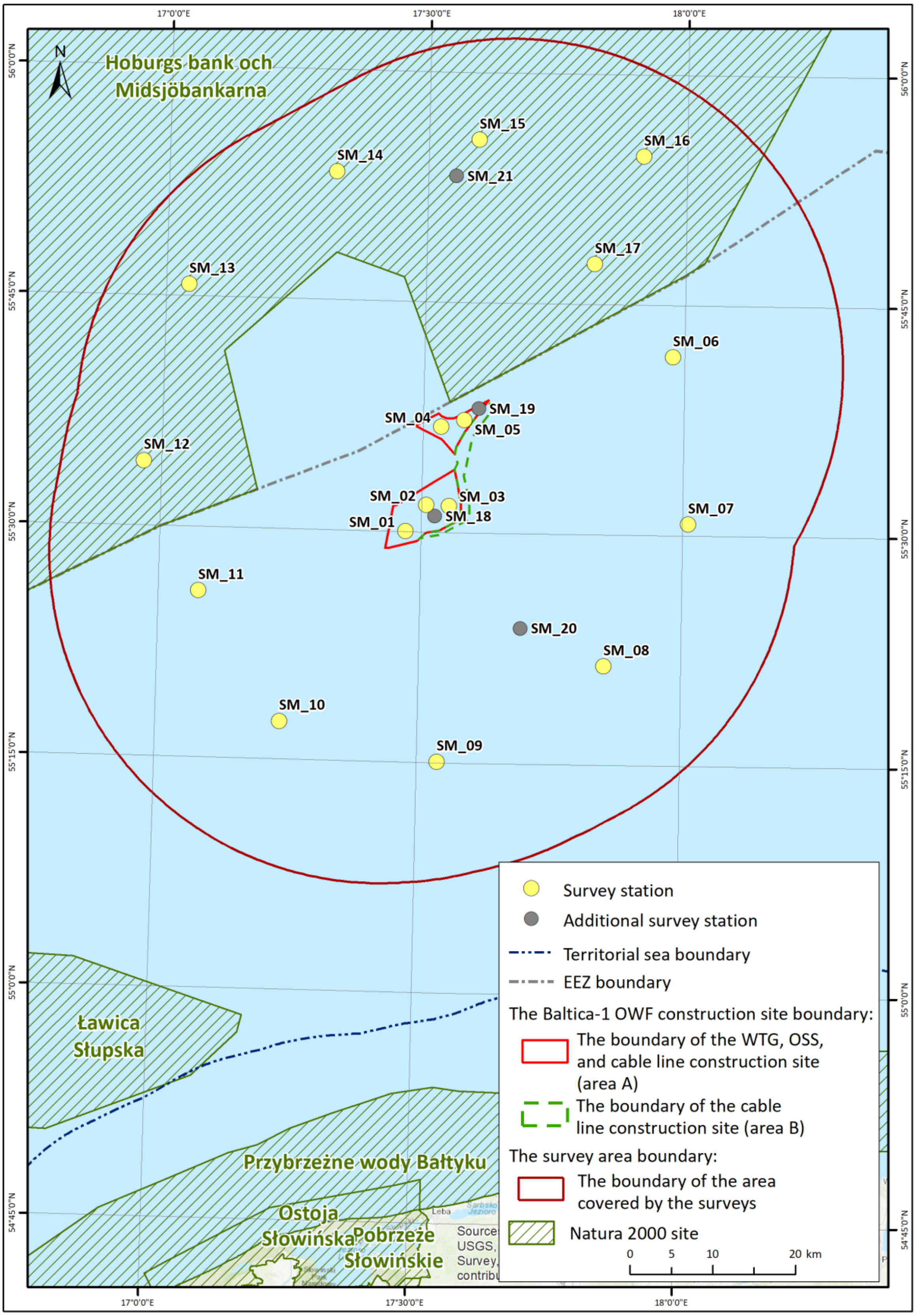

Figure 3.2. Location of the survey stations for passive acoustic monitoring within the survey area

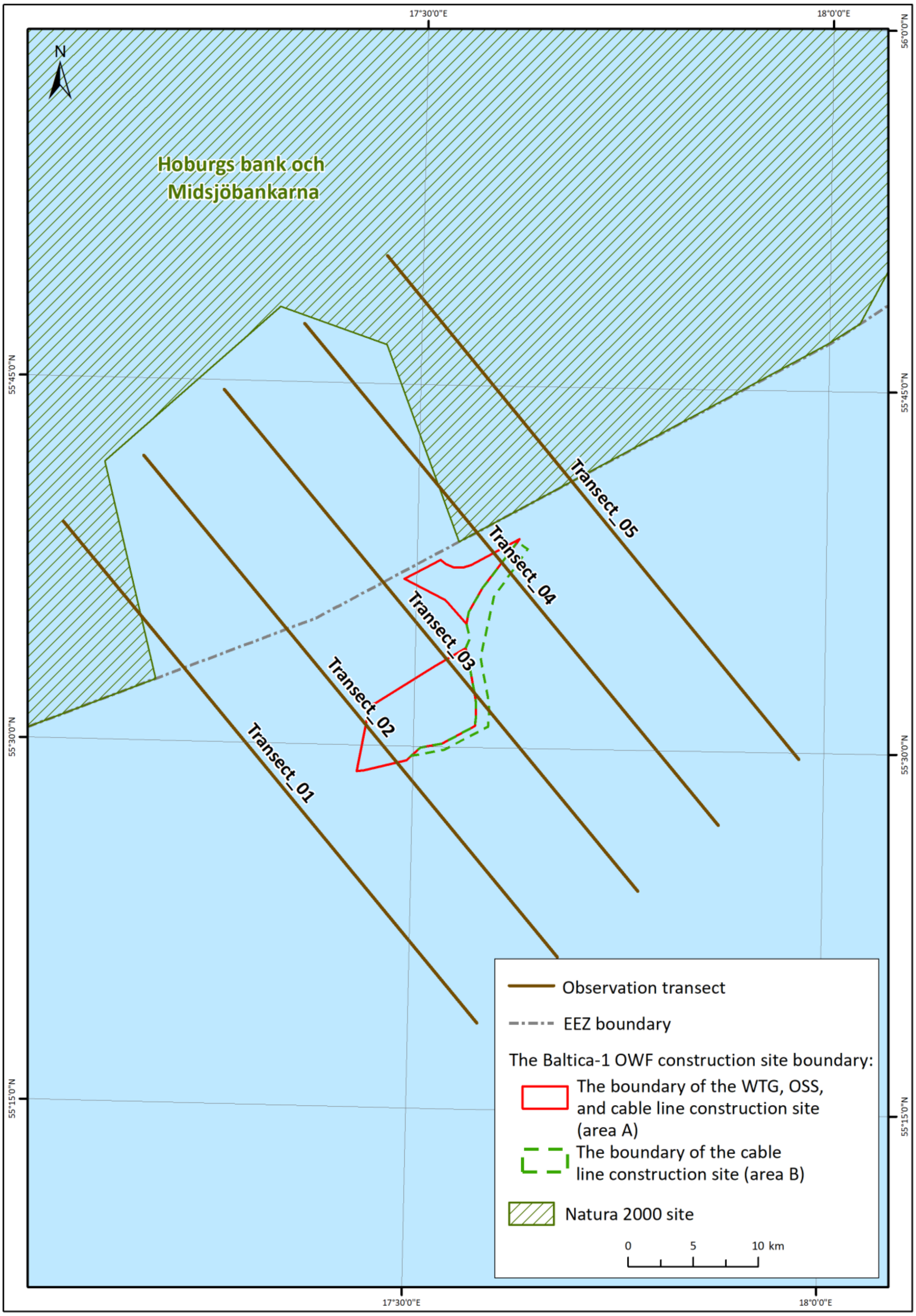

Figure 3.3. Location of observation transects during marine mammal monitoring from aircraft within the survey area

Marine mammal surveys were conducted using passive acoustic monitoring (for the harbour porpoise) and visual methods (the harbour porpoise and seals), including observations from aircraft as well as observations from aboard a vessel.

Passive acoustic monitoring was carried out using F-PODs – one at each survey station. The locations of the survey stations were selected in such a way so as to enable the collection of representative data on animal presence while avoiding repeated recording of the same clicks. The detectors were deployed 5 m above the seabed.

From the beginning of the monitoring, the F-PODs collected acoustic recordings in a continuous mode. Acoustic data collected with the F-PODs were processed using FPOD.exe software (Chelonia Limited, online), which employs an automated KERNO-F algorithm to identify a series of acoustic clicks and classifies them into different sound categories in the following manner:

- sound sources: 1) NBHF (porpoise), 2) other cetaceans, 3) side-scan sonar and 4) unknown;
- quality of data recorded: 1) high, 2) medium, 3) low, 4) questionable.

The results of the analyses were presented as the number and proportion of porpoise detection positive days (DPD) and detection positive minutes (DPM). DPD represents the day on which at least one porpoise detection was recorded, whereas DPM represents the minute on which a porpoise was recorded. The number of DPDs and DPMs were converted proportionally to the total number of days/minutes of data collection at the station on a monthly, seasonal and annual basis, and presented as a proportion of DPDs/DPMs.

Visual observations from an aircraft were conducted to provide additional information on the occurrence of marine mammals in the survey area. Aerial observations were conducted along five designated transects. They took place under favourable atmospheric conditions: sea state below 3, no heavy precipitation, and good visibility during the observations (at least 5 km).

During the observations, data were collected by two experienced observers, from two opposite sides of the aircraft, from a level of approximately 600 ft (about 183 m). The flight path was recorded continuously by two GPS units, at intervals of at least 5 seconds. Meteorological data (sea state, glare, cloud reflectivity, cloud coverage, precipitation and water turbidity) were recorded by each observer on a voice recorder at the beginning of each transect, when the weather conditions changed during the flight, and when a marine mammal was spotted. When an animal was identified, observers recorded its location in relation to the transect, swimming direction, distance from the transect, and time of recording (date; hour; minute; second in relation to the local time).

Additionally, observations of marine mammals were conducted from the vessel during seabird surveys.

3.2.2.10 Biotic components – seabirds

The aim of the marine avifauna surveys was to obtain data on the species composition, abundance and distribution of birds related to the marine environment in the sea area covering the area intended for the Baltica-1 OWF, and in the reference area designated for the purpose of comparison with the area intended for the Project.

Seabird observations were carried out in the OWF development area including a 4 km wide buffer zone, and in a reference area with similar environmental conditions, situated north-west of the Baltica-1 OWF, within the Swedish EEZ. The observations were conducted along designated transects. The surveys took place between December 2022 and the end of November 2023.

Seabird observations were carried out along transects designated in such a way that the counts covered not less than 10% of the sea basin and that the results obtained were representative of the changing conditions resulting from depth changes. Seven observation transects were delineated in the survey area and four transects in the reference area [Figure 3.4]. The length of the observation transects within the survey area and the reference area was 87 km and 52 km, respectively, while their surface area was approx. 50.9 km^2 and 29.6 km^2, respectively, accounting for 15% of the survey area and 18.6% of the reference area.

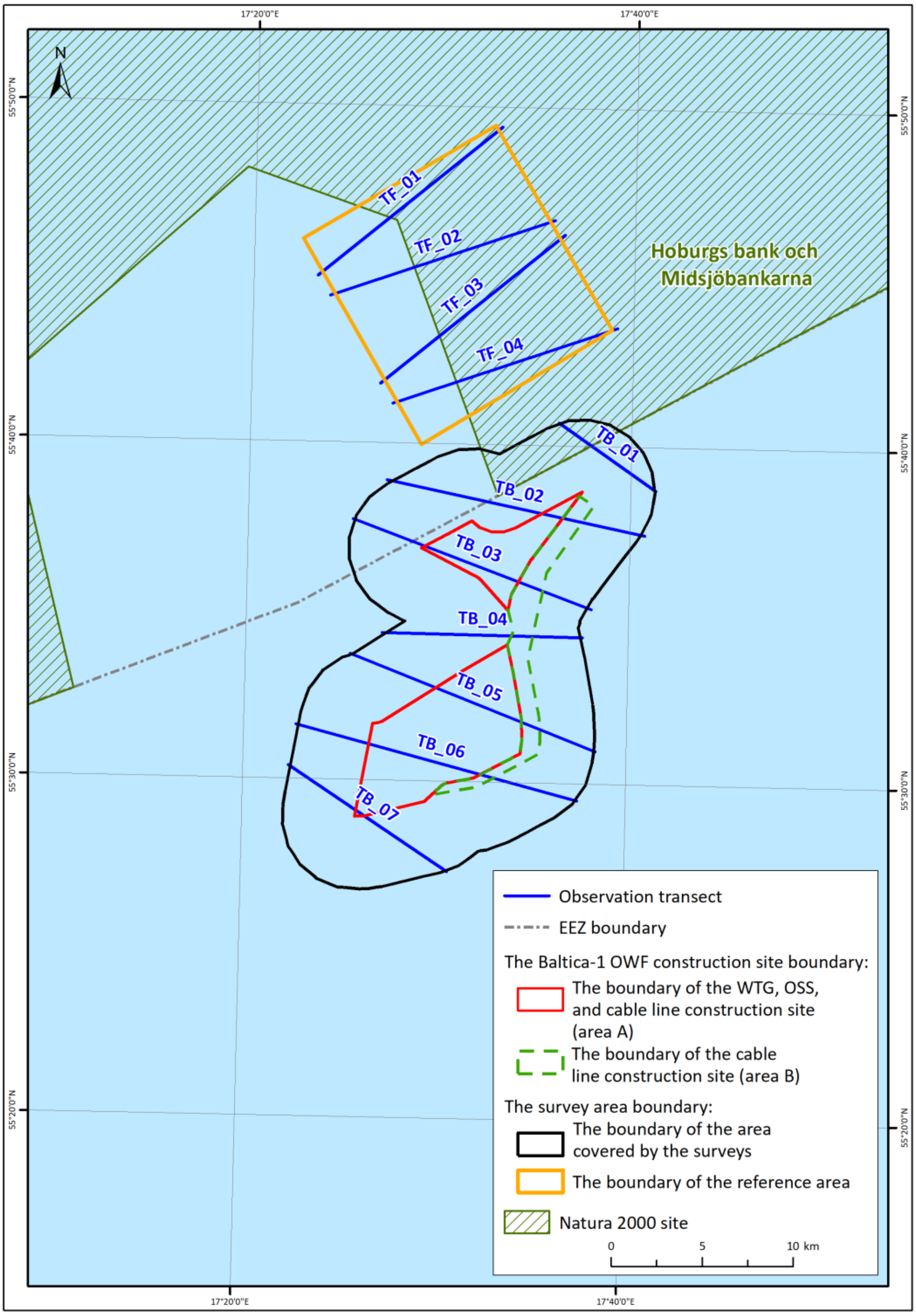

Figure 3.4. *Location of the survey area, reference area and observation transects along which the seabird counts were conducted within the survey area and the reference area*

The surveys were conducted throughout the year, which enabled tracing changes in the grouping of seabirds in subsequent phenological periods – the wintering period, the spring migration period, the summer period and the autumn migration period. In total, 24 survey campaigns were carried out – 2 per month, except for October, when due to a long-lasting spell of unfavourable weather the second campaign had to be postponed to the following month.

The results of the counts of seabirds identified during the surveys in the survey area and in the reference area, which are located in the open sea zone, are presented per three groups of species:

- seabirds, which usually stay at sea during the non-breeding season, reaching the largest abundance in the offshore zone located over 1 km away from the shore. Gulls which accompany fishing boats to fishing grounds are an exception and their occurrence in the open sea is strongly conditioned by human activity. Among seagulls, the black-headed gull and the common gull were excluded from the group of seabirds, as they rarely stay in the open sea;
- waterbirds, which are mainly associated with inland reservoirs and appear at sea in large numbers only close to the shore, mainly within estuaries as well as in bays and coastal lagoons;
- birds associated exclusively with terrestrial environments, which only fly over the area and are unable to stay on the water.

A comparison of seabird groupings was made between the survey area and the reference area.

During the observations, the presence of other vessels within the transect strip, within a given section, was also monitored and their impact on bird behaviour was recorded (scaring, when a passing vessel frightened birds sitting on the water, or attracting, when birds congregated near the vessel – this usually applies to fishing vessels).

3.2.2.11 Biotic components – migratory birds

The spatial extent of the migratory bird surveys was the survey area comprising the Baltica-1 OWF development area covering wind turbine, OSSs and cable line construction area (Area A) as well as the cable line construction area (Area B), together with a zone with a width of not less than 4 km from the boundary of Area A.

Surveys of bird migrations during the wintering period (December 2022–February 2023) were conducted at two survey stations: LP_01 and LP_02, located within the boundaries of Area A and in a zone with a width of not less than 4 km away from the boundary of Area A [Figure 3.5]. During the spring migration (March–May 2023) and autumn migration (July–December 2023), bird migration surveys were conducted at two survey stations: MB_01 and MB_02, located within the boundaries of Area A [Figure 3.6].

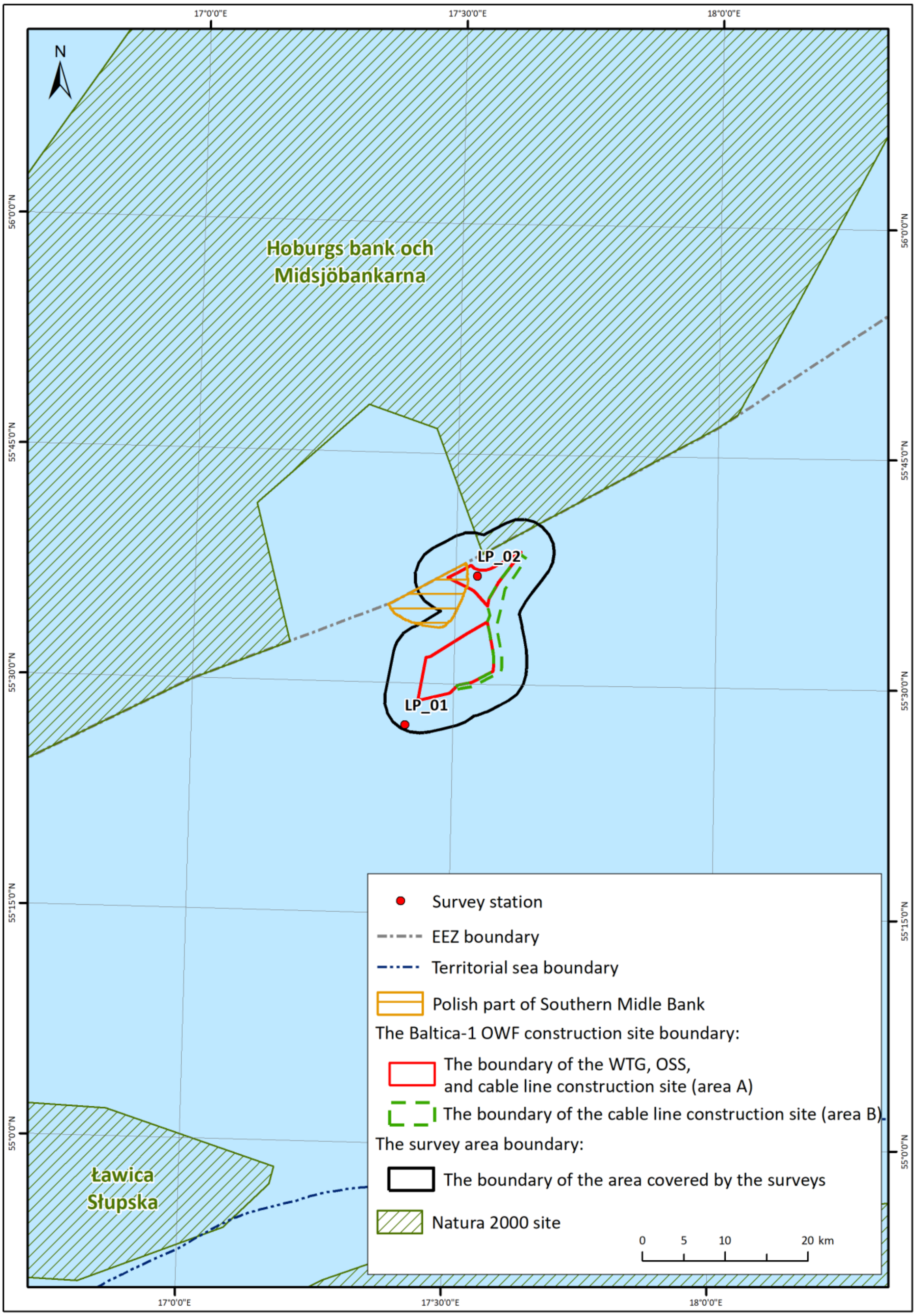

Figure 3.5. Location of survey stations as part of the surveys of bird movements during the wintering period in relation to the Natura 2000 sites and the Southern Middle Bank

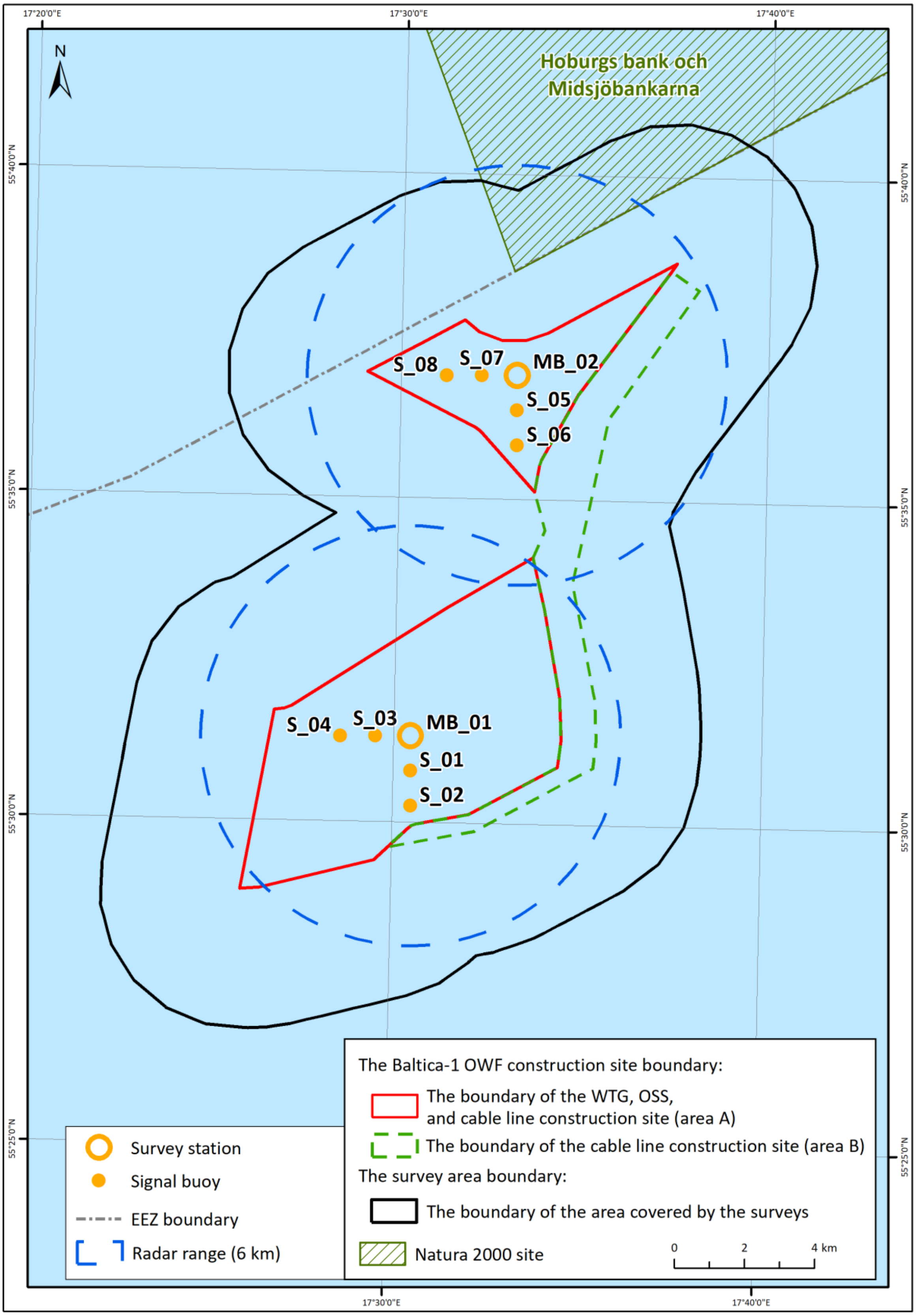

Figure 3.6. Location of survey stations within the survey area as part of the surveys of bird movements during the spring and autumn migration periods

The surveys of local migration during the wintering period were conducted using visual observations and radar surveys. The surveys of flights during the spring and autumn migration involved survey work using simultaneous recording with vertical and horizontal radar, visual observations and acoustic monitoring.

The visual observations were conducted from a survey vessel constituting a survey station, along two transects alternately. This made it possible to identify species and determine the number of bird flights and flight directions of the most abundant migrants per day. Visual observations began 30 minutes before sunrise and continued until 30 minutes after sunset. Observers recorded bird species, the number of individuals observed, flight altitude, direction, behaviour and time of observation in 15-minute intervals.

The radar observations were carried out using 3Bird radar systems that are based on radar systems with an automatic bird flight detection algorithm, manufactured by the Dutch company RobinRadar and adapted by 3Bird for operation on research vessels.

Flight trajectories were automatically identified in real-time from analyses of radar images recorded by horizontal radar, whereas the flight altitude of migrating birds (the height at which moving birds were recorded) was recorded by vertical radar.

Acoustic recordings were made automatically, by means of a microphone and recording equipment, by continuously recording bird calls for 15 minutes every hour, both during daytime and night-time. The recordings were analysed and processed by an experienced observer. Whenever possible, bird calls were identified to the species level, then counted and aggregated for 15-minute periods.

3.2.2.12 Biotic components – bats

Acoustic monitoring of bats was conducted in the Baltica-1 OWF Area [Figure 3.7].

Acoustic signals were recorded during cruises along the designated survey transect divided into 4 sections, with a total length of approximately 47.5 km, and at four survey stations serving as monitoring points.

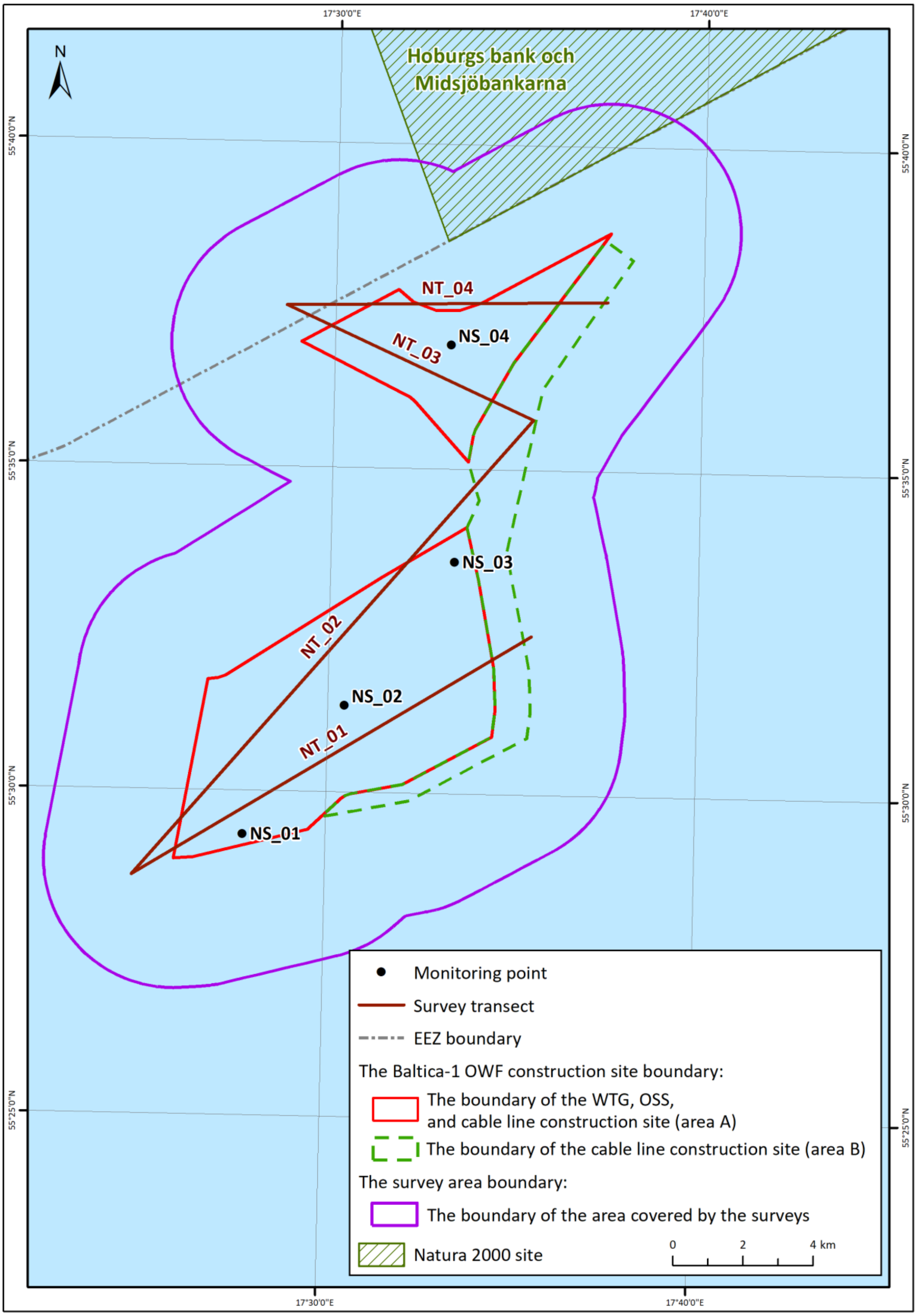

Figure 3.7. Locations of chiropterofauna acoustic monitoring; NT_01–NT_04 – transects, NS_01–NS_04 – passive recording points

Bat activity was recorded during 35 all-night inspections, in two bat migration periods −the spring migration period (1 April – 31 May 2023) and the autumn migration period (1 August – 31 October 2023).

Bats were detected on the basis of the recordings made using specialist recording equipment under favourable weather conditions.

All the surveys were conducted throughout the night and, during the spring migration, included at least 7 surveys along the transects and two surveys at each survey station (of which one was conducted in April and one in May) as well as, during the autumn migration, at least 7 surveys along the transects and two surveys at each survey station (of which one was conducted in August and one in September).

The inspections at survey stations were conducted from aboard an anchored vessel. The inspections along the survey transect (divided into sections) were conducted from a vessel moving at a speed not exceeding 8 knots, in order to minimise the impact of noise on the acoustic signals being recorded.

To monitor bat activity along the survey transect (divided into sections) and at the survey stations, a bat detection and recording system was used, recording the acquired acoustic data in lossless or low-loss format. Afterwards, the recorded sounds generated by bats were separated from potential other sounds recorded, using spectral analysis of the recorded sound, taking into account knowledge of bat sonograms.

3.3 Technological development of wind energy

Given the constantly advancing technology, the offshore wind energy sector is characterised by intense technical development of the individual wind farm elements, including wind turbines and foundations. Therefore, it is difficult to predict at present exactly what technology will be available and what the best possible technological solution will be during the Project construction phase. In the following years, it may be possible to install wind turbines with higher capacities, which will translate into their technical parameters and thus increase the potential production of electricity from wind turbines located in the same area, in comparison with technologies and technical solutions available at present. Technological progress leads to the emergence of new solutions that streamline and improve both the design and the efficiency of wind turbines.

3.4 Description of the production process

Wind turbines are devices designed for converting the kinetic energy of wind into electricity using a wind-driven rotor driving a power generator. The mechanical energy of the rotor is converted into low-voltage AC electricity, which is usually converted to medium voltage and then to high voltage for further transmission.

Due to location conditions, wind farms situated in offshore areas are built as complexes of individual wind turbines together with associated infrastructure (e.g. offshore substations, inter-array cable lines). Electricity produced by the OWF is brought ashore via a power connection and supplied to the onshore substation (OnSS). The connection and the OnSS will constitute a separate project, subject to a separate environmental impact assessment.

3.5 Description of individual elements of the Project

The offshore wind farm consists of three main components, connected functionally and structurally [Figure 3.8]:

- offshore wind turbines – a nacelle with a rotor and a supporting structure (the above-water part, transition elements and underwater part);
- offshore substation or offshore substations comprised of offshore transformer substations and, in the case of the HVDC solution, also offshore converter substations;
- medium- or high-voltage subsea inter-array cable lines together with accessories.

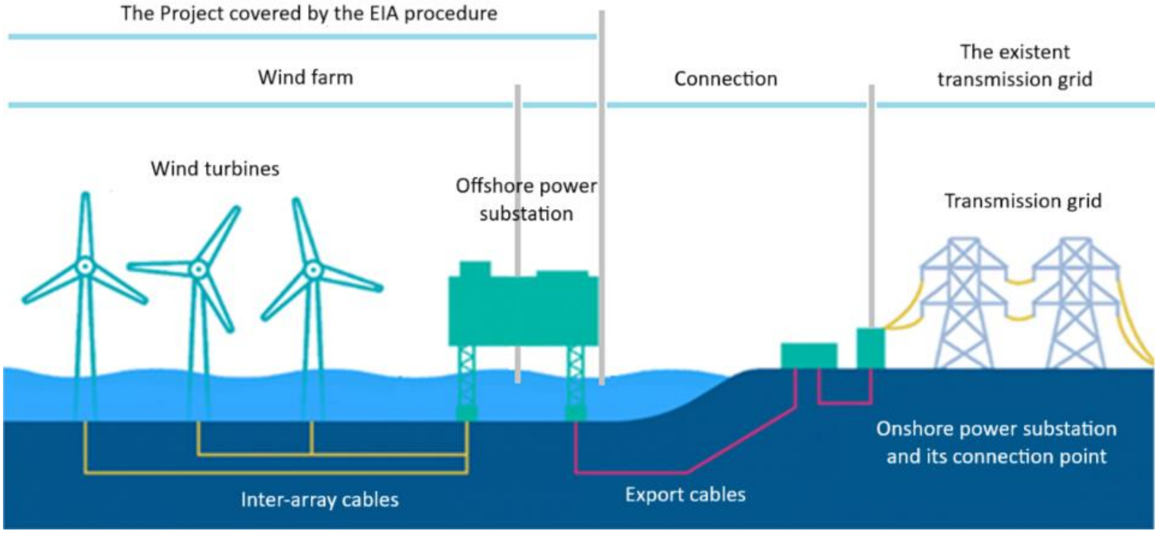

Figure 3.8. Main elements of an offshore wind farm along with transmission infrastructure

Table 3.1 contains a detailed scope of parameters characterising the Baltica-1 OWF

Table 3.1. Compilation of the most important parameters of the Baltica-1 OWF in the Applicant Proposed Variant

Name of a structure or parameter	Unit	Value
Maximum capacity of the offshore wind farm	MW	900
Minimum capacity of a single wind turbine	MW	15
Maximum capacity of a single wind turbine	MW	25
Maximum number of wind turbines with the minimum single turbine capacity (15 MW)	pcs.	60
Maximum number of wind turbines with the maximum single turbine capacity (25 MW)	pcs.	36
Minimum distance between wind turbines	-	RD 3.5
Maximum distance between wind turbines	-	RD 12
Maximum total rotor zone	m^2	2 750 000
Minimum number of offshore substations	pcs.	1
Maximum number of offshore substations	pcs.	4
Minimum length of inter-array cable routes in the OWF	km	120
Maximum length of inter-array cable routes in the OWF	km	140
Maximum width of the seabed strip covered by the works related to the construction of a single cable line	m	16

3.5.1 Wind turbines

The main components of wind turbines are:

- a support structure erected on a foundation installed in the seabed;
- a transition piece connecting the support structure with the turbine tower;
- a turbine tower, usually with a boat-landing platform for mooring vessels that transport personnel involved in periodic servicing and repair works;
- a nacelle with a generator inside, among others;
- a rotor, usually with three blades installed on a rotor hub attached to the nacelle.

Figure 3.9 presents a diagram of an offshore wind turbine structure with an example of a monopile foundation most commonly used in OWF construction.

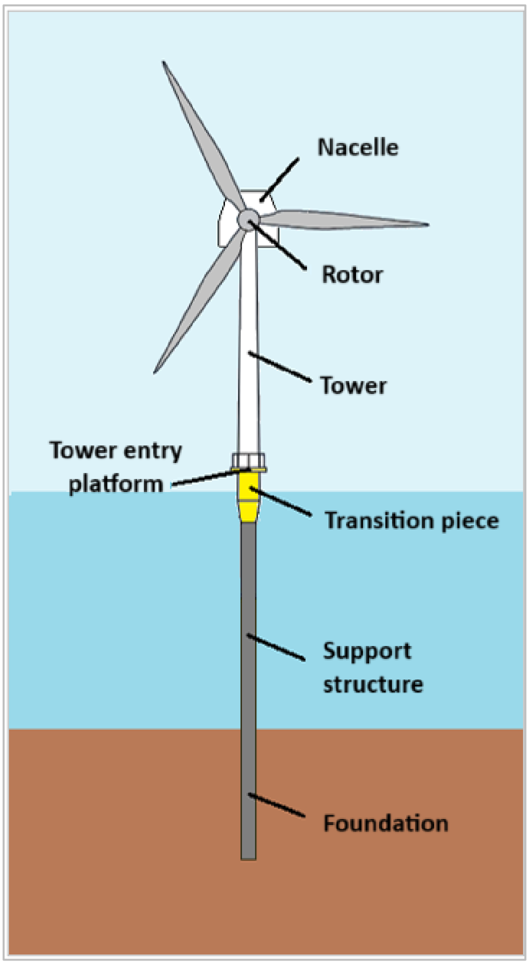

Figure 3.9. Diagram of a structure of a single wind turbine with a monopile foundation (source: internal materials)

The development of offshore wind turbine technology makes it impossible to define the detailed technical and structural parameters of wind turbines that will be used at the Baltica-1 OWF at this stage of the Project implementation. Therefore, the environmental impact assessment was carried out in such a way that the maximum boundary conditions were taken into account, representing the worst-case scenario the parameters of which cannot be exceeded. This means that the actual environmental impact of the completed Project may turn out to be lower than that demonstrated in the environmental impact assessment prepared.

The offshore wind turbines that are currently being installed have a rated capacity of 12–15 MW, with turbines above 15 MW in the implementation phase. The analysis of the rate of increase in the nominal capacity of offshore wind turbines over the last 10 years allows the assumption that at the moment of contracting the delivery of components for the construction of the Baltica-1 OWF, wind turbine designs with a capacity from 15 MW to 25 MW may be available on the market.

Considering the possibility of using 25 MW units, the maximum diameter of the rotor is anticipated to be 310 m. Assuming that the rotor blade tip clearance above the water surface will be at least 20 m, the minimal height of a single wind turbine will be 330 MASL.

The maximum number of offshore wind turbines comprising the Baltica-1 OWF will depend on the rated capacity of the selected units and will be from 36 units with a capacity of 25 MW to 60 units with a capacity of 15 MW, or a correspondingly different number of units if turbines with a capacity less than 25 MW and more than 15 MW are selected.

3.5.2 Foundations and support structures

A vast majority of offshore wind turbines and other structures comprising an OWF – mainly OSSs – are installed on foundations embedded in the seabed, which involves transferring the weight of the equipment (the wind turbines and OSS platforms) to the seabed substrate. The foundations are designed to safely carry the loads exerted by the turbines, exceptional loads (e.g. periodic ice and snow cover on the turbine surfaces, significantly increasing the weight of the structure), as well as the loads exerted on the turbine structures by the environment (movement of water and air masses) throughout the designed lifetime of an OWF. Nowadays, steel monopile foundations are the most commonly used, but concrete gravity-based foundations are also in use. Among the solutions available, monopile foundations, piled or jacket foundations, and gravity-based structures were adopted. Protective stone layers will be laid around the foundations as erosion protection measures.

Foundation technology is an area undergoing continuous optimisation. The technology available is changing and will be detailed before the beginning of the proposed OWF construction.

Therefore, the specific foundation type for support structures will be selected at later stages of the Project implementation, after the completion of geotechnical surveys of the OWF Area and the selection of wind turbines and OSS types.

3.5.2.1 Noise Reduction System

To minimise the adverse impact of underwater noise during the installation of the pile foundations, various types of noise reduction solutions are foreseen, which collectively constitute a Noise Reduction System. The selection of specific technical solutions within the NRS, together with appropriately planned underwater noise monitoring, will be finally presented to the RDEP at least 2 months before the commencement of piling.

The selection of specific solutions will particularly take into account:

- piling locations, including piling locations on adjacent developments (within a 50 km radius),
- the schedule of the works, including works on other projects (piling activities within a 50 km radius),
- the parameters of the pile driver (type, maximum energy and values during the operating cycle, frequency and number of strikes) or other technical solutions used for driving the pile into the seabed,
- geotechnical parameters of the sediments,
- parameters of the piles being driven (geometry and materials),

- seasonal variations in environmental conditions (including periods of particular importance for animals and underwater noise propagation parameters).

Depending on these conditions, a Noise Reduction System may include:

- visual and acoustic observations together with deterrent systems and a soft-start pile driving system,
- passive noise control systems with appropriate noise-mitigating features (e.g. bubble curtains, cofferdams, sound insulation or other similar mitigation measures),
- organisation of the work progress, taking into account the schedules of works at other projects.

The Noise Reduction System to be implemented is expected to minimise the impact of underwater noise on pinnipeds and porpoises, ensuring that underwater noise from foundation piling is reduced as follows:

- throughout the year, at a distance of 11 km from the source in the most favourable propagation direction, not to exceed the maximum underwater noise levels, i.e. 140 dB re 1 μPa^2s SEL_{cum} HF-weighted (HF-weighting function for marine mammals with high sensitivity to high-frequency sounds – porpoise) and 170 dB re 1 μPa^2s SEL_{cum} PW-weighted (PW-weighting function for pinniped marine mammals – seals);
- from June to August, in order to protect the porpoise breeding time when the animals congregate within the Natura 2000 area, not to exceed the maximum underwater noise levels at the boundary of the Natura 2000 site *Hoburgs Bank och Midsjöbankarna* (SE0330308), i.e. 140 dB re 1 μPa^2s SEL_{cum} HF-weighted (HF-weighting function for marine mammals with high sensitivity to high-frequency sounds – the harbour porpoise);
- throughout the year, in order to prevent transboundary underwater noise impacts, the maximum level of 140 dB re 1 μPa^2s SEL_{cum} HF-weighted (HF-weighting function for marine mammals with high sensitivity to high-frequency sounds – porpoise) should not be exceeded at the EEZ boundary.

If noise measurements indicate that the above-mentioned thresholds are exceeded, pile driving will be stopped. Such a situation will be immediately notified to the appropriate Regional Director for Environmental Protection, and further work can continue once measures agreed upon with them in writing have been implemented to eliminate noise exceedances.

Examples of noise reduction measures currently available and applied include:

- Big Bubble Curtain (BBC) – a solution consisting of perforated tubes that are placed on the seabed in the form of a ring surrounding the monopile installation site, and air is pumped into them from compressors situated on board a vessel; the air released into the water column rises towards the sea surface in the form of bubbles, forming a kind of curtain that dissipates some of the underwater noise generated by the pile driver strikes;
- IQIP noise mitigation system (IQIP-NMS) – a system taking the form of a dual-wall air-filled insulation structure surrounding the driven monopile; the system relies on impedance difference values between the housing, water and air to reduce the intensity of the sound wave [Koschinski and Lüdermann 2013].
- Hydro Sound Dampers (HSD) – this system consists of a net or frame surrounding a monopile to which gas-filled balloons and polyethylene foam elements are attached in order to absorb and dissipate the piling sound.

3.5.3 Offshore substations

Offshore substations have various dimensions depending on the amount of power collected and exported by a particular substation.

OSSs are equipped with devices and systems necessary for voltage conversion and power transmission, such as:

- transformers,
- instrumentation and controls,
- control and communication equipment,
- backup power systems including fuel,
- reactive power compensation systems,
- current converter systems,
- other systems for the operation and maintenance of the substation (e.g. helipad, crane, etc., as required).

As an option, it is permitted to install dwelling spaces on selected substations to enable the short-term stay of maintenance crews, for example, in the case of sudden weather events or failures that impede the immediate transfer of maintenance crews to the shore after the work has been completed. OSSs will not be designed as permanent maintenance substations.

On the one hand, the number of OSSs depends on economic factors and, on the other hand, on the technology of electricity transmission from an OWF to land. Two main technologies for energy transmission to shore are distinguished, namely high-voltage alternating current (HVAC) and direct current (HVDC) technology.

The OSSs will be installed on foundations and support structures adjusted to their structural parameters (dimensions, loads), the geological conditions of the seabed as well as the hydrometeorological and environmental conditions present in that location (depth, sea currents, wave motion parameters, ice conditions, etc.), after the completion of geotechnical surveys within the OWF area.

Moreover, the possibility of installing a helipad on the OSS platform is assumed. According to §3(1)(61) of the Regulation of the Council of Ministers of 10 September 2019 *on projects that may have a significant impact on the environment* (Journal of Laws of 2019, item 1839, as amended) '*airports other than those mentioned in § 2(1)(30) or landing areas, with the exception of landing areas referred to in the Regulation of the Minister of Health of 27 June 2019 on the hospital emergency department (Journal of Laws, item 1213)*' are among projects that may have a potentially significant impact on the environment.

In Polish legal environment, the proposed Project is a public purpose project within the meaning of Article 6(4)(a) of the Act of 21 August 1997 *on real estate management* (consolidated text: Journal of Laws of 2023, item 344, as amended), according to which a public purpose includes '*the construction and maintenance of an offshore wind farm within the meaning of the Act of 17 December 2020 on promoting energy production in offshore wind farms (Journal of Laws of 2022, items 1050 and 2687) including a set of devices for power export within the meaning of this Act'*. A public purpose denotes projects whose significance extends beyond the public aspect, pursuing or achieving objectives of economic or social importance.

3.5.4 Inter-array cables

Inter-array cables are to be buried in the seabed at a depth of up to 3 MBSB. Considering local conditions associated with the structure of the seabed, the inter-array cables may be buried deeper – up to 6 MBSB. There is a likelihood that it may not be possible to bury power cables in the seabed along the entire route. If it is impossible to change the cable line route in order to avoid an obstacle located on or below the seabed, for example, if a third-party linear infrastructure is present, it will be necessary to lay sections of the cable line on the seabed surface and provide it with appropriate protection solutions, e.g. riprap, rock bags, concrete covers, reinforced concrete half-shells, casing pipes and protective HDPE mouldings.

The maximum total length of inter-array cables in the OWF is anticipated to be 140 km.

3.6 Construction

The construction phase of the Baltica-1 OWF is estimated at approximately 2 years. This phase will involve the largest number of vessels, equipment and human resources. It will be necessary to develop a complex process of supply chain of both goods and specialist services in various areas: manufacturing, transport, construction, assembly and installation. Precise coordination of individual activities will be necessary, taking into account specific conditions resulting from the Project implementation in a maritime area. The construction phase will cover four areas of activities related to:

- the preparation of the seabed prior to the installation of foundations or support structures for wind turbines and OSSs as well as laying cable lines and the preparation of the seabed, if necessary, at the location of spud cans of jack-up installation vessels. The type of actions taken will be determined by the geological conditions at the foundation sites and the foundation type used;
- transport and installation of OWF foundations or support structures in the seabed;
- transport and installation of wind turbine and OSS components;
- installation of inter-array cables connecting wind turbines and OSSs.

Depending on the strategy adopted for the Project implementation, the above-mentioned actions may be performed sequentially or simultaneously.

Due to the location of the proposed Project within the maritime area, all related activities, in all the Project phases, will be conducted in a manner typical of maritime operations, taking into account their unique conditions and specificity. Transport to and from the Baltica-1 OWF Area will be carried out using various types of vessels, e.g. large construction and installation vessels (including jack-up vessels), transport vessels and barges (e.g. for transporting foundations or support structures, towers, nacelles and blades), push-boats and tugboats as well as service vessels, cable laying vessels, guard vessels. The use of helicopters is also anticipated for transporting personnel to and from the vessels. Transport of the wind farm structural components will be carried out from ports with extensive storage and warehousing space for materials and farm components. At the current development stage of the Baltica-1 OWF project, the following ports of installation are considered: Gdynia, Gdańsk, Sassnitz-Mukran, Szczecin, Świnoujście, Rønne, Rostock, Aalborg, Karlskrona and Klaipėda. The nearest port with complete infrastructure used for offshore wind energy activities is Rønne on the island of Bornholm (in Denmark). The closest ports in Poland that can serve as installation ports are the ports of Gdańsk and Gdynia.

3.7 Putting into service and operation

The operation phase will begin with the start-up of the Baltica-1 OWF – the beginning of electricity generation by wind turbines. The lifetime of the OWF is expected at up to 35 years.

Operation of the wind farm will be conducted from a service centre located onshore. Although the operation of the Baltica-1 OWF will not require permanent staff supervision in the wind farm area, both planned and ad-hoc inspections, service works and, if necessary, repair works will be carried out during the operation phase in the following scope (among others):

- service and maintenance – continuous maintenance of the wind farm, which requires transport of personnel and materials, by smaller service boats, ships or helicopters;
- replacement of major components – during the operation of the wind farm, major components (e.g. gearboxes, rotor blades) may need to be replaced, and electrical equipment and fittings may need to be replaced at the stations.

Unlike the construction phase, the operation phase will be characterised by reduced vessel traffic. Regarding the general vessel traffic, an increased proportion of small and medium-sized vessel traffic related to OWF operation and maintenance will be recorded in this phase. During operation, the following will be possible:

- the use of medium-sized vessels – service bases that will perform periodic service duty in the OWF Area and make cyclical trips to service ports to replenish the supplies and exchange service personnel or crew. The estimated number of trips will minimally increase the intensity of navigation for the main navigation routes and will only slightly increase the intensity of navigation in the service port;
- the use of small vessels travelling between the service port(s) and the OWF Area as well as fast response units in the daily work cycle. The estimated number of cruises will increase the intensity of shipping along navigation routes and in ports;
- the use of helicopters for transporting service crews from land to the OSS with a helipad installed.

The number of specialist offshore operations related to the operation phase of the Baltica-1 OWF will be directly proportional to the number of facilities installed and constructed in the OWF Area, including also the length of the electricity grid installed.

During the operation phase, the Baltica-1 OWF will mainly rely on smaller ports, i.e. ports in Władysławowo, Ustka, Łeba, Hel, Darłówek and Kołobrzeg or Dziwnów, which are situated at a smaller distance from the proposed Project area than the ports indicated in Section 3.6. PGE Baltica is constructing an operations and maintenance base in Ustka, which is eventually expected to provide services for offshore wind farms constructed by the PGE Group, including the Baltica-1 OWF.

3.8 Decommissioning

At the end of the Baltica-1 OWF operation phase, scheduled for 35 years, two possible options are considered: further operation with the possibility of upgrading the OWF infrastructure or decommissioning of the Project. Decommissioning assumes dismantling the wind farm structure and leaving *in situ* those elements, the removal of which would be too expensive and/or might generate stronger adverse impacts on the environment than leaving them in place. This applies especially to the parts of the foundations below the seabed surface and the buried cable lines.

As the offshore wind farm decommissioning process is complex, it proceeds in the opposite way to its construction. Planning the dismantling process of the OWF structures should be considered at the design stage, taking into account the presently available production, dismantling and transport methods as well as possible improvements resulting from future technological advancement. Once disconnected from the electricity grid, wind turbines and OSSs will be dismantled in reverse order of their installation process, using the equipment and procedures used during installation. Particular attention will be paid to the dismantling of components containing environmentally harmful or hazardous substances such as oils, lubricants, refrigeration gases and fluids, etc. The next stage of decommissioning will involve the dismantling of foundations. Given the specificity of monopile foundations and jacket-type structures – permanently fixed to the substrate – only partial decommissioning is possible. The part of the foundation extending above the seabed will be cut right above its surface. The cut-off foundation part will be loaded onto a vessel and transported to the shore. The structure remaining in the seabed will be secured, e.g. with rock reinforcement.

