REPORT ON THE ENVIRONMENTAL IMPACT ASSESSMENT OF THE BALTICA-1 OFFSHORE WIND FARM

Applicant	**Elektrownia Wiatrowa Baltica-1 sp. z o.o.**
Contractor	**Maritime Institute of the Gdynia Maritime University**
	MEWO S.A.
Subcontractors	**National Marine Fisheries Research Institute**
	DHI Polska Sp. z o.o.
	Marea sp. z o.o.
	ODJT

DECLARATION

In order to meet the requirement referred to in Article 66(1)(19a) in connection with Article 74a(3) of the Act of 3 October 2008 on the provision of information on the environment and environmental protection, public participation in environmental protection and on environmental impact assessments (Journal of Laws of 2023, item 1094, as amended), I declare that I meet the requirements referred to in Article 74a(2) of the above-mentioned Act of 3 October 2008 on the provision of information on the environment and its protection, public participation in environmental protection and environmental impact assessments (Journal of Laws of 2008, no. 199, item 1227, as amended) and I am aware of criminal liability for making a false declaration.

Head of the Team

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ABBREVIATIONS AND DEFINITIONS

µPa	micropascal – a unit of pressure
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
Applicant / Project Owner	Elektrownia Wiatrowa Baltica-1 sp. z o.o.
APV	Applicant Proposed Variant
Baltica-1 OWF	Baltica-1 Offshore Wind Farm
BBC/DBBC	Big Bubble Curtain / Double Big Bubble Curtain – technology designed to reduce the propagation of sound underwater
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
Bq	Becquerel, the SI unit of radioactivity
CBDG	Central Geological Database
chiropterofauna	bats
CI	offshore wind farm connection infrastructure
CIEP	Chief Inspectorate of Environmental Protection
CO_2	carbon dioxide
construction phase	synonym used in the document for the expression ‘implementation phase’, as used in Article 66(1)(16) of the EIA Act, referring to the construction period of the project
C-POD/F-POD	Continuous Porpoise Detector
dB	decibel – a logarithmic measure of sound intensity (pressure)
DBT	dibutyltin
DEC	Decision on Environmental Conditions within the meaning of the Act of 3 October 2008 on the provision of information on the environment and environmental protection, public participation in environmental protection and on environmental impact assessments (consolidated text: Journal of Laws of 2023, item 1094, as amended).

diving benthivorous birds	species of water birds feeding on benthic organisms for which they dive to the bottom of water bodies
DPD	detection positive day
DPM	detection positive minute
EEZ	Exclusive Economic Zone within the meaning of the Act of 21 March 1991 on the maritime areas of the Republic of Poland and maritime administration (consolidated text: Journal of Laws of 2023, item 960).
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
EIA Act	Act of 3 October 2008 on the provision of information on the environment and environmental protection, public participation in environmental protection and on environmental impact assessments (consolidated text: Journal of Laws of 2023, item 1094, as amended)
EIA Report	Environmental Impact Assessment Report within the meaning of the Act of 3 October 2008 on the provision of information on the environment and environmental protection, public participation in environmental protection and on environmental impact assessments (consolidated text: Journal of Laws of 2023, item 1094, as amended)
EMF	electromagnetic field
epifauna/periphytic fauna	group of invertebrates inhabiting the surface layer of seabed sediment
epiflora/periphytic flora	group of plant organisms inhabiting the surface layer of seabed sediment
EU	European Union
euphotic zone	surface water layer, the lower limit of which is determined by the depth at which photosynthetic active radiation is degraded down to 1% of its surface strength
EUROBATS	Agreement on the Conservation of Populations of European Bats
GBS	gravity-based structure
GDEP	General Directorate for Environmental Protection
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)
heavy metals	group of metals characterised by high density and often toxicity (arsenic, chromium, zinc, copper, cadmium, lead, mercury, nickel)

HELCOM	Helsinki Commission – Baltic Marine Environment Protection Commission
HFC	hydrofluorocarbons
HF-cetaceans	group of cetaceans (including the harbour porpoise) using high-frequency echolocation clicks for communication (division of hearing groups based on NMFS 2018)
HF-weighted SEL	sound exposure level with a high frequency weighting function, according to susceptibility to noise-induced hearing damage in cetaceans (based on NMFS 2018)
HSD	Hydro Sound Damper
IALA	International Association of Lighthouse Authorities
ICES	International Council for the Exploration of the Sea
IMWM-NRI	Institute of Meteorology and Water Management – National Research Institute
ind.	individual/individuals
IQIP-NMS	noise mitigation system by IQIP, also referred to as IHC-NMS
kVa	kilovolt-ampere
LOI	organic matter content in a sample, marked as loss on ignition
macrozoobenthos	a complex of invertebrate organisms living on the surface of seabed sediments (epifauna) or inside the sediment, which are retained on a 1 mm mesh sieve during sediment sieving
MARPOL 73/78	International Convention for the Prevention of Pollution from Ships, adopted in London on 2 November 1973, together with Annexes I, II, III, IV, and V, as well as the 1978 Protocol relating thereto, together with Annex I adopted in London on 17 February 1978
MASL	metres above sea level
MBSB	metres below seabed level
MBT	monobutyltin
MI GMU	Maritime Institute of the Gdynia Maritime University
MSFD	Marine Strategy Framework Directive (Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy, OJ L 164, as amended)
MSPPSA	Maritime Spatial Plan of Polish Sea Areas

MW	megawatt - unit of power in the International System of Units (SI)
MZPM	Monitoring of Wintering Seabirds conducted as part of the State Environmental Monitoring
NM	nautical mile
NM	nautical mile
NMFS	National Marine Fisheries Service – US federal agency responsible for the management of national marine resources, which has published criteria for assessing the impact of noise on marine mammals, including the weighting of the frequency of sounds received
NOAA	National Oceanic and Atmospheric Administration
NPS	National Power System
NPZDR	National Fisheries Data Collection Programme (abbreviation from Polish: *Narodowy Program Zbioru Danych Rybackich*)
NRS	noise reduction system
NT	Near-Threatened species, according to the IUCN Red List categories (close to but not yet classified as VU category)
nutrients/biogenic substances	essential chemical elements (biogenic substances) found in every living organism, including carbon, hydrogen, nitrogen, oxygen, phosphorus and sulphur
OSPAR	Convention for the protection of the marine environment of the North-East Atlantic of 22 September 1992 (OJ L 1998, no. 104 , p. 2)
OSS	offshore substation
OWF	offshore wind farm
PAHs	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
phytobenthos	aquatic plants including vascular plants rooted in the seabed (e.g. seagrass), as well as macroalgae, which attach themselves to hard surfaces (cobbles, wrecks, structures) or lie freely on the seabed
Piscivorous birds	species of birds feeding on fish
POP	persistent organic pollutants
ppm	parts per million
Project	Baltica-1 Offshore Wind Farm

PSA	Polish Sea Areas within the meaning of the Act of 21 March 1991 on the marine areas of the Republic of Poland and maritime administration (consolidated text: Journal of Laws of 2023, item 960).
PSE	PSE S.A.
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
PTS (1h cum.)	permanent shift in the hearing threshold due to the accumulated noise from 1 hour of piling
PTS (single strike)	permanent threshold shift in marine organisms as a result of a single blow of a pile driver
PW	hearing group of phocid pinnipeds (e.g. the grey seal and the harbour seal) (division of hearing groups based on NMFS 2018)
RAV	Reasonable Alternative Variant
RD	rotor diameter
RES	renewable energy sources
resuspension	repeated disturbance and redistribution of sediment particles previously deposited on the seabed, caused by e.g. wave motion, drilling, net dragging, etc.; it can be an internal source of water enrichment with nutrients (biogenic material) accumulated in the sediment
ROV	remotely operated vehicle
RP	Republic of Poland (Polish: *Rzeczpospolita Polska*)
SAMBAH	Static Acoustic Monitoring of the Baltic Sea Harbour Porpoise - an international research project
SAR	Maritime Search and Rescue Service
SDF	Standard Data Form for the Natura 2000 sites
sea ducks	ducks of the Mergini tribe
SEL	Sound Exposure Level
SEL_{cum}	Sound Exposure Level cumulative − the level of sound exposure accumulated over a period of one hour, e.g. from multiple blows of a pile driver

SPEC	Species of European Conservation Concern – the rank of special concern, considering the category of threat and the species occurrence in Europe and in the world, assigned to bird species by BirdLife International
SPEC 2	a higher concern category (species the global populations of which are concentrated in Europe and have unfavourable conservation status in Europe)
SPEC 3	a higher concern category (species the global populations of which are not concentrated in Europe but whose conservation status in Europe is unfavourable)
SPL	Sound Pressure Level
spudcan	support element of a mobile-drilling jack-up platform, circular or polygonal in horizontal section, with a convex base and a diameter of a dozen to several dozen metres, providing a stable foundation for the unit on the seabed during installation work
TBT	tributyltin – organotin compound
Territorial sea	Maritime area with a width of 12 nautical miles (22 224 m) measured from the baseline of the sea
TOC	total organic carbon
TTS	Temporary Threshold Shift
TTS (1h cum.)	temporary threshold shift as a result of a cumulative noise dose during one hour of piling
TTS (single strike)	temporary threshold shift as a result of a single pile driver strike
VHF-cetaceans	group of cetaceans (including the harbour porpoise) using very high-frequency signals for communication (division of hearing groups based on Southall *et al.* 2019)
VHF-weighted SPL	sound exposure level with a very high frequency weighting function, according to susceptibility to noise-induced hearing damage in cetaceans (based on Southall *et al.* 2019)
VMS	Vessel Monitoring System
VU	vulnerable species, according to the IUCN Red List categories (i.e. species that may become extinct relatively soon but not as soon as those from the 'endangered' category)
WFD	Water Framework Directive (Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, OJ L 327, as amended)

1 INTRODUCTION

1.1 INTRODUCTION

This document constitutes the Environmental Impact Assessment Report for the Baltica-1 Offshore Wind Farm (hereinafter referred to as: Baltica-1 OWF, or the Project).

The Project Owner applying for the determination of the conditions for the implementation of the project in question is Elektrownia Wiatrowa Baltica-1 sp. z o.o. with its registered office in Warsaw, at Mokotowska 49, 00-542 Warsaw, entered in the register of entrepreneurs under the National Court Register (KRS) number 0000396848, Statistical Identification Number (REGON): 143242637, Tax Identification Number (NIP): 5272664716. The owner of Elektrownia Wiatrowa Baltica-1 sp. z o.o. is PGE Polska Grupa Energetyczna S.A.

The Baltica-1 OWF with the maximum total capacity of 900 MW is located in the maritime areas of the Republic of Poland, covering the area of 85.53 km^2, at a distance of approx. 75 km from the seashore [Figure 1.1].

The proposed Project involves the construction, operation and possible decommissioning of the Baltica-1 OWF, which will comprise up to 60 wind turbines, up to 140 km of inter-array cable lines and up to 4 offshore substations (hereafter: OSSs).

The electricity produced by the Baltica-1 OWF will be exported from the offshore area to the land by means of connection infrastructure, which constitutes a project entitled the Baltica-1 OWF Connection Infrastructure (hereafter: Baltica-1 OWF CI), which is covered by a separate application for a decision on environmental conditions.

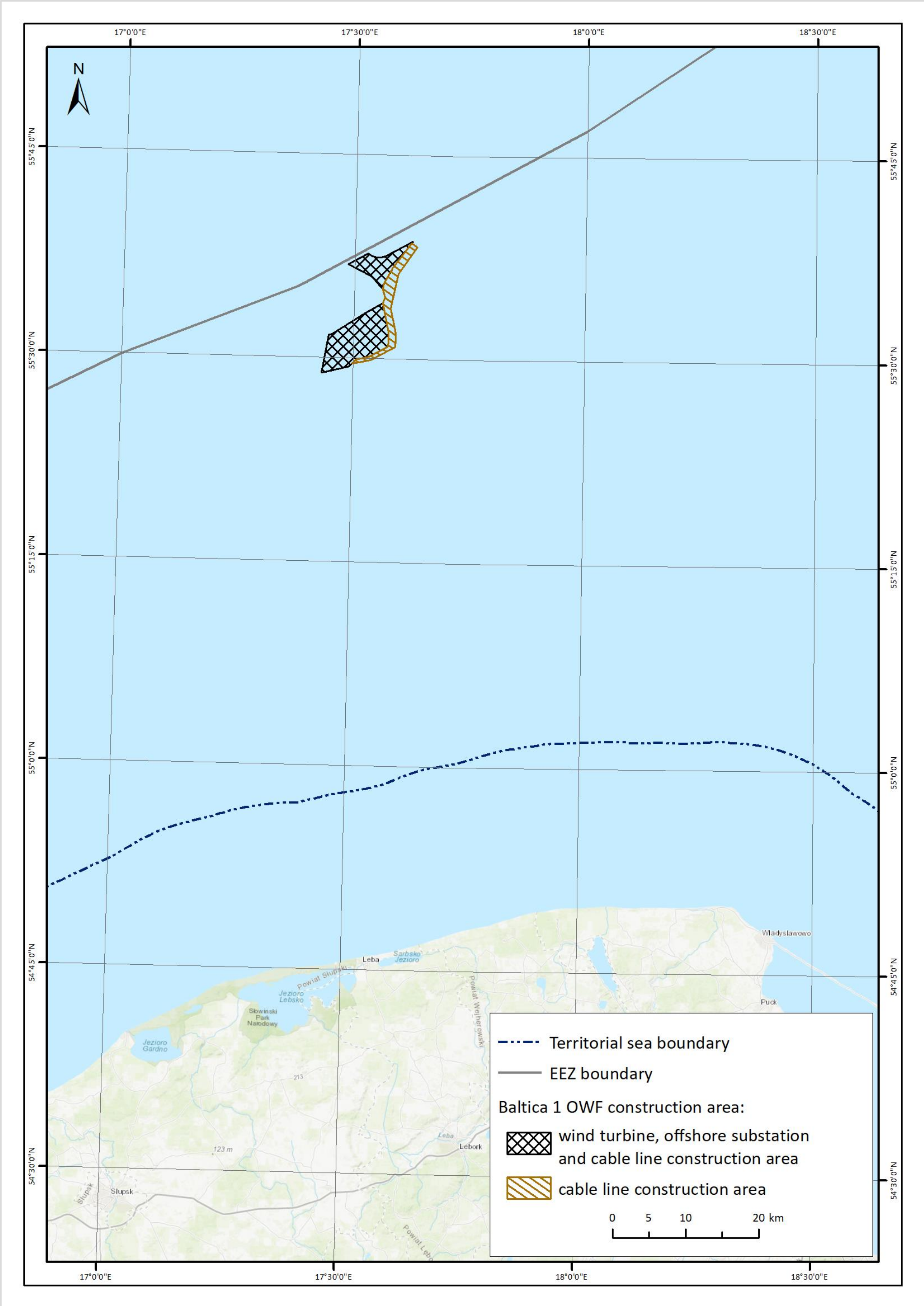

Figure 1.1. Location of the proposed Project, the Baltica-1 OWF.

Table 1.1 summarises the basic parameters of the Project in the Applicant Proposed Variant (hereinafter referred to as the APV).

Table 1.1. Basic parameters of the Baltica-1 OWF in the Applicant Proposed Variant

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
Number of wind turbines if 15 MW units are used	pcs.	60
Number of wind turbines if 25 MW units are used	pcs.	36
Minimum distance between wind turbines*	-	RD 3.5
Maximum distance between wind turbines*	-	RD 12
Minimum number of offshore substations	pcs.	1
Maximum number of offshore substations	pcs.	4
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

**RD – rotor diameter*

The purpose of the Project is to generate electricity using a renewable energy source – wind.

This Environmental Impact Assessment Report comprises an appendix to the application for a decision on environmental conditions (hereinafter: DEC) pursuant to the Act of 3 October 2008 *on the provision of information on the environment and environmental protection, public participation in environmental protection and on environmental impact assessments* (consolidated text: Journal of Laws of 2023, item 1094, as amended). According to Article 75(1)(1)(c), the Regional Director for Environmental Protection is the authority competent to issue the decision on environmental conditions for the projects executed in maritime areas. Taking into account the location of the Baltica-1 OWF, the competent authority for the purpose of processing the Application and issuing the DEC is the Regional Director for Environmental Protection in Gdańsk.

The Project area is covered by the Maritime Spatial Plan of Polish Sea Areas, at a scale of 1:200 000, adopted by the Regulation of the Council of Ministers of 14 April 2021 *on the adoption of the Maritime Spatial Plan for internal sea waters, territorial sea and the exclusive economic zone, at a scale of 1:200 000* (Journal of Laws of 2021, item 935, as amended) (hereinafter: MSPPSA). The Baltica-1 OWF construction area is located in the sea basin 60.E, for which the basic function is 'renewable energy generation'.

1.2 Aim and Scope of the Report

The Environmental Impact Assessment Report was prepared for the purpose of the assessment of the proposed project impact on individual environmental elements, aimed at obtaining the decision on environmental conditions.

The objective of the report is to specify:

- characteristics and scale of the project;
- possible variants of the project;
- the existing and planned use and development of the sea basins;

- environmental conditions, resources and values of abiotic, natural, cultural and landscape environments;
- other conditions resulting, among other, from specific regulations, e.g. concerning the prevention of breakdowns or structural collapses;
- nature, extent and significance of the anticipated environmental, spatial and social impacts related to the construction and operation of the Baltica-1 OWF;
- the possibility of avoiding, preventing, limiting and possibly compensating for adverse project impacts or threats identified, including potential emergency situations;
- need to formulate recommendations to be applied at the Project design and preparation stages, as well as during the construction, operation and decommissioning;
- need to protect people, people's health and living conditions from negative impacts of the Project;
- proposals for environmental monitoring conducted in all phases of the Project.

The subject of the Report is the analysis of the impact of the proposed Baltica-1 OWF on the environment, the comparison of the proposed project variants in terms of environmental protection and the indication of the variant most favourable for the environment.

The scope of this Report results from the provisions of Article 66 of the Act of 3 October 2008 *on the provision of information on the environment and environmental protection, public participation in environmental protection and on environmental impact assessments* (consolidated text: Journal of Laws of 2023, item 1094, as amended) (hereinafter: EIA Act) and it contains information enabling the analysis of the criteria listed in Article 62 of the EIA Act [Table 1.2]. Table 1.3 includes a reference to the requirements for the scope of the EIA Report resulting from the decision of the Regional Director for Environmental Protection in Gdańsk, dated 15.02.2024 (ref. no.: RDOŚ-Gd-WOO.420.59.2023.AM.13.)

Table 1.2. Compliance of the report content with the provisions of Article 62(1) and Article 66 of the Act of 3 October 2008 on the provision of information on the environment and environmental protection, public participation in environmental protection and on environmental impact assessment (consolidated text: Journal of Laws of 2023, item 1094, as amended). [Source: internal materials based on the EIA Act]

Provision of the EIA Act	Section of the Report
Article 62(1)	
Identification, analysis and assessment of direct and indirect environmental impact of the Project	Section 10
Identification, analysis and assessment of the direct and indirect impacts of the Project on the population, including people's health and living conditions	Section 10
Identification, analysis and assessment of the direct and indirect impacts of the Project on tangible property	Section 10
Identification, analysis and assessment of the direct and indirect impacts of the Project on historical monuments	Section 10
Identification, analysis and assessment of the direct and indirect impacts of the Project on landscape including cultural landscape	Section 10
Identification, analysis and assessment of the direct and indirect impacts of the Project on the interactions between the elements referred to above	Section 10
Identification, analysis and assessment of the direct and indirect impacts of the Project on accessibility of mineral deposits	Section 10
Identification, analysis and assessment of the risk of major failures as well as natural disasters and structural collapses	Section 6

Provision of the EIA Act	Section of the Report
Identification, analysis and assessment of possibilities and methods of preventing and reducing the negative impact of the Project on the environment	Section 15
Identification, analysis and assessment of the scope of the monitoring required	Section 16
Article 66(1)	
Description of the proposed Project, including:	
description of the entire project and conditions for the land use during implementation and operation or use phases, also in relation to the flood risk areas within the meaning of Article 16(34) of the Act of 20 July 2017 – the Water Law	Section 3
main characteristics of production processes	Section 3
anticipated types and quantities of emissions, including waste, resulting from the implementation and operation or use phases of the proposed Project	Section 5
information on biodiversity, the use of natural resources, including the use of soil, water and earth surface	Section 7
information on energy demand and its consumption	Section 4
information on demolition works concerning projects likely to have a significant impact on the environment	Section 18
risk assessed on the basis of scientific knowledge regarding major breakdowns, natural disasters and structural collapses, taking into account the substances and technologies used, including the risk related to climate change	Section 6
Description of natural elements of the environment covered by the scope of the anticipated impact of the proposed Project on the environment, including:	Section 7
Description of environmental elements under protection pursuant to the Act of 16 April 2004 on nature protection and ecological corridors within the meaning of this Act,	Section 7
hydromorphological, physico-chemical, biological and chemical properties of waters	Section 7
Results of environmental inventory surveys, understood as a set of field surveys carried out in order to characterise elements of the natural environment, if such surveys were carried out, along with a description of the methodology applied	Appendix 1 to the EIA Report
Description of heritage monuments protected under the regulations concerning monument protection and care for monuments, located within the impact range of the proposed Project and its immediate vicinity	Section 7
Description of the landscape within which the Project is to be located	Section 7
Information on relations to other projects, in particular on the accumulation of impacts of the implemented, completed or planned projects, for which a decision on environmental conditions has been issued, located in the area where the Project is to be implemented and in the area of the project impact or the impacts of which fall within the area of the proposed Project – to the extent to which their impacts may lead to the accumulation of impacts with the proposed Project	Section 10
Description of the environmental impacts predicted in the case the Project is not implemented, taking into account the available environmental information and scientific knowledge	Section 15
Description of variants taking into account the specific characteristics of the Project or its impact, including:	
Applicant Proposed Variant and Reasonable Alternative Variant	Section 2
Reasonable, most environmentally beneficial variant, along with the justification of the choice	Section 2 and Section 13
Determination of the environmental impacts predicted for the variants analysed, including the case of a major industrial accident or a natural or construction disaster, as well as impacts on the climate, including greenhouse gas emissions and impacts important in terms of adaptation to climatic changes, and possible transboundary environmental impacts	Section 10 and Section 6
Comparison of the impacts of the variants considered on:	

Provision of the EIA Act	Section of the Report
people, plants, animals, fungi and natural habitats, water and air	Section 10
ground surface, including mass movements of the earth, and landscape	Section 10
tangible property	Section 10
historical monuments and cultural landscape, covered by the existing documentation, in particular a register or inventory of monuments	Section 10
forms of nature protection, referred to in Article 6(1) of the Nature Conservation Act of 16 April 2004, including the objectives and the subject of protection in the Natura 2000 sites as well as the continuity of the ecological corridors connecting them	Section 10
elements listed in Article 68(2)(2)(b), if included in the environmental impact assessment report or if required by the competent authority	Section 10
interactions between elements mentioned in items a–f above	Section 10
Justification of the Applicant Proposed Variant, taking into account the information referred to in Article 66(1)(6) and 66(1)(6)(a) of the EIA Act	Section 13
Description of forecasting methods applied by the Applicant and the description of the expected significant impacts of the proposed Project on the environment including direct, indirect, secondary, cumulated, short-term, medium-term and long-term environmental impacts, resulting from:	
the existence of the Project	Section 10
the use of environmental resources	Section 10
emissions	Section 10
Description of the actions planned with an aim to avoid, prevent, mitigate or environmentally compensate for the adverse impacts on the environment, in particular on the forms of nature conservation referred to in Article 6(1) of the Act of 16 April 2004 on nature conservation, including the impact on the objects and subjects of protection of Natura 2000 sites, and on the continuity of wildlife corridors connecting them, along with assessing their effectiveness during the implementation, operation and decommissioning of the Project, respectively	Section 15
If the proposed Project is related to the use of the installations, a comparison of the proposed technology with the technology meeting the requirements referred to in Article 143 of the Act of 27 April 2001 - Environmental Protection Law	Section 14
The reference to the environmental objectives resulting from strategic documents relevant to the implementation of the Project	Section 1.6, Section 10.6 and Section 10.7
Justification for meeting the conditions referred to in Article 68(1), (3) and (4) of the Act of 20 July 2017 – Water Law, if the Project affects the possibility of achieving the environmental objectives referred to in Article 56, Article 57, Article 59 and Article 61(1) of that Act	Section 10.4
The indication whether it is necessary, for the proposed Project, to establish a limited use area, referred to in the Act of 27 April 2001 - Environmental Protection Law, and to define the boundaries of such an area, the restrictions on the use of land, the technical requirements for buildings and ways of their employment; this does not apply to undertakings consisting in the construction or reconstruction of a road and projects consisting in the construction or reconstruction of a railway line or public use airport	Section 17
Graphical presentation of the issues	Entire document with appendices
Presentation of the issues in the cartographic form in the scale corresponding to the subject and the detailed scope of issues analysed in the Report, also enabling a comprehensive presentation of the analyses conducted regarding the environmental impact of the Project	Entire document with appendices
The analysis of possible social conflicts related to the proposed Project	Section 17
Presentation of proposals for monitoring the impact of the proposed Project in the phase of its implementation and operation or use, in particular on the forms of nature protection referred to in Article 6(1) of the Act of 16 April 2004 on nature conservation, including the impact on the objectives and the subject of protection of the Natura 2000	Section 16

Provision of the EIA Act	Section of the Report
site, and the continuity of wildlife corridors connecting them, as well as the information on other monitoring results available which may be relevant for the determination of responsibilities in this respect.	
Indication of difficulties resulting from technical shortcomings or gaps in current knowledge encountered during the preparation of the Report	Section 20
Non-technical summary of the information contained in the report, for each element of the report	Section 21
Signature of the author, and in the case when the report is written by the team of authors - the head of the team, including the name and surname as well as the date of the report	Before the list of Abbreviations and definitions
Declaration of the author, and if the author of the report is a team of authors - the head of the team, on meeting the requirements referred to in Article 74a section 2 of the EIA Act	Before the list of Abbreviations and definitions
Sources of information providing the basis for the report	Section 22

Table 1.3. Compliance of the content of the report with the provisions of the decision of the Regional Director for Environmental Protection in Gdańsk, dated 15.02.2024 (ref. no.: RDOŚ-Gd-WOO.420.59.2023.AM.13.) [Source: internal materials based on the decision of the RDEP in Gdańsk]

Provision of the Gdańsk RDEP decision	Section of the Report
determine the minimum spacing between individual elements of the OWF and indicate the elements of individual turbines together with the associated infrastructure	Section 1.1
determine the technical parameters of the turbines and the OSS	Section 3.1.1, Section 3.2.2.1, Section 3.2.2.3
determine the technical parameters of foundations in the foundation technologies considered for individual OWF elements, in order to specify the seabed development area	Section 3.2.2.2
determine the length and width of the seabed area used for the construction of offshore power cable lines	Section 3.2.2.4
determine the scope and schedule of works related to the OWF construction, together with the impact of the works on individual environmental components	Section 4.2.2, Section 10.2, Section 10.3
determine the method of transportation of construction materials and wind farm structural elements together with the environmental impact, including the impact in the event of breakdown or accident at sea	Section 3.2.2.1, Section 3.2.2.4, Section 3.2.2.5, Section 4.2.3, Section 10.2, Section 10.3, Section 10.5
Make reference to requirements arising from:	
• Directive 2008/59/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive)	Section 10.6
• Convention of 9 April 1992 on the Protection of the Marine Environment of the Baltic Sea Area (the Helsinki Convention) and the recommendations made on its basis;	Section 10.7
The following types of alternative variants requiring environmental impact assessment (including transboundary impacts) have been identified:	
• the use of different technical parameters of the wind turbines, taking into account the tower height, the rotor diameter and the power of the generators installed	Section 10.2, Section 10.3, Section 11, Section 12
• different quantities of the turbines planned	Section 10.2, Section 10.3
• application of different technical parameters of foundations in the considered technologies of providing foundations for OWF structures	Section 10.2, Section 10.3
Types of impacts and environmental components to be analysed in detail:	

Provision of the Gdańsk RDEP decision	Section of the Report
1. Impact of the Project and technologies applied for its implementation on the species and habitats present within the Project area, with a particular focus on:	
• Impact on avifauna and on the maintenance of bird migration corridors, particularly with reference to the subjects of protection of the N2000 site *Ławica Słupska* (PLC990001) (e.g. the long-tailed duck)	Section 10.2.1.9.5, Section 10.2.1.9.6, Section 10.2.2.9.5, Section 10.2.2.9.6, Section 10.2.3.9.5, Section10.2.3.9.6, Section 10.3.1.9.5, Section 10.3.1.9.6, Section 10.3.2.9.5, Section 10.3.2.9.6, Section 10.3.3.9.5, Section 10.3.3.9.6, Section 10.2.1.10, Section 10.2.2.10, Section 10.2.3.10, Section 10.3.1.10, Section 10.3.2.10, Section 10.3.3.10
• Impact on the population of marine mammals, particularly on the harbour porpoise	Section 10.2.1.9.4, Section 10.2.2.9.4, Section 10.2.3.9.4, Section 10.3.1.9.4, Section 10.3.2.9.4, Section 10.3.3.9.4
• Impact on the subjects of protection of the N2000 site *Ławica Słupska* (PLC990001)	Section 10.2.1.10, Section 10.2.2.10, Section 10.2.3.10, Section 10.3.1.10, Section 10.3.2.10, Section 10.3.3.10, Section11
• Measures anticipated to minimise the above mentioned impact, resulting from the impact assessment carried out	Section 15
2. Cumulative impacts on the environment, including in particular on animal species (fish, mammals (including bats), birds) and on natural habitats, as well as on fish spawning grounds and impacts on Natura 2000 sites and the coherence of the network, resulting from the implementation of the proposed Project, in the context of other planned, ongoing and existing projects in the vicinity of the Baltica-1 OWF (including aggregate extraction activities within the Southern Middle Bank and other offshore wind farms, such as Bałtyk I OWF, Kriegers Flak, Kriegers Flak II Nord, Kriegers Flak II Syd and Energy Island Bornholm, Njord, Öland-Hoburg I, Baltic Central wind farm, Baltic Offshore Beta, Cirrus, Neptunus, Södra Victoria, Bornholm Bassin Øst and Baltic Edge). Planned mitigation measures to be presented, with indication of their effectiveness.	Section 11, Section 15
3. Impact of the Project on bird populations, taking into account the likelihood of collisions with structures and vessels, as well as changes in the space use by individual species. Significance of this impact in relation to the conservation of individual populations and the relevance for the coherence of the Natura 2000 network – to be specified.	Section 10.2.1.9.5, Section 10.2.1.9.6, Section 10.2.2.9.5, Section 10.2.2.9.6, Section 10.2.3.9.5, Section10.2.3.9.6, Section 10.3.1.9.5, Section 10.3.1.9.6, Section 10.3.2.9.5, Section 10.3.2.9.6, Section 10.3.3.9.5, Section 10.3.3.9.6, Section 10.2.1.10, Section 10.2.2.10, Section 10.2.3.10, Section 10.3.1.10, Section 10.3.2.10, Section 10.3.3.10
4. Impact of the Project on bats, in particular on migration routes, including potential mortality due to barotrauma.	Section 10.2.1.9.7, Section 10.2.2.9.7, Section 10.2.3.9.7, Section 10.3.1.9.7, Section 10.3.2.9.7, Section 10.3.3.9.7
5. Impact of the Project on the populations of marine mammals, accounting for the impact of underwater noise generated at the stage of Project implementation, as well as the impact of the Project on the migration	Section 10.2.1.9.4, Section 10.2.2.9.4, Section 10.2.3.9.4, Section 10.3.1.9.4, Section

Provision of the Gdańsk RDEP decision	Section of the Report
routes of individual species and their possibility to use the space. Significance of this impact in relation to the conservation of population in Europe and the relevance for the coherence of the Natura 2000 network – to be specified.	10.3.2.9.4, Section 10.3.3.9.4, Section 10.2.1.10, Section 10.2.2.10, Section 10.2.3.10, Section 10.3.1.10, Section 10.3.2.10, Section 10.3.3.10
6. Impact of the Project on the resources and recruitment of fish important for fishing (commercial species)	Section 10.2.1.9.3, Section 10.2.2.9.3, Section 10.2.3.9.3, Section 10.3.1.9.3, Section 10.3.2.9.3, Section 10.3.3.9.3, Section 10.2.1.13.1, Section 10.2.2.13.1, Section 10.2.3.13.1, Section 10.3.1.13, Section 10.3.2.13, Section 10.3.3.13
7. Impact of the Project, including the impact of subsea cables and the electromagnetic field they emit, on spawning areas and fish migration routes, including on legally protected fish species, benthic species, as well as species constituting the food supply for marine mammals (in particular the harbour porpoise and the grey seal).	Section 10.2.1.9.3, Section 10.2.2.9.3, Section 10.2.3.9.3, Section 10.3.1.9.3, Section 10.3.2.9.3, Section 10.3.3.9.3, Section 10.2.1.9.2, Section 10.2.2.9.2, Section 10.2.3.9.2, Section 10.3.1.9.2, Section 10.3.2.9.2, Section 10.3.3.9.2
8. Impact of the Project (increased vessel traffic during construction and operation will generate underwater noise as well as increased risk of collision) on marine mammals, particularly the direct impact on their health and on the change of their behaviour with respect to each life stage (feeding, breeding, migration, wintering).	Section 10.2.1.9.4, Section 10.2.2.9.4, Section 10.2.3.9.4, Section 10.3.1.9.4, Section 10.3.2.9.4, Section 10.3.3.9.4
9. Impact of the Project on the natural habitats 1110 (sandbanks which are slightly covered by sea water all the time), 1170 (reefs) within Natura 2000 sites: *Hoburgs bank och Midsjöbankarna* (SE0330308) and *Ławica Słupska* (PLC990001) associated with changes in the direction of sea currents, wave directions and energy, and changes in sedimentary processes.	Section 10.2.1.10, Section 10.2.2.10, Section 10.2.3.10, Section 10.3.1.10, Section 10.3.2.10, Section 10.3.3.10
10. Analysis of the Project impact on shipping routes; associated risks and mitigation measures – to be identified.	Section 7, Section 10.2.1.13.2, Section 10.2.2.13.2, Section 10.2.3.13.2, Section 10.3.1.13, Section 10.3.2.13, Section 10.3.3.13, Section 15
11. Risks of accidents and collisions associated with increased vessel traffic in the area of the Project (construction, operation, decommissioning phases), as well as the risks of oil spills – to be assessed. Risk mitigation measures – to be identified. In addition, considering the significant distance from the ports with vessels of the Maritime Search and Rescue Service capable of handling environmentally hazardous spills, it should be indicated whether the Project Owner anticipates its own additional resources and forces within the OWF to mitigate potential spills and provide immediate response.	Section 6, Section 15
12. Project impact on other uses of the maritime space, including in particular on fishing. Possible restrictions to fishing activities in the Project area and in its vicinity – to be indicated.	Section 10.2.1.13, Section 10.2.2.13, Section 10.2.3.13, Section 10.3.1.13, Section 10.3.2.13, Section 10.3.3.13
13. Analysis of dismantling works in the decommissioning phase.	Section 10.2.3, Section 10.3.3
14. Transboundary impacts, in particular the impact of the Project on the Natura 2000 sites located within the Project impact range, including on the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308) – to be identified and discussed in the impact analysis.	Section 12

1.3 PROJECT CLASSIFICATION

In order to classify the Project, each element of the Baltica-1 OWF infrastructure was verified in terms of compliance with the criteria set out in 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).

The planned total capacity of the Baltica-1 OWF will be 900 MW. Pursuant to § 2(1)(5)(b) of the above-mentioned regulation, '*plants using wind energy for electricity generation, located in maritime areas of the Republic of Poland*' are classified as projects that are always likely to have a significant impact on the environment.

The possibility of installing a helipad on the OSS platform is assumed. According to § 3(1)(61) of the aforementioned regulation, '*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.

The proposed Project is a public purpose project because according to Article 6(4)(a) of the Act of 21 August 1997 *on real estate management* (consolidated text: Journal of Laws of 2023, item 344), a public purpose is '*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 evacuation within the meaning of this Act'*.

Substations and power cable lines located in the offshore area are not included in the above-mentioned regulation as projects likely to have a significant impact on the environment, hence they are not included in the classification analysis.

1.4 TERMS FOR THE PREPARATION AND SCOPE OF THE REPORT

The basis for the preparation of this report was:

- Applicant's documentation:
    - Permit of the Minister of Transport, Construction and the Maritime Economy for the construction and use of artificial islands, structures and devices in the Polish Sea Areas for the Project entitled 'Zespół morskich farm wiatrowych o maksymalnej łącznej mocy 900 MW oraz infrastruktura techniczna, pomiarowo-badawcza i serwisowa związana z etapem przygotowawczym, realizacyjnym i eksploatacyjnym' [literally: 'The Complex of Offshore Wind Farms with the Maximum Total Power of 900 MW together with Technical, Measurement and Research, and Service Infrastructure Associated with the Pre-investment, Implementation and Operation Stages'] (decision no. MFW/3/12 of 16 April 2012, ref. no.: Gt7/62/1157763/decyzja/2012), amended by the Decision of the Minister of Infrastructure of 21 October 2021 (ref. no.: DGM-3.530.1.2021),
    - Modelling of underwater noise propagation,
    - Modelling of the barrier effect and collision risk posed to migratory birds,
    - Modelling of suspended solids propagation,
    - Technical documentation of the Baltica-1 Offshore Wind Farm Project,
    - Documentation containing the results of environmental surveys and inventory carried out in the years 2022 to 2023 for the purpose of this EIA Report (Appendix 1 to the EIA Report);

- publicly available data sources at national, European or global levels, such as Emodnet, ICES;
- strategic, programming and planning documents at international, national, regional and local levels, relating to offshore wind energy and the state of the Baltic Sea environment;
- applicable legal regulations, including:
    - Act of 3 October 2008 *on the provision of information on the environment and environmental protection, public participation in environmental protection and on environmental impact assessments* (consolidated text: Journal of Laws of 2023, item 1094, as amended).
    - 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* (amended by the Directive of 16 April 2014),
    - UN Economic Commission for Europe *Convention on Environmental Impact Assessment in a Transboundary Context*, signed in Espoo on 25 February 1991 (Journal of Laws of 1999, No. 96, item 1110).
    - other international, EU and national regulations.

In addition, the preparation of this EIA Report relied on sources of information resulting from the implementation of the projects listed in Section 11, in particular on Environmental Impact Assessment Reports, consultation documents based on the ESPOO procedure (especially for OWFs located in neighbouring countries) or other documentation for the existing, ongoing or planned projects located closest to the proposed Project, including:

- Environmental Impact Assessment Report for the Bałtyk I Offshore Wind Farm;
- Environmental Impact Assessment Report for the Baltica Offshore Wind Farm;
- Environmental Impact Assessment Report for the Baltic Power Offshore Wind Farm;
- Environmental Impact Assessment Report for the BC-Wind Offshore Wind Farm;
- Environmental Impact Assessment Report for the Södra Victoria Offshore Wind Farm;
- Environmental Impact Assessment Report for the FEW Baltic II Offshore Wind Farm.

In the decision regarding the scope of the impact assessment report for the Baltica-1 OWF, the Regional Director for Environmental Protection in Gdańsk indicated the need for the analysis to address the cumulative impacts with other projects, including aggregate extraction activities within the Southern Middle Bank, and other offshore wind farms, such as Bałtyk I OWF, Kriegers Flak, Kriegers Flak II Nord, Kriegers Flak II Syd and Energy Island Bornholm, Njord, Öland-Hoburg, Baltic Central wind farm, Baltic Offshore Beta, Cirrus, Neptunus, Södra Victoria, Bornholm Bassin Øst and Baltic Edge. All of the projects listed in the decision, as well as the Ymer wind farm located in the Swedish waters (the consultation document for that wind farm was made available for public inspection on 12.06.2024. – notice of the Regional Director for Environmental Protection in Gdańsk dated 11.06.2024 – RDOŚ.Gd.WOO.442.6.2024.AJ.2.zpo), were included in the progress analysis and relevant data on them were acquired. Up-to-date information on the development of offshore wind farms in Swedish waters is available from the Swedish Energy Agency (https://vbk.lansstyrelsen.se/). As the analysis has shown, the majority of proposed Swedish offshore wind farms are at a very early stage of development and no information is available on their technical parameters, technological solutions for their implementation, and the specific impacts they may have on the environment. Some projects are highly unlikely to be implemented as they occupy the same sea space. Examples include the Ymer, Cirrus, Neptunus and Baltic Offshore Beta offshore wind farms.

1.5 INFORMATION ON THE LINKS BETWEEN THE BALTICA-1 OWF AND OTHER PROJECTS

The power generated by the Baltica-1 OWF will be exported onshore via a power connection, the implementation of which will constitute a separate project and will be subject to a separate procedure for issuing a decision on environmental conditions.

1.6 CONDITIONS RESULTING FROM STRATEGIC AND PLANNING DOCUMENTS

The proposed Project, Baltica-1 OWF, is in line with the assumptions of the 'Energy Policy of Poland until 2040' (hereinafter: EPP2040)[1], 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, electricity production by offshore wind farms will have the highest proportion in 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.

An important premise for the investment is the ability to avoid emission of pollution into the atmosphere. 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[2].

The above indicators for the project in question will be an element of Poland's compliance with international regulations at global and regional levels.

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 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 by 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 negative 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 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);

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

[2] 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

- 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'[3], i.e. achieving zero level of greenhouse gas emissions by 2050, and with the idea of the European Green Deal[4].

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 percent than from gas power.

Other international and national documents, the provisions of which affect the proposed Project or the provisions of which are implemented by the proposed Project, are presented below.

1.6.1 International documents, including EU documents

The **EU Strategy to harness the potential of offshore renewable energy for a climate neutral future**, published in November 2020, indicates that offshore renewable energy (mainly from wind) is one of the most promising routes to increase future power generation in the coming years in a way that meets Europe's decarbonisation objectives and expected rise in electricity demand in an affordable manner. Europe's oceans and sea basins hold a vast potential, which can be harnessed in a sustainable and environmentally sound way, complementing other economic and social activities. The strategy sets out the scaling up of offshore renewable energy and its use as an EU priority. Its development has positive industrial, economic and social impacts spread across the EU and its regions.

VASAB – in its strategy document VASAB Vision for the Territorial Development of the Baltic Sea Region in 2040 (2022), the intergovernmental cooperating committee of Baltic Sea Region ministers responsible for spatial planning and development defines the directions for the region's development in the perspective reaching the year 2040. In the document, offshore wind energy is identified as one of the key methods of electricity production. The document indicates that offshore energy development in the Baltic is carried out in accordance with the existing and planned uses of the sea basins, with respect for the protection of the maritime environment and for the concept of ecosystem services. Bearing this information in mind, the proposed Project should be considered compliant with the directions of development of the Baltic Sea region, as suggested by VASAB.

Poland is a signatory to the **1992 Convention for the Protection of the Marine Environment of the Baltic Sea Area** (Helsinki Convention). Under the Helsinki Convention, actions for the Conservation of the Baltic Sea focus on the implementation of the Baltic Action Plan (BAP), adopted at the HELCOM Ministerial Meeting in 2007. The Baltic Action Plan assumed that good ecological status of the Baltic Sea would be achieved by 2021 and set out the areas of action to achieve that goal. Given the lack of possibility to achieve the results set out in the BAP, in 2021 HELCOM prepared an update of the document, which included a description of measures and actions to be implemented by 2030 at the latest, in order to achieve the updated environmental targets. The new version of the plan points out the need for intensive development of offshore wind energy in order to achieve the climate targets by

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

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

2030 and 2050. It was noted that offshore wind farms, similarly to other offshore activities, can have negative impacts on the marine environment, including in particular on underwater noise levels and on seabirds. It was acknowledged that studies of the impact of the construction, operation and dismantling of offshore wind farms on marine biota, including cumulative effects of multiple windfarms, should be conducted by 2026. Based on the results of the studies, relevant action should be taken to develop appropriate mitigation measures to reduce the impact of underwater noise by 2029.

The 2013 Ministerial Conference in Copenhagen adopted **Recommendation 34E/1** for safeguarding important bird habitats and migration routes in the Baltic Sea from negative effects of wind and wave energy production at sea. The positive aspect of wind energy development in the context of climate change is emphasised in this document, recommending specific steps that may help to reduce the negative impact of investments on the environment. It should be underlined that the proposed Project will be implemented in accordance with the Recommendation 34E/1 of HELCOM. The provisions of this recommendation refer mainly to the activities of the States Parties to the Helsinki Convention and as such do not concern the proposed Project, but the Applicant assumes that the Project will be conducted so as to avoid or minimise the impact of the Project on the environment, including, in particular, on important bird habitats and their migration routes.

Poland is also a signatory to the International Convention on the Control of Harmful Anti-fouling Systems on Ships, signed on 5 October 2001 in London (Journal of Laws of 2008, no. 134, item 851), referred to as the ‘AFS Convention’. The AFS Convention is a framework convention allowing the prohibition of harmful anti-fouling systems used on ships, in accordance with clearly defined procedures, taking due account of the precautionary principle set out in the Rio Declaration on Environment and Development. At this stage, the AFS Convention prohibits the use of organotins on ships.

1.6.2 National documents

The main planning document outlining the conditions for the implementation of offshore wind farms in Polish sea areas is the **Maritime Spatial Plan of the Polish Sea Areas** (adopted by way of Regulation of the Council of Ministers of 14 April 2021 *on the adoption of the Maritime Spatial Plan for the Internal Marine Waters, the Territorial Sea and the Exclusive Economic Zone at a scale of 1:200 000* (Journal of Laws of 2021, item 935, as amended)). According to the Plan, Polish sea areas are divided into sea basins with main functions assigned on the basis of their existing or planned development and use. The areas with the main function of ‘renewable energy production’ were indicated as places for the construction of offshore wind farms and associated infrastructure, e.g. power connections exporting the generated power to the shore. The main function takes precedence over other functions of the sea basin and determines the possibility of implementation, except for issues regulated by law, e.g. related to the protection of nature and cultural heritage, and national defence. The Baltica-1 OWF Area is located in the sea basin marked as POM.60.E, which is described in Section 3.1.3. The proposed Project is in line with the provisions of the MSPPSA.

The **Maritime Policy of the Republic of Poland until 2020 (with an outlook until 2030)**, adopted by the Council of Ministers on 17 March 2015, specifies that the real potential of development of offshore wind energy in Poland, which may bring the greatest benefits for the Polish energy balance and the Polish economy, amounts to 6 GW of power installed in the OWF until 2030. Creating conditions for the construction of offshore wind farms was identified as an action to improve energy security. High technology costs, complicated licensing and permitting procedures as well as grid connection problems were identified as the main barriers to offshore wind energy development.

The **National Energy and Climate Plan for the years 2021–2030** indicates that the development of offshore wind energy is one of the areas related to ensuring the country's energy security (meeting the increasing demand for electricity) and a component of meeting the RES target in gross final energy consumption in 2030. The document estimates that the potential for OWF-generated capacity will be approximately 3.8 GW in 2030 and approximately 8 GW by 2040. It was noted that in order to enable the export of the full power generated by the offshore wind sector, in addition to the electricity grid components necessary for voltage application and connection, also upgrades and extension of the transmission grid are required .

The **Strategy for Responsible Development for the period up to 2020 (including the perspective up to 2030)** states that the modernisation of generation sources and innovative solutions in the economy, along with the development of capacities available from renewable sources, will contribute to the reduction of greenhouse gas emissions. The Strategy states that RES sources are mostly non-controllable sources. Continuous subsidisation of RES causes serious disturbances in the functioning of energy markets − leading to an increase in energy prices. Therefore, the Strategy identified the following as necessary:

- ensuring the possibility of balancing and interaction of RES sources with other sources (not subject to limitations by forces of nature);
- evolutionary process of changes.

The **2030 National Environmental Policy** recognises the developing use of energy from renewable sources as one of the instruments for reducing the environmental impact of the energy sector. The document states that, in addition to the development of photovoltaics, the development of offshore wind farms will play a key role in achieving the target in the electricity sector.

The development of offshore wind energy was also taken into account in the **Development Plan for Meeting the Current and Future Electricity Demand for 2018–2027**, prepared by Polskie Sieci Elektroenergetyczne S.A. (PSE). The part concerning potential directions of transmission networks extension ensuring the reliability of the power system indicates the performance of analytical works in the scope of offshore transmission networks construction and indicates that among the expected system effects of the development of the extra high voltage networks is the preparation of the capability for connection and output of the installed power on wind farms at the level allowing to meet the RES share in the energy balance of the country. The document also presents various OWF connection scenarios. The more recent version of the Plan (for the years 2023–2032) indicates plans to build substations to receive electricity from OWFs and integrate it into the NPS and identifies opportunities to build electricity grids for cross-border connections.

The **National Program for Low-Emission Economy Development** determines the need for greater diversification of the energy mix. The coastal region was defined as the main place for wind farm location. It was also specified that modernisation and extension of the national power system is required to meet the requirements of the RES market. It was stated in the document that the maximum productivity of the OWF in the PMA is estimated at 12 GW of installed capacity and 48–56 TWh of energy per year. The viable investment plans until 2030 are 6 GW. The document specifies that for the development of offshore wind energy in Poland, it is necessary, among others:

- to conduct analyses regarding the grounds for the OWF development in Poland;

- to develop offshore power networks.

1.6.3 Regional and planning documents

The **2030 Pomorskie Voivodeship Development Strategy** adopted by the Regional Council of the Pomeranian Voivodeship in Resolution No. 376/XXXI/21 of 12 April 2021 is the main strategic document setting out the directions of development of the Pomorskie Voivodeship. The Strategy sets three key objectives: Sustainable Security, Open Regional Community and Resilient Economy. They are specified within 12 operational objectives. The proposed Project contributes to the achievement of operational objective 1.2. 'Energy security' by using the potential of sea areas for the development of renewable energy. The Pomeranian Voivodeship was presented as strongly dependent on external electricity supplies. The development of this sector may result in the creation of numerous jobs, which is referred to, among others, in the above-mentioned operational objective 1.2 'Energy security' (in the context of building new elements of the energy system) and 3.1 'Competitive position' (regarding the use of shipbuilding potential).

The **2030 Pomorskie Voivodeship Spatial Development Plan** was adopted by Resolution no. 318/XXX/16 of the Pomorskie Regional Assembly of 29 December 2016. In terms of spatial policy, the focus is, among others, on the growth of electricity production and the transformation of the region into the national leader in renewable energy generation. The spatial policy activities and projects included in the 2030 Pomeranian Voivodeship Spatial Development Plan (PVSDP) include, among others: '...the construction of transmission and distribution systems as well as power stations for power evacuation from the new and renewable energy sources systems (wind farms, including offshore...), (...)extension of the 400/110 kV substation in Żarnowiec to create a possibility of connecting the offshore wind farms to the National Power System (NPS)...'. The 2030 Pomorskie Voivodeship Spatial Development Plan outlines the vision of spatial transformations of the region. One of the elements of the vision is the thesis that as a result of the installation of large power capacities within the voivodeship, in the form of a nuclear power plant, coal-fired power plant and OWE, as well as due to the development of distributed power sector, the security of energy supply of Northern Poland will be improved and the voivodeship will become energetically self-sufficient. It is indicated that in the ports in Łeba, Ustka and Władysławowo, the shipyard areas should be activated for the activities related to the management of maritime areas (e.g. logistic and service and maintenance centre for the OWF).

1.6.4 Summary

The analysis of various documents differing in terms of spatial extent demonstrates that the proposed Project is in line with the expectations of numerous policies and strategies, in particular ones 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).

2 PROPOSED PROJECT VARIANTS

2.1 APPROACH TO ESTABLISHING PROJECT OPTIONS

The implementation of the Baltica-1 OWF project 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 Environmental Impact Assessment 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), 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 environmentally favourable.

No location variants are possible for the Project because the location 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 have been 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;
  - swept area of the operating wind turbine;
  - number of support structures and the area covered by them within the OWF;
  - maximum length of inter-array cable lines in the OWF;
- 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 2.1 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 a maximum total swept area for the entire wind farm to 2 750 000 m^2. 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 it is highly probable that higher-performance structures will 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 2.1. Comparison of basic technical parameters of the Baltica-1 OWF in the APV and RAV

Parameter	APV		RAV
Specific capacity of the 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 the 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
Number of OSSs	1-4		5

2.2 Project variants considered

2.2.1 Applicant Proposed Variant (APV), the most favourable option for the environment

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, including, in particular, for wind turbines larger than those available in the market at the time of submitting the Report on Environmental Impact Assessment for the Baltica-1 OWF. Bearing the above in mind, the APV is the most environmentally favourable option.

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 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;
- fewer power cable lines and their shorter total length within 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.

2.2.2 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 offshore wind farm will be 900 MW, the adoption of 14 MW units translates into the construction of a maximum of 64 wind turbines. The RAV will be implemented in the same area, but due to the larger number of wind turbines to achieve a farm capacity of 900 MW, it 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.

The technology of the Project implementation in the APV and RAV is described in detail in Section 3.2.

3 Description of the proposed Project – Applicant Proposed Variant and Reasonable Alternative Variant

3.1 General characteristics of the Project

3.1.1 Subject and scope of the Project

The Project under discussion is the Baltica-1 OWF with a maximum nominal capacity of 900 MW, to be situated in the Polish Exclusive Economic Zone. 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 an offshore converter substation;
- medium- or high voltage subsea cable lines together with accessories.

The Project will consist of three main phases: construction, operation and decommissioning, which are described in detail in Section 4.

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

3.1.2 Project location and the sea area occupied by the Project

The Baltica-1 OWF Area is situated within the EEZ of the Republic of Poland, on the eastern side of the Middle Bank, in the depth range from approximately 16 m to approximately 50 m, 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 1.1].

The Baltica-1 OWF Area covers a surface area of 85.53 km^2. Table 3.2 contains the geocentric coordinates of boundary corner points of the Baltica-1 OWF Area. Table 3.3 presents the geocentric coordinates of the boundary corner points of the construction area of the wind turbines, offshore substations and inter-array cables, whereas Table 3.4 contains the coordinates of the area within which only the elements of the inter-array cable lines will be constructed.

Table 3.2. Geocentric coordinates of the boundary corner points of the Baltica-1 OWF Area

Boundary marker symbol	Geocentric geodetic coordinates within the ETRS89 reference system	
	Geodetic latitude Φ	Geodetic longitude λ
1	55°38'16.206" N	17°38'03.776" E
2	55°31'16.018" N	17°35'40.167" E
3	55°33'43.771" N	17°34'46.304" E
4	55°32'09.162" N	17°35'21.458" E
5	55°32'03.321" N	17°35'23.627" E
6	55°31'56.204" N	17°35'26.269" E
7	55°31'19.695" N	17°35'29.710" E
8	55°31'17.057" N	17°35'29.579" E
9	55°31'01.612" N	17°35'26.574" E
10	55°30'53.163" N	17°35'24.930" E
11	55°30'42.510" N	17°34'50.515" E
12	55°29'53.123" N	17°32'14.175" E
13	55°29'43.030" N	17°30'45.137" E
14	55°29'36.940" N	17°29'52.854" E
15	55°29'25.168" N	17°29'31.287" E
16	55°28'57.603" N	17°26'25.966" E
17	55°28'56.144" N	17°25'54.331" E
18	55°31'42.251" N	17°26'44.303" E
19	55°31'43.594" N	17°27'00.863" E
20	55°31'46.079" N	17°27'12.463" E
21	55°33'19.449" N	17°31'23.992" E
22	55°34'06.850" N	17°33'40.983" E
23	55°34'32.229" N	17°33'59.580" E
24	55°35'07.555" N	17°33'41.076" E
25	55°31'02.838" N	17°32'11.364" E
26	55°31'06.396" N	17°32'02.976" E
27	55°31'56.064" N	17°29'05.042" E
28	55°37'24.525" N	17°30'35.467" E
29	55°37'45.553" N	17°31'42.228" E
30	55°37'34.673" N	17°32'05.771" E
31	55°37'27.287" N	17°32'42.422" E
32	55°37'27.289" N	17°33'21.362" E
33	55°37'34.677" N	17°33'58.079" E
34	55°38'41.045" N	17°37'26.888" E
35	55°38'33.742" N	17°37'18.176" E

Table 3.3. Geocentric coordinates of the boundary corner points of the Baltica-1 OWF Area – the construction area for wind turbines, offshore substations and inter-array cables

Boundary marker symbol	Geocentric geodetic coordinates within the ETRS89 reference system	
	Geodetic latitude Φ	Geodetic longitude λ
1	55°35’07.555” N	17°33’41.076” E
2	55°31’02.838” N	17°32’11.364” E
3	55°31’06.396” N	17°32’02.976” E
4	55°31’56.064” N	17°29’05.042” E
5	55°37’24.525” N	17°30’35.467” E
6	55°37’45.553” N	17°31’42.228” E
7	55°37’34.673” N	17°32’05.771” E
8	55°37’27.287” N	17°32’42.422” E
9	55°37’27.289” N	17°33’21.362” E
10	55°37’34.677” N	17°33’58.079” E
11	55°38’41.045” N	17°37’26.888” E
12	55°38’31.390” N	17°37’15.371” E
13	55°31’39.919” N	17°34’51.822” E
14	55°31’38.132” N	17°34’49.825” E
15	55°35’37.494” N	17°33’51.521” E
16	55°35’32.435” N	17°33’48.439” E
17	55°34’06.850” N	17°33’40.983” E
18	55°33’18.564” N	17°34’01.464” E
19	55°31’58.034” N	17°34’28.954” E
20	55°31’19.286” N	17°34’32.633” E
21	55°30’53.817” N	17°34’27.689” E
22	55°30’08.491” N	17°32’04.213” E
23	55°29’58.893” N	17°30’39.551” E
24	55°29’57.369” N	17°30’31.942” E
25	55°29’54.694” N	17°30’25.390” E
26	55°29’25.168” N	17°29’31.287” E
27	55°28’57.603” N	17°26’25.966” E
28	55°28’56.144” N	17°25’54.331” E
29	55°31’42.251” N	17°26’44.303” E
30	55°31’43.594” N	17°27’00.863” E
31	55°31’46.079” N	17°27’12.463” E
32	55°33’19.449” N	17°31’23.992” E

Table 3.4. Geocentric coordinates of the boundary corner points of the Baltica-1 OWF Area – the construction area for inter-array cables

Boundary marker symbol	Geocentric geodetic coordinates within the ETRS89 reference system	
	Geodetic latitude Φ	Geodetic longitude λ
1	55°34’06.850” N	17°33’40.983” E
2	55°34’32.229” N	17°33’59.580” E

Boundary marker symbol	Geocentric geodetic coordinates within the ETRS89 reference system	
	Geodetic latitude Φ	Geodetic longitude λ
3	55°35’07.555” N	17°33’41.076” E
4	55°35’32.435” N	17°33’48.439” E
5	55°35’37.494” N	17°33’51.521” E
6	55°31’29.199” N	17°34’41.668” E
7	55°31’38.132” N	17°34’49.825” E
8	55°31’39.919” N	17°34’51.822” E
9	55°38’31.390” N	17°37’15.371” E
10	55°38’33.742” N	17°37’18.176” E
11	55°38’33.742” N	17°37’18.176” E
12	55°38’16.206” N	17°38’03.776" E
13	55°31’16.018” N	17°35’40.167” E
14	55°33’43.771” N	17°34’46.304” E
15	55°32’09.162” N	17°35’21.458” E
16	55°32’03.321” N	17°35’23.627” E
17	55°31’56.204” N	17°35’26.269” E
18	55°31’19.695” N	17°35’29.710” E
19	55°31’17.057” N	17°35’29.579” E
20	55°31’01.612” N	17°35’26.574” E
21	55°30’53.163” N	17°35’24.930” E
22	55°30’42.510” N	17°34’50.515” E
23	55°29’53.123” N	17°32’14.175” E
24	55°29’43.030” N	17°30’45.137” E
25	55°29’36.940” N	17°29’52.854” E
26	55°29’54.694” N	17°30’25.390” E
27	55°29’57.369” N	17°30’31.942” E
28	55°29’58.893” N	17°30’39.551” E
29	55°30’08.491” N	17°32’04.213” E
30	55°30’53.817” N	17°34’27.689” E
31	55°31’19.286” N	17°34’32.633” E
32	55°31’58.034” N	17°34’28.954” E
33	55°33’18.564” N	17°34’01.464” E

3.1.3 Conditions for the sea basin use

The Project will be located in the area 60.E.2 indicated in Annex 1 to the Act of 17 December 2020 *on promoting energy production in offshore wind farms* (consolidated text: Journal of Laws of 2024, item 182) as one of the areas in which offshore wind farms may be developed. Part of the Baltica-1 OWF Area intended exclusively for the construction of cable lines [Figure 3.1], is included in the area covered by the Decision of the Minister of Infrastructure No. 4/K/21, dated 21 October 2021, *approving cable laying location and methods of cable maintenance in the exclusive economic zone, from the boundary of the Offshore Wind Farm Complex Baltica-1 designated by the location decision of the Minister of Transport, Construction and Maritime Economy of 16 April 2012 no. MFW/3/12, ref.no.:*

GT7/62/1155763/decyzja/2012) on the permit for the construction and use of artificial islands, structures and devices within the sea areas, up to the territorial sea boundary.