In the case of the OWF inter-array cables, it is assumed that they will be decommissioned and left in the seabed after the end of the OWF operation. The estimated decommissioning time for the Baltica-1 OWF will be approximately 2 to 3 years. This estimate accounts for the time needed to secure the elements left in the seabed. The same vessel types are to be used during the decommissioning phase as in the construction phase.

3.9 PRELIMINARY SCHEDULE OF CONSTRUCTION WORKS

The maximum total construction time for the Project is expected to be approximately 2 years.

Given the specificity of the offshore conditions, technological constraints and the need to ensure high quality and durability of the structures, the construction phase mainly involves the installation of the individual structures and equipment comprising the wind farm. These elements are prefabricated onshore. The installation works are conducted during weather windows, which ensures an appropriate level of safety. A preliminary schedule of Project activities is provided in Figure 3.10.

Figure 3.10. Preliminary schedule of activities related to the implementation of the Baltica-1 OWF

The schedule presented should be regarded as indicative and preliminary. Many different factors may cause changes in the schedule, which will result in the need to adjust it to the progress of the Project.

Wind turbines are delivered by the manufacturer to the quay of an installation port. Individual sections of the tower, the blades and the nacelle are transported and stored separately. If the characteristics of a particular installation vessel allow, individual sections of the tower and, independently, the rotor with blades are assembled on the quay and transported as a whole unit to the installation location by the installation vessel. Usually, installation vessels can transport a few such wind turbine assemblies at the same time.

The operations associated with the pre-assembly and storage of offshore wind turbine elements in installation ports require the use of heavy-duty lifting and cargo handling equipment, i.e. cranes, selfpropelled platforms, specialist trucks with flatbed trailers for the transport of blades, specialist forklifts, etc.

At the same time, foundation works can be carried out in an OWF area. The ready, pre-assembled foundation elements are transferred from the port to the installation location. The elements are transported aboard installation vessels or by barges, and then, the foundations are installed by installation vessels on the previously prepared seabed in the case of gravity-based structures or driven or vibrated into the seabed with a hydraulic pile driver in the case of monopiles and jacket foundations. Depending on the technology adopted, the next stage is the assembly of the transition piece, which constitutes the connection between the foundation installed in the seabed and the wind turbine tower and generator mounted in the next step, or a direct installation of the tower onto the foundation with the integrated transition piece (a TP-less design). Depending on the depth of the sea basin and the forecast weather conditions, the construction of seabed erosion protection may be necessary. Such works are carried out using a specialist rock-dumping vessel, which dumps aggregate or rip-rap precisely on the seabed around the already erected foundation.

The estimated duration of work related to the installation of all wind turbines depending on the adopted foundation technology is:

- monopile foundations – 1800–2900 hours (36–60 turbines);
- gravity-based structures – 1500–2500 hours (36–60 turbines);
- jacket foundations – 2400–3900 (36–60 turbines).

The estimated duration of work related to the installation of just the foundations of the wind turbines depending on the adopted foundation technology is:

- monopile foundations – 720–1200 hours (36–60 turbines);
- gravity-based structures – 620–1020 hours (36–60 turbines);
- jacket foundations – 1440–2400 (36–60 turbines).

The maximum duration of a single wind turbine installation depending on the foundations applied is:

- gravity-based structure – 40 hours;
- monopile – 48 hours;
- jacket foundation – 64 hours.

The duration of a single foundation and wind turbine installation does not differ significantly depending on the adopted capacity of the wind turbine.

The maximum duration of a single foundation installation depending on its type is:

- gravity-based structure – 17 hours;
- monopile – 20 hours;
- jacket foundation – 40 hours.

The duration of installation of a monopile and a jacket foundation if drilling becomes necessary is impossible to be determined before a detailed examination of the ground conditions. For this purpose, information about the thickness of the ground/rock layers which require the execution of boreholes as well as their geotechnical parameters along with the depth at which they are located will be necessary.

In the case of OSSs, the construction of the foundations, including the supporting structure and the station platform installation deck, is expected to take 5 days for gravity-based structures and monopile foundations and 7 days for jacket foundations. The maximum total installation time of an OSS will be 21 days.

The installation time of connections between wind turbines depends on many factors related to the seabed relief and structure, the location of turbines and OSSs within the construction area, the connection layout, as well as the type of installation equipment or the prevailing weather conditions. The total estimated length of all connections between the wind turbines and the OSSs is 140 km at maximum. Depending on the scenario adopted, the number of wind turbines will range from 36 to 60 connected to a maximum of 4 OSSs.

The preliminary estimated installation time for the cable connections including the insertion of cables into the connectors is 650 man-hours.

The time values apply only to the work at sea and do not include downtime that may be caused by logistical problems related to the delivery of materials to the construction site or downtime resulting from technological reasons and unfavourable weather conditions.

The total volume of excavations for cable connections in the Project area will depend on the selected method or methods of cable line construction, which will be dictated mainly by geological conditions in the construction area and the availability of preferred equipment and economic calculations. Commonly used cable line construction technologies – ploughing and mechanical cutting – do not generate significant amounts of suspended solids. In the case of ploughing technology, excavation or liquefaction of the seabed sediments is local and temporary. Table 3.2 contains excavation parameters for the considered and most frequently used cable line construction methods, which enable the estimation of the excavation volume.

Table 3.2. Cable trench parameters depending on the construction method

Cable line construction technology	Trench depth (maximum)	Trench width (maximum)	Construction rate*	Description
	[m]	[m]	[m/h]	
Jetting	0–3 3–6	1	120–1000 120–500	A method of creating a trench using directed water jets. It is assumed that this is the method that has the greatest potential for creating suspended solids. Trench width assuming simultaneous excavation and cable burying.
Ploughing	3	5	300–600	The material is ploughed to the sides of the trench and is not disturbed significantly. Often the cable is buried and covered again at the same time. Using this method, the cable is usually buried up to a depth of 2 m. The geometry of the trench resembles a triangle with a base area equal to the width of the trench and a height equal to its depth.
Mechanical cutting	3	0.7	100–600	For hard and very hard ground, cutting the ground with rotating discs or chains, minimising the stirring up of suspended solids.
Mass flow excavation (MFE)	This method is intended only for cleaning previously prepared trenches in the event of their natural re-filling while waiting for the cable installation. Most probably it will not be required.			

The expected excavation rate will depend on the method of execution (jetting/cutting/ploughing), the depth (geometry) of the excavation, the type of seabed sediment, conditions on the sea surface (e.g. wave motion, currents, wind strength) and the complexity of the cable route.

3.10 Mitigation measures

The environmental impact assessment carried out for the Baltica-1 OWF shows that the Project implementation will not result in significant adverse environmental impacts.

To reduce or eliminate the environmental impacts identified, the following mitigation measures are proposed during the construction phase:

- the use of a Noise Reduction System (NRS) during piling;
- carrying out piling during a period important from the point of view of the porpoise biology and the activity of the species in the OWF Area and the Swedish Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308), which includes the months from June to August, in such a way that the range of impact at the behavioural level does not cover more than 1% of the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308), which results from the application of the above-mentioned NRS that requires maintaining the value of 140 dB re 1 µPa2s HF-weighted SELcum (the HF weighting function for marine mammals with high sensitivity to high-frequency sounds, i.e. the harbour porpoise) at the boundary of the Natura 2000 area in the period from June to August;
- during piling in the period from October to April, carrying out ornithological supervision, taking into account weather conditions and the safety of its implementation. The supervision aims to observe auks, in particular the subjects of protection of the Natura 2000 site, i.e. guillemots, as well as diving benthivorous birds, in particular the subjects of protection of the Natura 2000 site, i.e. long-tailed ducks and eiders. If the ornithological supervision does not record the presence of aggregations of guillemots sitting on the water in a number greater than a flock of 35 individuals or a density greater than 15 individuals/km^2, long-tailed ducks in a number greater than a raft of 350 individuals or a density greater than 50 individuals/km^2 and eiders in numbers greater than a flock of 35 individuals or a density greater than 15 individuals/km^2 in an area with a radius of 1.5 km from the piling site, the work can be started. The supervision should be carried out from vessels or from the air in conditions that ensure their safe performance. In the case of piling conducted during the day, observations should be made before each piling. In the case of piling conducted at night, observations should be made before dusk. The methodology of ornithological supervision will be presented to the Regional Director for Environmental Protection in Gdańsk at least 2 months before the commencement of piling and will include information on the conditions enabling the safe performance of supervision and the organisational and methodological conditions of supervision;
- piling in shallow water areas where benthivorous birds feed, i.e. up to a depth of 25 m, should be carried out from May to the end of November when the abundance of birds in this sea area is the lowest; during the remaining period, piling must be avoided in these locations or carried out under ornithological supervision according to the rules listed in the point above;
- limiting sources of strong light at night, directed upwards and, where possible, to the sides. This applies in particular to bird migration periods. Light emission should be limited to the necessary level, in compliance with the applicable regulations and work safety standards;
- preventing contamination of seabed sediments with organic tin compounds, particularly tributyltin. In each phase of the Baltica-1 OWF, only ships the hulls of which have not been covered with antifouling paint containing TBT compounds should be allowed to work. Currently used antifouling agents must not contain TBT. However, in older vessels, antifouling protective

coatings may contain TBT and such vessels should not be allowed to operate at any stage of the work;

- implementing an action plan to handle accidents/collisions of ships and helicopters and accidental exposure to water and seabed sediment of the pollution caused by such craft. Before the beginning of the construction phase, relevant procedures should be implemented to prevent spills of petroleum pollutants (among others) along with procedures for handling such incidents to minimise adverse impacts on the water and seabed sediments.

The mitigation measures proposed for the operation phase include:

- limiting the sources of strong light at night, directed upwards and, where possible, to the sides. This applies in particular to bird migration periods. Light emission should be limited to the necessary level, in compliance with the applicable regulations and work safety standards;
- equipping the OWF with a system enabling a short-term shutdown of selected wind turbines during crane migration periods in the case when the results of operational monitoring will indicate that an intense migration of cranes takes place over the OWF Area at the collision height;
- if lattice foundations are used, their above-water elements will be painted in a bright colour to minimise the risk of bird collisions;
- implementing an action plan to handle accidents/collisions of ships and helicopters and accidental exposure to water and seabed sediment of the pollution caused by such craft. Before the beginning of the operation phase, relevant procedures should be implemented to prevent spills of petroleum pollutants (among others) along with procedures for handling such incidents to minimise adverse impacts on the water and seabed sediments.

The mitigation measures proposed for the decommissioning phase include:

- removing all possible debris and contaminants from the seabed after the completion of the wind turbine and OSS dismantling; unless otherwise agreed with the maritime administration;
- implementing an action plan to handle accidents/collisions of ships and helicopters and accidental exposure to water and seabed sediment of the pollution caused by such craft. Before the beginning of the decommissioning phase, relevant procedures should be implemented to prevent spills of petroleum pollutants (among others) along with procedures for handling such incidents to minimise adverse impacts on the water and seabed sediments.

4 RISK ASSESSMENT

4.1 INTRODUCTION

This section summarises the results of the risk assessment concerning accidents and failures affecting the environment and risks to the population (third-party or societal risk). In this section, the term 'risk' is defined as the likelihood of an accidental event occurring, together with its consequences.

Appropriate safeguards, discussed later on in this section, as well as the mitigation measures detailed in Section 3.10 hereof, will be applied to prevent the occurrence of failures and accidents.

Mitigation measures and safeguards will be considered at the wind farm design stage so that the risk to human and environmental safety remains below the risk acceptance criterion. In addition, measures have been implemented to ensure further risk reduction to the lowest reasonably practicable level (ALARP). This applies to both the OWF construction and operation phases. For the Baltica-1 OWF Project, risk assessments were conducted as part of the Polish environmental impact assessment, for all phases of the Project. The results of the risk assessment concerning accidents affecting the environment and risks to the population (third-party or societal risks) are summarised below. This report does not cover issues related to the working environment and risks incurred by workers involved in construction activities. The framework for risk control during construction and operation is set out in the Project Owner's health, safety and environmental management system.

4.2 APPLICATION OF THE ALARP PRINCIPLE

The Baltica-1 OWF Project has been designed on the assumption that risks are reduced to be as low as reasonably practicable (ALARP). The ALARP principle is described in Figure 4.1. According to the figure, intolerable risks in the upper part of the diagram require unconditional mitigation: risks are beyond legal requirements, company operating standards, etc. The risks in the ALARP area, i.e. tolerable risks, should be reduced to the lowest reasonably practicable level (ALARP), i.e. until the costs associated with further risk reduction become disproportionately high in relation to the benefits obtained.

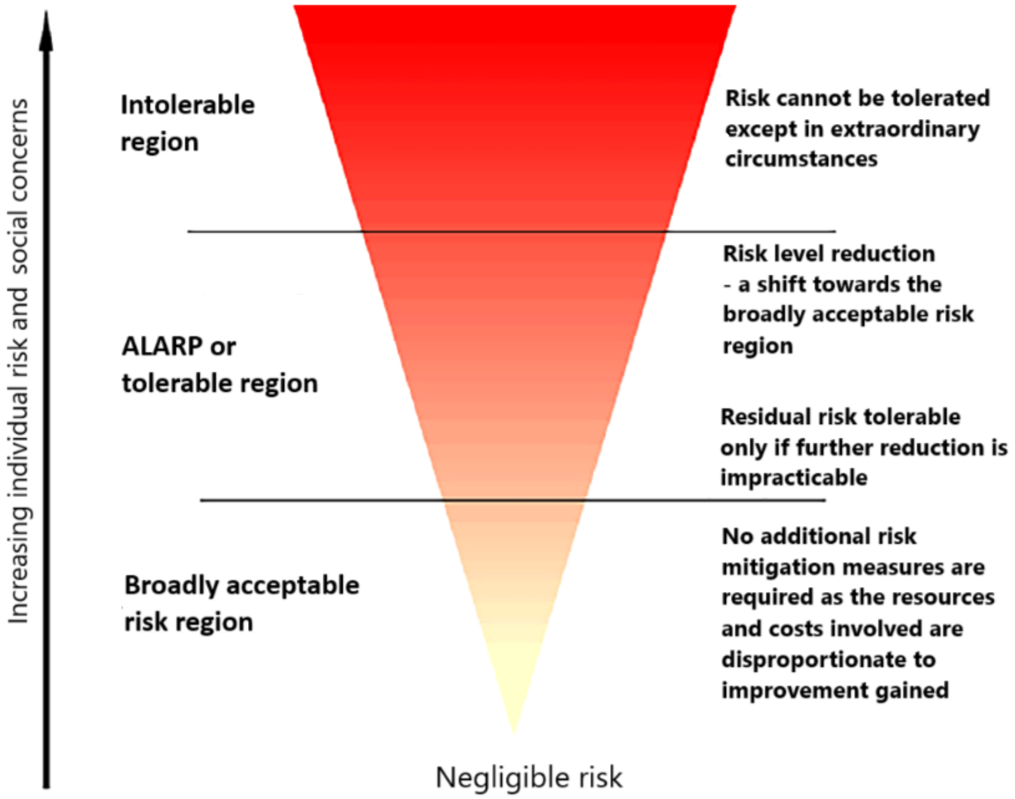

Figure 4.1. ALARP triangle

4.3 Risk acceptance criteria

The following elements can be distinguished in the risk assessment process:

- hazard identification;
- risk estimation and risk ranking;
- risk assessment and implementation of reduction measures until the level of acceptability is reached;
- process review.

The primary objective of risk assessment is to identify risks and to estimate their level for ranking purposes, as well as to manage them accordingly. Each step in the risk assessment process should be seen as an opportunity to identify potential means of risk reduction.

G+ data (Global Offshore Wind Health and Safety Organisation) for the period 2019–2021 show that accidents associated with marine operations represent only a small proportion of the total number of accidents – in the range of 4.6–6.9%, with an average of 45 accidents per year.

4.4 Vessel traffic risks

The main risks of incidents (accidents), both during the construction and operation phases, are related to the fact that although the Baltica-1 OWF is located outside the main shipping routes of the Baltic Sea, the usual route leading to the port of Klaipeda runs through its southern part. This means that there is a risk of collision between third-party vessels and a construction or service vessel, which could cause a health and life hazard and/or an oil spill into the sea. It also means that there is a risk of unplanned interaction between vessel traffic and the farm structures during the operation phase.

4.4.1 Spill of petroleum products during normal operation of vessels or in an emergency

During the Project construction phase, followed by possible decommissioning by dismantling, the most significant potential threats to the environment will be emergencies resulting in spills of petroleum products, mainly fuel, hydraulic, transformer and lubricating oils from vessels. To a lesser extent, accidental or incidental releases of hazardous substances, or materials containing them, from vessels, vehicles and equipment may pose a threat to the marine and terrestrial environment. The same threats were identified for the operation phase; however, the probability and effect of their occurrence will be lower due to a limited scope of work assumed for this phase of the Project, which mainly involves periodic inspections and maintenance as well as ad hoc repairs.

In order to counteract the threat of a leak of hazardous substances, all vessels involved in each phase of the Project shall meet the requirements and shall comply with the regulations resulting from the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78); in particular, they shall have and follow the procedures contained in 'Shipboard Oil Pollution Emergency Plans', developed individually for each vessel. To minimise the risk of an emergency, a detailed schedule of offshore works shall be prepared and a centre coordinating these works shall be established.

The magnitude of petroleum product contamination can be classified as follows:

- Tier 1 (small spill) – small spills of petroleum products that do not require the intervention of external forces and resources and are possible to be removed with own resources. These spills are of local character, their removal does not pose particular technical difficulties, and they do not pose a significant threat to the marine environment;
- Tier 2 (medium-sized spill) – spills of petroleum products, the scale of which requires a coordinated counteraction within the maritime area under the authority of a maritime office director with territorial competence who decides on the scale of the counteraction required;
- Tier 3 (catastrophic spill) – spills of petroleum products that are extremely dangerous to the environment, the neutralisation of which involves forces and resources subordinate to more than one director of the maritime office.

During a normal operation of vessels, small spills of petroleum products, i.e. diesel oil, lubricants and petrol, may occur. In most cases, the released petroleum products cause Tier 1 spills.

The largest petroleum product spills may occur as a result of serious vessel failure or collision with other vessels and OWF structures. In the worst-case scenario, during the construction and decommissioning stages, Tier 3 spills (catastrophic spills) might occur.

The risk of a major accident resulting in the emission of hazardous substances is minimal.

Assuming the worst-case scenario and the release of several hundred cubic metres of diesel fuel into the marine environment, and also taking into account its type, behaviour in seawater, the time of oil dispersion and drift, it is estimated that the range of pollution will not exceed 5 to 20 km from the Baltica-1 OWF Area. The determination of the actual extent of a spill will be technically possible only during the event, on the basis of the current meteorological data and the data on the type and potential quantity of the contaminant.

It should be emphasised that the key issue there is not so much the size of the spill as the place where it occurred. There are known cases of high bird mortality due to small oil spills into the sea. Extensive oil slicks drifting away from the coasts, in sea areas with very low numbers of birds, do not cause as high population losses as smaller spills in areas of large seabird concentrations (Meissner, 2005). The Baltica-1 OWF Area is located near the Swedish Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308), which is an important wintering site for seabirds and one of the main areas of porpoise population occurrence in the Baltic Sea. However, it should be emphasised, that in the case of Tier 1 spills, providing proper organisation of prevention and counteraction is ensured, the dispersal of petroleum products threatening the protected areas and the objects of protection in those areas is unlikely.

4.4.2 Risk of vessel collisions with other vessels and offshore wind farm structures

The following hazards can be distinguished as causes of marine incidents, which potentially, in combination with most incident types, will result in an increase in the risk level beyond the acceptable area:

- navigation error (non-compliance with navigation regulations, error, mistake, wrong decision);
- malfunction of navigation equipment or steering–propulsion system;
- inappropriate watchkeeping practices or poorly organised crew rest;
- lack of sufficient sea room for manoeuvring due to the presence of OWF structures, other wind farm structures and other vessels;
- error in the detection of another vessel due to radar interferences in the vicinity of an OWF in poor visibility conditions.

In addition, the following hazards were identified that, in combination with at least one incident type, may result in an unacceptable level of risk:

- lack of information on the presence of a structure, structure unnoticed or undetected;
- navigation hindered by the presence of other vessels;
- a strong wave within the wind farm area caused by another vessel passing through or near an OWF;
- OWF structures interfering with VHF/AIS communications;
- emergency anchoring;
- the person affected is unable to determine their location.

4.4.2.1 Significant hazards

Both in the opinion of experts and based on analyses of accident statistics, the most serious hazards, combined with the highest probability, include vessel collisions, vessel contact with OWF structures, as well as accidents related to offshore operations.

It should be noted that the hazards are independent of the OWF life phase. However, the probability of these incidents will vary depending on the number, class and category of vessels involved in the Project.

During the construction phase, the risk of incidents is increased due to the large number of vessels, the new navigational situation in the sea area, and the more serious consequences associated with the involvement of large installation vessels. During the operation phase, the risk of incidents is reduced due to the less serious consequences associated with the absence of large installation vessels and the known navigation situation within the sea area. On the other hand, the number of less serious accidents increases due to the increased number of small vessels. In the decommissioning phase, the risk of incidents is slightly higher, and the consequences are more serious than in the operation phase due to a certain number of installation vessels. The overall risk is lower than during the construction phase due to the known navigation situation in the sea area and since certain marine operations are not performed.

4.5 Risks associated with potential finds of man-made objects

Another cause for a major accident is the possibility of a release of hazardous substances from objects of anthropogenic origin lying on the seabed surface or buried in the seabed sediment. The Project Owner conducted geophysical surveys as part of the environmental surveys and no hazardous objects were found on the seabed. It cannot be ruled out however that during the preparatory work for the Baltica-1 OWF construction process, and particularly during the seabed surveys focused on the presence of UXO and chemical weapons, man-made objects can be discovered, the disturbance of which could result in the release of contaminants contained therein (e.g. containers with chemicals or unexploded ordnance). Before the commencement of the construction, the Project Owner shall conduct detailed surveys on the presence of UXOs and duds on the seabed. In case any chemical warfare agents/UXOs are identified during these surveys, the Project Owner will notify the relevant authorities and institutions accordingly and will comply with their instructions and decisions. To determine the way of dealing with such finds, the Project Owner will prepare a plan for handling dangerous objects, both from the point of view of operational work at sea (for example, rules for conducting works in the vicinity of potentially hazardous objects) and from the point of view of possible removal or avoidance of the locations of such objects. The basic assumption of the plan for dealing with dangerous objects is to avoid threats to human life and health and to avoid the spread of contaminants from such objects.

4.6 Hazards and risks during the Baltica-1 OWF construction and decommissioning phases

The construction phase and the possible decommissioning by dismantling of the transmission infrastructure will be similar in terms of technologies, equipment and workload applied. Therefore, it can be assumed that the scope of potential hazards to the environment in both phases will be the same.

For the construction and possible decommissioning phases, the following emergencies were identified as potential sources of adverse impacts on the marine environment:

- spills of petroleum products as a result of a collision of ships in an emergency;
- spills of oils from the equipment used for cable burial in the seabed;
- accidental release of household waste or domestic sewage;
- accidental release of chemicals;
- contamination of water and seabed sediments with antifouling agents.

As a direct result of emergencies and incidents, the abiotic environment, especially seawater and to a lesser extent, seabed sediments can become contaminated. These events can also directly and indirectly affect the living organisms inhabiting or otherwise using the seabed, the water column and the surface of the sea. Possible contamination of water or seabed sediments with household waste or domestic sewage will involve a significantly lower environmental impact, which will be solely local. The collision of ships and the resulting release of hazardous substances into the environment (especially petroleum products) is a factor which can cause increased mortality and diseases of marine organisms, including those that are subject to protection in such areas. The likelihood of such events can be considered small. It should also be emphasised that these risks do not extend beyond the standard risks encountered in this type of project and can be reduced to a minimum. Moreover, the implementation of a collision and spill management plan for the duration of the Project, in accordance with the applicable laws, is aimed at minimising the impact of such events on marine organisms and the protected areas.

4.7 ENVIRONMENTAL HAZARDS DURING THE OWF OPERATION

During the operation, due to maintenance activities, threats to the marine environment may result from the contamination of water and, to a lesser extent, sediments with:

- petroleum products;
- antifouling agents;
- accidentally released municipal waste and domestic sewage;
- accidentally released chemicals.

Waste and sewage will be generated by people on service vessels periodically carrying out inspections of the OWF structures and on vessels involved in works aimed at rectifying potential failures. The impacts caused by the occurrence of emergencies during the operation phase are partially identical to those which may occur during the construction phase. Only the aspect regarding the accidental release of chemicals and waste is slightly different. Periodic inspections of the cable lines will be carried out during their operation. The possibility of small quantities of waste or operating fluids being accidentally released into the sea cannot be excluded.

Cable lines buried in the seabed sediment – as opposed to those laid on the seabed – are less exposed to adverse environmental factors, but their potential damage is usually permanent, and their repair is more expensive and time-consuming. It should be noted, however, that the failure rate of underground cable lines is extremely low, considerably lower than that of overhead lines. The following cable line failures can be distinguished [Pędzisz, 2007]:

- simple: single-, two- and three-phase earth faults; one-, two- or three-phase interruptions and transient short circuits;
- complex: including two or more simple failures, e.g. a single-phase short circuit with a simultaneous phase break.

Two types of causes of cable line damage are distinguished:

- external: any damage resulting from other human activities (e.g. anchoring of vessels and using active bottom-set fishing gear in the locations of the cable line installation) as well as random incidents (e.g. sinkholes);
- internal:
    - design errors and technological defects not found upon acceptance,
    - incorrect installation and assembly errors,
    - electrical, including partial discharge,
    - ageing, material fatigue,
    - inadequate protection of lines against overcurrent (increase of electric current in the circuit above the permissible value),
    - inadequate protection of lines against corrosion.

Most often, damage to cable lines occurs as a result of a process consisting of many aspects occurring in succession. According to literature, electrical causes account for the largest proportion of failures (approx. 40%) [Pędzisz, 2007]. In the marine environment, these include overcurrent. A malfunction of the protection and automation systems may make it more difficult to locate the fault, which will increase the repair time. In the case of the OSS failure, gas emissions to the atmosphere may occur (flue gases from the power generator activated in emergencies, leaks of cooling agent from the cooling system or leaks of SF6 insulating gas if gas-insulated switchgear is used). There is also a risk of leakage of electrolytes, fire extinguishing agents and power generator fuel.

The hazardous substance which will be used within the OSS area is transformer oil. In total, all transformer units may contain up to approximately 1550 Mg of transformer oil. To minimise the risk of contamination with oil from the equipment installed in substations, installations with separators and leak-proof tanks will be used to collect the substance in case of failure. Equipment containing oil will be equipped with oil sumps with a capacity of at least 10% larger than the volume of oil contained in them. The OSS is not classified as a plant with an increased or high risk of a serious industrial accident.

It should be emphasised that, similarly to the construction and decommissioning phases, the above-mentioned risks are standard risks during the operation of offshore wind farms. The likelihood of a failure occurring is relatively low and will be reduced accordingly, and if a failure does occur, appropriate actions will be taken to minimise and limit the extent of its effects.

4.8 Risk of structural collapses

In the case of the Baltica-1 OWF, a structural collapse, i.e. the destruction of wind turbines and/or accompanying infrastructure, could result from an emergency, in that case only due to a serious collision with a vessel or extreme weather phenomena. The likelihood of such occurrences will be very low, additionally eliminated and minimised by design solutions developed for the safe execution of work at sea.

Given their intended purpose, OWF structures are designed and erected with a view to withstanding extremely difficult environmental conditions. The same will apply to the Baltica-1 OWF design. All components, despite being subject to extremely high stresses, will be suited to many years of operation. All equipment will be continuously monitored and any sign of deviation from the situation classified as safe operation will trigger automatic remote maintenance interventions or changes in operating parameters, also including shutdown. The rotor will be stopped automatically at wind speeds exceeding the safe operation threshold for the wind turbine. A service plan will be developed, the implementation of which will ensure the safe and failure-free operation of the Baltica-1 OWF during the entire operation phase.

4.9 Risk of natural disasters

The proposed Project will be located in the open sea area; thus a natural disaster may occur due to electrical discharges, strong winds and intense precipitation. Other factors are related to land areas or do not apply to the Project. Sea ice phenomena were also disregarded as the open waters in this part of the Baltic Sea do not freeze, hence there is no drift ice. The development of wind turbines and the accompanying infrastructure will take into account the need to counteract extreme weather events over several decades of work. Wind turbines and OSSs will be fitted with arresters and surge protection systems (compliant with the international standard IEC 61400-24) for protection against discharges. Wind turbines have specified work ability in windy conditions. In the case of excessively strong winds, the rotor is automatically blocked, and its blades are set in such a way that the angle of attack is as small as possible (ensuring the least resistance). The construction of wind turbines and OSSs, as well as the security systems against the impact of extreme environmental phenomena, make it almost impossible for a natural disaster to occur and cause damage to the OWF elements.

It is also not expected that the impact of extreme weather phenomena could lead to damage or destruction of vessels supporting the construction, operation and decommissioning of the Baltica-1 OWF. Any work carried out at sea will be performed within the conditions set out in the procedures developed for particular works and stopped immediately when these conditions are exceeded. Any work will take into account the current meteorological conditions and their changes forecast in 12- and 24-hour cycles.

The maximum operating life of the Baltica-1 OWF is estimated at 35 years. Taking into account such a long-time perspective, it should be determined whether climate change taking place may affect the operation of the Project and how. According to the study 'Climate change in the Baltic Sea. 2021 fact sheet[4], parameters outside the Baltic Sea (external parameters) that significantly shape its condition. provides information on the predicted changes in the direct and external parameters, along with a description of how the changes may affect the operation of the Project. It should be noted that the referenced HELCOM document provides predictions of the direction and strength of parameter changes in the context of the end of the century, while the input values that formed the basis of the predictions were determined for the period 1976–2005. Assuming that the construction of the farm will begin in approximately 5 years and the operation will extend over 35 years, the shutdown will take place approximately 30 years before the time threshold for which predictions of change were prepared in the HELCOM document. However, taking a precautionary approach, the possible impact of changes in the Baltic Sea parameters was assessed in case they occurred before the year 2100 in the full range of directions and changes.

Despite the long-time horizon accounted for in the HELCOM study and the adoption of the worst-case projected environmental change scenario in the analysis, it does not demonstrate that the effect of climate change is likely to significantly affect the operation of the Project over its lifetime. It should be noted that the selection of the Baltica-1 OWF components and the construction process technology will account for several decades of operation and the forecasts of environmental changes that may occur during this period. The offshore wind farm components already available and the ones yet to be launched are characterised by a very wide range of resistance to environmental factors and take into account the climate changes taking place. In conclusion, the impact of climate change on the operation of the Baltica-1 OWF should be considered negligible.

4.10 Design, technological and organisational safeguards against failures, structural collapses and natural disasters

Design, technological and organisational security mainly rely on carrying out navigational risk assessments and developing prevention plans against:

- threats to human life – evacuation plans, rescue plans;
- fire hazards;
- threats of environmental pollution – a plan to counteract the threats and contamination by oil. The obligation to have a plan in place will apply not only to the facility but also to all large and

[4]HELCOM 2021. Climate change in the Baltic Sea. 2021 fact sheet. BSEP No 180. p. 45.

medium-sized vessels involved in the construction, operation and decommissioning of the OWF;
- the risk of structural collapse – all structures are designed in a manner accounting for possible extreme conditions that may occur during the operation period as well as during its possible extension.

Failure prevention covers a comprehensive range of activities related to the protection of human life and health, the natural environment and property, as well as the reputation of all participants in the processes related to the OWF construction, operation and decommissioning. These activities include, among others:

- developing plans for the safe construction, operation and decommissioning of the OWF in accordance with the applicable legal regulations for the duration of the Project implementation;
- developing rescue plans and training crews and personnel, including the principles of updating and verification by conducting regular exercises, in particular determining the procedures for the use of own vessels and external vessels, including helicopters;
- developing a plan for counteracting threats and pollution arising during the construction, operation and decommissioning of the OWF;
- selecting suppliers as well as certified parts and components of the OWF;
- designating protection zones;
- accurate marking of the OWF Area, its facilities and vessels moving within the area;
- planning offshore operations;
- applying the standards and guidelines of the International Maritime Organization (IMO), recognised classification societies and maritime administration recommendations;
- developing plans of safe navigation within the OWF Area and safe passages to ports;
- providing adequate navigational support in the form of maps and navigational warnings;
- providing direct or indirect navigational supervision using a surveillance vessel or remote radar surveillance and Automatic Identification System (AIS);
- continuous monitoring of vessel traffic within the OWF, direct or remote, throughout the entire period of the construction, operation and decommissioning of the OWF;
- establishing a coordination centre supervising the construction, operation and decommissioning of the OWF;
- maintaining regular communication lines between an OWF coordination centre and the coordinator of works at sea and other coordination centres (Maritime Rescue Coordination Centre in Gdynia, maritime administration).

4.10.1 Information on the marking of wind turbines

In accordance with §27 of the Regulation of the Minister of Infrastructure of 12 January 2021 *on air traffic obstacles, obstacle limitation surfaces and dangerous devices* (Journal of Laws of 2021, item 264), an air traffic obstacle such as a wind turbine should be marked by being painted white. The rotor blades, the nacelle and the top 2/3 of the support structure should be painted.

§ 37(1) of the aforementioned regulation provides for the night-time marking of individual wind turbines, hence the use of medium-intensity B-type obstruction marking lights placed at the highest point of a nacelle. A wind turbine should be additionally marked with at least three low-intensity

E-type lights placed at one level, set halfway between the surrounding terrain or water and the obstruction marking light.

A backup, medium-intensity, B-type obstruction marking light should be placed on the wind turbine, to be automatically activated in the event of failure of the obstruction marking light. When two or more turbines are situated within 900 m of one another, the obstruction marking light fitted on them shall flash simultaneously.

The navigational marking of the wind turbines will be implemented in accordance with the provisions of Part B, item 15 of the Regulation of the Minister of Transport, Construction and Maritime Economy of 4 December 2012 *on the navigational marking of Polish sea areas* (Journal of Laws of 2013, item 57) or relevant regulations in force during construction:

- the tower of each wind turbine should be painted all round from mean sea level (MSL) up to a height of 15 m or up to the level where the navigational markings are located (whichever of the two is higher); alternatively, all-round horizontal stripes with a width of not less than 2 metres and an interval the same as the width of the stripes may be used; reflective materials may also be used; navigational markings, if provided on the generator, shall be a white light flashing Morse code "U" – Mo (U), to be mounted at least 6 m above mean sea level (MSL) but below the lowest point of the arc traced by the rotor blades;
- corners and other points of change on the periphery of the wind farm should be marked with a yellow flashing light synchronised to display 'special mark' characteristics, so that they are visible from any direction and have a nominal range of at least 5 NM; the boundaries of the wind farm should be marked along the perimeter, at intervals of no more than 2 NM, by means of yellow flashing lights with the flash characteristics distinctly different from those used at the corners of the wind farm to ensure visibility from every direction, with a nominal range of at least 2 NM; the lateral distance between all the lights used, counting along the boundary of the wind farm, must not exceed 2 NM; the corner lights should be synchronised with one another; it is permissible to install yellow navigation lights, with the flash characteristics distinctly different from those used at the corners of the wind farm, visible from every direction, with a nominal range of at least 2 NM, on all the wind turbines forming the wind farm or all the wind turbines situated on the periphery of the wind farm;
- due to the need for accurate identification, the following may additionally be installed at wind turbine farms: racons, radar reflectors or radar target enhancers, and AIS equipment, as well as sound signals, the range of which should not be less than 2 NM;
- if a transformer station, meteorological station or service station is a part of a wind farm, it should be included in its navigational marking system, whereas if it is not a part of the farm, it should be marked as an offshore structure.

4.11 Measures for preventing unplanned events and mitigating their effects

The assumptions of measures for preventing unplanned events resulting from the implementation of the Baltica-1 OWF, and for mitigation of their effects on the safety of the natural environment and people, are indicated in Table 4.1.

Table 4.1. Measures for preventing unplanned events associated with the implementation of the Baltica-1 OWF and mitigating their effects on the safety of the natural environment and people

Event	Preventive measures
Potential collisions with vessels navigating along the adjacent shipping lanes and vessels involved in the construction of other wind farms located in the Middle Bank area as well as vessels involved in the possible exploitation of natural aggregate deposits within the Middle Bank.	During the construction and operation of the Baltica-1 OWF, all possible mitigation measures will be applied with the aim to minimise the risk of collision with vessels, in accordance with applicable regulations and best practices used for this type of offshore project. Such measures include coordination of vessels operating in the vicinity and within the area of an offshore wind farm by implementing an MCP (Marine Coordination Plan), their remote monitoring, marking of the offshore wind farm area at every step of its implementation using navigation buoys, use of surveillance vessel (guard vessels) capable of intercepting other ships. Moreover, the Project Owner will be in constant contact with competent entities responsible for the safety of navigation within the areas of other offshore wind farm projects to ensure coordination and harmonisation of operations resulting from shipping activity. All decisions of the maritime administration aiming to ensure the wind farm construction in a manner safe for people and the environment will be applied.
Oil spills	In case of emergencies resulting in oil spills, appropriate measures will be taken to prevent the spread of such substances and to remove them from the environment. Moreover, it should be noted that all vessels taking part in the operations associated with the Baltica-1 OWF are subject to all provisions of the International Convention for the Prevention of Pollution from Ships (MARPOL)
Collisions with linear infrastructure located on or in the seabed (pipelines, cables)	There are no pipelines nor subsea cables within the area of the Project and in its immediate vicinity. Therefore, there is no risk of collision with this type of infrastructure.
Encountering UXOs or CWAs due to interference with the seabed.	In the case UXOs or CWAs are encountered, adequate actions will be undertaken, including the notification of appropriate authorities and services, and in agreement with them, the Project Owner will undertake further actions to eliminate the risk
Potential explosions generated by adjacent industrial and military facilities	No industrial and military facilities are situated in the vicinity of the Baltica-1 OWF Area.
Events connected to climate changes and extreme weather phenomena	The scale and nature of the climate change and extreme weather phenomena that may occur in the region of the Project is difficult, if not impossible to foresee. However, due to the nature of the planned project, this hazard is most probably minor. Moreover, the design stage of the Baltica-1 OWF construction elements will account for aspects related to the potential increase of the sea level and extreme wind phenomena.

4.12 Impact of the Baltica-1 OWF on the operation and safety of shipping, military and civil aviation, as well as radar systems of border authorities and rescue services

OWF structures may cause radio wave interference such as shadowing, reflections or phase shifts, as well as additional radiation emissions. This applies to radio frequencies used for positioning, navigation and timekeeping, as well as communications including GMDSS and AIS systems.

OWF structures may produce radar reflections and cause certain areas to be invisible or shadowed during radar operation in the following interactions:

- ship – shore;
- ship – ship;
- VTS – ship;
- abnormal reception of signal emitted by a racon buoy;
- aircraft used for rescue operations – vessel or OWF structure.

OWF structures may cause interference with sonar systems used for fishing, as well as for industrial or military purposes. The Baltica-1 OWF may be the source of the following impacts on GMDSS and operational communication systems:

- reduction of communication ranges between base stations of both systems and ship stations. An OWF is an obstacle in the path of radio wave propagation, generating reflections, scatter and radio shadows. As a result of these undesirable factors, the useful communication range between base stations and ship stations may decrease, particularly in the vicinity of an OWF;
- limitations in communication between ship stations. An OWF is an obstacle in the path of radio wave propagation, generating reflections, scatter and radio shadows. As a result of these undesirable factors, the useful communication range between ship stations may decrease;
- being an obstacle in the path of radio wave propagation, an OWF is a source of undesirable radio shadows, i.e. places where the electromagnetic field strength may fall below the value corresponding to the usable sensitivity of the receiving station, thus preventing correspondence from being established. The shadows depend on the frequency range, the dimensions of the wind turbines and the distance from the station transmitting the useful signal;
- an OWF may be a source of undesirable reflection interference which, when present at the receiver input of a base station or ship station, may reduce the usable sensitivity or, in the case of duplex stations, generate unwanted system interference;
- an OWF can be a source of unwanted interference, which is generated by the overlap of the direct useful signal and the signal reflected from the farm surface. If an adequate distance between the levels of both signals is not ensured, the quality of the correspondence may deteriorate or even the correspondence may be lost;
- an OWF, and particularly its power infrastructure, may be a source of undesirable electromagnetic radiation, which may negatively affect the quality of correspondence by reducing the sensitivity of receiving stations and generating unwanted interference signals.

With regard to navigation and the distance between the wind turbine or the outer line of wind turbines and passing vessels, in particular shipping routes and vessel traffic separation zones, the principles set out in Table 4.2 should be applied.

Table 4.2. Requirements concerning the location, impact analysis, and provision of mitigation measures in the vicinity of shipping routes [Source: internal materials based on Maritime and Coastguard Agency MGN 543 (M+F)]

Distance of a wind turbine from the shipping route*	**Impact factors**	**Tolerability of the solution**
Below 0.5 NM (926 m)	X-Band radar interference. Vessels may generate multiple echoes on shore-based radars	Intolerable
0.5–3.5 NM (926–6482 m)	Navigation area, taking into account vessel size, manoeuvrability, and safe navigation rules. Distance from the traffic separation zone. S-Band radar interference. Impact on ARPA automatic target tracking systems.	Tolerable, subject to risk assessment and implementation of mitigation measures (ALARP)
Above 3.5 NM (6482 m)	Minimum separation distance between turbines on opposite sides of a route	Broadly acceptable

**The boundary of the shipping route is understood as the boundary of the traffic lane within which 90% of the vessels navigate.*

The assessment of the impact of the offshore wind farm and the complex of facilities on the system of radiolocation imaging, technical observation and maritime radio communications of the Border Guard, as well as possible proposals for prevention and mitigation measures, will be the subject of a technical expert report, which requires the approval of the minister in charge of internal affairs prior to obtaining the building permit.

4.13 EMERGENCY RESPONSE PLAN

Emergency response plans will be developed and implemented by the Project Owner before the commencement of the construction and operation phases, respectively. The emergency response plan will be suited to the scope of the activities planned and the risks associated with these activities, as described above.

5 Description of the Project variants analysed

According to Article 5 of the Espoo Convention, the Project Owner is required to assess possible alternatives to the proposed activity, including a so-called no-action variant, i.e. a variant under which the project is not implemented.

Under the national environmental impact assessment procedure, the Project Owner is also referred to as the Applicant.

The possible alternatives for the Baltica-1 OWF include the main variants related to the application of technological solutions and the ones accounting for the most effective use of the area covered by the PSzW decision.

The Baltica-1 OWF project implementation is characterised by a long, lasting up to 10 years, investment process. With the development of the technologies used in the offshore wind power sector being highly dynamic, it is impossible to specify the target parameters of all the elements comprising the Project. Therefore, in the national EIA Report, the Project is described using the so-called boundary condition envelope, i.e. the minimum and maximum technological and technical assumptions for its implementation.

Two feasible baseline variants of the Project were adopted, namely one preferred by the Project Owner – ensuring the most efficient use of the Project area and, as the impact analysis demonstrated, also the most beneficial for the environment – called the Applicant Proposed Variant (APV), and the Reasonable Alternative Variant (RAV), with both the APV and the RAV being feasible. A summary of the environmental impact analysis carried out for the Project will indicate which of these variants is the most favourable for the environment.

No location variants are possible for the Project because the location, considering site conditions (Baltic Sea area) has already been determined in the permit for the construction and use of artificial islands. Acceptable locations of offshore wind farms in the Polish Sea Areas are specified in the Regulation of the Council of Ministers of 14 April 2021 *on the adoption of the Maritime Spatial Plan for the Internal Sea Waters, Territorial Sea and Exclusive Economic Zone at a scale of 1:200 000* (Journal of Laws of 2021, item 935, as amended); however, the implementation of the Project in a different part of the sea basins intended for offshore renewable energy projects is impossible without obtaining a permit as part of the settlement procedure, under which the Minister of Infrastructure, after evaluating competing applications, grants permits to the project owner who receives the highest number of points. Therefore, any other location variant cannot be considered rational, as their implementation does not depend only on the Project Owner's decision.

The main elements subject to optioneering regarding the Baltica-1 OWF include:

- the maximum number of wind turbines – the parameter resulting from the rated capacity of a single turbine. The rated capacity of a single wind turbine determines the key parameters regarding the environmental impact, i.e.:
  - wind turbine height;
  - wind turbine rotor diameter;
  - the swept area of the operating wind turbine;
  - number of support structures and the area covered by them within the OWF;
  - the maximum length of inter-array cable lines in the OWF;

- the maximum number of OSSs – this parameter depends on the technological and economic constraints, the principle of redundancy and the target number of wind turbines.

Table 5.1 presents information on the key differences between the technical parameters in the APV and the RAV of the Baltica-1 OWF.

In the APV, the technical parameters are presented in the form of a matrix referring to the expected unit capacities of a single turbine, in the range of 15 to 25 MW, which have been adopted as extreme values, the use of which will generate the greatest, in envelope concept terms, environmental impacts. It should be noted that the Project accounts for the possible use of turbines with different capacities, with the same installation platform, offered by a single supplier, but due to dynamic technological progress, the selection of target units will be possible at a later stage of the Project.

In order to fully clarify the relevance of the matrix, two extreme cases involving the use of 15 MW, and 25 MW turbines should be considered for the APV. Given the total nominal capacity of the Baltica-1 offshore wind turbine array, which will be 900 MW, the number of turbines will be up to 36 units if 25 MW turbines are used, and 60 units if 15 MW turbines are used. At the same time, the rotor swept area in the case of a single 25 MW turbine (approximately 75 500 m^2) will be significantly larger than the swept area of a single 15 MW turbine (approximately 44 000 m^2).

Considering the above, the assumption is that it is possible to build a maximum of 60 wind turbines, at the same time reducing the maximum total swept area for the entire wind farm to 2 750 000 m^2 – which corresponds to the swept area if 36 turbines with a rotor diameter of 310 m are installed. Therefore, to describe the APV, a matrix was used, that enables an effective presentation of the parameters required to perform an impact assessment depending on the type of impact.

In the case of the RAV, units with a rated capacity of 14 MW were indicated for implementation. Turbines of this type are currently being installed in offshore wind farms under construction and will be used on a large-scale basis in offshore wind energy projects within the next few years. Although higher-performance structures will probably be available at the stage of wind turbine selection, it is assumed that turbines with a capacity of 14 MW will be still common on the market, and they will be easiest to procure due to a decline in project owners' interest in units of this capacity. For this reason, the use of 14 MW turbines provided the grounds for giving preference to the RAV.

Table 5.1. Comparison of basic technical parameters of the Baltica-1 OWF in the APV and RAV

Parameter	APV		RAV
Specific capacity of a wind turbine [MW]	from 15	to 25	14
Maximum number of wind turbines [pcs]	36–60		64
Minimum and maximum distance between wind turbines	3.5 RD–12 RD		3.5 RD–12 RD
Maximum total height of a wind turbine MASL [m]	330		266
Maximum diameter of a rotor [m]	236	310	236
Maximum zone of a single rotor [m^2]	44 000	75 500	44 000
Maximum total rotor zone [m^2]	2 650 000	2 750 000	2 800 000
Maximum area of the seabed occupied by one gravity-based structure, including erosion protection [m^2]	11,300	14 300	11 300
Maximum area of the seabed occupied by all gravity-based structures, including erosion protection [m^2]	735 000	575 000	800 000
Maximum OWF cable infrastructure length [km]	140	120	150

Parameter	APV	RAV
Number of OSSs	1–4	5

5.1 No-action variant

The non-implementation of the Project will have an adverse impact on the fulfilment of the effects expected under numerous policies and strategies, in particular concerning environmental protection (reduction of pollutant emissions, achievement of adopted environmental and climate objectives), sustainable development (use of renewable energy sources) and energy security (independence from external energy sources). Thus, the non-implementation of Baltica-1 will have an adverse impact on, among others, the national electricity supply system and the achievement of the sustainable development indicators assumed by Poland as well as the increase of electricity acquisition from renewable energy sources.

The non-implementation of the Project assumes, therefore, leaving the area in question in the baseline environmental conditions described in the EIA Report. In practice, this scenario is often referred to as a ‘no-action variant’.

When analysing the climate impact of the no-action variant, it should be noted that the lack of implementation of the Project means that no reduction in emissions will take place, and thus no reduction in climate impact related to the use of fossil fuels.

While analysing the Project, it was demonstrated that with a conservative assumption of 40% capacity utilisation and the assumed lifetime of the OWF, significant emissions of carbon dioxide, sulphur dioxide, nitrogen oxides and particulate matter from lignite-fired power plants can be avoided. Therefore, the non-implementation of the Baltica-1 OWF significantly prevents reducing environmentally harmful emissions, regardless of the calculation approach. It also means deviating from policies related to the reduction of air emissions from combustion sources, as well as failing to move towards measures related to the development and transition to renewable energy sources. In summary, in the variant assuming non-implementation of the Project, climate benefits are not obtained, which results in a failure to achieve the climate and environmental objectives assumed for both Poland and the EU.

The Applicant allows for the implementation of the Project both in a continuous process and in stages. This assumption does not apply to the no-action scenario.

5.2 Alternative variants considered

Considering the duration of an investment process, with the highly dynamic development of the technologies used in the offshore wind power sector, it is impossible to specify the target parameters of all the elements comprising the Project. Therefore, in the national EIA Report, the Project is described and assessed using the so-called boundary condition envelope, i.e. the minimum and maximum technological and technical assumptions for its implementation.

The Project maximum boundary conditions have been set for the option chosen for implementation at:

- the total capacity of the Baltica-1 OWF will not exceed 900 MW;

- the Baltica-1 OWF will comprise a maximum of 60 wind turbines (if using turbines with 15 MW capacity) or 36 wind turbines (if using turbines with 25 MW capacity);
- the maximum height of a single wind turbine, including the rotor, shall not exceed 330 MASL;
- the maximum diameter of the wind turbine rotor will not exceed 310 m;
- the maximum number of offshore substations will be 4.

The main elements subject to optioneering regarding the Baltica-1 OWF include:

- the maximum number of wind turbines – the parameter resulting from the rated capacity of a single turbine. The rated capacity of a single wind turbine determines the key parameters regarding the environmental impact, i.e.:
  - wind turbine height;
  - wind turbine rotor diameter;
  - the swept area of the operating wind turbine;
  - number of support structures and the area covered by them within the OWF;
  - the maximum length of inter-array cables within the OWF;
- the maximum number of OSSs – this parameter depends on the technological and economic constraints, the principle of redundancy and the target number of wind turbines.

5.2.1 Applicant Proposed Variant (APV)

The APV is a variant assuming the application, to the greatest extent possible, of state-of-the-art technologies available at the time of developing the building plans for each implementation stage of the Project. This includes, in particular, technologies for wind turbines larger than those available in the market at the time of submitting the EIA Report for the Baltica-1 OWF. This variant is the most beneficial for the environment, as shown later in the Section.

The APV envisages the possibility of using turbines with specific rated capacities ranging from 15 to 25 MW. Even though the turbines with the capacity indicated are not yet available on the market, this option will be considered reasonable, since turbines with a capacity of 15 MW and higher are already in the certification phase and will be available at the stage of applying for a building permit. However, this variant rightly assumes the possibility of using higher capacity turbines, in line with the current knowledge of the technology development plans of leading manufacturers and the analysis of the capacity development of individual units over the past decade.

The APV takes account of the fact that offshore wind turbine technologies are expected to be constantly developed, not only towards increasing sizes of rotors, generators and towers but also in terms of the effectiveness of the engineering solutions applied. This will allow the implementation of the Project with the parameters causing lower environmental impact, particularly thanks to:

- fewer wind turbines;
- smaller seabed area occupied by the wind turbine foundations and OSSs, including erosion protection systems;
- smaller number and shorter total length of the inter-array cable lines in the OWF.

In this way, the Project will be implemented in a shorter time and using less raw materials and fuels.

The APV envisages the construction of between 1 to 4 OSSs. The final number of substations will depend on the selected technology of electricity transmission on land, as well as on the cost and benefit analysis, the availability of production supply chains and on technological constraints, including the redundancy of the transmission system elements.

5.2.2 Reasonable Alternative Variant (RAV)

The RAV was selected as an alternative based on technologies that are currently used in offshore wind energy and available on the market. The variant assumes the application of wind turbines with a nominal capacity of 14 MW that are used and contracted in offshore wind farms currently under development. The more efficient designs envisaged in the APV, i.e. with capacities from 15 to 25 MW, are currently in the certification or design phase. Given the pace of development of wind turbine technology and the time horizon for the commencement of the construction phase, the availability of units with a capacity of even 25 MW on the market is highly probable. However, should currently unforeseeable external factors preventing their application occur, any technical limitations to their installation, inadequate supply or excess demand preventing the preferred units from being contracted within the required timeframe, the use of 14 MW turbines would also make it possible to achieve the Project objective, i.e. the construction of a 900 MW offshore wind farm. Considering that the maximum capacity of the Baltica-1 OWF will be 900 MW, the adoption of 14 MW units translates into the construction of a maximum of 64 wind turbines. In the assessment, the implementation of RAV in the same area was assumed, but due to the larger number of wind turbines to achieve a farm capacity of 900 MW, the RAV will require a different layout within its boundaries.

The RAV assumes the installation of 5 OSSs, based on conservative assumptions to ensure the security of electricity transmission. A larger number of substations ensures a higher redundancy and mitigates the effects of a single substation failure.

6 METHODOLOGY FOR CONDUCTING THE TRANSBOUNDARY ENVIRONMENTAL IMPACT ASSESSMENT

In general, the methodology for conducting a transboundary impact assessment is equivalent to that used in the national environmental impact assessment. This assumption ensures that the quality and detail of the environmental impact assessment is adequate and enables equal treatment of the Affected Party and the Party of Origin. However, this report focuses geographically on the maritime border areas between Poland and the Affected Parties.

The environmental impact assessment addresses the potential environmental and social impacts of all phases of the Project – implementation, operation and decommissioning – in terms of the relevant environmental and social elements. The assessment covers direct and indirect, cumulative and transboundary, permanent and temporary, as well as positive and adverse impacts of the Project, taking into account the objectives defined at the EU level (e.g. Marine Strategy Framework Directive, Water Framework Directive, Birds Directive and Habitats Directive) and at national levels. Impacts will be analysed in terms of their nature and extent and in relation to receptors (social and environmental). The impact analysis will determine receptor sensitivity and impact magnitude, and on that basis, the significance of the impact will be evaluated. The methodology used for the environmental impact assessment takes into account the following criteria for classifying environmental and social impacts:

- sensitivity of the environmental component/receptor;
- character, type and reversibility of the impact;
- strength/intensity, spatial extent/scale and duration of the impact;
- overall (general) significance of the impact.

The environmental impact assessment methodology is used for characterising the identified impacts and determining their overall significance.

In this report, the impact assessment accounts for the results of the Polish environmental impact assessment as well as the positions of the Affected Parties, with a particular focus on the environmental components identified in the Danish, Swedish and Finnish positions.

6.1 GENERAL METHODOLOGY OF THE ENVIRONMENTAL IMPACT ASSESSMENT

6.1.1 Basis for the assessment

Environmental impact assessments must always be based on a thorough identification and description of the environment affected by the potential impact (baseline situation). The level of detail in the representation of the baseline situation in the assessment depends on various factors, such as the nature of the project impacts and the characteristics of the receptor. These were determined for each receptor individually. In some cases, it is sufficient to rely on external data from the scientific literature and unpublished materials and data, including data from public institutions and monitoring results. In other cases, additional surveys are required. The table below [Table 6.1] compiles the marine environment components identified as receptors of impacts that may be generated by the Project consisting of the construction of the Baltica-1 OWF, also presenting the scope of specific surveys carried out within the Project as a basis for their baseline assessment. The survey methodology has been described earlier in this report, in Section 3.2 An extensive literature review was conducted for all the environmental components thus identified.

Table 6.1. The components of the marine environment identified as impact receptors, and a compilation of surveys conducted under the Baltica-1 OWF Project

Environmental component	Surveys/analyses
Abiotic components of the marine environment	
Depth and seabed relief, character of the seabed surface, deep seabed structure, deeper geological structures, magnetic anomalies	Geophysical surveys: bathymetric, sonar, seismo-acoustic surveys using sediment profilers, single-channel seismic and magnetometer surveys, ROV inspection, seabed sediment sampling, core sampling; in the area of Swedish waters, data on bathymetry and surface sediments were supplemented on the basis of publicly available data
Hydrology and meteorology	Wind speed and direction, air pressure, temperature and humidity, wave motion height, period and direction on the free sea surface, seawater depth, sea current velocity and direction as well as temperature, electrical conductivity, salinity and turbidity of water in the water column.
Physico-chemical parameters of water	Oxygen conditions (dissolved oxygen, BOD_5), total organic carbon (TOC), acidity (pH) and alkalinity, nutrients [ammoniacal nitrogen, nitrate nitrogen, total nitrogen, mineral nitrogen (DIN), phosphates, total phosphorus], suspended solids Analyses of the content of substances particularly harmful to the environment, such as mercury, nickel, lead, cadmium, arsenic, total chromium, chromium (VI), aluminium, phenols, cyanides, mineral oils, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (7 PCB congeners: 28, 52, 101, 118, 138, 153, 180) Measurements of the activity of radioactive caesium (^{137}Cs) and strontium (^{90}Sr) isotopes
Physico-chemical properties of sediments	Macroscopic description, particle size distribution analysis, humidity, loss on ignition (LOI), total organic carbon (TOC), content of metals (Pb, Cu, Zn, Ni, Cd, Cr, As, Hg) and their labile form, polycyclic aromatic hydrocarbons (16 PAHs), polychlorinated biphenyls (7 PCB congeners: 28, 52, 101, 118, 138, 153, 180), mineral oils, radioactivity of 137Cs, organic tin compounds (TBT, DBT, MBT), nutrient content (total nitrogen and total phosphorus)
Climatic conditions and climate change	Analysis of literature data and state monitoring data covering a period of several decades
Ambient noise	Underwater noise recording
Biotic components of the marine environment	
Phytobenthos	Seabed inspection and filming
Zoobenthos	Seabed sampling
Ichthyofauna	Collecting ichthyoplankton samples, hydroacoustic surveys and pelagic hauls, demersal fish surveys as well as surveys of herring concentration in terms of food supply for seabirds
Marine mammals	Surveys of the harbour porpoise and three species of seals – the grey seal, the harbour seal and the ringed seal – using passive acoustic monitoring (porpoises) and visual methods (porpoises and seals)
Seabirds	Observations from vessels.
Migratory birds	Visual observation, radar surveys and acoustic monitoring
Chiropterofauna	Acoustic monitoring at transects and monitoring points
Seabed habitats	Seabed inspection and filming
Natura 2000 sites	SDF and literature data analysis
Socio-economic components	
Archaeology, cultural heritage	Bathymetric, sonar and magnetometer surveys, visual inspection of the seabed
Navigation	HELCOM AIS data analysis
Fisheries	Analysis of the volume and value of catches and fishing effort (number of fishing days and fishing vessels) based on the data collected under the National Programme for Fisheries Data Collection

Environmental component	Surveys/analyses
Mineral extraction sites	Analysis of data contained in the Central Geological Database
Technical infrastructure	Geophysical surveys, analysis of SIPAM data

6.1.2 Potential environmental impacts of the Project

This Espoo Report focuses on activities conducted within the Polish EEZ in the context of the Baltica-1 OWF that have the potential to cause adverse environmental impacts within the territories of the Affected Parties – Sweden, Denmark and Finland.

Table 6.2 lists the elements of the environment that may be impacted and were therefore analysed as part of the Polish environmental impact assessment, and subsequently as part of this report.

Table 6.2. Environmental components subject to the Polish environmental impact assessment

Physico-chemical environment	Biological environment	Socio-economic environment
Geological structure Seabed sediments Raw materials and deposits Seawater and seabed sediment quality Climatic conditions State of atmospheric air Electromagnetic field Ambient noise	Phytobenthos Macrozoobenthos Ichthyofauna Migratory birds Seabirds Marine mammals Bats Protected areas and the subjects of protection in these areas	Cultural heritage Fisheries Navigation Landscape, including cultural landscape Population, health and living conditions

Environmental impacts were preliminarily described and classified according to their character (adverse or positive), type and degree of reversibility. The type helps identify whether an environmental impact is direct, indirect, secondary or cumulative. The degree of reversibility refers to the capacity of the exposed environmental or social component/resource to return to its pre-impact condition.

The predicted size of the environmental impact is further defined and assessed in terms of several variables, in particular the intensity, extent and duration of the environmental impact. In most cases, the values assigned to environmental impacts are objective.

A general flowchart of the assessment procedure is presented in Figure 6.1.

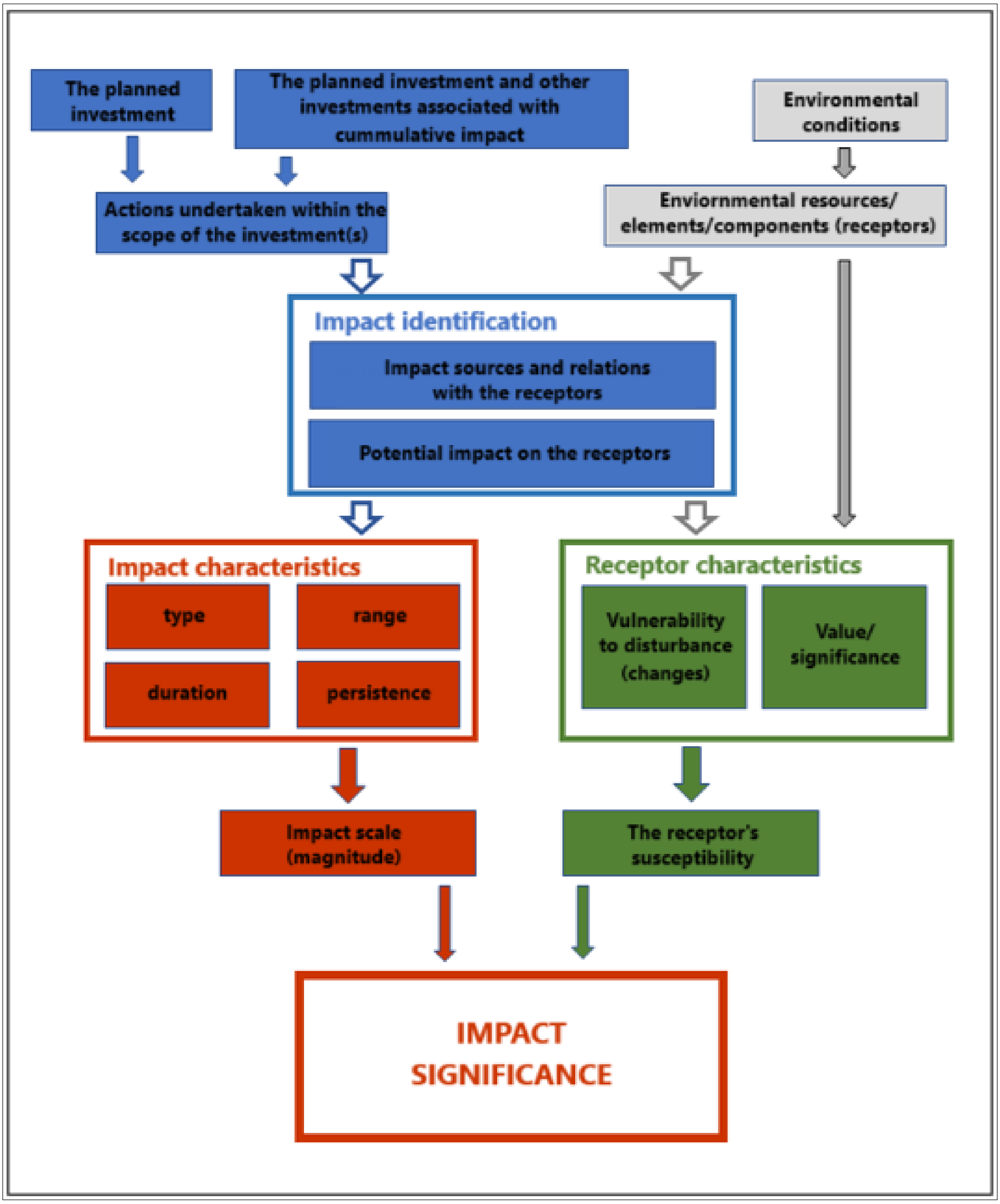

Figure 6.1. Outline of environmental impact identification and impact assessment, including the determination of impact significance [Source: internal materials based on Espoo Report (2017)]

An actual environmental impact occurs only when a specific sensitive receptor is present within the impact range. A receptor is considered to be an individual component of the environment (e.g. species of plants and animals, natural habitats, abiotic components, landscape) but also people and tangible property.

At the first stage of the assessment, environmental impacts that may affect individual receptors resulting from the construction, operation and decommissioning phases of the proposed Project were identified. Based on the environmental and inventory surveys carried out for the purposes of the national EIA Report, the receptors on which these activities may have an environmental impact were also specified. At the second stage of the assessment, the correlations between the sources of potential environmental impacts and individual receptors were identified on the basis of literature and experts' experience.

The environmental impacts identified were assigned features in four categories [Table 6.3]:

- type (direct, indirect, secondary);
- scope (transboundary, regional, local);
- duration (permanent, long-term, medium-term, short-term, temporary);
- permanence (irreversible, reversible).

Table 6.3. Characteristics of the Project environmental impacts on receptors

Category	Feature	Characteristics
Type	Direct	Impact from direct interaction between the activities resulting from the proposed Project and the environmental components
	Indirect	Impact from indirect interaction between the activities resulting from the proposed Project and the environmental components
	Secondary	Impact from the interaction between the proposed Project implementation and the environmental components, postponed in time, which may occur as a result of direct or indirect impact
Range	Transboundary	Impact the effects of which are felt outside Poland on the territory of other countries
	Regional	Impact the effects of which exceed the immediate vicinity of the activity related to the planned project but not go beyond the Polish sea areas or the area of the commune
	Local	Impact occurring in the direct vicinity of the activities related to the proposed Project
Duration	Permanent	Impact that will not subside after the conclusion of the activities related to the proposed Project
	Long-term	Impact that is limited in time and its effects are noticeable (measurable) either constantly or cyclically for 3 years or 3 vegetation periods from the beginning of the activity related to the proposed Project
	Medium-term	Impact that is limited in time and its effects are noticeable (measurable) either constantly or cyclically for 1 to 3 years or 1 to 3 vegetation periods from the beginning of the activity related to the proposed Project
	Short-term	Impact that is limited in time and its effects are noticeable (measurable) for a relatively short period but no longer than 1 year or 1 vegetation period from the beginning of the activity related to the proposed Project
	Temporary	Impact that is limited to the duration of the activity related to the proposed project
Permanence	Irreversible	Impact with effects that will not disappear after the cessation of activities related to the proposed Project, and the resources will not return to the baseline condition
	Reversible	Impact with effects that cease to be noticeable (measurable) after the activities related to the proposed Project are completed

As a result, each environmental impact was characterised and assessed in accordance with the scoring scale provided in Table 6.4.

Table 6.4. Method of assessing individual impacts on receptors

Impact	Environmental impact characteristics													Overall assessment
	Type			Range			Duration					Permanence		
	Direct	Indirect	Secondary	Transboundary	Regional	Local	Permanent	Long-term	Medium-term	Short-term	Temporary	Irreversible	Reversible	
	Points													
	3	2	1	3	2	1	5	4	3	2	1	2	1	4–13
Impact 1.														
Impact 2.														
…														
Impact n														

As a result of the ratings assigned to the environmental impact characteristics, the size (scale) of the environmental impact was described according to a five-point scale:

1) 4–5 pts – irrelevant;
2) 6–7 pts – low;
3) 8–9 pts – moderate;
4) 10–12 pts – high;
5) 13 pts – very high.

In the cases of possible interaction between the environmental impact and the receptor, the resistance of the receptors to individual environmental impacts as well as their significance and role in the environment were determined, including the conservation status in relation to environmental components. As a result, the resistance and significance of the receptors contributed to the determination of receptor sensitivity, which was also determined using the expert method, according to a five-point scale: (1) irrelevant, (2) low, (3) moderate, (4) high and (5) very high.

At the next stage of the assessment, taking into account the assigned size (scale) of the environmental impact and the receptor sensitivity, the significance of a given environmental impact on the receptor was also determined on a five-point scale [Table 6.5]:

- negligible environmental impact;
- low environmental impact;
- moderate environmental impact;
- important environmental impact;
- significant environmental impact.

Table 6.5. Matrix defining the significance of the environmental impact in relation to the environmental impact scale and the receptor sensitivity

Environmental impact significance		Receptor sensitivity				
		Irrelevant	Low	Moderate	High	Very high
Scale (size) of impact	Irrelevant	Negligible	Negligible	Negligible	Negligible	Low
	Low	Negligible	Negligible	Low	Low	Moderate

Environmental impact significance		Receptor sensitivity				
		Irrelevant	Low	Moderate	High	Very high
	Moderate	Negligible	Low	Low	Moderate	Moderate
	High	Negligible	Low	Moderate	Important	Significant
	Very high	Low	Moderate	Moderate	Significant	Significant

According to the methodology of the environmental impact assessment described above, a significant environmental impact may occur if a 'very high' scale of impact is determined and at the same time at least a 'high' sensitivity of the receptor and if a 'high' scale of impact with a 'very high' sensitivity of the receptor is identified at the same time.

The methodology described above was developed to standardise the environmental impact assessment for different types of activities, emissions and different types of receptors. This approach enabled an effective comparative assessment of all environmental impacts of the Project and the assessment of the Project as a whole. Due to the algorithm of the methodology adopted, it was necessary to quantify both the scale of environmental impact and the sensitivity of the receptors (assigning the number of points from the pool available for individual evaluation criteria).

A separate category, not subject to assessment with regard to impact characteristics, are cumulative environmental impacts occurring in combination with the environmental impacts resulting from other current and/or planned projects, concerning the same subjects of environmental impact. They were identified regardless of their characteristics and assessment.

In line with the purpose of this report, the focus was on environmental impacts identified as transboundary at the stage of the Polish environmental impact assessment. In addition, the environmental impacts identified were examined in terms of the issues raised in the positions of the Affected Parties, notified in accordance with Article 3 of the Convention. The characteristics of transboundary environmental impacts are presented in Section 7, while the conclusions in the context of the Affected Parties' expectations are presented in Section 11.

6.2 Assessments relating to Natura 2000 sites

Articles 6(3) and (4) of the Habitats Directive require an assessment of whether the Project may have a significant adverse environmental impact on areas belonging to the Natura 2000 network. As for the Baltica-1 OWF, the assessment of potentially exposed Natura 2000 sites is detailed in the national EIA Report. The methodology for conducting environmental impact assessments concerning Natura 2000 sites included four stages:

- preliminary assessment, i.e. screening (qualification);
- main assessment;
- assessment of alternative solutions;
- assessment conducted in the absence of alternatives and where adverse impacts persist.

The initial stage of the assessment was a screening of Natura 2000 sites and their conservation objectives, which helped identify the potential adverse environmental impacts of the Project on the sites, either individually or in combination with other projects or plans, to determine whether or not the impacts are likely to be significant. If the preliminary assessment indicates that significant adverse environmental impacts on the Natura 2000 site in question can be ruled out, no further assessment stages are required. Where adverse environmental impacts may be significant, a proper assessment was necessary. In such cases, the assessment also included transboundary environmental impacts to capture all potential environmental impacts in a given area. Section 7.3.6 of the Espoo Report summarises the results of the environmental impact assessments for Natura 2000 sites, including the subjects of their conservation, integrity and links to other sites, exposing transboundary impacts, if any.

6.3 Assessments in terms of Annex IV to the Habitats Directive

Article 12 of the Habitats Directive provides for the establishment and implementation – throughout the territory of the Member States – of a system of strict protection for the animal species listed in Annex IV(a) of the Habitats Directive.

With regard to strictly protected species, the Directive prohibits:

- all forms of deliberate capture or killing of specimens of such species;
- deliberate deterioration or destruction of breeding sites or resting places;
- deliberate disturbance of these wild fauna species, particularly during the period of breeding, rearing, hibernation and migration, in so far as such disturbance would be significant in relation to the objectives of this Convention;
- taking of their eggs from the wild and keeping these eggs, even if they are empty;
- possession of and domestic trade in such animals, alive or dead, including stuffed animals and readily recognisable parts or products thereof, if this could contribute to the effectiveness of the provisions of the aforementioned article.

Assessments of the environmental impacts of the proposed Project on the status of Annex IV species are included in the national EIA Report and are summarised in Section 7.3.6 hereof.

7 TRANSBOUNDARY ENVIRONMENTAL IMPACT ASSESSMENT

7.1 INITIAL ASSESSMENT OF THE POTENTIAL TRANSBOUNDARY IMPACT

This Espoo Report covers the Project-related activities carried out in the Polish maritime territory (EEZ) that can have potentially adverse environmental impacts on the Affected Parties: Denmark, Sweden and Finland.

A detailed assessment of each significant potential environmental impact on marine receptors was carried out and documented in the national EIA Report. Based on the results of this detailed assessment, the Espoo Report presents a preliminary assessment of the same impacts in terms of their potential transboundary environmental impact. In many cases, due to the limited extent of most impacts related to the Project, significant transboundary environmental impacts can be confidently ruled out. Therefore, these impacts were not analysed in detail in this Section.

The table below [Table 7.1] is a matrix indicating all the environmental impacts analysed and assessed in the national EIA Report. It identifies environmental impacts for which transboundary environmental impacts cannot be excluded. The transboundary environmental impacts identified in the table below are described and assessed in detail later in this Espoo Report.

Table 7.1. The list of potential environmental impacts analysed and assessed in the national EIA Report on the Project

Environmental component (receptor)	Potential environmental impact	Assessment in terms of transboundary environmental impact
Abiotic components		
Geological structure	Physical changes in the seabed structure (Sections 10.2.1.1, 10.2.2.1, 10.2.3.1 of the EIA Report). Presence of the OWF infrastructure elements (Sections 10.2.1.1, 10.2.2.1, 10.2.3.1 of the EIA Report).	The impacts are assessed to be negligible and will only occur locally, in the wind farm development area. Therefore, transboundary impacts can be excluded.
Seabed sediments	Changes in the character of surface sediments (Sections 10.2.1.2, 10.2.2.2, 10.2.3.2 of the EIA Report).	The impacts are assessed to be negligible and will only occur locally, in the wind farm development area. Therefore, transboundary impacts can be excluded.
Raw materials and deposits	Restricting or preventing access to deposits and possible exploitation of sand and gravel (Sections 10.2.1.3, 10.2.2.3, 10.2.3.3 of the EIA Report).	The impact was assessed as negligible and local. As it applies exclusively to the OWF area, transboundary impacts can be excluded.
Seawater and seabed sediment quality	Release of pollutants from the seabed sediments (heavy metals, PBCs, PAHs, nutrients) (Sections 10.2.1.4, 10.2.2.4, 10.2.3.4 of the EIA Report). Contamination of water and seabed sediments with petroleum products from vessels during normal operation (Sections 10.2.1.4, 10.2.2.4, 10.2.3.4 of the EIA Report). Contamination of water and seabed sediments with petroleum products from vessels in the event of a collision (Sections 10.2.1.4, 10.2.2.4, 10.2.3.4 of the EIA Report). Contamination of water and seabed sediments with antifouling agents (Sections 10.2.1.4, 10.2.2.4, 10.2.3.4 of the EIA Report). Contamination of water and seabed sediments by accidental release of municipal waste or domestic sewage (Sections 10.2.1.4, 10.2.2.4, 10.2.3.4 of the EIA Report). Contamination of water and seabed sediments by accidental release of chemicals and waste from the OWF construction (Sections 10.2.1.4, 10.2.2.4, 10.2.3.4 of the EIA Report). Contamination of water and seabed sediments with compounds from anti-corrosive agents (Section 10.2.2.4 of the EIA Report). Change in water and sediment temperature due to heat transfer from transmission cables (Section 10.2.2.4 of the EIA Report).	Transboundary impacts caused by contamination with petroleum products from vessel collisions and suspended solids propagation cannot be excluded (Section 7.2.1). The remaining impacts were considered negligible or of low significance and transboundary impact was excluded.
Hydrodynamic conditions	Impacts on water flows, waves and wind (EIA Report sections).	The impact of the OWF is limited to the local areas around each wind turbine/OSS due to the small dimensions in comparison with the

Environmental component (receptor)	Potential environmental impact	Assessment in terms of transboundary environmental impact
		distances between the structures. Transboundary impacts, if any, will be negligible.
Climatic conditions	Change in thermal conditions of the atmosphere (Sections 10.2.1.5, 10.2.2.5, 10.2.3.5 of the EIA Report).	The impacts are assessed to be negligible in character or of low significance and will only occur locally. The transboundary impact can be excluded.
State of atmospheric air	Exhaust emissions from vessels (Sections 10.2.1.6, 10.2.2.6, 10.2.3.6 of the EIA Report).	The impacts are assessed to be negligible in character and will only occur locally. The transboundary impact can be excluded.
Ambient noise	Impact on ichthyofauna, seabirds and marine mammals (Sections 10.2.1.9.3, 10.2.1.9.4, 10.2.1.9.6, 10.2.2.9.3, 10.2.2.9.4, 10.2.2.9.6, 10.2.3.9.3, 10.2.3.9.4, 10.2.3.9.6 of the EIA Report).	Transboundary impact cannot be excluded. The impact is discussed in the points concerning ichthyofauna, seabirds and marine mammals (Section 7.3).
Electromagnetic field	Electromagnetic field emission (Section 10.2.2.8 of the EIA Report).	The impacts are assessed not to occur or to be negligible in character and to only occur locally. The transboundary impact can be excluded.
Biotic components, protected areas and wildlife corridors		
Phytobenthos	Growth of macroalgae on underwater components of turbines – change in the natural character of the sea area (Section 10.2.2.9.1 of the EIA Report). Removal of established habitats during the wind farm decommissioning (Section 10.2.3.9.1 of the EIA Report).	The impacts will only occur locally. The transboundary impact can be excluded.
Macrozoobenthos	Interference in the seabed – disturbance of the seabed sediment structure, increased concentration of suspended solids in the water column, and redistribution of contaminants from sediments into the water column (Section 10.2.1.9.2 of the EIA Report). New structures in the seabed – loss of a fragment of the macrozoobenthos habitat, artificial reef effect (Section 10.2.2.9.2 of the EIA Report). Heat and EMF emissions from the cables (Section 10.2.2.9.2 of the EIA Report). Destruction of the artificial reef during the OWF decommissioning (Section 10.2.3.9.3 of the EIA Report). Suspended solids in terms of sediment deposition (Section 10.2.1.9.2 of the EIA Report).	Impacts are assessed to be negligible in character, of low or moderate significance and to only occur locally. Transboundary impacts can be excluded because disturbance of the seabed structure will only take place within the OWF Area, while the impact of an increase in suspended solids concentration and deposition will be so small that it will not affect macrozoobenthos in areas outside the immediate vicinity of the works.
Ichthyofauna	Noise and vibration (Sections 10.2.1.9.3, 10.2.2.9.3, 10.2.3.9.3 of the EIA Report).	The transboundary impacts caused by the noise generated during the construction phase cannot be excluded (Section 7.3.1).

Environmental component (receptor)	Potential environmental impact	Assessment in terms of transboundary environmental impact
	Increased concentration of suspended solids in the water (Section 10.2.1.9.3 of the EIA Report). Habitat change (Sections 10.2.1.9.3, 10.2.2.9.3, 10.2.3.9.3 of the EIA Report). Emission of pollutants (Section 10.2.1.9.3 of the EIA Report). Physical barrier (Sections 10.2.1.9.3, 10.2.2.9.3 of the EIA Report).	The remaining impacts were considered negligible or of low significance and transboundary impact was excluded.
Marine mammals	Increase in noise level (Sections 10.2.1.9.4, 10.2.2.9.4, 10.2.3.9.4 of the EIA Report). Habitat and food supply change (Sections 10.2.1.9.4, 10.2.2.9.4, 10.2.3.9.4 of the EIA Report).	Impacts caused by the noise generated during the construction phase are expected to be reduced through mitigation measures, and therefore no transboundary impacts are expected, or they will be low. However, due to the sensitivity of this environmental element, it is included in this report (Section 7.3.5). The remaining impacts were considered negligible or of low significance and transboundary impact was excluded.
Migratory birds	Barrier effect (Sections 10.2.1.9.5, 10.2.3.9.5 of the EIA Report). Collisions with construction vessels (Sections 10.2.1.9.5, 10.2.3.9.5 of the EIA Report). Risk of collision with the turbines (Sections 10.2.2.9.5, 10.2.3.9.5 of the EIA Report).	It is assessed that negligible or insignificant transboundary impacts may occur. They will be associated with the barrier effect and collision risk, and their significance will range from negligible to moderate (Section 7.3.2).
Seabirds	Habitat occupation (Sections 10.2.1.9.6, 10.2.2.9.6, 10.2.3.9.6 of the EIA Report). Barrier effect and risk of collision (Sections 10.2.1.9.6, 10.2.2.9.6, 10.2.3.9.6 of the EIA Report). Emission of artificial light (Sections 10.2.1.9.6, 10.2.2.9.6, 10.2.3.9.6 of the EIA Report). Emissions of noise and vibration (Sections 10.2.1.9.6, 10.2.2.9.6, 10.2.3.9.6 of the EIA Report).	The transboundary impacts on the benthivorous and piscivorous birds cannot be excluded. The impact was assessed as moderate or significant (Section 7.3.3). The impact on the European herring gull was assessed as low or negligible and of local extent.
Bats	Above-water noise (Sections 10.2.1.9.7, 10.2.2.9.7, 10.2.3.9.7 of the EIA Report). Barrier on the flight route (Section 10.2.2.9.7 of the EIA Report). Mortality as a result of collisions and barotrauma (Section 10.2.2.9.7 of the EIA Report).	Transboundary impacts due to mortality caused by collision and barotrauma at the operation phase cannot be excluded (Section 7.3.4). The remaining impacts were assessed as low or negligible and of local extent.

Environmental component (receptor)	Potential environmental impact	Assessment in terms of transboundary environmental impact
Protected areas and the subjects of protection in these areas	Underwater noise (Sections 10.2.1.10, 10.2.2.10, 10.2.3.10 of the EIA Report). Dispersion of suspended solids (Sections 10.2.1.10, 10.2.2.10, 10.2.3.10 of the EIA Report).	Transboundary impacts on the habitats protected as part of the Natura 2000 *Hoburgs Bank och Midsjöbankarna* (SE0330308) site can be excluded (Section 7.3.6). The transboundary impacts on the porpoise and avifauna, as well as on the connections between the protected areas, cannot be excluded.
Wildlife corridors	Barrier effect (underwater structures) (Sections 10.2.1.11, 10.2.2.11, 10.2.3.11 of the EIA Report).	The underwater structures will not restrict the movement of marine organisms in the water column and on the seabed – the individual foundations will be situated approximately 1 km apart while the inter-array cable lines will be buried in the seabed at a depth up to 6 m.
Socio-economic conditions		
Cultural heritage	There are no objects of cultural heritage in the Baltica-1 OWF Area and within the range of its impact that could be affected by the Project (Sections 10.2.1.12, 10.2.2.12, 10.2.3.12 of the EIA Report).	Transboundary impacts can be excluded due to the distance from the nearest objects of cultural heritage.
Fisheries	Increased distance to fishing grounds (Sections 10.2.1.13.1, 10.2.2.13.1, 10.2.3.13.1 of the EIA Report).	The impacts are assessed to be negligible in character and will only occur locally. Transboundary impacts can be excluded due to the low activity of the fishing fleet in the OWF Area, as well as the potential extension of routes to the fishing grounds, which is negligible from the perspective of the sea basin.
Navigation	Restrictions in navigation within the wind farm area (Sections 10.2.1.13.2, 10.2.2.13.2, 10.2.3.13.2 of the EIA Report). Possible need to adjust and extend shipping routes (Sections 10.2.1.13.2, 10.2.2.13.2, 10.2.3.13.2 of the EIA Report).	The impacts are assessed to be negligible due to the fact that the location of the farm may require only a slight correction of shipping routes, the significance of which from the perspective of the entire sea basin is negligible. The significant transboundary impact can be excluded.
Landscape, including cultural landscape	Traffic of vessels supporting the construction site / OWF (Section 10.2.1.14 of the EIA Report). Construction/presence of wind turbines and substations (Sections 10.2.1.14, 10.2.2.14 of the EIA Report).	The impacts are assessed to be negligible in character and of low significance due to the low value of the landscape within the visibility range of the OWF, the considerable distance from land and the lack of culturally significant sites within the impact area of the Project. The significant transboundary impact can be excluded.
Population, health and living conditions	Restrictions in the use of the sea area – discussed in the points concerning fishing and navigation (Sections 10.2.1.13.1, 10.2.2.13.1, 10.2.3.13.1, 10.2.1.13.2, 10.2.2.13.2, 10.2.3.13.2 of the EIA Report).	The impacts are assessed to be negligible. While potential impacts on people may only be related to navigation and fishing, significant transboundary impacts were ruled out for these elements.

7.2 ABIOTIC COMPONENTS

This section describes the initial status of potentially exposed environmental components (receptors) and provides an assessment of potential transboundary environmental impacts on the physico-chemical environment.

7.2.1 Seawater and seabed sediment quality

7.2.1.1 Current state

The results of tests of individual chemical parameters of water in the Baltica-1 OWF survey area, such as pH level, oxygenation, 5-day biochemical oxygen demand (BOD_5), TOC, nutrients, PCBs, PAHs, mineral oil, cyanides, metals, phenols, caesium, and strontium, did not diverge essentially from the values typical for the waters of the Southern Baltic.

These waters were characterised by alkaline pH (average pH from 7.76 to 8.31), alkalinity of approximately 1.70 $mmol \cdot dm^{-3}$ and relatively good oxygenation, with seasonal variability characteristic of the Southern Baltic waters. The assessment of the water quality index in the Baltica-1 OWF survey area, on the basis of the oxygen content in the near-seabed layer in summer (VII/IX), indicates a good water status (no oxygen deficit). The average contents of dissolved oxygen during this period were above the limit value of 6.0 $mg \cdot dm^{-3}$.

Throughout the entire survey period (January 2023 – November 2023), the average biochemical oxygen demand (BOD_5) in the water samples collected from the survey area during individual survey periods was below 2.00 $mg \cdot dm^{-3}$. Only in January was it slightly above the lower limit of the method quantification, i.e. 2.05 $mg \cdot dm^{-3}$. Also, the content of suspended solids in particular survey periods was at a level typical for the waters of the Southern Baltic. The lowest average concentrations of suspended solids in the area surveyed were recorded in September and November, whereas the highest ones – in May and March, which could have been caused by an increased primary production.

The content of nutrients such as total nitrogen, mineral nitrogen (total nitrates, nitrites and ammonia), phosphates and total phosphorus in the waters surveyed was characterised by seasonal variability typical for the waters of the Southern Baltic. The lowest concentrations of the substances surveyed were recorded in the period from May to September, whereas in the winter-spring months (January–March) their significant increase was observed, compliant with the seasonal trend of nutrient level restoration. The average concentration of total phosphorus in the water column between July and September was 0.016 $mg \cdot dm^{-3}$. The average phosphate concentration observed in the samples collected in January and March 2023 was 0.016 $mg \cdot dm^{-3}$ (average from the water column). The average concentration of the total nitrogen in the water samples collected in the Baltica-1 OWF survey area was similar in the entire survey period and fell within the range from 0.08 to 0.13 $mg \cdot dm^{-3}$. The average DIN concentration from the water column in the water samples from the Baltica-1 OWF survey area collected in January and March 2023, equalled 0.031 $mg \cdot dm^{-3}$.

The waters of the area surveyed were characterised by low concentrations of particularly harmful substances. Trace concentrations of the following substances were present: PCBs, mineral oils (mineral oil index), free and bound cyanides, metals [Pb, Cd, Cr tot., Cr(VI), As, Ni, Hg, Al] and phenols.

The waters tested were also characterised by low activity values of caesium ^{137}Cs and strontium ^{90}Sr, typical for the waters of the Southern Baltic, which confirms a slow downward trend of ^{90}Sr and ^{137}Cs concentration in the Baltic Sea area [Zalewska, 2012; Zalewska and Kraśniewski, 2022].

Slightly higher PAH concentrations than the ones specified by the data from literature [HELCOM 2002; Witt 2002] were observed in the survey area, which may be due to the differences at the stage of preparation of samples for analysis (PAHs concentrations in water were determined without the separation of suspended solids).

The assessment of the status of seawater carried out in compliance with the Marine Strategy Framework Directive (MSFD – Directive No. 2008/56/EC) indicates that the environmental status of seawaters in terms of eutrophication in the Baltica-1 OWF survey area is poor (subGES). The elevated concentrations of phosphates in winter were responsible for this status. The concentration limits for mineral nitrogen in winter nor for total nitrogen and total phosphorus expressed as annual averages (GES) were not exceeded. The concentrations of metals (cadmium and mercury) determined in the seabed sediments did not exceed the limit values, which classify the status of the sediments surveyed as good (GES). In contrast, the value of lead concentration in the seabed sediments exceeds the limit value, which classifies their status as unacceptable (subGES). Also, the environmental status with regards to the radioactive contamination of water by ^{137}Cs isotope was found to be unacceptable (subGES). In contrast, the concentrations of persistent organic pollutants (fluoranthene, benzo(ghi)perylene and indeno(1,2,3-cd)pyrene) did not exceed the limit values, which classifies the status of the sediments surveyed as good (GES) in terms of these parameters. The results obtained do not differ from the Baltic Sea seawater monitoring data.

7.2.1.2 Environmental impact assessment and transboundary environmental impact

7.2.1.2.1 Contamination of water and seabed sediments with petroleum products during breakdown or collision of vessels

The spills of petroleum products during normal vessel operation, both during construction, operation and decommissioning, will be minor (Tier 1 spills), they will disperse and evaporate relatively quickly, and their extent will be local – it should be limited to the Baltica-1 OWF Area.

In the event of a collision of vessels, a Tier 3 spill can be expected, i.e. one above 50 m^3 and up to approx. 200 m^3.

A visible effect of an oil spill is an oil slick which, under the influence of gravity and surface tension, spreads at a speed depending on the type of oil and ambient conditions. The size of the spill is determined by such factors as oil volume, density, viscosity, temperature, wind speed and time. The estimated speed of an oil slick movement in large water bodies is approx. 2–3% of the wind speed. It has been found that a spill of 1.6 t (1.8 m^3) of oil spreading over the surface of 1 km^2 during one day forms a dark film with a thickness of 2 µm. 40 kg of oil, on the other hand, causes a slick on the surface of 1 km^2 that has a film thickness of 0.05 µm [Gutteter–Grudziński, 2012].

Oil film formed on the water surface may cause:

- impeded exchange of gases, especially of oxygen, between the water and the atmosphere;
- 5–10% decrease in light intensity under the water surface (mainly due to the presence of heavy fractions of oil and sulphur) limiting photosynthesis;
- increase in the temperature of water during the day as a result of light absorption by the oil layer.

While an oil slick is spreading, other degradation processes are progressing which lower the concentration of hydrocarbons on the water surface (e.g. the release of low molecular weight hydrocarbons). Heavier oil fractions may undergo sorption on the surface of organic and mineral suspensions, which may increase their specific gravity and gradually make them sink onto the seabed. Thus, heavier oil fractions may be bound by seabed sediments, contaminating them. The susceptibility of seabed sediments to contamination depends on the grain size of the sediment and its packing. Loose sandy sediments are more susceptible to contaminant absorption. Compact till sediments inhibit the penetration of contaminants into the sediment. However, due to the type of sediments in the Baltica-1 OWF Area (small amount of organic matter and low content of fine fractions), oil spills will not cause a noticeable deterioration of their quality.

The probability of a breakdown or a collision of vessels in the Baltic Sea is low. Approximately 2 thousand vessels sail the Baltic Sea every day (including 200 tankers transporting oil and other liquids), and the number of collisions and failures in recent years has remained more or less constant (with a slight increase), i.e. approx. 120−190 accidents at sea every year. Most accidents in the Baltic Sea cause no contamination. The number of accidents involving contaminant release into water is up to 21 (which occurred in 2017) per year. However, it must be kept in mind that even one large-scale accident may seriously threaten the marine environment. In 2017, 139 vessel accidents occurred in the Baltic Sea area, 21 of which resulted in its contamination. None of the accidents that resulted in water contamination and required a clean-up occurred in the Polish exclusive economic zone [HELCOM, 2018]. 2017 saw 8 confirmed oil spills of less than 1 m^3 in volume, one with a volume in the range of 1–10 m^3 and one larger accident with a volume of 200 m^3 [*ibidem*].

In the south-eastern Baltic Sea area, in which the Baltica-1 OWF Area analysed can be included, the risk of a collision with a spill of over 5000 tonnes was estimated to be 1 incident in 1060 years, whereas the areas under the greatest threat are found around the Islands of Wolin and Rüggen as well as the Hel Peninsula.

During construction and maintenance works, vessels sail at low speeds, and therefore the risk of damage to the fuel tank is very low. A vessel generally holds fuel in several tanks, which reduces the risk of a major leak in case of a collision. Vessels used in the construction of wind farms may have fuel tanks with a total capacity of approx. 1200 m^3. Assuming a breakdown or a collision of the largest vessels used at the construction phase of the OWF (during inspections, maintenance and emergency repairs) and the destruction of the largest tanks of one vessel, no more than 200 m^3 of fuel oil, 15 m^3 of machine oil and approx. 2.5 m^3 of hydraulic oil may be released from one vessel (in the worst-case scenario) [Veldhuizen *et al*., 2014].

In the event of a construction disaster at the OWF (a wind turbine falling over or a vessel colliding with a wind turbine or a substation), a leak of fuel oil, machine oil, hydraulic oil or transformer oil may occur.

The most important parameters affecting the level of impact are the type and amount of petroleum products released, the weather conditions and the type of rock material forming the seabed.

A plan will be prepared for the OWF to prevent risks and contamination during the construction, operation and decommissioning of the OWF. This plan should specify the potential area under threat for various breakdown and disaster scenarios, as well as the methods of preventing and eliminating oil spills.

The contamination of seawater or seabed sediments with petroleum products released in an accident is a direct adverse environmental impact of the regional/transboundary range, which is mid-term, reversible, repeatable, and of high intensity.

Due to the random and sporadic nature of breakdowns and collisions, the significance of this environmental impact was assessed as moderate for seawaters and seabed sediments.

7.2.1.2.2 Environmental impact of suspended solids

Underwater works involving seabed clearing and levelling, as well as cable line construction, are associated with the resuspension of seabed sediment, its dispersion and resedimentation. The results of the modelling of suspended solids dispersion and sedimentation indicate that the environmental impact may also include Swedish waters. The majority of the material carried into the water column will sink to the seabed near the locations of seabed interference. The suspended solids dispersion outside the underwater works area refers only to the smallest and lightest sediment fractions, which will be dispersed over a large seabed area, also outside the Polish EEZ boundary. The analysis of the modelling of suspended solids propagation results demonstrated that its environmental impact range will be larger in the area of cohesive sediments occurrence, characterised by a high proportion of small grain size fractions. The suspended solids created through the mobilisation of this type of sediment remain suspended in the water column for a long time and are transferred by the movement of water masses at great distances, causing water turbidity and sedimentation. The analysis of the modelling results demonstrated that the highest values of suspended solids concentration in the water and its levels of sedimentation may occur in the case of works related to the seabed preparation before the installation of supports for the jack-up vessels. In the case of carrying out those works in the most unfavourable environmental conditions, the range of suspended solids of 30 $mg \cdot l^{-1}$ may cover an area within up to 3 km from the source, but within the distance of 3.5 km, the concentration of suspended solids should not exceed 5 $mg \cdot l^{-1}$. At the Swedish EEZ boundary, maximum concentrations of suspended solids may be approximately 100 $mg \cdot l^{-1}$, whereas within the Natura 2000 site *Hoburgs Bank och Midsjöbankarna* (SE0330308) they may be 60 $mg \cdot l^{-1}$ (due to the greater distance – more than 2000 m). Sedimentation of suspended solids may cause a 35-mm thick overlay of the seabed sediment at a distance of 150 m from the source, i.e. within the wind farm area exclusively, without affecting the Swedish waters. The thickness of the newly created sediment layer will decrease significantly with the distance – within 500 m from the source, the sediment thickness will be up to 9 mm, and the maximum growth of a 1-mm thick sediment will not occur at a distance of more than 6.3 km from the source. According to the results of modelling which assumes the most unfavourable environmental conditions during the construction of the cable line using the jetting method, the range of the suspended solids will be up to 0.6 km from the underwater works site (i.e. a concentration of 30 mg/l), and the range of its sedimentation – up to 200 m (i.e. the thickness of the new sediment layer will be up to 5 mm). The range of the suspended solids sedimentation will most likely cover the Swedish waters as well, including the northern part of the Natura 2000 site *Hoburgs Bank och Midsjöbankarna* (SE0330308), but the environmental impact will be negligible. As mentioned, the mobilised fine sediment fractions will be dispersed in the water column over a large area, and therefore its effect on the environment will be insignificant considering the low and short-time concentrations as well as low sedimentation. The modelling performed demonstrated that the maximum persistence time of suspended solids in the seawater, in concentrations exceeding the negligible value of 5mg/l, will not exceed 110 hours from the commencement of the seabed works including soil replacement for the reinforcement of the substrate for vessel support legs, 36 hours from the commencement of the seabed works at a single foundation, and no more than 53 hours in the case of cumulative impacts analysed. The low concentration of suspended solids will not significantly impair light penetration into the water column and its sedimentation will result in a very thin layer of new sediment, not exceeding a few millimetres in thickness at distances of up to 200 m from the underwater works site. In the Swedish EEZ, sedimentation will not exceed 5 mm.

A detailed description of the modelling process and its results can be found in Appendix 2 of the national EIA Report, also attached to this Espoo Report.

7.2.1.2.3 Conclusions concerning the transboundary environmental impacts

The transboundary environmental impacts related to the spills of petroleum products can occur as a result of a breakdown or collision of vessels. This is a direct adverse impact, which is mid-term, reversible, repeatable, and of high intensity. Due to the sporadic nature of this type of situation, as well as the implementation of a plan to counteract this type of hazard, the significance of this environmental impact was assessed to be low.

The analysis of the environmental impact of the suspended solids generated by underwater works and their sedimentation demonstrated that their impact on the environment will be negligible or low even at a small distance from the site of these works. In this context, it should be assumed that the environmental significance of this impact on Swedish waters and its influence on Natura 2000 site *Hoburgs Bank och Midsjöbankarna* (SE0330308) will be negligible.

7.2.2 Ambient noise

7.2.2.1 Current state

The results of ambient noise monitoring conducted in the period from December 2022 to November 2023 in the Baltica-1 OWF Area and in the adjacent sea areas, showed that the levels of underwater noise (and their variability ranges) indicate the values typical for the Southern Baltic [Lisimenka 2007; Klusek and Lisimenka 2016; Mustonen *et al*. 2019].

The SPL time courses demonstrate significant fluctuations in noise levels (single peaks), reaching values of 20–25 dB against a background of natural noise, which can be interpreted as a significant contribution of the anthropogenic component related mainly to vessel traffic, and also sporadically to the emission of low-frequency sounds during seismo-acoustic seabed surveys.

Noise level values show variability over time, depending on the seasonally varying sound propagation conditions in the Baltic Sea, which in turn depend on the thermohaline situation. The noise levels observed show higher values under favourable conditions of sound propagation typical of the winter season – with positive (directed towards the sea surface) sound refraction, compared to unfavourable conditions of sound propagation typical of the summer season – with negative (directed towards the seabed) sound refraction. This is consistent with previous results from numerical simulations [Klusek, 1977 a and b; 2000], as well as with *in situ* observations carried out in the Baltic Sea in the 1980s [Wille and Geyer 1984; Wagstaff and Newcomb 1987] and at present [project BIAS, 2012–2015; Klusek and Lisimenka 2016; Mustonen *et al*., 2019]. The results obtained also indicate a good concordance with the results of the noise level studies, which were conducted in other OWF areas: Bałtyk II, Bałtyk III, Baltica or Baltic Power OWFs.

The comparative analysis of the noise level values obtained over a wide frequency range (20–20 000 Hz) in different seasons showed that in winter the noise levels are a few decibels higher (2–7 dB) than in the other seasons.

In general, the SPL time courses show significant fluctuations in noise levels (single peaks), reaching values of 20–25 dB against a background of natural noise, which can be interpreted as a significant contribution of the anthropogenic component related mainly to vessel traffic, and also sporadically to the emission of low-frequency sounds during seismo-acoustic seabed surveys. In order to conduct an approximate assessment of the anthropogenic phenomena frequency, an algorithm was used to determine the samples of broadband SPL (20 Hz – 20 kHz) exceeding a threshold above 'SPLmedian + 3dB'. In general, the result of this assessment showed that the presence of anthropogenic sounds occurs up to about 1/3 of the observation time for all seasons.

7.2.2.2 Environmental impact assessment and transboundary impact

Noise sources

The construction of the Baltica-1 OWF will involve noise emissions into the atmosphere and water column during each phase of this Project. Due to the nature and extent of the activities, the highest noise levels will be generated during the construction phase, with the main sources being the piling of foundations into the seabed (underwater noise) and vessels involved in the construction works (underwater noise and noise emitted into the atmosphere).

During the operation phase, the main sources of underwater noise will be vessels carrying out OWF inspection and service works, along with possible repair and overhaul works, as well as sounds generated by the working rotor and nacelle transmitted into the water depths in the form of vibrations of the wind turbine support structure.

During the decommissioning phase, the main source of sound will be the vessels involved in the decommissioning phase and the equipment used to carry out underwater works.

In the case of large-diameter pile driving, underwater noise can reach instantaneous values of more than 230 dB at 1 m from the source. Piling without the application of noise reduction measures will result in adverse environmental impacts on the marine environment, mainly marine mammals and fish. Therefore, noise reduction systems will be used to effectively minimise the noise intensity and its spatial extent. Noise Reduction Systems are described in Section 3.5.2.

The intensity and frequency of underwater noise generated by vessels depend primarily on their size and speed. Larger, slower-moving vessels generate noise at lower frequencies, whereas smaller and faster vessels generate noise characterised by higher energy at higher frequencies. Noise emitted by vessels affects marine animals – mainly mammals and fish, causing behavioural changes and interference in the communication between individuals. Vessel noise will be similar in all phases of the Project.

Modelling of underwater noise propagation

For the purpose of the national EIA Report, acoustic emissions from the piling of foundations in the seabed in the area of the Baltica-1 OWF were analysed. A detailed methodology and the results of noise propagation modelling can be found in Appendix 3 to the national EIA Report, which is also attached hereto.

The analysis was carried out for wind turbine locations in the northern, central and southern parts of the Baltica-1 OWF Area. The analyses were conducted:

- for the northern point, for the winter season, which was considered to be the scenario with the largest environmental impact due to the enhanced propagation of acoustic waves in winter,

- for all points, for the summer season, in which the impact area is considerably smaller than in winter due to less favourable propagation conditions; however, increased porpoise activity is recorded during this period.

Based on the modelling performed, the noise impact zones (in the form of distance from the sound source expressed in km) on marine mammals (porpoises and seals) and on fish with a swim bladder were estimated. The considered impact effects concerned the behavioural response (changes in behaviour) and hearing damage in the form of temporary and permanent shifts of the hearing threshold (TTS and PTS and reversible hearing damage in the case of fish).