The sea area in which the proposed Project is located fulfils various functions resulting from the existing human activity and the natural resources present there. The Baltica-1 OWF Area is located entirely within the boundaries of the sea basin POM.60.E, the boundaries of which are specified in Annex 1 to the Regulation of the Council of Ministers of 14 April 2021 *on the adoption of the Maritime Spatial Plan for 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) [Figure 3.1].

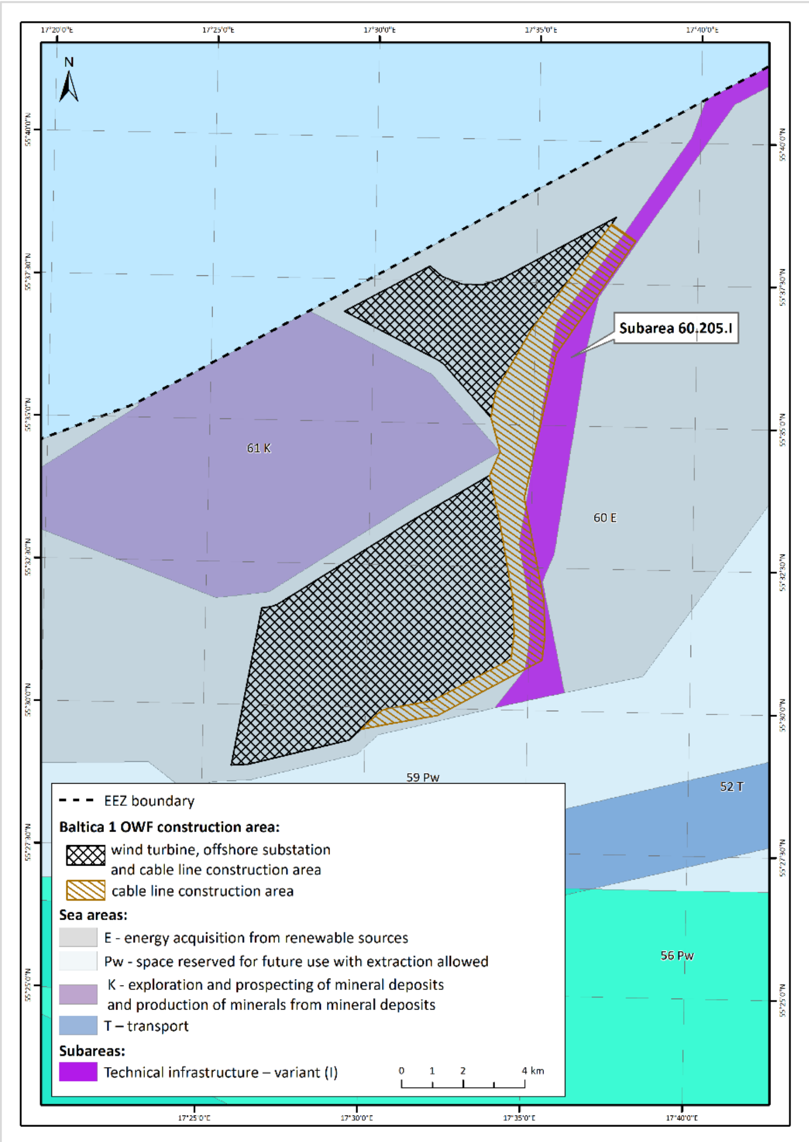

Figure 3.1. Location of the Baltica-1 OWF Area in relation to the sea basins and sub-sea basins resulting from the Maritime Spatial Plan of Polish Sea Areas [Source: internal materials based on the spatial data from the Maritime Administration Spatial Information System (SIPAM)]

The sea basin card provided in Annex 2 to the above-mentioned regulation defines the principal use of the given sea basin, i.e. its basic function which governs the remaining forms of use, called the allowed functions. The set of sea basin functions results from its existing and planned use. The sea basin card also includes the prohibitions and restrictions [Table 3.5] as well as conditions for the sea basin use

[Table 3.6], which mainly regulate the possibility of implementing the allowed functions along with other forms of shared use, in order to subordinate them to their main function.

The sea basin card does not cover the conditions of the sea basin use in the context of: 'environment and nature conservation', 'national defence and security' as well as 'cultural heritage', which are fully governed by separate regulations.

The proposed Project fulfils the provisions of the MSPPSA, in particular with regard to the conditions of the POM.60.E sea basin card. The Baltica-1 OWF serves the primary function defined for the POM.60.E sea basin, i.e. renewable energy production.

Table 3.5. Prohibitions or restrictions on the use of particular areas within the allowed functions of the POM.60.E sea basin [Source: internal materials based on Annex 2 to the Regulation of the Council of Ministers of 14 April 2021 on the adoption of the Maritime Spatial Plan for 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)]

Allowed function of the sea basin	**Prohibitions or restrictions in the use of particular basins**
aquaculture	The implementation of the function within the entire sea basin is limited only to projects agreed upon with the relevant offshore wind farm project owner
scientific research	Within the entire sea basin, scientific research is restricted to methods that: – do not disturb the linear elements of technical infrastructure; – do not endanger the ecological function of spawning grounds and the survival of the early development stages (eggs and larvae) of commercial fish species;
cultural heritage	Not determined
technical infrastructure	Within the entire sea area: – laying linear elements of technical infrastructure is restricted to infrastructure necessary for the performance of the energy production function; – the implementation of the function is limited to methods which do not endanger the ecological function of spawning grounds and the survival of the early development stages (eggs and larvae) of commercial fish species; linear elements of the technical infrastructure are required to be laid in a space-efficient manner, below the seabed surface, and if this is impossible, other permanent safeguards should be applied to allow the safe use of anchored gillnets.
exploration and prospecting of mineral resources, as well as extraction of minerals from deposits	The implementation of the function in the entire sea basin is limited to the following methods which: – do not disturb the linear elements of technical infrastructure; – do not endanger the ecological function of spawning grounds and the survival of the early development stages (eggs and larvae) of commercial fish species; in the entire sea basin, extraction of minerals from deposits is limited only to projects agreed upon with the relevant offshore wind farm project owner.
fishing	Not to be determined until the commencement of the erection of offshore wind turbines; during the operation of offshore wind farms, until the rules governing fishing activities in the sea basin have been established, it is prohibited to conduct fishing activities in the safety zones designated for each structure as well as in places where the safety of internal connection infrastructure may be at risk;
artificial islands and structures,	In the entire sea basin, it is prohibited to construct artificial islands, structures and equipment for hydrocarbon extraction; It is prohibited to construct artificial islands and structures at a distance smaller than 2 km from the boundaries of the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308); the implementation of functions in the remaining part of the sea basin is restricted to: – for the purpose of aquaculture only in places at which the linear elements of technical infrastructure shall not be disturbed; – such project planning so as to make it possible for vessels up to 250 m performing aggregate extraction in the sea basin POM.61.K to pass safely during the concession period; – methods which do not endanger the ecological function of spawning grounds and the survival of the early development stages (eggs and larvae) of commercial fish species;

Allowed function of the sea basin	**Prohibitions or restrictions in the use of particular basins**
	in the sub-basin 60.205.I, structures shall be limited to external collector substations allowing the connection of multiple generating sources.
transport	Not to be determined until the commencement of the erection of offshore wind turbines; during the operation of offshore wind turbines, until the conditions for safe navigation have been established by a decision of the territorially competent director of the maritime office, sailing is restricted to vessels up to 50 m in length, with the exception of vessels involved in the service and maintenance of offshore wind farm structures and installations as well as aquaculture.
tourism, sports and recreation	Not determined
other	After the Project implementation is completed, in the sub-basins intended for laying and maintenance of linear elements of technical infrastructure, it is required that a safety zone around them is established by the territorially competent director of the maritime office. Within the zone, anchoring will be prohibited, except for emergency anchoring and anchoring related to installation and maintenance works.

Table 3.6. Conditions for using the sea basin POM.60.E [Source: internal materials based on Annex 2 to the Regulation of the Council of Ministers of 14 April 2021 on the adoption of the Maritime Spatial Plan for 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)]

Form of the sea basin shared use	**Conditions for using the sea basin**
environmental protection	Not determined
national defence and security	Not determined
cultural heritage protection	Not determined
fishing and aquaculture	An agreement with the relevant offshore wind farm project owner should be secured at the stage of issuing an administrative decision which would permit the development of aquaculture in the sea basin. Detailed location as well as technological and technical solutions should be indicated at the building permit design stage. During the operation, it is required to impose, by a decision of the territorially competent director of the maritime office, restrictions on fishing in the safety zones designated for each project.
renewable energy generation	Area intended for wind power generation by offshore wind turbines. Both the internal and external technical infrastructure are integral parts of a project. Upon commencement of a project involving the construction of artificial islands and structures, the requirement arises to impose, by a decision of the territorially competent director of the maritime office, restrictions on fishing and navigation in the sea basin in which construction activities take place, which also applies to a 500-metre safety zone around the sea basin, throughout the duration of the construction works. During the operation of offshore wind farms, the requirement arises to impose, by a decision of the territorially competent director of the maritime office, restrictions on fishing and navigation in the safety zones designated for each structure as well as in places which can pose a threat against the security of the internal connection infrastructure.
prospecting and exploration of mineral deposits, and extraction of minerals from deposits	Prospecting and exploration of mineral deposits is allowed in the entire sea basin. Extraction of minerals from deposits is permitted in accordance with the restrictions in Section 7, points 5 and 7.

3.1.4 Project phasing

In order to:

- ensure economic and organisational optimisation of the entire Project;

- enable comprehensive contracting of the necessary services and supplies;
- consider possible limitations in the access to services and supplies necessary for the Project (specialist vessels, port infrastructure and other components in the supply chain) related to the possible implementation of similar investment plans in the offshore wind energy sector by other entities,

the Applicant allows for the implementation of the Project in a continuous process as well as in stages.

3.2 DESCRIPTION OF TECHNOLOGICAL SOLUTIONS

This section includes a description of the technological solutions commonly used at the time of writing the Report regarding the implementation of offshore wind farms. It should be noted that the most common systems currently used, based on alternating current generation and transmission, can be replaced by the Applicant by the systems based on direct current generation and transmission, or any combination of the two. At the time of the EIA Report submission, the Applicant does not exclude the possibility of applying either of these technologies.

3.2.1 Description of the production process

Wind turbines are devices designed for converting kinetic energy of wind into electricity by means of 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, cable lines). Electricity produced by the OWF is brought ashore via a power connection and supplied to the onshore substation (OnSS) [Figure 2.4]. The connection and the OnSS will constitute a separate project, covered by a separate decision on environmental conditions.

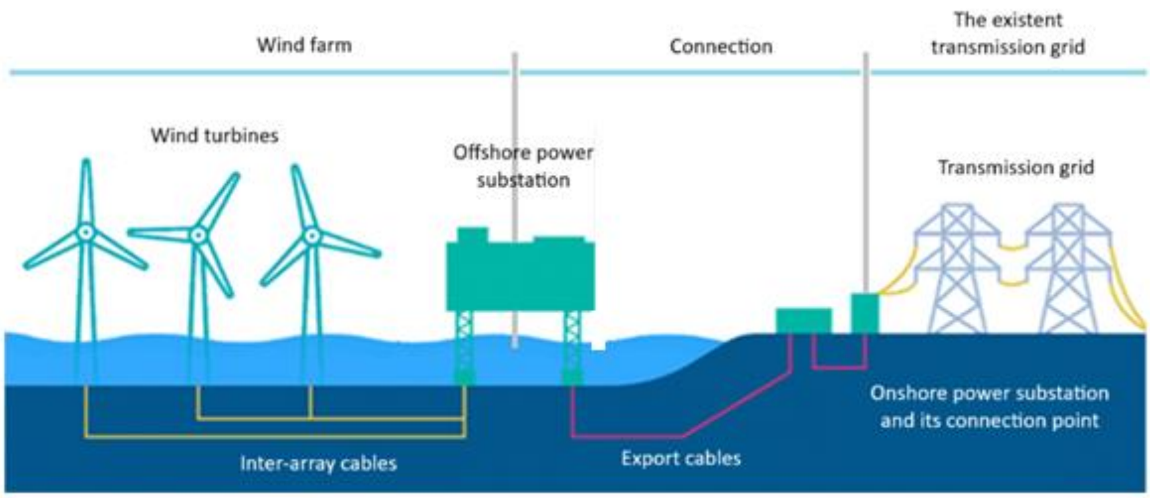

Figure 3.2. Main elements of an offshore wind farm along with transmission infrastructure

Wind turbines do not require the supply of fuels and raw materials to produce electricity. Properly operated, they do not generate environmental pollution. The demand for electricity, in small amounts, occurs only in the case of windless weather. The demand for raw materials and energy, similarly to other energy installations, is related to the process of construction and installation of structural elements of individual wind farm components, operation of vessels and decommissioning.

3.2.2 Description of individual elements of the Project

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;
- medium- or high voltage subsea cable lines together with accessories.

The commencement of the construction phase will be preceded by the preparation of the seabed prior to the installation of foundations or support structures for individual OWF structures, i.e. wind turbines and OSS platforms, as well as the preparation of the seabed, if necessary, at the location of spudcan foundations for 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. A detailed description of individual OWF components is provided below.

3.2.2.1 Wind turbines

Pursuant to Article 3(4) of the Act of 17 December 2020 *on promoting energy production in offshore wind farms* (consolidated text: Journal of Laws of 2024, item 182), an offshore wind turbine is a single standalone assembly of devices used for electricity generation exclusively from wind power at sea.

The main components of wind turbines are:

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

Figure 3.3 presents a diagram of an offshore wind turbine structure with an example of a monopile foundation most commonly used in OWF construction.

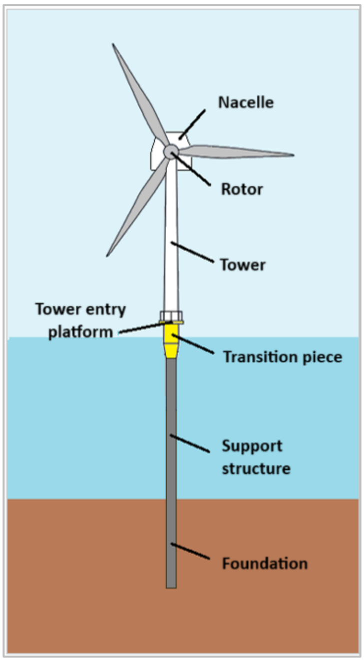

Figure 3.3. Diagram of a structure of a single wind turbine with a monopile foundation (source: internal materials)

The development of the 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.

Offshore wind turbines currently installed have a rated capacity of 12–15 MW, while turbines above 15 MW are 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 assuming 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. As a result, the use of offshore wind turbines with a capacity from 15 to 25 MW is assumed for the Baltica-1 OWF in the APV, and 14 MW units in the RAV.

Considering the possibility of using 25 MW units, the maximum diameter of the rotor is anticipated to be 310 m. Assuming that the distance between the rotor blade tip and the water surface will be 20 m, the maximum height of a single wind turbine will be 330 MASL. Therefore, it has been assumed that regardless of the wind turbine type selected, the maximum height of the structure will not exceed 330 MASL, and the distance of the rotor blade from the sea surface will not be smaller than 20 m. In the RAV, the maximum rotor diameter will be 235 m, and the total height of the wind turbine will not exceed 266 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 up to 36 25 MW units and up to 60 15 MW units, or a correspondingly different number of units if turbines with a capacity less than 25 MW and more than 15 MW are selected. In the RAV, there will be up to 64 units with a capacity of 14 MW.

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 in a designated harbour area. If the characteristics of a particular installation vessel allow, individual sections of the tower and, independently, the rotor assembly are assembled on the quay and transported as a whole unit to the installation location by an installation vessel. Typically, the installation vessels are capable of delivering up to seven such assembly sets simultaneously.

The operations associated with the pre-assembly and storage of offshore wind turbine elements in installation ports require heavy-duty lifting and cargo handling equipment, i.e. caterpillar cranes, self-propelled 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 the location intended for the OWF. Depending on the type of the solution selected, the ready-made prefabricated elements are transported from the port to the installation location. Transport is carried out on board installation vessels, by barges, or by vessels towing submerged elements to the installation site (so-called wet tow), and afterwards the foundations are installed by the installation vessels on the previously prepared seabed – gravity-based foundations. The monopiles and piles for jacket foundations are either driven or vibrated into the substrate with a pile driver. 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 the direct installation of the tower on the foundation integrated with the transition piece (a TP-less design). Depending on the depth of the sea basin and the forecast weather conditions, the construction of a seabed erosion protection/reinforcement may be necessary. Such works are carried out using a specialist rock-dumping vessel, which dumps aggregate or rip-rap precisely on the seabed. The estimated duration of work for a single wind turbine is 2–4 days.

3.2.2.2 Foundations and support structures

Thus far, a vast majority of offshore wind turbines and other structures comprising an OWF – mainly OSSs – have been installed on foundations transferring the load from the installations (the wind turbines and OSS platforms) to the seabed. 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 the OWF. Nowadays, steel foundations are the most commonly used, however, concrete foundations are also in use.

A different solution for the wind turbines installation are floating foundations; however, they are generally used in sea areas with depths exceeding 60 m. In shallower waters, foundations embedded in the seabed remain the least costly solution.

The following sections present the parameters of individual foundation types that could potentially be used in the Project regarding the construction of offshore wind turbines. Their description includes the maximum values of individual parameters that result from the installation of 25 MW units, which are characterised by the greatest dimensions and mass. For the purposes of the environmental impact assessment, it must be taken into consideration that the most unfavourable values of the individual parameters will not occur simultaneously for individual cases.

Monopile, jacket or gravity-based foundations are planned to be used to construct the OSSs. The technical description of these types of foundations, including information on the duration of their construction and footing, is contained in the subsections below. Section 3.2.2.3 contains information on the foundation parameters in reference to the OSSs.

The 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 ultimate selection of wind turbines and OSSs.

3.2.2.2.1 Monopile foundations – monopiles

Monopiles are usually structures comprised of tubular steel sections, which are drilled, piled or vibrated into the seabed using a hydraulic pile driver. Piling and vibrating monopiles into the seabed can be carried out on the seabed with different types of sediments – sands, tills and soft solid rock. However, if the seabed is formed by hard rock, the monopile is installed after drilling a borehole, which takes place inside the rings forming the pile. No previous preparatory works of the seabed in the location of a monopile installation are necessary, except for a situation, in which there are boulders or debris on the seabed, in which case such obstructions should be removed prior to foundation installation or, if the problem is local in scale, the location of individual wind turbine foundations should be changed. Additionally, the seabed may need to be cleared and reinforced by dredging and providing riprap protection, if a jack-up vessel is to be used for monopile installation.

In locations where the seabed is affected by hydrodynamic processes, i.e. shallow areas and areas with near-seabed currents, and where there is a risk of sediment scour around the foundations, it is necessary to protect the seabed surface around the pile with a protective layer, for example, rip-rap. The monopile protrudes above the sea level and is connected to the tower with a transition piece [Figure 3.4]. The transition piece, which can have varying lengths, is installed on the outer surface of the monopile (the most common solution) or inside it. The monopile and the transition piece are usually bonded together with grout. At first, the transition piece is placed on temporary supports and aligned to a vertical position, Next, the grout is pumped between the foundation surface onto the transition piece surface and left to solidify. Those elements can also be screwed together using a flanged connection or welded. Currently, a technology of a transition piece integrated with a monopile (TP-less) is being introduced, which accelerates the installation and reduces the amount of work at sea.

If the installation of the foundation is hindered by the presence of hard rocks in the seabed, drilling may be necessary. Drilling can take place inside the pile or in a casing pipe. Any gap that develops between the drilled hole and the monopile will be filled with concrete. The spoil from drilling is usually extracted onto a barge. Once the foundation installation is complete, most of the spoil will be placed inside the monopile and the excess will be spread in a location agreed with the maritime authority. If possible, some of the excess excavated material will be used as foundation scour protection.

Soil samples will be collected from representative locations prior to drilling. If contaminants are found in the soil, the material excavated during the drilling of the monopile hole will be classified as waste. Consequently, it will be transported to land and subjected to waste treatment processes. Preliminary estimates for the largest monopiles indicate that the volume of spoil temporarily stored on a barge could amount to a maximum of 8200 m^3. The volume of potential excess soil that will need to be spread at a location agreed with the relevant maritime authority will be a maximum of 2200 m^3. The estimated volume of concrete used for filling the gap between the drilled hole and the foundation will be a maximum of 550 m^3 per foundation. It should be emphasised that drilling technology will only be considered in exceptional cases and for a small number of foundations. Extensive use of this method of pile installation is uneconomical under current technological conditions. It is also acceptable to spread the material from the inside of a pile in the immediate vicinity of the foundation, without loading it onto a barge.

Figure 3.4. Monopile foundation [Source: Ramboll]

In order to protect it against corrosion, the monopile surface is covered with protective coatings in the area of the water surface fluctuations and above; passive and active corrosion protection systems are also used.

The most common corrosion protection method used in the marine environment is cathodic protection, which is a passive corrosion protection. It can be implemented as galvanic or electrolytic protection. Galvanic anode cathodic protection (GACP) involves the installation of aluminium or zinc anodes on the foundations and/or support structures. The anodes gradually wear out and the aluminium or zinc is transferred to water and accumulates in the seabed sediments. In the initial operation period, no emission of zinc and aluminium from anodes will take place. This process will take place over time and will progress with the increasing degree of damage to the protective coating on the components subject to corrosion protection. It is assumed that the total dissolution of the anodes takes place over a period of 35 years and will be similar to the design life of the Project.

Impressed current cathodic protection (ICCP) is an option of an active corrosion protection system that involves supplying electric power to the system. The ICCP (impressed current cathodic protection) system consists of protective anodes connected by a system of cables and connectors to an external electrical power source and then to the structure to be protected (the cathode). When an electrical voltage is applied to the resulting system, a potential difference is induced, thus creating a forced cell. Such a system does not emit ions like the GACP system does, however, it entails some potential operational issues. The ICCP system may work with less coating than the GACP system (case by case), which can be generally considered environmentally beneficial.

Table 3.7 contains information on the parameters of a monopile foundation for wind turbines with capacities of 25 MW, 15 MW and 14 MW.

Table 3.7. Basic parameters of a monopile foundation for turbines with a capacity of 25 MW and 15 MW (APV), and 14 MW (RAV)

Parameter	Value for a 25 MW turbine	Value for 15 MW and 14 MW turbines
Diameter (maximum)	12 m	11 m
Monopile length (maximum)	110 m	90 m
Foundation weight (maximum)	2500 t	2400 t
Transition piece weight (maximum)	300 t	300 t
Seabed penetration (maximum)	55	55
Average wall thickness (for a wind turbine)	85 mm	80 mm
Width of the erosion protection layer counted from the foundation edge (average)	25 m	20 m
Scour protection layer depth (average)	2.0 m	1.5 m
Maximum seabed area occupied by a gravity-based structure (GBS)	115 m^2	95 m^2
Maximum seabed area occupied by a wind turbine foundation, including the seabed reinforcement area	3100 m^2	2100 m^2
Total volume of excavations	0 m^3	0 m^3
Effective time of a single foundation piling (average)	3–5 h	3–5 h
Maximum completion time per wind turbine	48 h	48 h
Pneumatic pile driver strike energy (maximum)	8 000 kJ	8 000 kJ
Average impact energy of pile driver strikes	2600 kJ	2600 kJ
Number of pile driver strikes per hour	2000	2000
Number of pile driver strikes per one pile	6000-10 000	6000-10 000

3.2.2.2.2 Piled jacket foundations

Jacket foundations are load-bearing foundations consisting of three or four steel pipes joined together using steel connectors. A complete jacket structure, including the transition piece / connector, is assembled on land and transported on a vessel to the installation location, where it is mounted on piles, previously driven into the seabed [Figure 3.5]. The piles are driven into the seabed using a hydraulic pile driver. Prior preparation of the seabed before piling is not required, except where there are boulders or debris on the seabed. In such a case, the obstacles should be removed, and if this is impossible, the foundation location should be changed. Additionally, the seabed may need to be cleared and reinforced by dredging and providing riprap protection, if a jack-up vessel is used for the foundation installation.

Two types of pile driving approaches can be distinguished for jacket foundations, i.e. pre-piled jacket and post-piled jacket methods. Post-piled jacket method requires the use of special flanges which usually entails an increased consumption of steel. Pile driving prior to the installation of a jacket structure requires the use of an additional structure, the so-called seabed template, which facilitates piling works, especially when there are numerous foundations of similar dimensions.

If the installation of the piles is hindered by the presence of hard rocks in the seabed, drilling may be necessary. The pile drilling technology for jacket structures is similar to that used for monopile foundations. The same assumptions and environmental standards also apply. Preliminary estimates for the largest jacket structures founded on the largest piles indicate that the volume of spoil temporarily stored on a barge could amount to a maximum of 6000 m^3. The volume of prospective excess soil that will need to be spread outside the pile footprint, at a location agreed with the relevant maritime authority, will be a maximum of 2200 m^3. It is also acceptable to spread the material from inside the pile in the immediate vicinity of the foundation, without loading it onto a barge. The estimated volume of concrete used for filling the gaps between the drilled hole and the piles will be a maximum of 1000 m^3. The values are specified for a single jacket foundation based on 4 piles. It should be emphasised that drilling technology will only be considered in exceptional cases and for a small number of foundations. Extensive use of this installation method is uneconomical under current technological conditions.

If the installation takes place on soft sediments with a large thickness, it is possible to install jacket foundations in the seabed using suction caissons mounted at the end of the load-bearing pipes. In that case, the foundation is initially driven into the seabed under the structure's own weight and at the target depth, thanks to the vacuum force inside the caissons, the pressure differential across the top plate effectively ‘pulls’ the caissons into the seabed. The suction pump is mounted on the installation vessel and pumps the water and air from inside the caisson. The possible noise comes from the pump on board the vessel; no spoil is generated.

As is the case with monopiles, the seabed around the jacket foundation legs can be secured against erosion with a protective layer, for example rip-rap; and to protect the surface of the jacket structure against corrosion, protective coatings will be applied in the area of water surface fluctuations and above, as well as a passive or active corrosion protection system will be used.

In the case of jacket foundations, corrosion protection will be provided in the form of protective coatings (in the area of water surface fluctuations and above) and passive or active corrosion protection systems (sacrificial anodes and ICCP system).

The most common corrosion protection method used in the marine environment is cathodic protection, which is a passive corrosion protection. It can be implemented as galvanic or electrolytic protection. Galvanic anode cathodic protection (GACP) involves the installation of aluminium or zinc anodes on the foundations and/or support structures. The anodes gradually wear out and the aluminium or zinc is transferred to water and accumulates in the seabed sediments. In the initial operation period, no emission of zinc and aluminium from anodes will take place. This process will take place over time and will progress with the increasing degree of damage to the protective coating on the components subject to corrosion protection. It is assumed that the period of anode dissolution is similar to the design life of the Baltica-1 OWF, i.e. 35 years. The metals in question will first pass into the water, in which they can undergo precipitation and accumulate in the sediment.

Impressed current cathodic protection (ICCP) is an option of an active corrosion protection system that involves supplying electric power to the system. The ICCP system consists of protective anodes connected by a system of cables and connectors to an external electrical power source and then to the structure to be protected (the cathode). When an electrical voltage is applied to the resulting system, a potential difference is induced, thus creating a forced cell. Such a system does not emit ions like the GACP system does, however, it entails some potential operational issues. The ICCP system may work with less coating than the GACP system (depending on the case), which can be generally considered environmentally beneficial.

Figure 3.5. Piled jacket foundation [Source: Ramboll]

Table 3.8 contains information on the parameters of a piled jacket foundation for wind turbines with capacities of 25, 15 and 14 MW.

Table 3.8. Basic parameters of a piled jacket foundation for turbines with a capacity of 25 MW and 15 MW (APV), and 14 MW (RAV)

Parameter	Value for a 25 MW turbine	Value for 15 MW and 14 MW turbines
Distance between the foundation legs (maximum)	40 m	35 m
Number of the foundation legs (maximum)	4 units	4 units
Diameter of the foundation legs (maximum)	3.5 m	3.5 m
Pile diameter (maximum)	4.2 m	4.0 m
Pile length (maximum)	70 m	60 m
Foundation mass (excluding piles, maximum)	2000 t	1700 t
Single pile mass (maximum)	400 t	300 t
Width of the scour protection layer counted from the foundation edge (maximum)	15 m	10 meter
Scour protection layer depth (average)	2.0 m	1.5 m
Seabed area occupied by a single foundation (maximum)	800 m^2	620 m^2
Footprint of a single foundation including the seabed reinforcement (maximum)	3500 m^2	2000 m^2
Total volume of excavations for individual types of foundations	0 m^3	0 m^3
Effective installation time of a single pile	6-8 h	6-8 h
Effective installation time per foundation (average)	24–30 h	24–30 h
Maximum installation time per wind turbine	64 h	64 h
Pneumatic pile driver strike energy (maximum)	4000 kJ	4000 kJ
Number of pile driver strikes per hour	3000	3000
Number of pile driver strikes per one pile	6000–10 000	6000–10 000

3.2.2.2.3 Suction bucket jacket foundations

Suction bucket jacket (SBJ) foundations are made of a steel lattice structure (consisting of tubular steel elements and welded joints) installed in the seabed by means of suction buckets located under each leg of the foundation structure [Figure 3.6]. Those elements, the so-called caissons, play a role similar to piles in a standard jacket foundation. Three-legged and four-legged foundations are used. Hammer is not used for installing this type of foundations. The possibility of using SBJ foundations depends largely on soil conditions.

The SBJ foundation initially penetrates into the seabed under its own weight. Afterwards, it is driven further into the seabed to the target depth with vacuum pressure (suction) created inside the caissons. The pressure difference on the upper plates effectively drives the structure into the seabed to the design depth. The suction pump can be located on the installation vessel or directly on the caissons.

Before the installation of the SBJ foundation, it may be necessary to remove boulders lying on the seabed at the site, and partially level the area. The spoil generated during the seabed preparation for foundations will be spread in the wind farm area or will be managed in accordance with the decision of the territorially competent director of the maritime office.

Figure 3.6. Suction bucket jacket (SBJ) foundation [Source: Ramboll]

Table 3.9 contains information on the parameters of a suction bucket jacket (SBJ) foundation for wind turbines with capacities of 25, 15 and 14 MW.

Table 3.9. Basic parameters of a suction bucket jacket (SBJ) foundation for turbines with a capacity of 25 MW and 15 MW (APV), and 14 MW (RAV)

Parameter	Value for a 25 MW turbine	Value for 15 MW and 14 MW turbines
Distance between the foundation legs (maximum)	40 m	35 m
Number of the foundation legs (maximum)	4 pcs.	4 pcs.
Diameter of the foundation legs (maximum)	3.5 m	3.5 m
Caisson diameter (maximum)	14 m	12 m
Weight of a single caisson (maximum)	550 t	450 t
Caisson installation depth (maximum)	17 m	15 m
Total foundation weight, including the seabed part (maximum)	4000 t	3200 t
Width of the scour protection layer counted from the foundation edge (maximum)	15 m	15 m
Scour protection layer depth (average)	2.0 m	2.0 m

Parameter	Value for a 25 MW turbine	Value for 15 MW and 14 MW turbines
Seabed area occupied by a single foundation (maximum)	700 m^2	550 m^2
Footprint of a single foundation including the seabed reinforcement (maximum)	6200 m^2	5800 m^2
Effective installation time per foundation (average)	16 hours	16 hours
Maximum completion time per wind turbine	50 hours	50 hours
Total volume of excavations for individual types of foundations	9000 m^3	7500 m^3

3.2.2.2.4 Gravity-based structures

A gravity-based structure [Figure 3.7] requires special seabed substrate preparation and is used on very rigid and high-bearing capacity soils. The preparation of the seabed consists of possible removal of boulders at the foundation location, excavation to get rid of the top non-bearing layer of sediment and levelling of the substrate. The spoil generated during the seabed preparation for foundations will be spread in the OWF Area or will be managed in accordance with the decision of the territorially competent director of the maritime office. The seabed dredging depth for the purposes of the gravity-based foundations is usually several meters. Additionally, in the immediate vicinity of the foundation, sea currents are subject to modification – the effects of possible sediment scour are offset by the shape of the foundation footing and possible erosion protection systems. Gravity-based structures are prepared (levelled) on land and, after being towed to the correct location, they are sunk and placed on the seabed. Therefore, jack-up vessels are not planned to be used for the foundation installation. However, this type of vessel can be utilised at the stage of turbine assembly. Additionally, if boulders are present on the seabed, the seabed may need to be cleared and reinforced by dredging and providing riprap protection, if a jack-up vessel is to be used for the foundation installation.

High-cement content concrete with improved strength parameters is used for constructing gravity-based structures. Corrosion protection in the form of protective coatings is used in the area of the water surface fluctuations and above. Secondary steel elements are also protected using anti-corrosion coatings.

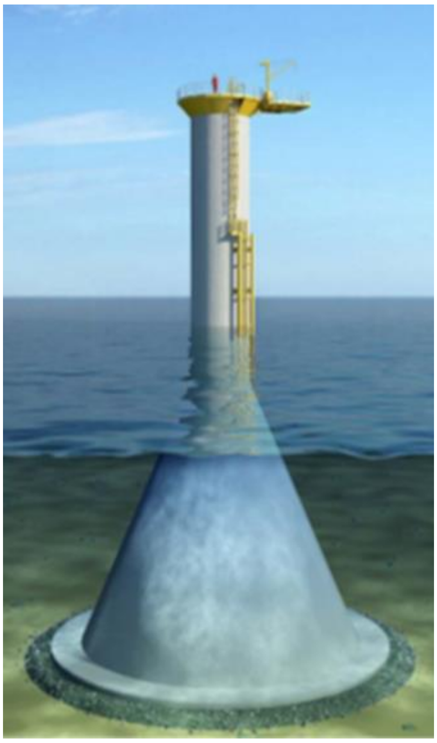

Figure 3.7. Gravity-based structure {Source: Ramboll]

Table 3.10 contains information on the parameters of a gravity-based structure for wind turbines with capacities of 25, 15 and 14 MW.

Table 3.10. Basic parameters of a gravity-based structure for turbines with a capacity of 25 MW and 15 MW (APV), and 14 MW (RAV)

Parameter	Value for a 25 MW turbine	Value for 15 MW and 14 MW turbines
Base diameter (maximum)	55 m	45 m
Seabed dredging diameter (maximum)	75 m	65 m
Seabed dredging depth (maximum)	5 m	5 m
Foundation weight (without ballast, maximum)	16 000 t	12 500 t
Ballast weight (maximum)	19 000 t	16 500 t
Width of the scour protection layer counted from the foundation edge (average)	40 m	37.5 m
Scour protection layer depth (average)	3 m	3 m
Foundation column diameter (maximum)	13 m	11 m
Seabed area occupied per foundation (maximum)	2400 m^2	1600 m^2
Seabed footprint per single foundation including the erosion protection	14 300 m^2	11 300 m^2
Dredging time per single foundation (average)	12 hours	12 hours
Installation time per single wind turbine (average)	30–40 hours	30–40 hours
Assumed number of foundations, for which seabed dredging will be carried out simultaneously	1–2 pcs.	1–2 pcs.
Excavation volume per single foundation (maximum)	22 000 m^3	16 500 m^3

3.2.2.2.5 Noise Reduction System – NRS

The driving of pile foundations (monopiles and piled jacket foundations) into the seabed during the construction phase will be associated with the emission of high levels of impulsive sound into the water depth, which may have a negative impact on marine organisms – mainly on marine mammals and fish. In the case of large diameter piles, underwater noise at a distance of 1 m from the source can exceed 230 dB.

In order to minimise the negative impact of underwater noise during the installation of the pile foundations, various types of noise reduction solutions are foreseen, collectively constitute a Noise Reduction System.

The selection of the underwater Noise Reduction System should take into account in particular:

- 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 solution 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, the 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 µPa2s SEL_{cum} HF-weighted (HF-weighting function for marine mammals with high sensitivity to high frequency sounds – porpoise) and 170 dB re 1 µPa2s 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 must be stopped. Such a situation should be immediately notified to the appropriate regional director for environmental protection, no later than within 7 days of occurrence. Further work may be continued after the implementation of measures agreed in writing with the regional director for environmental protection, in order to exclude the occurrence of noise exceedances.

The technical solutions of the NRS, together with appropriately planned underwater noise monitoring (in accordance with the provisions of Section 16.1.2.), will be submitted to the competent authority at least 2 months prior to the commencement of piling. The following is a description of examples of noise reduction measures currently available and applied.

Big Bubble Curtain – BBC

This technical solution consists 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 depth from the holes in the tube walls rises in the form of bubbles towards the sea surface, forming a kind of curtain. The underwater noise generated by the pile driver strikes is partially dissipated on the air bubbles travelling upwards, which results in reduced noise levels in the marine environment [Koschinski and Lüdermann 2013].

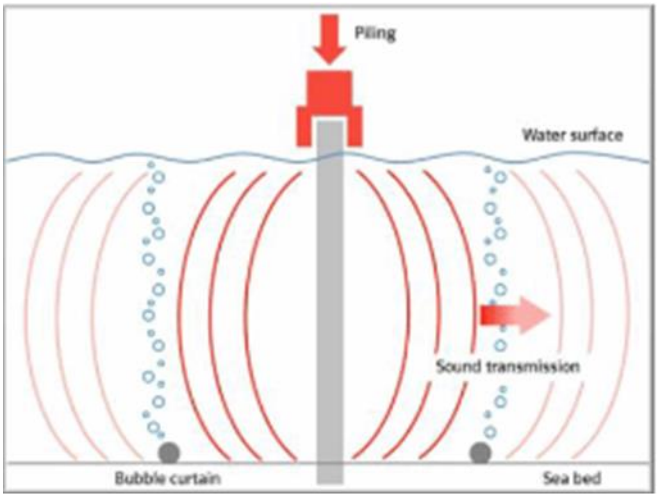

Figure 3.8. Schematic operation of a big bubble curtain [Source: E.ON Climate & Renewables 2011]

Depending on the substrate and the configuration of the big bubble curtain, the noise reduction value will vary [ibid.]. Noise reduction values (dB) obtained in construction projects employing the big bubble curtain ranged from 11 to 15 dB SEL at depths of up to 40 m [Grießmann *et al.* 2009, Bellmann 2012]. The application of double bubble curtain systems is possible in order to reduce noise levels propagated underwater even more effectively.

IQIP-NMS Noise Mitigation System

A noise reduction system developed by IQIP. In its basic form, the IQIP-NMS takes 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]. The IQIP-NMS system can consist of several layers with different parameters, e.g. metal, composite, foam, etc., and can feature an integrated bubble curtain to increase the noise mitigation capacity [Van Vessem 2012]. The effectiveness of such a system is 13–17 dB [Bellmann 2020].

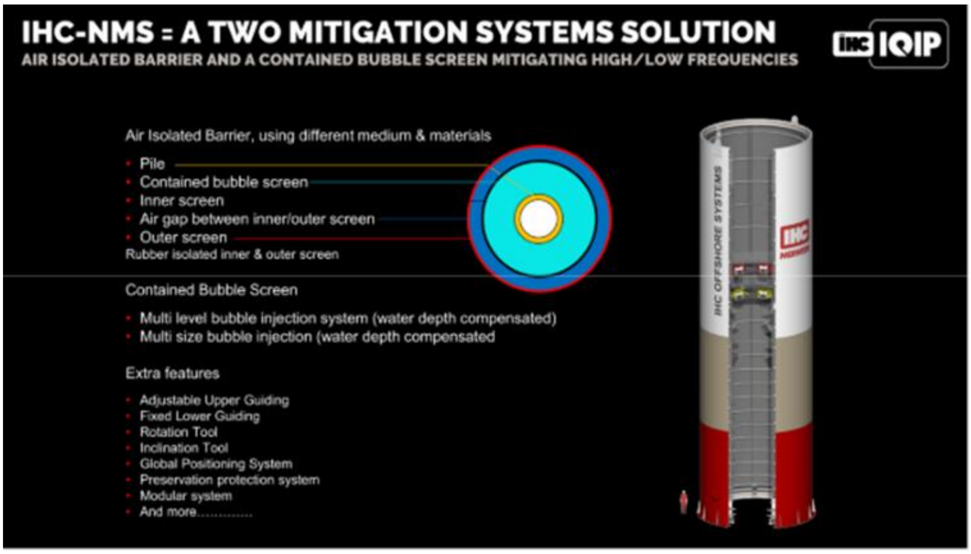

Figure 3.9. Diagram illustrating an IQIP-NMS noise reduction system [Source: Merchant and Robinson 2019]

HSD (Hydro Sound Damper) systems

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. The size, number and configuration of the noise-mitigating elements on the frame are selected to suit the sound characteristics of the source [Lee *et al.*, 2011]. [Elmer *et al.,* 2012].

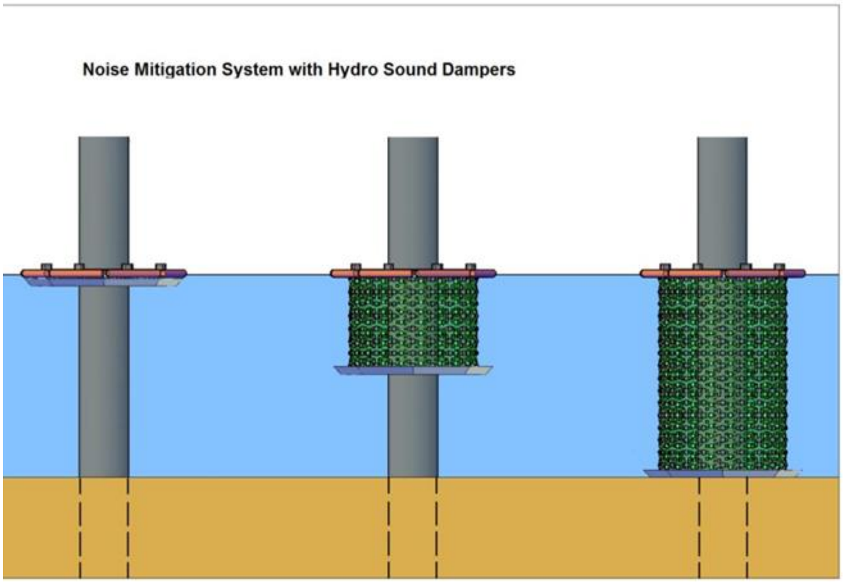

Figure 3.10. Installation of noise reduction dampers around a monopile [Source: Elmer and Savery, 2014]

HSD systems enable underwater noise reduction by 10–12 dB [Bellmann 2020]. In addition, an HSD system can be fitted with a small bubble curtain to increase the effectiveness of the noise reduction.

3.2.2.3 Offshore substations

Offshore substations have various dimensions, depending on the amount of power collected and exported by a given substation. It is assumed that the Baltica-1 OWF will consist of a maximum of four OSSs in the APV (however, in order to optimise costs and enhance the rational use of the sea basin, the construction of one large substation has not been ruled out) and five substations in the RAV.

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. In the case of the HVAC technology, transformer substations are installed, whereas in the case of the HVDC technology, converter substations are installed (also equipped with transformers, but additionally fitted with converter systems).

Usually, 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,
- 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 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.

One of the possible OSS types to be used is an AC substation with a voltage up to 275 kV on the high voltage side of the transformer/transformers located on that substation.

Since it is possible to export power from the offshore wind farm using the HVDC technology, the construction of converter substations in a DC system with converter systems has not been ruled out either. As a result, the possibility of converting alternating current, used in the OWF inter-array connections, into direct current and exporting direct current to land is also not excluded. To implement such a solution, it is necessary to use a converter substation with systems converting alternating current (AC) to direct current (DC). The converter substation can be executed as a separate substation, constructed independently of the OSS, but can also be integrated with the OSS after being fitted with the necessary voltage converting systems.

In the case of the HVAC technology, the number of OSSs can be more than one (up to 4), depending on cost analyses as well as availability and reliability assumptions. A maximum of one converter substation with the possibility of up to three transformer substations is foreseen for the HVDC technology. In the RAV, five OSSs are to be constructed.

The anticipated maximum dimensions of the offshore transformer station are 50/40/45 m (length/width/height) and the offshore converter station – 110/80/60 m.

The converter substation typically consists of the following elements:

- transformer and thyristor or transistor system,
- harmonic filters,
- capacitor banks,
- shunt reactors,
- cooling system,
- instrumentation and controls,

- control and communication equipment,
- backup power systems including fuel.

If the DC technology is utilised, HVAC transformer substations, connected with the converter substation, can be used.

During the construction, operation and decommissioning phases, access to substations will be from vessels conducting construction and installation works. During the operation phase, access will be from vessels, SOVs, via walk-to-work gangways, or from CTVs, or by helicopter.

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.). It is possible to use monopile, jacket, as well as gravity-based foundations. In the case of large converter stations, installation is possible on more than one foundation. In addition, it may be necessary to reinforce the seabed around the foundation with rip-rap.

The parameters of the OSS foundations will be largely identical to those described in Section 3.2.2.2. The most important technical parameters of the OSS foundations, including those relating to the possibility of installing large transformer-converter stations on several foundations at the same time, are provided in Table 3.11.

Table 3.11. Technical parameters of OSS foundations

Parameter	Value
Monopile foundation	
Seabed footprint per foundation (maximum)	115 m^2
Seabed footprint per foundation, including erosion protection	3100 m^2
One large transformer-converter station	
Seabed area occupied by 6 foundations (maximum)	690 m^2
Seabed area occupied by 6 foundations, including erosion protection	14 000 m^2
Jacket foundation	
Seabed footprint per foundation (maximum)	800 m^2
Seabed footprint per single foundation including the erosion protection	3500 m^2
One large transformer-converter station	
Seabed area occupied by 2 foundations (maximum)	4500 m^2
Seabed area occupied by 2 foundations, including erosion protection	9600 m^2
Gravity-based structure	
Seabed footprint per foundation (maximum)	2400 m^2
Seabed footprint per foundation, including erosion protection	28 000 m^2
One large transformer-converter station	
Seabed area occupied by 4 foundations (maximum)	4000 m^2
Seabed area occupied by 4 foundations, including erosion protection	21 000 m^2

The following sequence is applied for OSS installation:

- preparation of the OSS foundations / support structures and their installation in the target location.

The foundations are transported to the target location by a suitable vessel or barge. Next, they are installed in the seabed using a heavy lift crane vessel (HLCV). The method used for foundation installation depends on the type of foundation selected;

- transport of the OSS platform by an appropriate installation vessel or barge to the target location, and its installation on the foundation / support structure prepared in the target location, using an HLCV,
- installation of a self-supporting OSS structure including topside;
- installation and connection of MV and HV cables;
- commissioning.

3.2.2.4 Connection infrastructure between wind turbines as well as between turbines and offshore substations

3.2.2.4.1 Characteristics of power cable lines

The system of inter-array connections of the Baltica-1 OWF will consist of medium voltage (MV) or high voltage (HV) offshore cable systems connecting the wind turbines into assemblies (circuits/sections) with one or several MV/HV or HV/LV offshore substations, as well as the necessary teletechnical and telecommunication connections in the form of fibre optic lines, integrated into the power cables or in separate teletechnical lines, laid in parallel with the power cables.

Three-phase cables with three copper or aluminium conductors, operating in AC technology, will be used in the construction of the Baltica-1 OWF cable lines. Conductors inside the cables are covered with a multilayer sheath that fulfils insulating, shielding and protective functions. Fibre optic bundles may also be present inside the cable [Figure 3.11]. The cables will meet standards and certifications confirming approval for use in the marine environment.

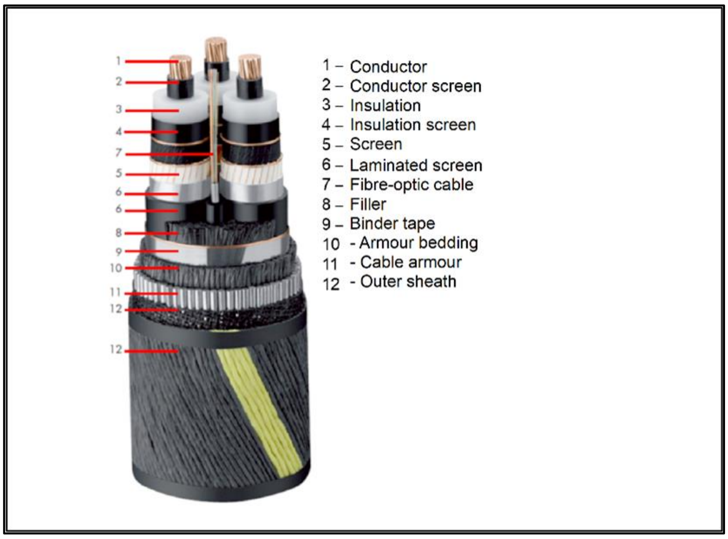

Figure 3.11. The structure of a typical three-phase AC power cable

At the current stage, it is impossible to determine detailed rated parameters of subsea cables, taking into consideration the unknown rated capacity of the offshore wind turbines planned to be installed and their mutual configuration in the Baltica-1 OWF Area and the location of the OSSs. Depending on the wind turbines used and the power take-off solutions adopted, AC multi-conductor subsea cables with cross-sections depending on the design load – up to a maximum of 2500 mm^2, with a maximum rated voltage of 66 kV or 132 kV – can be used. The actual voltage and size of the cables will be determined with the progress of work and optimisations implemented in the Project.

The method of laying cable networks that are part of the inter-array system of wind turbines and the OSSs will depend on the technical requirements and the requirements of the manufacturer of the cable system used as well as the parameters and the topology of the cable route, as well as the geophysical, geotechnical and environmental conditions associated with the route selected.

The decision regarding the selection of the technology for laying and securing the cable lines will be made at the stage of the detailed design for the cable lines, after the Cable Burial Risk Assessment has been developed.

Individual power cables, which will be used to connect individual wind turbines with OSSs, will join up to a maximum of 6 wind turbines in a series, assuming that alternating current (AC) technology cables with a 66 kV rated voltage are used. For the 66 kV AC cables, the maximum load capacity is 90 MW. The possibility of using a cable technology with a rated voltage of 132 kV is also assumed; in that case, a maximum of up to 10 wind turbines with a capacity of 15 MW can be connected in a series. The maximum operating temperature of power cable main conductors will be 90°C.

The depth of power cable burial in the seabed along the majority of the cable route will be approximately 3 MBSB. Considering local conditions associated with the structure of the seabed, the cables may be buried deeper – up to 6 MBSB.

The maximum total length of inter-array cables in the OWF is anticipated to be 140 km in the APV, and 150 km in the RAV.

Since cable lines are to be laid in the seabed using remotely operated vehicles (ROVs) that will bury the cable in the seabed using the technique of seabed fluidisation or ploughing with simultaneous cable burial using the excavated material, no excavations in the seabed are anticipated.

3.2.2.4.2 Cable line construction technologies in the Baltica-1 OWF Area

Cable lines comprised in the system connecting the wind turbines and the OSSs are laid after the installation of the wind turbine and OSS foundations, including the transition pieces.

The installation of MV or HV cables on the seabed is carried out using a specialist cable-laying vessel. For that type of work, trenching and burial equipment is used, which is deployed to the seabed from aboard the cable layer. The operation of such devices is monitored using an ROV. The cable itself is laid from aboard a cable layer; the cable is uncoiled from the reel (carousel) mounted on the vessel [Figure 3.12].

Depending on the geological conditions, the length of the sections to be laid and the cable parameters, other cable-laying methods can also be used, including trenchless methods and typical methods used for laying HV export cables, for example ploughing that involves a plough dragged behind the vessel, from which the cable is supplied and inserted directly into the seabed to the required depth behind the ploughshare. After laying, cables are pulled into the wind turbines and the OSSs, where they are installed in electrical switch rooms.

Figure 3.12. Example of a cable layer conducting complex operations related to subsea cable laying [Source: nexans.com]

When laying cable lines in the seabed or on its surface, various types of machinery and equipment which bury the cable in the seabed are used to construct a cable trench of an appropriate depth. The first group is jetting equipment with heavy-duty seawater pumping systems. This equipment uses seawater which is injected under pressure into the sediment to produce a trench, the route of which is aligned with the movement of the equipment. They are also used to bury a cable previously laid on the seabed into soft sediments such as silt or loose and medium-grained sand. Such equipment can be installed on sleds or self-propelled crawlers [Figure 3.13]. The lances of the jetting equipment have numerous nozzles generating water jets and loosening the seabed sediment in which the cable is buried, as shown in Figure 3.14.

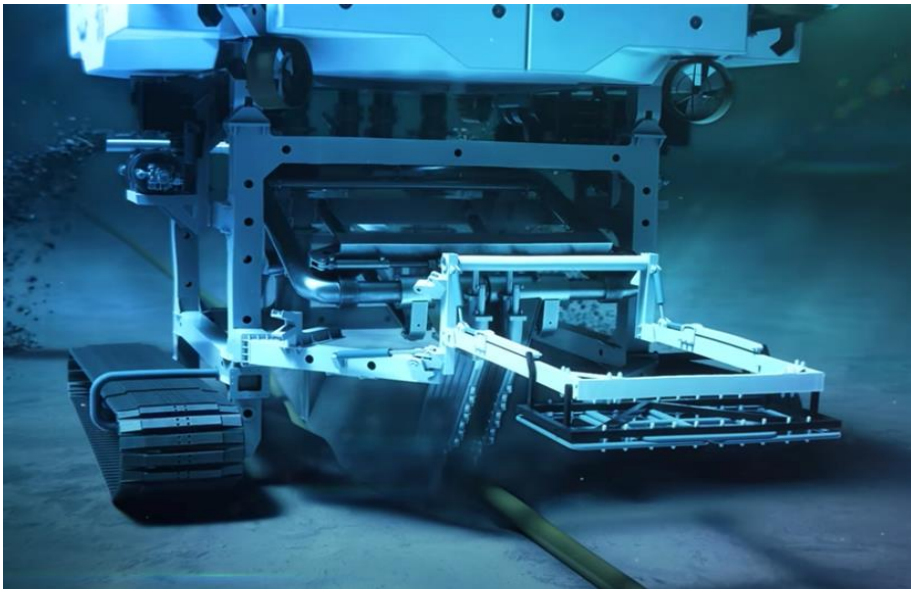

Figure 3.13. Jetting equipment example [Source: FUGRO]

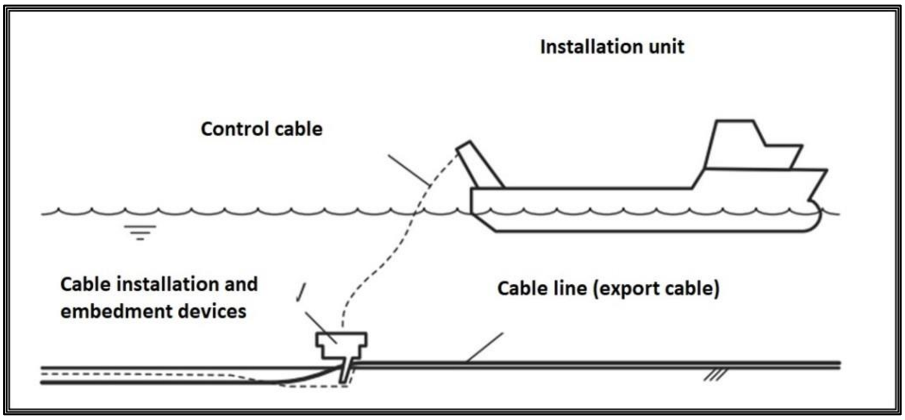

Figure 3.14. Cable laying technology – burial of a cable previously laid on the seabed [Source: DNV]

Another group of equipment used for laying subsea cables are mechanical dredgers excavating trenches in the seabed, which can be used for simultaneous cable laying and burial, the burial of cable previously laid on the seabed, as well as the excavation of trenches before cable laying in harder sediments, such as till or compact fine-grained sand [Figure 3.15]. The device is equipped with a movable chain with blades that cut a narrow trench in the seabed. The blades are replaceable and can be adjusted to specific soil conditions. When a trench is excavated along a seabed section with hard (rocky) bottom or in compact boulder areas, an attachment with a cutting wheel is used in mechanical dredgers. A diagram of a trench excavated with a mechanical dredger is shown in Figure 3.16.

Figure 3.15. Example of a mechanical dredger [Source: boskalis.com]

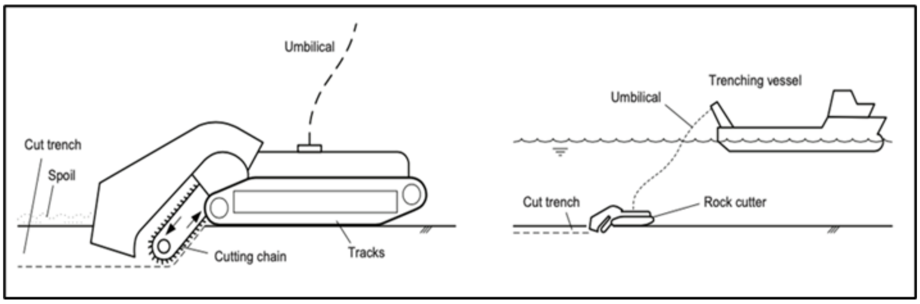

Figure 3.16. Mechanical trencher [Source: rules.dnv.com]

The last group of equipment used during the construction of cable lines are cable ploughs [Figure 3.17]. Such devices enable simultaneous cable laying and burial in the seabed sediment. Thanks to this, they are commonly used to optimise costs and work time. The cable plough dragged behind the moving vessel on a line creates a hollow in the seabed, at the same time laying a cable inside it using a depressor [Figure 3.18]. Some devices have additional systems for injecting water into the sediment, which makes it easier for the ploughshare to penetrate it.