The calculations were made for a monopile with a diameter of 12 m and a hammer with an impact energy of 8000 kJ. The calculated level of the sound source (sound level at 1 m distance) was expressed as sound exposure level (SEL), i.e. the acoustic energy emitted (in dB re 1 $\mu Pa^2 s$) and as peak sound pressure levels (SPL_{peak} [dB re 1 µPa]). The values were determined for single pile strikes as well as for the estimated maximum number of strikes necessary to drive one foundation into the seabed. The following values were used in modelling:

- SEL for a single strike = 228.9 dB re 1 $\mu Pa^2 s$;
- SPL_{peak} for a single strike = 248.9 dB re 1 µPa;
- cumulative SEL for all strikes = 267.1 dB re 1 $\mu Pa^2 s$.

The cumulative SEL was calculated based on a 24-hour time interval, taking into account the total number of strikes needed to install the monopile.

The emitted sound levels were also estimated with the application of NRS such as single underwater noise reduction measures or their combinations. A Big Bubble Curtain (BBC), a system consisting of HSD (Hydro Sound Damper) and a Double Big Bubble Curtain (DBBC) (HSD + DBBC) as well as IQIP noise mitigation screen combined with a Double Big Bubble Curtain (IQIP + DBBC) were considered for this purpose.

The results of noise modelling during the construction phase in the winter showed higher values of the environmental impact ranges than those obtained for the summer.

Analyses carried out for the winter, without mitigation, indicate that the environmental impact ranges for the harbour porpoise are in most cases higher than those for the grey seal and the harbour seal. In the case of the harbour porpoise, the largest environmental impact ranges were found for behavioural response, while for seals they were calculated for the cumulative TTS. For harbour porpoises, the range of behavioural response exceeded the model domain of 150.0 km from the sound source. Considering the cumulative TTS, the maximum impact range was 104 km for the harbour porpoise and 112 km for seals. The range of the cumulative PTS reached 26.3 km for the harbour porpoise and 2.9 km for seals.

For fish with a swim bladder, the greatest impact ranges were obtained for the behavioural response together with the cumulative TTS, reaching the minimum values of 150 km. Considering the cumulative reversible hearing damage, the maximum range was 19.2 km.

Calculations performed with the application of NRS indicated a decrease in the ranges of all the environmental impacts analysed.

With the application of an NRS in the form of a bubble curtain, the range of behavioural response, as well as the cumulative TTS and PTS, for the harbour porpoise decreased significantly. In the case of fish with a swim bladder, calculations with the application of a BBC showed that the maximum range of the behavioural response still exceeded the range of the model domain, similar to the scenario without mitigation measures, while for cumulative TTS – the range remained at a high level.

Calculations were also carried out assuming the use of mitigation measures in the form of HSD + DBBC. The results of the model analyses showed a decrease in all impact ranges. The maximum range for the behavioural response of the harbour porpoise decreased to 20.8 km, and of the seals – to 3.4 km.

Regarding the fish with a swim bladder, calculations taking into account the use of HSD + DBBC showed that the maximum distance for the behavioural response decreased to 41.3 km. For cumulative TTS, the range decreased to a maximum of 11.6 km.

Analyses conducted assuming the application of double mitigation in the form of IQIP + DBBC showed a decrease in the impact range for behavioural changes to a maximum distance of 20.8 km for harbour porpoises and 1.9 km for seals.

In the case of fish with a swim bladder, the application of IQIP + DBBC indicated a further decrease in the ranges and areas of impact, both for the behavioural response as well as TTS and PTS.

Analyses conducted for the summer season without the use of mitigation indicate that similarly to the winter season, the greatest ranges of impact concern the behavioural response of harbour porpoises and the cumulative TTS in seals. The maximum ranges of individual effect impacts are lower than in the winter scenario.

In the case of fish with a swim bladder, the greatest ranges of environmental impact were obtained for the behavioural response, reaching a value of 118 km. Taking into account the cumulative TTS, the maximum range was 39.1 km. In terms of cumulative reversible hearing loss, the values obtained for the summer season were lower than those for the winter season and amounted to 11.2 km.

Calculations performed assuming the application of BBC indicated a decrease in the impact ranges. The maximum range of behavioural response of the harbour porpoise decreased to 10.7 km. The range of cumulative environmental impacts decreased to levels below 1 km for both groups of marine mammals.

In the case of fish with a swim bladder, calculations assuming the application of a BBC showed that the maximum range of behavioural response is up to 42.3 km. For cumulative TTS, the ranges decreased to a maximum of 19.1 km, and for cumulative reversible hearing loss – to 4.0 km.

Calculations assuming the application of HSD + DBBC and IQIP + DBBC mitigation measures showed a further decrease in all environmental impact ranges. The lowest values of the behavioural response of the harbour porpoise were up to 8.6 km assuming the application of HSD + DBBC and 1.6 km for seals if IQIP + DBBC were applied. The ranges of the cumulative environmental impact of TTS and PTS were at a similar level for both double mitigation systems.

Considering the fish with a swim bladder, the lowest environmental impact values were found for the mitigation in the form of IQIP + DBBC.

Calculations of the noise propagation resulting from pile driving at several locations showed that the ranges and areas of environmental impact of all noise exposure effects analysed (behavioural response, TTS and PTS) increase with the number of pile driving sources, regardless of the modelled season, with the ranges and areas of impact being significantly larger in winter than in summer. This trend was observed for all animals. The greatest ranges and areas of impact were reached in the scenario with four sources and for the behavioural response.

Due to the proximity of the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308), in which the harbour porpoise is protected, noise levels that can be generated at the boundary of this site were determined. The obtained values were compared with the acoustic thresholds determined for TTS and PTS in the harbour porpoise. The results showed that the cumulative TTS level can be met at the boundary of the Swedish Natura 2000 site if the NRS is adjusted accordingly. In the case of cumulative environmental impacts, the permissible limits may be exceeded in both seasons analysed, if appropriate organisational solutions as part of NRS are not applied. According to the calculations, the HSD + DBBC and IQIP + DBBC systems can reduce noise only if piling during summer is conducted at two locations 20 km apart. The results also indicated that the application of IQIP + DBBC reduces the ranges of cumulative TTS and PTS less effectively than HSD + DBBC, which is due to the poorer reducing properties at frequencies around 800 Hz.

Additionally, the analysis of the potential environmental impact in the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308) was carried out for the behavioural response. The calculations showed that the area affected by changes in the behaviour of porpoises will vary depending on the mitigation measures applied, the season and the location of the piling. The further south the piling location is situated, the smaller the impact on the Natura 2000 site will be – for part of the Baltica-1 OWF Area, piling using NRS may not affect this Natura 2000 site even at the behavioural response level. The greatest range can be expected in the winter when the use of the mitigation measures analysed reduces the percentage of the area covered by the environmental impact up to a maximum of 3.8%. In summer, the percentage of the area covered by the potential environmental impact is below 1% if any of the mitigation systems analysed are applied.

7.2.2.3 Conclusions concerning the transboundary environmental impacts

Transboundary environmental impacts may occur due to the construction of the farm, in particular due to foundation piling operations. This is related to the impact of noise on marine organisms. In order to ensure the maximum possible mitigation of this impact, a number of measures are foreseen to reduce the noise propagation in the aquatic environment. With regard to marine mammals, the results of acoustic modelling demonstrated that for piling at a single location in the northern part of the OWF Area, with dual mitigation measures applied, the ranges of noise impact in the form of hearing damage (PTS and TTS) will be negligible and will not cause transboundary impacts, whereas the range of behavioural changes may be transboundary in nature. For the remaining piling locations, no transboundary impacts are anticipated.

The impact of underwater noise on marine organisms is described in more detail in the sections concerning fish and marine mammals.

7.3 Biotic components and protected areas

This section describes the initial status of potential environmental impact receptors (exposed environmental components) and provides an assessment of potential transboundary environmental impacts on the biological environment.

7.3.1 Ichthyofauna

7.3.1.1 Current state

The ichthyofauna surveys were conducted in the Baltica-1 OWF Area to determine the species composition, abundance and distribution of ichthyofauna, the structure and biological characteristics of the species of fish occurring there, including also the species composition and abundance of ichthyoplankton. The spatial extent of the ichthyofauna surveys was the survey area comprising the Baltica-1 OWF wind turbine, OSSs and cable line construction area (Area A) and the cable line construction area (Area B), together with a zone with a width of not less than 4 km from the boundary of Area A.

The ichthyofauna surveys were conducted in a one-year-long cycle and included 4 survey campaigns covering all seasons of the year.

The result of demersal catches conducted in the Baltica-1 OWF survey area using bottom-set nets is 1421.9 kg of fish belonging to 14 taxa. Cod and flounder dominated. Other species were caught as by-catch (great sand eel, plaice, shorthorn sculpin, pogge, mackerel, twaite shad, turbot, sprat, herring, lumpfish, lesser sand eel and viviparous eelpout). In the case of catches with gillnets aimed at checking the usage of the area for spawning by herring, the same taxonomic composition (fourhorn sculpin was recorded additionally) as in the case of multi-mesh gillnets was recorded.

Fish belonging to 24 taxa were caught in all the survey gear in the Baltica-1 OWF survey area. The list is presented in Table 7.2.

Table 7.2. All taxa recorded during the survey catches conducted within the Baltica-1 OWF survey area

No.	Species	Pelagic catches	Demersal catches	Ichthyoplankton catches
1.	Gobies			X
2.	Garfish	X		
3.	Nine-spined stickleback	X		
4.	Three-spined stickleback	X		
5.	Common sea snail			X
6.	Great sand eel	X	X	X
7.	Cod	X	X	
8.	Plaice		X	
9.	Shorthorn sculpin		X	
10.	Fourhorn sculpin		X	
11.	Pogge		X	
12.	Atlantic salmon	X		
13.	Mackerel	X	X	
14.	Fourbeard rockling			X
15.	Rock gunnel			X
16.	Twait shad		X	
17.	Anchovy	X		
18.	Turbot	X	X	
19.	Flounder	X	X	X
20.	Sprat	X	X	X
21.	Herring	X	X	X
22.	Lumpfish	X	X	
23.	Lesser sand eel		X	
24.	Viviparous eelpout		X	

The efficiency analysis of the gillnet survey gear demonstrated that the peak of fish density occurred in the summer and autumn because shallower waters of the Baltica-1 OWF survey area serve as feeding grounds during these seasons. In other periods, fish densities were similar, while the lowest efficiencies were recorded in the winter.

The taxonomic diversity of ichthyoplankton (larvae belonging to 8 fish taxa) in the Baltica-1 OWF survey area was low in comparison with what is usually observed in the Southern Baltic surveys.

The low salinity and the great depth of the Baltica-1 OWF survey area exclude the possibility that the larvae caught came from the spawning taking place in that region. Depending on the species, they most likely originated from the spawning taking place in the Słupsk Furrow (sprat, flounder, fourbeard rockling), the Middle Bank (ammodytids, gobies, autumn herring), the Stilo Bank (gobies), the Czołpino Shallows (gobies) and the Słupsk Bank (gobies, common seasnail, rock gunnel).

The Baltica-1 OWF survey area is typical in terms of species diversity among the waters of similar depth, with a clear predominance of cod and flounder in demersal catches, and herring and sprat in pelagic catches. The highest areal biomass density of sprat was estimated for the spring survey campaign; however, it was more than two times lower than the average value of this parameter determined on the basis of the May SPRAS cruises in the years 2017–2021. The highest areal biomass density of herring was estimated for the summer survey campaign when it was two times higher than the average value of this parameter determined on the basis of spring SPRAS cruises as well as more than two times lower than the average from the spring SPRAS cruises in the years 2017–2021. In February 2023, as in the previous years, sprat started the first phase of spawning in the waters of the Baltic Sea, in areas deeper than the depth of the Baltica-1 OWF survey area. The process intensified on a large scale in May, then gradually died out in the second half of summer.

The results obtained indicate that during the survey period, the area of the proposed Project provided a habitat for herring and that the migration routes leading towards wintering grounds as well as the spawning (probably) and feeding migration routes run across the area. The Baltica-1 OWF survey area is not a significant spawning ground for herring due to its depth, the lack of suitable substrate and the distance from the shore. The observed concentrations of spring shoals are represented by fish that had already spawned in the coastal regions.

The area of the proposed Project constituted a part of a sea area in which periodical spawning and feeding migrations of sprat took place. Taking into account the information from the literature and the results of the surveys conducted, it can be assumed that sprat spawning does not take place in the Baltica-1 OWF survey area.

The results of cod abundance surveys indicate that the proposed Project area constitutes a less significant habitat for fish of this species in the winter-spring season than it does in summer and autumn.

The survey area served as a habitat mainly for adult flounder. Flounder abundance was the highest in summer and the lowest in autumn. Since the hydrological conditions prevailing in the area are not favourable for the reproduction of European flounder, it is safe to assume that the fish migrated from the survey area to the nearby Słupsk Furrow or the Gdańsk Deep to spawn.

Four of the taxa recorded within the Baltica-1 OWF survey area, i.e. gobies, common seasnail, fourhorn sculpin and twaite shad, belong to partially protected species pursuant to the Regulation of the Minister of the Environment of 16 December 2016 *on the protection of animal species* (consolidated text: Journal of Laws of 2022, item 2380).

In conclusion, out of the 24 taxa observed during the ichthyofauna surveys carried out for the purpose of the proposed Project, 4 are of particular economic importance in terms of commercial fishing. These are sprat, herring, cod, and flounder. Gobies, common seasnail and twaite shad were also included in the impact analysis as partially protected species. In the case of fourhorn sculpin, only one individual of this species was caught, so it was decided to exclude it from the analysis.

To assess the significance of the Baltica-1 OWF survey area regarding ichthyofauna, its following values were considered: taxonomic diversity, occurrence of protected and endangered as well as commercial species, feeding or spawning grounds, and migration routes. On the basis of the above-mentioned functions, the natural values of the area in question were assessed as moderate. This assessment was based on expert knowledge, taking into account the survey conclusions listed below:

- The low taxonomic diversity of ichthyoplankton in the survey area in comparison with what is usually observed in the surveys of the Southern Baltic.
- Due to the low salinity of the area, the early-spring spawning of sprat does not take place there. The larvae caught during that period probably came from the spawning taking place in the Słupsk Furrow. The absence of larvae in summer might have resulted from the timing of sampling coinciding with the final period of the summer shallow-water spawning.
- The salinity of the survey area is too low for the reproduction of flounder and fourbeard rockling to take place there. The larvae caught in the survey area originated from the spawning taking place in the Słupsk Furrow.
- The ammodytid larvae caught in the survey area probably came from the spawning taking place in the shallow regions of the Middle Bank, including the shallowest part of the survey area within the Southern Middle Bank.
- The too great depth of the survey area eliminates the possibility of the goby larvae caught there coming from the spawning taking place in that region. The reproduction probably took place in the coastal waters of the Stilo Bank, the Czołpino Shallows, the Słupsk Bank or in the shallowest part of the Middle Bank.
- The larvae of the autumn-spawning herring caught in October and March may have originated from the spawning taking place in the Słupsk Bank and the Middle Bank areas, and also within the survey area, in the shallowest part of the Southern Middle Bank.
- The few common seasnail and rock gunnel larvae caught in the survey area may have originated from the spawning taking place either in the shallowest part of the survey area, in the Słupsk Bank or in the coastal area.
- Two out of the taxa recorded in the survey area – gobies and common seasnail, belong to partially protected species pursuant to the Regulation of the Minister of the Environment of 16 December 2016 *on the protection of animal species* (Journal of Laws of 2016, item 2183, as amended).
- The survey area is typical in terms of species diversity among the waters of similar depth, with a clear predominance of cod and flounder in demersal catches, and herring and sprat in pelagic catches. Fish belonging to 24 taxa were caught in all the survey gear in the OWF area.
- The highest areal biomass density of sprat in the survey area was estimated for the spring survey campaign; it was more than two times lower than the average value of this parameter determined on the basis of the May SPRAS cruises in the years 2017–2021.
- The highest areal biomass density of herring was estimated for the summer survey campaign; it was two times higher than the average value of this parameter determined on the basis of

spring SPRAS cruises and more than two times lower than the average from the BIAS cruises in the years 2017–2021.

- The efficiency analysis of the survey gillnet gear demonstrated that the peak of fish density occurred in the summer and autumn, due to the fact that the shallower waters of the survey area serve as foraging grounds during those seasons. In other periods, fish densities were similar, while the lowest efficiencies were recorded in the winter.
- In February 2023, as in the previous years, sprat started the first phase of spawning in the water depth of the Baltic Sea, in areas deeper than the survey area. The process intensified on a large scale in May, then gradually died out in the second half of summer.
- The process of mass feeding of sprat intensifies once the spawning ends, particularly at the turn of summer and autumn, and then gradually declines to a minimum (starving state) at the beginning of winter, while in spring it is of an accidental nature and concerns only a few individuals.
- The analyses of stomach content confirm the more intense feeding of herring in spring and summer. The high proportion of fish with empty stomachs in winter and autumn indicates the occurrence of low intensity feeding in the proposed Project area, possibly related to the low availability of preferred zooplankton groups.
- The age structure of the fish caught reflects the typical age of herring in the Central Baltic stock, with the prevalence of the year class 2019 [ICES, 2023]. The catches indicate the periodical occurrence of juvenile fish, particularly in autumn, although herring with a length of less than 15 cm (age group 0 mostly) are rare, which suggests that the area is not a site of key significance for juvenile fish.
- In the planned project area, mature herring can migrate towards Swedish or Polish coasts, however, the planned project area alone is not a significant spawning ground for herring due to its depth, lack of suitable substrate and the distance from the shore. The observed concentrations of spring shoals are represented by fish that had already completed spawning in the coastal regions.
- The results of cod abundance surveys conducted during individual survey seasons indicate a low occurrence of these fish in winter and spring. The abundant occurrence of cod was recorded in the potential area of the offshore wind farm location in summer and autumn. The above-mentioned results of cod abundance surveys might, therefore, indicate, that the proposed Project area constitutes a less significant habitat for fish of this species in the winter-spring season than it does in the summer and autumn seasons.
- Seasonal changes in the length composition of cod recorded in the proposed Project area resulted from the biological characteristics of these fish. These are manifested by spawning migrations from the shore towards the depths, where cod spawning grounds are situated, and feeding migrations from the depths towards the shores. The proposed Project area lies on the path of the above-mentioned migrations.
- In spring, the cod preparing for spawning, i.e. larger and older individuals, migrate towards the spawning grounds outside of the proposed Project area. A similar situation took place in the proposed offshore wind farm area in the summer, when most adult cod spawned in the depths of the Baltic Sea. In the autumn, on the other hand, the proportion of the shortest cod was the smallest, while the proportion of longer fish increased, as a result of the individuals returning to the feeding grounds after spawning. The fish migrated towards the shore, also through the proposed Project area.

- In the survey area, there was food available for cod of a wide range of lengths.
- The survey area served as a habitat mainly for adult flounder. Flounder occurred there most abundantly in the summer and least abundantly in the autumn.
- The stages of gonad maturity recorded in the winter flounder catches indicated the ongoing spawning of this species. The gravid stage of gonad maturity dominated. The occurrence of individuals with gonads at the spawning and spent stage was also recorded. Since the hydrological conditions prevailing in the area (the maximum recorded salinity below 10 PSU) are not favourable for the reproduction of European flounder (*Platichthys flesus*) occurring in the survey area (Momigliano *et al.*, 2018), it is safe to assume that the fish migrated to spawn from the survey area to the nearby Słupsk Furrow or the Gdańsk Deep. The results of the ichthyoplankton catches carried out in the area surveyed in which flounder eggs were not recorded, can confirm that assumption. However, the occurrence of flounder larvae was recorded in the winter and spring catches, probably as a result of their drifting into the area from the spawning grounds located in the above-mentioned Baltic depths.
- The provisions of the Maritime Spatial Plan for Polish Sea Areas state that in sea basin POM.60.E ‘there are good habitat and hydrological conditions for effective spawning of the autumn herring population and, to a lesser extent, of the spring herring population’. However, in recent years, the autumn population of herring has constituted a very small part of all the fish of this species occurring in the Baltic Sea. This is also confirmed by detailed ichthyological analyses of adult individuals carried out in the Project area, which indicated a high stage of development of their gonads in winter and spring. This is a biological parameter that is the basis for identifying fish belonging to the spring spawning population. It can, therefore, be assumed that despite the good environmental conditions indicated in the aforementioned document, the autumn spawning of herring in the area surveyed does not take place or is of marginal importance. Spring spawning herring, on the other hand, prefers areas with smaller depths for spawning than those found in the survey area which is located in a deeper part of the sea area. For this reason, the potential of environmental conditions indicated in the Maritime Spatial Plan of Polish Sea Areas does not translate into the significance of the Project area as a spawning ground for this population.
- The sea basin POM.60.E card also states that in the part of its area adjacent to the survey area, ‘there are optimal conditions for effective spawning of turbot’. During the conducted surveys, no larvae of this species were found in the samples taken. This species was also rare in adult fish catches. The conditions in which turbot spawn (depth range 5–40 m, salinity 6–7 PSU, sandy, gravelly and silty seabed) occur over relatively extensive areas of the Baltic Sea. It can, therefore, be assumed that the area of the proposed Project does not constitute a key spawning ground for this species.

7.3.1.2 Environmental impact assessment and transboundary environmental impact

The main source of noise during the construction phase will be the construction of foundations for wind turbines and for OSSs using the pile-driving method. According to Popper and Hastings [2009], this is the only noise impact, apart from underwater explosions, that can kill fish.

The sound generated during pile driving is of pulsating nature, characterised by short duration (<1 s) and a bandwidth between 100 and 1000 Hz, however, most of its energy falls within the range of up to 500 Hz [Dahl *et al.*, 2015]. The level of noise emitted during pile driving depends mainly on the technical parameters of the process (pile diameter, technology of pile driving, force and frequency of pile driver strikes). Some of the technological requirements depend on the other hand, on the environmental conditions (depth, type of sediment).

The noise emitted during pile driving depends on the pile diameter and can reach from approx. 230 dB re 1 μPa^{2}s (a pile diameter of 1.5 m) [Thomsen *et al.*, 2006] to nearly 260 (a pile diameter of 4.5 m) [OSPAR Commission, 2009].

A slightly lower noise level should be expected during cable laying works (178 dB re 1 μPa^{2}s) [Wilhelmsson *et al.*, 2010]. The source of noise present at all stages is the vessel traffic reaching, depending on the size and speed of the vessel, from 160 to 190 dB re 1 μPa m [OSPAR Commission, 2009].

The ability of fish to register sound enables them to orient themselves in the environment, and the range of this orientation is much greater than it is with sight. Sound is a source of directional information for fish, providing rapid information on environmental events even at relatively long distances [Popper and Schilt, 2008]. Hearing allows communication between fish, detection of prey and predators or habitat selection. It is also an important element of mating behaviour and orientation during migration. Therefore, anything that interferes with the ability of fish to detect and respond to biologically relevant sounds can adversely affect the survival and fitness of individuals and populations [Popper and Hawkins, 2019].

Fish perceive environmental sounds as a movement of water particles and/or a change in pressure. For most fish, frequencies perceived range from below 50 Hz to approximately 300–500 Hz, but in some cases, they can perceive sounds between 3 and 4000 Hz [Ladich and Fay, 2013; Popper and Hawkins, 2019]. The sensitivity to sound depends on the structure of the acoustic stimuli receptors. The receptor common to all species is the inner ear, where particle movement is processed via otoliths and sensory hair into nerve impulses. An additional element that can enhance hearing ability is the swim bladder, which converts sound-induced pressure changes into particle movement, thereby amplifying the strength of the acoustic stimulus. The mechanism of sound perception among fish without a swim bladder (e.g. adult flatfish) or fish in which the swim bladder is far away from the ear (e.g. salmon) is limited to the perception of the movement of water particles. This is due to the narrow range of frequencies heard (usually up to approximately 500 Hz) as well as a higher sound sensitivity threshold. The range of sound sensitivity for plaice and common dab ranges from 30 to 250 Hz, with the lowest hearing threshold of approximately 90 dB re 1μPa observed at frequencies of 100–160 Hz [Popper and Hawkins, 2019]. In the case of salmon, the lowest hearing threshold was recorded at frequencies from 100 to 200 Hz (93.5 dB re 1μPa). In contrast, fish with a swim bladder close to or directly connected to the ear (e.g. clupeids, cod) register sound over a wider range of frequencies and their threshold of sensitivity to sound is lower. In the case of herring, the range of recorded frequencies is 30 Hz to 4 kHz, and the lowest hearing threshold of 75 dB re 1μPa occurs at 100 Hz. A similar hearing threshold was found in cod (75 dB re 1μPa at 160 Hz), but this species perceives sounds in a narrower frequency range (18–470 Hz).

Depending on the noise intensity and the distance from its source, the environmental impact can have various effects, ranging from behavioural changes to the death of fish [Table 7.3].

Table 7.3. Potential environmental impact of noise on ichthyofauna [source: internal materials based on Popper et al., 2014]

No.	Environmental impact effect	Environmental impact characteristics
1.	Death	Death due to the damage resulting from exposure to sound
2.	Damage to tissue; disturbance of physiology	Example of damage: internal haemorrhage, damage to organs filled with gas, such as swim bladder and surrounding tissues
3.	Temporary Threshold Shift (TTS)	Hair cell damage, temporary threshold shift (TTS)
4.	Masking	Masking of important biological sound signals from the environment, including from other individuals
5.	Behavioural changes	Disturbance of normal activities, such as feeding, spawning, shoal formation, migration, movement from preferred areas, avoidance response

The lethal effects of impulse sound and tissue damage as well as disruption of fish physiology are the result of rapid pressure changes to which the gases in the body are subjected (barotrauma). These result in damage to the swim bladder and adjacent tissues. The rapid changes in external pressure cause changes in the volume of the swim bladder and gas bubbles found in the blood and tissues. This can lead to the adjacent tissues damage. Damage to the swim bladder reduces swimming efficiency and the ability to maintain buoyancy and increases the risk of mortality related to predation. The drop in pressure associated with the sound impact also reduces the solubility of the gas found in the tissues and blood. The effect is the appearance of gas bubbles that increase blood pressure, which in extreme cases results in the bursting of blood vessels. Gas bubbles in the bloodstream of fish can interfere with or damage important organs such as the heart, gills, kidneys, brain and gonads. If they appear in the gills or heart, immediate death can occur. Even if noise impacts do not cause immediate death, they can lead to delayed mortality due to haemorrhaging and indirectly increased vulnerability to predation [National Academies of Sciences, Engineering, and Medicine, 2011].

Temporary threshold shift (TTS) in fish is a periodic reduction in hearing sensitivity caused by exposure to intense sound. This effect is caused by damage to the sensory cell hairs and/or damage to the auditory nerves innervating the inner ear. Since in fish these cells are subject to regeneration or replenishment, this effect disappears after a certain period, from a few hours to several days [Popper *et al.*, 2014]. During a period of reduced sensitivity to auditory stimuli, there may be a reduction in the ability to communicate, detect predators or prey and orientate themselves in the environment.

The latest criteria for determining the level of pile-driving noise that causes specific effects in fish published in 2020 by the California Department of Transportation[5] citing the individual threshold values determined by Popper *et al.* (2014) are presented in Table 7.4.

[5]n the Baltic Sea. 2021 fact sheet. BSEP No 180. 45 s. -manual-a11y.pdf

Table 7.4. Environmental impact of a pile driver sound on ichthyofauna, taking into account morphology and developmental stage. For impact effects for which it was impossible to determine the sound level, the relative risk (low, moderate, high) was determined depending on the distance from the source of the sound: (C) close – several dozen meters, (M) moderately far – several hundred meters, (F) far – several thousand meters. Units for peak values: dB re 1 µPa and for the cumulative SEL value: dB re 1 µPa²s [Source: internal materials based on Popper et al. 2014]

Type of organism	Mortality and potential lethal damage	Reversible hearing damage	Temporary Threshold Shift (TTS)	Masking	Behavioural changes
Fish without swim bladder (detection of molecule movement) e.g. flatfish	>219 dB SEL_{cum} >213 dB_{peak}	>216 dB SEL_{cum} >213 dB_{peak}	>186 dB SEL_{cum}	(C) moderate (M) low (F) low	(C) high (M) moderate (F) low
Fish with swim bladder unconnected to the inner ear (detection of molecule movement) e.g. Atlantic salmon	210 dB SEL_{cum} >207 dB_{peak}	203 dB SEL_{cum} >207 dB_{peak}	>186 dB SEL_{cum}	(C) moderate (M) low (F) low	(C) high (M) moderate (F) low
Fish with a swim bladder connected to the inner ear (acoustic pressure detection) e.g. Atlantic cod, herring	207 dB SEL_{cum} >207 dB_{peak}	203 dB SEL_{cum} >207 dB_{peak}	186 dB SEL_{cum}	(C) high (M) high (F) moderate	(C) high (M) high (F) moderate
Eggs and larvae	>210 dB SEL_{cum} >207 dB_{peak}	(C) moderate (M) low (F) low	(C) moderate (M) low (F) low	(C) moderate (M) low (F) low	(C) moderate (M) low (F) low

The impact range (the distance or area within which the noise level reaches the value that produces the effect) depends on both abiotic conditions (seabed relief, salinity, temperature) and technical conditions (pile diameter, number of blows needed to install one element, pile driver power). The sensitivity of the fish species/group to sound levels, resulting from the structure of the auditory senses, is also a fundamental factor.

According to the generalised assessment of the environmental impact of wind farms in the Baltic Sea by Bergstrom *et al*. (2014), the noise impact from pile driving will be at a level ranging from moderate (the Baltic Proper and the Gulf of Bothnia) to high (the Danish Straits).

Other sources of noise emissions at the construction stage, will be the burying of cables connecting the wind turbines and the connection infrastructure cables. According to Nedwell and Howell [2004], the noise level during the construction of trenches for cables was 178 dB re: 1 µPa²s at a distance of 1 meter from the sound source. A higher value of 187 dB re: 1 µPa²s, is given by Bald *et al.* [2015, qtd. in Taormina *et al.*].

Most studies [Meisner *et al*., 2006; OSPAR, 2008; OSPAR, 2012; Taormina *et al*., 2018] assume that the environmental impact of this factor on marine organisms will be relatively small.

An increased vessel traffic can be expected during the construction phase of the Project. The noise generated by vessels reaches, depending on the size and speed of the vessel, from 160 to 190 µPa²s [OSPAR Commission, 2009] and appears to pose less of a threat than the sound sources directly associated with construction works.

The numerical model of noise propagation during pile driving predicts behavioural impacts that, while not causing bodily injuries, may, in some cases lead to avoidance of an area with elevated noise levels and ultimately lead to the disruption of spawning. The modelling results showed that the area in the case of two simultaneous pile driving operations would reach 6600 km^2, including the area of the Słupsk Furrow, which constitutes a cod spawning ground of low significance. The direction of sound propagation indicates that the impact will not reach the Bornholm Deep, which is one of the main spawning grounds for Baltic cod. It should be emphasised that considering the behavioural effect in terms of an avoidance response which may cause the spawning ground abandonment is a very conservative approach. The noise level used in the model for behavioural response is the value at which the sprat shoal dispersal was observed, so it is not necessarily the same as the value causing the avoidance response. Additionally, in some cases, the so-called habituation may take place, which is a phenomenon occurring when fish become accustomed to the level of the stimulus after a certain period of its impact. Research by Mueller-Blenkle *et al*. [2010] showed that the directional response of cod and sole to sound ceased with successive noise emissions. Also, the aforementioned information on the lack of environmental impact of pile driving carried out near an ichthyofauna-inhabited wind farm on the distribution of fish in its area may indicate the occurrence of habituation.

Detailed information on the ranges of noise impact on fish is included in Appendix 3 to the EIA Report. Assuming the application of NRS in summer, no impact is expected even at the behavioural level on the areas of Denmark and Finland, and the impact at the behavioural level on the Swedish area will have a small extent. In winter, the ranges of impacts will be larger, but there will still be no impact on Danish and Finnish waters, and in Swedish waters, the area of impact both at the behavioural and TTS levels will be limited to several dozen square kilometres.

The environmental impact of noise and vibration on adult fish will be adverse, direct, short-term and reaching beyond the Baltica -1 OWF Area (transboundary). Noise and vibration will affect the spawning grounds of cod, flounder and sprat, which are located in deeper waters. However, the impact area is small when it comes to the total spawning area of the species listed.

The sensitivity of cod, herring, sprat and sand goby to the impact was assessed as very high, while in the case of flounder, common seasnail and twaite shad − as high.

The significance of the environmental impact was assessed as moderate for all the fish species examined.

Potential transboundary environmental impacts on ichthyofauna may also be related to the dispersion of suspended solids. Increased suspended solids concentrations may, in rare cases, cause a lethal effect, but they may also be sublethal such as tissue damage, disruptions to physiological processes, reduced growth rate, increased susceptibility to diseases, as well as behavioural changes – changes in behaviour and reproductive efficiency, avoidance response, reduced efficiency of food acquisition.

Increased suspended solids concentrations may also inhibit larval growth and negatively affect the development and survival of eggs.

The relatively rare mortality of juvenile and adult stages of ichthyofauna results from the fact that in the case of increased suspended solids concentrations, the avoidance response occurs often, i.e. fish move to areas which are not affected by this factor.

In the report prepared for the environmental impact assessment of the Sæby OWF (Ramboll 2014) based on the analysis of the available literature, concentration limits were proposed at which an avoidance response can be expected [Table 7.5].

Table 7.5. Limit values of suspended solids concentrations causing an avoidance response and lethal effect in adult fish [Source: internal materials based on Ramboll 2014]

Species	Avoidance response	Lethal effect	Maximum concentration at the boundary of	
			the Swedish EEZ	Natura 2000 site *Hoburgs Bank och Midsjöbankarna* (SE0330308)
Pelagic	10 mg·dm^{-3}	>500 mg·dm^{-3}	approx. 100 mg·dm^{-3}	approx. 60 mg·dm^{-3}
Demersal	50 mg·dm^{-3}	>3000 mg·dm^{-3}		

The modelling of suspended solids showed that the predicted increase in concentration in the Swedish EEZ will be so small that its environmental impact on the ichthyofauna on a transboundary level can be considered negligible.

7.3.1.2.1 Conclusions concerning the transboundary environmental impacts

Due to the construction of the wind farm, particularly the pile driving of the foundations, a transboundary environmental impact may occur due to the adverse effects of noise and vibration on fish. This will be an adverse, direct and short-term impact. Due to a very high sensitivity to the impact of cod, herring, sprat and sand goby and a high sensitivity of flounder, common seasnail and twaite shad, but a relatively small impact area in relation to the total spawning area of these species, the significance of this environmental impact was assessed as moderate. Regardless of the above, the Project Owner has planned a system of mitigation measures aimed at limiting to the maximum possible extent the adverse impacts related to noise emissions, including its impact on ichthyofauna. These measures, constituting a comprehensive noise reduction system (NRS), are described in Section 3.5.2.1.

7.3.2 Migratory birds

7.3.2.1 Current state

The most abundant migratory birds observed during the surveys included sea ducks (the long-tailed duck and the common scoter) and the razorbill, as well as ducks, geese, auks and passerines unidentified as to the species. The migratory birds observed were classified into 105 categories, 89 of which were birds identified to the species level. Migratory bird species observed during the survey period together with their protection status and total abundance of the individuals observed during surveys are presented in Table 7.6.

Table 7.6. Number of bird individuals identified up to the species, recorded during visual observations in the spring and autumn of 2023 together with their national and international protection status

Common name	Binomial nomenclature	Number of individuals	Species protection in Poland[1]	Annex I to the EU Birds Directive	IUCN[2]	HELCOM threat category[3]
Long-tailed duck	*Clangula hyemalis*	9539	SP	No	LC/VU	EN (wp)
Common scoter	*Melanitta nigra*	3804	SP	No	LC	EN (wp)
Razorbill	*Alca torda*	964	SP	No	LC	
Great black cormorant	*Phalacrocorax carbo*	405	PP	No	LC	
Eurasian wigeon	*Anas penelope*	343	SP	No	LC	

Common name	Binomial nomenclature	Number of individuals	Species protection in Poland[1]	Annex I to the EU Birds Directive	IUCN[2]	HELCOM threat category[3]
Lesser black-backed gull	*Larus fuscus*	296	SP	No	LC	VU
Little gull	*Larus minutus*	296	SP	Yes	LC	NT
Eurasian curlew	*Numenius arquata*	292	SP	No	NT	
Common gull	*Larus canus*	242	SP	No	LC	
Common guillemot	*Uria aalge*	231	SP	No	LC	
Velvet scoter	*Melanitta fusca*	230	SP	No	VU	VU (bp) EN (wp)
Common chaffinch	*Fringilla coelebs*	215	SP	No	LC	
Greylag goose	*Anser anser*	190	G	No	LC	
Common starling	*Sturnus vulgaris*	189	SP	No	LC	
Greater scaup	*Aythya marila*	158	SP	No	LC	VU
Greater white-fronted goose	*Anser albifrons*	147	G	No	LC	
Black-throated diver	*Gavia arctica*	134	SP	Yes	LC	CR (wp)
Common teal	*Anas crecca*	133	G	No	LC	
European herring gull	*Larus argentatus*	125	PP	No	LC	
Eurasian siskin	*Spinus spinus*	118	SP	No	LC	
White wagtail	*Motacilla alba*	99	SP	No	LC	
Common swift	*Apus apus*	88	SP	No	NT/LC	
Mallard	*Anas platyrhynchos*	63	G	No	LC	
Eurasian skylark	*Alauda arvensis*	62	SP	No	LC	
Mute swan	*Cygnus olor*	58	SP	No	LC	
Red-breasted merganser	*Mergus serrator*	55	SP	No	NT/LC	VU
Black-headed gull	*Chroicocephalus ridibundus*	51	SP	No	LC	
Pintail	*Anas acuta*	46	SP	No	VU/LC	
Common crane	*Grus grus*	44	SP	Yes	LC	
Barn swallow	*Hirundo rustica*	38	SP	No	LC	
Red-throated diver	*Gavia stellata*	36	SP	Yes	LC	CR (wp)
Black guillemot	*Cepphus grylle*	35	SP	No	LC	
Grey heron	*Ardea cinerea*	30	PP	No	LC	
European golden plover	*Pluvialis apricaria*	29	SP	Yes	LC	
Common tern	*Sterna hirundo*	27	SP	Yes	LC	
Tufted duck	*Aythya fuligula*	20	G	No	NT/LC	NT
Great black-backed gull	*Larus marinus*	19	SP	No	LC	
Great egret	*Ardea alba*	17	SP	Yes	LC	
Dunlin	*Calidris alpina*	17	SP	No	LC	EN (schinzii)
Northern shoveler	*Anas clypeata*	16	SP	No	LC	

Common name	Binomial nomenclature	Number of individuals	Species protection in Poland[1]	Annex I to the EU Birds Directive	IUCN[2]	HELCOM threat category[3]
Sanderling	*Calidris alba*	16	SP	No	LC	
Whooper swan	*Cygnus cygnus*	13	SP	Yes	LC	
Common wood pigeon	*Columba palumbus*	12	G	No	LC	
Arctic tern	*Sterna paradisaea*	12	SP	Yes	LC	
Meadow pipit	*Anthus pratensis*	9	SP	No	LC	
Great tit	*Parus major*	9	SP	No	LC	
Parasitic jaeger	*Stercorarius parasiticus*	9	SP	No	EN/LC	
Black tern	*Chlidonias niger*	9	SP	Yes	LC	
Goosander	*Mergus merganser*	8	SP	No	LC	
European robin	*Erithacus rubecula*	8	SP	No	LC	
Fieldfare	*Turdus pilaris*	7	SP	No	LC	
Eurasian wren	*Troglodytes troglodytes*	7	SP	No	LC	
Goldcrest	*Regulus regulus*	7	SP	No	LC	
Rook	*Corvus frugilegus*	6	PP	No	VU/LC	
Tundra swan	*Cygnus columbianus*	6	SP	No	VU/LC	
Song thrush	*Turdus philomelos*	6	SP	No	LC	
Common shelduck	*Tadorna tadorna*	6	SP	No	LC	LC
Hooded crow	*Corvus corone cornix*	5	PP	No	LC	
Eurasian sparrowhawk	*Accipiter nisus*	5	SP	No	LC	
Short-eared owl	*Asio flammeus*	5	SP	Yes	LC	
Western yellow wagtail	*Motacilla flava*	5	SP	No	LC	
Long-eared owl	*Asio otus*	4	SP	No	LC	
Black-legged kittiwake	*Rissa tridactyla*	4	SP	No	VU	EN (bp) VU (wp)
Eurasian blue tit	*Parus caeruleus*	4	SP	No	LC	
Common linnet	*Linaria cannabina*	4	SP	No	LC	
Common redpoll	*Acanthis flammea*	4	SP	No	LC	
Pomarine skua	*Stercorarius pomarinus*	3	SP	No	LC	
European sand martin	*Pluvialis squatarola*	3	SP	No	LC	
Stock dove	*Columba oenas*	2	SP	No	LC	
Barnacle goose	*Branta leucopsis*	2	SP	Yes	LC	
Common blackbird	*Turdus merula*	2	SP	No	LC	
Osprey	*Pandion haliaetus*	2	SP	Yes	LC	
Common snipe	*Gallinago gallinago*	2	SP	No	VU/LC	
Ruff	*Philomachus pugnax*	2	SP	Yes	NT/LC	VU
Brambling	*Fringilla montifringilla*	1	SP	No	LC	

Common name	Binomial nomenclature	Number of individuals	Species protection in Poland[1]	Annex I to the EU Birds Directive	IUCN[2]	HELCOM threat category[3]
Common eider	*Somateria mollissima*	1	SP	No	EN/NT	VU (bp) EN (wp)
Common goldeneye	*Bucephala clangula*	1	SP	No	LC	
Common kestrel	*Falco tinnunculus*	1	SP	No	LC	
Dunnock	*Prunella modularis*	1	SP	No	LC	
Horned grebe	*Podiceps auritus*	1	SP	Yes	NT/VU	VU (bp) NT (wp)
Northern lapwing	*Vanellus vanellus*	1	SP	No	VU/NT	NT
Red-necked grebe	*Podiceps grisegena*	1	SP	No	VU/LC	EN (wp)
Eurasian blackcap	*Sylvia atricapilla*	1	SP	No	LC	
European nightjar	*Caprimulgus europaeus*	1	SP	Yes	LC	
Lesser whitethroat	*Sylvia curruca*	1	SP	No	LC	
Sand martin	*Riparia riparia*	1	SP	No	LC	
Sandwich tern	*Sterna sandvicensis*	1	SP	Yes	LC	LC
Snow bunting	*Plectrophenax nivalis*	1	SP	No	LC	
Woodlark	*Lullula arborea*	1	SP	Yes	LC	

[1]Regulation of the Minister of the Environment of 16 December 2016 on the protection of animal species; Regulation of the Minister of the Environment of 11 March 2005 on establishing the list of game species: SP – strict protection, PP – partial protection, G – game species
[2]IUCN: EN – endangered, VU – vulnerable, NT – near threatened, LC – least concern
[3]HELCOM: CR – critically endangered; EN – endangered; VU – vulnerable, NT – near threatened, LC – least concern; wp – wintering population, bp – breeding population

The most abundant migratory fluxes were determined for the long-tailed duck, the common scoter, passerines including pigeons, auks, geese, Charadriiformes, dabbling ducks and the common gull [Table 7.7]. Among seagull species, the highest fluxes were recorded in April for the common gull, the lesser black-backed gull, the little gull and the European herring gull. Based on the summary estimation of migration intensity, it can be concluded that the spring migration was more intense in the survey area than the autumn migration. The autumn migration was only more abundant in the case of the common scoter, passerines including pigeons, dabbling ducks, the common gull, terns, the great black cormorant and the European herring gull.

Table 7.7. Estimate of the migration intensity through the survey area of the most abundant migratory birds in spring and autumn

Common name	Binomial nomenclature	Abundance of the biogeographical population	Abundance of the Baltic population	Estimate of migration intensity (no. of individuals)		
				Spring	Autumn	Total
Long-tailed duck	*Clangula hyemalis*	1 600 000	350 000	113 866	23 365	137 231
Common scoter	*Melanitta nigra*	550 000	500 000	41 289	85 136	126 425
Passerines/ pigeons	*Passeriformes /Columbinae*	100 000 000	N/A	52 322	70 808	123 130
Auks	*Alcidae*	5 000 000	23 000	33 751	16 885	50 635
Geese	*Anserinae*	3 500 000	N/A	24 633	8511	33 144

Common name	Binomial nomenclatu re	Abundance of the biogeographical population	Abundance of the Baltic population	Estimate of migration intensity (no. of individuals)		
				Spring	**Autumn**	**Total**
Charadriiformes	*Charadriidae*	1 600 000	N/A	15 049	4620	19 669
Ducks	*Anatini*	6 500 000	1 500 000	4778	6654	11 432
Common gull	*Larus canus*	1 200 000	75 000	5256	5800	11 056
Lesser black-backed gull	*Larus fuscus*	1 200 000	56 000	5644	3938	9582
Terns	*Sternidae*	1 800 000	440 000	491	7138	7630
Divers	*Gaviidae*	400 000	8600	5773	1006	6778
Little gull	*Hydrocoloeus minutus*	72 000	50 000	3221	2718	5939
Great black cormorant	*Phalacrocorax carbo*	405 000	100 000	1406	4215	5621
Velvet scoter	*Melanitta fusca*	450 000	170 000	2585	1576	4161
European herring gull	*Larus argentatus*	700 000	300 000	1497	2551	4048
Black-headed gull	*Chroicocephal us ridibundus*	4 770 000	1 350 000	1008	951	1958
Swans	*Cygnidae*	300 000	100 000	1100	485	1584
Skuas	*Stercorariidae*	100 000	2000	574	556	1129
Common crane	*Grus grus*	410 000	40 000	297	133	430
Total				**314 539**	**247 045**	**561 583**

The visual observations conducted demonstrate that the vast majority of the bird groups and species analysed flew at altitudes of up to 20 MASL [Table 7.8]. Only in the case of the common crane were all the observed flights recorded above 20 MASL, while in the case of geese, it was near 75%. No significant difference in the proportion of birds flying below and above 20 MASL was found for Charadriiformes and swans. Similar results were obtained during other OWF surveys in that area [Bednarska *et al.*, 2017; Opioła *et al.*, 2020; SMDI Advisory Group, 2015a, b; Gajewski *et al.*, 2021]. It should be remembered that the flight altitudes obtained from visual observations represent only a part of all flying birds and these values should be regarded as supporting information. Visual observations are intended to identify as many birds as possible, but due to the nature of this type of monitoring, birds flying low are much more frequently recorded than birds flying at altitudes above 100 MASL. The auxiliary nature of the flight altitude observations should be emphasised, as they are vitiated by an error due to the limited possibilities of bird detection at high altitudes, in favour of birds flying lower and closer to the observers located at the survey station.

Table 7.8. Flight altitude of species and groups of species observed at a distance of up to 20 m and more than 20 m above the water

No.	Common name	Binomial nomenclature	Below 20 MASL (%)	Above 20 MASL (%)
1	Long-tailed duck	*Clangula hyemalis*	99.6	0.4
2	Common scoter	*Melanitta nigra*	96.7	3.3
3	Passerines/pigeons	*Passeriformes/Columbinae*	91.3	8.7
4	Auks	*Alcidae*	99.9	0.1
5	Geese	*Anserinae*	25.4	74.6

No.	Common name	Binomial nomenclature	Below 20 MASL (%)	Above 20 MASL (%)
6	Charadriiformes	*Charadriidae*	42.8	57.2
7	Ducks	*Anatini*	82.4	17.6
8	Common gull	*Larus canus*	80.6	19.4
9	Lesser black-backed gull	*Larus fuscus*	74.3	25.7
10	Terns	*Sternidae*	97.8	2.2
11	Divers	*Gaviidae*	82.9	17.1
12	Little gull	*Hydrocoloeus minutus*	77.7	22.3
13	Great black cormorant	*Phalacrocorax carbo*	76.8	21.1
14	Velvet scoter	*Melanitta fusca*	90.4	9.6
15	European herring gull	*Larus argentatus*	100	0
16	Black-headed gull	*Chroicocephalus ridibundus*	94.1	5.9
17	Swans	*Cygnidae*	52.6	47.4
18	Skuas	*Stercorariidae*	78.6	21.4
19	Common crane	*Grus grus*	0	100
Percentage share of all observations			**88.4**	**11.6**

On the basis of the acoustic recordings collected, 9331 calls in spring as well as 11 456 calls of 41 bird species and categories were identified. Among the passerines, the following species were most commonly identified during night hours − the common blackbird, the redwing, the European robin and the song thrush, while during daylight hours − the white wagtail, the goldcrest, the Eurasian blue tit, the great tit and the common chaffinch [Table 7.9]. Three species of Charadriiformes were also identified – the common snipe during night hours, the green sandpiper during daylight hours and the Eurasian curlew during both daytime and at night. In spring, similarly as in autumn, the calls of gulls dominated. The vast majority of the calls were recorded in the daylight hours.

Table 7.9. Bird calls identified based on the recordings made during the spring and autumn migration

No.	Common name	Binomial nomenclature	Day/Night (time of recording)	Spring	Autumn	Total
1	Unidentified large gull	*Larus sp.*	D/N	4692	5021	9713
2	European herring gull	*Larus argentatus*	D/N	587	2015	2602
3	Caspian gull	*Larus cachinnans*	D/N	0	1556	1556
4	Goldcrest	*Regulus regulus*	D	766	736	1502
5	Common blackbird	*Turdus merula*	D/N	948	23	971
6	White wagtail	*Motacilla alba*	D/N	237	513	750
7	Song thrush	*Turdus philomelos*	D/N	143	504	647
8	Eurasian blue tit	*Parus caeruleus*	D	8	496	504
9	Common gull	*Larus canus*	D/N	408	37	445
10	Redwing	*Turdus iliacus*	D/N	256	70	326
11	Great tit	*Parus major*	D	314	5	319
12	European robin	*Erithacus rubecula*	D/N	216	85	301
13	Unidentified gull	*Laridae indet.*	D	92	107	199
14	Common chaffinch	*Fringilla coelebs*	D/N	54	89	143
15	Eurasian skylark	*Alauda arvensis*	D/N	138	0	138

No.	Common name	Binomial nomenclature	Day/Night (time of recording)	Spring	Autumn	Total
16	Long-tailed duck	*Clangula hyemalis*	D	99	0	99
17	Lesser black-backed gull	*Larus fuscus*	D/N	40	37	77
18	Black-headed gull	*Chroicocephalus ridibundus*	D/N	53	7	60
19	Meadow pipit	*Anthus pratensis*	D	49	4	53
20	Grey heron	*Ardea cinerea*	N	0	51	51
21	Twite	*Linaria flavirostris*	D	0	50	50
22	Yellowhammer	*Emberiza citrinella*	D	48	0	48
23	Eurasian siskin	*Spinus spinus*	D	38	0	38
24	Eurasian curlew	*Numenius arquata*	D/N	33	0	33
25	Western yellow wagtail	*Motacilla flava*	D	13	19	32
26	Eurasian wigeon	*Anas penelope*	D/N	31	0	31
27	Passerine of an unidentified species	*Passeriformes indet.*	D/N	31	0	31
28	Great black-backed gull	*Larus marinus*	D	6	23	29
29	Common starling	*Sturnus vulgaris*	D	10	0	10
30	Common snipe	*Gallinago gallinago*	N	0	4	4
31	Spotted flycatcher	*Muscicapa striata*	N	1	3	4
32	Fieldfare	*Turdus pilaris*	N	3	0	3
33	Great tit/Eurasian blue tit	*Parus major/ Cyanistes caeruleus*	D	3	0	3
34	Mediterranean gull	*Ichthyaetus melanocephalus*	D	3	0	3
35	Tree pipit	*Anthus trivialis*	D/N	3	0	3
36	Unidentified duck	*Melanitta indet.*	N	3	0	3
37	Common chiffchaff	*Phylloscopus collybita*	D	2	0	2
38	Common linnet	*Linaria cannabina*	D	1	0	1
39	Common whitethroat	*Sylvia communis*	D	1	0	1
40	Green sandpiper	*Tringa ochropus*	D	0	1	1
41	Mistle thrush	*Turdus viscivorus*	N	1	0	1
Total				**9331**	**11 456**	**20 787**

Tracking individual birds in flight and recording their flight paths allows the determination of the flight direction during migration for individual species or groups of species. In total, 9214 flight paths were recorded in spring for 88 species and 23 categories of birds unidentified as to species, and in autumn – 2968 flight paths for 81 species and 15 categories in cases in which identification as to the species was impossible. The analyses carried out using the horizontal radar indicate fairly uniform directions of migratory bird flights both in spring (N–E direction) and in autumn (W–S direction) [Figure 7.1 and

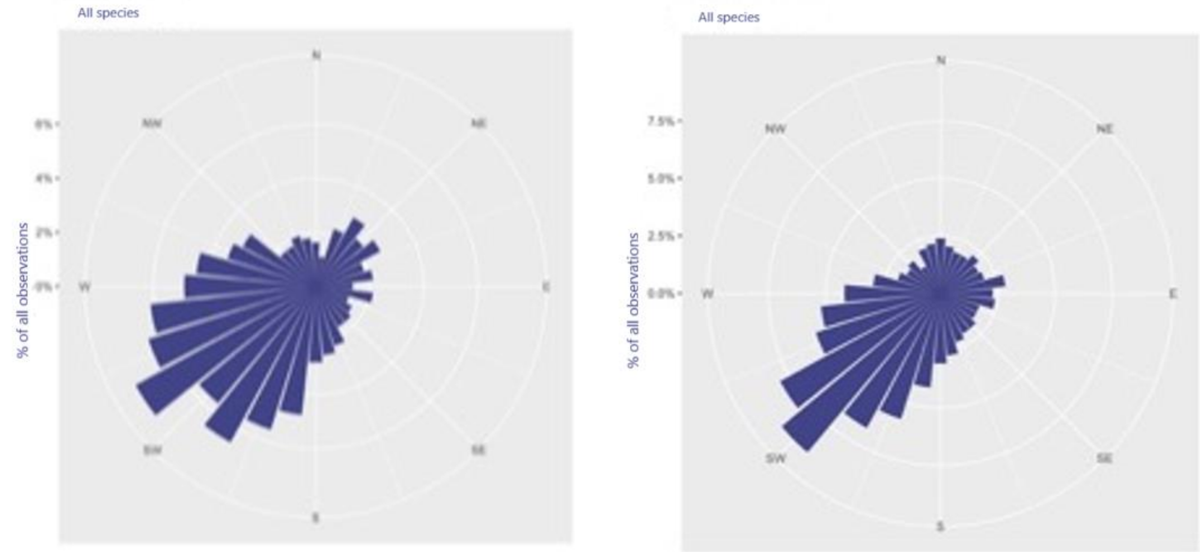

Figure 7.2]. Some of the groups and bird species subject to tracking flew in the direction opposite to the main direction of migration. This situation was observed for gulls, auks and divers, which may be due to the fact that not all radar-tracked birds belonging to those groups were migrating at the time. In the case of auks and divers, it is possible that some birds had already completed their migration, and the paths referred to birds moving locally within the wintering area. In the case of gulls, it is likely that the paths were recorded for local gulls staying in the coastal water area of the Baltic Sea all year round. The migration patterns observed are comparable with the flight directions recorded during other spring and autumn OWF surveys in that area [Bednarska *et al*., 2017; Opioła *et al*., 2020; SMDI Advisory Group, 2015a, b; Gajewski *et al*., 2021].

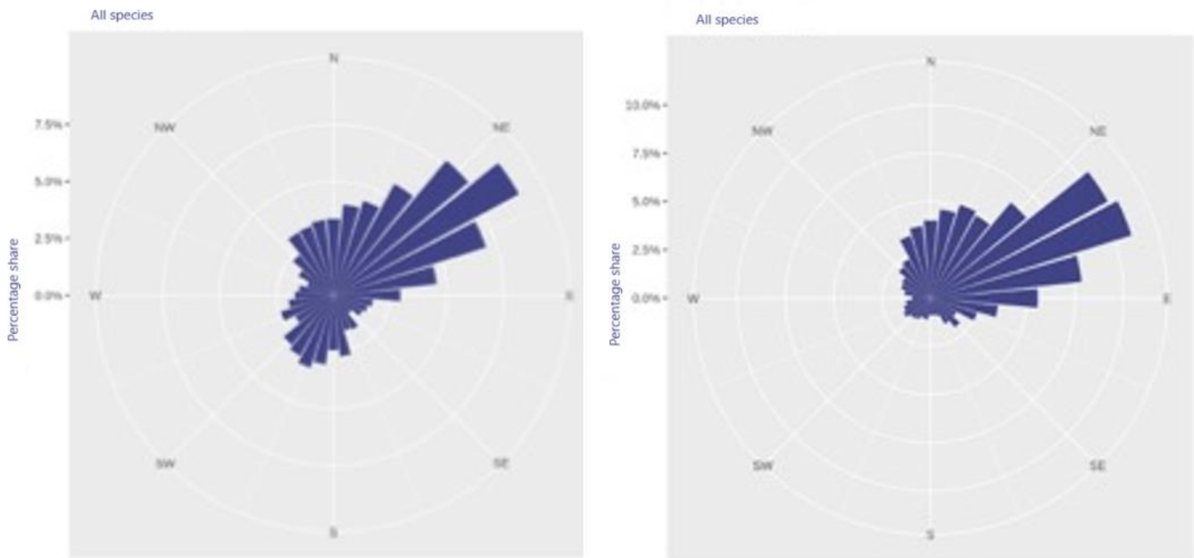

Figure 7.1. Flight directions of all the birds recorded at station MB_01 (on the left) and MB_02 (on the right) during the spring migration period

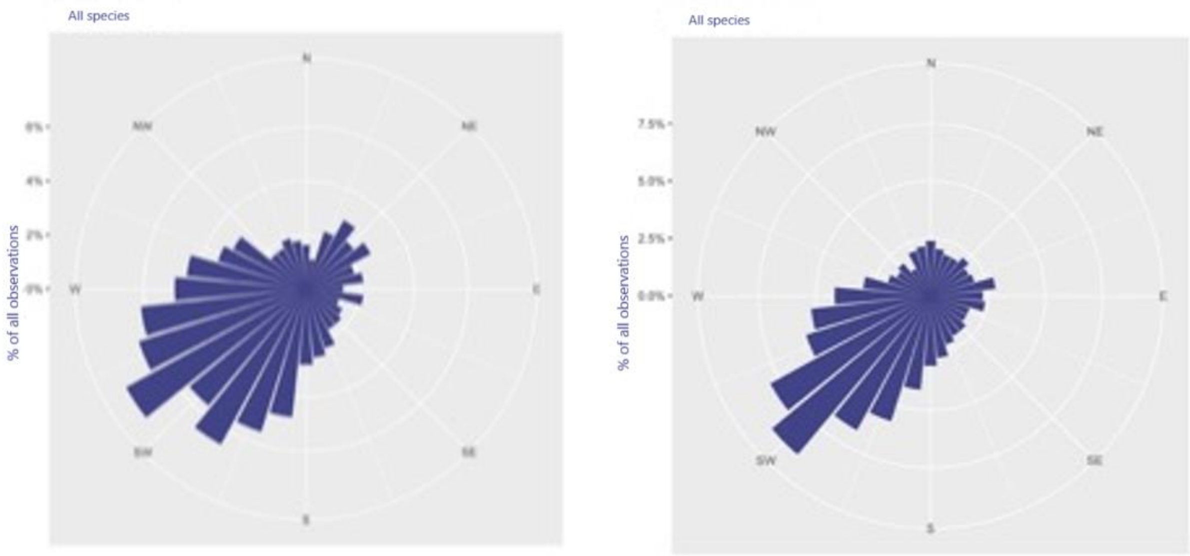

Figure 7.2. Flight directions of all the birds recorded at station MB_01 (on the left) and MB_02 (on the right) during the autumn migration period

In further analyses for the purposes of the modelling of collision risk and barrier effect for the environmental impact assessment, species were selected according to the abundance criterion – number of observations (the most commonly observed species and groups of species were included), as well as according to the criterion of expert knowledge on the species usually migrating across the Baltic Sea area and observed sparsely during surveys (e.g. the common crane). The information on the species protection status and the importance of the species as a receptor according to the methodology adopted in the EIA Report were also taken into consideration. This information along with the size of biogeographic populations and the assessment of the resource importance are presented in Table 7.10. The above information was the basis for the significance assessment of the Baltica-1 OWF environmental impact on migratory birds.

The long-tailed duck and the common scoter were the two most abundant species during the surveys of birds migrating in the spring and autumn of 2023. Based on the analysis of the migratory flux, 7.51% of the biogeographical common scoter population may fly over the OWF Area in spring and 15.48% in autumn [Table 7.10]. In the case of the long-tailed duck, these values represent 7.12% of the biogeographical population in spring and 1.46% in autumn. The relatively intense migration of the common scoter in the early autumn months (July) is related to moulting. Shortly after breeding, males head to resting sites where they become flightless during moulting. Since in the case of surveys in the remaining OWF areas, the monitoring of birds migrating in autumn started usually in August, it is not possible to compare the high flight values obtained for the common scoter in July in the survey area. While the long-tailed duck was abundant during both the spring and autumn surveys, the common scoter was only observed in higher numbers during the spring months (except for observations made in July). The low abundance of the common scoter during autumn migration surveys may be related to the different migration routes to the wintering grounds in the Kattegat Strait, the Pomeranian Bay and the Gulf of Gdańsk. Common scoters nesting on the coasts of Sweden and Finland follow the coast towards the west before crossing the Baltic Sea and reaching the Pomeranian Bay. Such movement pattern is similar to the results obtained during other OWF surveys in that area [Bednarska *et al*., 2017; Opioła *et al.*, 2020; SMDI Advisory Group, 2015a, b; Gajewski *et al*., 2021].

The long-tailed duck was observed in high abundance in both spring and autumn, but significantly higher abundances were recorded in spring. Such movement patterns (high intensity in spring, lower in autumn) are similar to the results obtained during other OWF surveys in that area (*ibid.*), but the estimated intensity of spring migration in the survey area is mostly 40–60% higher than in the more southern locations near the Słupsk Bank. The largest concentrations of long-tailed ducks in the Baltic Sea occur in sandy shallows, the Hoburgs Bank, northern and southern Midsjo Bank and the Słupsk Bank [Opioła *et al*., 2020, Skov *et al*., 2011; Durnick *et al*., 2011]. The OWF site is in close proximity to the Midsjo Bank and the Swedish Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308), hence the constant presence of birds during the surveys.

Relatively high migratory fluxes were obtained for the little gull, at 4.47% of the biogeographical population in spring and at 3.77% in autumn. This is consistent with other surveys conducted in the Baltic Sea [Bednarska *et al*., 2017; Opioła *et al*., 2020; SMDI Advisory Group, 2015a, b; Gajewski *et al*., 2021].

The estimated intensity of auk migration refers to 0.68% of the biogeographical population in spring and 0.34% in autumn, but in relation to the abundance of the local Baltic population, these values represent more than 100% in spring and 73.41% in autumn. Since there are no data on the movement of razorbills outside the breeding season (which could only be investigated using telemetry), it is predicted that a large number of the estimated number of razorbills flying over the wind farm area is related to local flights of individuals inhabiting nearby areas, rather than flights associated with migrations of the species. This thesis is supported by the fact that no clearly dominant direction of bird flight was recorded in either spring or autumn. Based on the above, it can be concluded that the survey area does not lie in the path of a major razorbill migration route, but it is an area of importance for birds living in nearby areas and flying locally. The values obtained are similar to the results obtained during other OWF surveys in that area (*ibid*.).

Table 7.10. Species and groups of species included in the analyses for the purposes of this Report with the assessment of the significance of vulnerable populations

Common name	Binomial nomenclature	Abundance of the biogeographical population	Abundance of the Baltic population	Migration season	Estimate of migration intensity (no. of individuals)	Proportion of the biogeographical population (%)	Proportion of the Baltic population (%)	Importance of the species
Long-tailed duck	*Clangula hyemalis*	1 600 000	350 000	Spring	113 866	7.12	32.53	High
				Autumn	23 365	1.46	6.68	
Common scoter	*Melanitta nigra*	550 000	500 000	Spring	41 289	7.51	8.26	High
				Autumn	85 136	15.48	17.03	
Passerines/ pigeons	*Passeriformes/ Columbinae*	100 000 000	N/A	Spring	52 322	0.05	-	Low
				Autumn	70 808	0.07	-	
Auks	*Alcidae*	5 000 000	23 000	Spring	33 751	0.68	100.00	Low
				Autumn	16 885	0.34	73.41	
Geese	*Anserinae*	3 500 000	N/A	Spring	24 633	0.70	-	Low
				Autumn	8511	0.24	-	
Charadriiformes	*Charadriidae*	1 600 000	N/A	Spring	15 049	0.94	-	Low
				Autumn	4620	0.29	-	
Ducks	*Anatini*	6 500 000	1 500 000	Spring	4778	0.07	0.32	Low
				Autumn	6654	0.10	0.44	
Common gull	*Larus canus*	1 200 000	75 000	Spring	5256	0.44	7.01	Low
				Autumn	5800	0.48	7.73	
Lesser black-backed gull	*Larus fuscus*	1 200 000	56 000	Spring	5644	0.47	10.08	Low
				Autumn	3938	0.33	7.03	
Terns	*Sternidae*	1 800 000	440 000	Spring	491	0.03	0.11	Low
				Autumn	7138	0.40	1.62	
Divers	*Gaviidae*	400 000	8600	Spring	5773	1.44	67.12	Moderate
				Autumn	1006	0.25	11.69	
Little gull	*Hydrocoloeus minutus*	72 000	50 000	Spring	3221	4.47	6.44	High
				Autumn	2718	3.77	5.44	

Common name	Binomial nomenclature	Abundance of the biogeographical population	Abundance of the Baltic population	Migration season	Estimate of migration intensity (no. of individuals)	Proportion of the biogeographical population (%)	Proportion of the Baltic population (%)	Importance of the species
Great black cormorant	*Phalacrocorax carbo*	405 000	100 000	Spring	1406	0.35	1.41	Low
				Autumn	4215	1.04	4.22	
Velvet scoter	*Melanitta fusca*	450 000	170 000	Spring	2585	0.57	1.52	High
				Autumn	1576	0.35	0.93	
European herring gull	*Larus argentatus*	700 000	300 000	Spring	1497	0.21	0.50	Low
				Autumn	2551	0.36	0.85	
Black-headed gull	*Chroicocephalus ridibundus*	4 770 000	1 350 000	Spring	1008	0.02	0.07	Low
				Autumn	951	0.02	0.07	
Swans	*Cygnidae*	300 000	100 000	Spring	1100	0.37	1.10	Low
				Autumn	485	0.16	0.48	
Skuas	*Stercorariidae*	100 000	2000	Spring	574	0.57	28.68	Low
				Autumn	556	0.56	27.79	
Common crane	*Grus grus*	410 000	40 000	Spring	297	0.07	0.74	Low
				Autumn	133	0.03	0.33	

7.3.2.2 Environmental impact assessment and transboundary environmental impact

Due to the construction, operation as well as decommissioning of the Baltica-1 OWF, environmental impacts on migratory birds related to the barrier effect and collision risk may occur. In the first place, this will result from the presence of construction vessels in the OWF Area and the subsequent erection of wind turbines.

During the construction and decommissioning phases, the scale of the impact will depend on the number of vessels, their size, their operating hours, and the time of year (season).

Migratory birds, sensitive to disturbances generated by ships, may change the trajectory of flight vertically or horizontally, which may extend their flight, and thus, increase the energy costs of the migration. However, the change of the route will constitute only a small part of the entire migration journey; therefore, the additional energy costs related to it will be irrelevant, as, for example, the cost calculated by the Masden team for the long-tailed duck [Masden and Cook 2016]. The analysis of the change in the length of the migration route during the operation phase indicates that the route was extended only slightly (approximately 0.02%). Changes of this size have a minimal effect on the total length of migration. Due to the fact that the distance covered by birds of the same species is not identical (due to different stopover places, nesting places, differences in the flight route selection, etc.) (Appendix 1 to the EIA Report), the significance of the environmental impact also during the construction phase was assessed as negligible for all species and groups of species analysed.

Migratory birds, especially some terrestrial species, may be attracted by the lights used on ships at night or during bad weather conditions (heavy rain, fog). The scale of this impact has been poorly known so far and the current state of knowledge does not allow quantifying this impact. There are reports documenting the fact that similarly as in the case of terrestrial structures, passerine birds occasionally collide with offshore structures [Blew *et al.*, 2013]. During their migrations at night, birds can be especially attracted by ship lights. Such situations have been documented in the area of South Greenland, where the collisions were substantially correlated with poor visibility at sea [Masden and Cook, 2016].

The presence of OWFs creates a barrier effect influencing the behaviour (movement) of migratory birds. The scale of the environmental impact will depend on the number of wind turbines, their size and distribution within the Baltica-1 OWF Area. Birds may be forced to change the flight direction horizontally or vertically, which may slightly extend the journey and increase energy requirements. Research conducted so far on this topic indicates, however, that bypassing even a few OWFs increases slightly both the total length of the migration route, and the energy expenditure associated with the migration. Therefore, the magnitude of the barrier effect during the operation phase is considered moderate.

The forced change of the route in order to avoid the Baltica-1 OWF extends it by an average of 21 km, which is an extension of the migration route by an average of 1.25%, and in the case of cranes by 0.25%. The extension of the route by 21 km due to the OWF barrier effect will increase the energy expenditure on the route to a negligible extent [Merkel and Johansen 2021; Pennycuick 2001]. Additionally, in the case of passerine birds travelling mainly at night and at high altitudes (above the rotor range), the barrier effect will not occur as the birds will fly over the Baltica-1 OWF. Therefore, the significance of the barrier effect impact on all bird groups and species included in the analysis was considered as negligible.

The risk of bird collisions with the OWF elements depends on the OWF parameters, such as the number of wind turbines, rotor diameter, the size of the clearance between the lower range of the rotor and the water surface, on biological and species parameters such as body size, flight speed, flight altitude, collision avoidance rate, as well as on the weather parameters. In the case of reduced visibility (low clouds, night, dense fog), birds can spot an OWF from a considerably shorter distance, which results in a higher risk of collision. Among all the species included in the analysis, the impact significance resulting from the collision is assessed as negligible, minor or moderate for all species and species groups. Collisions remain at a very low level of a few individuals in both seasons or, as in many cases (skuas, terns, auks, the common wood pigeon, the Eurasian skylark), they do not occur at all. The environmental impact in the form of the risk of collision was assessed as negligible (e.g. the velvet scoter, Gaviiformes, auks) and low (e.g. the long-tailed duck, the common scoter) for most species and species groups, and moderate for the common crane. In the case of geese, the risk of collision in the worst-case scenario exceeded 26 individuals, but due to very large populations of species included in this category (estimated at more than 3.5 million individuals), the significance of the environmental impact was assessed as negligible.

A detailed analysis of the impact of the barrier effect and the risk of collision on migratory birds based on model calculations is included in Annex 5 of the national EIA Report, which is also appended to this Espoo Report.

7.3.2.2.1 Conclusions concerning the transboundary environmental impacts

It was assessed that migratory birds are an element of the environment that may be affected by the transboundary environmental impact associated with the construction, operation and decommissioning of the Baltica-1 OWF due to the barrier effect and the risk of collision. However, this will not be a significant impact.

The significance of the environmental impact during the construction and decommissioning phases was assessed as negligible and low, depending on the sensitivity of the species to the impact, of a small scale.

During the exploitation phase, the scale of the barrier effect will be moderate, and, despite its transboundary extent, its significance will be negligible. Depending on the species, the significance of the risk of collision is considered negligible or low and the scale is considered moderate.

7.3.3 Seabirds

7.3.3.1 Current state

The Baltic Sea area is used by seabirds as a location for wintering or a stopover during migration. Most of the birds surveyed reach the greatest abundances in the offshore zone, located more than 1 km away from the shore. Gulls, which accompany fishing boats to fishing grounds, are an exception and their occurrence in the open sea is strongly conditioned by human activity. The data on the quantitative and qualitative structure of seabirds in the Baltica-1 OWF Area come from the surveys carried out in the preparation of the EIA Report. No monitoring of seabirds under the State Environmental Monitoring is conducted in the above-mentioned area. Seabird observations were carried out in the OWF development area including a 4 km wide buffer zone and in a reference area with similar environmental conditions, situated north-west of the Baltica-1 OWF, within the Swedish EEZ. The observations were conducted along the designated transects. The surveys took place between December 2022 and the end of November 2023.

In both sea areas covered by the survey, 24 bird species were identified, including 13 seabird species and 11 species of water birds rarely encountered at sea away from the coast. Of these, 16 species were recorded in extremely low abundances, not exceeding 1% of the grouping during the entire year-long monitoring period. It can, therefore, be assumed that neither the Baltica-1 OWF survey area nor the reference area are important foraging and/or resting sites for them.

Of the 8 most abundant species, 7 are strictly protected and one is under partial species protection in Poland (the European herring gull). Two species are listed in Annex I of the EU Birds Directive, the black-throated diver and the little gull. The Polish Red List of Birds [Wilk *et al*., 2020] includes 4 species − the European herring gull with the LC category (least concern), the common gull with the VU category (vulnerable) as well as the black-throated diver and the little gull with the RE category (regionally extinct). However, it should be remembered that the species threat categories in the above publication refer to breeding populations. The International Union for Conservation of Nature classifies 7 species as least concern (LC) and one, the long-tailed duck, as vulnerable (VU) (IUCN, 2024). In the Red List of Birds (wintering populations) prepared by the HELCOM Baltic Marine Environment Protection Commission, 4 species have a higher threat category, i.e. the little gull (NT), the long-tailed duck and the common scoter (EN) and the black-throated diver (CR) [HELCOM, 2013] [Table 7.11].

Table 7.11. List of seabird species and waterbird species rarely encountered at sea which were present in the Baltica-1 OWF survey area and the reference area. The species whose proportion in the grouping exceeded 1% for the entire survey cycle are marked with colour

No.	Species	Species protection in Poland[1]	Annex I to the EU Birds Directive[2]	PRLB threat category[3]	IUCN threat category[3]	HELCOM threat category[3]
1	Razorbill *Alca torda*	SP	NO	-	LC	LC
2	Brent goose *Branta bernicla*	SP	NO	-	LC	NT
3	Great black cormorant *Phalacrocorax carbo*	PP	NO	LC	LC	-
4	Mallard *Anas platyrhynchos*	G	NO	LC	LC	-
5	Long-tailed duck *Clangula hyemalis*	SP	NO	-	VU	EN
6	Eurasian coot *Fulica atra*	G	NO	LC	NT	-
7	Common scoter *Melanitta nigra*	SP	NO	-	LC	EN
8	Little gull *Hydrocoloeus minutus*	SP	YES	RE	LC	NT
9	Great black-backed gull *Larus marinus*	SP	NO	-	LC	-
10	Common gull *Larus canus*	SP	NO	VU	LC	-
11	European herring gull *Larus argentatus*	PP	NO	LC	LC	LC
12	Lesser black-backed gull *Larus fuscus*	SP	NO	LC	LC	LC
13	White-billed diver *Gavia adamsii*	SP	NO	-	VU	-
14	Black-throated diver *Gavia arctica*	SP	YES	RE	LC	CR
15	Red-throated diver *Gavia stellata*	SP	YES	-	LC	CR
16	Black guillemot *Cepphus grylle*	SP	NO	-	LC	LC
17	Goosander *Mergus merganser*	SP	NO	LC	LC	-
18	Common guillemot *Uria aalge*	SP	NO	-	LC	LC
19	Great crested grebe *Podiceps cristatus*	SP	NO	LC	LC	-
20	Common tern *Sterna hirundo*	SP	NO	LC	LC	-

No.	Species	Species protection in Poland[1]	Annex I to the EU Birds Directive[2]	PRLB threat category[3]	IUCN threat category[3]	HELCOM threat category[3]
21	Red-breasted merganser *Mergus serrator*	SP, SPZ	NO	RE	NT	VU
22	Black-headed gull *Chroicocephalus ridibundus*	SP	NO	LC	LC	-
23	Eurasian wigeon *Mareca penelope*	SP	NO	CR	LC	-
24	Velvet scoter *Melanitta fusca*	SP	NO	-	VU	VU

[1]Pursuant to the Regulation of the Minister of the Environment of 16 December 2016 on the protection of animal species (Journal of Laws of 2016, item 2183): Species protection in Poland: SP – strict protection, SPZ – protection of nesting and regular habitat zones, PP – partial protection; in accordance with the Regulation of the Minister of the Environment of 11 March 2005 on establishing the list of game species (Journal of Laws of 2005, No. 45, item 433): G – game species.

[2]Listed in Annex I to Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (OJ L 20/7 of 26.01.2010): YES – species listed; NO – species not listed.

[3]IUCN Threat Categories – classification developed by the International Union for Conservation of Nature, also applied in the Polish Red List of Birds – PRLB [Wilk et al., 2020] and the HELCOM Red List of Birds [HELCOM, 2013]: LC – least concern species, NT – near threatened species (species close to being classified as VU but not classified as such yet), VU – vulnerable species (species threatened with extinction in the near future but not as close to it as endangered species), EN – endangered species (species at high risk of extinction in the near future), CR – critically endangered species (species at the highest risk of extinction), RE – regionally extinct. NA – regionally unclassified.

7.3.3.2 Species composition of birds sitting on the water

Twenty-two species of birds sitting on the water, including 13 seabird species, were recorded in the Baltica-1 OWF survey area. A total of 17 420 individuals were recorded during the entire survey cycle, of which as many as 13 737 were long-tailed ducks (80.0% of the grouping). The European herring gull was also abundant (11.4%), as were the razorbill and the common guillemot (2.6% each). The remaining species were less abundant, not exceeding a 1% share in the grouping. Additionally, 13 individuals found were unidentified as to the species (unidentified divers, gulls and Anatidae) [Table 7.12].

Table 7.12. Abundance and proportion in the group of individual bird species sitting on the water, found in the Baltica-1 OWF survey area along the cruise route in the entire period from December 2022 to the end of November 2023

No.	Species	Number of individuals observed	Proportion in the grouping [%]
Seabirds			
1	Long-tailed duck *Clangula hyemalis*	13 937	80.0
2	European herring gull *Larus argentatus*	1988	11.4
3	Razorbill *Alca torda*	459	2.6
4	Common guillemot *Uria aalge*	458	2.6
5	Little gull *Hydrocoloeus minutus*	123	0.7
6	Black-throated diver *Gavia arctica*	104	0.6
7	Black guillemot *Cepphus grylle*	47	0.3
8	Common scoter *Melanitta nigra*	46	0.3
9	Lesser black-backed gull *Larus fuscus*	45	0.3
10	Velvet scoter *Melanitta fusca*	10	0.1
11	Great black-backed gull *Larus marinus*	7	<0.1
12	Red-throated diver *Gavia stellata*	3	<0.1
13	White-billed diver *Gavia adamsii*	1	<0.1

No.	Species	Number of individuals observed	Proportion in the grouping [%]
Waterbirds rarely encountered at sea away from the coast			
14	Common gull *Larus canus*	152	0.87
15	Red-breasted merganser *Mergus serrator*	13	<0.1
16	Mallard *Anas platyrhynchos*	4	<0.1
17	Black-headed gull *Chroicocephalus ridibundus*	3	<0.1
18	Eurasian wigeon *Mareca penelope*	3	<0.1
19	Brent goose *Branta bernicla*	1	<0.1
20	Great black cormorant *Phalacrocorax carbo*	1	<0.1
21	Goosander *Mergus merganser*	1	<0.1
22	Eurasian coot *Fulica atra*	1	<0.1
Birds unidentified as to species			
23	Unidentified diver *Gavia* sp.	6	<0.1
24	Velvet scoter or common scoter *Melanitta* sp.	6	<0.1
25	Unidentified seagull *Laridae*	1	<0.1
Total		17 420	100

During the wintering period, the most abundant species found within the Baltica-1 OWF survey area were the long-tailed duck (43.8%) and the European herring gull (39%), which together accounted for 82.8% of all the birds observed. The remaining species were observed in small numbers within the sea area in question, not exceeding 100 individuals found during a single survey campaign.

During the spring migration period, the long-tailed duck was also the most abundant of the species found, accounting for up to 96.3% of all the birds found. The main influence on this result was the April 2023 observation, when more than 11,000 individuals of the species were recorded. The very abundant appearance of long-tailed ducks meant that none of the other species exceeded 1% in the grouping in that period. However, despite its small share in the grouping, relatively high abundances were reached by the black-throated diver during this period (101 individuals).

In the summer period, the common guillemot prevailed in terms of abundance, accounting for as much as 53% of all the birds recorded. In August, birds of this species begin to appear in sea areas situated away from the shore, because once the breeding period is over, they follow shoals of fish together with their fledglings and young birds. Relatively abundant (over 100 individuals) was the European herring gull, constituting 43.1% of the entire grouping. However, the abundance of the entire grouping of birds present in the Baltica-1 OWF survey area was low in the summer.

Three species were observed in greatest abundance during the autumn migration period: the European herring gull (32.8% of the grouping), the long-tailed duck (26.2%) and the common guillemot (25.8%). In total, they constituted 84.7% of the grouping residing in the sea area surveyed. The lesser black-backed gull (5.3%), the razorbill (3.7%), the common scoter (2.5%) and the common gull (1.0%) also reached the 1% participation threshold in the grouping. The abundance of the birds during the autumn migration period was low and the total number of none of these species exceeded 200 individuals [Figure 7.3].

The very high abundances of the long-tailed duck and the black-throated diver indicate the very high importance of this sea area for these species during the spring migration period. Having conducted the avifauna surveys during only one season, it is impossible to conclude whether such high concentrations occur every year, which would indicate that this sea area is regularly used as a stopover site on the migratory route towards the eastern Baltic Sea and further towards breeding grounds. The low abundances of the long-tailed duck in the winter and at the beginning of the spring migration period indicate that the area of the proposed Project does not play an important role for this species, which congregated there in great numbers only during the later phase of the spring migration period (April 2023). The single large appearance may have been a one-off occurrence and may have been due, for example, to poor conditions during migration and forced stopover. It cannot be ruled out that the above-mentioned occurrence may have been related to movements of a local nature, unrelated to the access to rich feeding grounds.

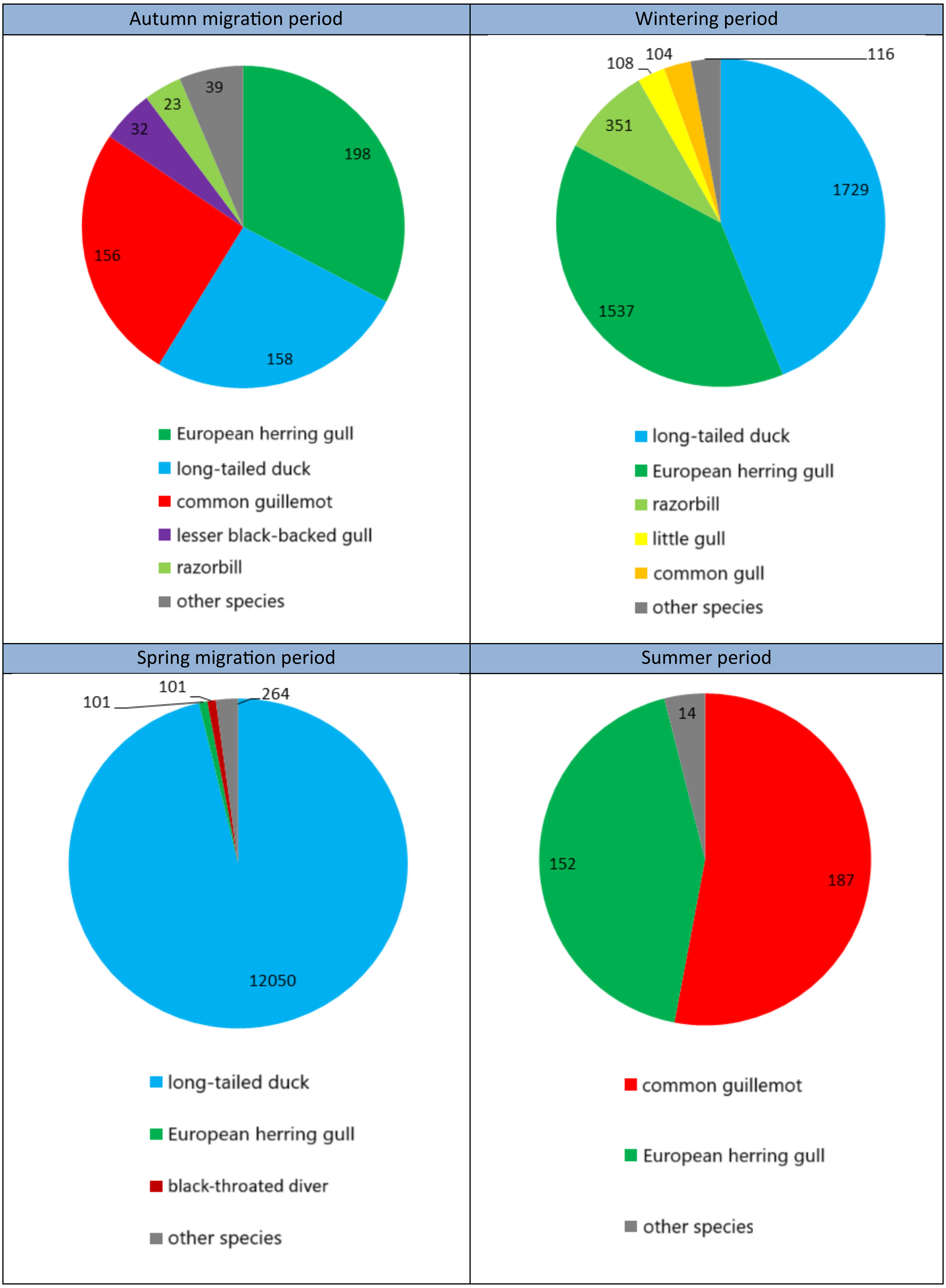

Figure 7.3. Abundance of the dominant bird species sitting on the water in the Baltica-1 OWF survey area throughout the entire period from December 2022 to the end of November 2023

7.3.3.3 Species composition of birds sitting on the water in the reference area

A total of 20 species of birds sitting on the water, including 13 species associated with the marine environment, were recorded during observations in the reference area, i.e. an area with similar environmental conditions where no offshore wind farms will be developed, a part of the Swedish Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308). A total of 7238 individuals were recorded during the entire survey cycle, of which as many as 5888 were long-tailed ducks (81.3% of the grouping). Also abundant were the European herring gull (6.4%), the razorbill (5.3%), the common guillemot (3.7%) and the common gull (1.2%). The remaining species were less abundant, not exceeding a 1% share in the grouping. Additionally, 16 individuals were found unidentified to the species (unidentified divers and Anatidae) [Table 7.13]. A detailed list of the number of birds of particular species recorded during all survey campaigns, broken down by the method of their registration, is presented in the environmental impact assessment documentation for the purposes of national proceedings.

Table 7.13. Abundance and percentage share in the group of individual bird species sitting on the water, found in the reference area along the cruise route in the entire period from December 2022 to the end of November 2023

No.	Species	Number of individuals observed	Proportion in the grouping [%]
Seabirds			
1	Long-tailed duck *Clangula hyemalis*	5888	81.3
2	European herring gull *Larus argentatus*	465	6.4
3	Razorbill *Alca torda*	382	5.3
4	Common guillemot *Uria aalge*	270	3.7
5	Common scoter *Melanitta nigra*	43	0.6
6	Black-throated diver *Gavia arctica*	30	0.4
7	Little gull *Hydrocoloeus minutus*	15	0.2
8	Black guillemot *Cepphus grylle*	8	0.1
9	Velvet scoter *Melanitta fusca*	7	0.1
10	Lesser black-backed gull *Larus fuscus*	6	0.1
11	Red-throated diver *Gavia stellata*	4	0.1
12	Great black-backed gull *Larus marinus*	2	<0.1
13	Yellow-billed loon *Gavia adamsii*	2	<0.1
Waterbirds rarely encountered at sea away from the coast			
14	Common gull *Larus canus*	87	1.2
15	Red-breasted merganser *Mergus serrator*	6	0.1
16	Mallard *Anas platyrhynchos*	2	<0.1
17	Goosander *Mergus merganser*	2	<0.1
18	Eurasian coot *Fulica atra*	1	<0.1
19	Great crested grebe *Podiceps cristatus*	1	<0.1
20	Common tern *Sterna hirundo*	1	<0.1
Birds unidentified as to species			
21	Unidentified diver *Gavia* sp.	15	0.2
22	Unidentified ducks *Anatidae*	1	<0.1

No.	Species	Number of individuals observed	Proportion in the grouping [%]
Total:		7238	100.0

During the wintering period, the long-tailed duck was definitely the most abundant species in the reference area, constituting 80.6% of the entire grouping. The European herring gull and the razorbill (8.7% and 6.5% of the grouping, respectively) occurred in great numbers. The other species were less abundant.

During the spring migration period, long-tailed ducks were definitely the most numerous. They constituted as much as 91.6% of the grouping residing in the sea area surveyed. Of all the birds observed, the species exceeding 1% in terms of abundance were the razorbill (3.1%) and the common scoter (1.2%). The abundances of other species were very low and none of them totalled more than 30 individuals.

During summer, 4 bird species closely associated with the marine environment and 1 bird species rarely encountered at sea away from the coast were recorded. As in the Baltica-1 OWF survey area, the most abundant species recorded was the common guillemot, which constituted 61% of the grouping present in the survey area. The European herring gull was also present in quite high numbers (32.6% of the grouping), but its high proportion was attributed to the low abundance of the entire bird grouping. The abundance of other species was very low.

Common guillemots (26.3%), European herring gulls (20.4%) and razorbills (19%) were observed most abundantly during the autumn migration period. In total, they accounted for more than half (65.7%) of the grouping of waterbirds observed in the sea area. The abundance of birds during the period discussed was very low and none of the species totalled more than 50 individuals.

7.3.3.4 Waterbirds' distribution and densities in the sea areas surveyed

The results of the avifauna observations covering four phenological periods showed that the Baltica-1 OWF survey area is not a site of high seabird concentrations, since low bird densities were recorded over most of its area. However, during the spring migration period, a very high congregation of long-tailed ducks and black-throated divers, i.e. species with an elevated conservation status, was recorded there.

The long-tailed duck was the most abundant species within both sea areas, and its distribution determined the spatial distribution of the average densities of the entire seabird grouping. The example of this benthivorous species very clearly illustrates the dependence of its density on the depth of the sea area. In the depth zone exceeding 30 m, the long-tailed duck was recorded in small numbers and in a wide area it was not found at all. In the reference area, on the other hand, the correlation between density and depth was not evident, whereas around the 20-m isobath, the average density was very low. The reason for this distribution of the long-tailed duck in the reference area may be due to the lower supply of food resources in the shallowest part of the sea area.

During the winter period, the average densities of the entire grouping were slightly higher in the reference area than in the Baltica-1 OWF survey area. In the reference area, densities ranging from 10 to 50 ind.·km^{-2} prevailed; such values were recorded for approximately 70% of the surface of this sea area. On the other hand, in the Baltica-1 OWF survey area, densities ranging from 1 to 5 ind.·km^{-2} were recorded within more than 70% of its surface area, and the highest densities of avifauna in this area were found in its north-western part [Figure 7.4].

During the spring migration, the average densities of the entire bird grouping were higher in the Baltica-1 OWF survey area, where in half of the area they remained within the range of 10–100 ind.·km^{-2}. The highest densities above 50 ind.·km^{-2} were recorded at approximately 20% of the entire Baltica-1 OWF survey area, in its western part. In the reference area, the average bird densities above 50 ind.·km^{-2} occurred only locally, and densities within the range of 10–50 ind.·km^{-2} were found at about 75% of this sea area. The sites of the most abundant concentrations of the long-tailed ducks occurring during this period mostly lay outside the boundaries of the future wind farm. However, once it is built, most birds are expected to be displaced from the area [Petersen *et al*., 2006; Vanermen *et al*., 2014] [Figure 7.5].

In the summer, the average densities of the entire bird grouping in the Baltica-1 OWF survey area and the reference area were very low, below 5 ind.·km^{-2}. The highest density, slightly exceeding the value of 5 and reaching up to 10 ind.·km^{-2}, was recorded locally, within a small area in the central part of the Baltica-1 OWF survey area, in its western fragment. Contrary to the other phenological periods, during the summer, there was no correlation between bird density and the depth of the sea basin, which was due to the lack of diving benthivorous birds in the grouping – it is their presence that determines the occurrence of such a correlation [Figure 7.6].

During the autumn migration period, the average densities of the entire avifauna grouping were higher in the Baltica-1 OWF survey area, exceeding 100 ind.·km^{-2} at the north-western end of the area, and remaining above 10 ind.·km^{-2} within a significant part of this sea area. In the rest of the Baltica-1 OWF survey area, however, the average bird densities were much lower, exceeding 5 ind.·km^{-2} only at small sections. In the reference area, the average densities of avifauna did not exceed 10 ind.·km^{-2}, remaining within the range of 1–5 ind.·km^{-2} within approximately 80% of the sea area [Figure 7.7].

The spatial distribution of the average densities of all waterbirds in both sea areas surveyed is illustrated in Figure 7.8–Figure 7.11, while the spatial distribution of the average densities of the long-tailed duck is in Figure 7.8–Figure 7.11.

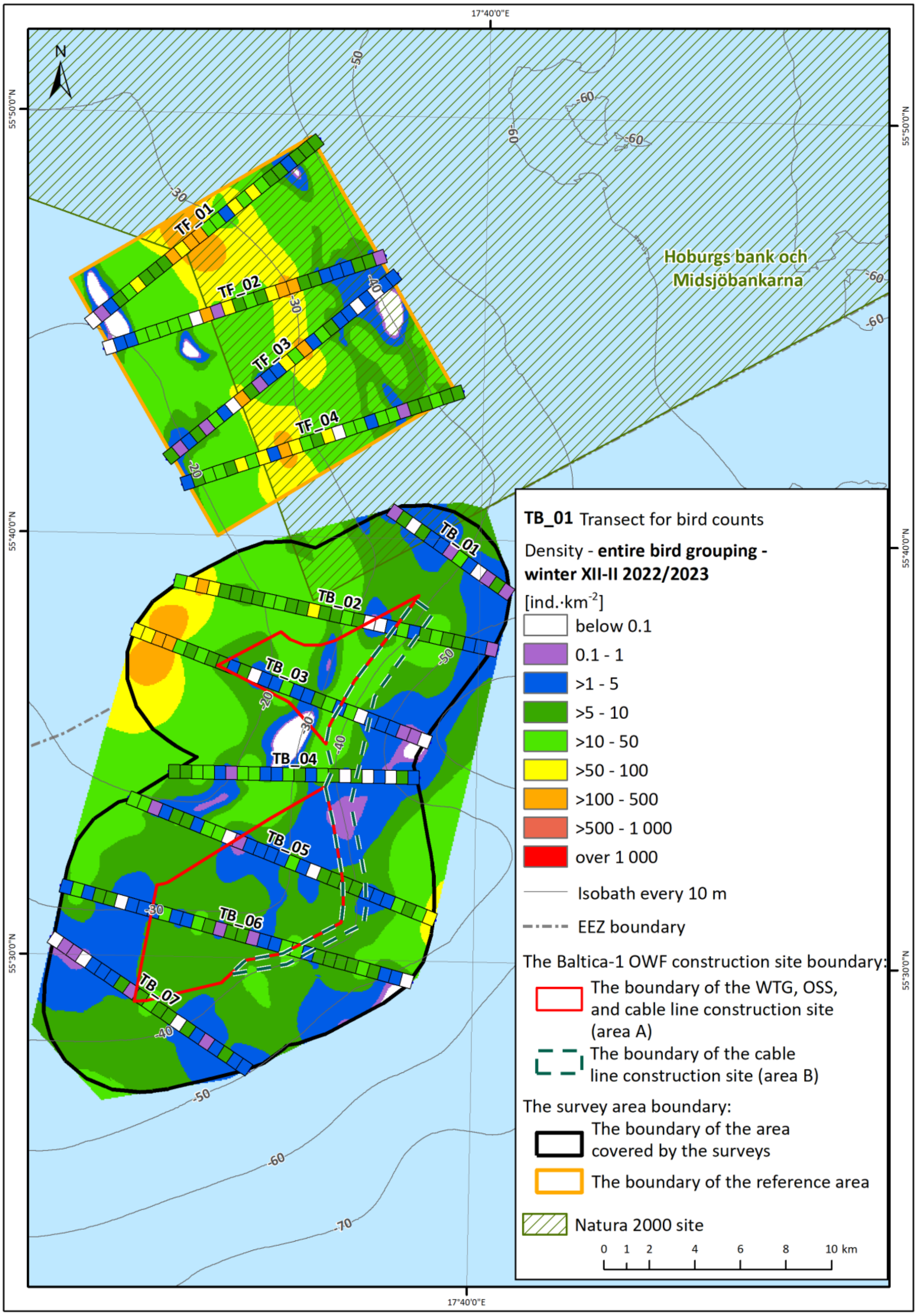

Figure 7.4. Spatial distribution of the average densities of all waterbirds in the areas surveyed during the wintering period

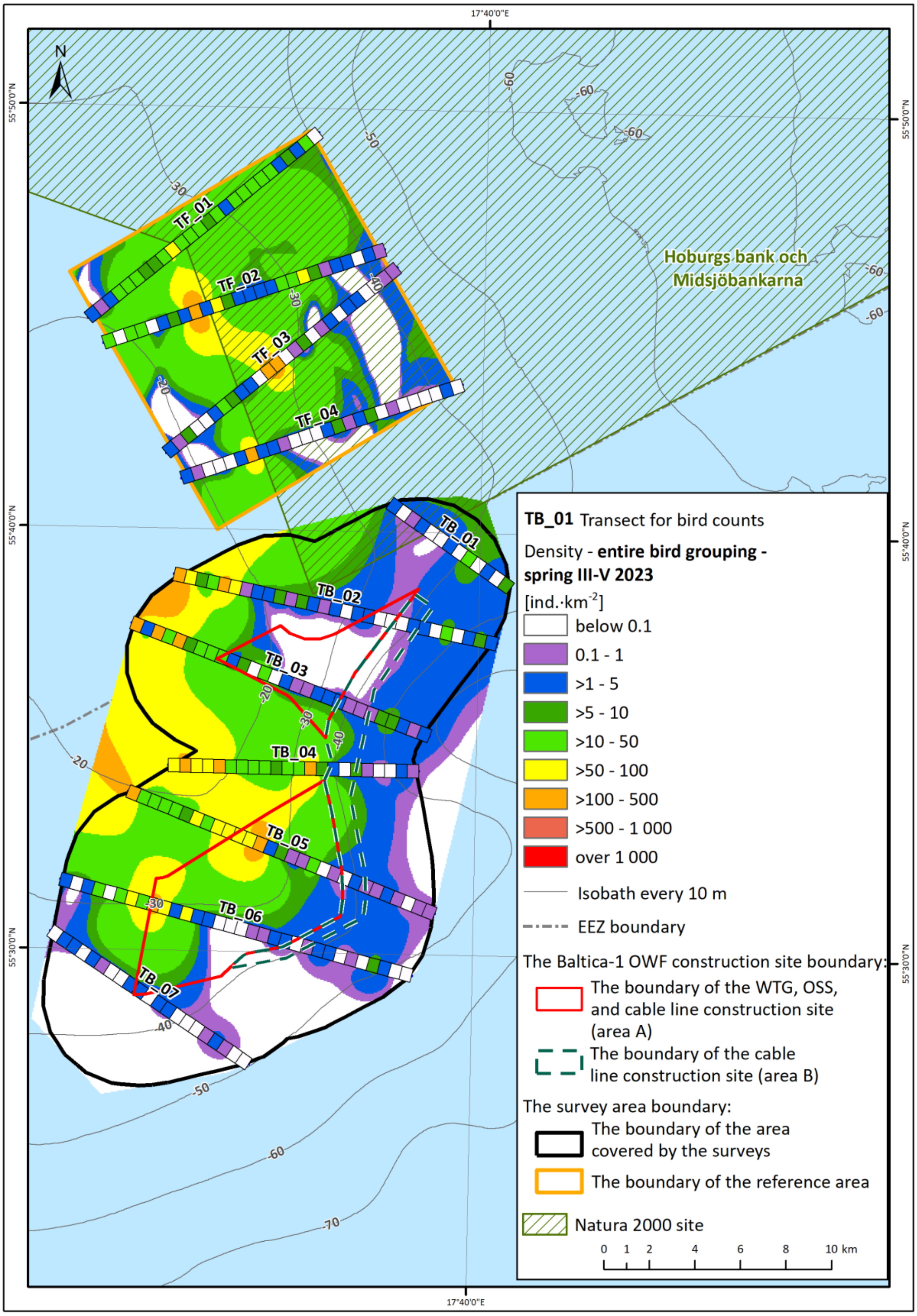

Figure 7.5. Spatial distribution of the average densities of all waterbirds in the areas surveyed during the spring migration

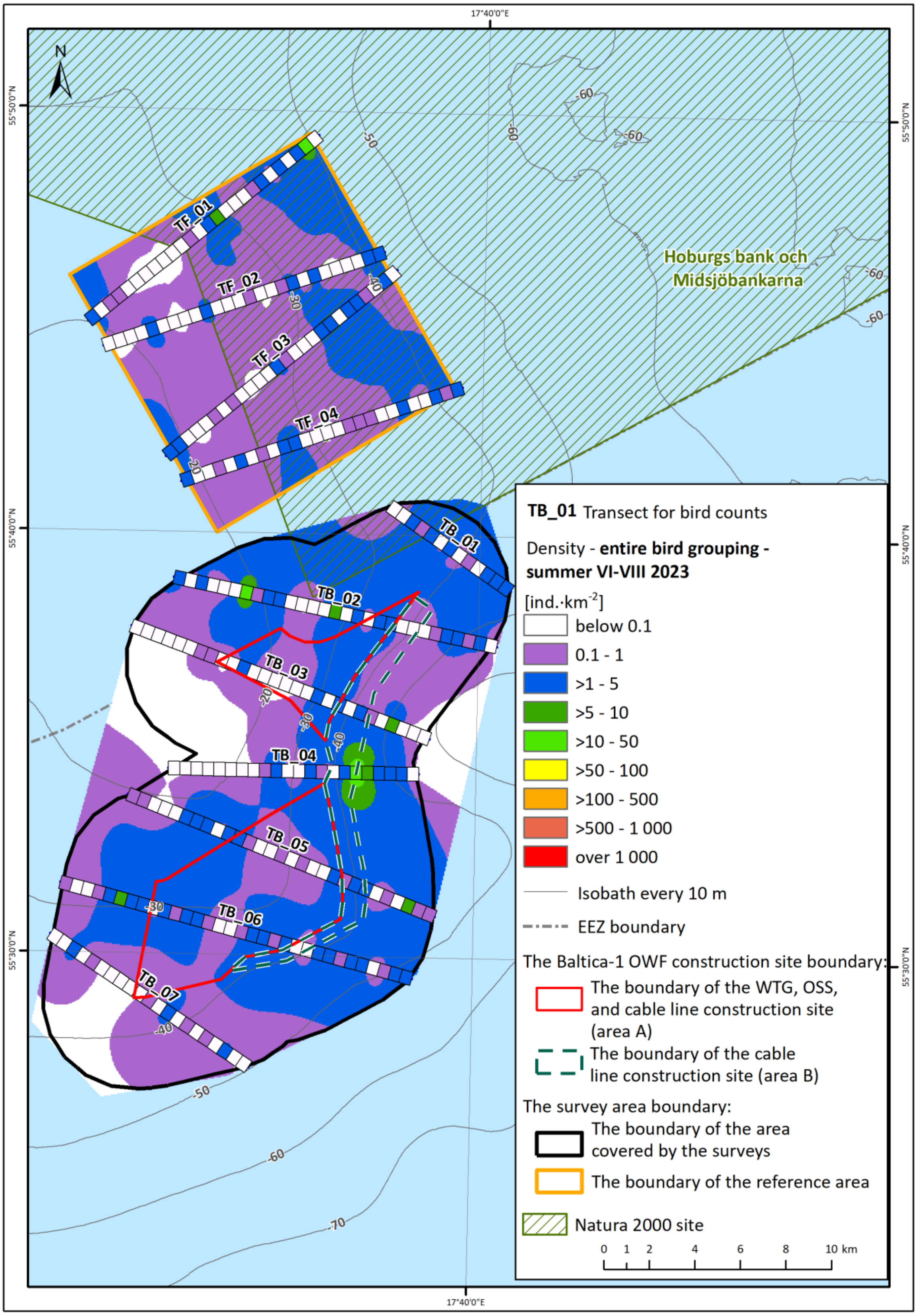

Figure 7.6. Spatial distribution of the average densities of all waterbirds in the areas surveyed during the summer period