Figure 3.17. Example of a cable plough [Source: https://www.youtube.com/watch?v=wblle4zRA2M]

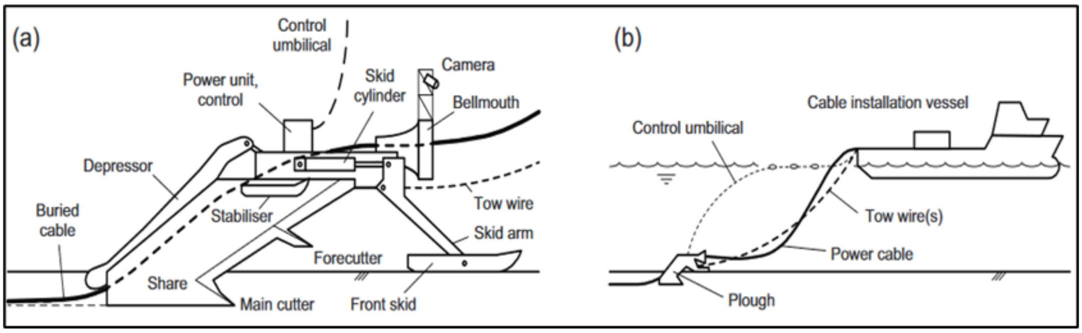

Figure 3.18. Cable laying technology using a cable plough [Source: rules.dnv.com]

Regardless of the type of cable line construction technology, it is assumed that the width of the seabed strip covered by subsea works for the cable line will be up to 16 m. This value corresponds to the maximum width of the seabed zone subject to the clearance of obstacles that would prevent cable laying, or the maximum spacing of the tracks of the equipment used for cable line construction.

3.2.2.4.3 Technical solutions in the case of intersections with a third-party infrastructure

It is possible that cable line burial will not be possible along the entire length due to obstacles present on or under the seabed surface, mainly other infrastructural elements present in the Baltica-1 OWF construction area. If it is impossible to change the cable line route in order to avoid such an obstacle, e.g. 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 systems.

Four main methods for protecting cables laid on the seabed surface and at intersections with third-party infrastructure can be distinguished, as described below:

- rock dump,
- rock bags,
- concrete mattresses,

- reinforced concrete half-shells, casing pipes, and protective HDPE fittings.

3.2.2.4.3.1 Rock dump

This method involves levelling the substrate in/at which the third-party infrastructure is located and covering it with a rock layer. The cable line is laid on an aggregate substrate prepared in that way, and then it is secured by rock dumping from the top. This is a universal method for protecting subsea cables; however, its disadvantage is a risk of the cable line being washed out if the dump volume or rock grading is incorrect. Figure 3.19 presents a rock dump structure and Figure 3.20 illustrates its construction method.

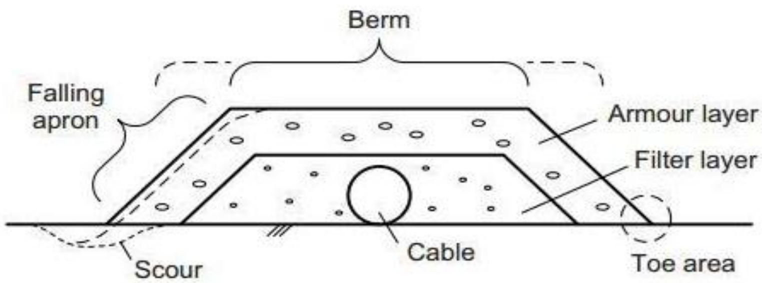

Figure 3.19. Cross-section of a rock dump used for protecting a subsea cable laid on the seabed surface

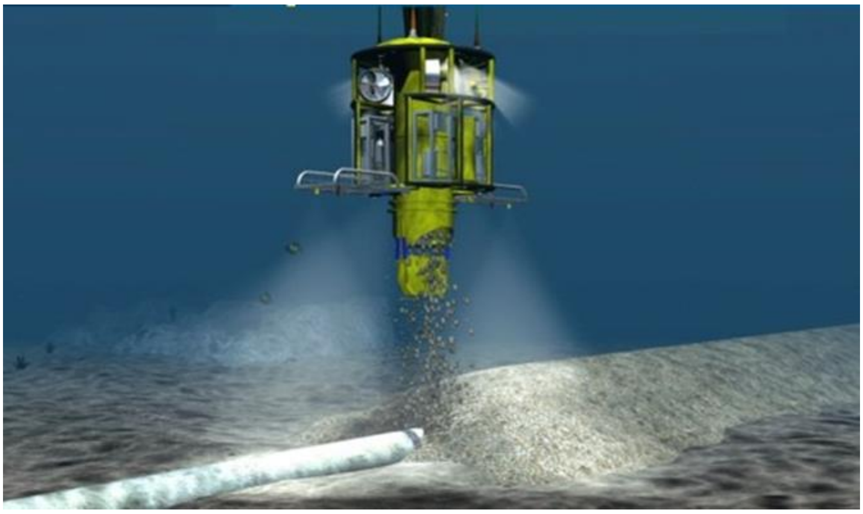

Figure 3.20. Visualisation of a rock berm construction [Source: offshore-fleet.com]

3.2.2.4.3.2 Rock bags

Rock bags can be used in the same way as rock dumps, but usually smaller grade stones wrapped with durable fibre nets are used [Figure 3.21]. The applications include protection against seabed scrubbing (e.g. by bottom trawls) around cable routes leading to offshore structures. The vessels installing rock bags can differ from fall pipe vessels used for placing rock material on the seabed. This method is universally applied. Compared with rock dumping, its advantage is that the aggregate is enclosed in durable nets preventing the aggregate as well as the protected infrastructure and cable lines from being washed away from the seabed.

Figure 3.21. Method of constructing and laying rock bags on a cable line [Source: bluemont.com.au]

3.2.2.4.3.3 Concrete structures

Concrete structures are a solution in which prefabricated concrete elements are used to provide protection of crossings; they are arranged specifically to separate the existing third-party infrastructure from the cable lines being laid [Figure 3.22]. The advantage of this method is a short execution time. Its disadvantage is the limited applicability due to the geometry, dimensions and angle of intersection with the third-party infrastructure. Crossings constructed with the use of concrete prefabricates can also be secured by rock dumping.

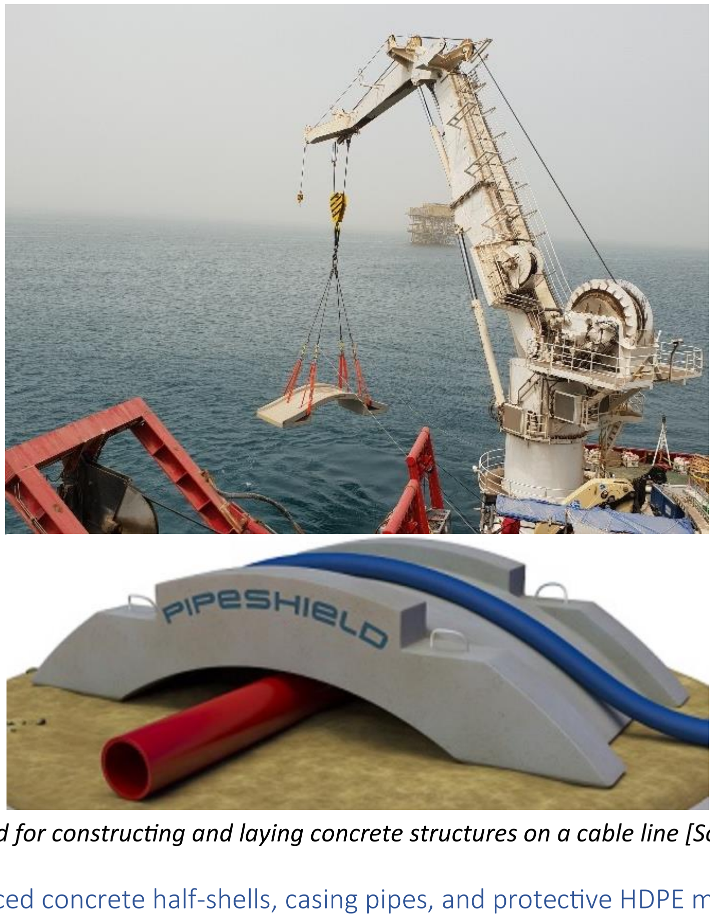

Figure 3.22. Method for constructing and laying concrete structures on a cable line [Source: pipeshield.com]

3.2.2.4.3.4 Reinforced concrete half-shells, casing pipes, and protective HDPE mouldings

In certain circumstances, rock protection may not be optimal due to such factors as velocity of near-seabed currents, bathymetry, and type of seabed sediments. An alternative to this form of cable protection can be the use of half-shells (articulated pipes) or a modern equivalent of hybrid polyurethane pipes [Figure 3.23]. Apart from cable protection, these structures provide ballast and stability for the pipes laid on the seabed.

Protective HDPE mouldings are a solution intended for cable line protection involving the installation of polyethylene flanges, which enables line protection and separation at infrastructure crossings. Moulding systems connected to one another and to the cable in a flexible manner that prevents them from moving along the cable allow the creation of flexible flowlines of desired length. If necessary, the protective mouldings can be additionally supplied with concrete or lead ballast systems. The solution is used in situations when it is impossible to lay the cable below the seabed level.

Figure 3.23. Reinforced concrete half-shells, casing pipes, and protective HDPE mouldings used for protecting power cables laid on the seabed [Source: crpsubsea.com]

3.2.2.5 Types and number of vessels involved in offshore operations

The specialist vessels that will operate during the construction of the Baltica-1 OWF can be divided into three main groups:

- small vessels (ships), e.g.: CTV, guard vessels, and tugs[5];
- medium-sized vessels (ships), e.g.: SOV, specialist vessels, cable layers[6];
- large vessels (ships), e.g.: installation vessels supporting the installation of foundations and elements of wind turbines, such as: HLCV, HLJV, dredgers, and rock dumping vessels[7].

For the installation of foundations on the seabed, usually heavy-duty installation vessels are used. In the past, such operations were also carried out by vessels intended for turbine installation; however, as foundations increased in size and companies from the offshore wind energy supply chain expanded their investments, various vessels have been designed that are better suited to the above purposes and do not require leg installation on the seabed. Examples of new generation vessels that are currently under construction include:

a) DEME 'Orion' – specification provided on the shipowner's website: length 216.50 m, crane with a capacity of 5000 tonnes, accommodation for 160 persons (extendable to 239 persons), equipped with a dynamic positioning system; available on the market;

[5] The group includes: CTVs, vessels supporting coordination tasks, commissioning, light installation works, tugs and guard vessels.
[6]The group includes: vessels used for transporting elements, vessels used for noise reduction solutions.
[7] The group includes: HLCVs, JUVs, CLVs, vessels supporting the construction of scour protection systems.

b) 'Seaway Alfa Lift' – specification provided on the shipowner's website: length of 217.88 m, crane capacity of 3000 tonnes, accommodation for 100 persons, equipped with a dynamic positioning system; vessel under construction;
c) Jan de Nul 'Les Alizes' – specification provided on the shipowner's website: length 236.80 m, crane with a capacity of 5000 tonnes, accommodation for 120 persons, equipped with a dynamic positioning system; under mobilisation for the project.

In the process of delivering foundations to an OWF construction area, both installation vessels as well as barges and tugs of various sizes are used, depending on the dimensions of the structural elements transported, the logistic strategy and the equipment stock available.

In order to prepare the substrate for the gravity-based structures and spudcans of jack-up installation vessels and to provide erosion protection, auxiliary vessels such as dredgers and rock-dumping vessels are used for transporting sediments, as well as for transporting and dumping riprap. Additionally, one or two vessels with appropriate installation capabilities are used in the cable laying process, depending on the scope of work adopted. To provide scour protection, a specialist supporting rock dumping vessel is used that is capable of transporting and dumping aggregates around the foundation constructed. The rock dumping vessel is equipped with at least one cargo hold for aggregates, auxiliary cranes and a dynamic positioning system.

Usually, the turbine installation is carried out using a heavy lift jack-up vessel (HLJV), which, depending on the size of the deck available and the size of turbine elements, can transport several turbine assemblies and install them in the wind farm area in a single cycle. Next, the vessel returns to the installation port for re-loading. This type of vessel navigates within the farm area and to the installation port using its own propulsion. The jack-up vessel, using a dynamic positioning system, reaches the target position for lowering the supports (legs) to the seabed in order to install the wind turbines.

Other types of vessels can also be used for turbine installation, for example semi-submersible heavy-lift vessels or other vessels equipped with cranes with a capacity of several thousand tonnes.

In the process of installing foundations and wind turbine elements, consideration should be given to the hydrological and meteorological conditions that could cause potential delays in the installation process.

The vessels with the above parameters will be sufficient to support the construction of the Baltica-1 OWF, as well as the dismantling of its structures during the decommissioning phase.

Used operating fluids will be stored in sealed vessel hull tanks or in tanks on board the vessel intended for that purpose. Operating fluids belonging to various waste groups will not be mixed. Next, they will be transported to land and handed over to a recipient authorised to provide services of professional disposal of liquid waste – either directly or using an intermediary.

3.2.2.6 Vessel traffic related to the construction, operation and decommissioning of the Baltica-1 OWF

The construction process will involve small and large vessels travelling from ports designated by the Project Owner. Vessel traffic will take place along the shortest possible routes, in compliance with navigational safety conditions and regulatory requirements. In general, the traffic of vessels servicing individual phases of the Baltica-1 OWF project will not follow regular shipping routes connecting the ports, because the objective is to perform tasks related to the construction, operation and decommissioning of the OWF located at sea. To a large extent, this resembles e.g. the movement of vessels associated with the operation of oil and gas extraction platforms or navigation associated with fishing activities.

As at the current stage of the Project it is impossible to clearly indicate the location of the installation ports, the assessment of the OWF impact on the safety of navigation must account for all alternative routes.

On the basis of navigation expert reports for other projects already performed and approved, e.g. the Baltica OWF, after comparing the project scale it is possible to estimate the number of cruises necessary for the construction, operation and decommissioning of the Baltica-1 OWF. The relevant data are provided in Table 3.12. The estimates presented in the table for the decommissioning phase may be subject to considerable error. The decades-long perspective of the commencement of this phase and the lack of data on the realistic pace of its progress – as only one very small Vindeby OWF (in Denmark) has been dismantled so far – do not allow for an accurate estimation of the number of cruises. Estimates for the construction phase and a maximum duration of 3 years for this phase were used as a reference, assuming a reduced scope of work in comparison with the construction phase (without the removal of the OWF components buried in the seabed).

Table 3.12. Estimated number of vessel cruises in the individual phases of the Baltica-1 OWF project

Ship class	Construction phase		Operation phase	Decommissioning phase		
	Year 1	**Year 2**	**One year of the operation phase**	**Year 1**	**Year 2**	**Year 3**
Large and medium-sized vessels	62	82	12–52	80	70	50
Small vessels	301	351	364	350	300	250

3.2.3 Comparison of the technology proposed with the technology compliant with the requirements stated in Article 143 of the Act of 27 April 2001 – *Environmental Protection Law*

Pursuant to Article 143 of the Act of 27 April 2001 – *Environmental Protection Law* (consolidated text: Journal of Laws of 2024, item 54), technologies used in newly launched installations should meet the requirements the determining of which takes into special consideration the following issues:

- use of substances with a low hazard potential;
- effective generation and use of energy;
- ensuring rational consumption of water and other raw materials as well as consumables and fuels;
- use of waste-free and low-waste technologies, and possibility of waste recovery;
- type, range and volume of emissions;
- use of comparable processes and methods which have been effectively applied on an industrial scale
- scientific and technical progress.

This catalogue of requirements refers to the newly launched or significantly modified industrial installations and equipment that are the source of environmental hazards. Due to the technological specification of the construction, exploitation and decommissioning phases, as well as special conditions of operation in the marine environment, offshore wind farms require these conditions to be verified at an early stage of investment planning.

The structural elements of the OWF will be made of materials neutral to sea water and substrate (seabed). The resistance to erosion, corrosion or chemical compounds activity that may occur in the water is a basic condition for failure-free operation of the OWF.

Efficiency of energy generation will be one of the basic criteria for the selection and distribution of wind turbines. The overriding criterion of energy efficiency is energy generation, with obvious limitations related to the windiness of the sea basin, without the consumption of energy resources – in a fully renewable manner.

In the case of this type of renewable energy sector, the actual efficiency of energy use involves non-returnable energy consumption for the production of OWF components (mainly wind turbines, foundations, OSSs and power cables) and their installation at sea.

The consumption of water, materials, raw materials and fuels will take place during the construction process (installation of wind turbines and OSSs, as well as laying of subsea cable lines) and during the decommissioning of OWF elements after they are technically worn out. For the 35-year period of operation, it will be necessary to use consumables, fuel and tap water during maintenance activities of the OWF components.

Emissions and their extent will mainly concern acoustic impacts accompanying the wind turbine and OSS construction during piling activities. The analysis of the sound impact on the environment is provided in Sections 10.2 and 10.3.

The most advanced and verified technological solutions will be applied for the execution of the Baltica-1 OWF to ensure effective operation of the Project in the marine environment with highly variable wind conditions throughout its lifetime.

4 DESCRIPTION OF THE INDIVIDUAL PHASES OF THE PROJECT – APPLICANT PROPOSED VARIANT AND REASONABLE ALTERNATIVE VARIANT

4.1 GENERAL INFORMATION RELATING TO ALL PHASES OF THE PROJECT

Due to the location of the proposed Project within the maritime area, all related activities, in all 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 with the use of various types of vessels:

- construction and installation vessels – large, specialised vessels providing an advanced level of safety, equipped with dynamic positioning systems (with varying degrees of security), not requiring anchoring during work. Such vessels can often be fully stabilised in position during their operations thanks to a system of supports resting on the seabed – jack-up vessels;
- rock dumping vessels – auxiliary vessels used for providing scour protection, capable of transporting and dumping aggregates to a designated seabed area. The rock dumping vessel is equipped with at least one cargo hold for aggregates, auxiliary cranes and a dynamic positioning system;
- dredgers – vessels performing seabed dredging operations. The most commonly used dredging solution is suction hopper-dredger technology, which consists in excavating the seabed sediment and sucking the resulting slurry to the sea surface via a suction pipe;
- transport vessels – universal or specialised vessels adapted to transporting large structures (including foundations or support structures, towers, nacelles, and blades), often equipped with dynamic positioning systems;
- transport barges (platforms) – vessels used for transporting large structural elements to the site, usually without their own drive, using pushers or tugs;
- pushers and tugs – auxiliary vessels used for manoeuvring larger vessels, transport barges or for transporting large structural elements (e.g. foundations or support structures for wind turbines) from ports to the place of installation;
- service vessels - usually smaller vessels, used for transporting OWF service personnel or consumable materials, adapted for mooring to the towers of wind turbines or accompanying platforms and enabling a safe transfer of people and smaller equipment to structural elements of OWFs.

In certain cases, helicopters can be used for transporting vessel crews and service personnel, or in emergency situations.

Activities related to the transport of large-size structural elements of OWFs must be carried out from ports that meet specific requirements, i.e. in particular:

- sufficient length and bearing capacity of the quay, allowing the assembly, storage and loading of the OWF structural elements;
- appropriate depth of port basins, allowing for the operation of large construction vessels.

It is assumed, that the estimated size of the area used as a space of storage and potential pre-assembly of OWF structural elements should be approximately 20 ha. The quay at which works related to loading of these elements on ships are possible should be approximately 300 m long and should have the appropriate bearing capacity.

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 nearest ports in Poland that can serve as installation ports are the ports of Gdańsk and Gdynia.

During the Baltica-1 OWF operation phase, it will be possible to use smaller ports located closer to the area of the proposed Project than the ports indicated above, i.e. the ports in Władysławowo, Ustka, Łeba, Hel, Darłówek, as well as Kołobrzeg or Dziwnów. PGE Baltica is implementing the construction of an operations and maintenance base in Ustka, which is eventually expected to provide services for offshore wind farms.

Pursuant to Article 24(1) of the Act of 21 March 1991 *on the maritime areas of the Republic of Poland and maritime administration* (consolidated text: Journal of Laws of 2023, item 960), a director of the maritime office managing the given area will be able to establish, by way of a regulation, safety zones around all OWF structures or around complexes of these structures located at a distance of up to 1000 m from one another, adjusted to the type and purpose of artificial islands, structures and devices or their complexes, reaching out not more than 500 m from each point of their external edge, unless a different range of the zone is permitted by generally accepted international standards or recommended by a competent international organisation. In the regulation issued, the director of the maritime office shall define the conditions for navigation within the established zones, including in particular restrictions regarding navigation, fishing, water sports, diving and underwater work.

The information about activities conducted during the OWF construction phase, the establishment of safety zones around OWF structures, as well as about a total or partial decommissioning of the OWF will be published in official publications of the Hydrographic Office of the Polish Navy.

In each phase of the Baltica-1 OWF implementation, mandatory legal requirements and good practices will be applied regarding waste and sewage treatment. A list of anticipated waste types and maximum estimated quantities is provided in the tables below [Table 5.6, Table 5.10, and Table 5.13], accompanying the descriptions of individual phases.

All vessels involved in the entire Project will meet the requirements and will comply with the regulations resulting from the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78), including in particular the procedures contained in "Shipboard Oil Pollution Emergency Plans".

Moreover, throughout the Baltica-1 OWF installations, should the Project Owner be unable to use dry transformers, measures will be applied to prevent the spillage of hazardous substances along with measures to eliminate the effects of a possible spillage of hazardous substances (e.g. trays capturing possible spillages of transformer oil) as well as measures to eliminate the effects of spillage of these substances (e.g. sorbents). The oil-polluted water produced during the works will be collected and separated to obtain oil-derivative concentrations below 15 ppm and the oil obtained from the separation process will be stored and transferred in appropriate containers to specialised waste disposal companies.

The same shall apply in the case of other waste, including other hazardous waste – it shall be sorted, collected in specially marked and secured containers, transported ashore and transferred to specialised companies for utilisation.

4.2 CONSTRUCTION PHASE

The Baltica-1 OWF construction 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:

- seabed preparation before setting foundations or support structures for wind turbines and OSSs. The type of preparation works will be determined by the geological conditions at the foundation sites and the foundation type used;
- transport and installation of the OWF foundations or support structures in the seabed;
- transport and installation of wind turbine and OSS components;
- installation of inner-array cables connecting individual wind turbines, and wind turbines with the OSS.

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

It is assumed that the construction phase will be completed in the shortest possible time lasting approximately 2 years. Before beginning the OWF construction phase, it will be necessary to set up an area on land (construction facilities and storage yards) where the initial assembly of wind turbine components will be performed and where other OWF construction elements will be stored. The area will be located within the port or shipyard infrastructure existing for the duration of the Project, with direct or very good access to a quay dedicated to the operations of loading and unloading of vessels involved in the construction process and subsequent maintenance of the OWF. Individual OWF elements will be transported by ships to the Project construction area.

Maritime transportation will be of main significance and the impact of land transportation should be minimal. Land transportation will be carried out using the existing transportation solutions. It is possible that the assembly or production of large-scale elements will take place in port or shipyard areas. Traffic in maritime transportation will take place in areas where so far, it has been small or insignificant. Depending on the selected supply concept, as well as supply and service ports, the transportation system will include transshipment activities and vessel traffic on routes such as port–OWF–port or between ports.

The number of specialist offshore operations related to the Baltica-1 OWF construction phase is directly proportional to the number of structures constructed within the OWF Area, also including the length of the cable lines. The number of offshore operations and their impacts (e.g. fuel consumption, transport emissions) in the APV will be lower than in the RAV due to the lower maximum number of wind turbines and OSSs, and the shorter length of cable lines to be installed.

4.2.1 Preparatory work on the seabed

Before the construction of the Baltica-1 OWF is commenced, preparatory works will be carried out, including for example:

- identification of the seabed morphology (survey engineering), which involves determining the position of natural and man-made elements on the seabed surface or below it, and using that information for planning, designing and constructing elements of the wind farm;

- seabed surveys aimed at identifying the presence of hazardous objects (UXO) using bathymetric, sonar and magnetometer surveys;
- works involving soil investigation to determine its strength and rate of settlement (consolidation);
- dredging works aimed at removing unwanted seabed sediments prior to the installation of gravity-based structures (if used for the foundation of support structures) of wind turbines and OSSs;
- seabed clearance to remove obstacles in the areas of support structure erection, cable installation and jack-up vessel installation, as well as along cable laying routes;
- preliminary removal of bumps and depressions for the purpose of seabed preparation, using one or more dredgers, to enable equipment placement on the seabed;
- in the event of particularly unfavourable ground conditions, it may be necessary to prepare the seabed for the installation of jack-up vessel support legs. Preparation of the seabed may involve local soil replacement or application of a bedding layer using material with higher bearing capacity;
- preparation of the locations of cable crossings with third-party infrastructure (if detected in the area on the basis of magnetometer survey results).

Before the seabed clearance, a survey campaign will be carried out during which a scan of the area will be conducted in search of anomalous objects, e.g. UXO. These usually include unexploded ordnance from World War I or World War II, posing a health and safety hazard in areas where they interfere with the planned location of infrastructure and associated vessel operations.

When UXO items are found, they are either bypassed or removed/detonated on site (Explosive Ordnance Disposal, or EOD). Due to the intensity of the surveys required to accurately identify UXOs, this work cannot be carried out until the planned location of the infrastructure has been confirmed in detail as part of the design work. Therefore, it is currently impossible to determine the number of potential UXO items that may require detonation. Detonation of UXOs is a source of additional noise in the marine environment and therefore may need to be included in the assessments for some receptors. Information on what can be expected from UXO detonation is provided below.

UXO assessments for projects are conducted as the project in question develops (from general to specific), increasing the level of detail. Initially, as part of the environmental surveys, magnetometer surveys are carried out on a sparse grid of survey lines (tens to even hundreds of metres). The purpose of such surveys is to identify large objects, such as wrecks on the seabed. As the OWF project develops and the parameters of the infrastructure layout are established, geophysical surveys are prepared to thoroughly investigate the project area at the site of the planned foundation of infrastructural elements (wind turbines, OWF, cable lines).

For the OWF construction project, a strategy for approaching unexploded ordnance is defined in consultation with a consultant/expert in this field. The information contained therein will determine how to handle the UXO encountered.

For the location of invasive geotechnical investigations, an analysis of the data collected in the area is performed and ALARP certificates are prepared, certifying an acceptably low risk of encountering UXO.

Surveys used in UXO analyses:

- magnetometer surveys;

- sonar surveys;
- bathymetric surveys (involving an echo sounder).

The seabed clearance works will be carried out at the locations of the support structure installation, from which boulders will be removed to enable the execution of foundation works and the installation of jack-up vessel support legs. Clearing works will also be conducted within the installation strip for cable line installation and will be carried out using one of the methods described below:

- removal of stones or boulders using a specialist pre-lay plough;
- removal of stones or boulders using a grappler.

Ploughs are mechanical devices that move passively on the seabed, pulled by a vessel along a designated route. The plough blades, angled towards the direction of pull, push stones and boulders on the seabed to the sides. A common practice is to simultaneously dig a trench with a plough and lay a power cable in that trench. Figure 4.1 presents an example of a plough used for seabed clearing.

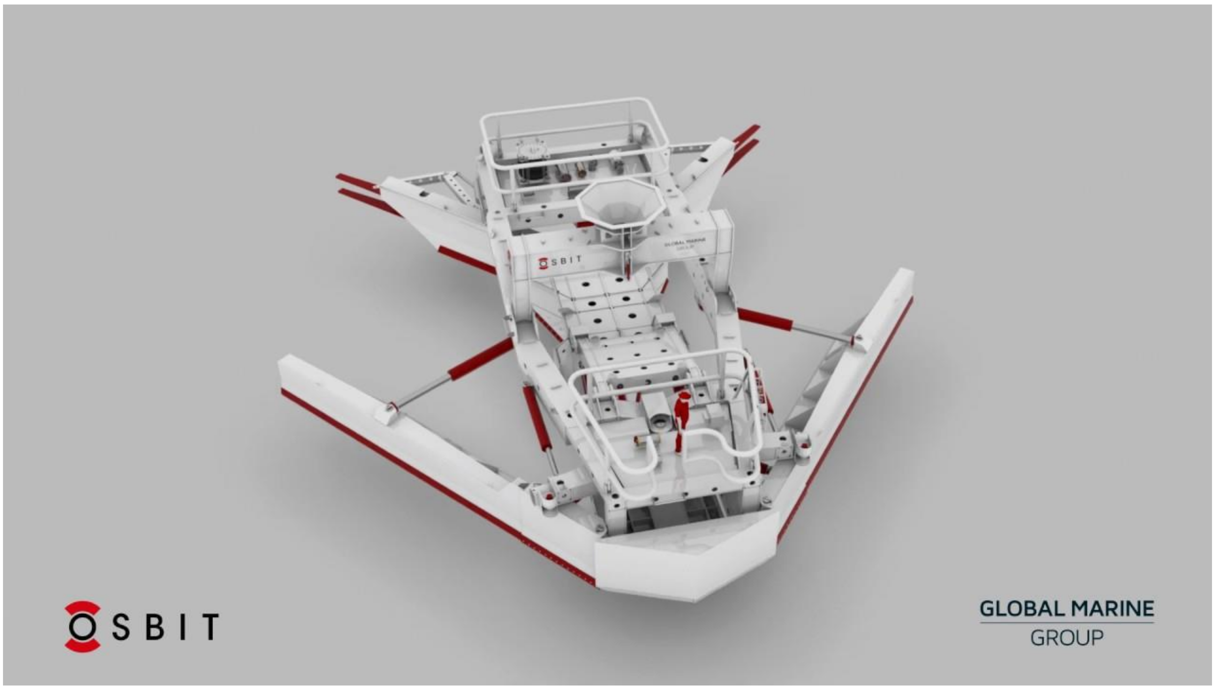

Figure 4.1. Example of a pre-lay subsea plough [Source: www.osbit.com]

Another method of removing and transferring boulders from the cable corridor is to grab large boulders or to collectively grab groups of smaller boulders [Figure 4.2].

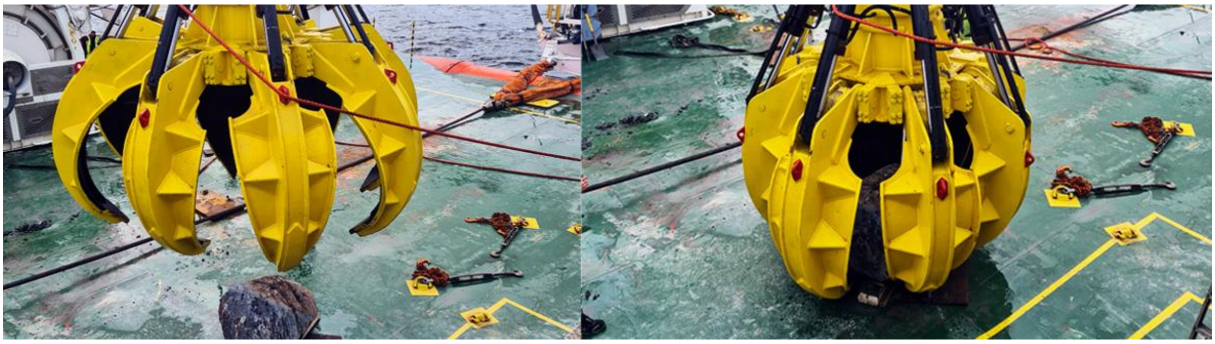

Figure 4.2. Example of a grappler used to remove boulders from the seabed [Source: assogroup.com]

In the areas with obstacles other than boulders and other hard spatial structures present on the seabed, e.g. ropes, cables and fishing gear, etc., preliminary seabed clearance is performed with anchors dragged behind vessels and other hooking tools that can be combined into multifunctional systems, e.g. PLGR – pre-lay grapnel run [Figure 4.3]. The tools ensure effective removal of this type of obstacles from the seabed surface and up to a depth of 0.5 m into the sediment.

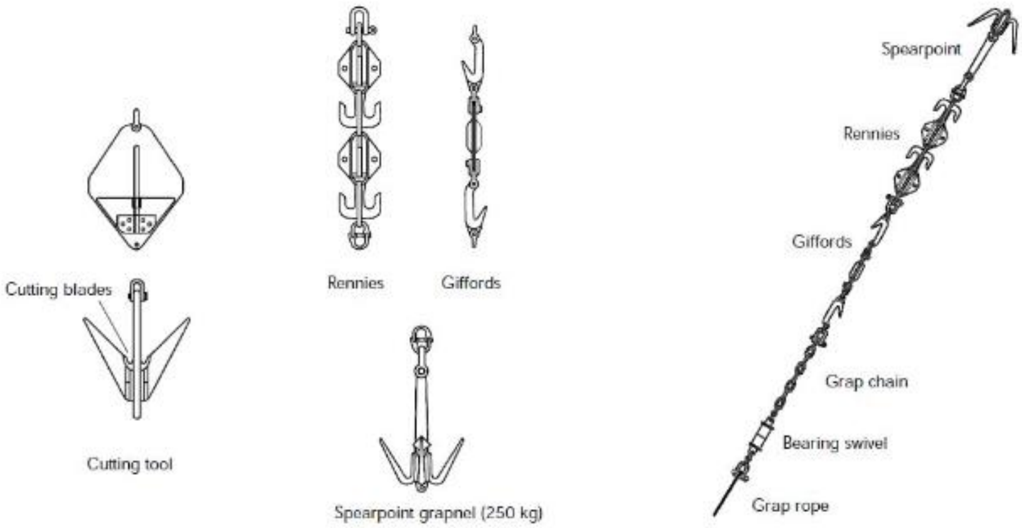

Figure 4.3. Examples of dragged tools used for the seabed pre-lay clearance [Source: HKA Submarine Cable - Chung Hom Kok, Project Profile]

Clearing the seabed of obstacles will be carried out only in the locations where the wind turbine and OSS foundations are erected directly on the seabed. Also, in the case of cable lines, the seabed clearance will be carried out only along those route sections at which obstacles will be identified.

If a decision is made to use gravity-based structures, it will be necessary to dredge the seabed and level it in the location intended for foundations. These operations will be performed by specialist vessels – dredgers and rock-dumping vessels. Seabed levelling will also be carried out in the possible locations of the OWF power cable intersections with other linear infrastructure, if identified within the OWF Area.

4.2.2 Duration and schedule of the Baltica-1 OWF construction

Considering the maximum time values provided in this study for the installation of individual components, and the possibility of performing part of the works simultaneously, the maximum total duration of the Project construction is anticipated at 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 4.4.

Figure 4.4. 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 are able to transport a few of 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, self-propelled 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 taken 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 a 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 (APV: 36–60 turbines);
- gravity-based structures – 1500–2500 hours (APV: 36–60 turbines);
- jacket foundations – 2400–3900 hours (APV: 36–60 turbines).

Depending on the foundation technology adopted, the estimated duration of work related to the installation of only the foundations of the wind turbines in the APV will be:

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

The estimated maximum duration of work related to the installation of all OWF structures in the RAV, depending on the foundation technology adopted, will be:

- monopile foundations – 3100 hours (RAV: 64 turbines);
- gravity based structures – 2600 hours (RAV: 64 turbines);
- jacket foundations – 4100 hours (RAV: 64 turbines).

The estimated maximum duration of work related to the installation of only the foundations of all OWF structures in the RAV, depending on the foundation technology adopted, will be:

- monopile foundations – 1300 hours (RAV: 64 turbines);
- gravity-based structures – 1100 hours (RAV: 64 turbines);
- jacket foundations – 2600 hours (RAV: 64 turbines).

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.

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 requires 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 for 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 will be up to 140 km in the APV and up to 150 km in the RAV. Depending on the scenario adopted, the number of wind turbines will range from 36 to 60 (APV) connected to a maximum of 4 OSSs, or 64 (RAV) connected to a maximum of 5 OSSs.

The preliminary installation time estimated for the cable connections including the insertion of cables into connectors will be 650 man-hours in the APV, and 800 man-hours in the RAV.

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 fluidisation of the seabed sediments is local and temporary (see Section 3.2.2.4.2). Table 4.1 contains excavation parameters for the cable line construction methods considered and most frequently used, which enable the estimation of the excavation volume.

Table 4.1. 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. By default 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.

4.2.3 Vessels involved in the construction of the Baltica-1 construction

For the purpose of the Project discussed, specialist vessels operating during the technological works in the sea area can be divided into three groups, namely:

- small vessels (ships), e.g. CTVs, guard vessels, tugs;
- medium-sized vessels (ships), e.g. SOVs, specialist vessels, cable layers;
- large vessels (ships), e.g.: installation vessels supporting the installation of foundations and elements of wind turbines, such as HLCVs, HLJVs, and rock dumping vessels.

For the installation of foundations on the seabed, usually heavy-duty installation vessels are used. In the past, such operations were also carried out by jack-up vessels intended for turbine installation; however, as foundations increased in size and companies from the offshore wind energy supply chain expanded their investments, various vessels have been designed that are better suited to the above purposes and do not require leg installation on the seabed.

In the event of particularly unfavourable ground conditions, it may be necessary to prepare the seabed for the installation of jack-up vessel support legs, either by using dredgers to prepare the seabed for the location of the jack-up support legs, or by preparing a bedding layer by rock dumping vessels, using material with higher bearing capacity.

To provide scour protection, a supporting rock dumping vessel is used that is capable of transporting and dumping aggregates around the foundation constructed. The rock dumping vessel is equipped with at least one cargo hold for aggregates, auxiliary cranes and a dynamic positioning system.

Usually, wind turbine installation is carried out using a heavy lift jack-up vessel (HLJV), which, depending on the size of the deck available and the size of turbine elements, can transport several turbine assemblies and install them in the farm area in a single cycle. Next, the vessel returns to the installation port for re-loading. This type of vessel navigates within the farm area and to the installation port using its own propulsion. The jack-up vessel, using a dynamic positioning system, reaches the target position for lowering the supports (legs) to the seabed in order to install the wind turbines.

Other types of vessels can also be used for turbine installation, for example semi-submersible heavy-lift vessels or other vessels equipped with cranes with a capacity of several thousand tonnes.

In the process of installing foundations, wind turbine elements, OSSs, and cable lines, consideration should be given to the hydrological and meteorological conditions that could cause potential delays in the installation process.

Taking the above into account, the following vessels are to be used during the construction phase:

a) up to four installation vessels with a length of approximately 250 m, crane capacity up to 5000 t, including up to two crane vessels and up to two jack-up vessels. All vessels equipped with a dynamic positioning system;
b) up to two cable-laying vessels (CLV) with a length of approximately 180 m, with a dynamic positioning system;
c) up to three barges with a length of approximately 120 m each, enabling the transport of structural elements;
d) up to three tugs with a length of up to 75 m;
e) up to four crew transfer vessels (CTV) with a length of up to 50 m;
f) up to two auxiliary vessels with a length of up to 100 meters, used e.g. for bubble curtain installation in order to reduce the impact of noise during the installation of monopiles;
g) one support vessel – a rock dumping vessel with a length of 200 m, for transporting and dumping aggregates in order to provide scour protection;
h) one service operation vessel (SOV) used for commissioning and light installation works;
i) one guard vessel used for monitoring the traffic of other vessels near the wind farm and for warning against hazards;

The aforementioned vessels can also be used in the decommissioning phase for dismantling and transporting the OWF elements, except for the cable-laying vessels, as the undersea cables are not currently expected to be removed after the end of the OWF operation.

Table 4.2 contains a lists and parameters of vessels intended for OWF installation works.

Table 4.2. Parameters of vessels intended for offshore installation works

Vessel	Purpose	Vessel type	Engine power [kW]	Fuel tank capacity [m^3]	Maximum speed [knots]
Crew Transfer Vessel (CTV)	transfer of people	small	up to 1500	up to 15	25–35

Cable Laying Vessel (CLV)	cable laying	medium	10 000 –15 000	1000–1500	12–15
Service Operation Vessel (SOV)	turbine servicing, maintenance works	medium	10 000 – 15 000	400–600	15
Rock Dumping Vessel	provision of erosion control measures	large	20 000 – 25 000	1500–2000	14–16
Heavy Lift Jack-Up Vessel	installation of turbines and foundations	large	15 000 – 25 000	1000–2000	10–14
Crane Vessel	installation of foundations and offshore substations	large	35 000 – 45 000	1500–2000	12–15

4.2.3.1 Installation and service ports

Table 4.3 provides a list of potential ports together with distances to the Project area, whereas Figure 4.5 illustrates the probable shipping routes from these ports.

Table 4.3. List of potential installation and service ports

Port name	Port code	Route length [NM]
Łeba (O&M)	PLLEB	43
Ustka (O&M)	PLUST	60
Gdańsk	PLGDN	90
Rønne	DKRON	104
Klaipėda	LTKLJ	123
Mukran	DEMUK	151
Świnoujście	PLSWI	152
Władysławowo	PLWLA	55

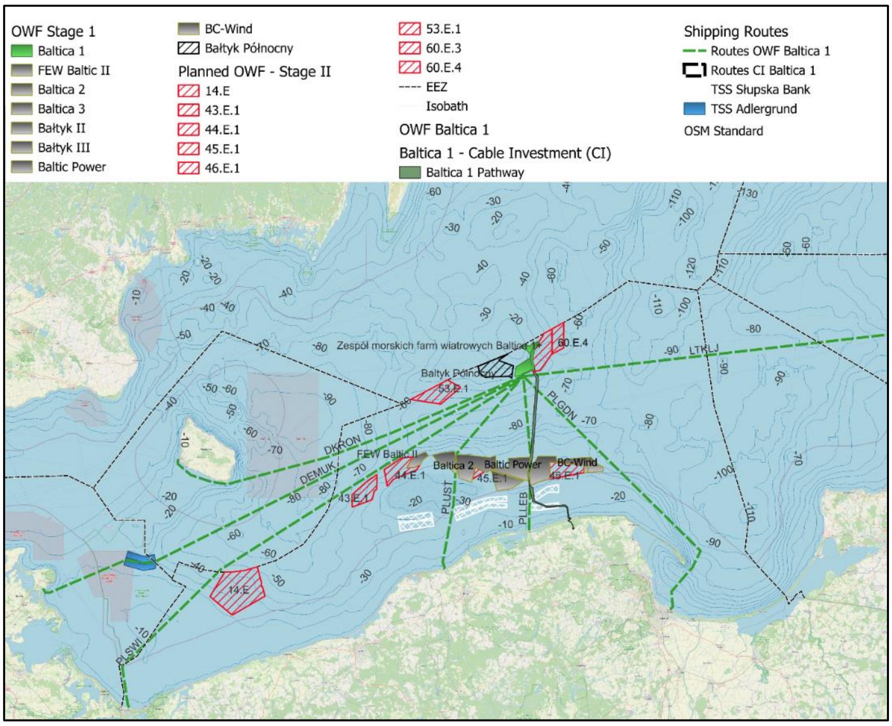

Figure 4.5. Navigation routes from the installation (service) ports to the Baltica-1 OWF Area

4.2.4 Information on energy demand and consumption

During the construction phase, it is not expected that electricity will be drawn from the grid. Energy will be produced from the combustion of fuels by vessel, helicopters, and machinery.

4.2.5 Information on water demand and consumption

During the construction phase, water will be used for welfare needs of vessel crews involved in the construction works. The total water demand throughout the construction phase is expected to be approximately 10 000 m^3. Drinking water tanks will be refilled during port stopovers. After use, water will be stored in waste water tanks and handed over for treatment during the next port call.

The application of the jet trenching technology for cables line installation will involve the use of seawater. A specialist device takes water from the environment and injects it under pressure into the surface layer of the seabed sediment in order to loosen its structure, which enables cable laying. During this process, neither the chemical composition of the water nor its temperature will be changed. The entire water collected will be returned to the environment. Depending on the device used, it is expected that the water flow may reach from approx. 800 to approx. 5000 m^3/h [Atangana *et al.* 2020].

4.2.6 Information on the demand for and consumption of raw materials (including fuels) and consumables

During the construction phase, aggregates are to be used for preparing scour protection for the foundations of the wind turbines and OSSs, and concrete – for filling the gaps between the walls of the drilled holes and the piles. Table 4.4 provides information on the quantity of aggregates to be used for constructing scour protection, depending on the number of OWF structures and the foundation type, as well as the amount of concrete needed to fill the gaps between the walls of the drilled holes and the piles. As indicated in Section 3.2.2.2, filling the gaps with concrete will most probably apply only to a small number of pile foundations, only if their installation has to be preceded by drilling.

Table 4.4. Estimated maximum quantities of aggregates and concrete to be used during the Baltica-1 OWF construction phase

Raw material	Purpose of using the raw material	Anticipated maximum quantities
Aggregate	Creating erosion protection for foundations	36 turbines with a capacity of 25 MW: – 220 000 m^3 (monopile foundation) – 1 500 000 m^3 (gravity-based structure) 60 turbines with a capacity of 15 MW: – 190 000 m^3 (monopile foundation) – 2 000 000 m^3 (gravity-based structure) 64 turbines with a capacity of 14 MW: – 202 667 m^3 (monopile foundation) – 2 134 000 m^3 (gravity-based structure)
	Preparation of riprap for jack-up vessel support legs	18 turbines with a capacity of 25 MW: – 278 000 m^3 (regardless of the foundation type) 30 turbines with a capacity of 15 MW: – 463 500 m^3 (regardless of the foundation type) 32 turbines with a capacity of 14 MW: – 494 500 m^3 (regardless of the foundation type)
Concrete*	Filling the gaps between the walls of the drilled hole and the pile	36 turbines with a capacity of 25 MW: –19 800 m^3 (monopile foundation) –36 000 m^3 (jacket foundation)

Raw material	Purpose of using the raw material	Anticipated maximum quantities
		60 turbines with a capacity of 15 MW: –33 000 m^3 (monopile foundation) –60 000 m^3 (jacket foundation) 64 turbines with a capacity of 14 MW: –35 200 m^3 (monopile foundation) –64 000 m^3 (jacket foundation)

**values considerably overestimated – gap filling with concrete will most probably concern a very small number of foundations*

During the construction phase, fuel will be consumed by the vessels involved in the construction of the Baltica-1 OWF. Table 4.5 presents preliminary information regarding the type and number of vessels to be engaged in the construction works, along with the information regarding their expected daily fuel consumption.

Table 4.5. Estimated fuel consumption of vessels involved in the Baltica-1 OWF construction phase

Vessel size	Expected fuel consumption [kg/h]	Expected daily operation time [h]	Expected number of vessels [pcs]	Expected total daily fuel consumption [Mg]
Large	1000–2000	12–24	7	85–340
Medium	500–1000	12–24	5	30–120
Small	50–500	12–24	10	6–120
Total:				121–580

Considering the scope of work anticipated during the construction phase as well as the number and types of vessels involved in the construction work, the quantities of fuel to be consumed during the construction phase of the Project were estimated. The estimated fuel quantities are presented in Table 4.6.

Table 4.6. Estimated fuel consumption of vessels during the Baltica-1 OWF construction phase

Variant		APV (36 turbines)	APV (60 turbines)	RAV (64 turbines)
Anticipated daily fuel consumption		120–480 t/day		
Net working days at the implementation stage*		350 days	470 days	510 days
Fuel consumption at the implementation stage	Min.	21 000 t	28 000 t	30 000 t
	Max.	84 000 t	112 000 t	120 000 t

**some operations will be conducted simultaneously, hence the number of workdays required to complete the operations is not equal to the number of calendar days during which the operations are conducted. The operation simultaneity coefficient was assumed at level 2.*

Using a helicopter is allowed for transporting technical personnel for the purpose of e.g. crew changes, with average fuel consumption of approximately 500 kg per flight-hour.

4.3 Operation phase

4.3.1 Activities to be implemented during the Baltica-1 OWF operation phase

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 to be 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.

Table 4.7 provides an example of an inspection schedule for OWF elements as well as the most common repairs, together with an estimated duration of such works per year.

Table 4.7. Example of a schedule of inspections and repairs of the Baltica-1 OWF elements

Group of tasks	Element	Task type	Number of elements		Average (active**) maintenance time [h/year]	
			APV*	RAV	APV*	RAV
Failure above the waterline	Wind turbine	General minor repairs	60	64	2600	2800
	Wind turbine	General major repairs	60	64	340	360
	Wind turbine	Replacement of major components	60	64	170	190
Failure below the waterline	Wind turbine – foundation	General minor repairs	60	64	70	80
	Wind turbine – foundation	General major repairs	60	64	20	20
	OSS – foundation	General minor repairs	1 (4)	5	1.1 (4.2)	5.3
	OSS – foundation	General major repairs	1 (4)	5	0.3 (1.2)	1.6
	Cable lines	Major repairs and replacements	13 (15)	16	69.9 (80.6)	86.0
Planned, above the waterline	Wind turbine	Annual inspections	60	64	1500	1600
	OSS	Annual inspections	1 (4)	5	24.0 (96.0)	120
Planned, below the waterline	Wind turbine – foundation	Biannual inspections	60	64	1500	1600
	OSS – foundation	Biannual inspections	1 (4)	5	24.0 (96.0)	150.0
	Cable lines	Biannual inspections	13 (15)	16	168.0 (192.0)	192.0

** the values in brackets are presented for the APV, assuming the construction of 4 OSSs*

*** time required to perform the task, excluding the time of transportation to and from the Baltica-1 OWF Area*

4.3.2 Vessels involved in the Baltica-1 OWF operation phase

Unlike the construction phase, this 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 the OWF operation and maintenance will be recorded for this phase. Three variants of operation are 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 trips will significantly increase the intensity of navigation on 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. Therefore, the number of operations and their effects (e.g. fuel consumption, emissions related to transport) for the APV will be smaller than for the RAV.

Table 4.8 contains information on the type and number of vessels to be used for inspections and repairs .

Table 4.8. Type and number of vessels involved in inspections and repairs during the Baltica-1 OWF operation phase

Vessel		**Minimum number of vessels required**	
Group	**Type**	**APV**	**RAV**
Small	CTV	2	2
	CTV with helicopter capabilities	1	1
Medium	SOV – works conducted above the waterline	2	2
	OSV – underwater works	2	2
	OSV with ROV capabilities	1	1
Large*	JUV	1	1
	CLV	1	1

**large vessels will be used only in case of major failures resulting in the need for replacing large OWF components (e.g. a rotor, nacelle, replacement of a cable line section)*

In emergency situations when the use of vessels is impossible, it is assumed that a helicopter can be used for transporting service personnel.

4.3.3 Information on energy demand and consumption

During the operation phase, the electricity demand for the OWF will be:

- approximately 1% of the total capacity for auxiliary power consumption during the OWF downtime (low wind conditions preventing the turbine operation);
- a maximum of 3% of the total annual power generation during the OWF operation.

4.3.4 Information on water demand and consumption

During the operation phase, the only demand for potable water will be for the welfare of the personnel performing maintenance and repair works on the vessels conducting these works. The consumption of freshwater on the vessels will be approximately 70 l/person/day.

4.3.5 Information on the demand for and consumption of raw materials (including fuels) and consumables

The number of vessels expected to be involved in the planned as well as ad hoc maintenance and repair operations will be significantly smaller than during the construction phase. The following is preliminary information regarding the type and number of vessels to be involved as service support for the Baltica-1 OWF during the operation phase, in the APV and RAV, along with the information regarding their anticipated daily fuel consumption required for providing maintenance services [Table 4.9] and repair services [Table 4.10].

Table 4.9. Estimated fuel consumption of vessels involved as service support for the Baltica-1 OWF during the operation phase, annually – maintenance activities

Vessel size	Expected fuel consumption [kg/h]	Expected annual number of vessels providing service support for the Baltica-1 OWF [pcs]	Expected total annual vessel operation time [h]	Expected total annual fuel consumption [Mg]
Medium	500–1000	2	3500	3500–7000
Small	50–500	2	8000	800–8000
Total:				4300–15 000

Table 4.10. Estimated fuel consumption of vessels involved as service support for the Baltica-1 OWF during the operation phase, annually – repair activities

Vessel size	Expected fuel consumption [kg/h]	Expected annual number of vessels providing service support for the Baltica-1 OWF [pcs]	Expected total annual vessel operation time [h]	Expected total annual fuel consumption [Mg]
Large	1000–2000	2	400	800–1600
Small	50–500	1	500	25–250
			Total:	825–1850

If a decision is made to build a helipad on the OSS, helicopters can be used for transporting maintenance and repair personnel. It is assumed that the maximum annual operation time of a helicopter will not exceed 400 hours. Table 4.11 contains the estimated quantities of aviation fuel that will be consumed during the operation phase.

Table 4.11. Estimated quantities of aviation fuel to be consumed by helicopters in the operation phase of the Baltica-1 OWF

Variant	APV (36 turbines)	APV (60 turbines)	RAV
Expected fuel consumption	0.5 t/hour		
Total annual fuel consumption	60 t	200 t	210 t
Total fuel consumption during the operation phase	2100 t	7000 t	7350 t

During the operation phase, fuel will also be consumed by diesel generators with a fuel tank, installed at the OSSs, which will be used as emergency power sources for the substations. Test runs of the generators will also be conducted, usually once or twice a year. Refuelling after test runs or emergency power supply will be carried out in accordance with good marine practice by means of a certified flexible hose or a special tank delivered by a vessel (e.g. SOV, PSV, CTV). The installation of one high-power generator (approximately 3000 kVa) is anticipated if one OSS is used, and several smaller generators (approximately 500 kVa) if more OSSs are used. Table 4.12 provides fuel consumption estimates for the power generators.

Table 4.12. Estimated fuel consumption of power generators installed at OSSs

Generator	Expected fuel consumption [l·h^{-1}]	Expected number of vessels	Expected total operating time per year [h]	Expected total fuel consumption per year [l]	Generator sound power [dB]
Power rating approximately 500 kVA	150	2–4 (APV) 5 (RAV)	40	30 000	<85
Power rating approximately 3000 kVA	600	1 (APV)	40	24 000	<100

4.4 DECOMMISSIONING PHASE

4.4.1 Baltica-1 OWF 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 of the wind farm structure and leaving in situ those elements, the removal of which would be too expensive and/or might generate stronger negative 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.

Offshore wind farm decommissioning is a complex process, following the reverse order compared to the construction. First of all, it requires planning, taking into account:

- safety of the decommissioning process;
- minimisation of harmful effects on the environment, including potential pollution as well as impacts on flora and fauna;
- social aspects of decommissioning;
- economic aspects of decommissioning;
- technological aspects of decommissioning available at the time of the OWF dismantling;
- waste management, including recycling or reuse.

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 foundation extending above the seabed will be cut right above its surface. The cut-off foundation part will be transferred 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 cable lines, it is assumed that they will be decommissioned and left in the seabed after the end of the OWF operation.

In summary, decommissioning of the Baltica-1 OWF will involve removing the wind farm elements rising above the seabed surface from the environment. The following will be left in situ:

- fragments of foundations situated below the seabed surface;
- cable lines.

The estimated decommissioning time for the Baltica-1 OWF structures will be approximately 2 to 3 years. This estimate accounts for the time needed to secure the elements left in the seabed.

4.4.2 Vessels involved in the Baltica-1 OWF decommissioning phase

During the decommissioning phase of the Project, the following vessels are expected to be used:

a) two vessels with lengths of up to 250 m, with a crane capacity of up to 5000 tonnes, equipped with a dynamic positioning system (e.g. one jack-up vessel with a high lifting capacity and one crane vessel for loading smaller components);
b) up to three tugs with a length of up to 75 m;
c) up to three barges with lengths of up to 120 m each, enabling the transport of structural elements;
d) up to four crew transfer vessels (CTV) with a length of up to 50 m;
e) one guard vessel used for monitoring the traffic of other vessels near the wind farm area and for warning against hazards;

Vessel parameters will be the same as those used in the construction phase and presented in Table 4.2.

4.4.3 Information on energy demand and consumption

During the decommissioning phase, the electricity required to power the vessels, machinery and equipment will not be drawn from the grid. Energy will be produced from the combustion of fuels by vessels and machinery.

4.4.4 Information on water demand and consumption

In the decommissioning phase, water will be used for the welfare of service vessel crews involved in the construction works. The total water demand throughout the decommissioning is expected to be approximately 1000 m^3. The drinking water tanks are refilled during port stopovers. After use, the water is stored in waste water tanks and handed over for treatment during the next port call.

4.4.5 Information on the demand for and consumption of raw materials (including fuels) and consumables

If a decision is made to decommission the Project, fuel will be consumed by the vessels involved in dismantling the Baltica-1 OWF. Table 4.13 presents the preliminary information regarding the type and number of vessels to be engaged in the dismantling works, along with the information regarding their expected daily fuel consumption. The number of vessels involved in the decommissioning phase will probably be lower than the number of vessels to be engaged in the construction of the Baltica-1 OWF, since only some of the OWF structures are to be dismantled – the power cables and parts of foundation piles are not expected to be removed from the seabed.

Table 4.13. Estimated fuel consumption of vessels involved in the Baltica-1 OWF decommissioning phase

Vessel size	Expected fuel consumption [kg/h]	Expected daily operation time [h]	Expected number of vessels [pcs]	Expected total daily fuel consumption [Mg]
Large	1000–2000	12–24	2	24–96
Medium	500–1000	12–24	3	18–72

Small	50–500	12–24	8	5–96
			Total:	47–264

5 TYPES AND QUANTITIES OF EMISSIONS, INCLUDING WASTE

Exhaust fumes

Exhaust fumes will be emitted by vessels engaged in construction works during the construction phase, maintenance and repairs during the operation phase and dismantling works during the decommissioning phase. In case the helicopters are used to transport people, they will also be a source of exhaust emissions. During the operation phase, the power generators installed in the OSS will also be a source of exhaust emissions. The generators will be used to provide emergency power to the station and for testing purposes once or twice a year.

Noise

Underwater and above-water noise will be generated mainly during the construction and decommissioning phases by vessels and foundation pile driving works. During the operation phase, noise will be emitted mainly by vessels carrying out maintenance work and possible repairs to the Baltica-1 OWF infrastructure.

EMF and heat

EMF and heat emissions will result from the operation of power cables throughout the operation phase of the Baltica-1 OWF.

Waste and domestic sewage

During the construction and decommissioning phases of the Baltica-1 OWF, various types of waste associated with the operation of vessels and equipment used for the construction and disassembly of the offshore wind farm will be generated, while during the operation phase, waste will generated by vessels performing inspection and maintenance work. Information on the anticipated types and quantities of waste generated in each phase of the Project is presented in Sections 5.1.4, 5.2.4 and 5.3.4. Waste compilations cover the implementation of an OWF with 60 and 36 wind turbines in the APV and 64 turbines in the RAV. The waste names and codes are compliant with the Regulation of the Minister of Climate of 2 January 2020 *on the waste catalogue* (Journal of Laws of 2020, item 10) At this stage of the Project development, it is impossible to determine precisely the types or the quantities of waste to be generated; therefore, the tables include all theoretically possible types of waste and the estimates of their maximum expected quantities based on the information regarding the technology assumed to be used.

During the different phases of the Baltica-1 OWF, domestic sewage will be generated by the personnel staying on board the vessels. The number of personnel will vary depending on the phase and operations conducted. It is expected that during the construction phase, a maximum of 400 people will be involved in the implementation of a single operation. The maximum construction time will depend mainly on the number of wind turbines to be installed:

- up to 350 days for the construction of 36 wind turbines (APV);
- up to 470 days for the construction of 60 wind turbines (APV);
- up to 510 days for the construction of 64 wind turbines (RAV).

As far as the operation phase is concerned, the presence of the personnel will result from the planned or *ad hoc* maintenance and repair works. It is expected that one wind turbine will be operated by one team of six people per year, with maintenance work lasting six days.

During the decommissioning phase, a maximum of 350 people will be simultaneously involved in the disassembly works. The estimated time for dismantling works will be 2 to 3 years and will depend mainly on the number of wind turbines installed.

The information on the maximum estimated wastewater volumes for each phase of the Project is presented in Table 5.1.

Table 5.1. Maximum quantities of wastewater generated during the different phases of the Baltica-1 OWF

Project phase	**Maximum estimated amount of wastewater**		
	60 wind turbines	**36 wind turbines**	**64 wind turbines**
Construction	10 000 m^3	7 500 m^3	10 000 m^3
Operation (for 1 year)	350 m^3	350 m^3	350 m^3
Decommissioning	10 000 m^3	7 000 m^3	10 000 m^3

The Project Owner shall require the contractors of all works related to the construction, operation and decommissioning of the offshore wind farm to comply with the legal requirements and good practices regarding waste and wastewater management, with a particular focus on the opportunities resulting from segregation of waste and possible recovery of some of them.

During different phases of the OWF, hazardous materials, including lubricating, fuel and hydraulic oils, will also be applied. Vessels and helicopters as well as those elements of the OWF that will contain such substances shall be appropriately equipped with protective measures against spillage of these substances into the environment (e.g. trays for possible transformer oil spills) and measures to eliminate the effects of spillage of these substances (e.g. sorbents). The oil-polluted water produced during the works (e.g. during equipment cleaning or deck washing activities) shall be collected and separated to obtain oil-derivative concentrations below 15 ppm (in accordance with the MARPOL Convention) and the oil obtained from the separation process shall be stored and transferred in appropriate containers to specialised waste disposal companies.

The same shall apply in the case of other waste, including other hazardous waste – it shall be sorted, collected in specially marked and secured containers, transported ashore and transferred to specialised companies for utilisation. The domestic sewage generated onboard the vessels and in the dwelling spaces available for short-term OSS occupancy by maintenance personnel in case of emergency during the construction, operation and decommissioning of the OWF shall be stored, pre-treated and dumped into the sea or transferred onshore for disposal in accordance with the MARPOL 73/78 Convention and the related regulations aimed at reducing pollution discharges from vessels. Comminuted or crushed food waste shall be the only waste allowed to be dumped from ships at sea. These are allowed to be removed from the ship at a distance of at least 12 nautical miles from the shore (MARPOL Annex V).

The OWF construction process will be planned in such a way as to minimise the amount of work related to the levelling or local dredging of the seabed, therefore no significant amounts of dredged material are expected to be generated. If it is necessary to carry out such works, the material from the seabed dredging and levelling will be managed in accordance with the conditions of the permit of the territorially competent director of the maritime office, within the development area of the Project or in another part of the sea area indicated in the permit. Obtaining a permit for the disposal of material from dredging into the sea will be subject to a separate procedure resulting from the Regulation of the Minister of Transport and Construction of 26 January 2006 *on the procedure for issuing permits for disposal of dredged material at sea and for dumping waste or other substances at sea* (Journal of Laws of 2006, No. 22, item 166). It is also permissible to distribute the material from within the pile in the immediate vicinity of the foundation without emptying it onto a barge. The sediment resulting from excavating trenches for laying cable lines will be used for burying the cable lines laid in trenches.

The techniques applied when laying (sinking) cable lines in the seabed – ploughing, fluidisation of the seabed or cutting chases – are not sources of dredged material. The sediment disturbed will be used for cable burial.

During the construction of the OWF, including the possible localised works related to levelling or localised dredging of the seabed, no material is expected to be removed. The ground from localised dredging of the seabed will either be used to fill in the seabed cavities along the cable line routes or 'distributed' in the vicinity of the excavation, within the limits of the building permit.

In a situation when it becomes necessary to drill prior to pile foundation in the seabed, drill cuttings may form and may need to be excavated to the sea surface. The description of the resulting dredged material handling process is presented in Section 5.1.4.

5.1 Construction phase

5.1.1 Emissions of chemical compounds into the atmosphere

During the construction phase of the Project, chemical compounds will be emitted into the atmosphere from the combustion of diesel oil by vessels involved in the construction of the Baltica-1 OWF. The volume of emissions from fuel combustion was calculated on the basis of data on the expected fuel consumption of the vessels, broken down into the three categories of their size shown in Table 5.2.

Table 5.2. Estimated daily fuel consumption for the vessels involved in the Baltica-1 OWF construction phase

Vessel size	Expected fuel consumption [kg/h]	Expected daily operation time [h]	Expected number of vessels [pcs.]	Expected total daily fuel consumption [Mg]
large	1000–2000	12–24	7	85–340
medium	500–1000	12–24	5	30–120
small	50–500	12–24	10	6–120
			total:	121–580

For such assumptions, the atmospheric emission rates of individual chemical compounds from the vessels were calculated and are shown in Table 5.3.

Table 5.3. Emission factors for diesel oil and estimated emissions of chemical compounds and particulates by vessels during the construction phase of the Baltica-1 OWF

Chemical compounds and particulates	Emission factor [g/kg of fuel][8]	Emissions per day of work [Mg]
nitrogen oxides (NO_x)	13.01	1.5–6.2
non-methane volatile organic compounds (NMVOC)	32 629	3.8–15.5
carbon oxide (CO)	3 377	0.4–1.6

[8] Sulphur content in fuel – 10 mg·kg^{-1} according to the Regulation of the Minister of Economy of 9 October 2015 on the quality requirements for liquid fuels (consolidated text: Journal of Laws of 2023, item 1314). Total oxidisation of sulphur to SO_2 in the combustion process – emission factor SO_2 0.02 g SO_2/kg of fuel was assumed. Unit emissions of nitrogen oxide, NMVOC, carbon oxide and particulate matter from combustion of 1 kg of diesel oil were adopted on the basis of the EMEP/EEA air pollutant emission inventory guidebook 2019 (emission factors for the group 'Non-road mobile sources and machinery'). It was assumed that 100% of NMVOC will consist of a mixture of hydrocarbons (HC) contained in the fuel, which were not combusted. It was assumed that the emission of aromatic hydrocarbons may constitute up to 35% of the sum of hydrocarbons (HC), while the remaining 65% will be aliphatic hydrocarbons [Merkisz, 1998].

Chemical compounds and particulates	Emission factor [g/kg of fuel][8]	Emissions per day of work [Mg]
total suspended particulate (TSP), including up to 100% of PM10 and PM2.5*	10 774	1.3–5.2
sulphur dioxide (SO_2)	2 104	0.25–1.00
aliphatic hydrocarbons (HC al.)	0.02	<0.01
aromatic hydrocarbons (HC ar.)	2 195	0.26–1.04
carbon dioxide (CO_2)	3 206	380–1550

In addition to vessels in the construction phase, helicopters could be used, for example to transport ship crew members. It is expected that in one month the total flight time of helicopters will not exceed 30 hours. Table 5.4 presents the estimates of atmospheric emissions, assuming an average aviation fuel consumption of 500 kg/h.

Table 5.4. Emission factors for aviation fuel and estimated emissions of chemical compounds and particulates by helicopters during the construction phase of the Baltica-1 OWF

Substance	Emission factor [kg/kg of fuel][9]	Emission factor per hour of helicopter flight [kg/h]
carbon dioxide (CO_2)	3.21	1600
nitrogen oxides (NO_x)	0.008	4
carbon oxide (CO)	2.4	1200
non-methane volatile organic compounds (NMVOC)	0.038	19
sulphur oxides (SO_x)	0.002	1

5.1.2 Sound emitted into water and atmosphere

The implementation 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 piling into the seabed (underwater noise) and vessels involved in the construction works (underwater noise and noise emitted into the atmosphere).

5.1.2.1 Sound generated during piling

During the construction phase, in the case of large-diameter pile driving, underwater noise at the source 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 negative 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. A common method of underwater noise attenuation is a bubble curtain. The method consists of pumping air through diffusers installed on the seabed. The resulting curtain created from air bubbles rising towards the sea surface effectively diffuses the sound generated by pile driving. A soft-start procedure, i.e. successive increase in pile driving energy, is also common, allowing marine mammals and fish to move away from the zone of the greatest noise impact.

The description of the modelling results for underwater noise propagation during the construction phase is included in Appendix 3 to the EIA Report.

[9] The carbon dioxide emission factor was adopted according to the U.S. Energy Information Administration data. The remaining indicators were adopted in accordance with the EMEP/EEA air pollutant emission inventory guidebook 2019 – 1.A.3a., 1A.5.b* Aviation, European Environment Agency.

5.1.2.2 Sound emitted by vessels and helicopters

The intensity and frequency of underwater noise generated by vessels depends 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. According to the study by the OSPAR Commission, noise generated by maritime transport can be divided according to vessel types:

- commercial vessels and recreational boats up to 50m in length generate continuous noise of 160–175 dB re 1μPa at a distance of 1m from the source, with frequencies from 1 to 10 kHz;
- commercial vessels of medium tonnage and 50–100 m in length: 165–180 dB re 1μPa at 1 m from the source, with frequencies below 1 kHz;
- large vessels longer than 100 m: 180–190 dB re 1μPa at a distance of 1 m from the source, with frequencies below 200 Hz.

Noise emitted by vessels affects marine animals – mainly mammals and fish, causing behavioural changes and interference in the communication between individuals. The results of the international project BIAS (Baltic Sea Information on the Acoustic Soundscape) showed that noise level in the Baltic Sea in the vicinity of the main shipping routes is 100–130 dB re 1 μPa, while away from these routes – 60–100 dB re 1 μPa.

A summary of the sound levels emitted by different types of vessels carrying out various works related to the wind farm construction is provided in Table 5.5.

Table 5.5. List of underwater noise sources divided by operation performed [Source: NaiKun Offshore Wind Energy Project, Volume 4 – Noise and Vibration, 2009]

Noise source	Operation	Sound level dB re 1 μPa at a distance of 1 m
e.g. cable layer, support vessel	dynamic positioning	177.9
e.g. cable layer, support vessel	standby	174.9
e.g. cable layer, support vessel, tug boat	operating at 'half ahead'	184.9
tug boat	seabed clearance	193.2
tug boat	maintaining position	179.0
barge	loading aggregate fractions	188.4

Ships and other vessels as well as equipment used during construction also generate noise into the atmosphere. Due to the large distance from the shore (more than 70 km) and the fact that the sea area is not subject to noise protection in accordance with the Regulation of the Minister of the Environment of 14 June 2007 *on permissible noise levels in the environment* (consolidated text: Journal of Laws of 2014, item 112), it is assumed that there will be no impact on people, apart from the construction personnel. The construction personnel will be subject to health and safety regulations, which include the use of appropriate personal protective equipment and limiting exposure to noise. Impacts on biotic components of the environment are discussed in Section 10.

During the construction and decommissioning phases, the helicopters transporting people to vessels, for example, can also be a source of noise emitted into the atmosphere. The sound power level of helicopters should not exceed 107 dB re 1 μPa at a distance of 1 m from the source.

5.1.3 EMF and heat emissions by power cables

During the construction phase of the Baltica-1 OWF, the power cables will not be active yet, thus eliminating the EMF and heat emissions.

5.1.4 Waste

Information on the types and quantities of waste that may be generated during the construction phase of the Baltica-1 OWF is provided in Table 5.6.

Table 5.6. Compilation of the estimated maximum quantities of waste to be generated per year during the Baltica-1 OWF construction phase

Types and quantities of waste expected during the OWF construction phase		**APV**		**RAV**
		36 turbines with a capacity of 25 MW	**60 turbines with a capacity of 15 MW**	**64 turbines with a capacity of 14 MW**
Waste code (*hazardous waste)	**Waste type**	**Estimated maximum quantities of waste to be generated [Mg/year]**		
08	Wastes from manufacture, formulation, supply and use (MFSU) of coatings (paints, varnishes and vitreous enamels), adhesives, sealants and printing inks			
08 01	Wastes from the manufacture, formulation, supply and use (MFSU) and removal of paint and varnish			
08 01 11*	Waste paint and varnish containing organic solvents or other hazardous substances	0.2	0.5	0.5
08 01 12	Waste paint and varnish other than those mentioned in 08 01 11	0.1	0.2	0.2
12	Wastes from shaping and physical and mechanical surface treatment of metals and plastics			
12 01	Wastes from shaping and physical and mechanical surface treatment of metals and plastics			
12 01 13	Welding waste	2.0	5.0	5.0
13	Oil wastes and wastes of liquid fuels (except edible oils, and those included in groups 05, 12 and 19)			
13 01	Waste hydraulic oils			
13 01 09*	Mineral-based chlorinated hydraulic oils	0.5	0.7	0.7
13 01 10*	Mineral based non-chlorinated hydraulic oils	0.1	0.2	0.2
13 01 11*	Synthetic hydraulic oils	2.0	3.0	3.0
13 01 12*	Readily biodegradable hydraulic oils	1.0	1.5	1.5
13 01 13*	Other hydraulic oils	0.5	1.0	1.0
13 02	Waste engine, gear and lubricating oils			
13 02 04*	Mineral-based chlorinated engine, gear and lubricating oils	1.0	2.0	2.0
13 02 05*	Mineral-based non-chlorinated engine, gear and lubricating oils	1.0	2.0	2.0
13 02 06*	Synthetic engine, gear and lubricating oils	1.5	2.0	2.0
13 02 07*	Readily biodegradable engine, gear and lubricating oils	1.0	1.5	1.5
13 02 08*	Other engine, gear and lubricating oils	0.5	1.0	1.0
13 03	Waste insulating and heat transmission oils			
13 03 01*	Insulating or heat transmission oils containing PCBs	1.0	1.5	1.5
13 04	Bilge oils			
13 04 03*	Bilge oils from other navigation	5.0	6.0	6.0
13 05	Oil/water separator contents			
13 05 02*	Sludges from oil/water separators	10.0	12.0	12.0
13 05 06*	Oil from oil/water separators	10.0	12.0	12.0
13 05 07*	Oily water from oil/water separators	5.0	6.0	6.0

Types and quantities of waste expected during the OWF construction phase		**APV**		**RAV**
		36 turbines with a capacity of 25 MW	**60 turbines with a capacity of 15 MW**	**64 turbines with a capacity of 14 MW**
Waste code (*hazardous waste)	**Waste type**	**Estimated maximum quantities of waste to be generated [Mg/year]**		
13 07	Wastes of liquid fuels			
13 07 01*	Fuel oil and diesel	10.0	15.0	15.0
13 07 02*	Petrol	0.5	0.6	0.6
13 08	Oil wastes not otherwise specified			
13 08 80	Oily solid waste from vessels	2.0	3.0	3.0
14	Waste organic solvents, refrigerants and propellants (except 07 and 08)			
14 06	Waste organic solvents, refrigerants and foam/aerosol propellants			
14 06 01*	Chlorofluorocarbons, HCFC, HFC	0.1	0.1	0.1
14 06 02*	Other halogenated solvents and solvent mixtures	1.0	1.2	1.2
14 06 03*	Other solvents and solvent mixtures	1.0	1.2	1.2
15	Waste packaging; absorbents, wiping cloths, filter materials and protective clothing not otherwise specified			
15 01	Packaging (including separately collected municipal packaging waste)			
15 01 01	Paper and cardboard packaging	10.0	12.0	12.0
15 01 02	Plastic packaging	15.0	20.0	20.0
15 01 03	Wooden packaging	40.0	50.0	50.0
15 01 04	Metallic packaging	20.0	30.0	30.0
15 01 05	Composite packaging	20.0	30.0	30.0
15 01 06	Mixed packaging waste	20.0	30.0	30.0
15 01 07	Glass packaging	10.0	12.0	12.0
15 01 09	Textile packaging	5.0	8.0	8.0
15 02	Absorbents, filter materials, wiping cloths and protective clothing			
15 02 02*	Absorbents, filter materials (including oil filters not otherwise specified), wiping cloths (e.g. rags, wipes), protective clothing contaminated by hazardous substances (e.g. PCB)	2.0	3.0	3.0
15 02 03*	Absorbents, filter materials, wiping cloths (e.g. rags, wipes) and protective clothing other than those mentioned in 15 02 02	5.0	7.0	7.0
16	Wastes not otherwise specified			
16 01	End-of-life vehicles from different means of transport (including off-road machinery) and wastes from dismantling of end-of-life vehicles and vehicle maintenance (except 13, 14, 16 06 and 16 08)			
16 01 14	Antifreeze fluids containing hazardous substances	70.0	80.0	80.0
16 06	Batteries and accumulators			
16 06 01*	Lead batteries	1.0	1.2	1.2
16 06 02*	Ni-Cd batteries	10.0	12.0	12.0

Types and quantities of waste expected during the OWF construction phase		**APV**		**RAV**
		36 turbines with a capacity of 25 MW	**60 turbines with a capacity of 15 MW**	**64 turbines with a capacity of 14 MW**
Waste code (*hazardous waste)	**Waste type**	**Estimated maximum quantities of waste to be generated [Mg/year]**		
16 06 04	Alkaline batteries (except 16 06 03)	0.5	1.0	1.0
16 81	Waste resulting from accidents and unplanned events			
16 81 01*	Wastes exhibiting hazardous properties	0.1	0.2	0.2
17	Wastes from construction, renovation and demolition of construction works and road infrastructure (including excavated soil from contaminated sites)			
17 01	Waste materials and building elements as well as road infrastructure (e.g. concrete, bricks, tiles and ceramics)			
17 01 82	Wastes not otherwise specified	2.0	4.0	4.0
17 02	Wood, glass and plastic			
17 02 01	Wood	2.0	3.0	3.0
17 02 02	Glass	0.5	1.0	1.0
17 02 03	Plastic	2.0	4.0	4.0
17 04	Waste and scrap metal and metal alloys			
17 04 01	Copper, bronze, brass	5.0	8.0	8.0
17 04 02	Aluminium	10.0	12.0	12.0
17 04 04	Zinc	1.0	1.2	1.2
17 04 05	Iron and steel	20.0	25.0	25.0
17 04 07	Mixed metals	1.0	1.2	1.2
17 04 11	Cables other than those mentioned in 17 04 10	1.0	2.0	2.0
17 09	Other construction and demolition wastes			
17 09 03*	Other construction and demolition wastes (including mixed wastes) containing hazardous substances	0.5	1.0	1.0
17 09 04	Mixed construction and demolition wastes other than those mentioned in 17 09 01, 17 09 02 and 17 09 03	20.0	25.0	25.0
19	Wastes from waste management facilities, off-site waste water treatment plants and the preparation of water intended for human consumption and water for industrial use			
19 08	Wastes from waste water treatment plants not otherwise specified			
19 08 05	Sludges from treatment of urban waste water	25.0	40.0	40.0
20	Municipal wastes (household waste and similar commercial, industrial and institutional wastes) including separately collected fractions			
20 01	Separately collected fractions (except 15 01)			
20 01 01	Paper and cardboard	15.0	20.0	20.0
20 01 02	Glass	10.0	15.0	15.0
20 01 08	Biodegradable kitchen and canteen waste	25.0	40.0	40.0
20 01 10	Clothes	10.0	15.0	15.0
20 01 21*	Fluorescent tubes and other mercury-containing waste	0.1	0.1	0.1
20 01 29*	Detergents containing hazardous substances	0.5	0.6	0.6

Types and quantities of waste expected during the OWF construction phase		**APV**		**RAV**
		36 turbines with a capacity of 25 MW	**60 turbines with a capacity of 15 MW**	**64 turbines with a capacity of 14 MW**
Waste code (*hazardous waste)	**Waste type**	**Estimated maximum quantities of waste to be generated [Mg/year]**		
20 01 30	Detergents other than those mentioned in 20 01 29	0.5	0.6	0.6
20 01 33*	Batteries and accumulators included in 16 06 01, 16 06 02 or 16 06 03 and unsorted batteries and accumulators containing these batteries	10.0	12.0	12.0
20 01 34	Batteries and accumulators other than those mentioned in 20 01 33	1.0	2.0	2.0
20 01 36	Discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23 and 20 01 35	1.0	1.2	1.2
20 03	Other municipal wastes			
20 03 01	Mixed municipal waste	20.0	20.0	20.0

5.1.4.1 Excavated material handling

During the installation of monopiles and jacket foundations / pile foundations for wind turbines and OSSs, it may be necessary to carry out pre-drilling of hard formations. The intended scope of such work is as follows:

- removal of loose sediments deposited on hard formations using dredging methods involving the shifting or removal of loose formations, using hopper dredgers to access more consolidated seabed layers;
- drilling hard formations to allow for the installation of piles.

Specialised drilling techniques are required in the case of more resistant layers (assuming no drilling fluid is involved, as is the case, for example, in oil and gas prospecting). The assumed drilling processes would be carried out using compressed air and seawater.

The material excavated in the course of construction work involving pile driving in the seabed constitutes naturally occurring material, as referred to in the provision of Article 2(3) of the Waste Act (consolidated text: Journal of Laws of 2023, item 1587). If the excavated material is not contaminated and will be used for construction purposes in its natural state in the area where it was excavated, the provisions of the Waste Act will not apply to such material, as is apparent from the exemption from the application of the Act cited above.

The possibility and methods of use of the excavated material will result from the provisions of the Baltica-1 OWF building permit. A prerequisite for this approach is that the entire process is carried out below the water surface and the excavated material is returned for the purpose of distribution on the seabed, without being extracted above the water surface nor stored even for a short time on barges or vessels. This condition must be adhered to, since the redistribution of such ground below the water surface will be treated as waste dumping. It should be noted that the extraction of material from the seabed to the water surface will constitute an action of the removal of the material from its original location. As stipulated in Article 11(1) of the Convention for the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention), the parties to the convention agree to prohibit the dumping of waste or other substances into the Baltic Sea. Although the provisions of the Convention allow the possibility of obtaining a derogation from this prohibition, it is granted with the authorisation of the territorially competent director of the maritime office.

In order to be able to benefit from this exemption under the Waste Act, it is necessary to confirm that the material in question is not contaminated. The confirmation should be based on the tests of the ground from the seabed at the site or area where the works will be taking place.

The condition of the seabed material samples collected can be compared with the limit parameters set out in the HELCOM Guidelines for the Management of Dredged Material at Sea to verify that the parameters indicated in these guidelines are not exceeded for any of the substances. At the same time, the methodology for conducting ground contamination surveys allows for the assumption, supported by risk analysis, that the absence of contamination in the surface layer dispenses with the need to conduct surveys in the deeper seabed layers. The samples for analysis can be taken from a representative number of planned drilling locations to determine the contamination of seabed material throughout the planned drilling zone. Thus, on this basis, it is possible to assume that the material excavated during the construction works will be uncontaminated. If the results showed the sediment to be contaminated to the extent that it could not be reintroduced into the marine environment, it would have to be transported to land and transferred to an industrial waste disposal site.

Information on the deep-seabed structure will not be known until geotechnical surveys, which are planned to be carried out after obtaining the DEC, have been completed. On their basis, an implementation design for the distribution of individual OWF components will be created and the location of sites where hard geological formations will need to be drilled prior to the ultimate installation of piles will be known. With this information and data in hand, the Project Owner will be able to develop in cooperation with the maritime administration authorities the detailed procedure for managing the seabed material. Should it be necessary to remove the material to the sea surface, a sediment contamination survey programme will be developed (taking into account the possibility of using the survey data for the preparation of the EIA Report for the Project), which will be submitted to the Regional Director for Environmental Protection in Gdańsk for opinion.

5.2 Operation phase

5.2.1 Emissions of chemical compounds into the atmosphere

During the operation phase, vessel traffic will be significantly lower than during the construction phase, both in terms of vessel numbers and their working hours related to operating the farm during this phase. For the purpose of carrying out the emissions calculations, the information on the expected fuel consumption of vessels carrying out maintenance and service works is presented in Table 5.7, and the estimates of fuel consumption of vessels carrying out possible repair work are presented in Table 5.8.

Table 5.7. Estimated annual vessel fuel consumption during the operation phase – inspection and service works

Vessel size	Expected fuel consumption [kg/h]	Expected number of vessels [pcs.]	Expected total annual vessel operation time [h]	Expected total annual fuel consumption [Mg]
medium	500–1000	2	3500	3500–7000
small	50–500	2	8000	800–8000
			Total:	4300–15000

Table 5.8. Estimated annual vessel fuel consumption during the operational phase – repair works

Vessel size	Expected fuel consumption [kg/h]	Expected number of vessels [pcs.]	Expected total annual vessel operation time [h]	Expected total annual fuel consumption [Mg]
large	1000–2000	2	400	800–1600
small	50–500	1	500	25–250
			Total:	825–1850

For such assumptions, the atmospheric emission rates of each chemical compound per day of vessel operation were calculated and are presented in Table 5.9.

Table 5.9. Emission factors for diesel oil and estimated emissions of chemical compounds and particulates by vessels during the operation phase of the Baltica-1 OWF

Substance	Emission factor [g/kg of fuel]	Emission factor per year of operation [Mg]	
		for service operations	for possible repair operations
nitrogen oxides (NO_x)	13.01	25.37–71.56	5.53–13.66
non-methane volatile organic compounds (NMVOC)	32.629	63.63–179.46	13.87–34.26
carbon oxide (CO)	3.377	6.59–18.57	1.44–3.55
total suspended particulate (TSP), including up to 100% of PM10 and PM2.5*	10.774	21.01–59.26	4.58–11.31
sulphur dioxide (SO_2)	2.104	4.10–11.57	0.89–2.21
aliphatic hydrocarbons (HC al.)	0.02	0.04–0.11	0.01–0.02
aromatic hydrocarbons (HC ar.)	2.195	4.28–12.07	0.93–2.30
carbon dioxide (CO_2)	3206	6252–17633	1363–3366

In addition to vessels, helicopters could be used in the operation phase, for example to transport ship crew members. It is expected that in one year the total flight time of the helicopters will not exceed 400 hours. Table 5.4 presents the estimates of atmospheric emissions, assuming an average aviation fuel consumption of 500 kg/h.

5.2.2 Sound emitted into water and atmosphere

During the operation phase, the main sources of underwater noise will be the vessels carrying out inspection and service works of the OWF and 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.

The noise generated by the vessels, mainly small- and medium-sized, will be comparable to its emission levels estimated for the construction phase and described in Section 5.1.2.

The description of the modelling results of underwater noise from wind turbines during the operation phase is included in Appendix 4 of the EIA Report.

Vessels and wind turbines also generate noise into the air during operation. Due to the long distance from the shore (more than 70 km) and the fact that the sea area is not subject to noise protection in accordance with the Regulation of the Minister of the Environment of 14 June 2007 *on permissible noise levels in the environment* (consolidated text: Journal of Laws of 2014, item 112), it is assumed that there will be no impact on people, apart from the construction personnel. The construction personnel will be subject to health and safety regulations, which include the use of appropriate personal protective equipment and limiting exposure to noise. Impacts on biotic components of the environment are discussed in Section 10.

5.2.3 EMF and heat emissions by power cables

5.2.3.1 Electromagnetic field emissions

Electromagnetic fields in the environment can be divided into natural fields and fields of anthropogenic origin. Changes in natural electric fields do not have a direct impact on living organisms as well as human well-being. Natural magnetic fields show differences depending on the geographical location.

Electromagnetic fields created by the flow of electric current can change the natural migration behaviour of marine mammals, they can also be a source of thermal energy introduced into the sea. However, the impact of subsea cables buried in the seabed on the electromagnetic field is negligible. Depending on the distance from a cable buried in the seabed at a depth of 1 m under the seabed, the strength of the electric component of the field is up to $8 \cdot 10^{-4}$ $V \cdot m^{-1}$ on the seabed, $3.4 \cdot 10^{-5}$ $V \cdot m^{-1}$ in the water column 5 m above the seabed and $1.24 \cdot 10^{-5}$ $V \cdot m^{-1}$ in the water column 10 m above the seabed. The magnetic field strength induced by AC cables is 0.89 $A \cdot m^{-1}$ on the seabed, $4 \cdot 10^{-2}$ $A \cdot m^{-1}$ in the water column 5 m above the seabed and $1.5 \cdot 10^{-2}$ $A \cdot m^{-1}$ in the water column 10 m above the seabed. For both the electric field component and the magnetic component, these values are much smaller than those found on the Earth's surface, i.e. from $1.0 \cdot 10^{2}$ $V \cdot m^{-1}$ to $1.5 \cdot 10^{2}$ $V \cdot m^{-1}$ (electric field strength) and from 24 $A \cdot m^{-1}$ to 48 $A \cdot m^{-1}$ (magnetic field strength) [https://pl.wikipedia.org/wiki/Ziemskie_pole_magnetyczne].

The OWF operation will be a long-term project. Wind turbines will be connected by electricity grid and teletechnical networks with OSSs. The total length of cable lines is assumed to reach a maximum of 140 km for APV and 150 km for RAV. Cables buried in the seabed are optimised to emit a residual electric field. The possible magnetic component of the EMF is minimised by the running of the individual wires in the greatest proximity to each other (for individual phases for alternating current or the flow directions of direct current). In the case of the DC cables, the impact range of EMF is the smaller the closer the individual conductors of the line are run (there are practically no interactions in the composite cable). In the case of alternating current, the use of a composite cable reduces the magnetic field, but it may remain at the level generating electric field in the seawater. The remedy for this is the burial of the cable in the sediment, which does not reduce the effects of EMF by itself but separating the cables from seawater reduces the impact considerably.

5.2.3.2 Heat emission from electromagnetic cables

Electric current, flowing through a cable, causes it to heat up, as a result of power losses on the resistance, in accordance with Joule's law. As the temperature of the cable increases above the ambient temperature, the transfer of heat from the cable to the surrounding environment commences. An accurate quantification of the given heat is difficult because of the following phenomena: conduction, lifting and radiation of the heat, subject to different physical laws [Rakowska *et al.*, 2006]. The heating of sediments may lead to a change in the taxonomic composition of the benthos living on and in the seabed in the immediate vicinity of the cables [Merck, 2009]. The cable burial depth will be determined on the basis of the sediment type (kind and characteristics, including their thermal conductivity) and the type of power grid (size and type of loads, thermal characteristics).

5.2.4 Waste

Information on the types and quantities of waste that may be generated during the operation phase of the Baltica-1 OWF is presented in Table 5.10.

Table 5.10. Compilation of the estimated maximum quantities of waste to be generated per year during the Baltica-1 OWF operation phase

Types and quantities of waste expected during the OWF operation phase		**APV**		**RAV**
		36 turbines with a capacity of 25 MW	**60 turbines with a capacity of 15 MW**	**64 turbines with a capacity of 14 MW**
Waste code (*hazardous waste)	**Waste type**	**Estimated maximum quantities of waste to be generated [Mg/year]**		
08	Wastes from manufacture, formulation, supply and use (MFSU) of coatings (paints, varnishes and vitreous enamels), adhesives, sealants and printing inks			
08 01	Wastes from the manufacture, formulation, supply and use (MFSU) and removal of paint and varnish			
08 01 11*	Waste paint and varnish containing organic solvents or other hazardous substances	1.0	2.0	2.0
08 01 12	Waste paint and varnish other than those mentioned in 08 01 11	1.0	2.0	2.0
12	Wastes from shaping and physical and mechanical surface treatment of metals and plastics			
12 01	Wastes from shaping and physical and mechanical surface treatment of metals and plastics			
12 01 13	Welding waste	1.0	2.0	2.0
13	Oil wastes and wastes of liquid fuels (except edible oils, and those included in groups 05, 12 and 19)			
13 01	Waste hydraulic oils			
13 01 09*	Mineral-based chlorinated hydraulic oils	5.0	7.0	7.0
13 01 10*	Mineral based non-chlorinated hydraulic oils	5.0	7.0	7.0
13 01 11*	Synthetic hydraulic oils	8.0	10.0	10.0
13 01 12*	Readily biodegradable hydraulic oils	5.0	7.0	7.0
13 01 13*	Other hydraulic oils	5.0	7.0	7.0
13 02	Waste engine, gear and lubricating oils			
13 02 04*	Mineral-based chlorinated engine, gear and lubricating oils	1.0	2.0	2.0
13 02 05*	Mineral-based non-chlorinated engine, gear and lubricating oils	1.0	2.0	2.0
13 02 06*	Synthetic engine, gear and lubricating oils	24.0	32.0	32.0
13 02 07*	Readily biodegradable engine, gear and lubricating oils	1.0	2.0	2.0
13 02 08*	Other engine, gear and lubricating oils	1.0	2.0	2.0
13 03	Waste insulating and heat transmission oils			
13 03 06*	Mineral-based chlorinated insulating and heat transmission oils other than those mentioned in 13 03 01	5.0	5.0	5.0

Types and quantities of waste expected during the OWF operation phase		**APV**		**RAV**
		36 turbines with a capacity of 25 MW	**60 turbines with a capacity of 15 MW**	**64 turbines with a capacity of 14 MW**
Waste code (*hazardous waste)	**Waste type**	**Estimated maximum quantities of waste to be generated [Mg/year]**		
13 03 07*	Mineral-based non-chlorinated insulating and heat transmission oils	5.0	5.0	5.0
13 03 08*	Synthetic insulating and heat transmission oils other than those mentioned in 13 03 01	5.0	5.0	5.0
13 03 09*	Readily biodegradable insulating and heat transmission oils	5.0	5.0	5.0
13 04	Bilge oils			
13 04 03*	Bilge oils from other navigation	1.0	2.0	2.0
13 05	Oil/water separator contents			
13 05 02*	Sludges from oil/water separators	5.0	7.0	7.0
13 05 06*	Oil from oil/water separators	5.0	7.0	7.0
13 05 07*	Oily water from oil/water separators	5.0	7.0	7.0
13 07	Wastes of liquid fuels			
13 07 01*	Fuel oil and diesel	1.0	1.0	1.0
13 07 02*	Petrol	1.0	1.0	1.0
13 08	Oil wastes not otherwise specified			
13 08 80	Oily solid waste from vessels	1.0	2.0	2.0
14	Waste organic solvents, refrigerants and propellants (except 07 and 08)			
14 06	Waste organic solvents, refrigerants and foam/aerosol propellants			
14 06 01*	Chlorofluorocarbons, HCFC, HFC	0.1	0.2	0.2
14 06 02*	Other halogenated solvents and solvent mixtures	0.7	1.0	1.0
14 06 03*	Other solvents and solvent mixtures	0.5	1.0	1.0
15	Waste packaging; absorbents, wiping cloths, filter materials and protective clothing not otherwise specified			
15 01	Packaging (including separately collected municipal packaging waste)			
15 01 01	Paper and cardboard packaging	5.0	7.0	7.0
15 01 02	Plastic packaging	10.0	15.0	15.0
15 01 03	Wooden packaging	20.0	25.0	25.0
15 01 04	Metallic packaging	15.0	20.0	20.0
15 01 05	Composite packaging	15.0	25.0	25.0
15 01 06	Mixed packaging waste	15.0	25.0	25.0
15 01 07	Glass packaging	10.0	15.0	15.0
15 01 09	Textile packaging	5.0	7.0	7.0
15 02	Absorbents, filter materials, wiping cloths and protective clothing			
15 02 02*	Absorbents, filter materials (including oil filters not otherwise specified), wiping cloths (e.g. rags, wipes), protective clothing	4.0	6.0	6.0

Types and quantities of waste expected during the OWF operation phase		**APV**		**RAV**
		36 turbines with a capacity of 25 MW	**60 turbines with a capacity of 15 MW**	**64 turbines with a capacity of 14 MW**
Waste code (*hazardous waste)	**Waste type**	**Estimated maximum quantities of waste to be generated [Mg/year]**		
	contaminated by hazardous substances (e.g. PCB)			
15 02 03*	Absorbents, filter materials, wiping cloths (e.g. rags, wipes) and protective clothing other than those mentioned in 15 02 02	4.0	6.0	6.0
16	Wastes not otherwise specified			
16 01	End-of-life vehicles from different means of transport (including off-road machinery) and wastes from dismantling of end-of-life vehicles and vehicle maintenance (except 13, 14, 16 06 and 16 08)			
16 01 14	Antifreeze fluids containing hazardous substances	70.0	80.0	80.0
16 06	Batteries and accumulators			
16 06 02*	Ni-Cd batteries	3.0	5.0	5.0
16 06 04	Alkaline batteries (except 16 06 03)	1.0	2.0	2.0
16 06 05	Other batteries and accumulators	3.0	5.0	5.0
16 81	Waste resulting from accidents and unplanned events			
16 81 01*	Wastes exhibiting hazardous properties	0.1	0.2	0.2
16 81 02	Wastes other than those mentioned in 16 81 01	0.05	0.1	0.1
17	Wastes from construction, renovation and demolition of construction works and road infrastructure (including excavated soil from contaminated sites)			
17 01	Waste materials and building elements as well as road infrastructure (e.g. concrete, bricks, tiles and ceramics)			
17 01 01	Waste concrete and concrete rubble from demolitions and renovations	0.5	0.7	0.7
17 01 03	Tiles and ceramics	0.5	0.7	0.7
17 01 07	Mixed waste from concrete, brick rubble, ceramic materials and elements of equipment other than those listed in 17 01 06	0.5	0.7	0.7
17 01 82	Wastes not otherwise specified	1.5	3.0	3.0
17 02	Wood, glass and plastic			
17 02 01	Wood	1.5	3.0	3.0
17 02 02	Glass	0.5	0.7	0.7
17 02 03	Plastic	1.5	3.0	3.0
17 04	Waste and scrap metal and metal alloys			
17 04 01	Copper, bronze, brass	2.5	3.0	3.0
17 04 02	Aluminium	5.0	7.0	7.0
17 04 04	Zinc	0.1	0.2	0.2
17 04 05	Iron and steel	15.0	20.0	20.0
17 04 07	Mixed metals	1.0	1.5	1.5
17 04 11	Cables other than those mentioned in 17 04 10	1.0	1.5	1.5
17 09	Other construction and demolition wastes			

Types and quantities of waste expected during the OWF operation phase		APV		RAV
		36 turbines with a capacity of 25 MW	60 turbines with a capacity of 15 MW	64 turbines with a capacity of 14 MW
Waste code (*hazardous waste)	**Waste type**	**Estimated maximum quantities of waste to be generated [Mg/year]**		
17 09 03*	Other construction and demolition wastes (including mixed wastes) containing hazardous substances	0.2	0.5	0.5
17 09 04	Mixed construction, renovation and dismantling waste other than those listed in 17 09 01, 17 09 02 and 17 09 03	5.0	7.0	7.0
19	Wastes from waste management facilities, off-site waste water treatment plants and the preparation of water intended for human consumption and water for industrial use			
19 08	Wastes from waste water treatment plants not otherwise specified			
19 08 05	Sludges from treatment of urban waste water	15.0	20.0	20.0
20	Municipal wastes (household waste and similar commercial, industrial and institutional wastes) including separately collected fractions			
20 01	Separately collected fractions (except 15 01)			
20 01 01	Paper and cardboard	10.0	15.0	15.0
20 01 02	Glass	7.0	4.0	4.0
20 01 08	Biodegradable kitchen and canteen waste	2.0	5.0	5.0
20 01 10	Clothes	2.5	5.0	5.0
20 01 21*	Fluorescent tubes and other mercury-containing waste	0.05	0.1	0.1
20 01 23*	Discarded equipment containing chlorofluorocarbons	0.05	0.1	0.1
20 01 29*	Detergents containing hazardous substances	0.05	0.1	0.1
20 01 30	Detergents other than those mentioned in 20 01 29	0.1	0.5	0.5
20 01 33*	Batteries and accumulators included in 16 06 01, 16 06 02 or 16 06 03 and unsorted batteries and accumulators containing these batteries	5.0	10.0	10.0
20 01 34	Batteries and accumulators other than those mentioned in 20 01 33	0.5	0.7	0.7
20 01 35*	Discarded electrical and electronic equipment other than those mentioned in 20 01 21 and 20 01 23 containing hazardous components	0.1	0.2	0.2
20 01 36	Discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23 and 20 01 35	0.5	0.7	0.7
20 03	Other municipal wastes			
20 03 01	Mixed municipal waste	20.0	30.0	30.0

5.3 DECOMMISSIONING PHASE

5.3.1 Emissions of chemical compounds into the atmosphere

During the decommissioning phase of the Project, chemical compounds will be emitted into the atmosphere from the combustion of diesel oil by vessels involved in the dismantling of the Baltica-1 OWF elements. For the purpose of carrying out the emissions calculations, the information on the expected fuel consumption of the vessels, broken down into three size categories is presented in Table 5.11.

Table 5.11. Estimated daily fuel consumption for the vessels during the decommissioning phase

Vessel size	Expected fuel consumption [kg/h]	Expected daily operation time [h]	Expected number of vessels [pcs.]	Expected total daily fuel consumption [Mg]
large	1000–2000	12–24	2	24–96
medium	500–1000	12–24	3	18–72
small	50–500	12–24	8	5–96
			total:	47–264

For such assumptions, the atmospheric emission rates of each chemical compound per day of vessel operation were calculated and are presented in Table 5.12.

Table 5.13. Emission factors for diesel oil combustion and estimated emissions per day

Substance	Emission factor [g/kg of fuel][10]	Emissions per day of work [Mg]
nitrogen oxides (NO_x)	13.01	0.59–2.47
non-methane volatile organic compounds (NMVOC)	32.629	1.47–6.20
carbon oxide (CO)	3.377	0.15–0.64
total suspended particulate (TSP), including up to 100% of PM10 and PM2.5*	10.774	0.49–2.05
sulphur dioxide (SO_2)	2.104	0.10–0.40
aliphatic hydrocarbons (HC al.)	0.02	<0.01
aromatic hydrocarbons (HC ar.)	2.195	0.10–0.42
carbon dioxide (CO_2)	3206	145–610

During the decommissioning phase, it is also planned to use helicopters to transport people to the vessels involved in the dismantling work (e.g. periodic crew change). The exhaust emission values will be the same as for the construction phase (see Section 5.1.1).

[10] Sulphur content in fuel – 10 mg·kg^{-1} according to the Regulation of the Minister of Economy of 9 October 2015 on the quality requirements for liquid fuels (consolidated text: Journal of Laws of 2023, item 1314). Total oxidisation of sulphur to SO_2 in the combustion process – emission factor SO_2 0.02 g SO_2/kg of fuel was assumed. Unit emissions of nitrogen oxide, NMVOC, carbon oxide and dust from combustion of 1 kg of diesel oil were adopted on the basis of the EMEP/EEA air pollutant emission inventory guidebook 2019 (emission factors for the group 'Non-road mobile sources and machinery'). It was assumed that 100% of NMVOC will consist of a mixture of hydrocarbons (HC) contained in the fuel, which were not combusted. It was assumed that the emission of aromatic hydrocarbons may constitute up to 35% of the sum of hydrocarbons (HC), the remaining 65% will be aliphatic hydrocarbons [Merkisz, 1998].

5.3.2 Sound emitted into water and atmosphere

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. The OWF decommissioning will consist of dismantling the OWF structures elevated above the seabed sediment. The foundations of wind turbines and OSSs located below the seabed surface and cable lines will not be removed from the environment. For this reason, underwater works will not involve high-impact sound emissions.

The description of sound emission from vessels and the values characterising it described in Section 5.1.2 relating to the construction phase are the same for the sound emitted into the environment by vessels in the decommissioning phase, excluding underwater noise from pile driving.

5.3.3 EMF and heat emissions by power cables

During the decommissioning phase of the Baltica-1 OWF, power cables will no longer be in operation, thus eliminating EMF and heat emissions.

5.3.4 Waste

Information on the types and quantities of waste that may be generated during the decommissioning phase of the Baltica-1 OWF is presented in Table 5.13.

Table 5.14. Compilation of the estimated maximum quantities of waste to be generated per year during the Baltica-1 OWF decommissioning phase

Types and quantities of waste expected during the OWF decommissioning phase		**APV**		**RAV**
		36 turbines with a capacity of 25 MW	**60 turbines with a capacity of 15 MW**	**64 turbines with a capacity of 14 MW**
Waste code (*hazardous waste)	**Waste type**	**Estimated maximum quantities of waste to be generated [Mg/year]**		
12	Wastes from shaping and physical and mechanical surface treatment of metals and plastics			
12 01	Wastes from shaping and physical and mechanical surface treatment of metals and plastics			
12 01 13	Welding waste	3.0	5.0	5.0
13	Oil wastes and wastes of liquid fuels (except edible oils, and those included in groups 05, 12 and 19)			
13 01	Waste hydraulic oils			
13 01 09*	Mineral-based chlorinated hydraulic oils	0.2	0.3	0.3
13 01 10*	Mineral based non-chlorinated hydraulic oils	0.1	0.2	0.2
13 01 11*	Synthetic hydraulic oils	21.6	25.6	25.6
13 01 12*	Readily biodegradable hydraulic oils	1.0	1.5	1.5
13 01 13*	Other hydraulic oils	0.2	0.5	0.5
13 02	Waste engine, gear and lubricating oils			
13 02 04*	Mineral-based chlorinated engine, gear and lubricating oils	0.5	0.7	0.7
13 02 05*	Mineral-based non-chlorinated engine, gear and lubricating oils	0.1	0.2	0.2
13 02 06*	Synthetic engine, gear and lubricating oils	63.0	80.0	80.0
13 02 07*	Readily biodegradable engine, gear and lubricating oils	0.2	0.3	0.3
13 02 08*	Other engine, gear and lubricating oils	15.5	17.6	17.6
13 03	Waste insulating and heat transmission oils			
13 03 01*	Insulating or heat transmission oils containing PCBs	1.5	2.0	2.0

Types and quantities of waste expected during the OWF decommissioning phase		**APV**		**RAV**
		36 turbines with a capacity of 25 MW	**60 turbines with a capacity of 15 MW**	**64 turbines with a capacity of 14 MW**
Waste code (*hazardous waste)	**Waste type**	**Estimated maximum quantities of waste to be generated [Mg/year]**		
13 03 08	Synthetic insulating and heat transmission oils other than those mentioned in 13 03 01	180.0	208.0	208.0
13 04	Bilge oils			
13 04 03*	Bilge oils from other navigation	5.0	7.5	7.5
13 07	Wastes of liquid fuels			
13 07 01*	Fuel oil and diesel	0.5	0.7	0.7
13 07 02*	Petrol	0.1	0.2	0.2
13 08	Oil wastes not otherwise specified			
13 08 80	Oily solid waste from vessels	0.5	0.7	0.7
14	Waste organic solvents, refrigerants and propellants (except 07 and 08)			
14 06	Waste organic solvents, refrigerants and foam/aerosol propellants			
14 06 01*	Chlorofluorocarbons, HCFC, HFC	0.1	0.1	0.1
14 06 02*	Other halogenated solvents and solvent mixtures	0.2	0.5	0.5
14 06 03*	Other solvents and solvent mixtures	0.1	0.2	0.2
15	Waste packaging; absorbents, wiping cloths, filter materials and protective clothing not otherwise specified			
15 01	Packaging (including separately collected municipal packaging waste)			
15 01 01	Paper and cardboard packaging	2.0	3.5	3.5
15 01 02	Plastic packaging	2.0	3.5	3.5
15 01 03	Wooden packaging	5.0	7.0	7.0
15 01 04	Metallic packaging	7.0	10.0	10.0
15 01 05	Composite packaging	2.0	2.5	2.5
15 01 06	Mixed packaging waste	5.0	7.5	7.5
15 01 07	Glass packaging	2.0	3.5	3.5
15 01 09	Textile packaging	1.0	2.0	2.0
15 02	Absorbents, filter materials, wiping cloths and protective clothing			
15 02 02*	Absorbents, filter materials (including oil filters not otherwise specified), wiping cloths (e.g. rags, wipes), protective clothing contaminated by hazardous substances (e.g. PCBs)	1.0	1.5	1.5
15 02 03*	Absorbents, filter materials, wiping cloths (e.g. rags, wipes) and protective clothing other than those mentioned in 15 02 02	1.5	2.0	2.0
16	Wastes not otherwise specified			
16 01 14	Antifreeze fluids containing hazardous substances	400.0	500.0	500.0
16 06	Batteries and accumulators			
16 06 01*	Lead batteries	0.1	0.2	0.2
16 06 02*	Ni-Cd batteries	7.5	10.0	10.0
16 06 03*	Mercury-containing batteries	0.2	0.5	0.5
16 06 04	Alkaline batteries (except 16 06 03)	0.5	1.5	1.5
16 06 05	Other batteries and accumulators	0.1	0.2	0.2
16 81	Waste resulting from accidents and unplanned events			
16 81 01*	Wastes exhibiting hazardous properties	0.05	0.07	0.07
16 81 02	Wastes other than those mentioned in 16 81 01	0.05	0.05	0.05

Types and quantities of waste expected during the OWF decommissioning phase		**APV**		**RAV**
		36 turbines with a capacity of 25 MW	**60 turbines with a capacity of 15 MW**	**64 turbines with a capacity of 14 MW**
Waste code (*hazardous waste)	**Waste type**	**Estimated maximum quantities of waste to be generated [Mg/year]**		
17	Wastes from construction, renovation and demolition of construction works and road infrastructure (including excavated soil from contaminated sites)			
17 01	Waste materials and building elements as well as road infrastructure (e.g. concrete, bricks, tiles and ceramics)			
17 01 01	Waste concrete and concrete rubble from demolitions and renovations	290,000**	405,000**	405,000**
17 01 03	Tiles and ceramics	0.1	0.2	0.2
17 01 07	Mixed waste from concrete, brick rubble, ceramic materials and elements of equipment other than those listed in 17 01 06	0.05	0.1	0.1
17 01 82	Wastes not otherwise specified	0.5	1.0	1.0
17 02	Wood, glass and plastic			
17 02 01	Wood	1.0	2.0	2.0
17 02 02	Glass	0.5	1.0	1.0
17 02 03	Plastic	5500	7000	7000
17 04	Waste and scrap metal and metal alloys			
17 04 01	Copper, bronze, brass	1500***	1600***	1600***
17 04 02	Aluminium	1500***	1600***	1600***
17 04 04	Zinc	0.5	0.7	0.7
17 04 05	Iron and steel	105 000**	155 000**	155 000**
17 04 07	Mixed metals	2.0	2.5	2.5
17 04 11	Cables other than those mentioned in 17 04 10	5.0	7.5	7.5
17 09	Other construction and demolition wastes			
17 09 03*	Other construction and demolition wastes (including mixed wastes) containing hazardous substances	0.2	0.3	0.3
17 09 04	Mixed construction and demolition wastes other than those mentioned in 17 09 01, 17 09 02 and 17 09 03	5.0	7.5	7.5
19	Wastes from waste management facilities, off-site waste water treatment plants and the preparation of water intended for human consumption and water for industrial use			
19 08	Wastes from waste water treatment plants not otherwise specified			
19 08 05	Sludges from treatment of urban waste water	15.0	20.0	20.0
20	Municipal wastes (household waste and similar commercial, industrial and institutional wastes) including separately collected fractions			
20 01	Separately collected fractions (except 15 01)			
20 01 01	Paper and cardboard	5.0	7.5	7.5
20 01 02	Glass	7.5	10.0	10.0
20 01 08	Biodegradable kitchen and canteen waste	15.0	17.5	17.5
20 01 10	Clothes	5.0	7.5	7.5
20 01 21*	Fluorescent tubes and other mercury-containing waste	0.05	0.1	0.1
20 01 23*	Discarded equipment containing chlorofluorocarbons	0.05	0.1	0.1
20 01 29*	Detergents containing hazardous substances	0.5	0.7	0.7
20 01 30	Detergents other than those mentioned in 20 01 29	0.2	0.25	0.25
20 01 33*	Batteries and accumulators included in 16 06 01, 16 06 02 or 16 06 03 and unsorted batteries and accumulators containing these batteries	10.0	15.0	15.0

Types and quantities of waste expected during the OWF decommissioning phase		**APV**		**RAV**
		36 turbines with a capacity of 25 MW	**60 turbines with a capacity of 15 MW**	**64 turbines with a capacity of 14 MW**
Waste code (*hazardous waste)	**Waste type**	**Estimated maximum quantities of waste to be generated [Mg/year]**		
20 01 34	Batteries and accumulators other than those mentioned in 20 01 33	0.2	0.5	0.5
20 01 35*	Discarded electrical and electronic equipment other than those mentioned in 20 01 21 and 20 01 23 containing hazardous components	0.5	0.7	0.7
20 01 36	Discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23 and 20 01 35	0.2	0.5	0.5
20 03	Other municipal wastes			
20 03 01	Mixed municipal waste	5.0	7.5	7.5

*** the maximum values for different foundation types were given, these values will not occur simultaneously*

****as the cable material will not be known until DEC has been obtained, cable weights in both cases (Al and Cu) have been taken into account, these values will not occur simultaneously*

6 RISK OF MAJOR ACCIDENTS OR NATURAL AND CONSTRUCTION DISASTERS, TAKING INTO ACCOUNT THE SUBSTANCES AND TECHNOLOGIES APPLIED, INCLUDING THE RISK RELATED TO CLIMATE CHANGE

6.1 RISK OF MAJOR ACCIDENTS

Pursuant to Article 3(23) of the Act of 27 April 2001 *Environmental Protection Law* (consolidated text: Journal of Laws of 2022, item 2556, as amended), a major accident is *'an event, in particular an emission, fire or explosion happening during industrial process, storage or transportation, in which one or more dangerous substances are involved, resulting in an immediate threat to human life or health, or threat to the environment, or a delayed occurrence of such a threat.'*

The Baltica-1 OWF will not be a place of storage of substances determining the Project classification as a plant with an increased or high risk of a major industrial accident pursuant to § 1 of the Regulation of the Minister of Development of 29 January 2016 *on the types and quantities of hazardous substances present in an industrial plant, which determine the plant classification as a plant with an increased or high risk of a major industrial accident* (Journal of Laws of 2016, item 138).

It is expected that the highest risk of a major accident will be related to the construction and possible decommissioning phases, when the intensity of works and the involvement of vessels in the Project will be the highest. The spills of petroleum products, mostly diesel oil from a vessel/vessels, resulting from collisions with other vessels or OWF structures, are considered the highest risk of a major accident. Even though the risk of such an event is very low, it still cannot be completely dismissed. The number of potential leaks is proportional to the number of vessels used to carry out every phase of the Project implementation.

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 sea area under the authority of a territorially competent maritime office director 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. fuel oils, 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. The probability of such events as ship collisions belongs to the category of very rare events (1 per 100 years), while events such as vessel contact with the OWF construction remains in the category of very rare events (1 per 200 years). Taking into account the effects in the form of 200 m^3 of diesel oil emission to the environment, the risk level is within an acceptable range. Emission of 200 m^3 of diesel oil will cause insignificant damage to the environment because it will disperse within 12 hours.

Assuming the worst-case scenario and the release of several hundred cubic metres of diesel fuel into the marine environment, as well as 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 the distance from 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.

From the environmental point of view, the most sensitive area in the event of possible spills will be the Middle Bank area, both in the Polish and in the Swedish EEZs. It should be emphasised that the key issue there is not so much the size of the spill as the place where it has 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 high 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 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.

Another cause for a major accident is the possibility of a release of hazardous substances from the objects of anthropogenic origin lying on the seabed surface or buried in the seabed sediment. It cannot be ruled out that during the preparatory work for the Baltica-1 OWF construction process, including, in particular, the seabed surveys 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, see: Section 7.9). As part of the EIA Report preparation for the Baltica-1 OWF, geophysical surveys were carried out enabling a preliminary identification of the presence of anthropogenic objects on/in the seabed and the absence of threats as part of this survey. Moreover, before the commencement of the construction, the Project Owner shall conduct surveys on the presence of UXOs and duds. 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. In order 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 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.

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

The list of risks presented below was developed on the basis of the MCA guidelines – Methodology for Assessing Marine Navigational Safety & Emergency Response Risks of Offshore Renewable Energy Installations. This assessment was based on a list of incident scenarios developed for Triton Knoll OWF. In accordance with the procedure applicable in Great Britain, such lists are prepared on the basis of consultation with groups of navigation experts. The expert assessment is an activity following the survey work, which means that the experts are provided with the following information:

- technical data defining the scope of the project;
- analyses of vessel traffic density;
- statistical data on marine accidents;
- data on atmospheric and hydrological conditions;
- results of studies on the impact of the offshore wind farm on communications and navigation radars;
- results of modelling studies related to the probability and consequences of navigation events: collision, contact, grounding.

Table 6.1 provides a list of navigation hazards in relation to the different types of incidents.