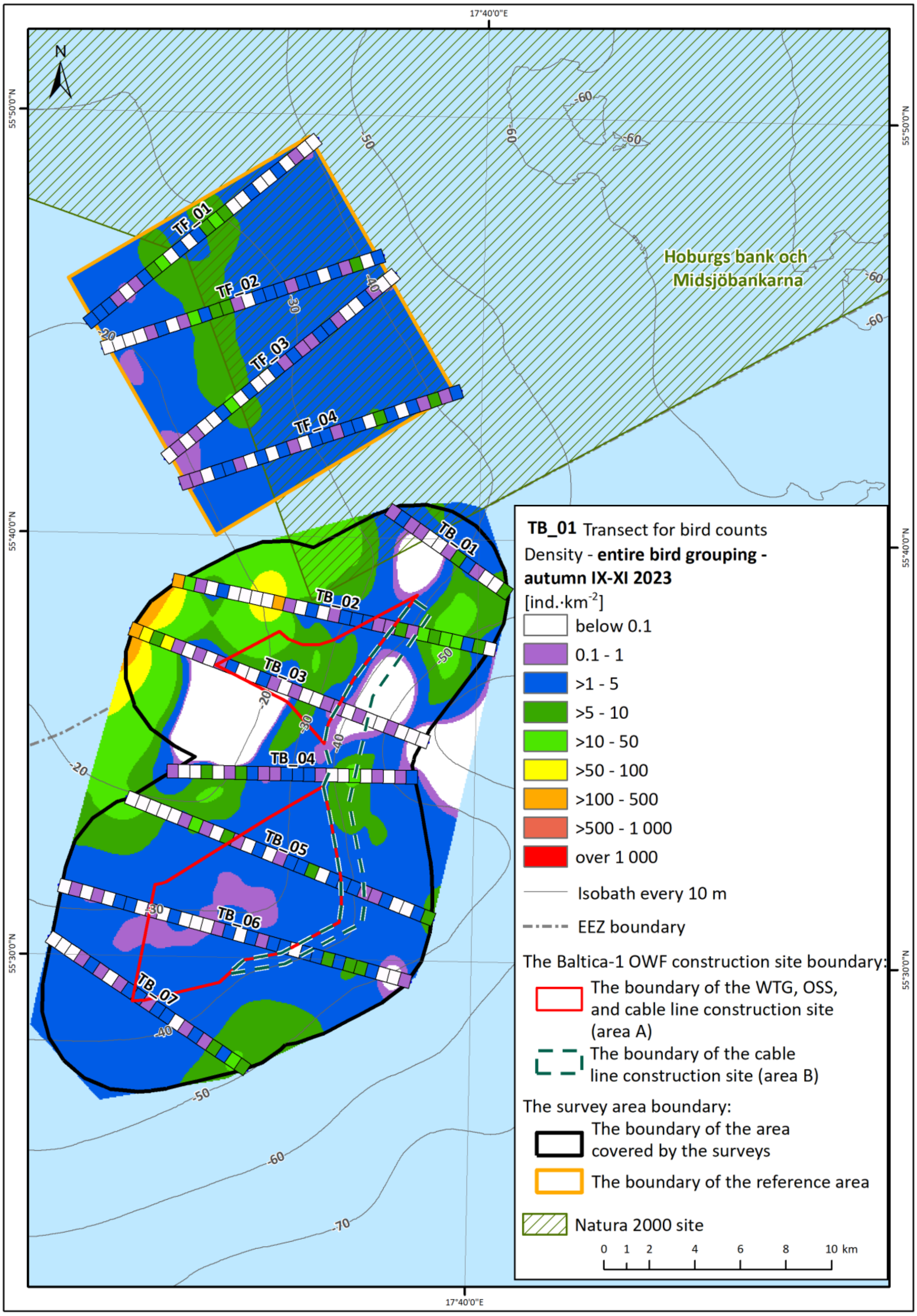

Figure 7.7. Spatial distribution of the average densities of all waterbirds in the areas surveyed during the autumn migration

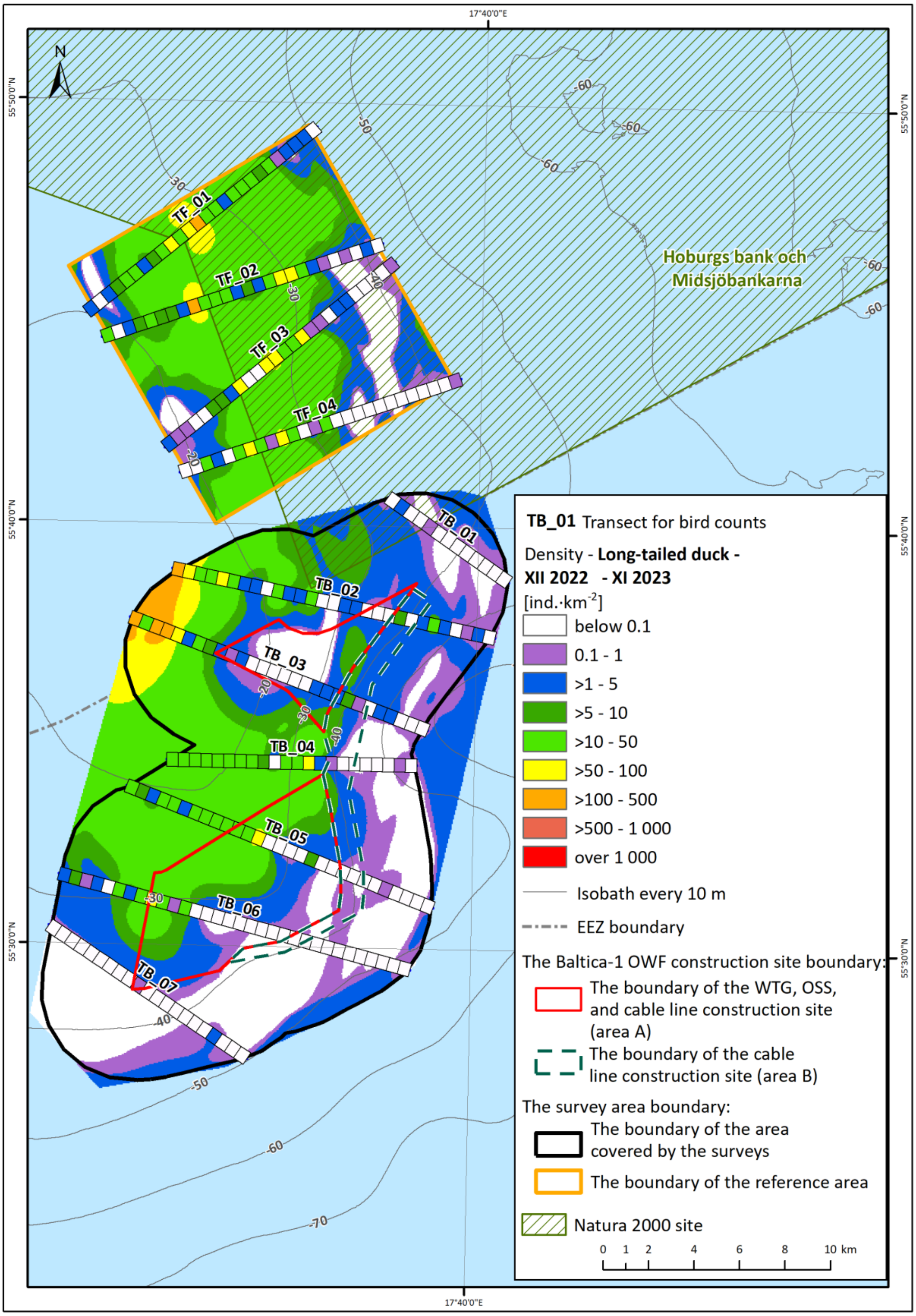

Figure 7.8. Spatial distribution of the average densities of the long-tailed duck within the survey area and the reference area between December 2022 and November 2023.

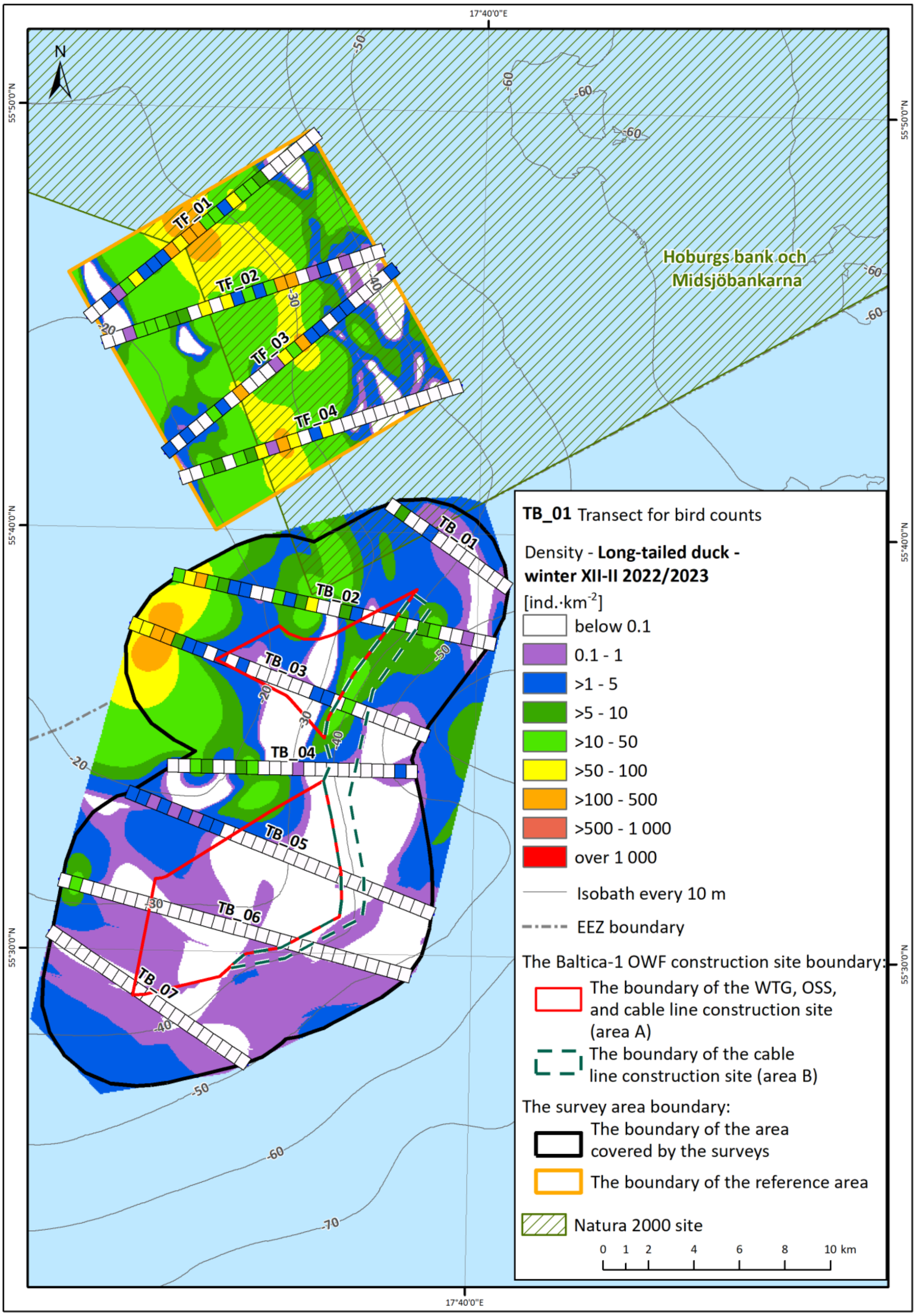

Figure 7.9. Spatial distribution of the average densities of the long-tailed duck within the survey area and the reference area during the wintering period

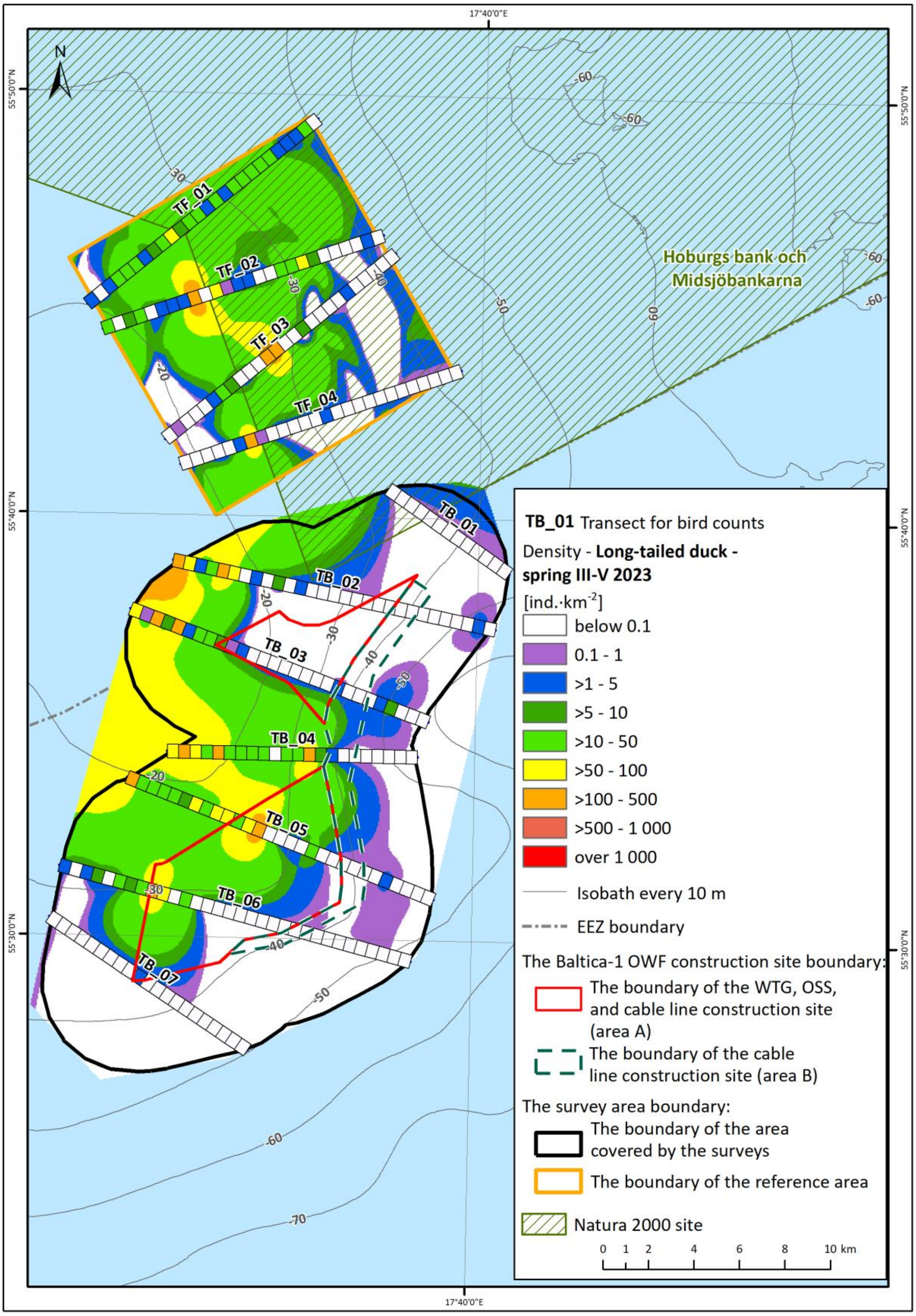

Figure 7.10. *Spatial distribution of the average densities of the long-tailed duck within the survey area and the reference area during the spring migration period*

Figure 7.11. Spatial distribution of the average densities of the long-tailed duck within the survey area and the reference area during the autumn migration period

7.3.3.5 Species of seabirds included in the environmental impact assessment

Birds present (sitting on the water) along the transects during the survey campaigns conducted were included in the Baltica-1 OWF environmental impact assessment. The assessment does not include the results obtained from the radar surveys, dealing with the issue of avifauna migration in detail. These data were analysed in the section dedicated to migratory birds. The assessment covered:

- the most abundant seabird species, the abundance proportion of which in the Baltica-1 OWF survey area and the reference area reached at least 1% (rounded up from 0.5%) at least in one phenological period;
- subjects of protection of the Swedish Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308).

Based on the surveys carried out, the first condition was met by 13 bird species, i.e. the long-tailed duck *Clangula hyemalis*, the common scoter *Melanitta nigra*, the Eurasian wigeon *Mareca penelope*, the goosander *Mergus merganser*, the coot *Fulica atra*, the razorbill *Alca torda*, the common guillemot *Uuria aalge*, the black guillemot *Cepphus grylle*, the black-throated diver *Gavia arctica*, the European herring gull *Larus argentatus*, the common gull *Larus canus*, the lesser black-backed gull *Larus fuscus* and the little gull *Hydrocoloeus minutus*. However, three species whose high proportion (above 1%) was due to the low total numbers of birds present in both sea areas during the autumn migration period, i.e. the Eurasian wigeon (3 individuals), the goosander (2 individuals) and the coot (1 individual) were excluded from further environmental impact assessment of the proposed Project.

The species under protection within the Natura site *Hoburgs bank och Midsjöbankarna* (SE0330308) are the black guillemot (1000–5000 individuals), the long-tailed duck (200 000–1 000 000 individuals) and the common eider *Somateria mollissima* (5000–50 000 individuals). The last species was not found during the annual survey cycle of the Baltica-1 OWF survey area. This species probably congregates elsewhere in the extensive Swedish Natura 2000 site.

The birds under assessment were classified into 3 ecological groups, bringing together species with similar habitat requirements and comparable sensitivity to impacts associated with the construction, operation and decommissioning of the OWF. These are:

1. benthivorous birds:
   - long-tailed duck *Clangula hyemalis,*
   - common scoter *Melanitta nigra;*
2. piscivorous birds:
   - razorbill *Alca torda,*
   - common guillemot *Uria aalge,*
   - black guillemot *Cepphus grylle,*
   - black-throated diver *Gavia arctica;*
3. gulls:
   - European herring gull *Larus argentatus,*
   - little gull *Hydrocoloeus minutus,*
   - common gull *Larus canus,*
   - lesser black-backed gull *Larus fuscus.*

Benthivorous and piscivorous birds are groups of birds that actively dive in search of food and make direct use of the areas surveyed. The long-tailed duck is a species widely spread in the Baltic Sea, concentrating mostly in areas of moderate depth (up to 20–30 m) rich in zoobenthos, which constitutes its main food supply [Durinck *et al.*, 1994; Bauer *et al.*, 2005; Mendel *et al.*, 2008; Skov *et al.*, 2011]. The susceptibility of benthivorous birds to potential impacts associated with the construction, operation and decommissioning of the Baltica-1 OWF was assessed as high [Dierschke and Garthe, 2006].

Piscivorous birds such as the razorbill, the common guillemot, the black guillemot and the black-throated diver are species strongly associated with the availability and abundance of ichthyofauna. These birds are perfectly adapted to foraging on fish, which they capture by diving. They feed less frequently on zoobenthos [Žydelis, 2002; Mendel *et al.*, 2008]. The susceptibility of piscivorous birds to potential impacts associated with the construction, operation and decommissioning of the Baltica-1 OWF was assessed as moderate [Mendel *et al.*, 2008].

The group of gulls includes species that do not use the survey areas directly. They are opportunistic animals, observed foraging on the surface or encountered incidentally. Gulls explore the sea area in search of food, mainly consisting of waste generated as a result of fish catching and processing on fishing boats [Garthe, 1997; Garthe, 2003; SMDI, 2015]. Therefore, they often accompany fishing boats at fisheries away from the coast. The susceptibility of gulls to potential impacts associated with the construction, operation and decommissioning of the Baltica-1 OWF was assessed as low.

7.3.3.6 Environmental impact assessment and transboundary environmental impact

7.3.3.6.1 Habitats occupation

The construction of foundations or support structures and the laying of internal power cables will result in the disturbance of benthic communities in the Baltica-1 OWF development area. This process will have a direct environmental impact on the seabed and the water column above it. Due to the above, some of the natural benthic habitats used by seabirds and by birds stopping there during migration will be lost, but most likely new ones will develop in their place (artificial reef effect). In addition to physical habitat change, birds may be forced out of the OWF Area. Petersen *et al*. [2006] indicate that for some of the species found the displacement could be between 2 and 4 km from the OWF Area, which could represent between 8 and 32 km^2 in the Swedish EEZ. This represents a negligible value compared to the total area of the wintering grounds of, for example, the long-tailed duck. In addition, it can be concluded that the Baltica-1 OWF Area is located at depths over 20 m, which are less frequently used for feeding.

As a result of the construction works, the seabed sediments shall be agitated, and the content of the suspended solids shall increase. The indirect transfer of sediments and their re-suspension shall result in a decrease in the water transparency. Sediment concentrations of 15 mg·dm^{-3} or more are considered problematic for the visibility of diving seabirds [Nord Stream 2009]. According to the modelling of suspended solids propagation carried out, the lowest estimated concentrations, at 5 mg·dm^{-3}, will propagate up to a maximum of 8.2 km and remain in the water for up to several hours. Higher concentrations, causing disruptions to seabirds, will be re-suspended more quickly and therefore the extent of their propagation will be smaller. The average concentration range at a distance of 500 m from the work site, depending on the cohesiveness of the soil, will be between 5 and 20 mg·dm^{-3}, with a maximum, instantaneous concentrations of suspended solids, reaching up to 250 mg·dm^{-3}. The thickness of the re-suspended sediments, as calculated, will be up to 6.3 mm at a distance of 100 m from the work site. At a distance of 500 m, it will be 1.9 mm, and the furthest distance at which the predicted sediment thickness will reach 1 mm will be 800 m. The predicted concentrations of suspended solids in the water and the duration of its propagation, will not pose a risk to fish. Instead, it will create temporary and localised difficulties for the birds hunting for fish. The re-suspension of seabed sediments and their deposition on benthic organisms will be associated with their increased mortality, and thus with a localised loss of the food base for diving benthivorous birds in the medium term. The scope of this impact, however, will also be local only.

However, benthivorous and piscivorous birds are groups of species that are very sensitive to disturbance from the presence of boats and other human activities at sea [Schwemmer *et al*., 2016]. Therefore, it is estimated that the environmental impact from disturbance due to the presence of construction vessels will be the first impact in the construction area, resulting in the displacement of sensitive species to other areas. As a result, these birds will not experience any additional environmental impact associated with a reduced foraging base during the construction phase. The destruction of benthic habitats and the turbidity of waters during construction works are direct environmental impacts on benthivorous and piscivorous birds, local in extent, medium-term and reversible.

Gulls are a group of birds almost unrelated to the benthic communities. As such, they are unaffected by an interference in the seabed and the turbidity of the waters. This environmental impact on the above-mentioned group of birds was assessed as indirect, local, temporary and reversible.

The impact scale on gulls was assessed as negligible and on the piscivorous and benthivorous birds as moderate.

7.3.3.6.2 Barrier effect and risk of collision

Offshore wind turbine structures protruding from the water, gradually appearing during the construction phase, can deter birds. With time, birds will most likely be able, to some extent, to become acclimatised to the presence of wind farms. However, individuals starting their migration towards the wintering grounds for the first time in their lives may have problems avoiding the extensive barrier of the cluster of wind farms. This may be due to insufficient experience of these individuals. It is the cause of a higher bird mortality in the first year of life [Clark, 2007; Redmond, 2012; McKim-Louder, 2013]. It should be noted that the parameter influencing the impact level is the number of offshore wind turbines under construction and the distance between individual offshore wind turbines in the farm and the neighbouring OWFs [Stewart *et al*., 2005]. Therefore, both the construction and operation of the OWFs located in close proximity to Baltica-1 OWF may cause a cumulative barrier effect for birds.

Construction and subsequent maintenance works shall require the presence of various types of vessels, which shall disturb the seabirds with their physical presence, the noise (including the noise generated by pile driving, if such foundations are selected) and the emission of light. The two first factors should not influence the change of the flight route of those waterbird species that do not use this area but only fly over it. However, it cannot be ruled out that such an environmental impact will occur at night or during unfavourable weather conditions, especially if the construction site is strongly illuminated. This is because during migration, birds navigate in relation to natural light sources such as stars and the sun. The duration of construction and the location of the offshore wind turbines within the Baltica-1 OWF Area, in which there will be increased vessel traffic, also result in an environmental impact. The period in which the work occurs is important, as most seabird species, including the long-tailed duck, show very large differences in abundance between phenological periods. The effect of scaring will increase with the progressing development of the OWF Area. Initially, it shall be local, but at the final stage of construction, the extent of this impact will clearly increase, severely restricting the birds' feeding and resting opportunities in the Baltica-1 OWF Area, probably resulting in their displacement to the nearby Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308).

The Baltica-1 OWF Area is not very attractive for birds. Nonetheless, during the spring migration, a high concentration of long-tailed ducks was observed during the April inspection (more than 11,000 individuals on 22.04.2022). During the remaining five inspections taking place in the aforementioned phenological period, the abundance of long-tailed ducks was low, ranging from 5 to 372 individuals. The meteorological conditions during the inspection carried out on 22.04.2022 were favourable. However, during the previous inspection on 17.04.2022, a strong northern wind and total cloud cover were observed, which may have forced the birds to temporarily stop or change their migration direction.

The closest Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308) is an important wintering area for the long-tailed duck. It can be assumed that the birds appearing at the proposed Project location come from this site. This is because seabirds show a strong attachment to their wintering site [Iverson *et al.*, 2006; Kirk *et al.*, 2008; Oppel *et al.*, 2008]. The most abundant seabirds in the Baltica-1 OWF Area during the wintering period were the long-tailed duck, the European herring gull, the razorbill and the common guillemot. Compared to the Baltic populations, the number of individuals found during the surveys in the area of the proposed OWF constitutes, in the case of the long-tailed duck, 0.21% [HELCOM, 2013], the razorbill – 0.16% [Chylarecki *et al*., 2018], and the common guillemot – 0.17% [Österblom *et al*., 2001]. There is no credible data on the size of the European herring gull Baltic population. However, these birds accompany fishing boats to fishing grounds and their occurrence in the open sea is strongly conditioned by human activity. Therefore, no significant transboundary environmental impacts shall occur. Thus, no significant transboundary impacts are expected from a single project consisting of the construction of the Baltica-1 OWF.

Outside the spring migration period, the seabird grouping abundance results are comparable between the two areas analysed. The low abundances of the long-tailed duck in the winter and at the beginning of the spring migration period indicate that the area of the proposed Project does not play an important role for this species, which congregated there in great numbers only during the later phase of the spring migration period (April 2023). It cannot be ruled out that the above-mentioned occurrence may have been related to the movements of a local nature, unrelated to the access to rich feeding grounds. Literature data indirectly confirms that, in particular, thanks to the long-tailed duck migration surveys carried out using geolocation [Žydelis *et al*., 2010; Žydelis *et al*., 2013; Karwinkel *et al*., 2018]. The results of the surveys are presented in Figure 7.12. It should be noted that the results represent the migration of 26 individuals of the long-tailed duck selected from the population wintering in the Baltic Sea, the number of which equals about 1.5 million individuals. The lines connecting the points are not the actual flight paths, but they connect the successive location registration points. Based on that, it can be concluded that the Baltica-1 OWF Area is of lesser importance for the long-tailed duck. Those birds have a much greater preference for the areas distributed along the coasts of Sweden, the Middle Bank and Hoburgs Bank, less frequently targeting the Polish Natura 2000 sites, i.e. the Pomeranian Bay PLB990003, the Słupsk Bank PLC990001, followed by the *Przybrzeżne wody Bałtyku* PLB990002 site.

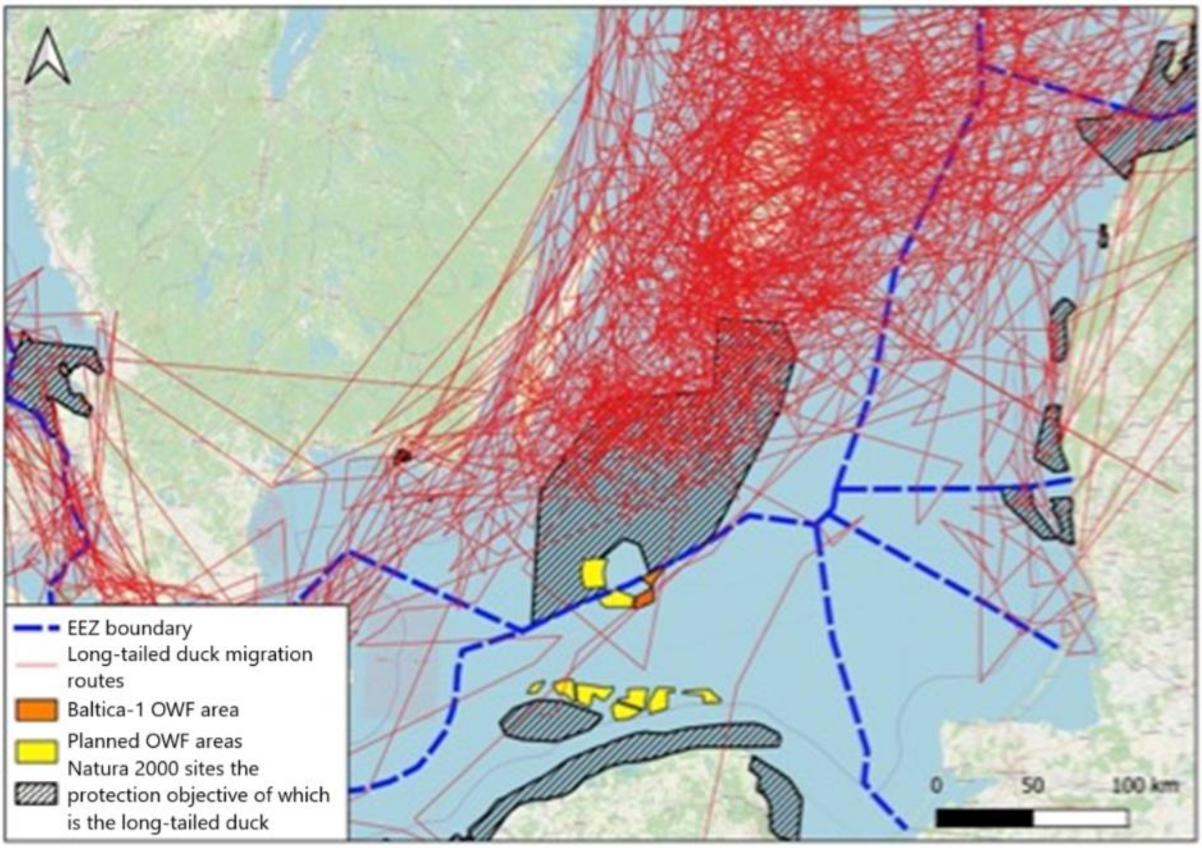

Figure 7.12. Migration routes of the long-tailed duck Clangula hyemalis in the Baltic Sea area (source: internal materials based on Žydelis et al., 2010; Žydelis et al., 2013; Karwinkel et al., 2018)

The presence of vessels and fixed structures protruding from the water, on the other hand, will lead to a greater presence of gulls, which use these elements as resting places and search for food near the vessels. Four species of large gulls, including the most abundant in the Baltica-1 OWF Area, the European herring gull, gather in the open sea around the fishing boats. If commercial fishing is reduced during the construction of the OWF, these birds will most likely move to other fishing locations.

The appearance of new structures at sea and the associated increased vessel traffic are direct, long-term and reversible impacts on benthivorous and piscivorous birds. In the case of gulls, this will be an indirect, short-term and reversible environmental impact. The extent of the environmental impact was assessed as transboundary for benthivorous birds, regional for piscivorous birds and local for gulls.

The significance of the barrier effect and collision risk on gulls was assessed to be negligible and on piscivorous and benthivorous birds to be moderate.

7.3.3.6.3 Emission of artificial light

During migration, birds navigate in relation to natural light sources such as stars and the sun. It was observed that at night they also fly towards lighthouses, drilling rigs and other structures illuminated with artificial light [Wiese *et al*., 2001]. The impact scale will depend on the number of wind turbines and vessels involved, their size, the method of lighting and the intensity of the light sources, the configuration of the lights, the duration of the construction phase and the phenological period during which the works will take place. Birds encountering sources of artificial light in their path, i.e. lampposts, wind farms and cities, may change their flight trajectory to match the direction of flight to the artificial light source, which they misinterpret as stars [Atchoi *et al*., 2020]. This effect is particularly exacerbated during periods of fog and high cloud cover as well as precipitation [Thompson, 2013]. In addition, light causes seabirds to congregate outside the migration period.

Lighting of the Project site during the construction phase will result in a direct environmental impact on seabirds that is transboundary, medium-term and reversible.

The scale of impact on benthivorous birds was assessed as a high impact of moderate significance, on piscivorous birds as a moderate impact of moderate significance, and on gulls as a moderate impact of low significance during the construction phase and negligible during the operation phase.

7.3.3.6.4 Noise and vibration emissions

The construction works in the Baltica-1 OWF development area, particularly pile driving will be a source of underwater noise. The modelling of noise propagation for the proposed Project, as well as the previous studies for other OWFs in the PSA area, showed the potential for significant underwater noise impacts on fish that constitute the food supply for piscivorous birds. NRS will be used during piling. For example, the use of mitigation in the form of a soft-start procedure for pile driving will result in minimising this adverse environmental impact [Lacroix *et al.*, 2003; Leopold *et al*., 2007; Opioła *et al*., 2020].

The emission of surface noise, caused by the presence, movement and operation of construction vessels, together with the presence of other vessels, will be one of the main causes of disturbance to seabirds in the sea area of the Baltica-1 OWF construction site. This environmental impact is estimated to be more significant for seabirds than underwater noise. Seabirds are very sensitive to disturbance caused by the presence of vessels and other human activities at sea. Therefore, the environmental impacts of disturbance as a result of the presence of construction vessels will constitute the main impact in this area, which will lead to the movement of the sensitive species to other areas. As a result, these birds will not experience additional environmental impacts associated with the underwater noise emissions during the construction phase [Lacroix *et al*., 2003; Leopold *et al*., 2007; Opioła *et al*., 2020]. Species that are less sensitive to disturbance, such as gulls, will not be affected by noise emissions. This is confirmed by the bird surveys carried out during the construction works on the Egmond aan Zee OWF in the Netherlands, where no observable reaction of the above-mentioned group of birds to disturbance by the presence of ships and pile driving was demonstrated [Leopold, 2007].

The modelling of noise generated by pile driving was carried out for the purpose of the preparation of the EIA Report for the Baltica-1 OWF. The noise modelling carried out confirmed that the planned pile driving in the Baltica-1 OWF Area could have a significant range and associated impacts on fish which constitute food for piscivorous birds. The analysis also shows that the use of a mitigating measure in the form of a bubble curtain is likely to lead to an insufficient reduction of the noise emitted during pile driving in the southern and central part of the proposed Project area, especially during the winter period. Only the use of a system in the form of a combination of Hydro Sound Damper (HSD) and Double Big Bubble Curtain (DBBC) leads to a significant reduction in the impact ranges. Given the less favourable noise propagation conditions, piling in summer will significantly reduce the extent of its impact.

The scenario of pile driving in one location only was characterised by the lowest impact. After the application of a combination of noise reduction systems, the ranges of TTS for fish in winter will reach a maximum of 100 m for a single strike while as a result of the cumulative noise dose from the pile driving from a single source – 11.6 km. The range of permanent threshold shift (PTS) will be 100 m for a single strike and 600 m for a cumulative dose, respectively. The behavioural response, i.e. fish scaring, following the application of mitigating measures, will be observed within the range of 33.2 km from the pile driving site. In summer, the ranges of cumulative noise doses will be lower – 6.4 km for cumulative TTS and 0.6 km for cumulative PTS, respectively. The range of fish scaring will be 17.8 km at the maximum during this period. The other scenarios analysed, involving pile driving at 2, 3 or 4 locations ranging from less than 1 km to more than 20 km apart, represent much higher values and often multiples of the TTS and PTS ranges. Pile driving should be limited to the period from May to the end of November, when bird abundance in the sea area is at its lowest, as well as due to less favourable sound propagation in the water during this period, which translates into a smaller impact range. Pile driving should be avoided during the remaining period.

Noise and vibration emissions during the construction phase are a direct impact on benthivorous and piscivorous birds, transboundary in extent, short-term and reversible. No significant impact on gulls is anticipated. Furthermore, these birds are strongly associated with human activities and are often found in large numbers in the vicinity of fishing vessels [Leopold *et al.*, 2007; Opioła *et al.*, 2020]. Therefore, the presence of construction vessels will be a factor in attracting the above-mentioned group of birds, which seek food in the vicinity of the vessels.

The scale of impact on piscivorous and benthivorous birds was assessed as moderate of moderate significance, and on gulls as negligible of negligible significance during the construction phase and low of negligible significance during the operation phase.

7.3.3.6.5 Conclusions concerning the transboundary environmental impacts

Due to the construction of the wind farm, particularly the pile driving of the foundations, there may be a transboundary environmental impact caused by the adverse influence of noise and vibration on fish, which constitute food for seabirds. There will be no impact during the operation phase, while the noise generated by the turbines will result in environmental impacts of the local range.

Construction of new structures that act as a barrier for bird passages and pose a risk of collision, as well as the increased vessel traffic, will constitute an adverse environmental impact of large scale and transboundary range for benthivorous birds.

Also, a large-scale transboundary environmental impact on benthivorous birds will occur as a result of artificial light emissions.

This will be an adverse, direct and short-term impact.

The environmental impacts associated with benthic habitat degradation and water turbidity will be temporary and local in nature, so these will not constitute a significant transboundary environmental impact on birds.

7.3.4 Bats

7.3.4.1 Current state

During the field surveys, which included acoustic monitoring along transects and at monitoring points, flights were recorded, and four species of bats were identified: the common noctule *Nyctalus noctula*, the northern bat *Eptesicus nilssonii*, the parti-coloured bat *Vespertilio murinus* and the Nathusius' pipistrelle *Pipistrellus nathusii*.

All identified bat species are strictly protected under the Bern Convention, the Bonn Convention and the Agreement on the Conservation of Populations of European Bats (EUROBATS). The species are also listed in Annex IV to the EU Habitats Directive. The species found within the area surveyed are common and widespread across Poland and are assigned the LC (Least Concern) category according to the IUCN (International Union for Conservation of Nature and Natural Resources). In the strip of northern lake districts, it is worth mentioning the northern bat, which has been observed only in winter [Sachanowicz *et al.,* 2006, Zapart *et al.,* 2022]. The recording of these species is consistent with the data obtained from the literature on the occurrence of chiropterofauna in the sea areas. No rare species or species with the highest protection status according to Annex II to the Habitats Directive were recorded.

The bat species recorded are classified as long-distance migrants.

7.3.4.2 Environmental impact assessment and transboundary environmental impact

The offshore wind turbines, like their onshore counterparts, pose a potential threat to migrating bats. This risk mainly stems from the possibility of a direct collision as well as barotrauma.

The operating offshore wind turbines will act as a physical barrier along the bat migration route. A collision with a working rotor is the main cause of mortality in these animals [Kunz *et al*., 2007; Kepel *et al*., 2011]. Individuals struck by rotor blades die from fractures, open wounds, multi-organ injuries or wing amputations [Kepel *et al*., 2011; Horn *et al*., 2008].

The collision mortality is further increased by the fact that bats often fly above the surface of the water and rapidly increase their flight height as they approach an obstacle. They also often use wind turbines as resting places.

As a result, the newly constructed turbines may attract migrating bats by providing a convenient resting place during migration, especially in adverse weather conditions. Excessively strong and white light used for lighting will attract nocturnal insects, creating feeding grounds, which may result in fatalities of these mammals even in areas not used by them before the Project implementation [e.g. Cryan and Brown, 2007; Horn *et al*., 2008; Hüppop *et al*., 2016].

Also posing a risk is the phenomenon of barotrauma (pressure shock), as a result of which the pulmonary alveoli burst, showing no external injuries in dead bats. The rotating blades of offshore wind turbines cause large pressure differences. This results in a decompression phenomenon inflicting barotrauma in bats that enter the area of reduced air pressure behind the rotor wing [Furmankiewicz *et al*., 2009; Baerwald *et a*l., 2008]. This risk usually increases in late summer and early autumn [Rydell *et al*., 2010], and the bat activity recorded (and therefore the increased risk of collisions with turbines) mainly takes place in the survey area in the second half of August.

According to the results of the surveys conducted, the Baltica-1 OWF Area is not an area of great importance for bats; however, only the activity surveys based on continuous recording in the first years of operation will give a real picture of bat activity in the area surveyed, and in the case of an increase in their activity, will allow to effectively establish the periods of restrictions in the wind turbines operation.

The European bat species most at risk of death from collisions with wind turbines are the Nathusius' pipistrelle, the common noctule, the northern bat and the parti-coloured bat.

The impact of surface noise from operating turbines is not expected to have a significant influence on bats.

Taking the above into consideration, the proposed Project brings a risk of bat mortality, although this would mainly concern the common and non-endangered species protected under national and international law.

7.3.4.2.1 Conclusions concerning the transboundary environmental impacts

Due to the operation of wind turbines, there is a potential for transboundary environmental impacts on bats associated with collisions with operating wind turbines and the occurrence of barotrauma. The significance of this environmental impact was assessed to be moderate.

7.3.5 Marine mammals

7.3.5.1 Current state

7.3.5.1.1 Harbour porpoise

The results of the acoustic monitoring carried out showed that porpoises occurred throughout the year in the Baltica-1 OWF survey area and their activity varied, both seasonally and spatially. The highest detection levels were recorded in the Swedish buffer zone (5.9% DPD of all recording days). Detection levels within the Polish EEZ differed between the two survey areas and were higher within the Baltica-1 OWF (1.6% DPD of all recording days). Detection levels were low at all survey stations (0.4% DPD of all recording days) within the Polish buffer zone. At one station, animals were not recorded at all. Sightings occurred mainly in summer and autumn, with the highest number of detections in the autumn months. In contrast to that area, in both the Baltica-1 OWF and the Swedish buffer zone, porpoises occurred throughout the year, in all seasons.

The number of detections in the areas in question was the highest during summer, particularly in August, and began to decrease in autumn. A distinct reduction in detection rates in Poland occurred in September, while in Sweden, a month later, in October. During the spring period, clear differences were found in the frequency of occurrences of porpoises at Polish and Swedish locations. Poland saw the lowest levels of detection in spring. The animals were recorded on several days, at two stations within the OWF (SM_04, SM_05). Spring detections in Sweden were frequent and recorded throughout the survey area. During the winter period, the occurrence of porpoises was rare throughout the Swedish buffer zone. Within the wind farm, the winter detection levels were similar to those in autumn, while in the Polish buffer zone, the animals were recorded only at two stations.

During the monitoring period, the highest DPD levels were recorded at stations SM_14 and SM_15, located in the northernmost part of the Swedish buffer zone. In addition, regional differences were found in the Swedish part of the survey area. In all seasons, porpoises occurred much less frequently at locations SM_16 and SM_17, in the eastern part of the area monitored. In Poland, detection levels throughout the year were similar at stations within the Baltica-1 OWF boundary, as well as between the stations in the buffer zone. The analyses of the acoustic data including DPM showed that on some days the animal registrations were very long, particularly in Sweden. In the Swedish buffer zone, the recordings of porpoises in a single day lasted up to 40 minutes at a single station.

The graphs below present porpoise activity divided into: OWF Area, Polish buffer zone and Swedish buffer zone, individual stations, phenological periods and months, respectively [Figure 7.13, Figure 7.14, Figure 7.15]. Maps [Figure 7.16] show porpoise activity in spatial terms.

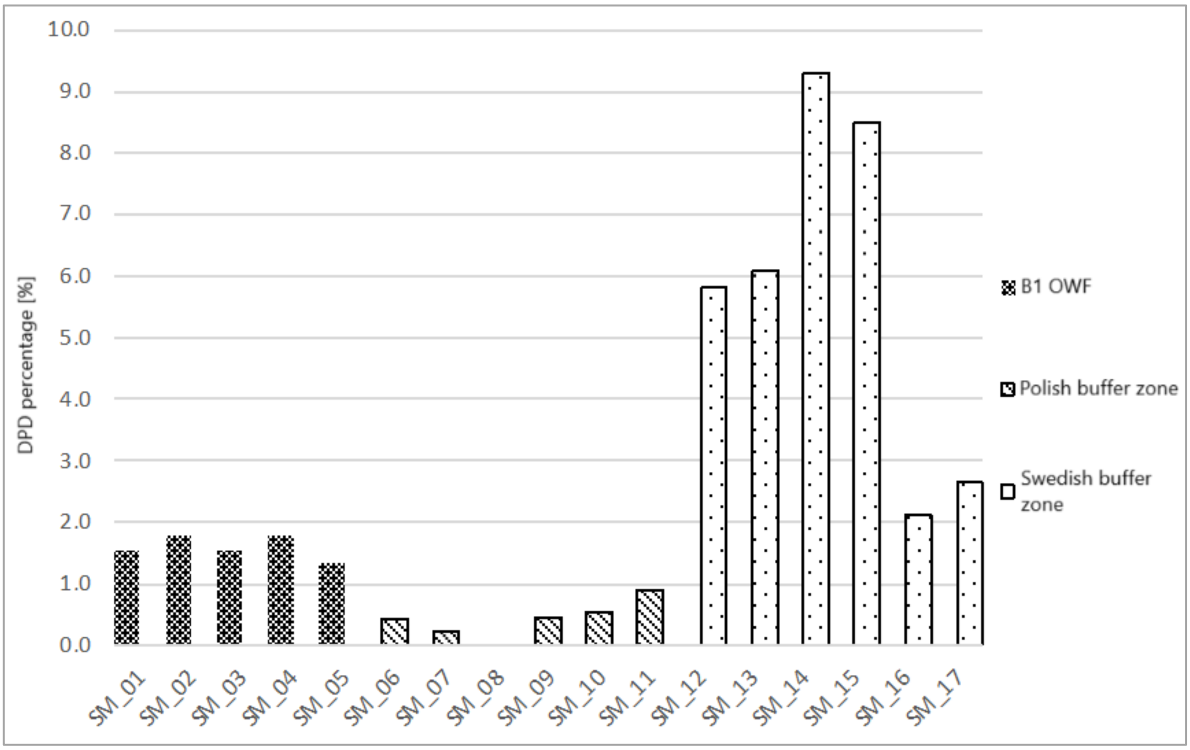

Figure 7.13. *Porpoise activity recorded at survey stations in the Baltica-1 OWF survey area during acoustic monitoring from 3 December 2022 (stations in Poland)/ 14 February 2023 (stations in Sweden) to 28 February 2024. Data are presented as a percentage of DPDs recorded relative to all the days of recordings collected at a station (source: internal materials)*

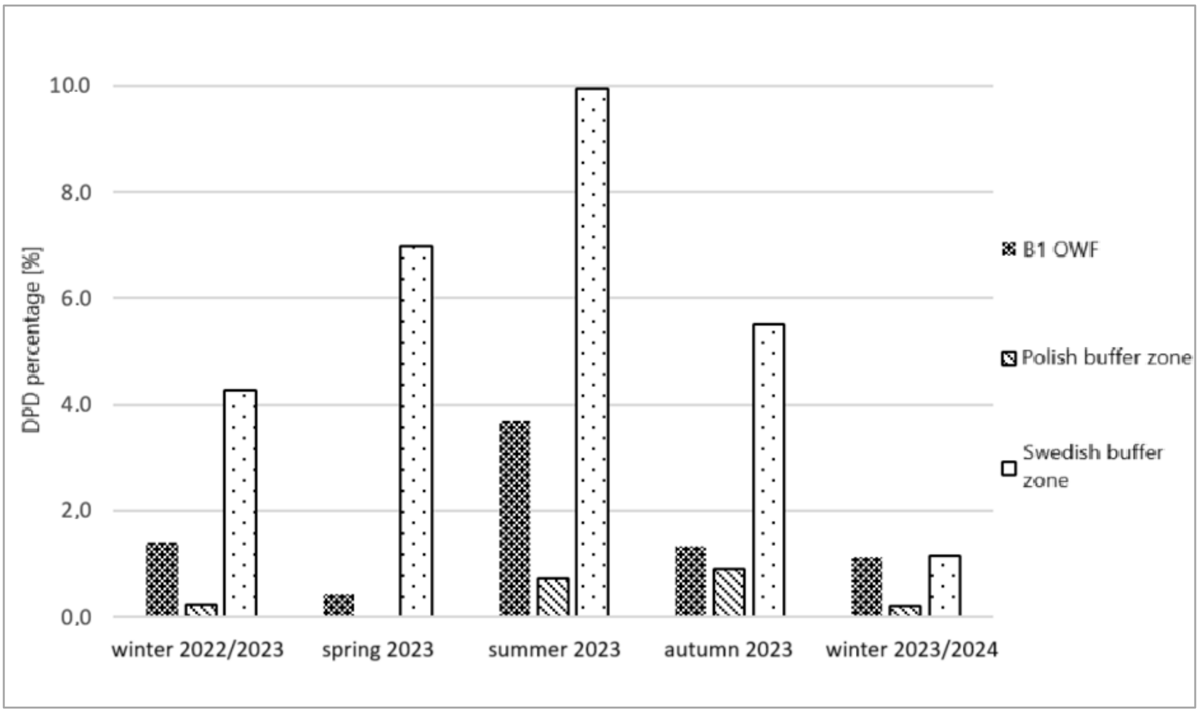

Figure 7.14. *Porpoise activity recorded seasonally at survey stations in the Baltica-1 OWF survey area during acoustic monitoring from 3 December 2022 (stations in Poland)/ 14 February 2023 (stations in Sweden) to 28 February 2024. Data were presented as a percentage of DPDs recorded relative to all the days of recordings collected during the season at a given station. It should be noted that the monitoring period during the winter season differs between the locations in Poland (winter 2022/2023, winter 2023/2024) and Sweden (two weeks in February 2023 and winter 2023/2024) (source: internal materials)*

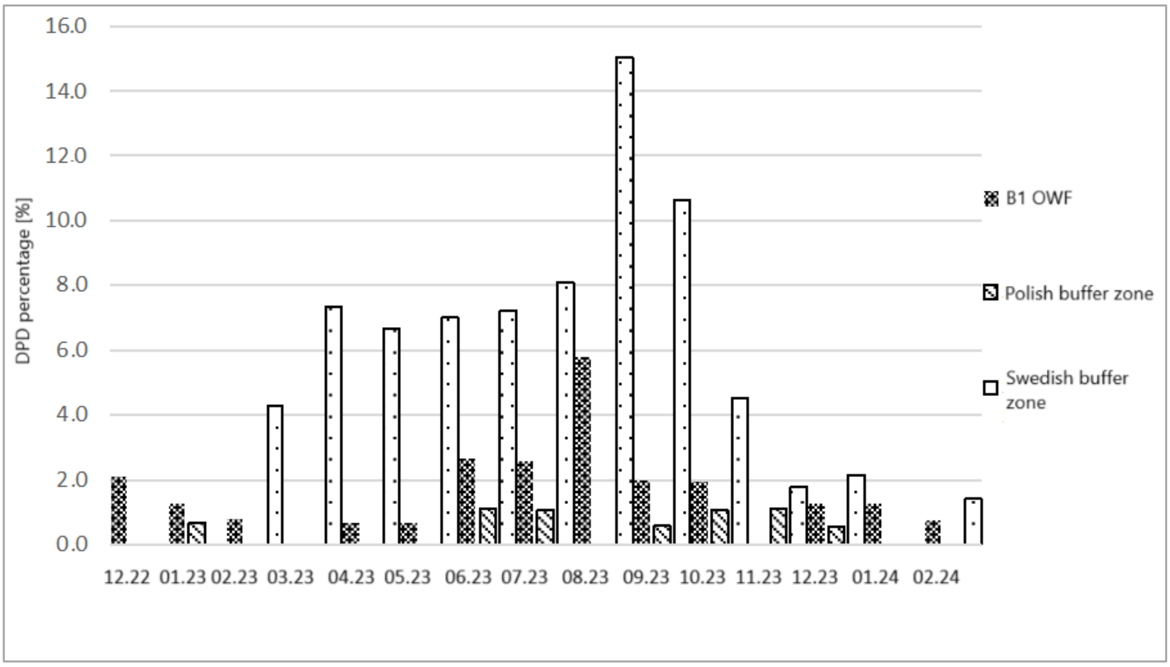

Figure 7.15. *Porpoise activity recorded monthly at survey stations in the Baltica-1 OWF survey area during acoustic monitoring from 3 December 2022 (stations in Poland)/ 14 February 2023 (stations in Sweden) to 28 February 2024. Data were presented as a percentage of DPDs recorded relative to all the days of recordings collected during the month at a given station. It should be noted that the monitoring period differs between the locations in Poland and Sweden. (source: internal materials)*

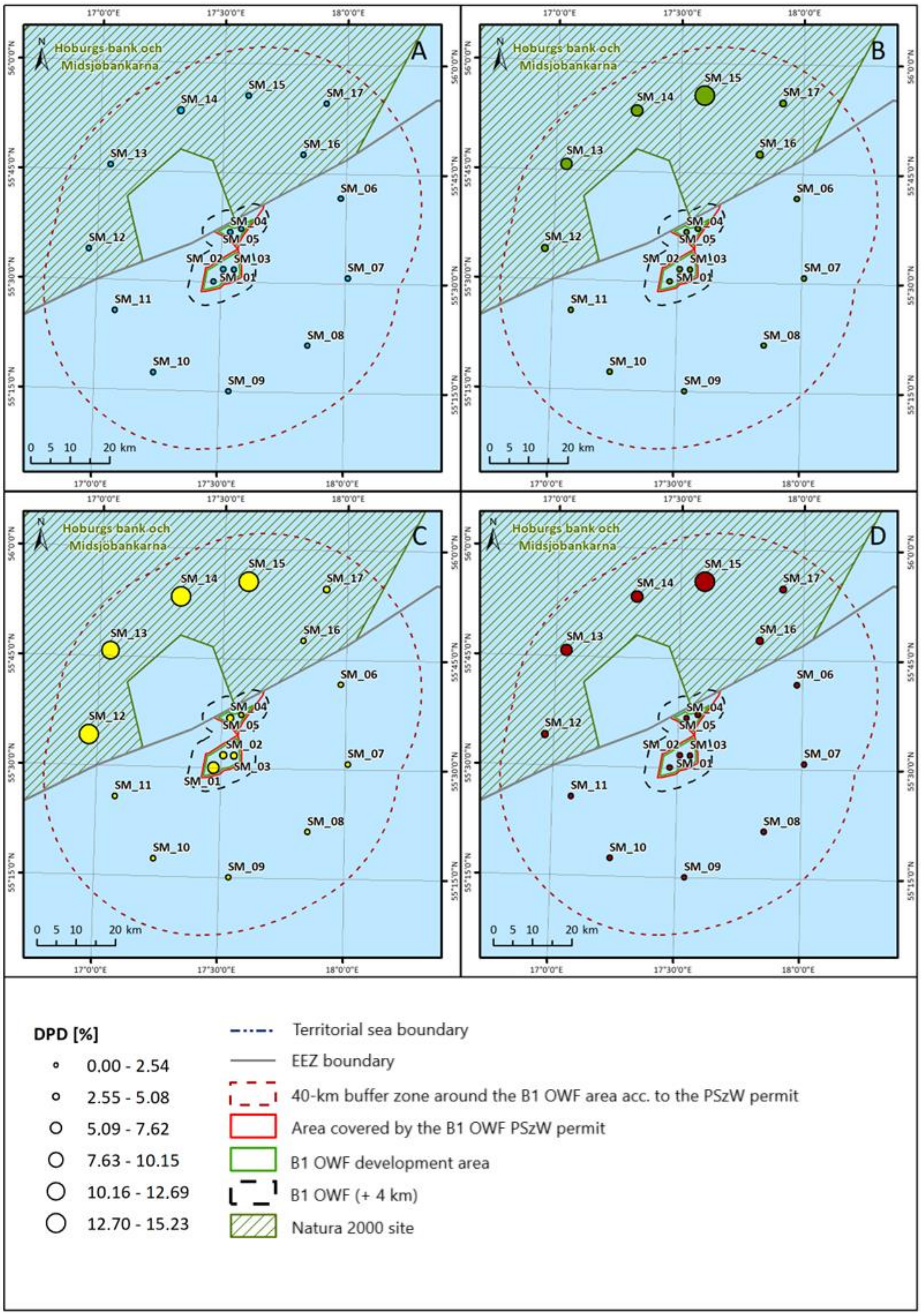

Figure 7.16. Porpoise activity recorded seasonally at survey stations in the Baltica-1 OWF survey area during acoustic monitoring from 3 December 2022 (stations in Poland)/ 14 February 2023 (stations in Sweden) to 28 February 2024. Data were presented as a percentage of DPDs recorded relative to all the days of recordings collected during the season at a given station. Map A (blue markings) – winter season, Map B (green markings) – spring season, Map C (yellow markings) – summer season, Map D (red markings) – autumn season. It should be noted that the monitoring period during the winter season differs between the locations in Poland (winter 2022/2023, winter 2023/2024) and Sweden (two weeks in February 2023 and winter 2023/2024) (source: internal materials)

The results obtained from the acoustic monitoring are consistent with the knowledge available on the occurrence of porpoises in the Baltic Proper. The Swedish part of the survey area for the Baltica-1 OWF is located within the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308), of which porpoises are the subject of protection. In the area, the species is found to have a high frequency of occurrence and to congregate during the breeding season. High levels of acoustic detections within the boundaries of the *Hoburgs bank och Midsjöbankarna* (SE0330308) site, compared to other parts of the eastern Baltic Sea, were also found in earlier surveys conducted for other projects (the SAMBAH project and the Swedish National Monitoring Programme, among others).