Table 6.1. List of navigation hazards developed for Triton Knoll OWF [Source: internal materials based on Strategic Marine Services Ltd, Issue 3, November 2011]

Incident type	Hazards potentially contributing to the incident
Collisions	
(1) Collision of two large merchant vessels	Lack of sufficient sea room for manoeuvring due to the presence of OWF structures and other vessels
	Lack of sufficient sea room for manoeuvring to keep out of the way of another vessel due to the proximity of shallow water
	Lack of sufficient sea room for manoeuvring to keep out of the way of another vessel due to the presence of other vessels
	Error in detection of another vessel due to radar interference in the vicinity of the OWF in good visibility conditions
	Error in detection of another vessel due to radar interference in the vicinity of the OWF in poor visibility conditions
	Navigational error (non-compliance with the regulations, human error, mistake, wrong decision)
	Malfunction of navigational equipment or steering–propulsion system
	Inappropriate watchkeeping practices or poorly organised crew rest
(2) Collision of a large merchant vessel and a small merchant vessel	Lack of sufficient sea room for manoeuvring due to the presence of OWF structures and other vessels
	Lack of sufficient sea room for manoeuvring to keep out of the way of another vessel due to the proximity of shallow water
	Error in detection of another vessel due to radar interference in the vicinity of the OWF in good visibility conditions
	Error in detection of another vessel due to radar interference in the vicinity of the OWF in poor visibility conditions
	Navigational error (non-compliance with the regulations, human error, mistake, wrong decision)
	Inappropriate watchkeeping practices or poorly organised crew rest
	Malfunction of navigational equipment or steering–propulsion system
(3) Collision of two small merchant vessels (4) Collision of a merchant vessel with a recreational vessel (5) Collision of a merchant vessel with a fishing vessel (6) Collision of a fishing vessel with a recreational vessel (7) Collision of a merchant vessel with an OWF installation/service vessel	Lack of sufficient sea room for manoeuvring due to the presence of OWF structures and other vessels
	Lack of sufficient sea room for manoeuvring to keep out of the way of another vessel due to the proximity of shallow water
	Error in detection of another vessel due to radar interference in the vicinity of the OWF in good visibility conditions
	Error in detection of another vessel due to radar interference in the vicinity of the OWF in poor visibility conditions
	Navigational error (non-compliance with the regulations, human error, mistake, wrong decision)
	Inappropriate watchkeeping practices or poorly organised crew rest
	Malfunction of navigational equipment or steering–propulsion system
	Lack of sufficient sea room for manoeuvring due to the presence of OWF structures and other vessels

Incident type	Hazards potentially contributing to the incident
(8) Collision of a fishing or recreational vessel with an OWF installation/service vessel (9) Collision of two OWF installation/service vessels	Lack of sufficient sea room for manoeuvring to keep out of the way of another vessel due to the proximity of shallow water
	Error in detection of another vessel due to radar interference in the vicinity of the OWF in good visibility conditions
	Error in detection of another vessel due to radar interference in the vicinity of the OWF in poor visibility conditions
	Navigational error (non-compliance with the regulations, human error, mistake, wrong decision)
	Inappropriate watchkeeping practices or poorly organised crew rest
	Malfunction of navigational equipment or steering–propulsion system
(10) Collision of a vessel with restricted manoeuvrability (underwater works) with an OWF installation/service vessel	Malfunction of navigational equipment or steering–propulsion system
	Error in detection of another vessel due to radar interference in the vicinity of the OWF in poor visibility conditions
	Navigation hindered by the presence of other vessels
Contact	
(11) Contact of a large (medium) merchant vessel with an OWF structure due to a give-way manoeuvre (12) Contact of a small merchant vessel with an OWF structure due to a give-way manoeuvre	Lack of sufficient sea room for manoeuvring due to the presence of OWF structures and other vessels
	Lack of sufficient sea room for manoeuvring due to the presence of shallow water
	Lack of information on the presence of a structure, structure unnoticed or undetected
	Error in detection of another vessel due to radar interference in the vicinity of the OWF in good visibility conditions
	Error in detection of another vessel due to radar interference in the vicinity of the OWF in poor visibility conditions
	Navigational error (non-compliance with the regulations, human error, mistake, wrong decision)
	Inappropriate watchkeeping practices or poorly organised crew rest
	Malfunction of navigational equipment or steering–propulsion system
(13) Contact of a recreational vessel with an OWF structure due to a give-way manoeuvre (12) Contact of a small merchant vessel with an OWF structure due to a give-way manoeuvre	Lack of sufficient sea room for manoeuvring due to the presence of OWF structures and other vessels
	Lack of sufficient sea room for manoeuvring due to the presence of shallow water
	Lack of information on the presence of a structure, structure unnoticed or undetected
	Error in detection of another vessel due to radar interference in the vicinity of the OWF in good visibility conditions
	Error in detection of another vessel due to radar interference in the vicinity of the OWF in poor visibility conditions
	Navigational error (non-compliance with the regulations, human error, mistake, wrong decision)
	Inappropriate watchkeeping practices or poorly organised crew rest
	Malfunction of navigational equipment or steering–propulsion system
Contact of an OWF installation/service vessel with an OWF structure due to a give-way manoeuvre	Lack of sufficient sea room for manoeuvring due to the presence of OWF structures and other vessels
	Lack of sufficient sea room for manoeuvring due to the presence of shallow water
	Lack of information on the presence of a structure, structure unnoticed or undetected
	Error in detection of another vessel due to radar interference in the vicinity of the OWF in good visibility conditions
	Error in detection of another vessel due to radar interference in the vicinity of the OWF in poor visibility conditions
	Navigational error (non-compliance with the regulations, human error, mistake, wrong decision)
	Inappropriate watchkeeping practices or poorly organised crew rest
	Malfunction of navigational equipment or steering–propulsion system
(16) Contact of any vessel with an OWF structure	Lack of sufficient sea room for manoeuvring due to the presence of OWF structures of numerous wind farms
(17) Contact of a large merchant vessel not under	Lack of information on the presence of a structure, structure unnoticed or undetected
	Vessel unable to regain its manoeuvrability or unable to anchor

Incident type	Hazards potentially contributing to the incident
command with an OWF structure	
(18) Contact of a small merchant vessel not under command with an OWF structure	Lack of information on the presence of a structure, structure unnoticed or undetected
	Vessel unable to regain its manoeuvrability or unable to anchor
(19) Contact of a recreational vessel not under command with an OWF structure	Lack of information on the presence of a structure, structure unnoticed or undetected
	Vessel unable to regain its manoeuvrability or unable to anchor
(20) Contact of a fishing vessel not under command with an OWF structure	Lack of information on the presence of a structure, structure unnoticed or undetected
	Vessel unable to regain its manoeuvrability or unable to anchor
(21) Contact of an installation/service vessel not under command with an OWF structure	Lack of information on the presence of a structure, structure unnoticed or undetected
	Vessel unable to regain its manoeuvrability or unable to anchor
(22) Contact of a vessel involved in underwater works, with restricted manoeuvrability, with an OWF structure	Malfunction of navigational equipment or steering–propulsion system
	Error in detection of a structure due to radar interference in the vicinity of the OWF in poor visibility conditions
	Navigation hindered by the presence of other vessels
Other navigation risks	
(23) A vessel anchor causing OWF cable damage	Presence of unknown cable, cable with marine growth/fouling deposits
	Navigation error, non-compliance with navigation rules
	Emergency anchoring
(24) Wind turbine component striking the vessel from above	Damage to a wind turbine, separation from a structure
(25) Ice falling on board the vessel	Ice falling from rotor blades
(26) Damage to a structure or a service vessel due to wave motion	Wave from a vessel passing in the vicinity of the OWF
	Wave from another service vessel
(27) Interference with communications and AIS in the vicinity of the OWF	OWF structures impact VHF communications
Search and rescue operations	
(28) Rescue action not feasible	The person affected unable to determine their location
	OWF structures interfering with rescue helicopter access
(29) Incident requiring the use of rescue equipment	Cause related to the OWF operation
(30) Interference with communications and AIS in the vicinity of the OWF	OWF structures affecting VHF communications with the rescue coordination centre ashore (MRCC)
	OWF constructions affecting VHF communications between vessels involved in the operations at sea
Risk and pollution mitigation measures	
(31) Incident requiring mitigation measures	Cause related to the OWF operation
(32) Pollution incident unrelated to the OWF	Limited possibility of implementing marine pollution mitigation measures due to the presence of the OWF

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 detection of another vessel due to radar interferences in the vicinity of the 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 the OWF;
- OWF structures interfering with VHF/AIS communications;
- emergency anchoring;
- the person affected unable to determine their location.

6.1.1.1 Significant hazards, hazard scenarios

Both in the opinion of experts and on the basis of 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.

In the assessment of incidents and the overall accident risk assessment covering all recorded occupational incidents related to the construction and operation of offshore wind farms, the global statistics recorded by G-Plus (G+) – the Global Offshore Wind Health and Safety Organisation – are particularly useful. Incident statistics have been collected and shared since 2013. It should be taken into account that these statistics cover all recorded accidents at work, not only those relating to navigation incidents.

As part of its statutory activities, G-Plus publishes guidance documents containing incident analyses, allowing for a full characterisation of the hazards and covering safe maritime practice guidelines. Table 6.2 provides a list of scenarios that may unfold following earlier incidents.

Table 6.2. Hazard scenarios based on potential incidents [Source: internal materials based on G-Plus data]

Structure/incident classification	Incident description
Loss of stability of a jack-up platform	Loss of stability e.g. due to a landslide (ground instability) and damage to one of the supports may lead to damage or collapse of the jack-up platform
Accidents during subsea operations	Although the involvement of divers in subsea operations is being gradually reduced, there are several examples where the assistance of a diver proves indispensable. Diving operations are not fully standardised and adequate procedures requiring prior risk assessment and appropriate concentration are often not in place
SIMOPS	Simultaneous marine operations performed incorrectly may lead to serious accidents. One example is a collision between a CTV and a vessel under dynamic positioning control, i.e. a system forcing the propellers to respond to an assumed position
Collapse of a structure or its component	The transport of heavy structures using cranes is a risky operation and the probability of the structures falling while being transferred cannot be eliminated, particularly when the weight and size of the structures are at the limit of technical feasibility

Structure/incident classification	Incident description
Transport	Towing operations, particularly involving large and heavy HLVs or barges, carry a high risk and the accidents of breakage, loss of tow occur most frequently on routes between construction ports and the OWF
UXO	Unexploded ordnance pose a high risk to any maritime operation involving interference with the seabed
Man overboard	Man overboard (MOB) – an unplanned fall of a crew or personnel member into the water remains a serious problem. It should be taken into account that the construction of an OWF involves the permanent transfer of crew or personnel from ship to ship and from ship to the construction facility, frequently in poor weather conditions
Medical assistance	Work at height, in confined spaces, or in the vicinity of energised mains and service cables are high-risk activities. Immediate professional medical assistance becomes practically essential. This necessitates the availability of adequate in-house equipment and trained personnel, or involvement of organisations or institutions providing specialist medical services

It should be noted that the hazards for most of the incidents presented in the table 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.

At a detailed level, the list of hazards may also vary due to the fact that certain marine operations are not performed.

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 in the construction phase due to the known navigation situation in the sea area and due to the fact that certain marine operations are not performed.

6.1.1.2 Tolerability 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 tolerability 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.

Risk estimation is conducted both from the level of threat (consequences of an event) and probability (frequency of occurrence). Risk matrices are used to present the level of risk analysed, using a qualitative and partly quantitative method to allow ranking.

The structure of the risk matrix is based on the comparison of the event severity (effect or consequences of an event) expressed as a numerical equivalent with the frequency (probability) of its occurrence interpreted as the number of events per ship year. In practice, given a significant probability range, a logarithmic severity index (S_I) and a logarithmic frequency index (F_I) are applied. These indices are presented in Table 6.3 and Table 6.4.

Table 6.3. Logarithmic severity index – SI [Source: MSC-MEPC.2/Circ.12/Rev.2, IMO]

S_I	Event severity	Effects on human safety	Effects on ship	Equivalent fatalities (S)
1	Minor	Single or minor injuries	Local equipment damage	1.0E-02
2	Significant	Multiple injuries or a single severe injury	Non-severe ship damage	1.0E-01
3	Severe	Single fatality or multiple severe injuries	Severe ship damage	1.0
4	Catastrophic	Multiple fatalities	Total loss	10

For the purposes of formal safety assessment (FSA), a case severity equivalent is used, expressed as equivalent fatalities (S). This means that one fatality equals ten major incidents (e.g. severe injuries) and is equivalent to one hundred minor incidents (e.g. minor injuries).

Table 6.4. Logarithmic frequency index – FI [Source: MSC-MEPC.2/Circ.12/Rev.2, IMO]

F_I	Event frequency	Definition	Events per ship year (F)
7	Frequent	Likely to occur once per month on one ship	10
5	Reasonably probable	Likely to occur once per year in a fleet of 10 ships, i.e. likely to occur a few times during the ship's life	1.0E-01
3	Remote	Likely to occur once per year in a fleet of 1000 ships (equivalent of repeatable events in the total life of several ships)	1.0E-03
1	Extremely remote	Likely to occur once in the lifetime (20 years) of a fleet of 5000 ships	1.0E-05

Damage to the marine environment is expressed in the form of a severity index (S_I). The division is presented in Table 6.5.

Table 6.5. Logarithmic severity index – S_I [Source: MSC-MEPC.2/Circ.12/Rev.2, IMO]

S_I	Severity	Definition
1	Category 1	Oil spill size < 1 t
2	Category 2	Oil spill size between 1.0 – 10.0 t
3	Category 3	Oil spill size between 10 – 100 t
4	Category 4	Oil spill size between 100 – 1000 t
5	Category 5	Oil spill size between 1000 – 10 000 t
6	Category 6	Oil spill size >10 000 t

The risk matrix is the result of the sum of the logarithmic severity index and the event frequency index, $R_I = F_I + S_I$, and is included in Table 6.6.

Table 6.6. Risk index R_I [Source: MSC-MEPC.2/Circ.12/Rev.2, IMO]

F_I	Frequency	Severity (S_I)			
		1	2	3	4
		Minor	Significant	Severe	Catastrophic
7	Frequent	8	9	10	11
6		7	8	9	10
5	Reasonably probable	6	7	8	9
4		5	6	7	8
3	Remote	4	5	6	7
2		3	4	5	6
1	Extremely remote	2	3	4	5

Combinations of events and associated risks in the area of tolerability are analysed using the ALARP method. In general, the purpose of the analysis is to distinguish between the levels of risk enabling the assessment of navigational safety in and around the offshore wind farm area and the impact of the Project on navigational safety.

The concept of the adopted division of risk tolerability is presented in Table 6.7.

Table 6.7. Risk tolerability division [Source: MSC-MEPC.2/Circ.12/Rev.2, IMO]

R_I	Tolerability
9–11	An area of intolerability indicating an intolerable level of risk and inability to apply control measures. Other solutions should be sought to reduce the frequency and/or severity of events
5–8	An area of tolerability within which the risk requires control measures extending the range of tolerability towards an area of wide general tolerability
2–4	An area of wide general tolerability within which risks are generally considered to be insignificant, not requiring additional control measures other than monitoring

G+ data for the period 2019–2021 demonstrate 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. The probability of an accident related to marine operations is presented in Table 6.8.

Table 6.8. Probability and recurrence period of accidents associated with marine operations [Source: G+ and HELCOM data]

OWF life phase	Probability	Recurrence period (years)
Construction – marine accidents	0.0060702	164.7
Operation – marine accidents	0.0079357	126.0
Construction – pollution	0.000424914	2353.4
Operation – pollution	0.000555499	1800.2

For marine accidents, the frequency of events remains in the range between reasonably probable and remote (100–1000 years). According to the risk index table, the RI ranges from 4 to 9. According to the risk tolerability table, all events except for the remote events of negligible severity (R_I = 4) are in an area where the risk requires control measures extending the range of tolerability towards an area of wide general tolerability.

Marine pollution incidents are events in the event frequency range between remote and extremely remote, with a logarithmic frequency index (F_I) in the range of 1–3. According to the risk tolerability matrix, only severe and catastrophic events require risk control measures.

6.2 RISK OF STRUCTURAL COLLAPSES

As defined in Article 73(1) of the Act of 7 July 1994 – *Construction Law* (consolidated text: Journal of Laws of 2023, item 682, as amended) a structural collapse is *'an unintentional, sudden destruction of a civil structure or its part, as well as structural elements of scaffolding, elements of forming devices, sheet piling and excavation lining.'* 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 situation, in that case only due to a serious collision with a vessel or extreme weather phenomena. The occurrence of such situations will be very rare, 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. All components, despite being subject to extremely high stresses, are suited to many years of operation. All devices are subjected to continuous monitoring and each signal about the occurrence of deviations from the situation classified as a safe operation causes an automatic activation of remote service interventions or a change of operating parameters including stopping the devices. The rotor is stopped automatically at wind speed exceeding the safe operation threshold for the wind turbine. A service plan will be developed, the implementation of which will ensure failure-free operation of the Baltica-1 OWF during the entire operation phase.

6.3 RISK OF NATURAL DISASTERS

As defined in Article 3(1)(2) of the Act of 18 April 2002 *on the state of natural disaster* (consolidated text: Journal of Laws of 2017, item 1897), a natural disaster is *'an event related to the action of natural forces, in particular lightning, seismic shocks, strong winds, heavy precipitation, extended periods of extreme temperatures, landslides, fires, droughts, floods, ice phenomena on rivers and sea as well as in lakes and water reservoirs, outbreaks of pests, plant or animal diseases or infectious human diseases, or the action of other element.'*

The proposed Project will be located in the open sea area, therefore a natural disaster caused by the factors listed in the above-mentioned definition 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). Construction of wind turbines and OSSs, as well as the security systems against the impact of extreme environmental phenomena shall almost completely exclude the possibility of destruction of OWF elements as a result of a natural disaster.

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 Project Execution Plan and stopped immediately when these conditions are exceeded. Any work shall take into account the current weather 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'[11], climate change affects various physico-chemical parameters within the Baltic Sea (direct parameters), as well as parameters outside the Baltic Sea (external parameters) that significantly shape its condition. Table 6.9 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, and 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.

Table 6.9. Description of the projected impact of climate change on the physico-chemical parameters of the Baltic Sea and the factors shaping its condition until the year 2100, together with a description of the possible impact on the operation of the Baltica-1 OWF [Source: internal materials based on HELCOM 2021]

Parameter affected by climate change	**Projected impact of climate change on the parameter until the year 2100**	**Impact on the Project**
air temperature	The average annual air temperature above the sea surface is projected to increase by between 1.4 and 3.9°C (averaged values), and by a maximum of 4.8°C (compared to air temperatures in the period 1976–2005).	**No impact or a minor positive impact** *Even in the case of the maximum projected increase in air temperature, the change in this parameter will not affect the operation of the Project. Components of offshore wind farms are designed to operate within a wide range of air temperatures. Currently used wind turbines can operate in a wide range of air temperatures, for example the Vestas V236-15.0 MW turbine operates between -15 and +23°C. Units and variants suitable for operation in regions with higher temperatures are also available. Given the forecasts indicating that mild winters will become more frequent in the future, it is possible that the energy performance of offshore wind farms in the Baltic Sea will increase due to less frequent periods of extremely low temperatures that preclude turbine operation.*
water temperature	Surface water temperatures are projected to rise by between 1.1 and 3.2°C (averaged values), and by a maximum of 4.1°C.	**None** *The impact of surface water temperature changes on the operation of the Project will be negligible. The materials of which the offshore wind farm foundations, support structures and cable lines are made are resistant to changes in water temperature over a wide range, and account for possible extreme conditions.*

[11] HELCOM 2021. Climate change in the Baltic Sea Area. 2021 fact sheet. BSEP No. 180. pp. 45.

Parameter affected by climate change	Projected impact of climate change on the parameter until the year 2100	Impact on the Project
large scale atmospheric circulation	The seasonal pattern is expected to be preserved in the Baltic Sea region, with milder winters characterised by higher rainfall.	**No impact or a minor positive impact** *The relatively minor changes projected in atmospheric circulation are not significant for the Project operation. Milder winters may improve the energy performance of the Baltica-1 OWF due to lower likelihood of very low air temperatures, which are an important factor determining the operation of wind turbines.*
ice cover	The spatial extent, area and thickness of ice cover is expected to decrease during winter.	**None** *No surface ice cover or drift ice occur in the Project location area and its vicinity.*
solar radiation	Uncertain direction of change – global models indicate a slight increase in insolation over the Baltic Sea during the year, while regional models indicate that there will be a decrease in insolation.	**None** *This parameter has no impact on the operation of offshore wind farms. Therefore, regardless of the direction of changes in the values of this parameter, they will not affect the operation of the Project in any way.*
salinity and salt water influx from the North Sea	An increase in water influx from the North Sea is predicted due to the rising level of the world ocean and, at the same time, a greater influx of river water (particularly from the catchment areas of the northern region). As the influx from the North Sea is projected to be greater than fresh water influx, an increase in salinity of the Baltic Sea waters is likely to be observed by the end of the century. By the end of the century, sea water salinity is projected to increase by up to 0.7 PSU.	**None** *The infrastructural components of offshore wind farms are designed to be implemented in seas and oceans with salinity levels several times higher than that of the Baltic Sea. Therefore, even the projected maximum salinity increase of 10% will not affect the OWF structures, the parameters of which enable their installation in areas with considerably higher salinity.*
river run-off	Increased river water influx is projected in the northern part of the Baltic Sea and potentially reduced influx in the southern part.	**None** *Due to the significant distance from river estuaries, a change of this parameter will not affect the operation of the Project.*
water stratification	Salt water influx from the North Sea and fresh river water influx, as well as an increase in the temperature of the surface water layers, will lead to increased stratification of the Baltic Sea waters. Water mixing processes in the column during spring and late autumn may decrease or cease altogether.	**None** *Water circulation in the column does not affect the functioning of offshore wind farm components. Also its possible reduction or even cessation will not affect the functioning of the Baltica-1 OWF.*
precipitation	An increase in precipitation is predicted for the northern part during winter and spring, while for the southern part the direction of change is uncertain.	**None** *This parameter has no impact on the operation of offshore wind farms.*
carbonate chemistry	Increased river run-off and increased atmospheric carbon dioxide concentrations are expected to result in a decrease in the pH of sea waters. By the end of the century, the pH of ocean water is projected to reach the value of 7.75, a slight decrease compared with the values recorded at present.	**None** *A decrease in water pH will not affect the operation of the Baltica-1 OWF. The materials used in the construction of offshore wind farms are resistant to a wide range of water acidification conditions, substantially beyond the projected changes in this parameter in the future.*

Parameter affected by climate change	**Projected impact of climate change on the parameter until the year 2100**	**Impact on the Project**
riverine nutrient loads and atmospheric deposition	The influx of nutrients is projected to increase in the northern part and decrease in the southern part.	**None** *This parameter has no impact on the operation of offshore wind farms.*
sea level	Baltic Sea level is projected to rise by approximately between 37 and 73 cm (averaged values) by 2100. Taking into account the maximum values, the sea level rise is estimated to be up to approximately 96 cm.	**None** *Sea level rise, even in the case of reaching the extreme value of 1 m, will not lead to impacts on the operation of the Project. The wind farm design will account for a rise in the water surface level during the operation period (e.g. location of the access platform) to ensure trouble-free operation when this phenomenon becomes noticeable in the environment.*
wind	A slight increase in wind strength is anticipated during autumn and a decrease in wind strength during spring. Thunderstorms, accompanied by strong winds, may occur more frequently in summer.	**Positive or negative** *Wind conditions are the main factor determining the energy performance of wind turbines. An increase in the number of days with winds enabling operation will contribute to the energy performance of the farm, while a decrease in windy days will have the opposite effect. More frequent occurrence of hurricane force winds with speeds of 32 m/s and above will result in turbine operation being stopped during such winds, which will also contribute to a decrease in the energy performance of the farm. At present, it is impossible to determine if and how changes in windiness over sea areas will affect the operation of the Baltica-1 OWF. Currently, it is just as likely to assume that the projected changes in windiness will improve its performance as that they will decrease it. Moreover, it cannot be ruled out that the annual balance of wind changes, i.e. lower windiness in spring and higher windiness in autumn, will be neutral. It should be added that offshore wind turbines used to date typically operate in a wind speed range between 3 and 31 m/s, but manufacturers are working on units with a greater range of tolerance to this parameter to ensure their most efficient operation.*
wave motion	Wave heights are projected to increase slightly, by approximately 5%, by the end of the century. The largest increase in wave height is likely to occur in the northern and eastern parts of the Baltic Sea.	**None** *The Baltica-1 OWF structures will be designed and built to withstand very rough sea conditions, including strong long-term wave energy. An increase in wave motion of 5% or more is not expected to affect the operation of the Project.*
seabed sediment transport	An increase in the transport of seabed sediments is anticipated in nearshore areas. The direction of sediment transport – from west to east – will most probably be maintained.	**None** *The projected increase in seabed sediment transport will take place in the shallow near-shore zone, where hydrodynamic conditions above the seabed are the strongest. The Baltica-1 OWF will be situated in a sea area far away*

Parameter affected by climate change	Projected impact of climate change on the parameter until the year 2100	Impact on the Project
		from the shore, with depths ranging from approximately 16 to approximately 50 m. At such depths, hydrodynamic processes in the zone above the seabed are very weak and no significant changes in the relief and in the seabed surface level occur within several decades. Therefore, there are no concerns that the projected increase in seabed sediment transport intensity will, for example, result in the exposure of cables buried and foundations embedded in the seabed.

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.

6.4 Types of accidents resulting in environmental contamination, risk of oil spills from vessels

During the Project construction phase, followed by possible decommissioning by dismantling, the most significant potential threats to the environment will be emergency situations 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.

Leakage of hazardous substances in an emergency situation may cause a long-term and significant negative impact on the biotic and abiotic environment of open and coastal waters and, if these substances reach the shore, also on the environment of the coastal strip margin, mainly beaches. The extent of this impact will depend on the size of the leak; in extreme cases it may cover an area of several dozen square kilometres. In order to address this risk, 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 situation, 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 director of the maritime office 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.

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

During a normal operation of vessels, small spills of petroleum products, i.e. fuel oils, lubricants and petrol, may occur. In most cases, the released petroleum products cause Tier 1 spills. From the environmental point of view, the most vulnerable area in case of possible spills will be the Middle Bank area and the nearshore waters area, in which high concentrations of birds are recorded during the wintering period, as well as the coastal strip stretching between 150 and 170 km of the shoreline chainage. Considering the prevailing westerly wind direction and the occurrence of coastal currents, the areas which might be at risk due to leaks of petroleum products include the coastal strip with tourist resorts (Białogóra, Dębki and Karwia) and the harbour in Władysławowo.

It should be emphasised that the key issue there is not so much the size of the spill as the place where it has 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 high seabird concentrations [Meissner, 2005]. The Project area is located near *Hoburgs bank och Midsjöbankarna* (SE0330308) site, which is an important wintering site for the grey seal and the main porpoise population area in the Baltic Sea. It should be emphasised, however, 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. The determination of the actual extent of spillage 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.

The number of potential leaks is proportional to the number of vessels used to carry out every phase of the Project implementation. The largest petroleum product spills may occur as a result of vessel failure or collision, sinking or grounding, as well as during seepage and operational leaks from vessels, and oil spills related to the maintenance and repair of cable lines. In the worst-case scenario, during the construction and decommissioning stages, Tier 3 spills (catastrophic spills) will occur. The probability of a major vessel accident has been calculated to be very low, approximately in the order of 1/10 000 years (1/200 probability of an event occurring in 50 years) [Reszko, 2017].

Assuming the worst-case scenario and the release of several hundred cubic metres of diesel fuel into the marine environment, as well as 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 the distance from 5 to 20 km from the Baltica-1 OWF Area.

6.4.2 Environmental hazards 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.

Given the technology to be used for the construction of the Project, its location, labour input and intensity of works, it is foreseen that in the event of an emergency situation, the marine environment will be the most negatively impacted. The following emergency situations during the construction and possible decommissioning phases which can become the source of negative impacts on the marine environment have been selected:

- a spill of petroleum products as a result of a collision of ships in an emergency situation;
- a spill 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 emergency situations 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 exclusively local. A 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. 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.

6.4.3 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 emergency situations 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. The following cable line failures can be distinguished [Pędzisz, 2007]:

- simple: single-, two- and three-phase earth faults; single-, 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 overcurrents (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%). In the marine environment, these include overcurrents. 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 an OSS failure, gas emissions to the atmosphere may occur (flue gases from the power generator activated in emergency situations, leaks of cooling agent from the cooling system or leaks of SF6 insulating gas if a 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.

6.5 Design, technological and organisational safeguards expected to be applied by the Applicant against failures as well as construction and natural disasters

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

- threats to human life – evacuation plans, rescue plans, HSE information;
- fire hazards;

- threats of environmental pollution – a plan to counteract the threats and contamination by oil. The principle of the obligation to have a plan will apply not only to the facility, but also to all large and 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 and maritime administration).

Examples of risk control measure suggestions to be implemented together with objectives and effects expected are presented in Table 6.10.

Table 6.10. Proposed risk control measures with justification [Source: internal materials based on Strategic Marine Services Ltd, No. 3, 2011]

Control measure	Objective	Expected effects
Construction vessel trips to the OWF basin along specified routes	Minimising conflicts with other vessels	Reducing the number of conflicts between vessels

Control measure	Objective	Expected effects
	Controlling access to the OWF construction area	Increasing navigation space near other vessels, OWF facilities and shallow water areas Controlling vessel traffic within the OWF area
Establishment of a vessel traffic coordination system for the port area (port, construction ports, service port)	Improving vessel traffic control between the port and the OWF	Reducing the number of conflicts between vessels Improving control of OWF vessel traffic Increasing navigation space near other vessels, OWF facilities and shallow water areas Reducing delays related with port approaches, avoidance of periods of increased traffic in the port
Establishing a vessel traffic monitoring system to ensure compliance with pre-planned routes, dissemination of information on potential vessel traffic problems in and around the OWF area	Monitoring vessel traffic in and around the OWF area, early warning system	Increasing navigation space near other vessels, OWF facilities and shallow water areas Reducing the number of conflicts between vessels Monitoring of the effectiveness of other measures introduced
Auditing OWF vessels to confirm compliance with safety requirements, ability to perform operations, level of training, working conditions	Increasing operational safety in relation to personnel Controlling working conditions	Ensuring an appropriate and optimal level of vessel management in relation to the implementation of individual operations Ensuring an appropriate watchkeeping system and rest regime
OWF vessels are managed and perform operations in accordance with an approved planned management system (PMS), which includes automatic supervision of the operation of vessel facilities and equipment. For individual operations, this may be a redundancy-related requirement. Implementing the requirement by means of an audit or by providing an appropriate class notation	Increasing operational safety in relation to technical condition	Reducing likelihood of incidents resulting from breakdowns
Maintaining standards for vessels not covered by the STCW Convention. This means the personnel qualifications and level of training in the operation of equipment and facilities in the OWF environment. In particular, this includes experience in operating communications, radar and AIS equipment in the event of interference with its operation	Improved safety of small vessel operations due to an increased number of navigators Eliminated effects of possible interference with communications, radar and AIS equipment	Reducing the likelihood of navigation error Reducing the likelihood of error resulting from interference with communications, radar and AIS equipment
Introducing obligatory, permanent, two-person crew on the bridges of all OWF vessels, when travelling to and staying within the OWF Area	Under normal sea conditions or in the case of vessels whose class notation allows for one-person operation, e.g. NAV1, only one person may be sufficient to steer the vessel. For special conditions – OWF construction and operation – the bridge manning level should be increased	Reducing the likelihood of incidents resulting from navigation errors due to inadequate watchkeeping practices or poorly organised crew rest
Implementing the obligation to equip all OWF vessels with a Class A AIS transponder	The SOLAS Convention requirement does not apply to vessels of less than 300 GT. Smaller vessels are typically	Capability of rapid detection and identification of vessels in interactions between the vessel and foreign vessels

Control measure	Objective	Expected effects
	equipped with Class B AIS transponders.	Capability of distinction between a vessel and an OWF facility Provision of information to shore-based marine traffic monitoring or surveillance system
Obligatory publication of corrections to navigation charts related to the OWF construction	In the nautical supplements disseminated in the form of publications, there is space intended for the areas where works are conducted, together with further related information	Providing Information on where the areas with ongoing construction activities are located and how to plan a cruise in order to make a safe passage to all sea users Reducing the likelihood of conflicts related to the movement of OWF vessels Increasing the navigation space for OWF vessels
Navigational warnings for shipping activities unrelated to the OWF, in order to avoid hazardous areas	Early warning of the danger associated with construction activities to safeguard the OWF construction	Reducing the number of recreational vessels that may interfere with construction activities Increasing the navigation space for the OWF construction vessels Navigation errors attributable to recreational vessels will not affect the safety of construction activities
Navigational warnings for all shipping activities, aimed primarily at fishing vessels, related to the execution of major maintenance works during the operation phase	Disseminating information necessary for all entities involved in sailing or fishing activities in the OWF Area and its immediate surroundings	Reducing fishing and other activities in the area of maintenance works Increasing navigation space for large OWF service vessels Reducing the likelihood of conflicts Reducing the likelihood of navigation errors in the area where the work is carried out
OWF vessels are assisted by multi-purpose escort vessels	The presence of escort vessels increases internal and external security of the OWF Large OWF vessels, especially ones with limited manoeuvrability, can be assisted, while small vessels may require assistance in case of breakdown or accident In a situation requiring assistance, vessels unrelated to the OWF can obtain such assistance at short notice	Increasing navigation space for OWF vessels Reducing the likelihood of navigation errors attributable to other vessels in the area where the work is carried out Reducing the likelihood of conflicts Reducing the risk caused by contact between a small vessel and an OWF structure due to the possibility of providing prompt assistance
Providing the responsible authorities, without undue delay, with information on each wind turbine or other OWF structure installed, in order to include it in the navigation charts and disseminate this information among other users of the sea basin	Providing all vessels passing through the OWF Area with up-to-date information on the layout of structures and the presence of underwater installations	Reducing the risk of contact between an OWF vessel and an OWF structure Providing up-to-date information on sea room available for manoeuvring within the OWF Area Reducing the risk of dropping anchor near a newly laid cable
Applying dedicated procedures for the purpose of conducting maritime operations in poor visibility conditions	Reduced visibility makes it more difficult to detect and identify other vessels or OWF structures, and increases the level of risk. There is a need for increased control over the movement and speed of vessels	Reducing the likelihood of navigation error due to poor visibility Mitigating consequences in the case of contact between a vessel and an OWF structure due to navigational error or steering/propulsion system failure
Introducing the principle of speed limitation within the OWF Area	Introducing speed limits for OWF vessels is necessary to mitigate the consequences of contact with an OWF structure	Reducing the likelihood of navigation error due to increased response time

Control measure	**Objective**	**Expected effects**
		Reducing the likelihood of the consequences of a technical breakdown due to increased response time Reducing the risk of an accident resulting from contact
Assessing the impact of power cable burial method in the context of anchoring possibilities	An analysis of the hazards associated with vessel drift shows that immediate anchoring may be necessary. The cable burial methodology should account for this circumstance Unburied cable presents a serious risk with consequences such as possible cable damage	The possibility of dropping anchor immediately is achieved, reducing the risk associated with a vessel drifting in the OWF Area Reducing the likelihood of cable damage and the need to stop wind turbine operations
Ensuring the availability of spill handling equipment in the event of a pollution incident	Counteracting pollution incidents	Reducing damage to the marine environment Reducing the costs borne by the party responsible for the pollution by limiting pollution extent Reducing possible OWF shutdowns related to spill handling operations Increasing local/regional potential for counteraction
Developing and implementing procedures for vessels operating in the vicinity of wind turbines	Before approaching any OWF structure, a vessel performs a propulsion/steering system check procedure to confirm full manoeuvrability Readiness for approach is reported to the vessel traffic control centre Support vessels provide the necessary room for manoeuvring, remaining outside the designated safety zone	Reducing the likelihood of contact due to breakdown Reducing the likelihood of collision between OWF vessels Reducing risks associated with damage and detachment of components of the erected structure
During the OWF construction phase, information on cable laying activities and, in particular, on cables already laid is disseminated via navigational warnings and nautical publications	All users of the sea are informed about the works and cable laying locations	Reducing the risk of cable damage resulting from anchor dropping Reducing the risk of cable damage resulting from the use of inappropriate fishing gear
Developing a procedure to give early warning of a conflict to other vessels and obliging the crews of small OWF vessels to follow it	Warning large vessels passing in the vicinity of the OWF is intended to eliminate situations in which small vessels are forced to make dangerous manoeuvres	Reducing the risk of damage caused by contact between an OWF vessel and a wind farm structure
Introducing a supervision and control system for the positioning of the nacelle, rotor blade planes and other moving parts of the OWF structure	Stopping and repositioning of moving parts is necessary for helicopter rescue operations	Creating the possibility and increasing the effectiveness of rescue operations, especially those involving helicopters
Developing procedures for handling, transporting, transferring and storing hazardous materials, including procedures for responding to pollution incidents	Adequate procedures increase safety associated with the use of hazardous materials	Reducing the risk of accidents, environmental damage and property damage Reducing the costs borne by the party responsible for the pollution by limiting pollution extent Reducing possible OWF shutdowns related to pollution cleanup operations and environmental remediation
Developing procedures for conducting underwater work involving dredgers, defining safety zones depending on the type, size and manoeuvrability of a	Achieving a situation in which all factors related to the safe performance of offshore operations	A safety zone for each OWF vessel, based on its parameters and weather conditions

Control measure	Objective	Expected effects
vessel or a group of vessels, and weather conditions	have been taken into account to determine the working conditions	Reducing the risk of contact between a dredger and an OWF structure
Establishing support systems for VHF and AIS communications to enable their effective use for safe navigation as well as search and rescue operations	VHF communications and AIS identification systems can be interfered with by OWF facilities. The support system will effectively eliminate such interference	Ensuring good communications during search and rescue operations Possibility of making full use of the AIS to monitor vessel movements, particularly during SAR operations

6.5.1 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 the 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):

- 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 at which the navigational markings are located (whichever of the two reaches higher); alternatively, all-round horizontal stripes with a width of not less than 2 metres in height and at intervals of the same width as 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 of 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.

6.6 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 mitigation of their effects on the safety of the natural environment and people, are included in Table 6.11.

Table 6.11. 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 projects. Such measures include coordination of vessels operating in vicinity and within the area of an offshore wind farm by implementing a 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 emergency situations resulting in oil spills, appropriate measures will be taken to prevent the spread of such substances and they will be removed 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 measures 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.

6.7 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. The 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 the OWF;
- limitations in communication between ship stations. The 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, the 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;
- The 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;
- The 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 6.12 should be applied.

Table 6.12. 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 the turbine boundary 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.*

In the distance interval of 0.5–3.5 NM, an impact analysis is necessary, taking into account the detrimental effects on navigational equipment and communications for all types of vessels operating in the area and additionally for:

- vessels operating at a safe navigational distance;
- vessels by the nature of their work necessarily operating at less than the safe navigational distance, e.g. OWF service vessels, rescue craft;
- vessels by the nature of their work necessarily operating within the OWF Area.

Analyses of the impact on marine positioning, communications and radar systems, as well as on the execution of rescue operations and combating hazards and pollution in the marine environment are the subject of separate expert reports and plans in accordance with the requirements of the Regulations of the Minister of Infrastructure of 15 December 2021 *on navigation expert reports and technical expert reports for the offshore wind farm and the complex of facilities* (Journal of Laws of 2021, item 2380):

- Technical expert report on the duration of the impact of the OWF and the complex of facilities on the Polish sea areas A1 and A2 of the Maritime Operational Communications System of the Maritime Search and Rescue Service;
- Technical expert report on the assessment of the impact of the OWF and the complex of facilities on the National Maritime Security System (NMSS);
- Emergency Plan specifying the types of threats to the health and life of the personnel involved in the construction, operation and decommissioning of the OWF and the complex of facilities, as well as methods and operational procedures in the event of these threats, and the forces and resources provided by the manufacturer to implement this emergency plan;
- Plan for combating threats and contamination for the OWF and the complex of facilities;

On the basis of the analysis carried out, it may be necessary to locate the so-called repair stations in the vicinity of the Baltica-1 OWF in order to compensate for the negative impact of the OWF on GMDSS Systems. Such stations act as repair stations for working GMDSS base stations. The proposed repair stations are an extension of the currently operating radio communication system, developed on the basis of a radio server and radio gateways.

Elements of the Baltica-1 OWF will undoubtedly constitute navigation obstacles, both for vessels and aircraft carrying out rescue operations or combating hazards and pollution in the marine environment.

In the case of transit to the site of operations, these vessels will have to take into account the presence of the Baltica-1 OWF components in the selection of the traffic route. However, due to the significant distances between the individual Baltica-1 OWF structures, the potential excess travel may be considered negligible.

In addition, in the case of operations commenced outside the Baltica-1 OWF Area but moving into the OWF Area as a result of drift, the operating vessels will also need to account for the Baltica-1 OWF structures in their operations. This obviously poses an operational difficulty for the crews of these vessels.

On the other hand, it should be noted that the possibility of using the infrastructure of the Baltica-1 OWF (for example as a place for assembling containment booms or using monitoring for surveillance or observation) can undoubtedly increase rescue and pollution response capabilities in the vicinity of this infrastructure.

It is necessary to point out the relevance of including the capacities, resources and procedures planned for the Baltica-1 OWF in the SAR Plan and the National Plan for Combating Risk and Pollution of the Marine Environment, as well as the operational cooperation towards the best use of the potential of the Project Owner's infrastructure.

A detailed assessment of the impact of the Baltica-1 OWF on the safety and efficiency of navigation will be presented as part of the navigational expert report, which the Project Owner is required to provide to the Director of the Maritime Office in Gdynia before obtaining the building permit.

Impacts on military aviation and defence systems will be the subject of a technical expert report on the assessment of the impact of the offshore wind farm and the complex of facilities on the national defence systems, including the radiolocation imaging system, technical observation, maritime radio communications and the air traffic control system of the Armed Forces of the Republic of Poland. The expert report requires the approval of the Minister of National Defence prior to obtaining a building permit.

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.

6.8 Relations between the Project parameters and its impacts

The matrix of relations between the Project parameters and its impacts on the environment in all phases of the Project implementation is provided in Table 6.13.

Table 6.13. Matrix of relations between the Project parameters and impacts

Parameter	**Type of emission or disturbance**															
	Disturbances of the above water space	**Disturbances of the underwater space**	**Heat emission****	**EMF emission**	**Above-water noise**	**Underwater noise**	**Waste types and quantities**	**Light effects**	**Seabed disturbances**	**Resuspension of contaminants**	**Suspended solids generation**	**Suspended solids resedimentation**	**Formation of an artificial reef**	**Water contamination**	**Air pollutions**	**Increased vessel traffic and collision risk**
Number and height of wind turbines	X	X			X	X	X	X								X
Rotor diameter [m]	X															
Number of OSSs	X	X				X	X	X								X
Number of foundations		X				X	X		X	X	X	X	X	X		X
Type of foundations and erosion protection width						X			X	X	X	X	X	X		
Surface of foundations		X				X			X	X	X	X	X			
Full height of structure	X				X			X								
Power cable type			X	X												
Length of cable lines		X	X	X						X	X	X				X
Construction method and depth of cable line burial			X	X		X				X						X
Organisation of technological processes (number of vessels, time)					X	X	X	X			X			X	X	X

7 DESCRIPTION OF NATURAL ELEMENTS OF THE ENVIRONMENT AND OTHER ENVIRONMENTAL CONDITIONS COVERED BY THE SCOPE OF THE ANTICIPATED IMPACT OF THE PROPOSED PROJECT ON THE ENVIRONMENT

7.1 SEABED

7.1.1 Location and seabed topography (seabed geomorphology)

The area surveyed lies within the south-eastern part of the Southern Middle Bank and on its southern, south-eastern and eastern slopes. It covers the seabed with depths ranging from approximately 13.7 to approximately 51.8 MBSL. In the bathymetric image, the shallower central and western parts of the survey area are more distinct. The seabed in that part of the area is located at a depth of approximately 14.0–23.0 MBSL, and it is separated from the rest of the survey area by a slope reaching, in places, up to 12 m in height with an inclination of several degrees. Below the slope, the seabed gently lowers towards the south, south-east and east to a depth of approximately 50.0 m [Figure 7.1].

In the north-eastern part of the survey area, numerous iceberg ploughmarks are visible in the seabed relief. They form a chaotic arrangement of elongated depressions more than 2 km long in places, up to 140 m wide and up to 1.4 m deep.

In the central part of the survey area, traces of sand extraction are visible in the seabed relief. To the west of the survey area boundary is the 'Southern Middle Bank – Southern Baltic' sand-gravel deposit, where three mining areas were designated, the nearest of which is approximately 60 m from the survey area boundary (see Section 7.10.4). Those areas were indicated as areas with a seabed relief modified due to the mining and further works conducted and the natural processes taking place on the seabed as a result of such works.

The depth distribution characteristics and the character of the seabed relief in the survey area were developed in the form of a map of seabed surface types [Figure 7.2] using a bathymetric map, a seabed slope map and a sonar mosaic. Within the area analysed, two types of seabed surfaces were differentiated, which include an accumulation platform and an abrasive-accumulative plain.

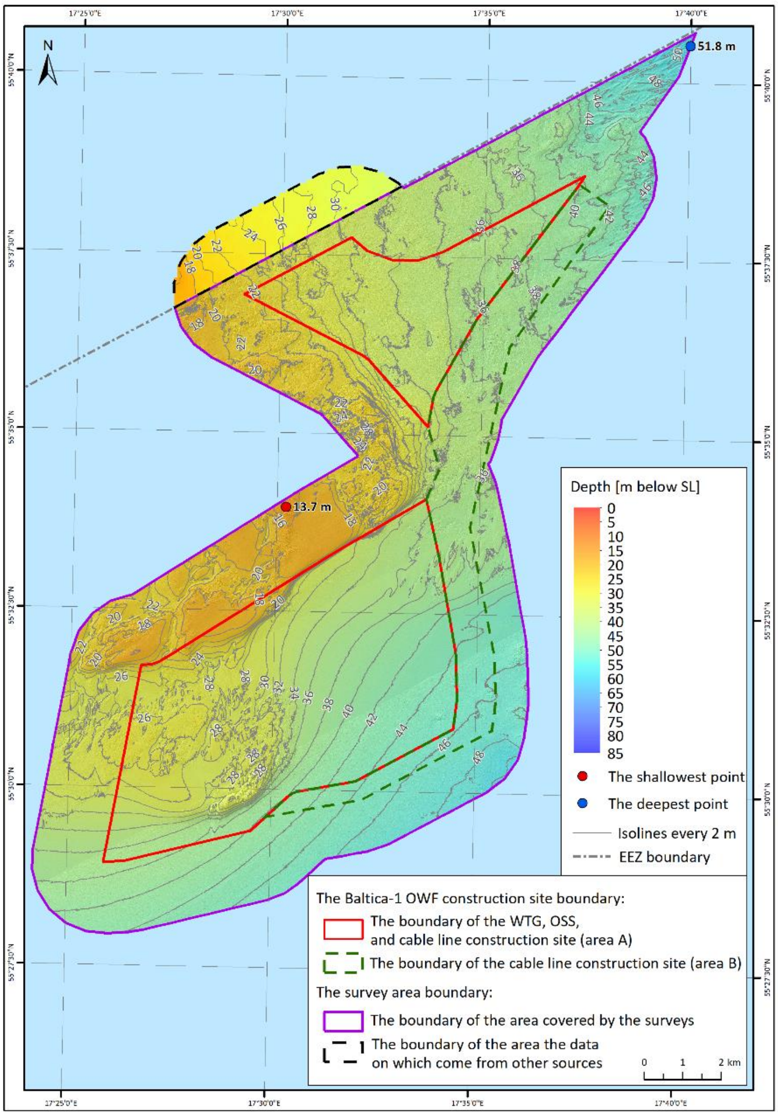

Figure 7.1. Bathymetric map of the survey area

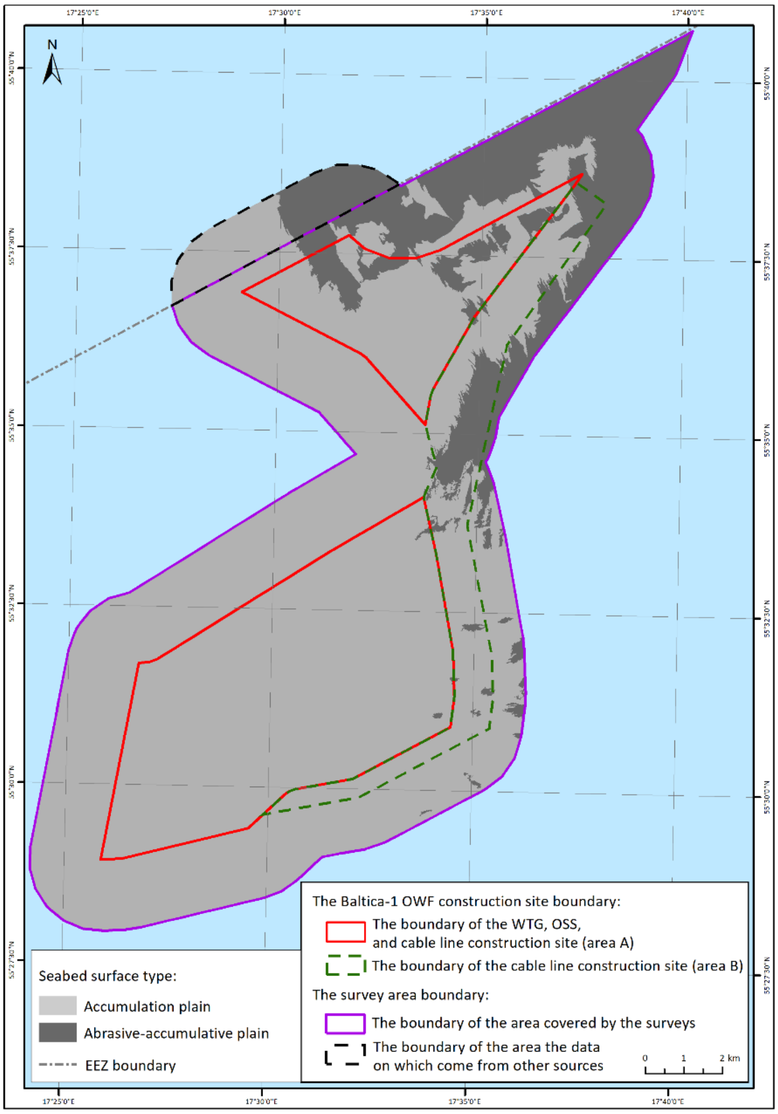

Figure 7.2. Map of seabed types in the survey area

Accumulation platform

The western and central parts of the survey area constitute an area with an accumulation platform character [Figure 7.3]. It covers the seabed with depths ranging from approximately 14.0 to approximately 35.0 MBSL. The seabed surface is slightly undulating, with minor changes in seabed elevation related to the presence of sandy formations. The seabed relief shows signs of sand extraction [Figure 7.4]. The seabed slopes are 2–3°, up to a maximum of over a dozen degrees on the slope visible in the seabed relief in the central part of the survey area and within the sand extraction areas.

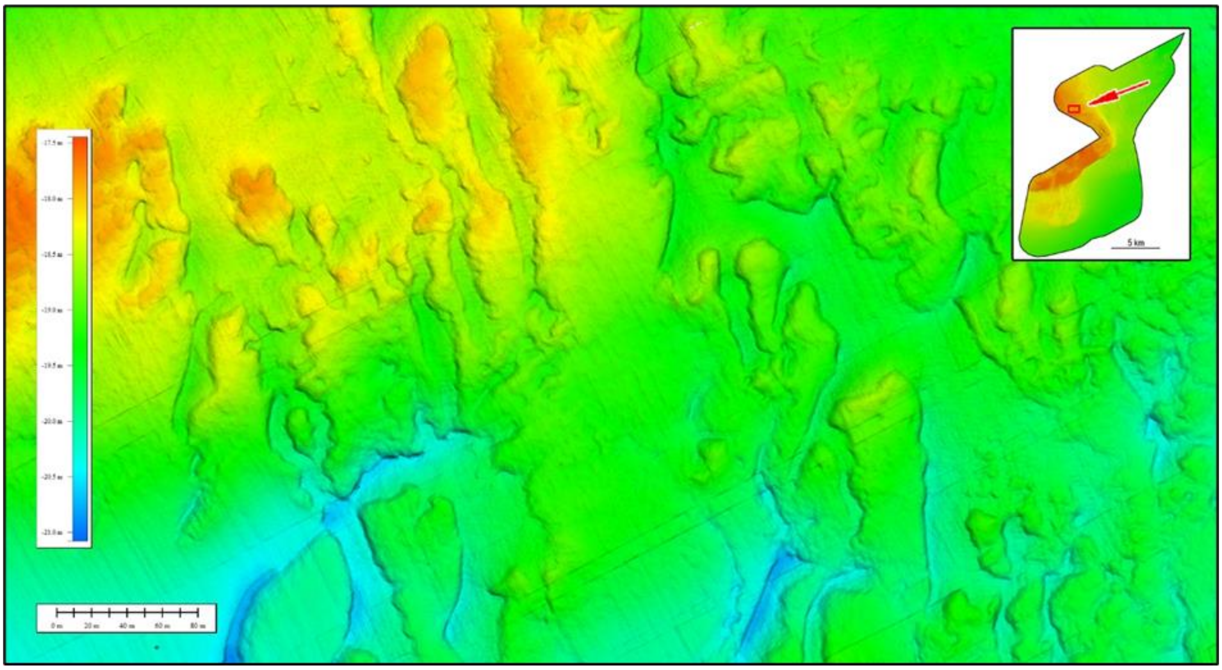

Figure 7.3. Fragment of a bathymetric map; undulating surface of the accumulation platform; visible signs of the seabed irregularities within the sand accumulations divided by depressions resulting from the periodical seabed surface washout, where mega-ripple marks can be seen in the MBES and SSS data

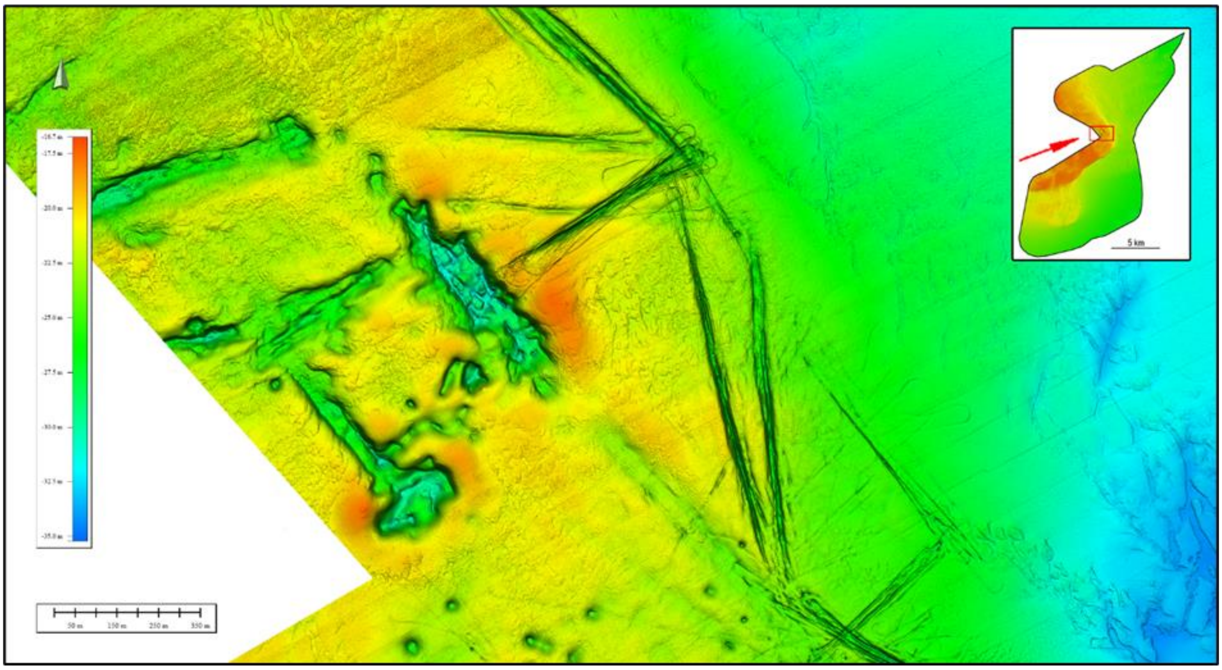

Figure 7.4. Fragment of a bathymetric map; undulating surface of the accumulation platform; visible signs (depressions) of sand extraction

Abrasive-accumulative plain

The eastern part of the seabed in the area analysed has the character of an abrasive-accumulative plain [Figure 7.5]. It covers the seabed with depths from approximately 35.0 to approximately 51.8 MBSL. The seabed is uneven, with 0.5–1.0 m changes in elevation due to the presence of sand accumulations and outcrops of older sediments (glacial and fluvioglacial sediments). The seabed slopes reach 2–3°, up to a maximum of over a dozen degrees within the slopes of the outcrops of older sediments.

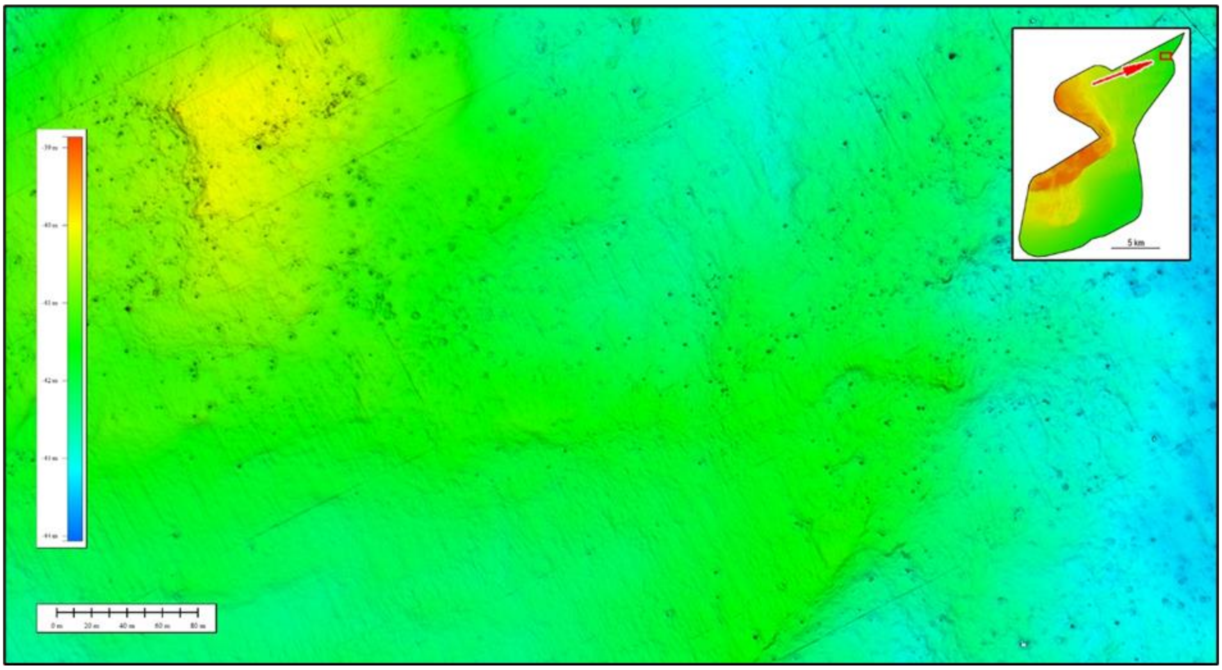

Figure 7.5. Fragment of a bathymetric map; uneven surface of the abrasive-accumulative plain; visible single boulders and boulder clusters

7.1.2 Geological structure

The survey area is situated on the Precambrian East-European platform within the Słupsk block. The top of the crystalline basement rises gently in a north-western direction – in the southern part of the survey area it is at a depth of about 1.7 km, while in the northern part of the field it is at a depth of about 1.5 km. The thickness of the sediment cover increases towards the south-east together with the decline of the crystalline basement top [Dadlez 1995; Kramarska *et al.* 1999; Pikies 1990, 1995; Uścinowicz, Zachowicz 1988 and 1991, https://www.sgu.se/en/].

The older Paleozoic is represented by Silurian formations, which constitute a direct Cenozoic substrate on the elevated Słupsk block. In the survey area, the Quaternary sediments are deposited on the Silurian formations.

Based on the analysis of seismo-acoustic and seismic profiling results, five main seismic units were distinguished. These units were interpreted geologically with reference to the general knowledge about the method and the survey region.

The basis of the differentiation was the diverse intensity and distribution of reflections, as well as the character of the unit boundaries. The interpretation of the tops of individual seismic units was carried out manually by an interpreter and is the original result of the analysis of the data collected and the literature data [Dadlez 1995; Kramarska 1995 a and b; Kramarska *et al*. 1999; Uścinowicz 1995; https://igs.pgi.gov.pl, https://geolog.pgi.gov.pl]. This approach results from the specificity of the Pleistocene and Holocene sediments forming the seabed of the Southern Baltic. These are usually the sediments of great internal diversity (e.g. glacial sediments) with a significant number of internal horizons appearing in the sediments of similar genesis (glaciolacustrine deposits, fluvioglacial deposits, marine deposits).

The units differentiated were described as:

- Unit IA – fine- to medium-grained sands, locally silty sands, in some places coarse grained sands and gravels (marine, fluvial and fluvioglacial). These are sandy and sandy-silty marine deposits (Holocene) forming a layer together with the sandy deposits of fluvial and fluvioglacial origin (sands, gravels, locally silts; Pleistocene/Holocene). The top of Unit IA forms the seabed surface of the sea area in which the deposits of this unit are present. In the areas in which the deposits of Unit IA do not occur, the seabed surface is formed by the highest deposited sediment layer. In view of a clear difference in the nature of reflections, an internal horizon IA_a was differentiated within this unit. These are fine- to medium-grained sands, locally silty sand filling the depressions in Unit ID1 top;
- Unit IB – fine and medium-grained sands, locally sands with gravel (lagoon, fluvial, fluvioglacial), form accumulations of varied character, heterogeneous, with alternating accumulations of sand and gravel. Possible boulder presence. Boulders and gravels may form surfaces of an erosive pavement character, especially in the top part of the unit;
- Unit ID – sands with gravel, gravels, tills (fluvioglacial and glacial); mainly glacial sediments with a large proportion of tills. This unit structure contains interbeddings and lenses of sand and sand and gravel sediments, possible boulder presence. In the top part, boulders may form surfaces of erosive pavement character. The following division into two sub-units within the fluvioglacial and glacial sediments was introduced:
  - Unit ID1 – clayey tills or silty tills, locally clays or silty clays with an admixture of sand and gravel fractions (subaquatic),
  - Unit ID2 – sands with gravel, gravels, tills (fluvioglacial and glacial) – within this unit, four internal horizons were differentiated, described as ID2_a, ID2_b, ID2_c and ID2_d (interpreted on the basis of multi-channel seismic data); these may be the tops of both glacial and fluvioglacial deposits;
- Unit IF – pre-Quaternary sediments:
  - Unit IF1 – sediments filling the valleys in the Silurian top, the age of which is difficult to determine at the current stage of surveys;
  - Unit IF2 – correlated as Silurian deposits.

In the south-western and central part of the survey area, the seabed is formed of fine- and medium-grained sands, locally silty sands, in some places coarse-grained sands and gravels (Unit IA). They form a layer with a thickness of up to approximately 17 m. These are mainly marine sands. In the northern and eastern part of the survey area, they form a discontinuous layer and occur on the seabed in the form of accumulations characterised by low thickness. Within this unit, an internal horizon IA_a was differentiated. These are fine- to medium-grained sands, locally silty sand filling the depressions in the top of Unit ID1, in the south-eastern part of the survey area. Below the sandy sediments, in the western and southern part of the survey area, fine- and medium-grained sands were identified, locally sands with gravel (Unit IB). They form a layer with a thickness of up to approximately 20 m. The sediments of this unit are not homogeneous. These are deposits of lagoon and fluvial origin, partially also fluvioglacial. Below the sediments of units IA and IB, in the southern part of the survey area, sediments of subaquatic origin were identified – clayey tills or silty tills, locally clays or silty clays with an admixture of sand and gravel fractions (Unit ID1). They form a layer with a thickness of up to approximately 8 m;

the exception is the filling of the buried valley identified in the central part of the survey area, which is mainly constituted by the sediments of Unit ID1 with a thickness of up to approximately 16 m. Greater thicknesses (approximately 16 m) occur also in the south-western part of the survey area. Another unit identified comprises the glacial and fluvioglacial sediments of Unit ID2. These are mostly sands, gravels and tills. The shallowest location in which they were identified is the eastern and north-eastern part of the area analysed, where they form outcrops on the seabed surface. Their top lowers towards the west and south-west, to the depth of approximately 27 MBSB. Within Unit ID2, four internal horizons were differentiated, D2_a, ID2_b, ID2_c and ID2_d, which may be the tops of both glacial and fluvioglacial deposits. Below the glacial sediments of Unit ID2, sediments representing Unit IF were identified, which were classified as pre-Quaternary sediments. Unit IF2 sediments were described as Silurian deposits. Those sediments (Unit IF2) were identified within the entire survey area. Valleys in the top of Unit IF2 are filled with sediments classified as Unit IF1 sediments. Examples of geological cross-sections are presented in Figure 7.6–Figure 7.9.

Table 7.1. Thickness of seismic units in the survey area

Unit name	Maximum thickness [m]	Most frequent thickness [m]
IA	17.6	approximately 0.2 – 0.9
IB	20.1	approximately 7.0 – 8.0
ID1	16.1	1.2 – 2.8
ID2	125.8	approximately 33.0 – 35.0
IF1	85.5	not applicable
IF2	36.8	approximately 19.0

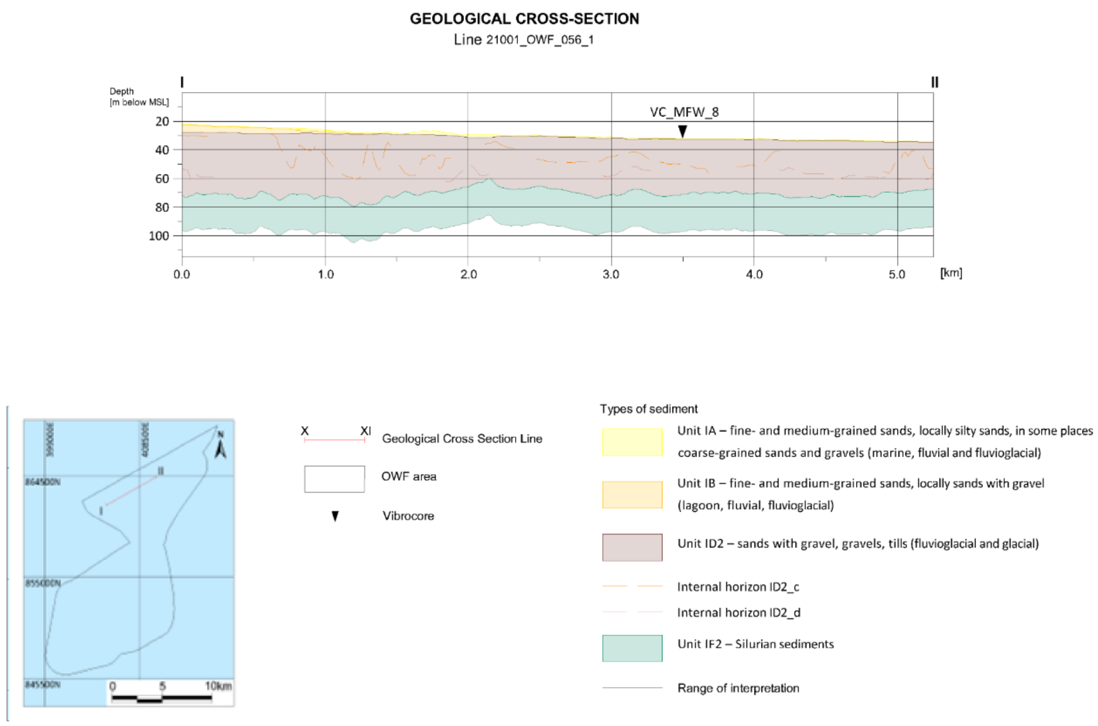

Figure 7.6. Geological cross-sections along survey line – line 21001_OWF_056_1; survey area

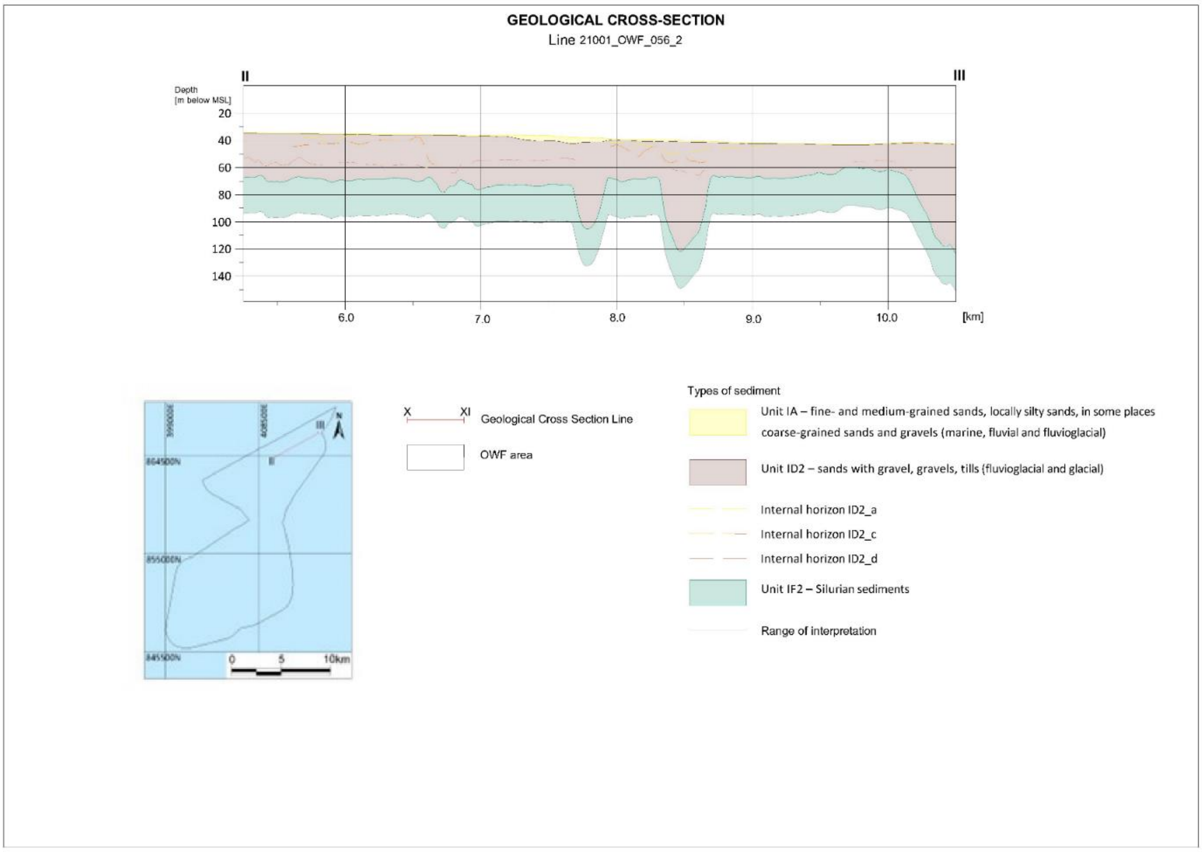

Figure 7.7. Geological cross-sections along survey line – line 21001_OWF_056_2; survey area

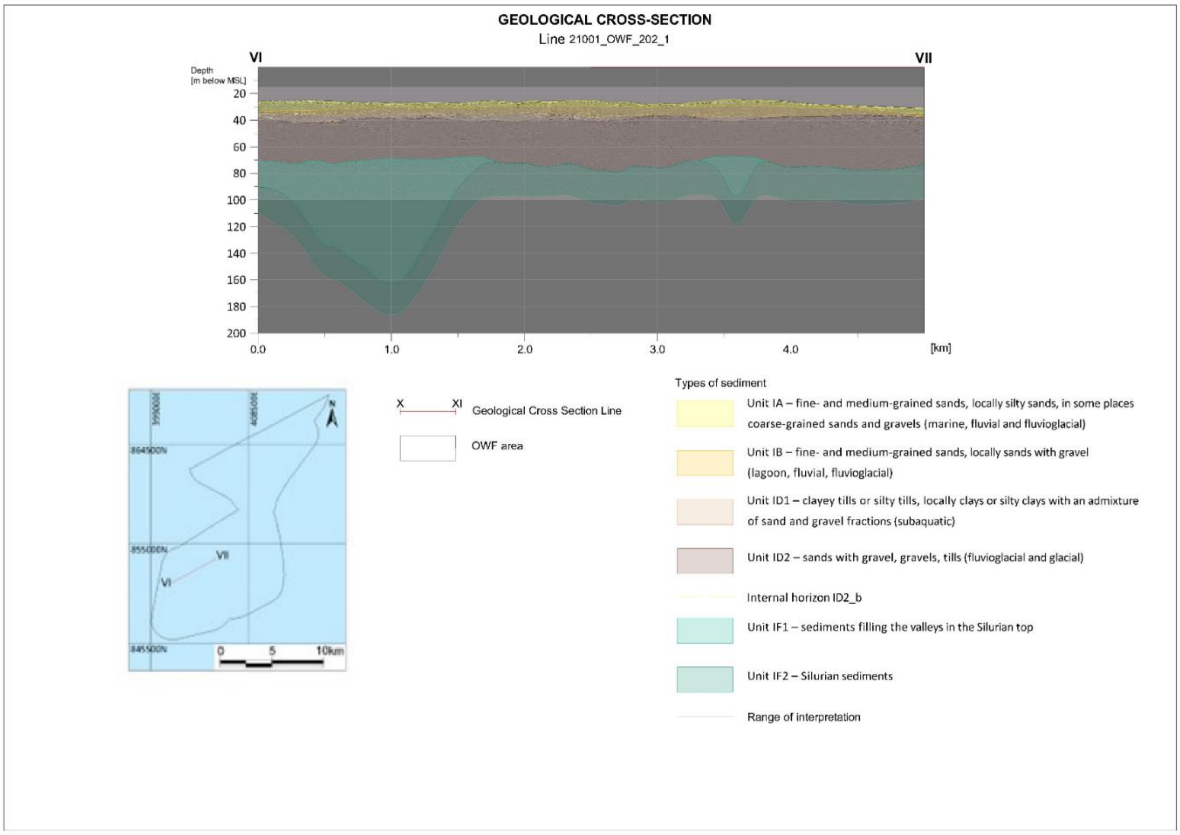

Figure 7.8. Geological cross-sections along survey line – line 21001_OWF_242; survey area

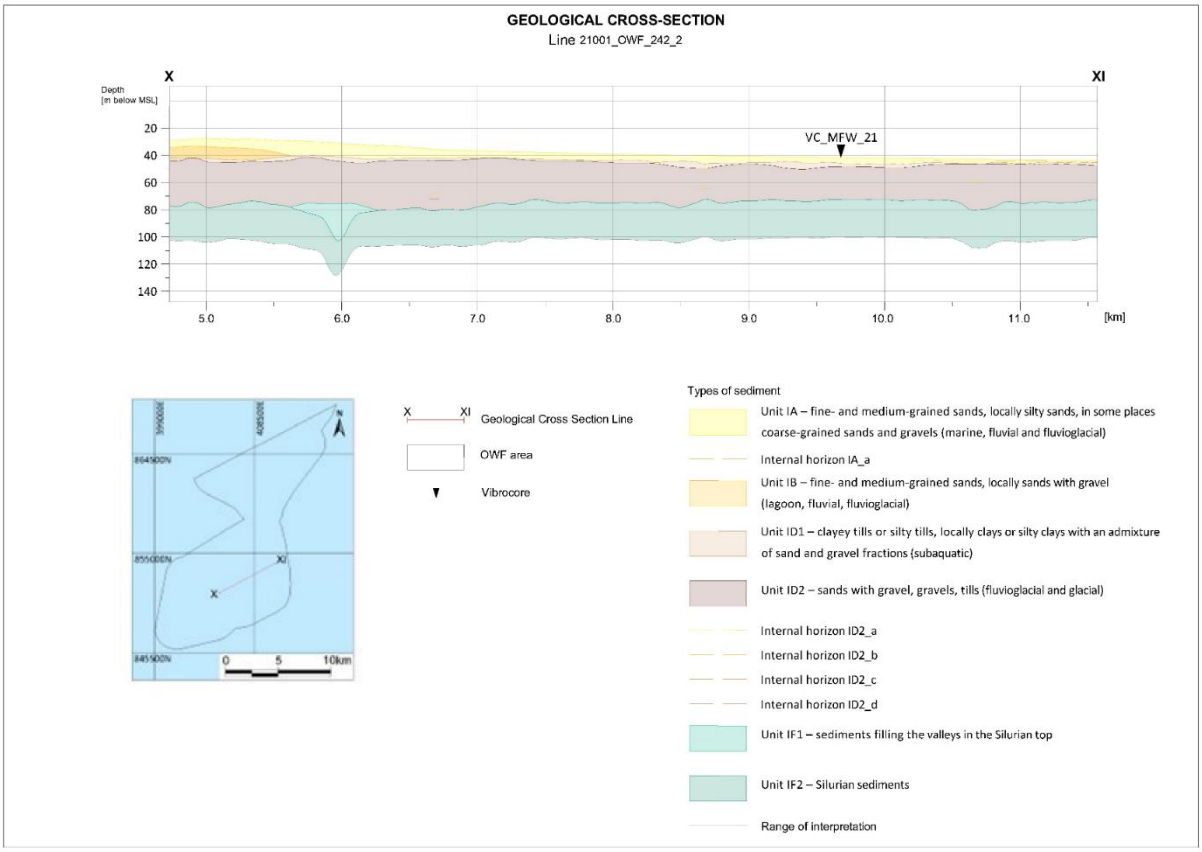

Figure 7.9. Geological cross-sections along survey line – line 21001_OWF_242_2; survey area

7.1.3 Seabed sediment characteristics

The western and central parts of the survey area seabed (accumulation plain) are formed by sandy sediments. The seabed surface is slightly undulating, with minor changes in the seabed elevation related to the presence of sandy formations. The seabed relief shows signs of sand extraction. The eastern and north-eastern parts of the survey area (abrasive-accumulative plain) are formed by cohesive sediments with a thin discontinuous sand cover and erosive pavement as well as single boulders on the surface. The seabed is uneven, with 0.5–1.0 m changes in elevation due to the presence of sand accumulations and outcrops of older sediments (glacial and fluvioglacial deposits). The distribution of individual types of surface sediments is shown in Figure 7.10.

Bathymetric and sonar data show areas of the seabed within which a series of ripple marks and mega-ripple marks are present on the surface. The features visible within the survey area reach a height of up to a dozen or so centimetres, while the cycle between the crests is approximately 1.8 m. They occur both within a sandy seabed and within a seabed formed by cohesive sediments with a thin, discontinuous sandy cover as well as erosive pavement with single boulders on the surface. It is within that thin sandy cover that the ripple marks and mega-ripple marks are formed, which can be freely shifted across the hard bottom formed by cohesive sediments. On the surface of the seabed consisting of fine- to medium-grained sands, ripple marks and mega-ripple marks are formed in areas where loose sandy sediments are shifted across the surface of more densely packed sands. Most ridges have a NW–SE or N–S orientation, however, in some places the second generation of ridges with a NE–SW orientation can be found.

On the basis of sonar and bathymetric data analysis, almost 17 000 boulders were identified in the survey area. Boulders with at least one dimension exceeding 0.25 m were identified. In the survey area, the majority of the boulders occur individually or in small clusters in the northern, north-eastern and eastern parts of the survey area [Figure 7.11]. The maximum number of boulders within a single polygon with a surface area of 0.01 km^2 in the survey area is 136 boulders.

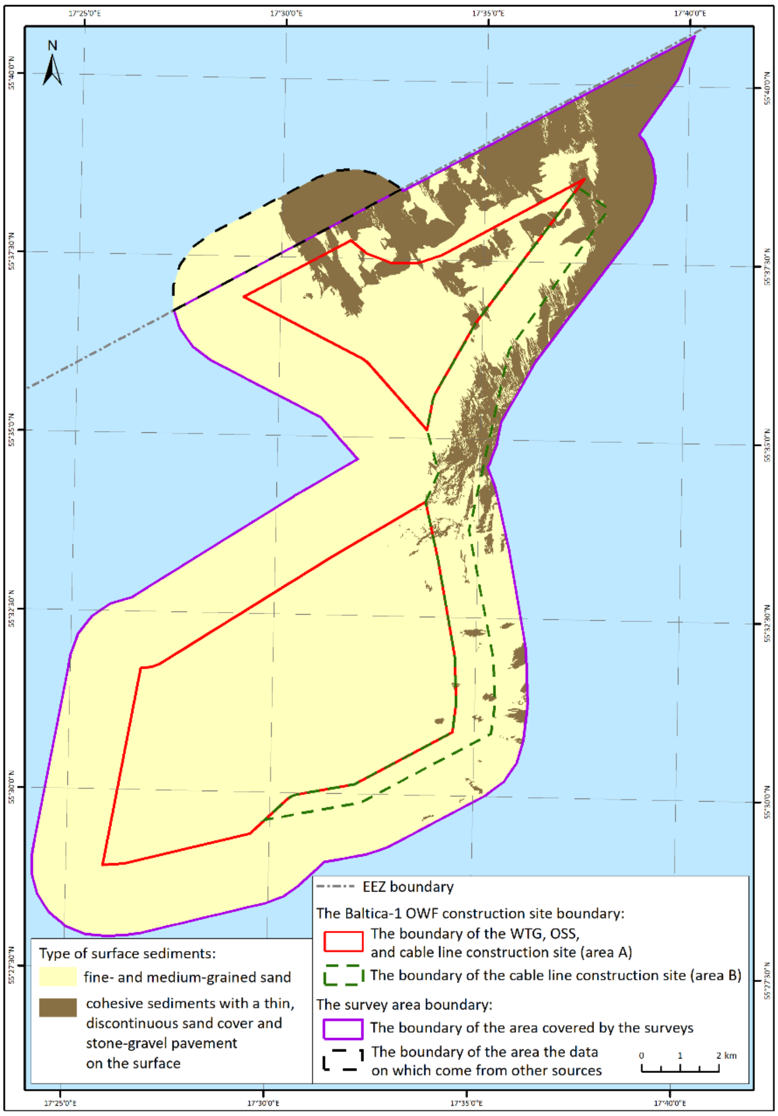

Figure 7.10. *Map of surface sediments in the survey area*

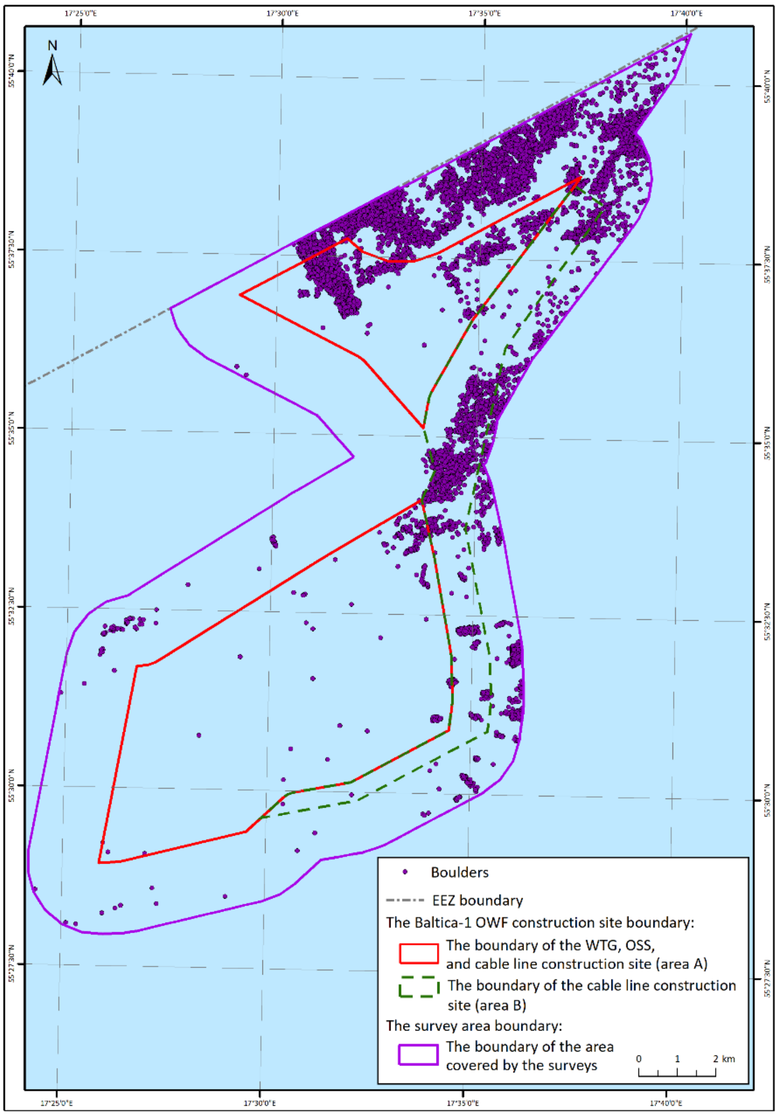

Figure 7.11. Map of boulder distribution within the survey area

7.1.4 Seabed sediment quality

Seabed sediments constitute a very important element of the aquatic ecosystem of the Baltic Sea, which is a shallow sea, with limited water exchange and an area about 4 times smaller than its catchment area. Such conditions mean that every interference in the marine environment, including the exploitation and development of the seabed, affects the delicate ecological balance of the marine ecosystem.

The transfer of contaminants from the sediment into the water (and thus, the change of water quality), and the formation of suspended solids that remain suspended in the water for a long time, depends on the type of sediment. The largest amount of pollutants and nutrients will be transferred to the water from the sediments with an increased organic matter content (e.g. silty, clayey sediments with a higher concentration of metals and POPs). Such sediments will also facilitate the formation of a greater amount of suspended solids, which will remain suspended in the water for a long time. Intense resuspension may cause the release of nutrients immobilised in the sediment and contribute to eutrophication. In the case of sandy deposits with low organic matter content (e.g. coarse sandy sediments), the processes described will be less intense. These sediments are generally characterised by a small amount of fine fractions and low concentrations of metals and POPs.

The analysed surface seabed sediments from the survey area belong to the inorganic deposits with organic matter content expressed as loss on ignition (LOI) of less than 2%.

Seabed sediments collected during the environmental surveys were analysed in terms of nutrient, metal and POPs (i.e. PAHs, PCBs, TBT, mineral oils) content.

None of the sediment samples tested exceeded the limit values specified for the concentration of metals (As, Pb, Cu, Zn, Ni, Cd, Cr, Hg), PAHs and PCBs listed in the Regulation of the Minister of the Environment of 11 May 2015 *on the recovery of waste outside installations and facilities* (Journal of Laws of 2015, item 796), which allows the classification of a sediment as clean in the context of practical applications, and although the limit values do not relate to a sediment transferred within water, they may form the basis for assessing the seabed sediment contamination with chemical compounds.

Primary processes influencing the **nutrient** content in the sea are the geophysical and geochemical processes, which control not only the supply of such elements to seawater, but are also responsible for the dispersion and removal of such compounds.

Nitrogen compounds present in the seabed sediments undergo cyclical changes as a result of biogeochemical processes. Oxidation of ammonia and its compounds by nitrifying bacteria leads to formation of nitrogen oxides, and later nitrates. Too intense nitrification, however, is not desirable, as nitrates are more easily eluted form sediments than ammonium ions. The processes related to the construction (laying) of foundations and/or a support structure, vessel anchoring or cable burying can result in a better oxygenation of sediments, and consequently an intensification of nitrification processes and a magnified release of nitrates to water. This can also affect the balance of the general scheme of nitrogen cycle by reducing the intensity of denitrification processes that occur under anaerobic conditions and involve the conversion of nitrates into molecular nitrogen [O'Neil, 1998; Trzeciak, 1995].

In the Baltic Sea sediments, nitrogen occurs mainly in organic form and its regional variability is analogous to the variability of carbon [Carman 2003]. Usually, inorganic forms of nitrogen constitute no more than 10% of the total nitrogen in the sediments [Carman, Rahl 1997]. An increase in the percentage share of inorganic nitrogen forms is possible in the area of erosion and transport of fine particle dispersion sediments [Uścinowicz 2011].

Due to the fact that the circulation of nitrogen in the environment is a very complex process, the intensity of which depends on many factors (e.g. oxygenation, temperature, season, primary production, etc.), as well as on the size of nutrient supply from the point or diffused sources, and the deposition from the atmosphere [Boynton *et al*., 1995; Fisher *et al*., 1988], a precise calculation of the nitrogen load, which would enter the water column from a sediment during construction work is impossible. For a very general estimation of the load of this element that can be transferred to the water depth during the works performed, own surveys were used. The average value of nitrogen concentration in the sediments surveyed was below the LOQ of the method applied (i.e. 200 $mg \cdot kg^{-1}$ DW). The presence of the total nitrogen was confirmed only in 19 samples collected in winter (max. concentration 423 $mg \cdot kg^{-1}$ DW) and in 27 samples collected in summer (max. concentration 395 $mg \cdot kg^{-1}$ DW).

This is consistent with the literature data regarding nitrogen content in the Southern Baltic sediments which falls between 98–2604 mg N·kg^{-1} DW in sandy sediments, 1106–3094 mg N·kg^{-1} DW in sandy-clayey sediments, 1904–9506 mg N·kg^{-1} DW in clays and 1694–4606 mg N·kg^{-1} DW in tills [Pęcherzewski 1972]. During own surveys, both in summer and winter the total nitrogen content remained below the LOQ of the method used, i.e. 200 mg·kg^{-1} DW in sandy seabed sediments of the central coast. Taking into consideration the above data, it was established that the nitrogen amount, which could transfer from the sediment to the water depth during construction works will be negligible in comparison to approximately 136 000 tons of the total nitrogen supplied to the Baltic Sea each year with the inflowing river waters [GUS 2023].

Phosphorus (P) in the seabed sediments is conventionally divided into labile (mobile, reactive) and refractive. Refractive forms are a combination of phosphorus with calcium, aluminium and clay minerals, as well as degradation-resistant organic forms of this element. Refractive phosphorus is subject to deposition, and thus, is removed from the circulation in the water depth. Labile phosphorus is the phosphorus contained in fresh organic matter, phosphates present in the interstitial waters, the combinations of phosphorus with Fe^{3+} and phosphates loosely bound by adsorption with different elements of the sediment. Such forms easily re-enter the circulation in the water depth, mainly due to the mineralisation of organic matter and the dissolution of combinations of phosphorus with Fe^{3+} as a result of the decrease in the value of the redox potential [Alloway and Ayres, 1999; Uścinowicz, 2011]. Phosphorus can act as a productivity-limiting factor for marine ecosystems (Weiner 2005). In aquatic environment, when primary production is limited by the quantity of phosphorus, the introduction of 1 mg of phosphorus means a 100 mg growth of algae dry weight per single biological cycle [Dojlido 1995].

The nutrient content in the area surveyed did not exceed the values typical for the sediments of the Southern Baltic. The amount of phosphorus that may be released into the water (the so-called available phosphorus) is estimated at 10–20 % of the total amount of phosphorus contained in the sediments (Wiśniewski *et al*., 2006). The average concentration of phosphorus in the seabed sediments surveyed was 188 mg·kg^{-1} DW in winter and 193 mg·kg^{-1} DW in summer.

The concentrations of POPs (**PAHs, PCBs**) and harmful substances such as metals or mineral oils, in the area surveyed were low and did not exceed the values typical for the sandy sediments of the Southern Baltic.

PAHs and PCBs present in the sediments may undergo numerous transformations and have a significant impact on the environment. The scope of impact depends on the transformations that these compounds undergo. These can be abiotic processes such as sorption, elution, oxidation, photodegradation, reactions with other compounds, and biological processes such as microbiological transformations. They may inhibit or stimulate the growth of microorganisms, have a phytotoxic or stimulating impact on the growth of plants, as well as be toxic to fauna [Galer *et al*., 1997]. The accumulation of PAHs and PCBs in sediments is promoted by, among others, a high percentage of silt and clay fractions with the size of sediment particles <0.063 mm and characterised by a large specific surface area and significant ability for adsorption of hydrophobic pollutants and organic compounds of phosphorus, sulphur, and nitrogen.

Pyrogenic PAHs as well as PCBs exhibit an exceptionally high persistence in seabed sediments, which is caused by the occlusion of these chemical compounds in very fine sediment particles (Bolałek *et al*., 2010). Therefore, the phenomenon of desorption of these substances from the sediments into the water is limited. Usually, it is maximally 0.5% for PCB congeners, and up to 5% for the analytes from the PAH group [Gdaniec-Pietryka 2008; Gdaniec-Pietryka *et al*. 2013]. Assuming that such amounts of these substances will transfer to the water, it can be concluded that the risk of water contamination related to the remobilisation of PAHs and PCBs in the area surveyed is insignificant.

The PAHs and PCBs concentrations in the sediments surveyed (dry weight) and their availability are presented in Table 7.2.

Table 7.2. Concentrations of PAHs and PCBs in the seabed sediments analysed in the survey area

Indicator	Average concentration in the sediments surveyed (calculated as dry weight) [$mg \cdot kg^{-1}$ DW]	Available form [%]
Congeners from the PCB group	<0.0001	0.5
Analytes from the PAHs group	0.023	5

Metal concentrations in the sediments analysed from the survey area were low. Additionally, their availability (i.e. the ability to permeate into the water), which depends on their physico-chemical form, should be taken into consideration [Siepak 1998]. Metals permanently bound in the crystalline structure of minerals are immobilised and will not transfer into the water in natural conditions. On the other hand, metals in the mobile (labile) form are prone to permeating into the water from the sediment [Siepak 1998; Dembska 2003; SMDI_BSII_2015, SMDI_BSIII_2015].

The labile form of metals may constitute (depending on the type of the sediment in relation to particular metals) from 30 to 80 % [Savvides *et al*., 1995; Parkman *et al*., 1996; Siepak, 1998; Usero *et al*., 1998; Dembska 2003; Davutluoglu *et al*., 2010]. The results of the analysis of the labile form of metals in the sediments analysed showed that in unfavourable conditions approximately 76% of lead, 57% of copper and 74% of zinc can transfer from the sediment into the water. In the case of nickel and chromium, which are more permanently bound with the sediment, this can occur in approximately 42% and 20%, respectively.

The average concentrations of metals in the sediments tested (dry weight) and the concentrations of the labile form are presented in Table 7.3.

Table 7.3. Average concentrations of metals in the seabed sediments analysed

Metal	Average concentration of the total content in the sediments surveyed (calculated as dry weight) [$mg \cdot kg^{-1}$ DW]	Average concentration of the available (labile) form [$mg \cdot kg^{-1}$ DW]
Lead (Pb)	3.30	2.47
Copper (Cu)	1.81	1.03
Zinc (Zn)	9.45	7.01
Nickel (Ni)	2.60	1.08
Chromium (Cr)	4.90	1.00

The concentrations of cadmium (LOQ <0.05 $mg \cdot kg^{-1}$DW), arsenic (LOQ <1.25 $mg \cdot kg^{-1}$ DW), mercury (LOQ <0.01 $mg \cdot kg^{-1}$DW) and TBT (LOQ <0.01 $mg \cdot kg^{-1}$DW) in the sediment surveyed were insignificant, usually below the lower LOQ. Consequently, the risk of contamination of waters related to the remobilisation of such chemical compounds from the seabed sediment during the construction of the OWF was acknowledged as negligible and no further analyses were conducted.

The sediments surveyed were also characterised by a low activity of the radioactive isotope of caesium ^{137}Cs, typical for sandy sediments.

The observed spatial variability of the physico-chemical properties of the seabed sediments does not restrict the location of structures, i.e. foundations and support structures as well as cable lines.

7.1.5 Raw materials and deposits

According to the literature data, the area analysed is located within the occurrence range of sands and sands and gravels of various grain sizes [Pikies 1990, and 1995]. Mainly fine- and medium-grained sands are deposited on the seabed surface while in the northern part of the area analysed, medium- and coarse-grained sands as well as gravelly sands and sandy gravels [Kramarska 1995 a and b; Kramarska *et al.* 1995] [Figure 7.12]. These are mainly fluvioglacial sands and gravels as well as marine sands and gravels. In most part of the survey area, the thickness of the sand and gravel sediments is greater than 1 m [Kramarska, 1995a]. Nearly the entire survey area is identified as prospective in terms of sand and gravel resources occurrence (area V – Southern Middle Bank) [Kramarska *et al.*, 2005 and 2019] [Figure 7.13].

The survey area is directly adjacent to the mining areas located on the 'Southern Middle Bank – Southern Baltic' sand and gravel deposit (see: Section 7.10.4).

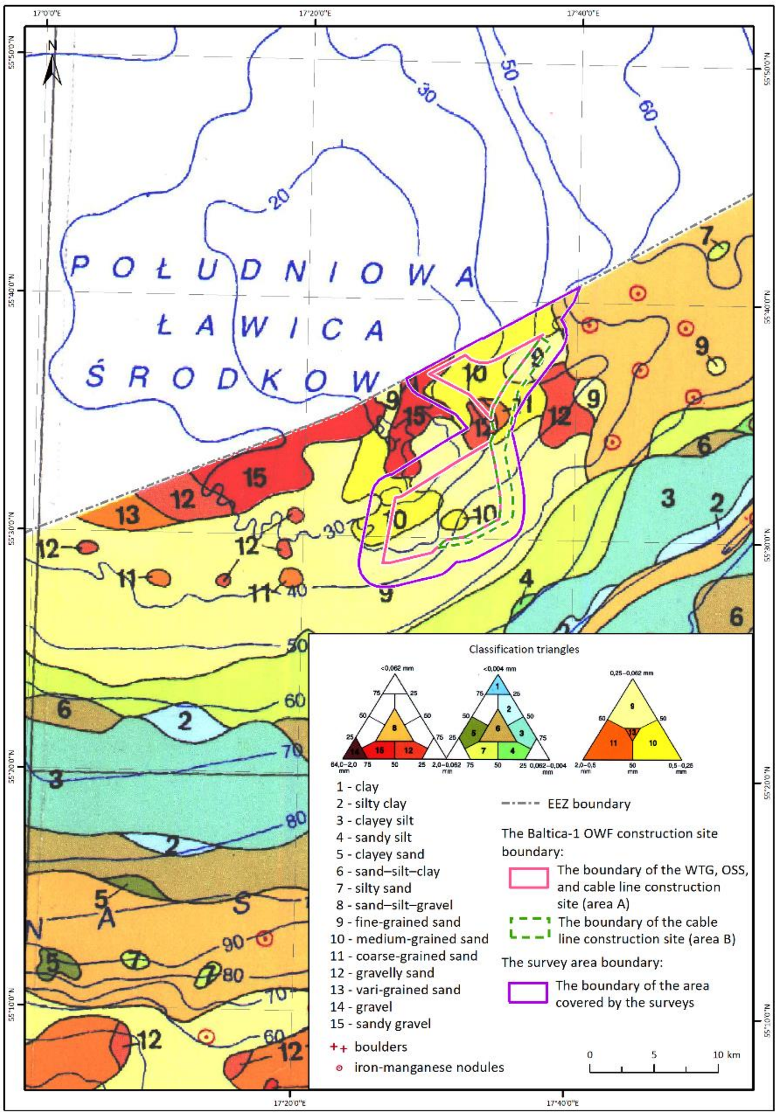

Figure 7.12. Survey area on the background of a fragment of the map of surface sediments [Source: internal materials based on Kramarska 1995b]

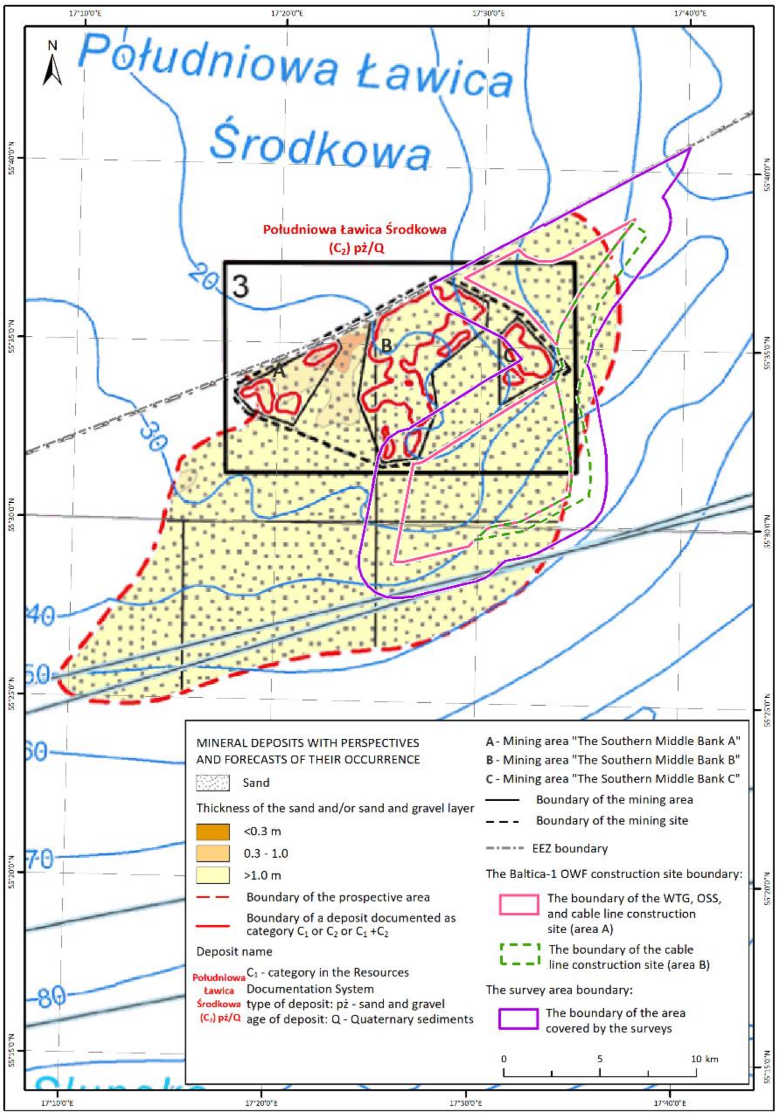

Figure 7.13. Survey area on the background of a fragment of the map of 'Deposits and prospective areas of aggregate resources' [Source: internal materials based on Kramarska et al. 2005]

The Baltica-1 OWF Area is located on the eastern side of the 'Southern Middle Bank – Southern Baltic' sand and gravel deposit with an area of 8167 ha (Register No. 9/2/226/a,b,c; license validity date: 15 November 2031). Within this area, three mining areas were indicated:

- Southern Middle Bank A with an area of 826 ha (Register No. 9/2/226/a; license validity date: 15 November 2031);
- Southern Middle Bank B with an area of 3360 ha (Register No. 9/2/226/b; license validity date: 15 November 2031);
- Southern Middle Bank C with an area of 702 ha (Register No. 9/2/226/c; license validity date: 15 November 2031) [igs.pgi.gov.pl; geolog.pgi.gov.pl].

The results of the analyses of the grain size distribution of the surface sediment samples collected from the survey area indicate that at all the designated surface sediment sampling points sand and sand and gravel sediments were identified.

The analysis of the core samples collected using a vibrocorer confirms the presence of sandy and sand and gravel deposits in the majority of the survey area. In the northern end of the area the presence of only a small thickness of sand and sand-gravel cover (with a thickness from 0.1 to 0.3 m) was confirmed, under which cohesive sediments (clays with silt, sand and gravel) are deposited. The proportion of sandy sediments in the borehole profiles increases towards the south. In the southern part of the OWF Area, the thickness of the sand and sand and gravel sediments reaches the limits of identification using core samples (6 m).

Conducted grain size analyses of the core samples from the survey area indicate a clear dominance of sands in the borehole profiles. Of all the samples from the OWF Area subjected to grain size analysis, 60% are coarse-grained soils (sands and sands with gravel). The remaining samples (40%) are fine-grained soils, mainly clays with silt and sand as well as sands with silt. Gravels occur sporadically (in less than 3% of the samples).

Coarse-grained material occurring directly on the seabed within the survey area is prospective in the context of raw material management.

A map of the extent and thickness of a potential deposit formed of sandy and sandy-gravelly sediments identified on the basis of seismic and seismo-acoustic data as Unit IA (fine- and medium-grained sands, locally silty sands (marine, fluvial and fluvioglacial)) and Unit IB (fine- and medium-grained sands, locally sands with gravel (lagoon, fluvial, fluvioglacial)) is presented in Figure 7.14. According to the methodology adopted, areas with a minimum deposit thickness of 2 m and a minimum surface area of the deposit field of 0.25 km^2 and a maximum sea depth of 40 m were delimited. Due to the high lithological diversity of the sediments and insufficient density of the sampling points for surface sediments and core sample collection, the median grain size and mineral dust content were not accounted for.

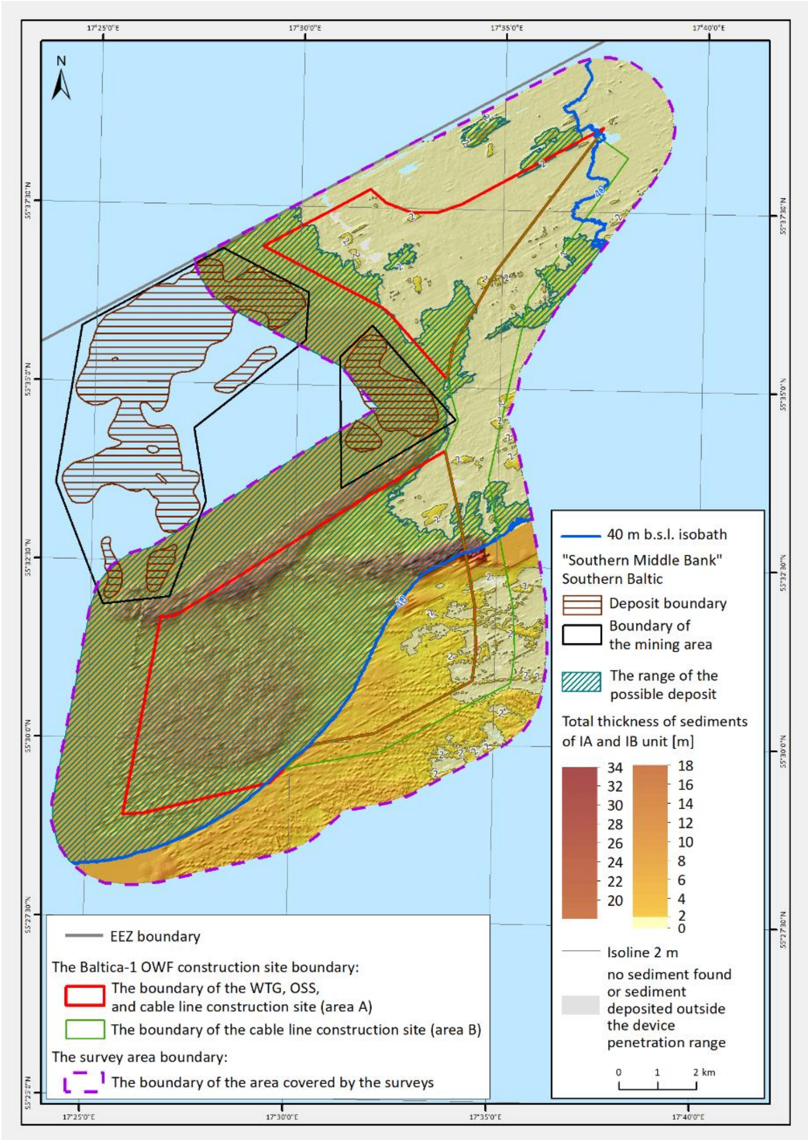

Figure 7.14. Map of the extent and thickness of the potential aggregate deposit (thickness >2 m) within the survey area

As part of the marine aggregate surveys, no project constraints were identified that would result from the environmental surveys conducted so far including the classification of a significant part of the survey area as an area prospective for the occurrence of clastic deposits.

In accordance with the provisions of the Regulation of the Council of Ministers of 14 April 2021 *on the adoption of the Maritime Spatial Plan for 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), the basic function for the sea basin POM.60.E, in which the Project area is located, is ‘renewable energy acquisition’. A permissible function is the 'exploration and prospecting of mineral resources and extraction of minerals from deposits', which is described further on in the sea basin card as: *'in the entire sea basin, the function of (prospecting and exploration of mineral resources and extraction of minerals from deposits) shall be limited to methods which do not disturb linear elements of technical infrastructure; do not jeopardise the ecological function of spawning grounds and the survival of the early development stages (eggs and larvae) of commercial species; in the entire sea basin the extraction of minerals from deposits is limited to projects agreed upon with the relevant project owners of offshore* *wind farms'*. Due to the indication of the superior function for the sea basin POM.60.E – acquisition of renewable energy, the function of exploration and prospecting of mineral resources, as well as extraction of minerals from deposits should be considered secondary.

7.2 SEA WATERS

7.2.1 Sea waters characteristics

The results of tests of individual chemical parameters of the water in the 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 greatly 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 $mmol·dm^{-3}$ and relatively good oxygenation, with seasonal variability characteristic of the Southern Baltic waters. The assessment of the water quality index in the 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 $mg·dm^{-3}$.

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 $mg·dm^{-3}$. Only in January was it slightly above the lower limit of the method quantification, i.e. 2.05 $mg·dm^{-3}$. Also the content of suspended solids in individual measurement periods was typical of the Southern Baltic waters. 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 $mg·dm^{-3}$. The average phosphate concentration observed in the samples collected in January and March 2023 was 0.016 $mg·dm^{-3}$ (average from the water column). The average concentration of total nitrogen in the water samples collected in the survey area was similar in the entire survey period and fell within the range from 0.08 to 0.13 $mg·dm^{-3}$. The average DIN concentration from the water column in the water samples from the survey area collected in January and March 2023, equalled 0.031 $mg·dm^{-3}$.

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 observed spatial variability of the physico-chemical properties of seawater tested does not restrict the location of structures, i.e. foundations and support structures as well as cable lines.

7.2.2 Seawater and seabed sediment status

The main EU directive concerning water protection and defining water policy is the Directive of the European Parliament and of the Council of 23 October 2000, known as the Water Framework Directive (WDF – 2000/60/EC, as amended). It imposes an obligation to monitor and assess the state of waters, including the parts of sea waters defined as transitional and coastal waters of all European seas, including the Baltic Sea. The Directive was transposed into Polish law by the Act of 4 January 2013 amending the Water Law Act and certain other acts (Journal of Laws of 2013, item 165). The current implementing regulation for the WFD is the Regulation of the Minister of Infrastructure of 25 June 2021 *on the classification of ecological status, ecological potential and chemical status and the method of classification of the status of surface water bodies and the environmental quality standards for priority substances* (Journal of Laws of 2021, item 1475).

Comparing the results obtained from the water surveys with the limit values specified in the aforementioned regulation, the physico-chemical components analysed in the area surveyed can be classified as water quality Class 1 (very good status) due to the concentration of nitrate nitrogen, DIN, total nitrogen and total phosphorus. Whereas, due to the phosphate phosphorus content (the average concentration in the water column was 0.016 mg·dm^{-3}), the waters tested did not reach a good quality status.

The assessment of quality in terms of specific synthetic and non-synthetic pollutants as well as a group of chemical indicators characterising substances particularly harmful to the aquatic environment and priority substances in the field of water policy, i.e. metals (Pb 14 µg·dm^{-3}, Cd 0.45 µg·dm^{-3}, Cr (VI) 0.02 mg·dm^{-3}, As 0.05 mg·dm^{-3}, Ni 34 µg·dm^{-3}, Hg 0.07 µg·dm^{-3}), mineral oil index – 0.2 mg·dm^{-3} and PAHs (naphthalene – 130 µg·dm^{-3}, anthracene – 0.1 µg·dm^{-3}, fluoranthene – 0.12 µg·dm^{-3}, benzo(a)pyrene – 0.027µg·dm^{-3}, benzo(b)fluoranthene and benzo(k)fluoranthene – 0.017 µg·dm^{-3}, benzo(g,h,i)perylene – limit value 0.00082 µg·dm^{-3}) carried out in the water samples collected in July 2023, indicated that the limit values were not exceeded in the water samples collected in the survey area. One exception is the mineral oil index with a value of 0.22 mg·dm^{-3} determined in one water sample in the near-seabed water layer. This exceedance was incidental, within the measurement uncertainty of the analytical method applied. On the other hand, the average concentration value of mineral oils in the water within the survey area was 0.05 mg·dm^{-3} and does not exceed the limit value. Limit values are given in the units of measurement in which they are indicated in the regulation to which they are referenced (Journal of Laws of 2021, item 1475).

Since 1 January 2022, §24 and Annex 26 *to the Regulation of the Minister of Infrastructure of 25 June 2021 on the classification of ecological status, ecological potential, chemical status and the method of classifying the status of surface water bodies as well as environmental quality standards for priority substances (Journal of Laws of 2021, item 1475),* which set out the limit values for the surface water quality Class 2 based on the indicators such as total chromium, aluminium, free and bound cyanides and volatile phenols are no longer applicable. These were as follows: total chromium – 0.05 mg·dm^{-3}, aluminium – 0.4 mg·dm^{-3}, phenols – 0.01 mg·dm^{-3}, free cyanides – 0.05 mg·dm^{-3} and bound cyanides – 0.05 mg·dm^{-3}. The current Annex 11 to the same regulation does not include these indicators, and thus, does not provide the current limit values for them. However, for illustrative purposes, after comparing the results obtained for the concentrations of total chromium, aluminium, phenols and cyanides in the waters of the survey area to the no longer applicable limit values of indicators for water quality applying to the SWBs of all categories, set out in Annex 26, it could be concluded that none of the indicators analysed exceeded the allowable values.

In all the analysed water samples from the survey area, the content of the sum of 7 PCBs was below the LOQ of the analytical methods applied (i.e. 0.001 $\mu g \cdot dm^{-3}$).

The average concentration of ^{137}Cs in the seawater collected in the survey area was 16.79 $Bq \cdot m^{-3}$. In the case of ^{90}Sr, its average activity in water was 4.54 $Bq \cdot m^{-3}$. The results obtained confirmed a successive decrease in radionuclide activity since the beginning of the continuous monitoring in 2010/2011.

Taking into consideration the distance of the survey area to the nearest surface water body, i.e. Polish coastal waters of the Gotland Basin (PLCW20001WB2) and the impact ranges of the Project, it should be assumed that the implementation of the Baltica-1 OWF shall have no impact on the achievement of the environmental objectives for this surface water body.

On the other hand, the Marine Strategy Framework Directive (MSFD – 2008/56/EC) of 17 June 2008 establishes a framework for community action in the field of marine environmental policy and requires member states to develop strategies to achieve good environmental status in the sea areas under their jurisdiction. The Directive was transposed into Polish law by the Act of 4 January 2013 amending the Water Law Act and certain other acts (Journal of Laws of 2013, item 165). In 2017 the MSFD was amended by the Commission Directive (EU) 2017/845 of 17 May 2017, hereinafter referred to as 'Directive 2017/845', by adopting a new version of Annex III to Directive 2008/56/EU in reference to the examples of lists of components taken into account in the development of marine strategies. The amendment of the Commission Directive was transposed into the Polish law with the Act of 11 September 2019 *amending the Water Law Act and certain other acts* (Journal of Laws of 2021, item 2233).

Regulation of the Minister of Infrastructure of 25 February 2021 *on the adoption of an update of the set of properties typical for good environmental status of marine waters* (Journal of Laws of 2021, item 568) is the currently applicable implementing regulation to the MSFD.

The primary indicator describing eutrophication and, at the same time, a causal factor in this process is the nutrient salt content of seawater (Criterion D5C1 – Nutrients concentrations in water). The indicators used for the assessment are total phosphorus (TP) and total nitrogen (TN) presented as average annual concentrations as well as mineral nitrogen (DIN) and mineral phosphorus (DIP) presented as average winter concentrations from the months December–February, since this is when the nutrient salt concentrations are the highest.

Table 7.4 includes a comparison between the concentrations of the indicators in question, obtained during the annual survey cycle from March 2017 to February 2018, and the threshold values from the Appendix to the Regulation of the Minister of Infrastructure of 25 February 2021 (Journal of Laws of 2021, item 568).

Table 7.4. Average concentrations (µM·dm^{-3}) in the surface layer of phosphorus (DIP) and nitrogen (DIN) minerals during the winter months (January) and annual average values of phosphorus (TP) and nitrogen (TN) concentrations in relation to threshold values. Values exceeding the threshold values are marked in red

Sea area	**Indicator**			
	DIN (average winter concentration XII–II)	**DIP (average winter concentration XII–II)**	**TN (average annual concentration)**	**TP (average annual concentration)**
Threshold values for the Eastern Gotland Basin	(<0.036 mg·dm^{-3}) <2.60 µM·dm^{-3}	(<0.009 mg·dm^{-3}) <0.29 µM·dm^{-3}	(<0.231 mg·dm^{-3}) <16.5 µM·dm^{-3}	(<0.021 mg·dm^{-3}) <0.68 µM·dm^{-3}
Average concentration values from the survey area	(0.031 mg·dm^{-3}) 2.21 µM·dm^{-3}	(0.014 mg·dm^{-3}) 0.44 µM·dm^{-3}	(0.103 mg·dm^{-3}) 7.35 µM·dm^{-3}	(0.013 mg·dm^{-3}) 0.42 µM·dm^{-3}
Survey period	January 2023	January 2023	January 2023 – November 2023	January 2023 – November 2023

The results of monitoring surveys carried out in 2023 at survey points in the seabed sediment survey area were used to assess the indicators of attribute 8 on the concentration of pollutants in the marine environment components according to the MSFD.

The average concentrations of metals and caesium in the environmental matrices collected during the marine surveys in the survey area in relation to the threshold values are shown in Table 7.5.

Table 7.5. Average values of metals, ^{137}Cs and persistent organic pollutant concentrations in environmental matrices (water, seabed sediment) collected during marine surveys in the survey area in relation to threshold values. Bad (unacceptable) status- subGES is marked in red, good status - GES is marked in green

Substance	**Survey period**	**Matrix**	**Threshold value**	**Average value from the survey area**
Analyses of water in the survey area				
Cadmium (Cd) (mg·kg^{-1} DW)	February 2023	Sediments	<2.3	<0.05
Lead (Pb) (mg·kg^{-1} DW	February 2023	Sediments	<2.3	3.3
Mercury (Hg) (mg·kg^{-1} DW)	February 2023	Sediments	<0.07	<0.01
^{137}Caesium (Bq·m^{-3})	July 2023	Water	<15	16.79
Fluoranthene (µg·kg^{-1} DW)	February 2023	Sediments	<2000	3.00
Benzo(g,h,i)perylene (µg·kg^{-1} DW)	February 2023	Sediments	<85	3.00
Indeno(1,2,3-cd)pyrene (µg·kg^{-1} DW)	February 2023	Sediments	<240	3.00

On the basis of the references above, it can be concluded that the environmental status of seawaters in terms of eutrophication of the survey area is bad (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.

7.3 Climatic conditions and air quality

7.3.1 Climate and the risk related to climate change

Sea areas of the Southern Baltic are located in a humid-moderate climate belt, where the influence of atmospheric circulation and winds from the North and Central Atlantic remains important. The vicinity of the Atlantic Ocean, due to the large air masses inflow, largely determines the climate of the Baltic Sea. As a result, the winters are mild and warmer, while the summers are cooler. In addition, it is characterised by predominantly westerly and south-westerly winds and, during storms, strong winds from northern, north-eastern and north-western sectors and a large variation in air humidity.