Comparing the monitoring data for the Baltica-1 OWF with the results of surveys conducted for other planned offshore wind farms, it can be concluded that the region of the proposed offshore wind farm is characterised by higher levels of porpoise detection (1.6% DPD) than in the case of projects located to the south - e.g. Bałtyk II OWF, Bałtyk III OWF, Baltic Power OWF (0.6% DPD), BC-Wind OWF (0.6% DPD) [Plichta et *al*., 2014 and 2015; Opioła *et al*., 2020; Gajewski *et al*., 2021]. In contrast, the animal activity recorded at stations in the Polish buffer zone appears similar to the frequency of occurrence of the species in the central open waters of the Polish EEZ. In these areas, porpoises appear sporadically, at different times of the year. When comparing the results obtained for the Baltica-1 OWF with the data from the nearby Bałtyk I OWF, similar trends in animal occurrence are noted. In both of these areas, porpoises were recorded with greater frequency than in the central part of the Polish sea areas. The overall detection rate found for the Bałtyk I OWF was 2.9% DPD, which is even higher than for the Project in question [Bałtyk I OWF EIA Report, 2022]. With regard to seasonal changes, in the area of both wind farms, porpoises appeared with the highest frequency during summer, while during the autumn period, the detection numbers started to decrease. The results presented here indicate that in both the Baltica-1 and Bałtyk I OWF areas, the occurrence of the species is largely related to the proximity to the Swedish Natura 2000 site.

Compared to another area of the open waters of the Polish EEZ, for which data on porpoise occurrence are available, the Stilo Bank (south-west of the Baltica-1 OWF), it can also be concluded that the area of the Baltica-1 OWF is characterised by a more frequent occurrence of the species. During the first part of the State Environmental Monitoring, the overall detection rate for the Stilo Bank from June 2016 to April 2018 was approximately 0.3% of the DPD [CIEP, 2018]. The subsequent phase of national monitoring confirmed the low detection levels in the area [CIEP, 2022]. Such results are similar to the data obtained for the area of the Polish buffer zone of the Baltica-1 OWF (0.4% DPD), confirming that in this part of the survey area, the frequency of porpoise occurrence is typical for the central part of the Polish EEZ.

In conclusion, the acoustic monitoring carried out for the Baltica-1 OWF showed that porpoise activity within the proposed wind farm area is higher than in other open water areas of the Polish EEZ for which the data are available. Such a result is related to the location of the Baltica-1 OWF on the border with the Swedish Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308), where the frequent appearance of porpoises coincides with the breeding season of the species [Carlen, 2018]. Seasonal changes in the occurrence of animals within the boundaries of the proposed wind farm appear to be related to their breeding activity in Sweden.

7.3.5.1.2 Seals

Three species of seals occur in the Baltic Sea, the grey seal, the harbour seal and the ringed seal [Cichocki *et al*., 2015].

In order to investigate the use of the Baltica-1 OWF Area and adjacent waters by seals, visual monitoring was carried out from an aircraft and from aboard a vessel between December 2022 and November 2023.

The results of the monitoring carried out within the Baltica-1 OWF (+4 km) Area and in the reference area showed the occurrence of seals in the analysed open sea zones in all seasons of the year. The animals were not recorded from land, within the onshore connection area. The only species recorded during the monitoring was the grey seal. Some seal individuals observed were not identified to the level of species. Regional differences were noted in the frequency of animal registration. The number of observations was significantly higher in the Baltica-1 OWF Area (19 observations) compared to the reference area (11 observations). Seals were most frequently recorded in December 2022, followed by April 2023 and September 2023. No animals were observed in January, March and June 2023. Overall, seal occurrences were found to be the most frequent in the winter season and the lowest in summer. The number of animal sightings was similar in spring and autumn.

The number of seal sightings divided into the OWF Area and reference area, for each phenological period and month, respectively, are presented in the charts below [Figure 7.17, Figure 7.18].

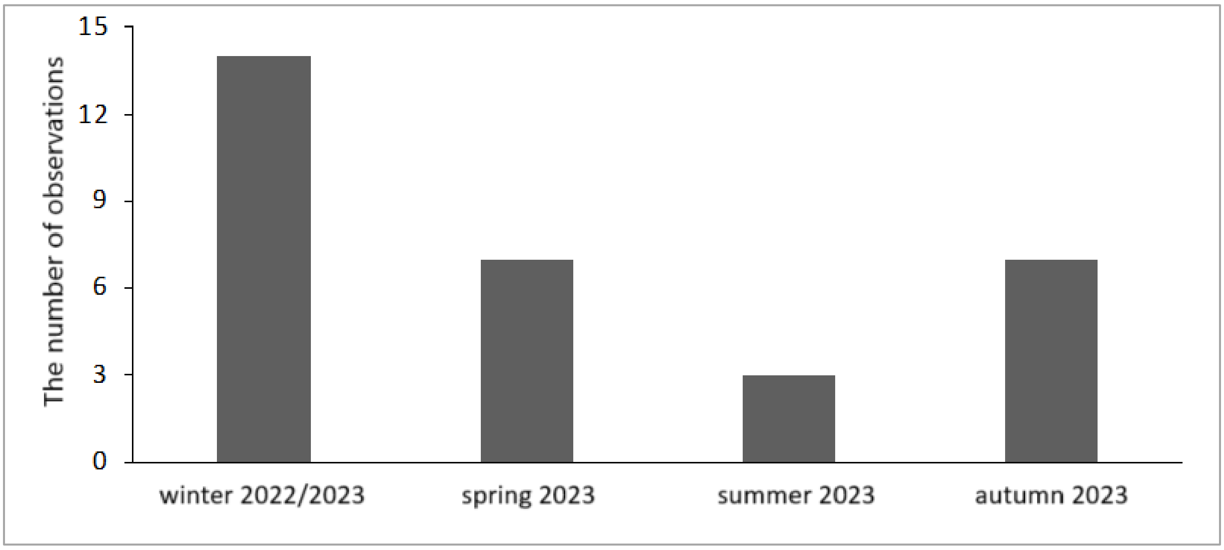

Figure 7.17. Number of seal sightings during individual seasons of the visual monitoring of marine mammals in the Baltica-1 OWF survey area between December 2022 and November 2023 (source: internal materials)

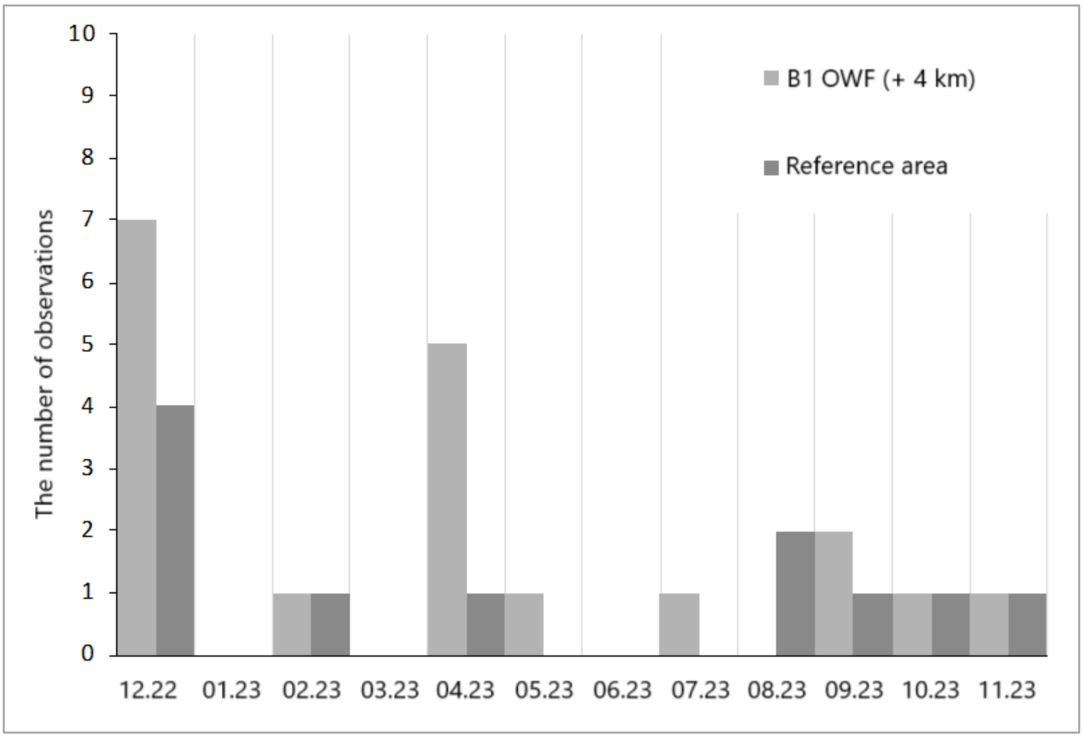

Figure 7.18. Number of seal sightings during the visual monitoring of marine mammals in the Baltica-1 OWF survey area between December 2022 and November 2023 (source: internal materials)

A comparison of the data obtained from the monitoring carried out with the information on seal occurrence along the Polish coast collected by WWF Polska and SMIOUG (Marine Station of the Institute of Oceanography of the University of Gdańsk) in 2020–2023 confirms that the grey seal is the most abundant species in the PSA [WWF, 2023a].

In conclusion, both the surveys carried out for the construction of the Baltica-1 OWF and the surveys carried out for other planned offshore wind farms, as well as literature data, indicate that grey seals occur in the area throughout the year, with the seasonality of their occurrence varying between locations and years of the surveys. In the Baltica-1 OWF Area and adjacent waters, animals were observed most frequently in winter and least abundantly in summer. It can be assumed that the reduced seal activity in the area monitored during summer (moulting season) is related to the numerous gatherings of the animals around the haul-out site, in the area of the Vistula Cut estuary.

7.3.5.2 Environmental impact assessment and transboundary environmental impact

During the offshore wind farm construction phase, the greatest environmental impacts on marine mammals, which may have a transboundary range, will be related to the noise generated during the pile driving of foundations for the wind turbines and OSSs.

Marine mammals, both porpoises and seals, respond to increased noise levels in the environment. Underwater noise is detected by animals when its values exceed the level of naturally occurring ambient noise. Due to the vital importance of sounds for the biology of porpoises and seals, noise can significantly affect their behaviour and physiological condition.

In general, the effects of noise on animals can be divided into several categories, which include detection, masking, behavioural changes, hearing damage (permanent and temporary) and physiological damage, which can even lead to the death of the organism [Thomsen *et al.*, 2021].

The wind turbines will be set on large-diameter piles driven into the seabed. The process of pile driving during construction works will be the source of underwater noise, which may significantly increase the background noise levels around the construction area and at great distances from it.

One common method of pile foundation is impact driving, during which a hydraulic hammer repeatedly strikes the top of a pile, approximately once per second. The sounds generated during pile driving are of high intensity and a wide range of frequencies, including the bands relevant to both porpoises and seals and can significantly affect both groups of marine mammals.

Data on the impact of noise from piling on porpoises and seals comes from the surveys conducted, both in the field, e.g. during the wind farm construction, and under laboratory conditions. Relevant information in this regard was obtained during the construction of farms in the North Sea. The surveys have shown that the zone in which porpoise behaviour changes is location-dependent and, for the case study, can extend up to 26 km. The behavioural changes observed included avoidance and acoustic activity reduction [Tougaard *et al*., 2009; Dähne *et al*., 2013; Brandt *et al*., 2012 and 2018]. The recorded levels of sound intensity at which reactions occurred were relatively low, averaging around 140 dB re 1 μPa^2s [Dähne *et al*., 2013; Brandt *et al*., 2011]. Furthermore, laboratory tests have shown that impulse noise generated during piling can cause temporary hearing loss (so-called TTS) in the harbour porpoise [Lucke *et al*., 2009; Kastelein *et al*., 2012 and 2016]. In the worst-case scenario, total hearing loss (PTS) is also possible.

Surveys of the impact of piling on seals carried out in the North Sea and in laboratory conditions have shown that the animals' reactions can vary. It was determined that seals may not respond at all and may change their behaviour, for example by stopping feeding or leaving the area around the noise source. For the cases analysed, the avoidance zone extended up to 25 km from where the piles were driven [Dietz *et al*., 2003; Russell *et al*., 2016; Aarts *et al*., 2018; Kastelein *et al*., 2018]. As in the case of porpoises, laboratory tests showed that noise generated during piling can cause temporary hearing loss in seals [Kastelein *et al*., 2012 and 2018]. Similarly, total hearing loss is also possible.

Since the preliminary analyses of sound propagation during pile driving in the Baltica-1 OWF Area showed very large noise propagation ranges, the calculations for the environmental impact assessment were carried out with the assumption that mitigating measures would be used (NRS described in Section 3.5.2.1).

Three mitigation scenarios were considered – using a big bubble curtain (BBC) with the concurrent use of a double big bubble curtain (DBBC) and a hydro sound damper (HSD), as well as simultaneously using the IQIP system together with the DBBC. The analysis was carried out for two seasons, summer and winter. The summer season was considered the worst-case scenario from an environmental point of view (a period of the greatest porpoise activity, based on the results of marine mammal monitoring), while winter was considered the worst-case scenario from a physical point of view (best conditions for sound propagation).

Based on the results obtained, it can be assumed that in the case of porpoises the use of NRS during piling at a single location will effectively reduce the noise impact associated with hearing damage (TTS, PTS). This applies to all the mitigation methods analysed [Table 7.14]. In the case of behavioural response, the impact area on the harbour porpoise may be about 0.2% in summer and about 1% of the population in winter. In both the summer and winter scenarios, the impact ranges associated with behavioural change reach values indicating that the Natura 2000 site *Hoburgs bank Midsjöbankarna* (SE0330308), where the harbour porpoise is protected, is affected. This impact diminishes along with the distance of the piling location from that area and piling in the southern part of the Baltica-1 OWF Area may not affect that Natura 2000 site. Given that the modelling results for the behavioural effect apply to a single hammer strike, it can be assumed that the entire OWF construction process may significantly affect the behaviour of porpoises around the work site. This effect is of particular relevance to the summer season, as this is an important period for the Baltic Proper population and also the time when animal activity is the highest in the area analysed. This is indicated both by literature data [SAMBAH 2016, Carlen *et al*., 2018] and by the results of the acoustic monitoring carried out for the Baltica-1 OWF. Its results also indicate that porpoise activity is lower within the Baltica-1 OWF as well as in the Natura 2000 site adjacent to the farm area and covered by the behavioural response than in the rest of the more remote part of the Natura 2000 site. This means that a small number of porpoises will be covered by the range of the behavioural response.

Table 7.14. Anticipated ranges of noise impact from piling during construction works in the Baltica-1 OWF Area obtained for porpoises based on numerical modelling, together with the results of calculations of part of the affected porpoise population in the Baltic Proper. The results presented account for the piling of a single turbine, with mitigation measures applied. The number and percentage of porpoises were calculated based on the Northeast Baltic population abundance data in Amundin et al., 2022. The results are presented assuming upper and lower density limits and animal abundances within the 95% confidence interval considered in Amundin et al., 2022

Mitigation type	**Season**	**Effect**	**Maximum impact range [km]**	**Impact area [km²]**	**Number of harbour porpoises affected by the impact**	**Percentage of harbour porpoises affected by the impact [%]**
BBC	Summer	PTS_{cum}	0.1	0.03	<0.01	<0.01
		TTS_{cum}	0.6	0.7	<0.01	<0.01
		Behavioural change	10.7	233	0.13 – 1.94	0.18 – 0.18
	Winter	PTS_{cum}	0.1	0.1	<0.01	<0.01
		TTS_{cum}	0.8	1.2	<0.01	<0.01
		Behavioural change	28.1	1394	0.99 – 5.88	1.05 – 1.05
HSD + DBBC	Summer	PTS_{cum}	0.1	0.03	<0.01	<0.01
		TTS_{cum}	0.2	0.1	<0.01	<0.01
		Behavioural change	8.6	164	0.09 – 1.37	0.12 – 0.12
	Winter	PTS_{cum}	0.1	0.03	<0.01	<0.01
		TTS_{cum}	0.3	0.23	<0.01	<0.01
		Behavioural change	20.8	863	0.61 – 3.64	0.65 – 0.65
IQIP+DBBC	Summer	PTS_{cum}	0.1	0.03	<0.01	<0.01
		TTS_{cum}	0.3	0.14	<0.01	<0.01
		Behavioural change	9.0	178	0.1 – 1.48	0.14 – 0.14
	Winter	PTS_{cum}	0.1	0.03	<0.01	<0.01
		TTS_{cum}	0.4	0.3	<0.01	<0.01

Mitigation type	Season	Effect	Maximum impact range [km]	Impact area [km^2]	Number of harbour porpoises affected by the impact	Percentage of harbour porpoises affected by the impact [%]
		Behavioural change	20.8	956	0.68 – 4.03	0.72 – 0.72

With regard to seals, the analyses carried out indicated that when NRS is applied during piling at a single location, the effect in terms of hearing damage may be negligible [Table 7.15]. Meeting the cumulative TTS level condition will require appropriate NRS planning. The ranges of impact in the form of a behavioural response are limited, particularly assuming the use of dual mitigation. Given the low frequency of the occurrence of seals in the survey area, it is presumed that the effect associated with the behaviour change will not significantly affect the animals.

Table 7.15. Anticipated ranges of noise impact from piling during construction works in the Baltica-1 OWF Area obtained for seals based on numerical modelling. The results presented account for the mitigation measures applied

Mitigation type	Season	Effect	Maximum impact range [km]	Impact area [km^2]
BBC	Summer	PTS_{cum}	0.1	0.03
		TTS_{cum}	0.5	0.6
		Behavioural change	7.7	132
	Winter	PTS_{cum}	0.1	0.03
		TTS_{cum}	2.1	7.3
		Behavioural change	10.3	241
HSD + DBBC	Summer	PTS_{cum}	0.1	0.03
		TTS_{cum}	0.1	0.03
		Behavioural change	3.0	23.1
	Winter	PTS_{cum}	0.1	0.03
		TTS_{cum}	0.1	0.03
		Behavioural change	3.4	31.3
IQIP+DBBC	Summer	PTS_{cum}	0.1	0.03
		TTS_{cum}	0.1	0.03
		Behavioural change	1.6	7.3
	Winter	PTS_{cum}	0.1	0.03
		TTS_{cum}	0.1	0.03
		Behavioural change	1.9	9.6

In conclusion, the analyses carried out showed that the noise generated during the construction process of the Baltica-1 OWF may propagate over large distances, affecting marine mammals. Based on the modelling results, it was concluded that the use of NRS would significantly reduce the extent of the adverse environmental impact. In winter (i.e. a period of better underwater noise propagation), due to the possibility of TTS in seals, this aspect should be included in the NRS. In some of the NRS scenarios considered, the harbour porpoise behavioural change zone may include both Polish waters and the Swedish Natura 2000 site where the harbour porpoise is protected, but the area affected will not exceed 1% in summer and 3.8% in winter. Of particular importance is the impact at the behavioural level on the harbour porpoise, especially in summer (breeding time), when the animals congregate in

Swedish waters and the frequency of their occurrence in the OWF Area also increases. In summer, the uncontrolled piling process could significantly affect the behaviour of porpoises in an area significant to the Baltic Proper population. This dependency applies to the entire period that is of greatest concern in terms of the species' reproduction in the Baltic Sea, i.e. from June to August. The calculations performed indicate that piling at points further south of the Natura 2000 site will significantly reduce or completely eliminate the impact, at the behavioural response level, on the Natura 2000 site and the Swedish territory. In winter and throughout the period from September to May, the species activity in the survey area is lower, limiting the adverse environmental impact associated with behavioural changes.

7.3.5.2.1 Conclusions concerning the transboundary environmental impacts

Due to the pile driving of wind turbine foundations during the construction of the offshore wind farm, there is a potential for transboundary environmental impacts on marine mammals in the Baltic Sea, due to the propagation of underwater noise. The significance of this impact was assessed to be negligible with appropriate mitigation measures constituting a Noise Reduction System.

7.3.6 Protected areas

7.3.6.1 Current state

There are no protected areas within the Baltica-1 OWF Area. At a distance of approximately 2 km from its boundary, a Swedish Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308) is situated. According to the Standard Data Form for the site, the subjects of protection within the area include two natural habitats – Sandbanks which are slightly covered by sea water all the time (code: 1110) and Reefs (code: 1170); three bird species − the black guillemot (*Cepphus grylle*), the common eider (*Somateria mollissima*) and the long-tailed duck (*Clangula hyemalis*), as well as the porpoise (*Phocoena phocoena*) [SDF 2016].

A number of threats with adverse environmental impacts on the site were identified in the SDF, of which the following were considered the most significant: shipping lanes (D03.02), professional active fishing (F02.02), and oil spills in the sea (H03.01). The following medium-level threats were considered − netting (F02.01.02), pollution to surface waters (limnic, terrestrial, marine and brackish) (H01), and nitrogen inputs (H04.02), as well as low-level threats − invasive non-native species (I01).

Among the conservation objectives for the site *Hoburgs Bank och Midsjöbankarna* (SE0330308), the following provisions were indicated:

- The Natura 2000 site *Hoburgs Bank and Midsjöbankarna* (SE0330308) must not be affected by impulse noise from human activities, which may cause temporary hearing loss (TTS) in porpoises.
- In the Natura 2000 site *Hoburgs Bank and Midsjöbankarna* (SE0330308), impulse or continuous underwater noise, including noise related to vessel traffic, must not cause an impact on behaviour in areas where the frequency of porpoise detection is the highest. In parts of the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308) where porpoise detection frequencies are lower, activities generating underwater noise exceeding the porpoise hearing threshold by 40 dB should be minimised.

Within the range of the Project environmental impacts, the Natura 2000 site *Ławica Słupska* (PLC990001), located 59 km from the boundary of the Project area, may be affected. The area includes a subsea bank with a seabed significantly shallower than in the surrounding areas. Its boundary roughly corresponds to the course of the 20 m isobath. It is an area with a highly varied seabed with numerous elevations and depressions ranging in depth from approximately 8.0 to approximately 35.0 m. The shallowest parts of the seabed include elevations within the so-called 'boulder areas' in the northern and western parts of the area (minimum depth of approximately 8.0 m) and parts of the sandy seabed of the central part of the area (minimum depth of approximately 12.0 m). The deepest parts of the seabed (up to 35 m) are located in the southeastern part of the area. The following habitat types can be distinguished within the Słupsk Bank − coarse-grained sediments in the sublittoral zone, sands in the sublittoral zone, hard substrate and mosaic substrate in the infralittoral zone. A series of hills consisting mostly of erosion-resistant pebbles and boulders is a distinctive morphological feature. The hard seabed and the relatively high water transparency create favourable conditions for the development of species-diverse benthic communities, among which the so-called habitat-forming species of high nature conservation value in the Baltic Sea ecosystem are found. These include the following red algae species − *Vertebrata fucoides* as well as the protected *Furcellaria lumbricalis*, *Ceramium diaphanum* and the bay mussels *Mytilus trossulus*. The macroalgae species that are rare not only in Polish sea areas, e.g. *Coccotylus truncatus*, *Desmarestia viridis*, *Rhodomela confervoides*, but also on the scale of the entire Baltic Proper, e.g. *Delesseria sanguinea*, develop in many parts of the Słupsk Bank boulder area [SDF, 2024].

The subjects of protection within the area include two natural habitats – sandbanks (1110) and reefs (1170) and three bird species − the black guillemot (*Cepphus grylle*), the long-tailed duck (*Clangula hyemalis*) and the velvet scoter (*Melanitta fusca*). In addition, the birds, the black-throated diver (*Gavia arctica*) and the red-throated diver (*Gavia stellata*) also occur in the area, as well as the porpoise (*Phocoena phocoena*), but these three species are not subject to protection in the area [SDF, 2024].

7.3.6.2 Environmental impact assessment and transboundary environmental impact

A protected area that is likely to be affected by the environmental impacts of the Baltica-1 OWF construction phase is the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308). Two natural habitats are subject to protection in the area − underwater sandbanks (1110) and reefs (1170), as well as one species of marine mammal, the porpoise, and three species of birds, the black guillemot, the long-tailed duck and the common eider.

According to the *Hoburgs Bank och Midsjöbankarna* (SE0330308) site conservation plan, the natural habitats sandbanks (1110) and reefs (1170) are located in the central and northern part of this area at a distance of at least 40 km from the boundary of the Baltica-1 OWF Area. The analysis of the modelling results and Project environmental impacts, including those with the largest spatial extent, i.e. underwater noise propagation and suspended solids dispersion, does not indicate that they are likely to extend to areas at such a distance from their source. For this reason, the construction phase of the Baltica-1 OWF will not result in environmental impacts that could affect the natural distribution, structure and functions as well as typical species of habitats 1110 and 1170 located in the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308).

Porpoises are likely to be found throughout the *Hoburgs Bank och Midsjöbankarna* (SE0330308) site, hence the risk that underwater noise emitted during the works related to pile installation in the seabed will result in a behavioural response, a temporary threshold shift in hearing (TTS) and in an extreme situation – a permanent threshold shift (PTS) or death. Two types of calculations based on numerical modelling were carried out to estimate the likelihood of the effects listed – with and without taking the escape response of marine mammals into account. Calculations were carried out at three locations.

The first type of analyses was to estimate whether the noise emitted during piling could exceed the permissible sound levels in the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308). The analyses were performed for two seasons (summer and winter), for a scenario without mitigation and with NRS in the form of BBC, HSD+DBBC and IQIP+DBBC. Calculations were performed for the cumulative effects of hearing damage, taking into account the criteria of the acoustic thresholds indicated for the harbour porpoise [NMFS 2018 and 2023]. The results were presented as differences in noise levels between the calculated SEL values and threshold values [Table 7.16–Table 7.19]. Analyses were performed for piling scenarios at a single location in the northern part of the Baltica-1 OWF, as well as at two and three locations simultaneously.

The results showed that even in the case of piling at a single location, the permissible noise limit for cumulative TTS and PTS for the harbour porpoise will be exceeded at the boundary of the Swedish Natura 2000 site if no mitigation measures are applied [Table 7.16]. The use of one mitigation measure in the form of a BBC may not be sufficient to reduce excessive sound emissions. The use of dual mitigation measures (HSD+DBBC or IQIP+DBBC) will reduce the noise if construction works are assumed to be performed in summer [Table 7.17]. The results of the impact analysis indicate the impact of piling during the period of the greatest concern for the Baltic Proper population, i.e. from June to August. During the remaining period with dual mitigation measures (HSD+DBBC or IQIP+DBBC), thresholds associated with the occurrence of TTS in the harbour porpoise may be exceeded. Therefore, it may be necessary to perform piling at this time in southern locations or to use more effective NRS.

Table 7.16. Modelled noise levels at the boundary of the Natura 2000 site Hoburgs bank och Midsjöbankarna (SE0330308), according to HF-weighted SEL limits for TTS and PTS, for piling at a single location within the Baltica-1 OWF Area without mitigation measures

Season	Effect	Threshold value of HF-weighted SEL at the Natura 2000 site boundary [dB re 1 µPa²s]	No mitigation measures	
			Modelled value of HF-weighted SEL at the Natura 2000 site boundary [dB re 1 µPa²s]	Difference between the modelled value of HF-weighted SEL and the threshold value [dB]
Winter	TTS_{cum}	140	183.6	+43.6
	PTS_{cum}	155		+28.6
Summer	TTS_{cum}	140	180.1	+40.1
	PTS_{cum}	155		+25.1

Table 7.17. Modelled noise levels at the boundary of the Natura 2000 site Hoburgs bank och Midsjöbankarna (SE0330308), according to HF-weighted SEL limits for TTS and PTS, for piling at a single location within the Baltica-1 OWF Area with mitigation measures in the form of BBC, HSD+DBBC and IQIP+DBBC

Season	Effect	Threshold value of HF-weighted SEL at the Natura 2000 site boundary [dB re 1 µPa²s]	Modelled value of HF-weighted SEL at the Natura 2000 site boundary [dB re 1 µPa²s]			Difference between the modelled value of HF-weighted SEL and the threshold value [dB]		
			BBC	HSD+ DBBC	IQIP+ DBBC	BBC	HSD+ DBBC	IQIP+ DBBC
Winter	TTS_{cum}	140	158.2	150.9	153.4	+18.2	+10.9	+13.4
	PTS_{cum}	155				+3.2	-4.1	-1.6
Summer	TTS_{cum}	140	154.0	122.7	122.1	+14.0	-17.3	-17.9
	PTS_{cum}	155				-1.0	-32.3	-32.9

Further to the above statements, the modelling results demonstrated that conducting simultaneous piling works at two or three locations next to a Natura 2000 site, that are no more than 50 km apart from each other, without mitigation measures may lead to exceedances of the hearing damage thresholds for porpoises in each of the scenarios analysed [Table 7.18]. The same is true for a single mitigation measure in the form of a BBC. Double mitigation may also not be sufficient to prevent exceedances of noise limits at the boundary of the Swedish Natura 2000 site. Exceedances of TTS thresholds were identified in both seasons, for both two and three sound sources [Table 7.19].

Table 7.18. Modelled noise levels at the boundary of the Natura 2000 site Hoburgs bank och Midsjöbankarna (SE0330308), according to HF-weighted SEL limits for TTS and PTS, for simultaneous piling at several locations within the Baltica-1 OWF Area and outside it, without mitigation measures

Season	Sound sources	Effect	Threshold value of HF-weighted SEL at the Natura 2000 site boundary [dB re 1 µPa²s]	No mitigation measures	
				Modelled HF-weighted SEL at the Natura 2000 site boundary [dB re 1 µPa²s]	Difference between the modelled value of HF-weighted SEL and the threshold value [dB]
Winter	2 sources – <1 km	TTS_{cum}	140	186.6	+46.6
		PTS_{cum}	155		+31.6
	2 sources – 20 km	TTS_{cum}	140	183.7	+43.7
		PTS_{cum}	155		+28.7
	3 sources – 2 <1 km, 1 = 20 km	TTS_{cum}	140	186.7	+46.7
		PTS_{cum}	155		+31.7
Summer	2 sources – <1 km	TTS_{cum}	140	183.1	+43.1
		PTS_{cum}	155		+28.1
	2 sources – 20 km	TTS_{cum}	140	180.1	+40.1
		PTS_{cum}	155		+25.1
	3 sources – 2 <1 km, 1 = 20 km	TTS_{cum}	140	183.1	+43.1
		PTS_{cum}	155		+28.1

Table 7.19. Modelled noise levels at the boundary of the Natura 2000 site Hoburgs bank och Midsjöbankarna (SE0330308), according to HF-weighted SEL limits for TTS and PTS, for simultaneous piling at several locations within the Baltica-1 OWF Area and outside it, with mitigation measures in the form of BBC, HSD+DBBC and IQIP+DBBC

Season	Sound sources	Effect	Threshold SEL value at the Natura 2000 site boundary [dB re 1 μPa²s]	Modelled value of HF-weighted SEL at the Natura 2000 site boundary [dB re 1 μPa²s]			Difference between the modelled value of HF-weighted SEL and the threshold value [dB]		
				BBC	HSD+ DBBC	IQIP+ DBBC	BBC	HSD+ DBBC	IQIP+ DBBC
Winter	2 sources – < 1 km	TTS_{cum}	140	161.5	156.6	157.9	+21.5	+16.6	+17.9
		PTS_{cum}	155				+6.5	+1.6	+2.9
	2 sources – 20 km	TTS_{cum}	140	158.2	150.9	153.4	+18.2	+10.9	+13.4
		PTS_{cum}	155				+3.2	-4.1	-1.6
	3 sources – 2 < 1km, 1 = 20 km	TTS_{cum}	140	161.5	156.6	157.9	+21.5	+16.6	+17.9
		PTS_{cum}	155				+6.5	+1.6	+2.9
Summer	2 sources – < 1 km	TTS_{cum}	140	157.8	150.6	153.0	+17.8	+10.6	+13.0
		PTS_{cum}	155				+2.8	-4.4	-2.0
	2 sources – 20 km	TTS_{cum}	140	154.0	122.7	122.1	+14.0	-17.3	-17.9
		PTS_{cum}	155				-1.0	-32.3	-32.9
	3 sources – 2 < 1km, 1 = 20 km	TTS_{cum}	140	157.8	150.6	153.0	+17.8	+10.6	+13.0
		PTS_{cum}	155				+2.8	-4.4	-2.0

The second stage of the assessment of the environmental impact of underwater noise generated by the Baltica-1 OWF piling works on the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308) included an analysis of the extent of the environmental impact related to the change in the harbour porpoise behaviour. On the basis of the threshold value adopted for the behavioural response of the harbour porpoise according to Tougaard [2021], the proportion of the Natura 2000 site affected by the environmental impact was calculated. The analysis was conducted for two seasons (summer and winter), for scenarios involving the application of mitigation measures in the form of BBC, HSD+DBBC and IQIP+DBBC, assuming piling works at a single location in the northern part of the OWF.

Based on the results obtained for the summer scenario, it was concluded that the proportion of the Natura 2000 site coverage is 0.6%, with the application of a single mitigation measure in the form of BBC, and 0.4% in the case of a dual mitigation solution involving HSD+DBBC. In the winter scenario, the areas with environmental impact are larger, ranging from 3.8% for BBC to 2.5% for HSD+DBBC [Table 7.20].

Table 7.20. The extent of impact from underwater noise associated with changes in harbour porpoise behaviour within the Natura 2000 site Hoburgs bank och Midsjöbankarna (SE0330308) as a result of piling at the northern location in the Baltica-1 OWF, accounting for the application of mitigation measures in the form of BBC, HSD+DBBC and IQIP+DBBC

Season	Mitigation type	Effect	Threshold value	Average distance [km]	Max. distance [km]	Impact area [km^2]	Percentage of the Natura 2000 site coverage [%]
Winter	BBC	Behavioural response	103 SPL VHF-weighted	20.9	28.1	1394	3.8
	HSD + DBBC	Behavioural response	103 SPL VHF-weighted	16.4	20.8	863	2.5
	IQIP + DBBC	Behavioural response	103 SPL VHF-weighted	17.3	20.8	956	2.6
Summer	BBC	Behavioural response	103 SPL VHF-weighted	8.6	10.7	233	0.6
	HSD + DBBC	Behavioural response	103 SPL VHF-weighted	7.2	8.6	164	0.4
	IQIP + DBBC	Behavioural response	103 SPL VHF-weighted	7.5	9.0	178	0.5

Based on the above-mentioned analyses, it was assessed that noise from piling may have a moderate environmental impact on porpoises, which occur only in the southern part of the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308) and in adjacent waters. In surveys conducted in 2023–2024 (Appendix 1 to the EIA Report), greater activity of porpoises was recorded to the north of these areas. It should be remembered that the modelled northern point is the closest to the protected area and piling in any other location within the OWF area will have a smaller impact. To prevent excessive adverse impacts of noise, also on the protection objects of the above-mentioned area, the Project Owner has planned to apply appropriate combinations of mitigation measures, both technical and organisational (so-called NRS, described in section 3.5.2.1). Specific sets of such measures will be determined on a case-by-case basis to minimise the range of acoustic impact, which includes preventing a situation of exceeding the TTS threshold for the harbour porpoise and limiting the area where exceedances of the hearing threshold of up to 40 dB may occur exclusively to the area with lower porpoise activity.

In the case of birds protected within the *Hoburgs Bank och Midsjöbankarna* (SE0330308) site, i.e. the long-tailed duck, the black guillemot and the common eider, the environmental impacts may result from underwater noise and the barrier in the form of the above-water space being occupied by the Baltica-1 OWF turbines. According to the conservation plan for the site *Hoburgs bank och Midsjöbankarna* (SE0330308), the wintering population of the long-tailed duck constitutes approximately 25% of the pan-Baltic population, so this is a very important area for the species. It is also the most abundant species during spring migrations and an abundant species during autumn migrations. In addition to the barrier effect obstructing the migration and creating a risk of collision, underwater noise could potentially have a major impact on the long-tailed duck. This bird feeds on benthic organisms and can dive up to 30 m in search of food. The black guillemot is a piscivorous bird and feeds mainly on fish, which it catches in the surface layer of the sea. The common eider, on the other hand, is also able to dive in search of food at the seabed, but to relatively shallow depths, up to 10 m. Summarising the information above, it should be noted that the long-tailed duck and, to a lesser extent, the black guillemot will be most at risk from underwater noise emissions. The common eider will not be affected due to the fact that there are no sites shallower than 13–14 m in the Middle Bank area, i.e. within the diving range of the common eider. Underwater noise will mainly affect the wintering birds, present on the waters of the bank and its vicinity for several months. Since the listed bird species which are subject to protection within the *Hoburgs Bank och Midsjöbankarna* (SE0330308) site, may fly through the Baltica-1 OWF Area during migration and also move locally to this part of the Middle Bank area during wintering, the impacts of the above-water structures (barrier and collision effects) during the operation phase and underwater noise during the construction phase should be subject to the same assessment as the one resulting from the analysis of environmental impacts on birds that are present directly in the Project area. The results of the analysis of the environmental impacts identified indicate that these impacts will be moderate.

An important aspect of limiting the adverse environmental impacts of the Baltica-1 OWF on the *Hoburgs Bank och Midsjöbankarna* (SE0330308) site is the fact that the recommendations of the environmental impact assessment for the MSPPSA, which was also subject to a transboundary environmental impact assessment under the Espoo Convention, were taken into account when planning its location. As a result, a provision was introduced into the MSPPSA to move the OWF wind turbine line away from that site by a minimum of 2 km, which will allow to avoid significant adverse impacts on avifauna, including protected bird species, their habitats and objectives, the subjects of protection, as well as the integrity of the Natura 2000 network. Within the meaning of the Nature Conservation Act of 16 April 2004 (consolidated text: Journal of Laws of 2023, item 1336), the integrity of the Natura 2000 site is 'the coherence of structural and functional factors determining the sustainable duration of populations of species and natural habitats for the protection of which a Natura 2000 site has been designed or designated'. The environmental impacts identified for the construction phase did not indicate that their influence could threaten the integrity of the factors determining the persistence of species populations and natural habitats in the *Hoburgs Bank och Midsjöbankarna* (SE0330308) site. The natural habitats 1110 and 1170 are located at a considerable distance from the Baltica-1 OWF construction area, and the environmental impacts on their structure and functioning will not occur. In the case of the protected populations, the porpoise, the long-tailed duck, the black guillemot and the common eider, the noise impacts will affect individuals of their populations but will scare them away from the nearest underwater work site and cause them to temporarily relocate to other areas of the Natura 2000 site. Taking into account the importance of the *Hoburgs Bank och Midsjöbankarna* (SE0330308) site for the porpoise and the long-tailed duck, which are the most abundant species in this Natura 2000 area, as well as the sensitivity of these species to underwater noise, the limited environmental impact duration (with the strongest impact during the construction works in the northern part of the Baltica-1 OWF Area) and the results of the analysis of underwater noise impact on the porpoise and benthivorous birds, it was assumed that the environmental impact of underwater noise on the protected species at the *Hoburgs Bank och Midsjöbankarna* (SE0330308) site will be moderate for the porpoise and the long-tailed duck and negligible for the common eider.

According to the Standard Data Form for the *Hoburgs Bank och Midsjöbankarna* (SE0330308) site, no links to other Natura 2000 sites were identified [SDF, 2016]. The site is an extensive sea area covering the northern part of the Middle Bank (excluding its shallowest elevated part) and the Hoburgs Bank (SE0330308 Site Conservation Plan). The nearest marine Special Protection Area for Birds, the *Ławica Słupska* (PLC990001) site, is located approximately 59 km from the Baltica-1 OWF Area. Despite the lack of identified links between the two Natura 2000 sites, they are similarly important for migrating and wintering long-tailed ducks and black guillemots. Hence, it is likely that the individuals of these species may migrate between these areas mainly during the wintering period. Construction works may disrupt bird flights, forcing them to consider navigational obstacles in the form of vessels involved in the construction works and the OWF structures being erected. However, this will not be a phenomenon that renders the movement of birds impossible but only causes them to adjust their routes. For this reason, the possible environmental impact on the link between the *Hoburgs bank och Midsjöbankarna* (SE0330308) site and the *Ławica Słupska* site (PLC990001) was assessed as negligible.

During the operational phase of the farm, potential impacts may only occur in the context of the integrity and coherence of the *Hoburgs Bank och Midsjöbankarna* (SE0330308) site with other Natura 2000 sites. Despite the lack of such links in the SDF of the site, it seems appropriate to consider its relationship with the *Ławica Słupska* (PLC990001) site, given the common species subject to protection, namely the long-tailed duck and the black guillemot, for which both the Słupsk Bank and the Middle Bank are important wintering grounds and navigation points during migration. It is important to assess the Project's impact on the mobility of the long-tailed duck, the black guillemot and the common eider. Taking into account the extent of the *Hoburgs Bank och Midsjöbankarna* (SE0330308) site and the width of the airspace used by birds during migrations, it should be assumed that the environmental impact of the operation phase of the OWF on the integrity of the site and its possible link with the site *Ławica Słupska* (PLC990001) site will be of minor importance, but considering the long-term operation of the wind farm, for a maximum of 35 years, it should be assessed as an environmental impact of moderate significance.

7.3.6.2.1 Conclusions concerning the transboundary environmental impacts

Due to the construction of the Baltica-1 OWF, there is a possibility of transboundary environmental impacts on the protected areas and the links between the protected areas.

The transboundary environmental impact on the protected species will occur during the construction phase and will be primarily related to the noise generated during pile driving of the foundations for the wind turbines and OSSs. The transboundary environmental impact on the links between the protected areas will be related to the influence of the wind turbine operation on the movement of avifauna between the protected areas.

7.4 CUMULATIVE ENVIRONMENTAL IMPACTS

Cumulative environmental impacts are environmental impacts resulting from the combined effects of the activities of the project under assessment with other ongoing or planned projects.

The national EIA Report identified the projects whose impacts could potentially cumulate with those of the Baltica-1 OWF, to assess them for the possibility of occurrence of cumulative environmental impacts.

The analysis carried out showed that the areas of such investments are located in the offshore areas of Poland and Sweden.

In Polish sea areas, these are:

- Baltica-1 OWF Connection Infrastructure;
- Bałtyk I Offshore Wind Farm;
- Baltica Offshore Wind Farm;
- Bałtyk II Offshore Wind Farm;
- Bałtyk III Offshore Wind Farm;

- Baltic Power Offshore Wind Farm;
- BC-Wind Offshore Wind Farm;
- FEW Baltic II Offshore Wind Farm.

In Swedish sea areas, these are[6]:

- Södra Victoria Offshore Wind Farm;
- Baltic Offshore Beta Offshore Wind Farm.

The Baltica-1+ OWF construction area is also within the cumulative impact range, but due to the early stage of this project and the lack of information on the extent of its impacts, it was not included in the cumulative environmental impact analysis.

Other areas of the planned offshore wind farms on the Swedish side may potentially result in the generation of cumulative environmental impacts from underwater noise. These are the Cirrus OWF, the Neptunus OWF (the areas of these two farms largely overlap with the Baltic Offshore Beta OWF area), the Baltic Edge OWF and the Öland-Hoburg OWF. However, as in the case of the Baltica-1+ OWF, the very early stage of development of these projects does not allow them to be included in the assessment of cumulative environmental impacts.

The analysis of the potential cumulative environmental impacts identified this way is presented below. Environmental impacts for which the possibility of transboundary cumulative environmental impacts was identified were taken into account in the description.

7.4.1 Cumulative environmental impact of underwater noise

Considering the results of the analysis of the cumulative environmental impact of different wind farms on the underwater noise impact, the effect of this impact was assessed, taking into account its common environmental impact area, the type of underwater noise impact and the possibility of cumulative environmental impact on the environment, including the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308).

To carry out a cumulative assessment of the impact of underwater noise on marine mammals, the results of noise propagation modelling during simultaneous piling at several locations were analysed in the first place. The results obtained for scenarios involving NRS in the form of BBC, HSD+DBBC and IQIP+DBBC were taken into consideration. The values obtained through modelling were analysed in terms of predicted areas and furthest extent of impact for three types of effects: cumulative TTS and PTS as well as behavioural changes. Next, it was verified whether or not the impact extents predicted could overlap with the area of other planned or existing OWFs.

The analysis focused primarily on the harbour porpoise as the species most sensitive to noise impacts and endangered in the Baltic Sea. As the harbour porpoise is protected in the Swedish Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308), bordering with the Baltica-1 OWF, possible noise exceedances in the area were also taken into account in the assessment of cumulative impacts.

[6] Data on location and progress of offshore wind farm projects in Swedish sea areas were obtained from Swedish Energy Agency website: *https://vbk.lansstyrelsen.se/* accessed on 27.03.2024

In addition, the modelling results obtained for seals were included in the study to verify whether or not the cumulative noise effects from piling works may also affect other marine mammals occurring in the Baltic Sea.

On the basis of the modelling results, it was concluded that for simultaneous piling at two or more locations, NRS in the form of a BBC might be insufficient. In both the summer and winter scenarios, the noise impact zones are large for cumulative TTS and behavioural change, in the case of both the harbour porpoise and seals [Table 7.21]. An analysis assuming NRS in the form of HSD+DBBC and IQIP+DBBC indicated that a PTS effect in marine mammals is unlikely. However, if piling works were to take place during the winter season, it is still possible that a TTS would affect the harbour porpoise over a large area. This applies to both scenarios with two and three sound sources. Furthermore, even NRS in the form of HSD+DBBC as well as IQIP+DBBC, might be insufficient to avoid the significant effects of piling noise on behavioural changes in marine mammals. The behavioural response of the harbour porpoise and seals can occur over an extensive area, regardless of the season.