In the Polish sea areas and in the coastal zone, long-term recordings of near-ground (near-water) atmospheric parameters (air pressure, temperature and humidity, wind conditions and insolation as well as precipitation intensity and type) and water column parameters (changes in the free sea surface level, water temperature and salinity as well as dynamic conditions – flows and wave motion) are carried out both at onshore stations, as well as on the high seas. This includes, in particular, the comprehensive measurements performed operationally for several decades by the IMWM-NRI at several dozen monitoring stations and points, and for several years also on buoys anchored at sea. In addition, IMWM-NRI conducts monitoring surveys in the Southern Baltic area several times a year, recording the hydro-physical and physico-chemical parameters of the sea within an established grid of points. Hydrological and meteorological surveys are also carried out by other scientific and research units. Wind conditions, air temperature and humidity as well as sea level changes are registered at the Coastal Research Station (CRS) in Lubiatowo, owned by the Institute of Hydro-Engineering of the Polish Academy of Science (IHE PAS), while the Institute of Oceanology of the Polish Academy of Sciences with a monitoring station located at the Sopot Pier monitors air temperature, pressure and humidity, insolation, as well as seawater temperature and salinity. As part of the SatBałtyk project carried out in 2010–2015, satellite measurements were collected enabling the determination of the characteristics of the sea and atmosphere in the form of maps presenting, for example, temperature distributions, ice covers, momentary water flow velocity, water mixing and turbidity. At the Maritime Institute in Gdańsk, in numerous research projects and at the request of various project owners, the recordings of the parameters of the near-water atmospheric layer as well as hydrophysical and dynamic values for the entire water column have been conducted in the last dozen years, at various locations within the Polish Exclusive Economic Zone of the Baltic Sea.

Environmental surveys in the area of the proposed Baltica-1 OWF, covering the monitoring of meteorological conditions of the near-water layer of the atmosphere (pressure, temperature, air humidity and wind parameters), dynamic conditions of the sea (wave motion on the surface, flows in the entire water depth and changes in the height of the free water surface), as well as hydrophysical conditions of the sea (water temperature, electrolytic conductivity and salinity) were conducted for a period of one year: from 1 December 2022 to 30 November 2023.

The survey system in the survey area comprised five survey stations (B_MFW_1 – B_MFW_5). At survey point B_MFW_3, a measuring buoy was anchored equipped with a LUFFT WS500-UMB autonomous weather station, with sensors to measure individual meteorological parameters, a Vaisala PTB210 barometer to measure atmospheric pressure, a strand with CTDs to measure hydrophysical water parameters at five depths in the water column − 1, 4, 8, 16 m and above the seabed, as well as an AWAC current profiler with a CTD and a turbidity sensor. At survey points B_MFW_1 and B_MFW_5, current profilers were located together with CTDs with turbidity sensors, whereas at survey points B_MFW_2 and B_MFW_4, only current profilers were located.

The surveys presented provided up-to-date information on the climatic conditions of the sea areas associated with the planned wind farm. Associated with similar recordings conducted by the neighbouring Baltic countries, the surveys allow determining the current trends and the anticipated directions of changes in the basic climatic parameters of the Baltic Sea, particularly its southern areas. Additionally, the information from simulation calculations of the climatological numerical models of the Global Atmospheric Circulation Model available, for example, from the research conducted as part of the BALTEX Assessment of Climate Change for the Baltic Sea Basin are used for the above-mentioned determinations.

The climate specific for the Polish coast and the adjacent sea areas can be classified as a coastal strip climate with relatively small air temperature amplitudes, high humidity, mild winters, cooler summers and strong winds. Winds from the western and south-western sectors prevail there. In the open sea areas, climatic conditions are characterised by smaller amplitudes of air temperature variations and average wind velocities higher than in the nearby land areas.

On the basis of the data and climatological analyses available, it is possible to present the most important forecasts regarding changes of particular parameters of the atmosphere and water in the Baltic Sea region:

- the increase in air temperature is faster here than the average global increase, this trend is expected to continue;
- the increase in surface water temperature is greater than in the deeper layers of the water column, this may result in stronger thermal stratification and the stabilisation of the thermocline throughout the year;
- the predicted salinity changes are not clearly defined and depend, on the one hand, on the changes in the air circulation conditions and the volume of water exchange with the North Sea and, on the other hand, on the volume of river water inflow; a decrease in salinity level is generally predicted;
- an increase in atmospheric precipitation is forecast for the entire Baltic Sea basin in winter, while in summer only in the northern part; the prevalence of extreme precipitation will increase;
- in terms of forecasting the changes in sea level, the effects of its global increase will not be felt to a significant extent. This is due to the fact that the Baltic Sea, which is a relatively small and shallow shelf sea, is connected with the North Sea by the rather narrow Danish straits, through which a greater exchange of oceanic waters (the so-called inflows) takes place only incidentally. Moreover, most of its area (in the northern part) is located within the Scandinavian plate, which is characterised by visible uplift processes (so-called isostatic rebound), which result in a decrease of the average sea level. In the southern part, the impact of these processes is

practically negligible, and the water level is determined mainly by the current atmospheric circulation conditions;

- forecasts regarding changes in wind climate are subject to considerable uncertainty, mainly due to the formation of global atmospheric circulation conditions. It is assumed that as the average surface water temperature increases, there will be a change in the stability conditions of the near-water atmosphere layer, and thus the average wind speed over sea areas is expected to increase;
- changes in wave climate are mainly related to the formation of wind conditions over the sea surface as well as to the frequency and intensity of storms – an increase in extreme storm events is anticipated there;
- model calculations indicate that there will be an increase in the extent of low oxygen area in the water and anaerobic areas near the seabed.

Forecasts of climate change for Poland, including the coastal zone and sea areas under Polish jurisdiction, as well as scenarios of adaptation activities aimed at mitigating and counteracting the effects of changes were and still are the subject of intensive work carried out by the Ministry of the Environment and the Institute of Environmental Protection, as part of the 'Polish National Strategy for Adaptation to Climate Change by 2020 with the perspective by 2030' and the KLIMADA project.

Taking into account the conclusions and recommendations related to the coast and the adjacent areas of the Baltic Sea, it was determined that the observed and projected climate changes will have a negative impact on the functioning of coastal zones. An adverse influence of the periodic sea level rises is predicted, resulting mainly from the increase in frequency and intensity of heavy storms, particularly in the autumn–winter period. In the case of the Baltic Sea, this refers to a possible increase in the number, intensity and duration of storms, with an increase in the irregularity of their occurrence, i.e. after long periods of relative calm, series of rapidly succeeding heavy storms may occur.

An additional factor that accelerates the process of coastal erosion is the warming of winters, the expected result of which will be a virtual disappearance of the ice cover protecting the beaches from storm surges, and thereby safeguarding them against coastal erosion. The scenarios of sea level changes demonstrate that in the years 2011–2030 the average annual sea level along the entire coast will be higher by approximately 5 cm in comparison to the values from the reference period, i.e. 1971–1990. An increase in the frequency of storm floods and more frequent flooding of low-lying areas, as well as the degradation of the coastal cliffs and seashore, which will entail a strong pressure on the infrastructure located in these areas, will be very important effects of the climate change.

Due to an increase in the average water temperature and an increased inflow of nutrient pollution into the sea (nitrogen and phosphorus compounds), a negative phenomenon that will occur will be the progressive eutrophication, especially on the water surface (algae blooms).

The activities undertaken as part of the near-shore zone adaptation to the climate change concern the areas situated along the Baltic Sea coastline. However, there are no detailed guidelines and recommendations relating to the open sea areas, including installations and structures located there, which present the scope of activities aimed at counteracting the effects of the climatic condition changes forecast.

7.3.2 Meteorological conditions

Current meteorological conditions of the open sea area covering the survey area were specified on the basis of the surveys of the near-water layer parameters conducted throughout one year – from December 2022 to November 2023. The conditions are characterised by wind speed and direction, air temperature, pressure and humidity recorded by an automatic atmospheric measurement station (located at 4.5 MASL). The basic statistical parameters obtained for the period specified are included in Table 7.6.

Table 7.6. Statistical analysis of meteorological parameters measured at survey station B_MFW_3 for the period 01.12.2022 (00:00) – 30.11.2023 (23:00)

Parameter	Unit	Value			
		average	minimum	maximum	median
relative humidity	%	86.10	42.41	100.00	87.57
atmospheric pressure	hPa	1012.87	980.01	1041.54	1013.15
air temperature	°C	10.16	-2.90	23.34	9.49
wind speed	$m \cdot s^{-1}$	7.28	0.00	20.84	7.02
dominant wind direction	-	WSW, SW, W			

The average wind speed for the entire survey period was approximately 7.3 $m \cdot s^{-1}$, and exceeded 20 $m \cdot s^{-1}$ at maximum (with gusts of 28 $m \cdot s^{-1}$). Winds from the western and south-western sectors prevailed, although the presence of north-eastern winds was also frequently observed. Air temperature ranged from approximately -2.9°C to approximately 23.3°C. Atmospheric pressure varied from 980.0 hPa to 1041.5 hPa. Relative humidity was characterised by high variability, oscillating from approximately 42% to 100%.

The values presented do not differ significantly from the same atmospheric parameters recorded in previous years at other locations in the Polish Baltic Sea areas.

7.3.3 Air quality

Due to the lack of direct measurement data regarding the purity parameters of the air over the sea areas intended for the construction of the wind farm, the air quality assessment of the near-water atmosphere layer was compared with the information obtained as part of the measurements carried out by the Environmental Protection Inspectorate as part of the State Environmental Monitoring for the nearest coastal research station (Łeba). However, it should be noted that due to the lack of significant pollution emission sources over the sea area under analysis, parameters of air purity should not be worse than those measured at the shore.

The assessment of air quality in Poland, including at coastal stations, has been carried out on the basis of the Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe. In Poland, the tasks related to conducting surveys and assessments of the state of the environment, including air quality monitoring, are carried out by the Environmental Protection Inspectorate as part of the State Environmental Monitoring, whose program is developed by the Chief Inspector for Environmental Protection and approved by the Minister of the Environment. As part of this program, the tasks related to the fulfilment of the requirements contained in EU regulations and in Polish law as well as in international conventions signed and ratified by Poland are implemented.

Due to the fact that the monitoring of air quality is conducted only in onshore areas, the results obtained from the measurements for the Pomorskie Voivodeship, and in particular for the coastal belt zone, have been taken as the reference level for the offshore areas. Since 2013, for the majority of the substances measured by the Environmental Protection Inspectorate the concentration criteria corresponding to class A quality were obtained. In 2022, this status has not changed significantly in relation to the measurements conducted in previous years[12].

No measurements have been made to assess the air quality in terms of greenhouse gas presence, particulate concentrations and other hazardous volatile substances in the survey area. The closest location within the coastal zone in which permanent air pollution monitoring is conducted is the coastal research station in Łeba, which is away from land emission sources, where such concentrations as sulphur dioxide, nitrogen dioxide and ozone are recorded. On the basis of the measurement data made available by CIEP and VIEP in Gdańsk, the concentrations of the above-mentioned gases presented in Table 7.7 were identified for the year 2022. These values were compared with the values from the last decade 2000−2022.

Table 7.7. Air pollution values in Łeba [Source: internal materials based on the CIEP data – http://powietrze.gios.gov.pl/pjp/archives]

Air component	Period covered	Annual values (in $\mu g \cdot m^{-3}$)		
		Average	Minimum	Maximum
SO_2	2022	2.6	0.2	18.6
	2000–2022	1.2	0.2	5.8
NO_2	2022	5.2	0.7	36.5
	2000–2022	4.4	0.7	18.4
O_3	2022	46.2	7.0	84.0
	2000–2020	63.1	0.1	171.1

In the case of sulphur dioxide (SO_2) – the average 24-hour concentration in 2022 amounted to 2.63 $\mu g \cdot m^{-3}$ with a permissible value of 125 $\mu g \cdot m^{-3}$. This is the lowest value recorded in the Pomorskie Voivodeship and since 2013–2022 it remains at a similar level.

In the case of nitrogen dioxide (NO_2) – the average 24-hour concentration in 2022 amounted to 5.23 $\mu g \cdot m^{-3}$ with a permissible value of 40 $\mu g \cdot m^{-3}$. This is the lowest value recorded in the Pomorskie Voivodeship and since 2013–2022 it remains at a similar level.

In the case of ozone (O_3) – the average 24-hour concentration in 2022 amounted to 46.17 $\mu g \cdot m^{-3}$ and in six cases the maximum concentration value from 8 hours with the assumed target value of 120 $\mu g \cdot m^{-3}$ was exceeded. This is one of the highest values recorded in the Pomorskie Voivodeship; however, according to the assessment contained in the VIEP report, the applicable criteria concerning the target level for the protection of human health and plant protection are met in the Pomeranian Voivodeship.

Such level of the parameters recorded means that the onshore area in the coastal zone near Łeba has air quality class A. Since the station in Łeba is located at a considerable distance from the Gdańsk agglomeration and other industrial sources of air pollution, similar values for concentrations of these pollutants are to be expected for the coastal regions of the sea, especially since these sea areas are located away from onshore sulphur dioxide and nitrogen dioxide emission sources. Those substances

[12] Annual Air Quality Assessment in the Pomorskie voivodeship – survey data for 2022, CIEP Gdańsk 2023 https://powietrze.gios.gov.pl/pjp/rwms/11/publications#

are emitted only by vessels, the traffic intensity of which is relatively low. The offshore areas surveyed are free from any terrain obstacles impeding the spread of these substances. Therefore, the average concentrations of the above-mentioned compounds in the air should have lower values.

7.4 Ambient noise

In order to determine the baseline situation ('zero point') regarding the underwater noise levels, ambient noise monitoring was carried out using an SM4M Wildlife Acoustics autonomous sound recorder. The main priority was to obtain input information on the typical underwater noise levels in the survey area, in order to be able to further identify potential changes to the sea environment caused by anthropogenic activities during the construction, operation and decommissioning stages of the project.

The survey in question analysed in detail acoustic data in the frequency range of individual 1/3-octave bandwidths with centre frequencies from 20 Hz to 20 kHz. 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, noise generated during the process of piling and during underwater explosions [Figure 7.15].

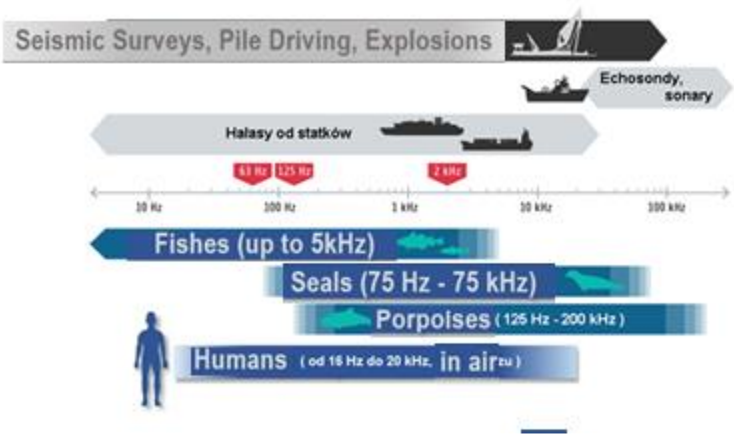

Figure 7.15. Frequency ranges of anthropogenic sounds with a schematic illustration of the hearing ranges of some of the types of marine organisms inhabiting the Baltic Sea. As a reference, the range of frequencies heard by humans in the atmosphere is also illustrated [Source: BIAS 2017 based on Scholik-Schlomer 2015]

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 values typical for the Southern Baltic area [Figure 7.16, Figure 7.17] [Lisimenka, 2007; Klusek and Lisimenka, 2016; Mustonen *et al*., 2019].

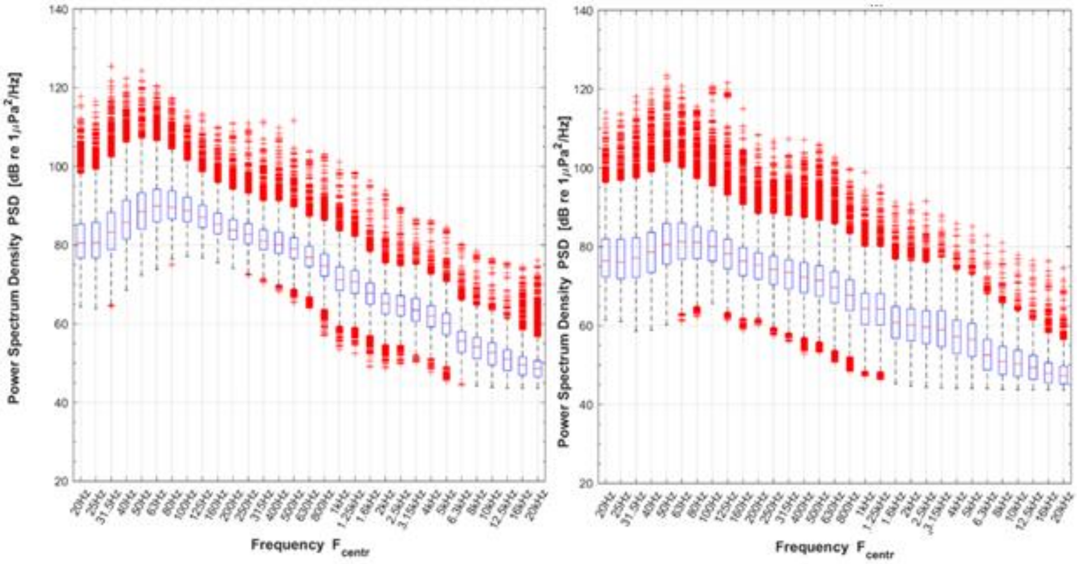

Figure 7.16. Statistical distribution of the occurrence of average noise power spectral density levels (PSD) [dB re 1 μPa²·Hz⁻¹] within 1/3-octave bandwidths. Centre frequencies F_{centr} of individual bands within the 20 Hz to 20 kHz range are marked on the horizontal axis. On the basis of the data obtained at survey station H_1 in two contrasting seasons – in the winter season (on the left, survey session carried out on 7.02–24.04.2023) and in the summer season (on the right, survey session carried out in 13.08–12.11.2023)

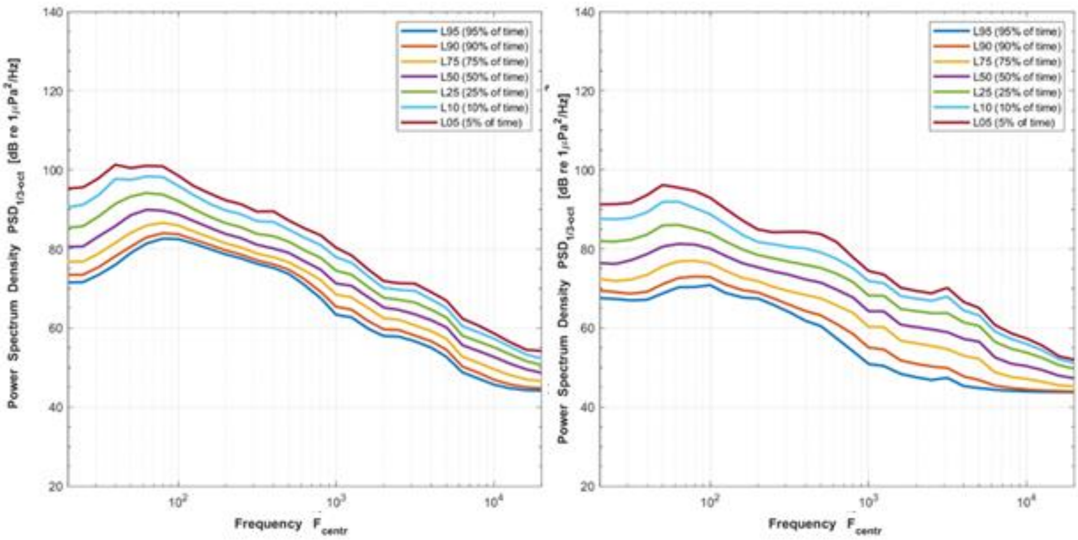

Figure 7.17. Average levels of noise power spectral density PSD1/3-octave [dB re 1 μPa²·Hz⁻¹] in 1/3-octave frequency bandwidths calculated for appropriate percentiles. On the basis of the data obtained at survey station H_1 in two contrasting seasons – in the winter (on the left, survey session carried out between 07.02–24.04.2023) and in the summer (on the right, survey session carried out between 13.08–12.11.2023)

In general, the SPL time courses [Figure 7.18, top panel] show significant fluctuations in noise levels (single peaks), reaching values of 20–25 dB against the background of natural noise, which can be interpreted as a significant contribution from the anthropogenic component related primarily to vessel traffic, and occasionally to the emission of low-frequency sounds during seismoacoustic seabed surveys.

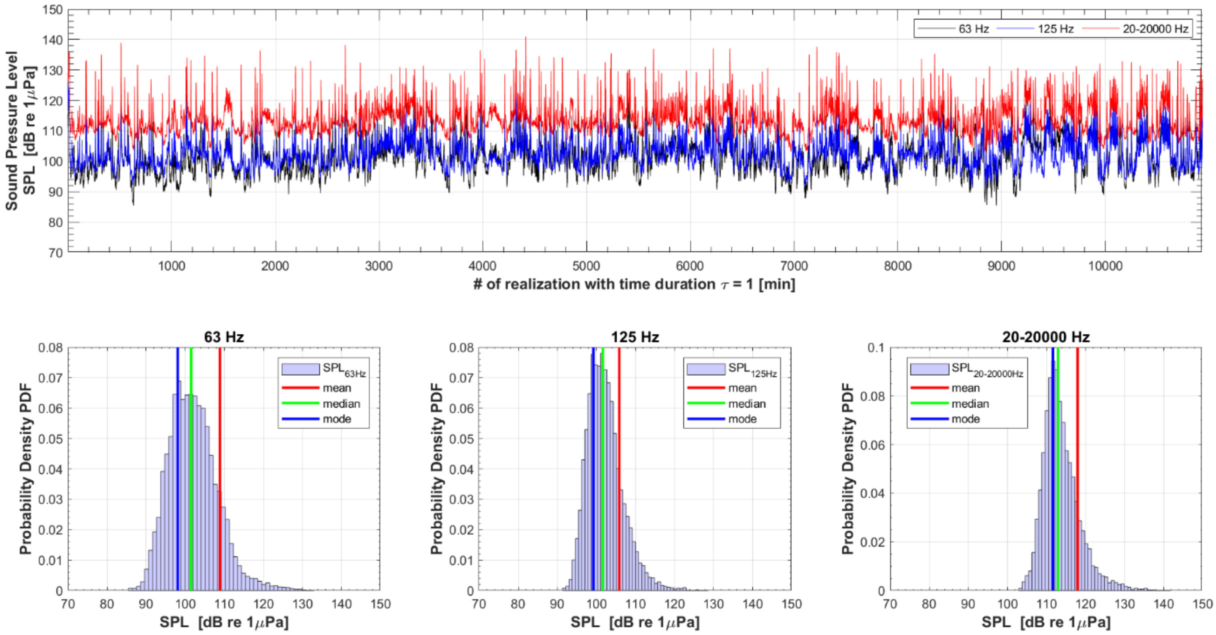

Figure 7.18. Sound pressure level (SPL) time series [dB re 1 µPa] in 63 Hz and 125 Hz thirds (black and blue respectively) and within a frequency bandwidth of 20–20 000 Hz. Sound pressure level histograms SPL63 Hz, SPL125 Hz and SPL20–20 000 Hz – lower panel. Red line – average SPL, green line – median SPL, blue line – mode value. Based on the survey data obtained at survey station H_1 during the winter (survey session carried out between 07.02–24.04.2023)

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 seismoacoustic 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.

7.5 ELECTROMAGNETIC FIELD

Electromagnetic fields in the environment can be divided into natural fields and fields of anthropogenic origin (called artificial fields). From the natural fields, the geomagnetic field of the Earth, the intensity of which ranges from 16 to 56 $A \cdot m^{-1}$, is best recognised. On the surface of the Earth, an electric charge is accumulated, which is the source of the natural electric field. The intensity value of the Earth's natural electric field at moderate weather conditions is approximately 120 $V \cdot m^{-1}$.

In the marine environment, the electric field and the geomagnetic field values are similar. In the survey area, there are no artificial sources of electromagnetic fields, such as active power cables.

Changes in the natural electric fields do not have a direct impact on the living organisms. Natural magnetic fields show differences depending on the geographical location. They have a significant impact on some living organisms.

Electromagnetic fields created as a result of electric current flow can change the natural migratory behaviour of marine mammals and fish, they can also be the source of thermal energy introduced into the marine environment. The burial of power cables in the seabed sediment is the simplest and most effective method of eliminating the EMF impact on the marine environment. As surveys have shown, cable burial at less than 1 m below the sediment surface effectively eliminates the effects of EMF on organisms dwelling on the seabed surface [Tricas and Gill, 2011]. In the case of power cables laid on the seabed surface and covered with protective structures, the impact of EMF emissions on benthic and demersal fauna (including demersal fish) may be greater. However, surveys have shown that even for those organisms that are sensitive to changes in the electromagnetic field within the seabed, such as elasmobranchs and flatfish, the negative impact of EMP emissions from operating power cables can only manifest itself in the case of long cable sections laid on the seabed, which can act as an obstacle to the movement of these organisms [Chapman *et al*., 2023; SunCable 2023]. In the case of the Baltica-1 OWF, such situation will not occur, due to the fact that the cables will be buried under the seabed surface and only in exceptional cases they will be laid on the surface in short sections. The results of the environmental surveys (see Appendix 1) did not reveal the presence of other linear objects in the OWF construction area that would necessitate the laying of new cable lines on the seabed surface. Nevertheless, it cannot be ruled out that there will be other reasons that will prevent the burial of power cables along their entire length. Such instances are likely to be sporadic and will involve laying cables on the seabed surface in sections of no more than a dozen metres in length.

To date, no methods have been developed for the assessment of the marine environment state regarding the descriptor W11, including indicator 11.4.1 'Strength and spatial range of electromagnetic and electric fields'. These factors are currently not monitored in the Polish sea areas [Zalewska 2024].

7.6 ANIMATE NATURE COMPONENTS

7.6.1.1 Phytobenthos

Phytobenthos (macrophytes) are underwater plants that are at least a few millimetres in size. They include:

- macroalgae such as green algae, brown algae and red algae. They grow on the surfaces of seabed cobbles, boulders, mussel shells, thalli of other macroalgae, as well as the stems and leaves of vascular plants and on man-made objects, e.g. wrecks and submerged elements of hydro-engineering structures and other marine structures. Some species attach themselves to the soft bottom with rhizoids (charales) or rest on the seabed in the form of mats (filamentous brown algae);

- vascular plants – aquatic plants occurring on the sandy seabed, attached by a root system (seagrasses, potamogetons) [Brzeska and Opioła 2020].

Aquatic plants are found only in water areas with sufficient light penetration, hence their distribution is limited to the euphotic zone [Schiewer 2008; Kautsky *et al.* 2017]. In the Polish zone of the Baltic Sea, the maximum depth of occurrence of macroalgae attached to the hard bottom is 22 m. In deeper areas of the Polish zone of the Baltic Sea, reaching approximately 26 m, sporadic occurrences of single macroalgal specimens were recorded. Vascular plants rooted in the sandy seabed are found only in the Bay of Puck up to a depth of 5–8 m [Feistel *et al.* 2008; Kruk-Dowgiałło *et al.* 2011; Błeńska *et al.* 2014, 2015a and 2015b; Brzeska-Roszczyk and Kruk-Dowgiałło 2017 and 2019; Brzeska-Roszczyk *et al.* 2017; Brzeska and Kruk-Dowgiałło 2017; Michałek *et al.* 2020; SEM data 2010−2022; Kruk-Dowgiałło 2000].

The spatial extent of the phytobenthos survey was the Baltica-1 OWF Area together with a zone of 1 NM in width. It is situated on the southern slopes of the Middle Bank located on the border between the Polish and Swedish exclusive economic zones, within the south-eastern part of the Bornholm Basin [Zaucha and Matczak 2011], in the depth range from approximately 14 to approximately 50 m. The largest part of the seabed surface within the survey area is covered by sand and gravel sediments. In the northern part of the survey area, there are fragments of the seabed covered by stones, at depths of approximately 25–40 m.

Phytobenthos surveys included seabed filming in the shallowest area of the stony seabed (24.4 to 27.5 m), situated in the north-western part of the survey area. The inspection performed with an ROV showed a lack of subsea vegetation along both 100 m transects delineated. Boulders and cobbles on the seabed were covered with dense colonies of bay mussels (*M. trossulus).* The stony seabed, which may constitute a substrate for the development of underwater vegetation, is located within the Baltica-1 OWF construction area, at depths beyond the range of phytobenthos occurrence.

Previously, no surveys had been conducted in the Baltica-1 OWF Area to identify the occurrence of phytobenthos. No phytobenthos monitoring stations were established under the State Environmental Monitoring (SEM) near the area [Zalewska 2024].

In the open waters of the Polish part of the Baltic Sea, macroalgae in the form of communities, including protected and habitat-forming species, occur only on the boulder area of the Słupsk Bank [Kruk-Dowgiałło *et al.* 2011; SEM data 2010−2022; CIEP 2016, 2017 and 2021; Michalek *et al.* 2020]. This boulder area features some of the most valuable habitat-forming species in the Polish sea waters, i.e. *Furcellaria lumbricalis* and *Polysiphonia fucoides*. They are accompanied by other red algae, e.g. *Ceramium diaphanum*, *Coccotylus truncatus*, *Rhodomela confervoides* and a species that is rare not only in Polish areas of the Baltic Sea but also within the entire Baltic Proper, namely *Delesseria sanguinea*, characteristic only for this boulder area [*ibidem*]. The presence of species indicating the high trophic levels of the water is also recorded − the brown algae *Pylaiella littoralis* and *Ectocarpus siliculosus* [Michałek *et al.* 2020]. Previously, phytobenthos surveys below a depth of 20 m had been performed mainly in the context of surveys for projects proposed in open sea areas. The results of the surveys indicated sporadic occurrence of phytobenthos, primarily in the form of small patches or single specimens scattered on the seabed [Błeńska *et al.* 2014 and 2015a; Brzeska-Roszczyk *et al.* 2017; Antczak *et al.* 2019] or its absence [Barańska *et al.* 2020].

7.6.1.2 Macrozoobenthos

Macrozoobenthos (seabed macrofauna) is a group of invertebrate organisms living on the surface layer of seabed sediments (epifauna), as well as the hard substratum (boulders, stones) or living inside the sediments (infauna), which remain on a sieve with a mesh size of 1 mm during sediment rinsing. Main macrozoobenthos groups are bivalves (Bivalvia), crustaceans (Crustacea), polychaetes (Polychaeta), oligochaetes (Oligochaeta) and snails (Gastropoda). These are mostly sedentary species with a lifecycle of at least one year. Macrozoobenthos plays an important role in the trophic chain of marine ecosystems. The benthic invertebrates are food for many species of fish and marine birds. Moreover, they shape the living conditions of other organisms (habitat-forming role) and influence the condition of the environment (e.g. sediment oxygenation, biofiltration of suspended solids from the water column). Taxonomic diversity, abundance and sensitivity of individual taxa constituting the complex of benthic organisms are indicative of the ecological quality of the seabed.

The macrozoobenthos survey area comprised the Baltica-1 OWF Area together with a zone of 1 NM in width, situated on the southern slopes of the Middle Bank located on the border between the Polish and Swedish exclusive economic zones, within the south-eastern part of the Bornholm Basin [Zaucha and Matczak 2011], in the depth range from approximately 14 to approximately 50 m. The largest part of the seabed surface within the proposed Project area is covered by sandy and gravelly sediments. In the northern part of the survey area, there are fragments of the seabed covered by stones, at depths of approximately 25–40 m.

For the purpose of this report, separate preliminary macrozoobenthos surveys were carried out on the soft bottom (sand and gravel sediments) and on the hard bottom (rocks), obtaining comprehensive data to conduct qualitative and quantitative analyses of benthic invertebrate communities in the proposed Project area and to assess the ecological quality status of the seabed habitats. The taxonomic composition, abundance and biomass identified for the macrozoobenthos of this area indicate that the area is inhabited by fairly diverse benthic macrofauna consisting of taxa characteristic and common for this depth range. In the macrozoobenthos samples collected on the soft bottom, 29 taxa belonging to two phyla and seven classes were recorded. The most common taxa were the small psammophilous polychaete *Pygospio elegans*, considered to be an indicator of a clean or medium-clean seabed, which includes sediment with a small admixture of organic matter, as well as one species of bivalve, *Macoma balthica*, which constitutes food for many species of ducks (e.g. the common scoter and the common eider) and fish, such as flounder and viviparous eelpout [Olafsson 1986; Żmudziński 1990; Gosling 2004]. The average abundance of the macrozoobenthos from the samples analysed was 2388±1815 ind.·m^{-2}, while the average biomass was 26.8±38.6 g WW·m^{-2}. The greatest proportion in the dominance structure of the soft-bottom macrozoobenthos abundance had *Pygospio elegans.* The total macrozoobenthos biomass was low and even across the entire survey area, not exceeding 50 g WW·m^{-2} except for point locations in the north-eastern part of the survey area as well as north-western part of the 1 NM wide area, where a stony seabed occurred and therefore the macrozoobenthos biomass reached over 200 g Ww·m^{-2} over there. The species with the largest proportion in the total macrozoobenthos biomass was the Baltic clam *Macoma balthica*. This bivalve inhabited the seabed in the survey area mainly in its southern and north-eastern parts, with slightly higher values of this species biomass (approximately 50 g WW·m^{-2}) occurring in the southern part of the survey area. In the case of the Baltic clam the most numerous were the juveniles.

The presence of the following another 3 bivalve species was confirmed in the samples: the bay mussel *Mytilus trossulus*, the soft-shell clam *Mya arenaria* and the lagoon cockle *Cerastoderma glaucum*. *Mya* *arenaria* constitutes a food source for ducks, such as the long-tailed duck and the common scoter, as well as for flatfish [Węsławski 2009; Piechocki and Wawrzyniak-Wydrowska 2016], whereas *Cerastoderma glaucum* serves as food for flatfish [Węsławski 2009].

Only seven taxa of periphytic and phytophilic fauna were found on the hard bottom, which occurs in points in the northern part of the survey area, indicating the poor qualitative and quantitative composition of this community. In terms of abundance and biomass, the hard-bottom benthic fauna was dominated by bivalves, bay mussels *Mytilus trossulus*, with a clear prevalence of specimens of the 1–5 mm size class. The abundance of the hard-bottom macrozoobenthos ranged between a minimum of 7344 ind.$\cdot$m^{-2} and a maximum of 25 543 ind.$\cdot$m^{-2}, while the biomass ranged from 278.3 g WW$\cdot$m^{-2} to 1398.9 g WW$\cdot$m^{-2}. Neither dense bay mussel aggregations nor a diverse periphytic fauna were found in places where the hard bottom macrozoobenthos occurs.

To assess the ecological quality status of the macrozoobenthos communities on the soft bottom, the multimetric index B was applied [Osowiecki *et al.* 2012], while for the hard bottom it was the index of typical species presence (TSP) [CIEP 2018], using a five-point scale. The areal distribution of the ecological status based on macrozoobenthos, within the boundaries of the survey area, has a mosaic character. A major part of the area under discussion has a sand as well as sand and gravel seabed, with macrozoobenthos representing poor and moderate status within the survey area. Areas characterised by higher quality (good status) are mainly found in the southern strip of the survey area. The valorisation in the point locations of the stony seabed occurrence indicates that this is not a valuable habitat area, because the status of the macrozoobenthos community inhabiting the stony seabed fragments was determined as poor in one place and good in another [Figure 7.19].

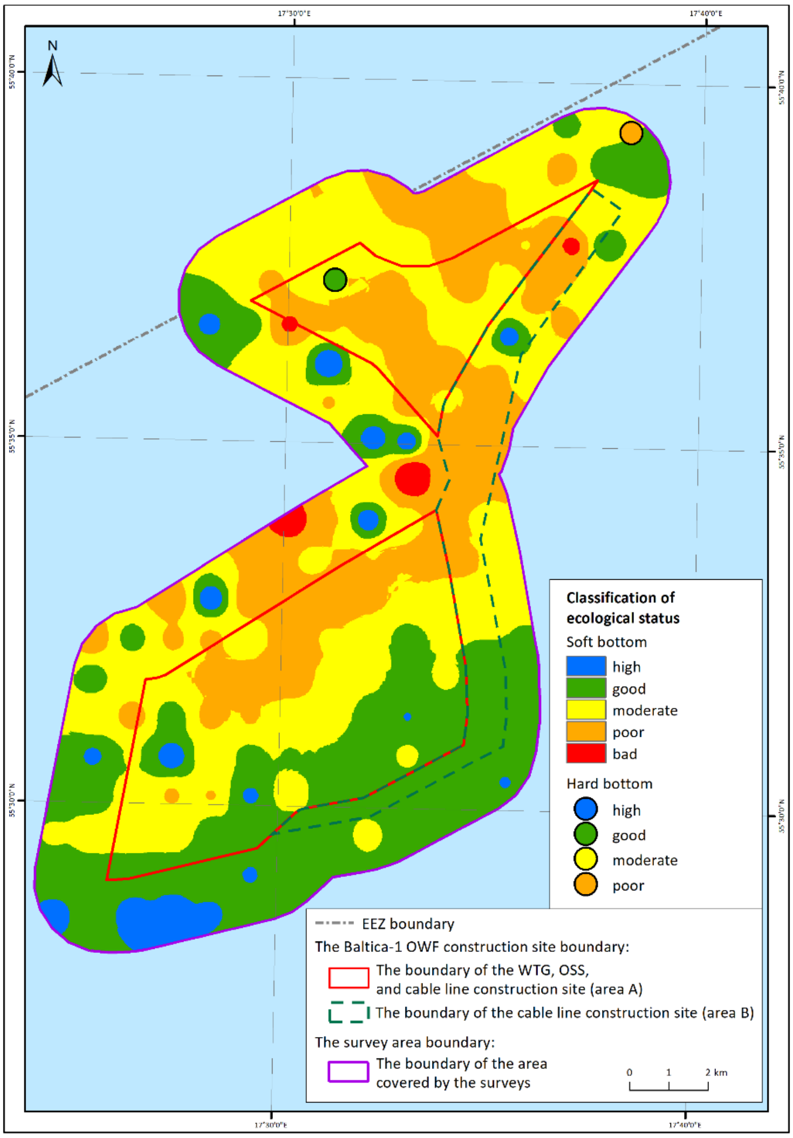

Figure 7.19. Ecological status distribution in the survey area based on macrozoobenthos quality status assessment

Until the pre-investment surveys were conducted, the area of the Baltica-1 OWF was one of the less recognised areas in the Southern Baltic in terms of biological data. The bank is situated outside the area of monitoring surveys conducted as part of the State Environmental Monitoring (SEM) [Zaucha and Matczak 2011]. Comparative material for macrozoobenthos surveys in the survey area can be provided by the results of environmental surveys covering macrozoobenthos, which were conducted in the immediate vicinity, on the western side of the proposed wind farm in the PSA, e.g. in 2005 for the purpose of a report on the environmental impact on the marine environment concerning a project involving the exploitation of the aggregate deposit 'Southern Middle Bank' [Zaucha and Matczak 2011], in 2016 within the framework of the 'Pilot implementation of species and marine habitat monitoring in 2015–2018' concerning surveys of the potential presence of habitat 1110 – Sandbanks which are slightly covered by sea water all the time [CIEP 2016], and in 2021 as part of the pre-investment surveys of the Bałtyk I OWF project [Bałtyk I OWF 2023].

The average abundance of benthic organisms, based on data collected in 2005, did not exceed 400 ind.·m^{-2}, and the most abundant species were *Pygospio elegans*, *Macoma balthica*, *Mya arenaria* and *Cerastoderma glaucum* [Zaucha and Matczak 2011].

In 2016, a maximum of 11 macrozoobenthos taxa were recorded at stations within the Southern Middle Bank up to the 20 m isobath, among which the polychaete *Pygospio elegans* prevailed in terms of abundance, and the bivalve lagoon cockle *Cerastoderma glaucum* dominated in terms of biomass. The average abundance was 423±109 ind.·m^{-2}, while the average biomass was 37.4±21.7 g WW·m^{-2} [CIEP 2016]. The area surveyed within the Middle Bank met the criterion of a 'sublittoral sandbank' to a minimum degree and was not recommended for further monitoring due to the different character of the sediment in comparison with the Oderbank and the Słupsk Bank [Barańska *et al.* 2018].

In the pre-investment surveys conducted in 2021 for the Bałtyk I OWF, on the other hand, 25 macrozoobenthos taxa were identified in the soft-bottom part of the area. The most common taxa were the two species of polychaetes – *Pygospio elegans* (dominant in terms of abundance) and *Marenzellaria* sp. as well as one bivalve species – *Macoma balthica* (dominant in terms of biomass). The average abundance of the soft-bottom macrozoobenthos was 1526 ind.·m^{-2} and the average biomass was 23.1 g WW·m^{-2}. A stony seabed represented a small area of the proposed Bałtyk I OWF. The macrozoobenthos community inhabiting the stony seabed consisted of 16 macrozoobenthos taxa representing 8 classes. The average abundance of this complex was 49 698 ind.·m^{-2} and the average biomass – 1810 g WW·m^{-2}. The macrozoobenthos communities of the soft bottom, which was predominant, were not characterised by high value and their average quality status was assessed as moderate, while in the case of the hard bottom, the ecological status was identified as good [Bałtyk I OWF 2023]. The results for sand and gravel seabed are similar to those obtained for the Project under discussion. The average abundance of the soft-bottom macrozoobenthos in the survey area was slightly higher than that obtained in the Bałtyk I OWF survey, but the results for the average biomass of the macrozoobenthos community are comparable. Also the ecological quality status indicates merely a moderate status of the soft-bottom benthic fauna community, in both cases. However, the data concerning the characteristics of the hard bottom of the Project discussed are considerably lower than for the Bałtyk I OWF area, which indicates that the sparse hard-bottom macrozoobenthos community in the survey area is neither an attractive feeding ground for benthivorous bird species such as diving ducks, nor for flatfish, round goby or cod.

On the Swedish side, east of the proposed Baltica-1 OWF, the Swedish Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308) is situated. This area includes habitats 1110 and 1170 – Rocky and stony seabed, reefs. However, these habitats are located very far from the Baltica-1 OWF Area – more than 40 km [Conservation plan for the Natura 2000 site SE0330308 *Hoburgs Bank and Midsjöbankarna*, 2021]. On the other hand, on the boundary of this area, and north-east of the Baltica-1 OWF, the Södra Victoria OWF is to be constructed in the Swedish EEZ.

7.6.1.3 Ichthyofauna

The ichthyofauna surveys conducted in the survey area aimed 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 area covered by ichthyofauna surveys included the Baltica-1 OWF Area together with a zone of 4 km in width.

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

The result of demersal catches in the survey area using bottom-set gillnets 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 herring gillnet catches, the same taxonomic composition (the 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 survey area [Table 7.8].

Table 7.8. Taxa recorded during survey catches conducted within the survey area

No.	Taxon	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 summer and autumn, due to the fact that the shallower waters of the 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 survey area was low in comparison with what is usually observed in the Southern Baltic surveys. 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 originated from the spawning taking place in the Słupsk Furrow. The absence of larvae in the 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 originated from the spawning taking place in the shallow regions of the Middle Bank, including the shallowest part of the survey area in the Southern Middle Bank.

The too great depth of the survey area rules out the possibility that the goby larvae caught originated 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 area, including the section of the area surveyed located 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.

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. 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 survey area. The process intensified on a large scale in May, then gradually died out in the second half of the summer.

The results obtained indicate that during the survey period, the area of the planned project provided a habitat for **herring**, as well as that the migration routes leading towards wintering grounds as well as the spawning (probably) and feeding migration routes run across the area. The 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 basin in which periodical spawning and feeding migrations of **sprat** took place. Taking into account the information from literature and the results of the surveys conducted, it can be assumed that sprat spawning does not take place in the 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).

Concluding, 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 survey area with respect to ichthyofauna, its following characteristics were considered − taxonomic diversity, occurrence of protected and endangered as well as commercial species, the presence of 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 evaluation was based on expert knowledge.

7.6.1.4 Marine mammals

The survey area for the Baltica-1 OWF is located in the northern part of the Polish waters of the Southern Baltic, on the border with the Swedish EEZ. Four species of marine mammals are found in the area – the harbour porpoise (*Phocoena phocoena*) as well as three species of seals – the grey seal (*Halichoerus grypus*), the harbour seal (*Phoca vitulina*) and occasionally the ringed seal (*Pusa hispida*).

Harbour porpoise

<u>Distribution of the species – current state of knowledge</u>

The harbour porpoise is the only cetacean species present in the Baltic Sea. Knowledge regarding the population status of this animal is still limited. The most detailed data on the harbour porpoise population in the Baltic Sea come from surveys involving passive acoustic monitoring, primarily the SAMBAH (Static Acoustic Monitoring of the Baltic Harbour Porpoise) project conducted in 2011–2013. On the basis of the results of that project, it was confirmed that there are two subpopulations of the species – originating from the Baltic Proper and from the Western Baltic. The Baltic Proper subpopulation was estimated at approximately 500 individuals (confidence interval: 95%, number of individuals: 71–1105). Furthermore, based on the data collected, animals from the Baltic Proper subpopulation were found to concentrate in Swedish waters during the breeding season, from May to October, primarily in the area of *Hoburgs bank och Midsjöbankarna* [SAMBAH 2016; Carlen *et al.* 2018; Amundin *et al.* 2022]. The region is currently a Natura 2000 site where the harbour porpoise is subject to protection. The results of the SAMBAH project demonstrated that outside the breeding season, from November to April, the occurrence of the harbour porpoise is more dispersed around the waters of the south-eastern Baltic Sea.

In the Polish EEZ, the exact status of harbour porpoise population is unknown, but the abundance is estimated to be generally low [Gillespie *et al.* 2005; Koschinski 2011; SAMBAH 2016]. The SAMBAH project indicates that both subpopulations of the harbour porpoise occur in the Polish waters seasonally, but primarily the Baltic Proper population is present. Data from the project also indicate that the likelihood of detecting the animals in the Polish EEZ is generally higher outside the breeding season [Figure 7.1]. However, such a trend is not evident throughout the Polish waters, including the waters adjacent to the Swedish Natura 2000 site where the proposed wind farm is to be located. The detection probability map derived from SAMBAH [Figure 7.20] shows that the difference in porpoise occurrence between the two seasons (May–October, November–April) is not clear within the survey area.

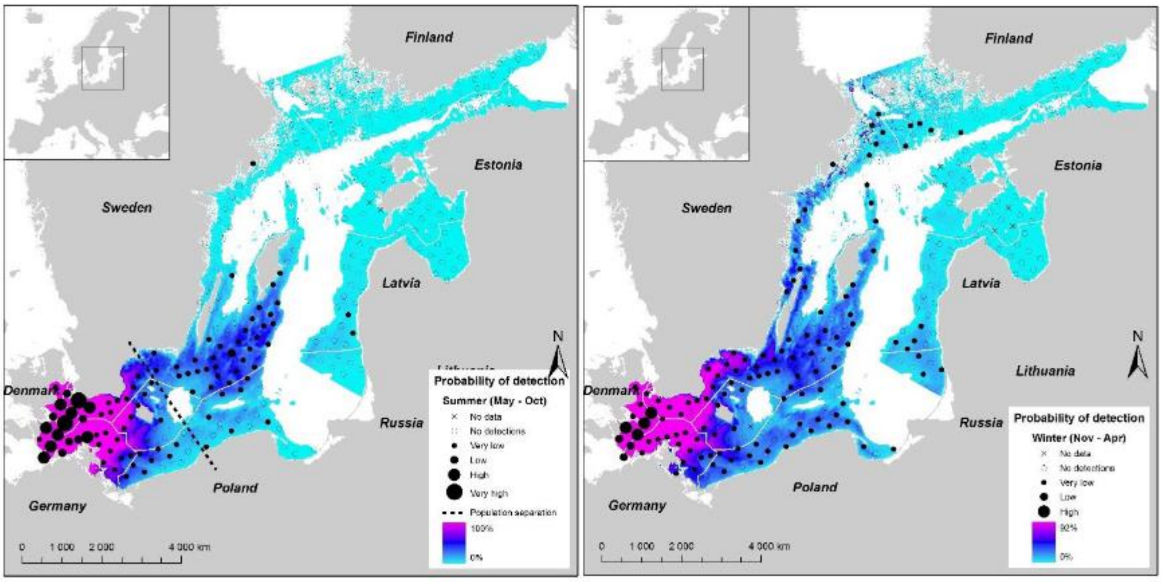

Figure 7.20. Harbour porpoise detection probability in two seasons: May–October (left) and November–April, demonstrated during the SAMBAH project (2011–2013) [Source: internal materials based on SAMBAH data]

Important information on the occurrence of the harbour porpoise in the PSA originates from the State Environmental Monitoring (SEM) data. As part of the SEM, passive acoustic monitoring of the harbour porpoise was carried out in 2016–2018, in the area of the Pomeranian Bay and the Stilo Bank, i.e. the locations in which the highest level of porpoise detections within the Polish waters was recorded during the SAMBAH project. The survey results demonstrated a significantly more frequent occurrence of the harbour porpoise in the Pomeranian Bay area (4.6% DPD out of all monitoring days) compared with the Stilo Bank (0.3% DPD), as well as seasonal variations in animal occurrence. In the Pomeranian Bay, the highest detection rate was recorded during the summer and autumn. In the Stilo Bank area, the number of detections was low throughout the survey period, but most were recorded in spring. The CIEP project also demonstrated higher porpoise detections compared to the results obtained from SAMBAH [CIEP 2018]. Another phase of the national programme for acoustic monitoring of the harbour porpoise confirmed the trends indicated earlier, both regionally and seasonally [CIEP 2022].

With the increasing number of monitoring surveys for various proposed OWFs, the availability of data on the presence of the harbour porpoise in the open waters of the Polish part of the Baltic Sea has also increased. The results of such surveys are currently available for the locations of the Baltica OWF, Bałtyk II OWF, Bałtyk III OWF, Baltic Power OWF, BC-Wind OWF and Bałtyk I OWF, among others. The project located closest to the Baltica-1 OWF Area from the west is the Bałtyk I OWF. Monitoring surveys conducted in that location in 2020–2022 demonstrated the presence of the harbour porpoise in all seasons of the year. The animals appeared with the highest frequency during the summer, with a decrease in detections in the autumn months. During the winter and spring, recording levels were the lowest and had similar values. The overall detection rate recorded during the surveys was 2.9% DPD [Bałtyk I OWF EIA Report 2023]. Projects located further south of the Baltica-1 OWF are the Baltic Power OWF and the BC-Wind OWF. The acoustic monitoring carried out in 2018–2019 for the Baltic Power OWF showed that the harbour porpoise is rarely present in the area surveyed. The animals were recorded on 12 out of the 1945 survey days (0.6% DPD). The detections were recorded in most of the months analysed, except for February, April, July and November, with the highest DPM in the autumn (0.003% DPM on average) [Baltic Power OWF EIA Report, 2020]. The results of the acoustic monitoring carried out in 2019–2021 for the nearby BC-Wind OWF also indicated the sporadic appearance of the harbour porpoise in the area under analysis. The overall detection rate during the surveys was 0.6% DPD (17 DPD per 2790 recording days), with the highest number of animals recorded during the summer [BC Wind OWF EIA Report, 2021]. Monitoring surveys conducted at locations south-west of the Baltica-1 OWF – Bałtyk II OWF, Baltica OWF, and Bałtyk III OWF – showed very low porpoise activity. In both areas, single animal detections were recorded throughout the year, mostly in the spring and summer. The animals were recorded both by acoustic methods and during visual observations from an aircraft [Plichta *et al*. 2014 and 2015].

Relevant data on the occurrence of the harbour porpoise in the Swedish Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308) originate from the SAMBAH project and the Swedish National Monitoring Programme (SNMP). During SAMBAH, on the basis of acoustic recordings collected between 2011 and 2013, it was concluded that the harbour porpoise appears in considerably higher numbers in the Midsjöbankarna area during this species' breeding and mating season. The overall detection rate recorded was 6.9% DPD (444 DPD per 6422 recording days). As part of the SNMP, acoustic monitoring continued from 2017 to 2020 at 12 stations previously surveyed during the SAMBAH project. On the basis of the data obtained, it was found that the frequency of the harbour porpoise detection increased during the May–October period in comparison with the results obtained during the SAMBAH project. The overall acoustic recording rate was 9.1% DPD (737 DPD per 8117 recording days) [Owen *et al*. 2021].

<u>Porpoise occurrence in the Baltica-1 OWF Area and in the adjacent waters</u>

In order to analyse the extent to which the survey area and adjacent waters are used by the harbour porpoise, passive acoustic monitoring was conducted with the use of F-PODs. The monitoring took place at seventeen survey stations situated within the Baltica-1 OWF (stations SM_01 – SM_05) and in the buffer zone extending up to 40 km from the OWF. The buffer zone included the area of Polish waters (stations SM_06 – SM_11) and Swedish waters (stations SM_12 – SM_17). The surveys were conducted between December 2022 and February 2024. At the Polish locations, the measurements started on 3–4 December 2022, whereas at the Swedish locations – on 14 February 2023. Acoustic recordings were collected in a continuous mode and acquired during service cruises.

The results of the acoustic monitoring demonstrated that porpoises occurred in the Baltica-1 OWF survey area all year long 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 [Figure 7.21]. At one station (SM_08), 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, within both the Baltica-1 OWF Area and the Swedish buffer zone, porpoises occurred throughout the year, in all seasons [Figure 7.21–Figure 7.23]. 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 porpoise was rare throughout the Swedish buffer zone. Within the wind farm boundaries, the winter detection levels were similar to those in the autumn, while in the Polish buffer zone, the animals were recorded only at stations SM_06 and SM_11 [Figure 7.22 and Figure 7.24].

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 [Figure 7.24]. 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.

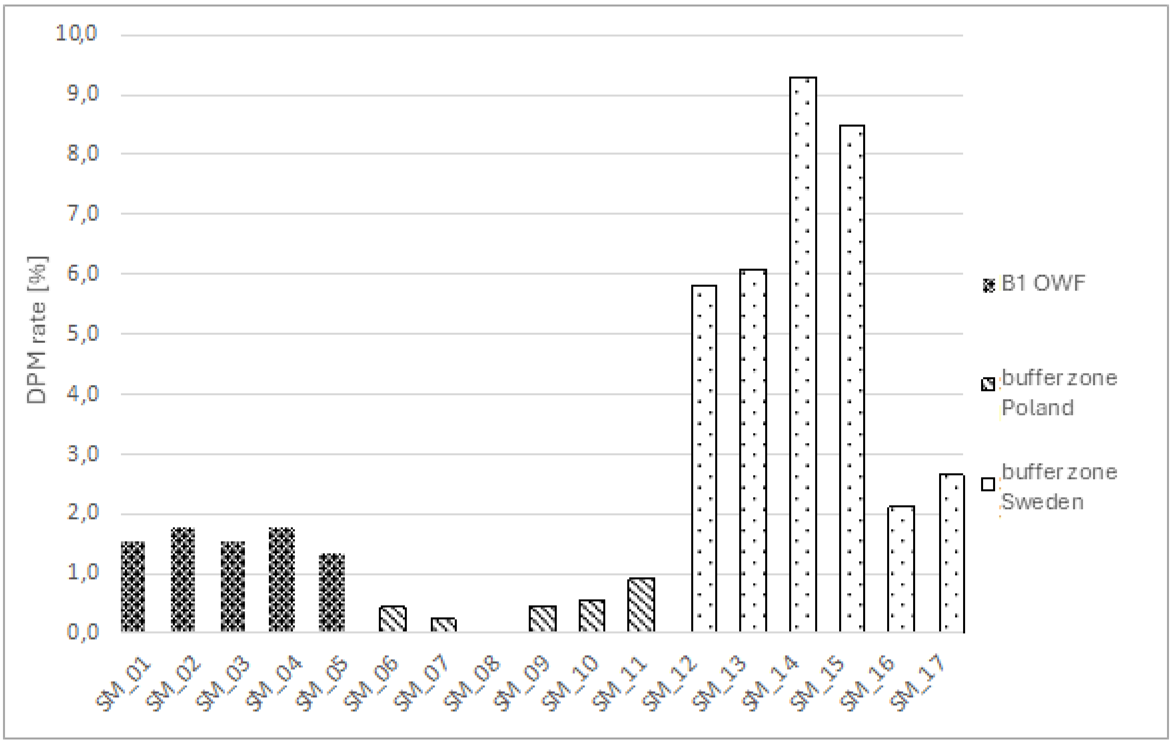

Figure 7.21. Porpoise activity recorded monthly at survey stations during acoustic monitoring from 3 December 2022 (stations in Poland) / 14 February 2023 (stations in Sweden) to 28 February 2024. Data were presented as a proportion of DPDs recorded in relation to all the days of recordings collected at a given station.