Table 7.21. Anticipated maximum extent of the noise impact from simultaneous piling during the construction of the Baltica-1 OWF and in adjacent areas, obtained for marine mammals based on numerical modelling. The results presented account for simultaneous piling works for two and three turbines, with mitigation measures in the form of BBC, HSD+DBBC and IQIP+DBBC

Animal species/ group	**Sound source**	**Season**	**Effect**	**Maximum impact area [km^2]**		
				BBC	**HSD + DBBC**	**IQIP+DBBC**
Harbour porpoise	2 sources	Summer	PTS_{cum}	0.06	0.06	0.06
			TTS_{cum}	37.2	0.4	0.6
			Behavioural change	502	328	357
		Winter	PTS_{cum}	0.06	0.06	0.06
			TTS_{cum}	56.7	40.8	29.4
			Behavioural change	2788	1726	1912
	3 sources	Summer	PTS_{cum}	0.09	0.09	0.09
			TTS_{cum}	44.0	0.8	0.9
			Behavioural change	735	492	535
		Winter	PTS_{cum}	0.09	0.09	0.09
			TTS_{cum}	59.5	45.4	36.9
			Behavioural change	3706	2399	2591
Seals	2 sources	Summer	PTS_{cum}	0.06	0.06	0.06
			TTS_{cum}	365	0.1	3.9
			Behavioural change	264	46.2	14.6
		Winter	PTS_{cum}	0.06	0.06	0.06
			TTS_{cum}	679	3.7	15.6
			Behavioural change	566	64.0	22.5
	3 sources	Summer	PTS_{cum}	0.09	0.09	0.09
			TTS_{cum}	482	0.2	2.3
			Behavioural change	396	85.8	32.0
		Winter	PTS_{cum}	0.09	0.09	0.09
			TTS_{cum}	966	35.4	16.5

Animal species/ group	Sound source	Season	Effect	Maximum impact area [km²]		
				BBC	HSD + DBBC	IQIP+DBBC
			Behavioural change	807	126	30.7

The analyses conducted indicate that simultaneous piling at two or more sites may generate significant adverse impacts on marine mammals. This is particularly relevant for the harbour porpoise, which congregates in large numbers in the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308) in summer. The results of noise propagation modelling indicate that even with dual mitigation measures, the extent of noise impact from simultaneous piling works at several locations will cover the Natura 2000 site, potentially resulting in behavioural changes and even hearing damage to the harbour porpoise. The noise-induced escape response may lead to avoidance of a biologically important area by this endangered species. As a result, impacts at the population level may occur. To mitigate the cumulative environmental impacts from underwater noise, in the piling planning the NRS accounted for other piling processes within 50 km from the Baltica-1 OWF.

In addition, calculations for both summer and winter showed that simultaneous piling works in two or more locations might lead to exceedances of noise thresholds related to hearing damage, even if dual mitigation (HSD+DBBC, IQIP+DBBC) is applied. In the winter season scenario, this applies to both the TTS and PTS.

The analysis also demonstrated that a cumulative impact of underwater noise will occur if simultaneous piling works take place within the nearby OWFs (e.g. Bałtyk 1 OWF west of the Baltica-1 OWF).

To mitigate the cumulative environmental impacts from underwater noise, in the piling planning the NRS accounted for other piling processes within 50 km from the Baltica-1 OWF, which would result in the significance of the cumulative noise impact from simultaneous piling at several locations being assessed to be low for marine mammals.

The environmental impact of cumulative noise from piling works may also affect populations of fish with a swim bladder, which is confirmed by numerical modelling results obtained in the Baltica-1 OWF project. The significance of this impact was assessed to be low.

During the operation and decommissioning phases (the designs of all OWFs included in this analysis assume that foundations and cable lines will remain in the seabed), the underwater noise levels will be significantly lower than during the construction phase. Therefore, the cumulative impact will be negligible.

7.4.2 Environmental impact of spatial disturbance on avifauna (barrier effect) and risk of collision

The possibility of cumulative environmental impacts during the construction phase can only occur when simultaneous or closely spaced successive works generating similar impacts are carried out. Assuming that the construction phases of the nearby OWFs will last several years, it is impossible to clearly indicate which activities will be carried out at similar or at the same time. Furthermore, following the principle that each project owner will seek to maximise the capacity and efficiency of their OWF, it should be assumed that they will be built using similar or the same technology. Cumulative environmental impacts may occur for the nearest OWFs due to the analogous nature of the projects and their impacts on birds. The aerial space above the sea areas is used regularly by birds, especially migratory birds. Its disturbance through the creation of a physical barrier will cause the birds to avoid it, both during migration to wintering grounds as well as during spring and autumn migrations. As construction works progress and more offshore wind turbines are erected, the barrier effect will gradually increase, reaching its peak during the operational phase. The cumulative environmental impact of the above-mentioned phenomenon on birds can be minimised at this stage by implementing the OWF gradually i.e. building structures successively, starting from one site, and gradually filling in the development area. This will allow the birds to become gradually accustomed to the new structures.

Calculation of the cumulative risk of collision for the Baltica-1 OWF was performed by extrapolating the values obtained in the collision risk modelling in relation to the power of individual projects expressed in the total value of the indicator or taking into account the values presented in the EIA Reports. For the OWF areas of Bałtyk I, Bałtyk II, Bałtyk III, Baltic Power, Baltica 2, Baltica 3, BC-Wind, 44.E.1, and FEW Baltic II, the anticipated mortality data (for individual species/group) included in environmental documentation were used. For the remaining OWFs, anticipated mortality levels of individual species and species groups were calculated on the basis of the results of collision modelling for the Baltic-1 OWF, taking into account the proportion of installed or planned capacity. The results of the calculations were presented in the EIA documentation for the national proceedings (detailed results can be found in Appendix 5 to the national EIA Report) as a cumulative collision risk with an avoidance rate of 99% for all species and groups except for the crane, for which an avoidance rate of 83% was applied. The maximum cumulative number of collisions during the migration period for all OWF projects in the Baltic Sea calculated through modelling is:

- 29–34 collisions for the long-tailed duck;
- 145–162 collisions for the common scoter;
- 53–59 collisions for the common guillemot;
- 77–79 collisions for the little gull;
- 136–152 collisions for the lesser black-backed gull, as well as
- 330−335 collisions for the common crane.

It should be noted that the spatial extent of these projects is very large, and it is unlikely that the same streams of birds migrating through the Baltic Sea will be the receptor for the environmental impacts of all the farms. Rather, the most likely cumulative environmental impacts relate to several OWFs in the immediate vicinity of the Baltica-1 OWF, such as the Bałtyk I OWF, the Södra Victoria OWF, the Njord OWF, the Oland-Hoburg I OWF and the Baltic Edge OWF. The estimated risk of cumulative collisions would then be several times lower. Nevertheless, even in the worst-case scenario, the significance of the impact still remains negligible and low for most seabirds.

To summarise the analyses, the environmental impacts associated with the cumulative environmental impact of the barrier effect were assessed to be moderate and the environmental impacts associated with collisions were assessed to be moderate at most.

7.4.3 Impact of spatial disturbance on chiropterofauna

In the case of bats, the greatest cumulative threat will not be the barrier effect, but the large number of wind turbines in operation during the operational phase. Bats are good at orienting themselves in space and detecting terrain obstacles through their sense of echolocation but can be adversely affected by barotrauma caused by rapidly rotating rotor blades, around which an overpressure is created that can cause damage to the respiratory system, often leading to the animals' death.

When attempting to assess the cumulative environmental impact of wind farms on chiropterofauna, it is important to note that any increase in the number of offshore turbines in operation will result in an increase in the risk of barotrauma. For this reason, in the context of the planned construction of the Baltica-1 OWF, the Bałtyk I OWF and the Södra Victoria OWF and their cumulative environmental impact on bats, the impact was assessed to be adverse with moderate significance.

During the construction and decommissioning phases of the OWF, the cumulative environmental impact on chiropterofauna will be negligible.

8 CONNECTIONS WITH CLIMATE POLICY

8.1 ESTIMATED EMISSIONS

When analysing the impact of an offshore wind farm, its entire life cycle and its influence on the amount of electricity generated compared to the electricity generated in power plants fired with other types of fuel was taken into account.

With a conservative assumption of the use of 40% capacity and 35 years of operation, the 900-MW OWF could generate 110.38 TWh/397.35 PJ of electricity, thus avoiding the emission of over 40 million Mg CO_2, over 540 thousand Mg SO_2, over 72 thousand Mg of nitrogen oxides and nearly 1.3 million Mg of particulate matter from lignite-fired power plants, assuming the emissions indicated by the European Environment Agency[7].

8.2 POLISH ENERGY MARKET

According to the data from Statistics Poland[8], the production of primary electricity in Poland is still dependent on fossil fuels. The share of individual factions in 2022 was:

- hard coal 50.2%;
- lignite 17.6%;
- other energy carriers (largely renewable) 25.2%;
- natural gas 5.4%;
- crude oil 1.5%.

Moreover, Poland depends on energy imports, which increased to 43% in 2021. The cost of fossil fuels imports in 2022 reached PLN 193 billion, which was associated with a drop in domestic extraction of thermal coal.

Due to geopolitical conditions and fluctuations in demand caused by the COVID-19 pandemic, 2022 was the year of the energy crisis which resulted in an increase in energy prices and policies related to the need to diversify the proportions of individual factions in electricity production.

The specific CO_2 emission of the electricity sector in 2021 amounted to 750 kg CO_2/MWh, putting Poland in penultimate place in the EU. The sector emissions drop between 2005 and 2022 is only 12%[9].

In 2022, the production volume in these facilities amounted to 134.7 TWh, which represented 75.0% of total production. Since 2018, the share of thermal power stations in production has decreased by 7.4%. The efficiency of thermal power stations has remained at a similar level for years and in 2022 it amounted to 42.1%.

Industrial power plants produced 14.0 TWh in 2022, which accounted for 7.8% of total production. In this case, a 3.4% fall in production can be observed compared to 2018, while efficiency in the period 2018–2022 increased by 2.5% to 58.8%. The remaining part of the electricity was produced in independent power plants, mainly wind power stations.

[7] *European Environment Agency (EEA), Air pollution from electricity-generating large combustion plants, EEA Technical report, No 4/2008; available at: https://www.eea.europa.eu/publications/technical_report_2008_4*

[8] Fuel and energy economy in 2021–2022, Statistics Poland, Warsaw, Rzeszów, 2023

[9] “Yearbook – energy data – Energy Forum” – available in Polish: Rocznik – dane o energetyce – Forum Energii (forum-energii.eu)

In Poland, the installed capacity in the NPS[10] amounted to a total of 67.770 MW, divided into:

- power plants – a total of 40 552 MW, including hydroelectric power stations – 2426 MW, and thermal power stations – 38 126 MW;
- wind power stations and other renewable energy sources – 27 217 MW;
- CDGU – 29 524 MW;
- non-CDGU – 38 246 MW.

In 2022, the most important fuel for electricity generation was hard coal (42.6% proportion) and lignite (26.5% proportion). In the period 2018–2022, the total proportion of these energy carriers decreased by 7.7%. Production from renewable energy sources accounted for 20.6% and increased by 7.9% since 2018. The most important carriers in this group were: wind energy (52.5%), solar energy (21.7%) as well as biomass and biogas (total 20.4%).

In recent years, the energy market has been changing due to the increase in the market share of RES, which is characterised by high instability, which affects the operation of installations using conventional sources, and thus forces their flexibility and the need to introduce RES integration. In addition, actions are necessary to reduce the demand for fossil fuels from the Russian Federation and other countries subject to economic sanctions, which, as a result, must accelerate actions to increase Poland's energy security.

Therefore, in the coming years it will be necessary[11], among others, to:

- increase technological diversification and expand capacity based on domestic sources;
- develop further renewable energy sources, including energy from offshore wind farms;
- develop network and energy storage;
- improve energy efficiency;
- implement nuclear energy.

In the above-mentioned elements, RES are an element of the electricity mix diversification. Until 2040, Poland will strive to achieve approximately half of its electricity production from renewable sources.

8.3 Energy policy of Poland and its connections with EU policy

The proposed Project, Baltica-1 OWF, is in line with the assumptions of the 'Energy Policy of Poland until 2040' (hereinafter: EPP2040)[12], providing for the construction of an OWF in the Polish exclusive economic zone (EEZ), with a total capacity of up to 5.9 GW by 2030 and a potential of up to approximately 11 GW in 2040. According to the EPP2040 content, electricity production by offshore wind farms will have the highest proportion in the production of electricity generated from RES. Due to the advantages of the operational characteristics of this technology, the implementation of offshore wind power has been defined as a strategic project of EPP2040.

The provisions of the United Nations Framework Convention on Climate Change, signed in 1992 in Rio de Janeiro, ratified by Poland in 1994, aimed at stabilising greenhouse gas concentrations in the atmosphere at a level that does not cause dangerous changes in the climate system are binding at the global level. A regulatory mechanism of the Convention, the so-called Kyoto Protocol, was adopted in

[10] Summary of quantitative data on the operation of the NPS in 2023, available at: Raporty za rok 2023 – PSE

[11] Assumptions for an update of EPP2040, available at: 2022-03-29_ZałożeniadoaktualizacjiPEP2040.pdf

[12] *https://www.gov.pl/attachment/52f58faa-cb7d-4045-8863-80322fc83dbf*

1997, setting a timeframe for reducing greenhouse gas emissions. The Protocol entered into force in 2005 and was ratified in Poland in 2002. In 2015, the Paris Agreement was developed to limit the global temperature rise below 2°C by the end of the 21st century. The Agreement was adopted in October 2016, also in Poland. The proposed Project consisting in the generation of electricity from a renewable energy source, such as wind, in maritime areas is part of the energy policy of Poland, contributing to the reduction of adverse environmental impact and of greenhouse gas emissions from the power sector. It is consistent with the 2030 framework for climate and energy policy (Climate and Energy Package) of EU, the main objectives of which are:

- reduction of greenhouse gas emissions by 40% relative to the emission level from 1990;
- ensuring at least 32% share of the energy generated by renewable sources (the original target of at least 27% was corrected in 2018);
- improvement of energy efficiency by at least 32.5% (the original target of at least 27% was corrected in 2018).

The proposed Project, through the production of energy from a renewable source and the simultaneous reduction of CO_2 emissions, covers directly two of the three objectives of the European Union in this respect.

The Baltica-1 OWF is also in line with the objective of the EU long-term strategy adopted in November 2018 'Climate neutrality by 2050'[13], i.e. achieving zero level of greenhouse gas emissions by 2050, and with the idea of the European Green Deal[14].

Electricity from wind farms will be the cheapest source of electric power for the European economy according to the experts' estimates. The costs of energy from this source will be cheaper by as much as several dozen per cent than from gas power.

[13] *https://ec.europa.eu/clima/policies/strategies/2050_pl*

[14] *https://commission.europa.eu/system/files/2020-04/political-guidelines-next-commission_en_0.pdf*

9 ENVIRONMENTAL MONITORING

The temporal and spatial scope of monitoring has been developed in such a way that its implementation will enable the detection of the Project's impact on the environmental components monitored and obtaining measurable data that will allow the assessment of the reaction of the affected area environment to this impact. The scope of the proposed environmental monitoring takes into account the differences in the scope of impacts generated by the Project in its individual phases of implementation.

The monitoring will be conducted within the Baltica-1 OWF Area. The following subsections present a proposal for the scope of environmental monitoring. The detailed methodology (including the plan and method of conducting the surveys) will be developed in consultation with the relevant authority. As part of this process, areas, procedures and periods of monitoring will be specified.

The scope of environmental monitoring for individual components of the environment was adopted on the basis of:

- environmental impact assessment, i.e. potentially significant impacts on environmental components caused by the implementation of the Project;
- experience from similar projects, including the expected outcome of the Project;
- implementation of mitigation measures.

The implemented monitoring will be selected so as to record the transboundary impacts on the environment of the Swedish waters and the impact on bird migrations. Due to the location of the Project area near the boundary of the EEZ, there will be transboundary impacts on this area, the most serious of which is the impact of underwater noise. According to the modelling results, the propagation of noise causing a behavioural response may cover an area over 25 km from the boundary of the Baltica-1 OWF Area, so it will also be noticeable in Swedish waters, including in the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308). The transboundary impact will also affect birds migrating in spring and autumn, passing over a large part of the Southern Baltic.

9.1 CONSTRUCTION PHASE

9.1.1 Seawater and seabed sediment monitoring

Monitoring during the construction phase may be required following random events such as accidents and ship collisions, in order to assess potential changes in water quality in the environment at the construction site. The scope and method of monitoring in the event of random incidents will be decided in the plan for combating risk and pollution for the offshore wind farm and the complex of facilities, agreed in accordance with the Maritime Safety Act by the Director of the Maritime Office.

9.1.2 Underwater noise monitoring

Hydrophone measurements should take place in the frequency range from 10 Hz to 20 kHz. Moreover, Skjellerup *et al.* (2015) recommend:

- the use of calibrated omnidirectional hydrophones with a sensitivity deviation of less than ±2 dB up to 40 kHz in the horizontal plane and less than ±3 dB up to 40 kHz in the vertical plane and the registration of the calibration signal;
- recording in the .wav format with a sampling frequency of 44.1 Hz and a 16-bit resolution;

- determination of SEL for each pile driver strike (SEL_{ss});
- conducting monitoring at two different depths, at 66 and 33% of the water depth (but always more than 2 m below the sea surface).

It is proposed to conduct the underwater noise monitoring comprised of four monitoring components:

a) a mobile survey station located at a distance of 11 km from the piling location in the main direction of underwater noise propagation. At the measurement location, the maximum underwater noise level, i.e. 140 dB re 1 μPa^2s SEL_{cum} HF-weighted (HF-weighting function for marine mammals with high sensitivity to high-frequency sounds – porpoise) and 170 dB re 1 μPa^2s SEL_{cum} PW-weighted (PW-weighting function for pinniped marine mammals – seals) should not be exceeded. When these levels of underwater noise are exceeded, it should be immediately reported to the appropriate regional director for environmental protection, no later than within 7 days of the event occurrence;
b) a mobile survey station located as close as possible to the EEZ boundary. At the measurement location, the maximum underwater noise level of 140 dB re 1 μPa^2s SEL_{ss} HF-weighted (HF-weighting function for marine mammals with high sensitivity to high-frequency sounds – porpoise) for a single strike of a pile driver should not be exceeded. When this level of underwater noise is exceeded, it should be immediately reported to the appropriate regional director for environmental protection, no later than within 7 days of the event occurrence;
c) a mobile survey station located as close as possible to the boundary of the Natura 2000 site *Hoburgs bank och Midsjöbankarn*a (SE0330308) during the period from June to August. At the measurement location, the maximum cumulative level of underwater noise of 140 dB re 1 μPa^2s SEL_{cum} HF-weighted (HF-weighting function for marine mammals with high sensitivity to high-frequency sounds – porpoise) should not be exceeded. When this level of underwater noise is exceeded, it should be immediately reported to the appropriate regional director for environmental protection, no later than within 7 days of the event occurrence;
d) at least 3 fixed survey stations for underwater noise measurements, at which the measurements shall be carried out continuously from a minimum of 2 weeks before the beginning of the first piling until a minimum of 2 weeks after the completion of the last piling. The measurements taken at these fixed stations are aimed at assessing the actual extent of the impact of underwater noise on the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308) at the level of behavioural impact on the porpoise (103 dB re 1 μPa^2s $SPL_{rms\ 125\ ms}$). The location of the stations shall be established at the stage of preparing the monitoring methodology and presented to the relevant authority.
e) at least 1 fixed survey station for underwater noise measurements, at which the measurements shall be carried out continuously from a minimum of 2 weeks before the beginning of the first piling until a minimum of 2 weeks after the completion of the last piling. The measurements taken at this fixed station are aimed at assessing the actual range of underwater noise impact. The location of the station shall be established at the stage of preparing the monitoring methodology and presented to the relevant authority.

It is planned to prepare a methodology for underwater noise monitoring along with a description of NRS technical solutions and to submit it to the competent authority at least 2 months before the piling commences.

9.1.3 Ichthyofauna monitoring

No monitoring of ichthyofauna during the construction period is planned.

9.1.4 Migratory birds monitoring

No monitoring of migratory birds during the construction period is planned.

9.1.5 Monitoring of seabirds

No monitoring is planned to be conducted during construction works.

However, a pre-investment monitoring of the Baltica-1 OWF regarding seabird surveys is planned and it should include the daytime counting of birds present in the OWF Area and in a reference area. The surveys should be conducted in a monthly cycle for one year before the beginning of the OWF construction. The dates of survey cruises should be synchronised so that counting in both sea areas is performed simultaneously or at an interval of no more than 3 days. The transects of a survey cruise should be delineated so as to cover the 5-kilometre zone around the OWF boundaries and to enable the assessment of changes in the density of birds staying at different distances from the future wind turbines.

The detailed methodology of the pre-investment monitoring will be possible to be developed after the final design of the Project has been approved and the schedule of the construction works has been presented by the Project Owner.

9.1.6 Monitoring of marine mammals

Due to the confirmed occurrence of porpoises in the area of the proposed OWF and adjacent waters, as well as the potential significant impact on the species during the Project construction phase, it is recommended to continue the monitoring of the animals in the Project area through passive acoustic monitoring, using C-PODs/F-PODs. In the area of the proposed OWF, at least 5 C-PODs/F-PODs should be placed, preferably in the same locations as during the environmental monitoring. Additionally, 6 C-PODs/F-PODs should be installed in a gradient system covering an area of not less than 20 km outside the boundary of the Baltica-1 OWF Area.

The monitoring should begin no later than 6 months before the construction commencement, during the construction and at least one year after its completion.

9.1.7 Monitoring of benthic organisms

No monitoring of macrozoobenthos during the construction period is planned.

9.1.8 Monitoring of bats

No monitoring of bats during the construction phase is planned.

9.2 Operation phase

9.2.1 Seawater and seabed sediment monitoring

During operation, the monitoring of seawater should be carried out in parallel with the monitoring planned for macrozoobenthos surveys. This monitoring will provide data that will be compared with the data from the pre-investment surveys to confirm the conclusions of the surveys indicated at the stage of preparing the national EIA Report.

It is assumed that environmental monitoring will be carried out 1 year, and 5 years after the laying of the wind turbine foundations.

9.2.2 Underwater noise monitoring

The monitoring of the ambient noise level during the operation phase is necessary to confirm the predictions contained in the environmental impact assessment.

The data from the measurements conducted at a minimum of 10% of wind turbines should be collected at random. The sound measurement should be carried out at a distance of approximately 100 m from the source of sound and the central area of the OWF.

Additionally, the measurements should be conducted outside the OWF Area at a distance of 1000 m and within the nearest protected area, providing that this area is located at a distance not exceeding 5 km from the OWF Area. If there is no protected area in the vicinity, sound measurements should be conducted at a distance of 5 km from the OWF Area.

During the first year of the OWF operation phase, the measurements should be carried out at each survey station at least once for each wind speed class corresponding to 2, 4, and 6 degrees on the Beaufort scale and in each season (spring, summer, autumn and winter).

9.2.3 Ichthyofauna monitoring

As part of the monitoring of ichthyofauna during the operation phase, the long-term artificial reef effect on the abundance and taxonomic composition of fish, including the presence of early developmental stages of fish such as larvae and fry, and the potential colonisation by invasive species will be assessed.

In addition, it will be examined, whether the artificial reef effect is limited to attracting fish from a nearby sea area to this area or whether a real increase in productivity is found.

The surveys should be conducted in the spring and summer periods, one year and 5 years after the beginning of the operation phase.

9.2.4 Migratory birds monitoring

The environmental monitoring will include radar monitoring as well as visual observations during the daytime. The radar surveys should be focused on the trajectory of birds flying towards the OWF and their response to a barrier in the form of the OWF, as well as on the determination of the intensity of migration in the OWF Area, to enable a comparative analysis with other available surveys in this regard and to provide new data to analyse the barrier effect and the avoidance frequency (birds turning back). The radar surveys should be carried out during the migration period, in the months from March to May and from the end of July to mid-November.

It is proposed that the monitoring of migratory birds is conducted in two cycles per year, resulting from the two bird migration periods, i.e. from March to May and from July to November, in four monitoring blocks:

- 2 cycles of surveys in the first year after obtaining the permit for use, i.e. one during the spring migration period and the other one during the autumn migration period;

- 2 cycles of surveys in the fourth year after obtaining the permit for use, i.e. one during the spring migration period and the other one during the autumn migration period;

9.2.5 Monitoring of seabirds

The monitoring for the purpose of seabird surveys should include the counting of birds present in the OWF Area and in the reference area during the daytime.

The survey cruise route should be the same or very similar to that in the pre-investment monitoring (before the construction begins). The surveys should be conducted at least once each month. The dates of survey cruises should be synchronised so that counting in both sea areas is performed simultaneously or at an interval of no more than 3 days.

The surveys should be conducted for 2 consecutive years (the first 2 years of the OWF operation phase) if the construction will not be staged. Otherwise, these surveys should be performed after the completion of the first phase of the construction stage, i.e. after obtaining the permit for use and after completing the construction of the entire farm within the OWF Area, each time for 2 years.

The detailed methodology of the post-investment monitoring will be possible to be developed after the final shape of the proposed Project has been approved and the schedule of the construction works has been presented by the Project Owner.

9.2.6 Monitoring of marine mammals

The porpoise monitoring during the operation phase should be conducted for 24 months from the moment of operation phase commencement using the same methods and survey stations that were used during the construction phase to determine if the farm operation influences porpoises to avoid its area.

9.2.7 Monitoring of benthic organisms

Due to the occurrence of adverse impacts on the benthic communities, the monitoring of these organisms should be carried out, since the OWF construction will influence the local changes in the seabed biocenosis structure. During the construction phase, the primary impact will be the disturbance of the seabed sediment structure and physical destruction of invertebrates, while during the operation phase, it will be the loss of a fragment of benthic fauna habitat and the artificial reef effect the significance of which in the PSA is unclear at present. Therefore, the purpose of the proposed monitoring is the determination of the scale, spatial and temporal extent of the aforementioned indicators, all the more because no OWF is operational yet within the PSA and the actual intensity of the impacts caused by such project in this part of the Baltic Sea is not supported by the knowledge gained during the post-implementation monitoring. Due to the lack of standard, commonly used guidelines for the implementation of this type of survey in the PSA, an original monitoring methodology was proposed, based primarily on the life cycle of benthic organisms in the Southern Baltic. The developed benthic monitoring proposal was also based on the available literature on the subject [Coates *et al.*, 2011; Degraer *et al.*, 2012; Standard, 2013]. The macrozoobenthos surveys should be carried out in accordance with standard methodologies [HELCOM, 2021] and the periphytic flora and fauna surveys, following the methodology of Kruk-Dowgiałło *et al.* [2010].

It is assumed initially that the monitoring will be carried out within the scope agreed with the competent authority in the first, third and fifth year after the laying of the wind turbine foundations.

9.2.8 Monitoring of bats

Monitoring as part of the post-implementation surveys should include the surveys of bats' activity – determining the species composition and abundance. The equipment used should enable automatic registration and meet the minimum equipment requirements applied in the pre-investment surveys.

Post-implementation monitoring should cover the period of 3 years, in the first year after the wind farm has been put into operation and in the second and third years of the OWF operation. The monitoring should cover the spring (April–May) and autumn (August–October) migration periods.

Due to the lack of technological solutions enabling the performance of reliable surveys of bat mortality and collisions, the above requirement, imposed by the proposed guidelines, should be abandoned [Kerchof *et al.*, 2010; Kepel *et al.*, 2013].

9.3 Decommissioning phase

At the end of the OWF decommissioning phase, the degree of changes that will occur after the destruction of the artificial reef, potentially constituting a habitat, feeding ground, shelter and breeding ground for many fish species, will be assessed.

The surveys should be conducted in the spring and summer periods during the first year after the completion of the removal of the OWF components. A set of research tools in the form of multi-mesh gillnets and, in the case of early developmental stages, a Bongo net for sampling ichthyoplankton should be used. Survey stations both in the Baltica-1 OWF Area should be established in the same number as during the surveys for the purposes of national EIA Report preparation.

9.4 Monitoring programme justification

The necessity to conduct the monitoring arises from Article 66 of the EIA Act. The monitoring proposal includes references to the individual impacts of the proposed Project in its construction and operation phases, in particular the impact on the forms of nature protection referred to in Article 6(1) of the Act of 16 April 2004 *on nature conservation* (Journal of Laws of 2023, item 1336), including the impact on the objects and subjects of protection of Natura 2000 sites and the continuity of wildlife corridors connecting them, as well as the information on other available monitoring results which may be relevant for the determination of responsibilities in this respect.

The monitoring programme was selected based on experience resulting from the preparation of this type of project, available literature, industry methodologies and experience from the implementation of offshore wind farms in other locations.

10 GAPS IN KNOWLEDGE AND UNCERTAINTIES

The greatest difficulty which appeared while preparing the national EIA Report, and thus this Espoo Report, was the wide range of technologies and devices possible to be applied during the implementation of the Project. This significantly widened the scope of the environmental impact analyses conducted. At this stage of the Project, the Project Owner has not selected the ultimate wind turbines and OSSs nor, as a consequence, their exact number. Dynamically developing wind turbine construction technologies aimed at maximising the rated capacity of units and the most effective use of wind in electricity generation allow the assumption that units with a capacity of 14 to 25 MW will be available at the stage of device contracting. Therefore, the limit values are determined by the derived uses of units with a capacity of 14 to 25 MW, i.e. their number, sizes, methods of installation on the seabed, the number of OSSs and the maximum length of cable lines buried in the seabed. Another significant difficulty in assessing the impact was the lack of information on the location of individual structures within the farm (the so-called layout). In this case, it is also caused by the inability to indicate at this stage the target wind turbines, as well as the lack of the results of detailed geotechnical tests, which, due to high costs, will be performed only after obtaining the DEC. A properly conducted environmental impact assessment should be based on the assumption of the worst environmental conditions. Thus, the national EIA Report adopted the concept of envelope conditions, i.e. the environmental impact assessment included those of the technological solutions and parameters of the Project considered that may cause the greatest environmental impact on a given environmental component (e.g. gravity-based structures occupying the largest seabed surface, monopiles, the piling of which into the seabed causes the highest levels of underwater noise, the possibility of locating structures within the entire area covered by the permit for the construction and use of artificial islands). Thanks to such an approach, the environmental impact analysis always assesses the ultimate scope of the Project, regardless of the technical parameters and technologies selected. For this reason, it can be assumed that the environmental impact assessment is reliable because it takes into account possible changes that will be introduced at subsequent stages of the Project and does not omit any option for the Project implementation resulting from these changes.

A major difficulty in an environmental impact assessment is the lack of sufficient information about the environment within the impact range of a given project. This is a common problem that arises before EIA reports are prepared and is a challenge even when there is a lot of data on resources and the state of the environment because the data is often outdated and incomplete. Therefore, comprehensive environmental surveys were carried out for the benefit of the Baltica-1 OWF, the aim of which was to obtain full knowledge of the environment within the Project development area, but also within the range of its greatest impact. The results of these surveys, supplemented with literature data, allowed for a thorough analysis of the impact of the Baltica-1 OWF implementation on the environment.

11 CONCLUSIONS

The resulting environmental impact assessment of the Project involving the construction of the Baltica-1 OWF indicated the possibility of transboundary environmental impacts. The report discusses these impacts in relation to the current status as well as the measures minimising the impacts.

The scope of the conducted environmental impact assessment accounted for the requirements of Polish legislation, as well as the expectations of the Affected Parties expressed in their responses to the notifications in accordance with Article 3 of the Espoo Convention.

The hitherto consultation process is described in Section 2 of the report. This section presents methods of taking into account in the assessment the positions of the Affected Parties.

11.1 TRANSBOUNDARY ENVIRONMENTAL IMPACTS: SWEDEN

The Swedish party presented its position in a letter dated 11.10.2023, at the same time providing the positions of state entities interested in a transboundary environmental impact assessment.

The table below [Table 11.1] summarises the issues raised by the Swedish party along with the information on how they were taken into consideration in the environmental impact assessment process and the Espoo Report.

It should be emphasised here that a comprehensive description of individual components of the environment based on the surveys conducted and literature data, as well as a complete assessment of the impact on all environmental components, was carried out at the stage of national environmental impact assessment and discussed in detail in the national EIA Report for the Baltica-1 OWF. In this document, pursuant to the provisions of the Espoo Convention, the focus was on the impacts for which the possibility of transboundary environmental impacts was identified, and these impacts were discussed. However, all issues raised in the position were taken into account and analysed.

Table 11.1. A summary of the issues raised by Sweden, including information on how they were taken into account in the environmental impact assessment process and the Espoo Report.

Issue	Method of taking into account in the environmental impact assessment
Analysis of the impact on abiotic components in the marine environment in the form of water turbidity, increased amount of nutrients, distribution of possible toxins from the seabed sediments and intensification of vessel traffic.	The impact on the quality of seawaters and seabed sediments is discussed in Section 7.2.1 of the Espoo Report. The analysis regarded the possible contamination of water or seabed sediments with petroleum products released in the event of an accident and with suspended solids generated during underwater works. The potential transboundary environmental impact occurrence related to the spills of petroleum products was identified. Due to the sporadic nature of this type of situation, as well as the implementation of a plan to counteract this type of hazard, the significance of this impact was assessed to be low. The transboundary environmental impact of suspended solids generated during underwater works was identified, however, its significance was assessed as negligible based on modelling. Other aspects were analysed as part of the Polish environmental impact assessment. The assessment has proven the absence of significant transboundary impact.

Issue	Method of taking into account in the environmental impact assessment
Sediments resedimentation analysis	The impact on the quality of seawaters and seabed sediments is discussed in Section 7.2.1 of the Espoo Report. The transboundary environmental impact of suspended solids generated during underwater works was identified, however, its significance was assessed as negligible based on modelling. The resedimentation of the sediments is not expected during the operation phase – vibrations caused by the rotor operation transmitted via the supporting structure to the seabed will be weak, and any disturbance of the sediment in the zone directly adjacent to the structure will be levelled by the erosion protection layer constructed around each foundation.
Impact on the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308) and its subjects of protection.	The issue is discussed in Section 7.3.6 of the Espoo Report. The possibility of a transboundary environmental impact on protected areas and connections between protected areas during the construction phase of the Baltica-1 OWF, related to noise emissions during foundation piling, was identified. This impact will be significantly reduced by implementing a number of measures that together form a comprehensive Noise Reduction System.
Impact on wind, waves and sea currents.	The issue was analysed as part of the Polish environmental impact assessment, which indicated no significant transboundary environmental impact. No impact on sea currents, waves, or wind is expected. The farm objects will be spaced at least 3.5 RD apart, which will allow the free flow of water masses.
Adverse impact on the hydromorphology of the coast.	The issue of changes in the wave motion in the coastal zone due to the construction of offshore wind farms is unlikely due to their distance from the land. There is also no evidence to state that such an impact may occur. Therefore, no possible transboundary environmental impact is expected.
Changes in the mixing of the near-surface layer of the sea which affects the biological production near the water surface.	The wind farm construction will not disturb the mixing of water in the column. Due to the large distances between the objects, i.e. 3.5 RD in the least, the free flow of water between the underwater objects and the free flow of wind above the water surface, which induce the mixing of waters, will be maintained.
A need to take into account cumulative impacts. The need to take into account the cumulation of impacts from mining, navigation, energy and fishing activities.	All possible cumulative impacts were analysed in detail in the Polish environmental impact assessment, including mining activities. Section 7.4 of the Espoo Report presents an analysis of cumulative impacts which may result in transboundary impact. Cumulative impacts may regard noise in particular and can be avoided or reduced by applying appropriate mitigation measures described in this report (Sections 3.5.2.1 and 3.10), therefore this impact was assessed as negligible. Potential cumulative impacts may also be related to spatial disturbance and will concern avifauna and chiropterofauna, however, this impact will not be significant. No cumulation of environmental impacts with the impacts resulting from navigation, energy (other than described in Section 7.4) and fishing activities is anticipated.

Issue	Method of taking into account in the environmental impact assessment
Performance of bird surveys from aboard both a vessel and a plane, as well as telemetry surveys with GPS transmitters and radar surveys.	Synthetic description of the surveys conducted is presented in Sections 3.2.2 (Survey methodology) and 7.3 (Survey results). A detailed description of the surveys is provided in Appendix 1 to the state EIA Report for the Project. The bird surveys included both visual observations, as well as horizontal and vertical radar tracking and acoustic monitoring. The surveys conducted covered all phenological periods. This allowed for the collection of a wide range of data enabling the assessment of the usage of the sea area and its vicinity by birds.
Assessment of impact on birds, including feeding grounds.	The assessment of the environmental impact on birds regarding transboundary context is presented in Sections 7.3.3 and 7.3.3 of the Espoo Report. Transboundary environmental impacts on birds will be related to a disruption of space – the barrier effect and collision risk. To minimize these impacts, a number of mitigation measures have been planned (section 3.10), related to e.g. limiting light emissions and a system for switching off the turbines in the event of the common crane passage. It was assessed that with the mitigation measures applied, the transboundary environmental impact on birds will not be significant.
The use of mitigating measures – lighting reducing the effect of attracting birds, painting the rotor blades, the function of immediate shutdown of the turbines in the event of a high risk of collision (large concentrations of birds).	The Project Owner provided for an application of the above-mentioned mitigating measures to minimise the farm's impact on birds. The mitigation measures are described in Section 3.10 hereof.
Impacts on the harbour porpoise, in particular the impact of noise. Taking into account the worst possible scenario.	The environmental impact on mammals including the harbour porpoise is presented in Section 7.3.6 of the Espoo Report. To assess the noise impact on mammals, including the harbour porpoise, mathematical modelling of noise propagation was carried out, taking into account also the worst-case scenario. The modelling results are attached to this report. The modelling and the assessment conducted showed that transboundary environmental impacts on mammals may occur, but with the use of a set of mitigation measures, together forming a comprehensive Noise Reduction System, they will not be significant.
Impact on fish including the spawning of cod	The environmental impact on fish is presented in Section 7.3.1 of the Espoo Report. To assess the noise impact on fish, including cod, mathematical modelling of noise propagation was carried out, taking into account also the worst-case scenario. The modelling results are attached to this report. The modelling and the assessment conducted showed that transboundary environmental impacts on fish may occur, but with the use of a set of mitigation measures, together forming a comprehensive Noise Reduction System, they will not be significant.

Issue	Method of taking into account in the environmental impact assessment
	Since the farm area is not an area significant for cod spawning, it is not expected that the project may have a significant impact on this aspect.
Application of mitigation measures minimising the impact on ambient noise.	The Project Owner provided for an application of the mitigating measures ensuring the minimisation of the impact of noise on marine organisms. These were included in the impact modelling. For this purpose, it is planned to implement a comprehensive Noise Reduction System, which involves the selection of appropriate actions, depending on a number of factors, in such a way as to ensure the required reduction of impacts related to underwater noise propagation.
Impacts related to seismic surveys	No environmental impact.
Taking into account maritime traffic conditions and the impact on shipping routes.	The issue was analysed as part of the Polish environmental impact assessment. The assessment has proven the absence of significant transboundary environmental impact. This is because the location of the farm may require only a slight correction of shipping routes, the significance of which on the scale of the entire sea area is negligible.
Impact on fishery	The issue was analysed as part of the Polish environmental impact assessment. The assessment has proven the absence of significant transboundary environmental impact. This is due to the fact that the activity of the fishing fleet in the Project area is low, and the potential extension of the routes to fishing grounds will be negligible on the scale of the entire sea area.
Impact on migratory bats.	The impact on bats is presented in Section 7.3.4 of the Espoo Report. Potential environmental impacts will be related to collisions with operating turbines and the occurrence of barotrauma. In order to limit these impacts, a number of minimising measures have been planned (Section 3.10), related to, among others, limiting the emission of light attracting bats. It was assessed that with the application of mitigation measures transboundary environmental impact on bats will not be significant.
Detailed seabed surveys regarding bathymetry, seabed types (erosive, accumulative, etc.), substrates, the content of chemical compounds in the sediment, current direction and velocity.	The surveys indicated were conducted as part of the surveys of environmental conditions. They are discussed in detail in the Report on Environmental Surveys constituting Appendix 1 do the national EIA Report.

11.2 Transboundary environmental impacts: Denmark

The Danish party presented its position in the letters from:

- Offshore Wind Energy Division of the Danish Energy Agency dated 03.10.2023;
- Species and Nature Department of the Danish Environmental Protection Agency dated 06.10.2023.

The table below [Table 11.2] summarises the issues raised by the Danish party along with the information on how they were taken into consideration in the environmental impact assessment process and the Espoo Report.

It should be emphasised here that a comprehensive description of individual components of the environment based on the surveys conducted and literature data, as well as a complete assessment of the impact on all environmental components, was carried out at the stage of national environmental impact assessment and discussed in detail in the national EIA Report for the Baltica-1 OWF. In this document, pursuant to the provisions of the Espoo Convention, the focus was on the impacts for which the possibility of transboundary environmental impacts was identified, and these impacts were discussed. However, all issues raised in the position were taken into account and analysed.

Table 11.2. A summary of the issues raised by Denmark, including information on how they were taken into account in the environmental impact assessment process and the Espoo Report.

Position	**Method of taking into account in the environmental impact assessment**
Assessment of cumulative impacts on: • migratory birds, • seabirds, • marine mammals, • migratory bats, • fish, • noise, • Natura 2000 network coherence.	Impacts on the indicated environmental components, along with cumulative environmental impacts, were analysed in detail in the Polish environmental impact assessment. The Espoo Report discusses the impacts on environmental components in the case of which transboundary impacts may occur: seabirds (Section 7.3.3), marine mammals (Section 7.3.6), bats (Section 7.3.4), fish (Section 7.3.1), noise (Sections 7.3.1 – 7.3.6), and the coherence of the Natura 2000 network (Section 7.3.6). Cumulative environmental impacts are discussed in Section 7.4. The assessment carried out did not exclude the possibility of cumulative environmental impact related to noise (impact on fish and marine mammals) and spatial disturbance (impact on birds and bats). Transboundary environmental impacts on fish and mammals with the application of a set of mitigation measures, together creating a comprehensive Noise Reduction System, will not be significant. To limit these impacts, a number of minimising measures have been planned (Section 3.10), related, among others, to limiting light emission and introducing a turbine shutdown system. It was assessed that with the application of mitigation measures, transboundary environmental impact on birds will not be significant.
Impact on the harbour porpoise population.	The environmental impact on mammals including the harbour porpoise is presented in Section 7.3.6 of the Espoo Report. To assess the noise impact on mammals, including the harbour porpoise, mathematical modelling of noise propagation was carried out, taking into account also the worst-case scenario. The modelling results are attached to this report. The modelling and the assessment conducted showed that transboundary environmental impacts on mammals may occur, but with the use of a set of mitigation measures, together forming a comprehensive Noise Reduction System, they will not be significant.

Position	Method of taking into account in the environmental impact assessment
Impact on birds.	The assessment of the environmental impact on birds in a transboundary context is presented in Section 7.3.3 of the Espoo Report. The transboundary environmental impacts on birds will be related to the spatial disturbance – barrier effect and risk of collision. In order to limit these impacts, a number of minimising measures have been planned (Section 3.10), related, among others, to limiting light emissions and introducing a turbine shutdown system. It was assessed that with the application of mitigation measures, transboundary environmental impact on birds will not be significant.

11.3 Transboundary environmental impacts: Finland

The Finnish party presented its position in a letter dated 04.12.2023, at the same time providing the positions of state entities interested in the transboundary environmental impact assessment.

The table below [Table 11.3] summarises the issues raised by the Finnish party along with the information on how they were taken into consideration in the environmental impact assessment process and the Espoo Report.

It should be emphasised here that a comprehensive description of individual components of the environment based on the surveys conducted and literature data, as well as a complete assessment of the impact on all environmental components, was carried out at the stage of national environmental impact assessment and discussed in detail in the national EIA Report for the Baltica-1 OWF. In this document, pursuant to the provisions of the Espoo Convention, the focus was on the impacts for which the possibility of transboundary impacts was identified, and these impacts were discussed. However, all issues raised in the position were considered and analysed.

Table 11.3. A summary of the issues raised by Finland , including information on how they were taken into account in the environmental impact assessment process and the Espoo Report.

Position	Method of taking into account in the environmental impact assessment
Performance of the assessment of cumulative impacts.	Cumulative environmental impacts are discussed in Section 7.4 of the Espoo Report. The assessment carried out did not exclude the possibility of cumulative environmental impact related to noise (impact on fish and marine mammals) and spatial disturbance (impact on birds and bats). Transboundary environmental impacts on fish and mammals with the application of a set of mitigation measures, together creating a comprehensive Noise Reduction System, will not be significant. To limit these impacts, a number of minimising measures have been planned (Section 3.10), related, among others, to limiting light emission and introducing a turbine shutdown system. It was assessed that with the application of mitigation measures

Position	Method of taking into account in the environmental impact assessment
	transboundary environmental impact on birds will not be significant.
Investigation and assessment of possible ways of mitigating adverse impacts and possible methods of compensation for impacts occurring within the Baltic Sea.	Methods of mitigating adverse impacts were discussed in detail in the national EIA Report, while in this Espoo Report (Section 3.5.2 and 3.10), these are mentioned in the case of environmental impacts for which the assessment showed a transboundary range. The most important mitigation measures include the Noise Reduction System, reduction of light emissions, and a system of turbine shutdowns in the event of the common crane passage. The environmental impact assessment of the Project conducted by Poland, which takes into account the application of measures to minimise potential impacts on the assessed receptors, clearly indicated the lack of significant adverse impacts of the Baltica-1 OWF. Hence, no need to introduce compensatory measures was identified.
A need to monitor migratory birds, identify areas where the birds rest and feed during migration, and identify species that are the most sensitive to impacts from wind energy. Using radar for this purpose.	The migratory bird surveys were carried out as part of the environmental surveys conducted. The surveys were conducted using both visual observations and radar surveys. A summary of the survey methodology and results is presented in this document (Sections 3.2 and 7.3), and their detailed description is included in Appendix 1 to the national EIA Report.
Identification and assessment of the types of marine habitats and benthic fauna present in the area in which the cables will be laid together with the assessment of the Project impact and its significance.	The marine habitats and benthic fauna surveys were carried out as part of the environmental surveys conducted. The detailed methodology and results are included in the Survey Report and summarised in the national EIA Report together with the results of the environmental impact assessment. Potential dredged material generated in the construction phase of the Baltica-1 OWF during the dredging and levelling of the seabed, will be managed, in accordance with the conditions of the permit issued by the territorially competent director of the maritime office, within the construction area or in another part of the sea area indicated in the permit. Obtaining a permit for the disposal of dredged material into the sea will be the subject of a separate environmental impact assessment procedure in accordance with applicable Polish regulations.
Impact on bats and marine mammals.	The environmental impact on bats is presented in Section 7.3.4 while on marine mammals in Section 7.3.6 of the Espoo Report. Potential environmental impacts will be related to collisions with operating turbines and the occurrence of barotrauma. To limit these impacts, a number of minimising measures have been planned (Section 3.10), concerning, among others, limiting the emission of light attracting bats. It was assessed that with the application of mitigation measures transboundary environmental impact on birds will not be significant. The surveys on the harbour porpoises conducted to assess the environmental impact of the Baltica-1 OWF were carried out in an area that constitutes a potential zone of impact on the behavioural level of these mammals.

Position	Method of taking into account in the environmental impact assessment
	To assess the impact on mammals, including the harbour porpoise and seal species, mathematical modelling of noise propagation was carried out. The modelling results are attached to this report. The modelling and the assessment conducted showed that transboundary environmental impacts on mammals may occur, but with the use of a set of mitigation measures, together forming a comprehensive Noise Reduction System, they will not be significant.
Impact on spawning grounds and the habitats of fish caught in commercial fishing. Impact on the fishery.	The environmental impact on ichthyofauna is discussed in Section 7.3.1 of the Espoo Report. To assess the noise impact on fish, mathematical modelling of noise propagation was carried out. The modelling results are attached to this report. The modelling and the assessment conducted showed that transboundary environmental impacts on fish may occur, but with the use of a set of mitigation measures, together forming a comprehensive Noise Reduction System, they will not be significant. The impact on fishery is analysed in detail in the national EIA Report. Since the assessment has proven the absence of significant transboundary impact on the fishery, it is not included in the Espoo Report. The results of ichthyofauna surveys conducted in the area of Baltica-1 OWF indicate that this area is not important for fish in the context of their feeding, spawning, and migration routes. Also, the analysis of fishing activity to date indicates that the area of the Project is not important in terms of fish harvest. Hence, the implementation of the Project will not significantly affect fisheries.
Cumulative impacts.	All possible cumulative environmental impacts were analysed in detail in the Polish environmental impact assessment. Section 7.4 of the Espoo Report presents an analysis of cumulative environmental impacts which may result in transboundary environmental impact. The assessment carried out did not exclude the possibility of cumulative environmental impact related to noise (impact on fish and marine mammals) and spatial disturbance (impact on birds and bats). Transboundary environmental impacts on fish and mammals with the application of a set of mitigation measures, together creating a comprehensive Noise Reduction System, will not be significant. To limit these impacts, a number of minimising measures have been planned (Section 3.10), concerning, among others, limiting light emission and introducing a turbine shutdown system. It was assessed that with the application of mitigation measures transboundary environmental impact on birds will not be significant.

Position	Method of taking into account in the environmental impact assessment
Analysis of the importance of the area as a spawning ground for commercially fished species if the planned ichthyoplankton surveys prove insufficient for this purpose.	The ichthyoplankton surveys were carried out as part of the environmental surveys conducted. The detailed methodology and results are included in the Survey Report and summarised in the national EIA Report together with the results of the environmental impact assessment, as well as in Section 7.3.1 of the Espoo Report. The environmental impact assessment demonstrated that the Baltica-1 OWF Area is not important in terms of spawning grounds for commercially caught fish species.
Taking into account the fishing activities of other EU countries.	The fishing activities of other UE countries were taken into account in the assessment of the impact on fisheries as part of the Polish environmental impact assessment. Since the assessment has proven the absence of significant transboundary impact on the fishery, it is not included in the Espoo Report. The lack of significant environmental impact results from the fact that the activity of the fishing fleet in the region of the Project is low, and the potential extension of routes to fishing grounds will be negligible on the scale of the entire sea area.
Due to the location of the Project near the Słupsk Furrow channel connecting the Bornholm Basin in the Baltic Sea with the East Gotland Basin, which brings salty and oxygen-rich water north of the Atlantic along the seabed, the impact on the sea current flow field should be analysed due to the changes in the impact of wind, and to a lesser extent the presence of foundation structures.	The Baltica-1 OWF Area is located over a dozen kilometres northeast of the Słupsk Furrow. There is no likelihood that the construction of the farm structure could in any way contribute to the deterioration of the propagation of inflow waters through the Słupsk Furrow towards the Gotland Deep and the Gdańsk Deep.
Impact on birds and their migration.	The environmental assessment of the impact on birds regarding transboundary context is presented in Sections 7.3.3 and 7.3.3 of the Espoo Report. The transboundary environmental impacts on birds will be related to the spatial disturbance – barrier effect and risk of collision. To limit these impacts, a number of minimising measures have been planned (Section 3.10), concerning, among others, limiting light emissions and introducing a turbine shutdown system in the case of a passage of the common crane. It was assessed that with the application of mitigation measures transboundary environmental impact on birds will not be significant.
Environmental impact on seals.	Environmental impact on mammals including the seal is presented in Section 7.3.5 of the Espoo Report. To assess the environmental impact on mammals, including seals, mathematical modelling of noise propagation was carried out. The modelling results are attached to this report. The modelling and the assessment conducted showed that transboundary environmental impacts on mammals may occur, but with the use of a set of mitigation measures, together forming a comprehensive Noise Reduction System, they will not be significant.

Position	Method of taking into account in the environmental impact assessment
Conducting an overall national review of offshore wind energy, which should form a part of the international review.	The letter draws attention to the need to introduce a pan-Baltic mechanism to control the impact of offshore wind energy development on the environment which goes beyond the scope of an environmental impact assessment for a specific project. It is informative and does not constitute a reason for its inclusion in the environmental impact assessment. However, the cumulative environmental impact assessment includes other OWFs whose impact may be cumulative with the impact of the Baltica-1 OWF.

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