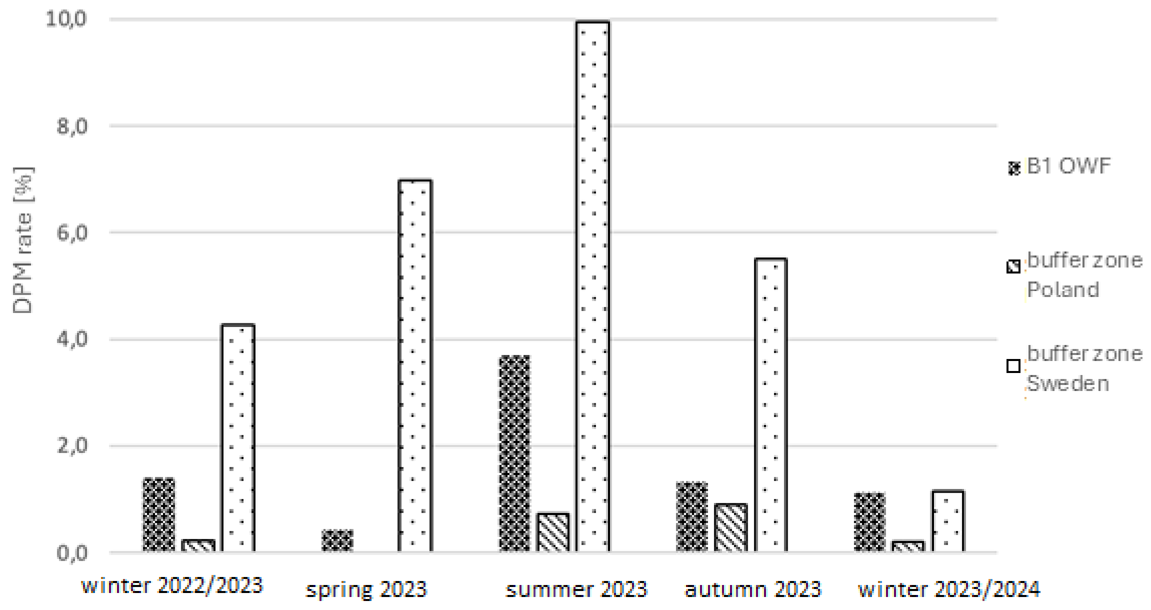

Figure 7.22. Porpoise activity recorded seasonally at survey stations during acoustic monitoring from 3 December 2022 (stations in Poland) / 14 February 2023 (stations in Sweden) to 28 February 2024. Data were presented as a proportion of DPDs recorded in relation to all the days of recordings collected 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 in Sweden (two weeks in February 2023 and winter 2023/2024)

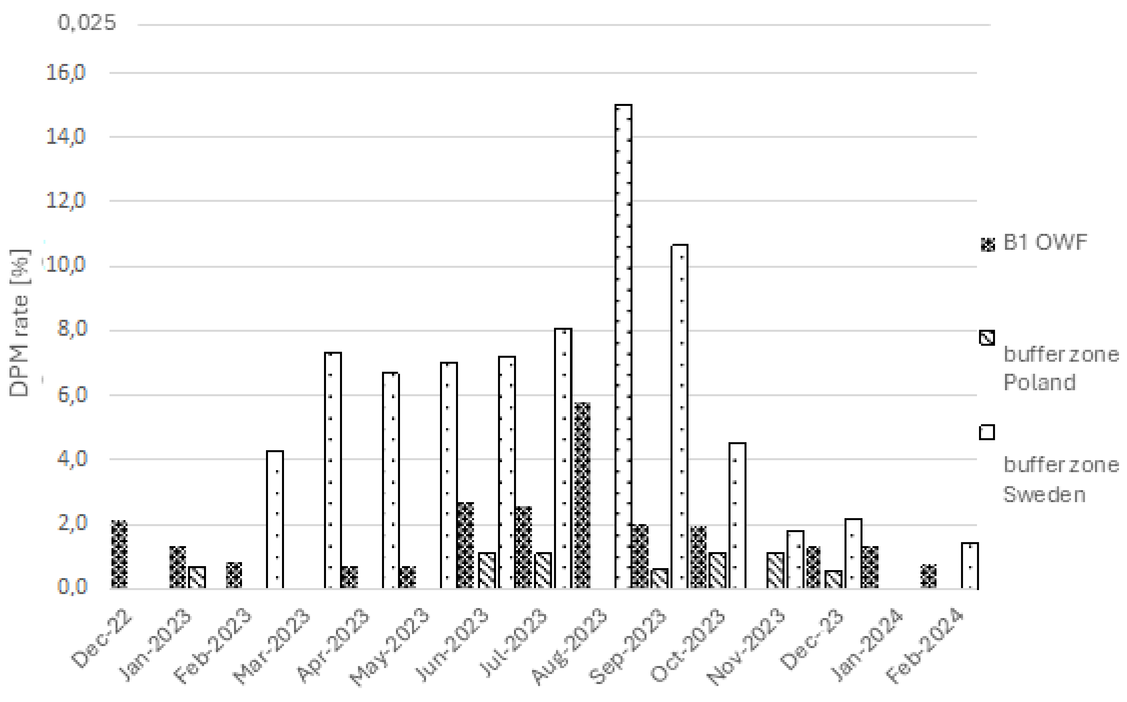

Figure 7.23. Porpoise activity recorded monthly at survey stations during acoustic monitoring from 3 December 2022 (stations in Poland) / 14 February 2023 (stations in Sweden) to 28 February 2024. Data were presented as a proportion of DPDs recorded in relation to all the days of recordings

collected during the month at a given station. It should be noted that the monitoring period differs between the locations in Poland and Sweden.

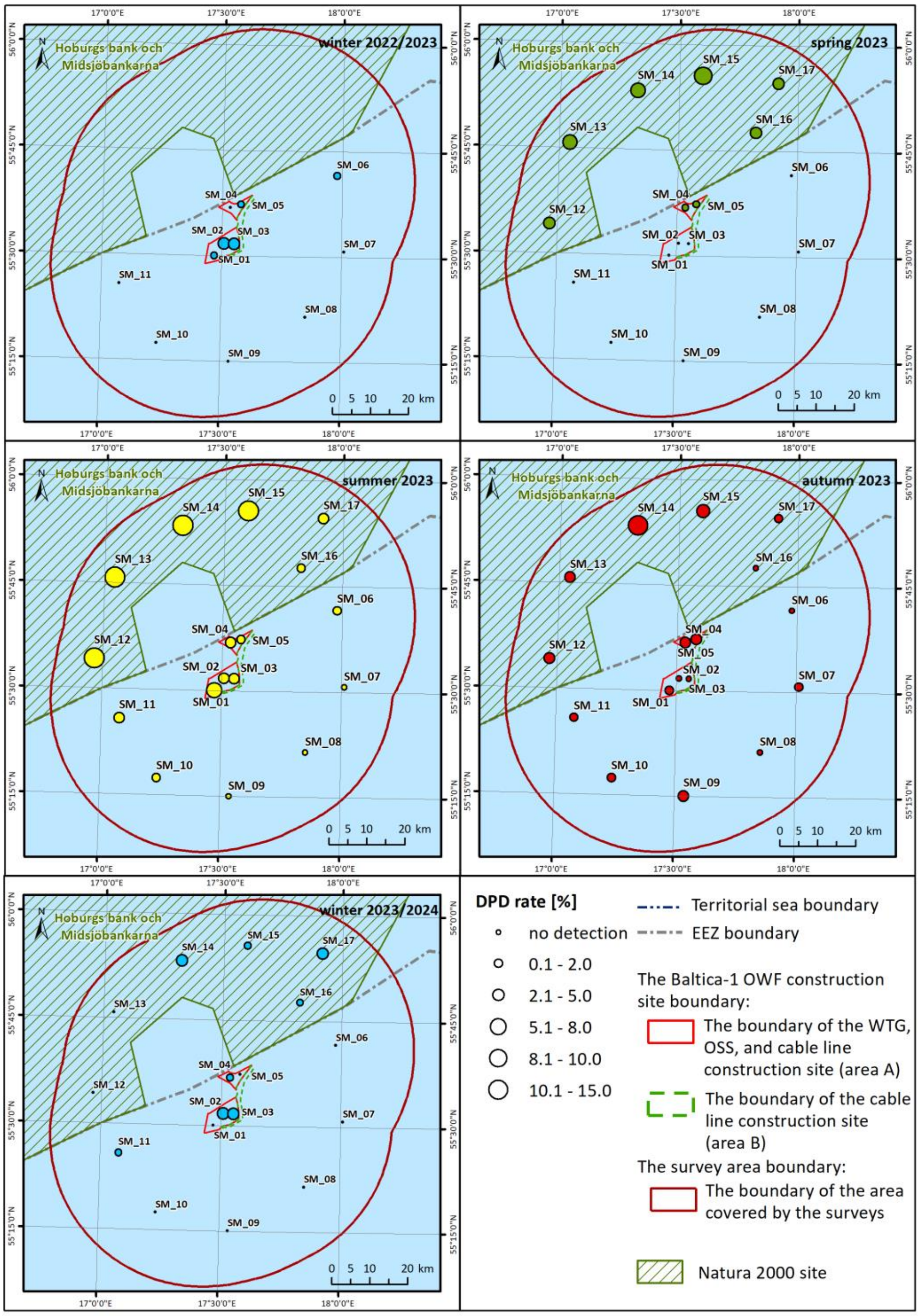

Figure 7.24. Porpoise activity recorded seasonally at survey stations during acoustic monitoring from 3 December 2022 (stations in Poland) / 14 February 2023 (stations in Sweden) to 28 February 2024. Data were presented as a proportion of DPDs recorded in relation to all the days of recordings collected 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 in Sweden (two weeks in February 2023 and winter 2023/2024)

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 is situated within the Natura 2000 site *Hoburgs bank och Midsjöbankarna*, in which porpoises are subject to 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 *Hoburgs bank och Midsjöbankarna*, compared to other parts of the eastern Baltic Sea, as well as seasonal trends in animal occurrence were identified in both the SAMBAH (Static Acoustic Monitoring of the Baltic Sea Harbour Porpoise) project and in the Swedish National Monitoring Programme (SNMP) [SAMBAH 2016; Carlen *et al.* 2018; Owen *et al.* 2021]. The results obtained during the surveys for the Baltica-1 OWF are consistent with the conclusions of SAMBAH and the SNMP, both in terms of frequency and seasonal variation in the harbour porpoise presence. The overall detection rate recorded in the Swedish buffer zone of the Baltica-1 OWF survey area was approximately 6% DPD (126 DPD per 2135 recording days). This value is similar to the results obtained during the SAMBAH project – 6.9% DPD (444 DPD per 6422 recording days) [Carlen *et al.* 2018]. During the SNMP, the detection rate was higher, namely 9.1% DPD (737 DPD per 8117 recording days) [Owen *et al.* 2021]. Furthermore, the seasonal trends recorded in the Project under discussion reflect the SAMBAH and SNMP results well. The high detection levels recorded between the spring and summer at Swedish locations indicate potential cases of animals gathering for breeding purposes [Carlen *et al.* 2018]. On the other hand, the noticeable decrease in the recordings in autumn and winter suggests that the species disperse to other areas of the Baltic Sea. This appears to be confirmed by the more frequent occurrence of the harbour porpoise in the Polish buffer zone during the autumn months. Furthermore, the trend of increasing numbers of detections in the survey area towards the north (with the highest values at stations SM_14 and SM_15) is also consistent with the SAMBAH and SNMP conclusions and indicates the different significance of individual parts of the survey area for the presence of the species.

The frequency of the harbour porpoise detections during the summer and autumn followed similar trends within the boundaries of the Baltica-1 OWF and the Swedish buffer zone, which can be linked to the location of the proposed wind farm area near the boundary with the *Hoburgs bank och Midsjöbankarna* area. In contrast, detection trends obtained in the Polish buffer zone, situated further away from the Swedish EEZ, differed from those recorded in the Swedish waters. The frequency of harbour porpoise occurrences in the area was generally low and increased considerably in the autumn months, after a period of increased porpoise activity in the Swedish waters. Such results support the conclusions of the SAMBAH project, indicating that after the breeding season (from November onwards), the occurrence of the harbour porpoise in the Baltic Proper is more dispersed.

The results obtained for the Polish part of the survey area can also be compared to data available from acoustic monitoring programmes conducted for other proposed offshore wind farms.

On the basis of data obtained during the surveys conducted for the Baltica-1 OWF, it can be concluded that the region of the proposed offshore wind farm is characterised by higher levels of porpoise detection (1.6% DPD) in comparison with the 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; Baltic Power OWF EIA Report, 2020; BC-Wind OWF EIA Report, 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 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 identified 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, the frequency of porpoise occurrence was the highest in summer, whereas during the autumn period, the detection numbers started to decrease. These results indicate that in both the Baltica-1 OWF and Bałtyk I OWF survey 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, namely the Stilo Bank (south-west of the Baltica-1 OWF), it can also be concluded that the survey area 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 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*, where the frequent occurrence of the porpoise 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.

Seals

<u>Species occurrence – current state of knowledge</u>

Three species of seals occur in the Baltic Sea – the grey seal, the harbour seal and the ringed seal [Cichocki *et al.*, 2015]. According to HELCOM data, the harbour seal and the ringed seal are assessed as species with a low probability of occurrence in the waters of the Southern Baltic. In Polish waters, the harbour seal is recorded sporadically, as its main distribution area covers south-western waters. The ringed seal, on the other hand, is mainly found in the northern region of the Baltic Sea [HELCOM 2018a]. The only species regularly observed in the PSA is the grey seal, whose permanent presence is recorded in the Vistula estuary area. In 2019, the abundance of this species in the Southern Baltic area was estimated at approximately 2537 individuals, which corresponds to approximately 7% of the Baltic population [Galatius *et al.* 2020].

Data on the occurrence of seals on the Polish coast are collected by the WWF Blue Patrol, in cooperation with SMIOUG (Hel Marine Station of the Institute of Oceanography at the University of Gdańsk). The report of the project entitled 'Protection of marine mammals and birds – continuation' shows that the grey seal was recorded most abundantly on the Polish coast between 2020 and 2023, with 1390 sightings. The number of sightings of other species was much lower – 40 sightings of the harbour seal and 8 sightings of the ringed seal. The grey seal was recorded most frequently east of Łeba [WWF, 2023a] [Figure 7.25–Figure 7.28].

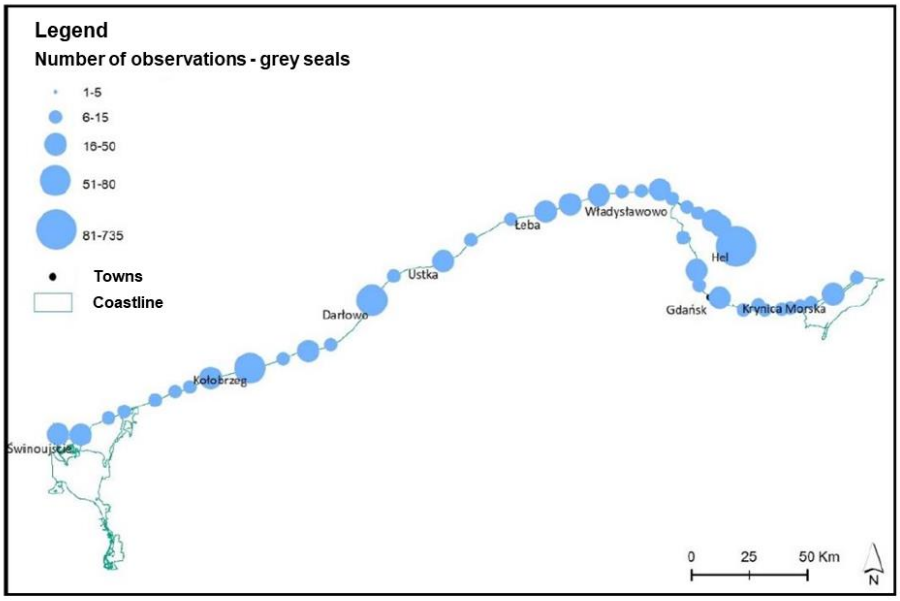

Figure 7.25. Observations of live grey seals in 2020–2023 [Source: WWF 2023]

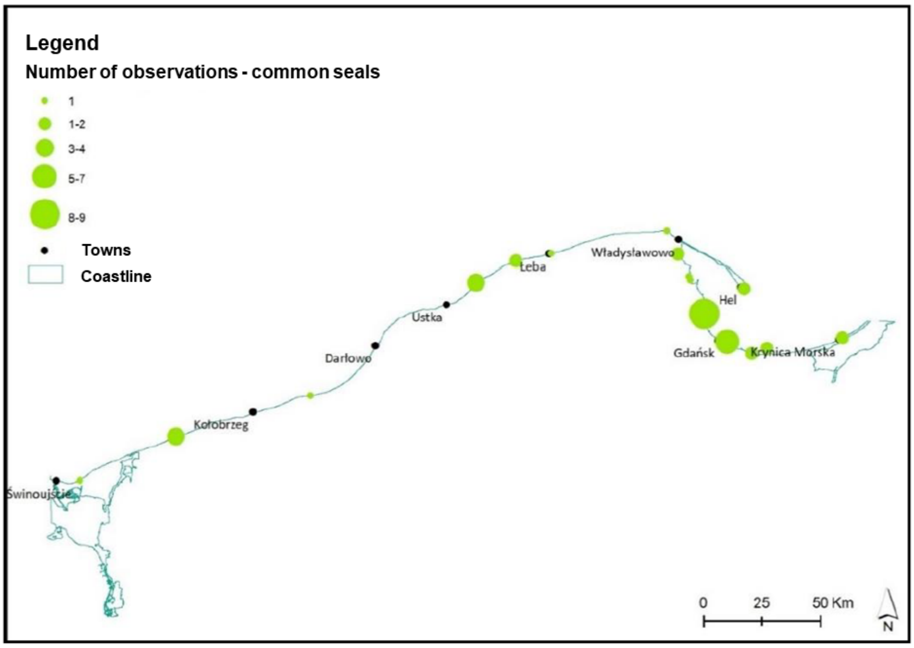

Figure 7.26. Observations of live harbour seals in 2020–2023 [Source: WWF 2023]

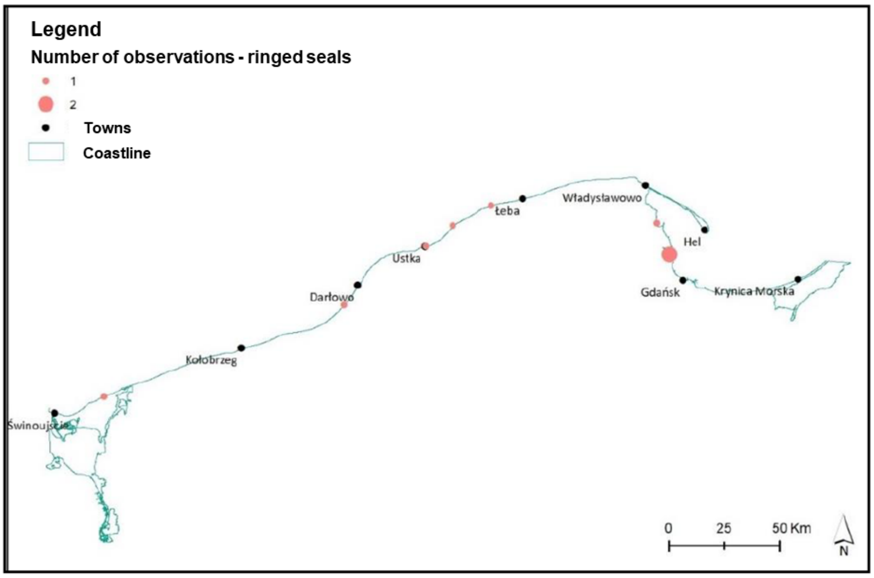

Figure 7.27. Observations of live ringed seals in 2020–2023 [Source: WWF 2023]

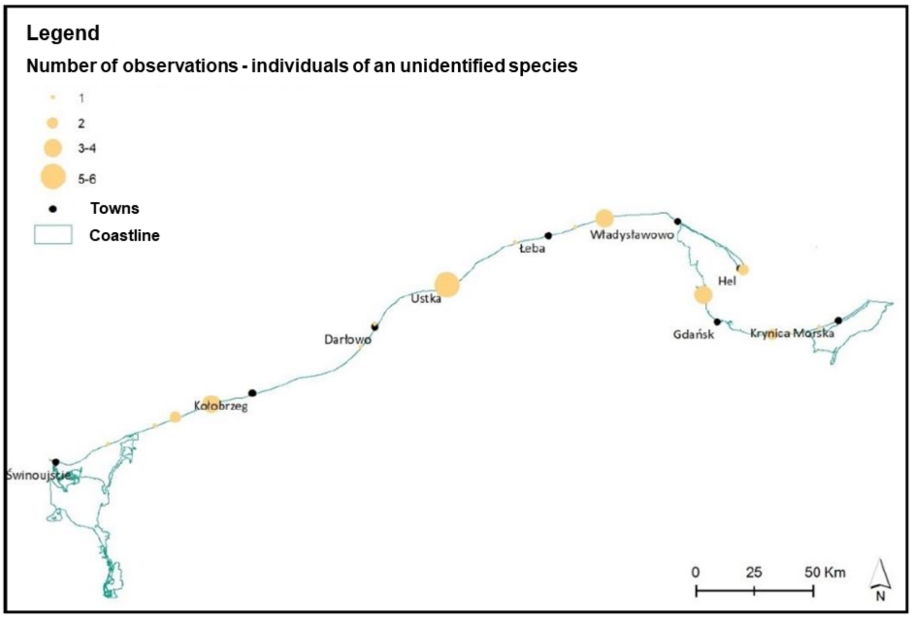

Figure 7.28. Observations of live seals unidentified as to the species in 2020–2023 [Source: WWF 2023]

In the Baltic Sea, seals migrate for exploration, feeding and breeding [Sjöberg and Ball 2000], covering long distances, up to 100 km per day [WWF, 2019; WWF, 2020]. Migration data come from tagging individuals with satellite transmitters. Data from transmitters indicate that seals use the entire area of the Polish part of the Baltic Sea [WWF 2019; WWF 2020] [Figure 7.29].

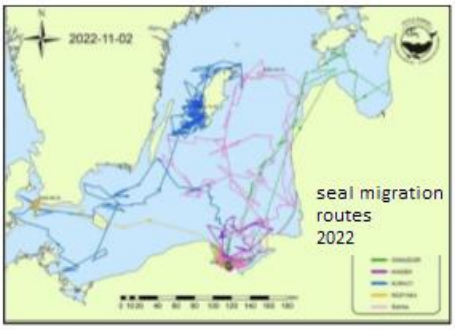

Figure 7.29. Migration routes of the juvenile grey seal in 2022 and 2023 [Source: press materials of the Hel Marine Station of the Institute of Oceanography at the University of Gdańsk, available online]

The data obtained during the State Environmental Monitoring, 'Pilot implementation of species and marine habitats monitoring in 2015–2018' and information collected in the WWF Poland database indicate that there is a seal colony in Polish sea areas [WWF 2019; WWF 2023b]. The so-called haul-out site, in which the animals congregate to rest, is located in the area of the Vistula Cut estuary. In 2016–2017, the herd of seals occurring in this area during the moulting season (in the summer) was found to total approximately 200 individuals [Opioła *et al.* 2017]. The haul-out site is situated approximately 160 km in a straight line from the Baltica-1 OWF location.

Available data on seal occurrence also originate from monitoring projects carried out for other proposed wind farms. Nine grey seal sightings were recorded during visual monitoring carried out from vessels in 2020–2022 for the nearby Bałtyk I OWF (west of the Baltica-1 OWF). The animals were recorded mainly during the autumn and to a lesser extent during the summer [Bałtyk I OWF EIA Report 2022]. A total of ten seal sightings were recorded during visual surveys conducted from vessels for the Baltic Power OWF (2018–2019). Grey seals and individuals unidentified as to species were recorded. The animals appeared in all seasons [Baltic Power OWF EIA Report 2020]. Seals were also recorded during the monitoring for the BC-Wind OWF (2020–2021). During surveys conducted from vessels, a total of 28 sightings were recorded, of which 21 were of the grey seal and the remaining ones – of individuals unidentified as to species. The animals were recorded in different periods of the year [BC-Wind OWF EIA Report 2021]. As part of the Bałtyk II OWF (2012–2013) and Bałtyk III OWF (2013–2014) projects, visual monitoring from an aircraft was conducted, during which few seal sightings were recorded. The animals were observed in the spring and autumn. The grey seal, the harbour seal, and individuals unidentified as to species were recorded [Plichta *et al.* 2014 and 2015].

<u>Occurrence in the Baltica-1 OWF Area and in the adjacent waters – monitoring results</u>

In order to investigate the level of 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. Visual monitoring took place between December 2022 and November 2023. Aerial surveys were conducted seasonally, during seven flights in total. Observations were conducted along designated transects covering the wind farm area and the buffer zone extending up to 4 km from the OWF, including both Polish and Swedish waters. Monitoring from a vessel was carried out opportunistically, during seabird surveys. 39 observation cruises were conducted in total. The observations took place along designated transects, taking into account the Baltica-1 OWF and the reference area located in Swedish waters, mainly within the Natura 2000 site *Hoburgs bank och Midsjöbankarna*.

The results of the monitoring carried out within the survey area and in the reference area showed the occurrence of seals in the analysed open sea zones in all seasons of the year [Figure 7.30 and Figure

7.31]. 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 recorded were not identified as to species. Regional differences were noted in the frequency of animal registration. The number of sightings was significantly higher in the survey 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 sighted in January, March and June 2023 [Figure 7.30]. In general, seal occurrences were found to be the most frequent in the winter season and the least frequent in the summer. In the spring and autumn, the number of animal sightings was similar [Figure 7.31].

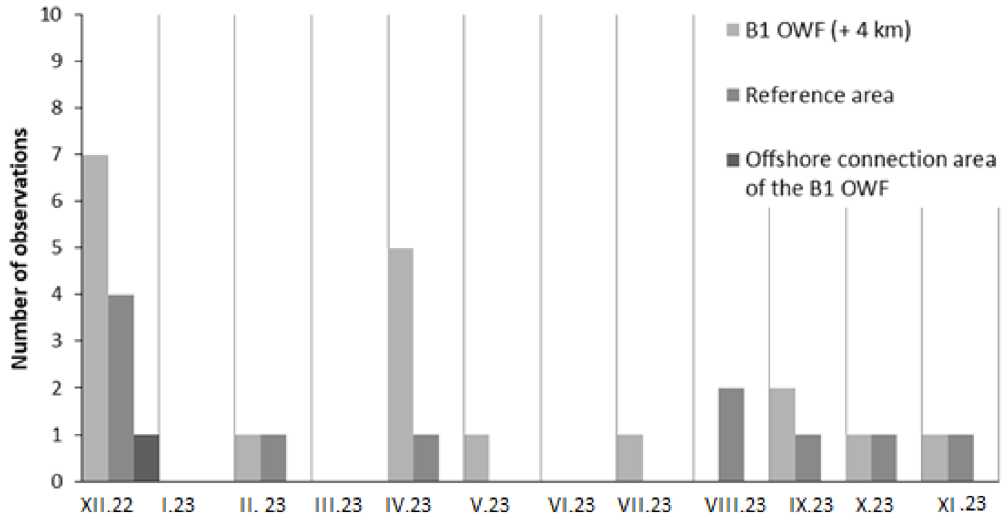

Figure 7.30. *Number of seal sightings during visual monitoring of marine mammals in the survey area between December 2022 and November 2023*

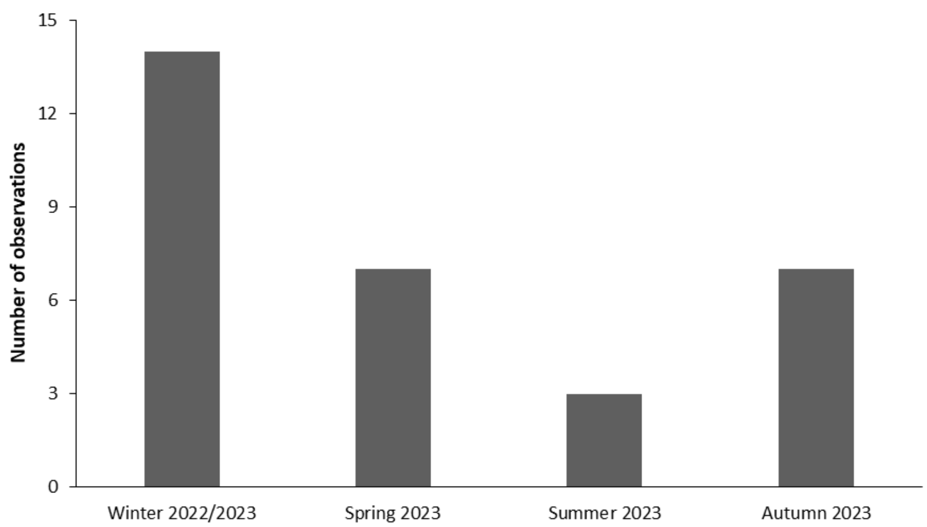

Figure 7.31. *Number of seal sightings during individual seasons of visual monitoring of marine mammals in the survey area between December 2022 and November 2023*

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 (Hel Marine Station of the Institute of Oceanography at the University of Gdańsk) in 2020–2023 confirms that the grey seal is the most abundant species in the PSA [WWF, 2023a]. It is worth noting that according to the WWF data, the grey seal was most frequently recorded east of Łeba.

The SEM data and information collected in the WWF Poland database indicate that there is a seal colony in Polish sea areas. The so-called haul-out site is situated in the area of the Vistula Cut estuary. Seals use it mainly during the moulting season, i.e. in summer. During that period, the abundance of these animals near the Vistula estuary is the highest [Opioła *et al.* 2017]. The proposed Baltica-1 OWF Area is located approximately 160 km in a straight line from the haul-out site. Based on the results obtained during the implementation of the Project under discussion, the occurrence of seals in the region surveyed is lowest in summer. This trend may be related to increased seal activity in the vicinity of the Vistula estuary, during the months in which moulting takes place. It can be suspected that seals congregate at the haul-out site during summer and their migration to the northern parts of the Polish EEZ is less frequent.

The results obtained for the Baltica-1 OWF Area can also be compared with available survey data for other proposed offshore wind farms, including the Bałtyk II OWF (2013–2014), the Bałtyk III OWF (2012–2013), the Baltic Power OWF (2018–2019), the BC-Wind OWF (2020–2021) and the Bałtyk I OWF (2020–2022). The monitoring surveys conducted for the aforementioned projects demonstrate that the open water region of the EEZ is used by the grey seal throughout the year. The frequency of the animal occurrence and their seasonal activity vary between the areas and years of surveys [Plichta *et al.* 2014 and 2015; Baltic Power OWF EIA Report 2020; BC-Wind OWF EIA Report 2021, Bałtyk I OWF EIA Report 2022]. Considering the high migratory capacity of the grey seal, mainly related to the search for suitable food supplies, it is probable that the differences recorded during the individual surveys result from food availability. The total number of seal sightings recorded during the year in the survey area (within the OWF and reference area) was most similar to the value recorded in the monitoring area for the BC-Wind OWF – in the central part of the Polish EEZ, south of the survey area. During monitoring from the vessel, 23 and 21 grey seal sightings were recorded in the aforementioned areas, respectively [BC-Wind OWF EIA Report 2021].

In conclusion, according to literature data, the area of the Southern Baltic waters is most frequently used by the grey seal, which was also observed during the surveys conducted for the Baltica-1 OWF project. The pre-investment surveys conducted for the proposed wind farms located in the open waters of the Polish EEZ indicate that the grey seal is present in the region throughout the year, and the seasonality of its occurrence differs between the 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 gathering of the animals around the haul-out site, in the area of the Vistula Cut estuary.

7.6.1.5 Migratory birds

The surveys of bird movements in the spring (March–May) and autumn (July–December) migration periods were carried out at two survey stations: MB_01 and MB_02 [Figure 7.32].

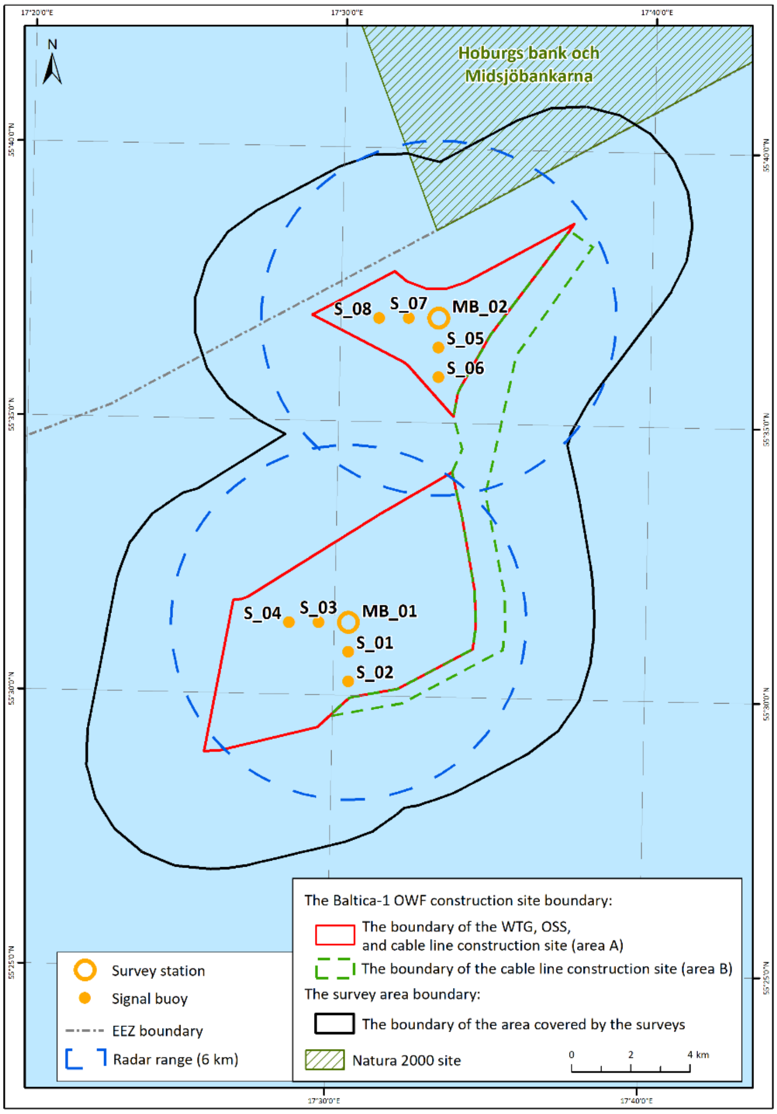

Figure 7.32. Location of survey stations as part of the surveys of bird movements during the spring and autumn migration periods

During the spring migration period, from March to the end of May 2023, 22 observation days were carried out at survey station MB_01 and 20 observation days at station MB_02. The inspections included visual observations, as well as horizontal and vertical radar tracking and acoustic monitoring.

During the autumn migration period, from July to the beginning of December 2023, 22 observation days were carried out at survey station MB_01 and 20 observation days at station MB_02. The inspections included visual observations, as well as horizontal and vertical radar tracking and acoustic monitoring.

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 in 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 7.9. The abundance of observations in categories identified only up to the order or family can be found in Table 7.10.

Table 7.9. Number of bird individuals identified up to the species, recorded during visual observations in spring and autumn 2023 and their national and international protection status

Common name	Binomial nomenclature	Number of individuals	Species protection in Poland[1]	Annex I of 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	
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	

Common name	Binomial nomenclature	Number of individuals	Species protection in Poland[1]	Annex I of the EU Birds Directive	IUCN[2]	HELCOM threat category[3]
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	
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	

Common name	Binomial nomenclature	Number of individuals	Species protection in Poland[1]	Annex I of the EU Birds Directive	IUCN[2]	HELCOM threat category[3]
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 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

Table 7.10. Number of bird individuals identified up to the species groups, recorded during visual observations in spring and autumn 2023

Species group	Binomial nomenclature	Number of individuals
Unidentified duck	*Anatinae indet.*	1571
Unidentified goose	*Anserini indet.*	1098
Unidentified auk	*Alca torda/Uria aalge*	792
Unidentified passerine	*Passeriformes indet.*	591
Unidentified wader	*Limicolae indet.*	444
Unidentified diver	*Gavia indet.*	252
Unidentified swan	*Cygnidae indet.*	94
Common/arctic tern	*Sterna hirundo/paradisea*	77

Species group	Binomial nomenclature	Number of individuals
Common/velvet scoter	*Mellanita indet.*	46
Unidentified tern	*Sternidae indet.*	13
Unidentified dunlin	*Calidris indet.*	11
Unidentified thrush	*Turdidae indet.*	7
Red-breasted merganser/goosander	*Mergus serrator/merganser*	4
Long-eared/short-eared owl	*Asio otus/flammeus*	2
Unidentified pipit	*Anthus indet.*	2
Unidentified skua	*Stercorariidae indet.*	2

For the purpose of the assessment of the Project impact on migratory birds, some species and categories were summed up at the family level (e.g. geese, gulls, terns) or at the order level (e.g. auks). Pigeons and the common swift were added up to all passerines due to similar migration phenology. Species representing the *Anatini* tribe were included in the category of dabbling ducks [Table 7.11].

Table 7.11. Number of individuals of particular groups of birds as well as autumn and spring migratory species observed during visual observations

No.	Common name	Binomial nomenclature	Number of observations			% of all observations
			Spring	Autumn	Total	
1	Long-tailed duck	*Clangula hyeamlis*	8294	1245	9539	39.53
2	Common scoter	*Mellanita nigra*	3015	789	3804	15.76
3	Auks	Alcidae	1508	514	2022	8.38
4	Unidentified ducks	Anatinae indet.	1101	470	1571	6.51
5	Passerines/pigeons	Passeriformes/Columbinae	662	852	1514	6.27
6	Geese	Anserinae	1186	251	1437	5.96
7	Charadriiformes	Charadriidae	700	117	817	3.39
8	Ducks	Anatini	424	363	787	3.26
9	Divers	Gaviidae	367	55	422	1.75
10	Great black cormorant	*Phalacrocorax carbo*	123	282	405	1.68
11	Little gull	*Hydrocoloeus minutus*	188	108	296	1.23
12	Lesser black-backed gull	*Larus fuscus*	217	79	296	1.23
13	Common gull	*Larus canus*	154	88	242	1.00
14	Velvet scoter	*Maellanita fusca*	175	55	230	0.95
15	Swans	Cygnidae	127	44	171	0.71
16	Terns	Sternidae	29	110	139	0.58
17	European herring gull	*Larus argentatus*	100	25	125	0.52
18	Red-breasted merganser	*Mergus serrator*	55	0	55	0.23
19	Black-headed gull	*Croicocephalus ridibundus*	35	16	51	0.21
20	Common/velvet scoter	*Mellanita indet.*	32	14	46	0.19
21	Common crane	*Grus grus*	34	10	44	0.18
22	Grey heron	*Ardea cinerea*	5	25	30	0.12
23	Birds of prey/owls	Accipitriformes/Strigiformes	16	3	19	0.08

No.	Common name	Binomial nomenclature	Number of observations			% of all observations
			Spring	Autumn	Total	
24	Great black-backed gull	*Larus marinus*	12	7	19	0.08
25	Great egret	*Ardea alba*	17	0	17	0.07
26	Skua	Stercorariidae	8	6	14	0.06
27	Other observations		15	3	18	0.07
Final sum			**18 599**	**5531**	**24 130**	**100.00**

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 7.12]. 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 pronounced in the survey area than the autumn migration. The autumn migration was more abundant only 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 7.12. Estimate of migration intensity of the most abundant birds migrating through the survey area in spring and autumn

Common name	Binomial nomenclature	Abundance of the biogeographical population	Abundance of the Baltic population	Estimate of migration intensity (number 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	Paseriformes/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
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	*Chroicocephalus ridibundus*	4 770 000	1 350 000	1008	951	1958
Swans	Cygnidae	300 000	100 000	1100	485	1584

Common name	Binomial nomenclature	Abundance of the biogeographical population	Abundance of the Baltic population	Estimate of migration intensity (number of individuals)		
				Spring	Autumn	Total
Skua	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 7.13]. Only in the case of the common crane were all the observed flights recorded above 20 MASL, while in the case of geese this was close to 75%. No significant difference in the proportion of birds flying below and above 20 MASL was identified in the case of Charadriiformes and swans. Similar results were obtained in the case of other OWFs in that area [Bednarska *et al*., 2017; EIA Report for the Baltic Power OWF 2020; EIA Report for the Bałtyk Środkowy II OWF; EIA Report for the Bałtyk Środkowy III OWF; EIA Report for the BC-Wind OWF]. It should be remembered that the flight altitudes obtained from visual observations represent only a part of all the birds flying 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 with 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 7.13. 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
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	Skua	Stercorariidae	78.6	21.4

No.	Common name	Binomial nomenclature	Below 20 MASL (%)	Above 20 MASL (%)
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 and 11 456 calls of 41 bird species and categories were identified. Among passerines, the common blackbird, the redwing, the European robin and the song thrush were most frequently identified during night hours, and the white wagtail, the goldcrest, the Eurasian blue tit, the great tit and the common chaffinch were most frequently identified during daylight hours [Table 7.14]. Three species of Charadriiformes were also identified – the common snipe during night hours, the green sandpiper during daylight hours and the Eurasian curlew both during the day and at night. In spring, similarly as in autumn, the calls of gulls dominated. Both in spring and autumn, the vast majority of the calls was recorded in the daylight hours.

Table 7.14. Bird calls identified on the basis of 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
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

No .	Common name	Binomial nomenclature	Day/Night (time of recording)	Spring	Autumn	Total
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 determining the flight direction during migration of individual species or groups of species. In spring, 9214 flight paths were recorded in total for 88 species and 23 categories of birds unidentified as to species, while in autumn 2968 flight paths were recorded for 81 species and 15 categories in cases where identification as to the species was impossible. The analyses carried out using the horizontal radar indicate fairly uniform directions of migratory birds both in spring (N–E direction) and in autumn (W–S direction) [

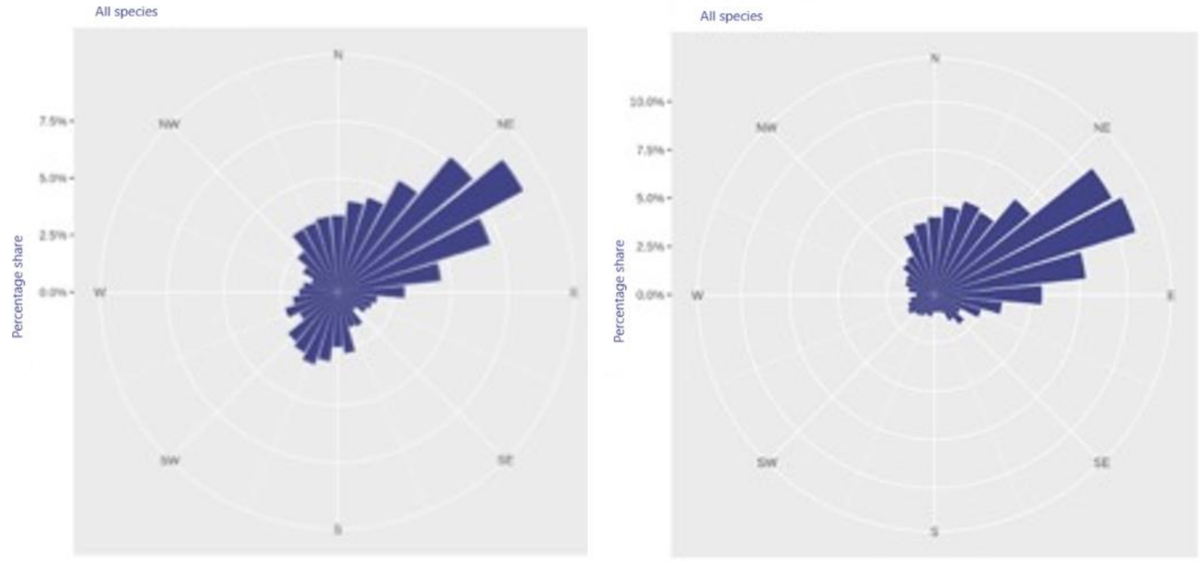

Figure 7.33 and

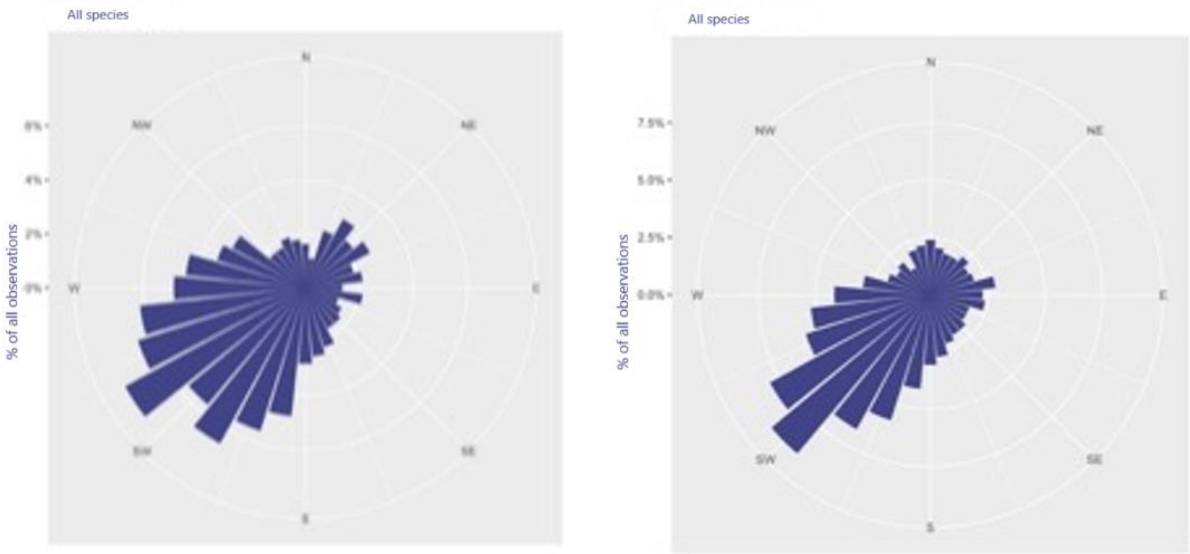

Figure 7.34]. Some of the groups and bird species subject to tracking flew in the direction opposite to the main direction of migration. This situation was observed for gulls, auks and divers, which may be due to the fact that not all radar-tracked birds belonging to those groups were migrating at the 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, which remained in the Baltic coastal waters area all year round. The migration patterns observed are comparable to the flight directions recorded during spring and autumn surveys at other OWFs in that area [Bednarska *et al*., 2017; EIA Report for the Baltic Power OWF 2020; EIA Report for the Bałtyk Środkowy II OWF; EIA Report for the Bałtyk Środkowy III OWF; EIA Report for the BC-Wind OWF].

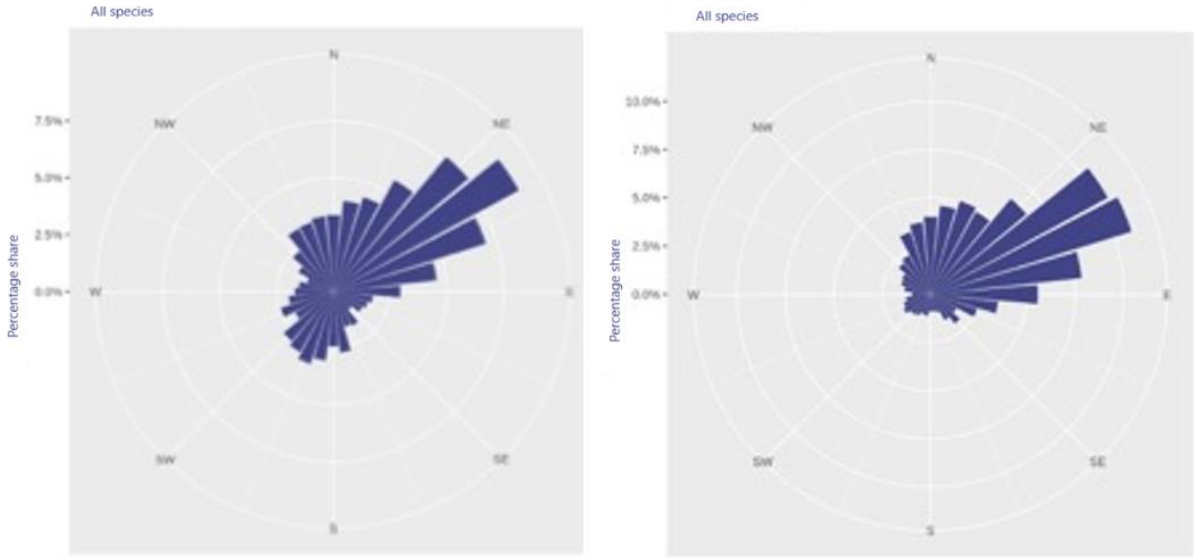

Figure 7.33. Flight directions of all the birds recorded at survey station MB_01 (left) and MB_02 (right) during the spring migration period

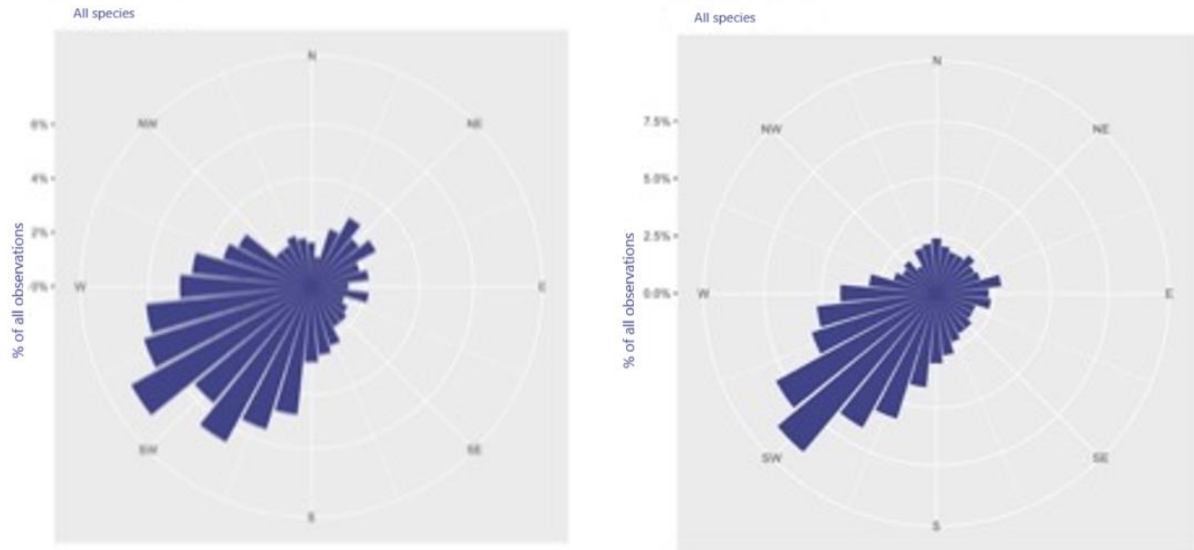

Figure 7.34. Flight directions of all the birds recorded at survey station MB_01 (left) and MB_02 (right) during the autumn migration period

In further analyses for the purposes of the modelling of collision risk and the 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 significance 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 7.15. The above information was the basis for the significance assessment of the Baltica-1 OWF impact on migratory birds.

During the migratory bird surveys in spring and autumn 2023, the common scoter and the long-tailed duck were the two most abundant species. Based on the migratory flux analyses, in spring 7.51% and in autumn 15.48% of the biogeographical population of the common scoter may fly over the OWF Area [Table 7.15]. In the case of the long-tailed duck, these values represent 7.12% and 1.46% of the biogeographical population in spring and autumn, respectively. This relatively intense migration of the common scoter in the early autumn months (July) is related to moulting. Shortly after breeding, the males head towards resting places where they become flightless during moulting. Since in the case of surveys in other OWF areas the monitoring of birds migrating in autumn started mostly in August, it is impossible to compare the high flight values obtained for the common scoter in July in the survey area. While the long-tailed duck was recorded in large numbers during both spring and autumn surveys, the common scoter was only observed in greater numbers during the spring months (with the exception of the observations carried out 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, the Pomeranian Bay and the Gulf of Gdańsk. Common scoters nesting on the coasts of Sweden and Finland follow the coast westwards 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; EIA Report for the Baltic Power OWF 2020; EIA Report for the Bałtyk Środkowy II OWF; EIA Report for the Bałtyk Środkowy III OWF; EIA Report for the BC-Wind OWF].

The long-tailed duck was recorded in great numbers both in spring and autumn, however, notably 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 [*ibidem*], 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 are located in sandy shallows, the Hoburgs Bank, northern and southern Midsjo Bank and the Słupsk Bank [Baltic Power OWF EIA Report, 2000; 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; EIA Report for the Baltic Power OWF 2020; EIA Report for the Bałtyk Środkowy II OWF; EIA Report for the Bałtyk Środkowy III OWF; EIA Report for the BC-Wind OWF].

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 [*ibidem*].

Table 7.15. Species and groups of species included in the analyses for the purposes of this report including 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 (number of individuals)	Proportion of the biogeographical population (%)	Proportion of the Baltic population (%)	Species significance
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	*Paseriformes/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	Medium
				Autumn	1006	0.25	11.69	
Little gull		72 000	50 000	Spring	3221	4.47	6.44	High

Common name	**Binomial nomenclature**	**Abundance of the biogeographical population**	**Abundance of the Baltic population**	**Migration season**	**Estimate of migration intensity (number of individuals)**	**Proportion of the biogeographical population (%)**	**Proportion of the Baltic population (%)**	**Species significance**
	Hydrocoloeus minutus			Autumn	2718	3.77	5.44	
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	
Skua	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	

7.6.1.6 Seabirds

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 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 Baltica-1 OWF Development Area including a 4 km wide buffer zone and in a reference area with similar environmental conditions. The surveys took place between December 2022 and the end of November 2023. Detailed survey results for both areas were included in the final report on the surveys of biotic elements of the marine environment (Appendix 1 to the EIA Report).

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 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), 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). 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 publication mentioned 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 7.16].

Table 7.16. List of seabird species and waterbird species rarely encountered at sea which were present in the survey area and in 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]	CLPP 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

No.	Species	Species protection in Poland[1]	Annex I to the EU Birds Directive[2]	CLPP threat category[3]	IUCN threat category[3]	HELCOM threat category[3]
9	great black-backed gull *Larus marinus*	SP	NO	-	LC	-
10	common gull *Larus canus*	SP1	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*	SP1	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*	SP1	NO	LC	LC	-
21	red-breasted merganser *Mergus serrator*	SP1, 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; Pursuant to 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, RU – regionally unclassified.

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 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 was 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 were found unidentified to the species (unidentified divers, gulls and Anatidae) [Table 7.17]. 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 included in Appendix 1 to the EIA Report.

Table 7.17. Abundance and proportion in the group of individual bird species sitting on the water, found in the survey area along the cruise route during 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
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 survey area were the long-tailed duck and the European herring gull, 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. Abundant presence of the European herring gull in offshore areas away from the coast is typical, since they accompany fishing vessels, congregating in areas of fishing activity [Garthe *et al.*, 2003].

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 summer, 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 survey area was low in summer.

Three species were observed in greatest abundances 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 of birds 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 7.35].

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). 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. Without additional survey campaigns during the spring migration period, it cannot be fully resolved whether it was a one-off occurrence caused by, for example, a sudden deterioration of weather conditions during migration, which may have forced the migrating birds to stop their flight, or whether the birds regularly use the survey area as a stopover site on their migration route. Similarly, it would be necessary to confirm whether the post-breeding concentrations of the common guillemot observed in that area in the summer and autumn are a recurrent phenomenon or whether the grouping of these birds occurred there once.

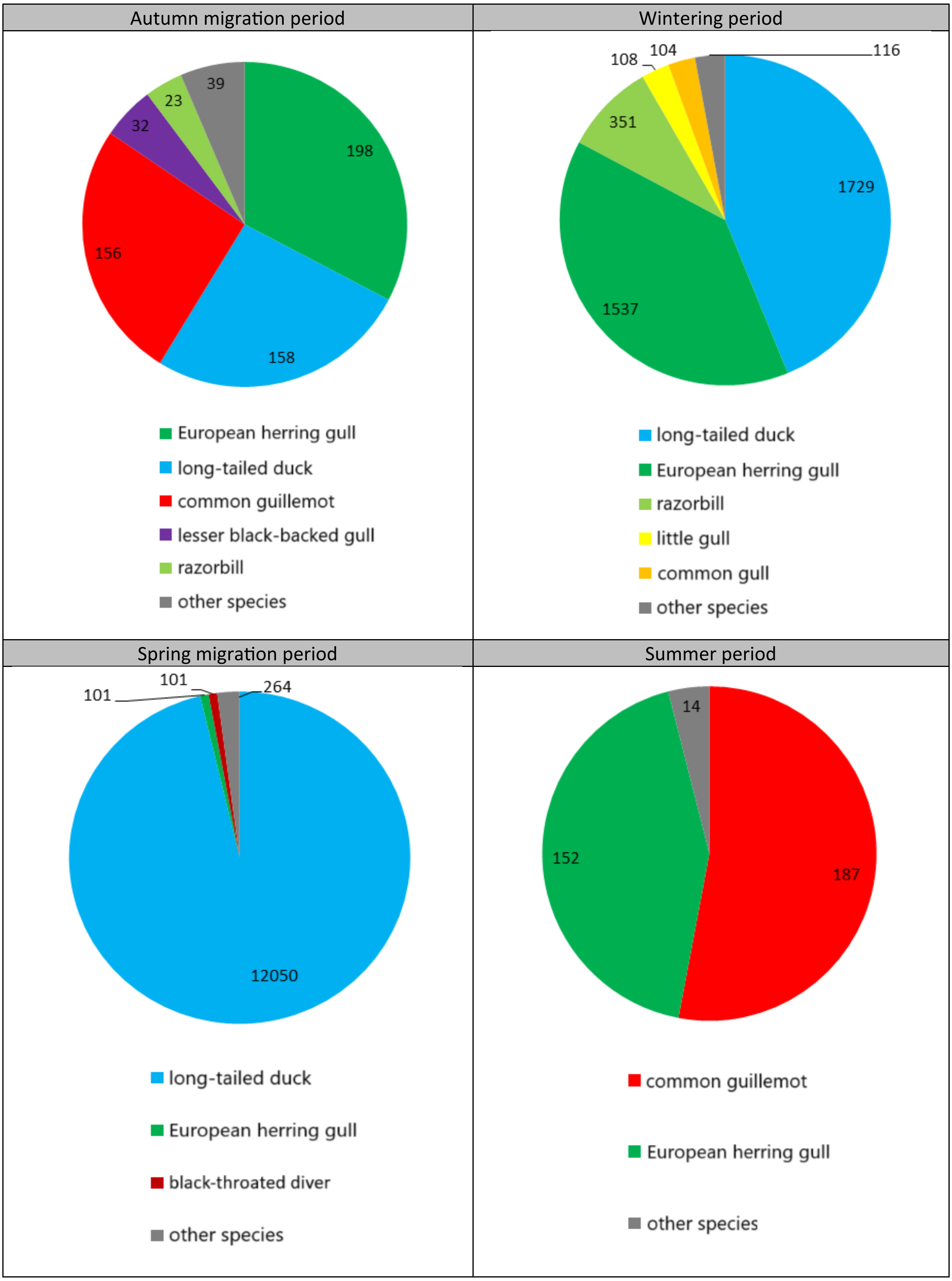

Figure 7.35. *Share of the prevailing species of birds sitting on the water in the entire group of birds in the survey area throughout the entire period from December 2022 to the end of November 2023*

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 period, 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% proportion in the grouping. Additionally, 16 individuals were found unidentified to the species (unidentified divers and Anatidae) were found [Table 7.18]. 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 included in Appendix 1 to the EIA Report.

Table 7.18. Abundance and proportion in the group of individual bird species sitting on the water, found in the reference area along the cruise route during 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	white-billed diver *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
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 survey area, the most abundant species recorded was the common guillemot, which constituted 61% of the bird 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 birds 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.

Waterbird distribution and densities in the sea areas surveyed

The results of the avifauna observations covering four phenological periods showed that the 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. Without repeating the survey over one more season, it is impossible to state unambiguously whether the shallowest part of the survey area is a regularly used stopover site for the long-tailed duck and the black-throated diver during their migration towards breeding grounds, or whether their concentrations observed on one occasion were caused by weather conditions that forced the birds to temporarily stop their migration. 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 over 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 survey area. In the reference area, densities ranging from 10 to 50 ind./km^2 prevailed; such values were recorded for approx. 70% of the surface of this sea area. On the other hand, in the 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 7.36].

During the spring migration, the average densities of the entire bird grouping were higher in the 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 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 7.37].

In summer, the average densities of the entire bird grouping in the survey area and in 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 survey area, in its western fragment. Contrary to the other phenological periods, during 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 7.38].

During the autumn migration period, the average densities of the entire avifauna grouping were higher in the 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 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 7.39].

A detailed analysis of the distribution of bird species by phenological period can be found in Appendix 1 to the EIA Report. The spatial distribution of the average densities of all waterbirds in both sea areas surveyed is illustrated in Figure 7.36–Figure 7.39.

Species of seabirds included in the 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, whose abundance proportion in the survey area and in 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*, as well as gulls: the European herring gull *Larus argentatus*, the common gull *Larus canus*, the lesser black-backed gull *Larus fuscus* and the little gull *Hydrocoloeus minutus* [Table 7.17 and Table 7.18]. 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.

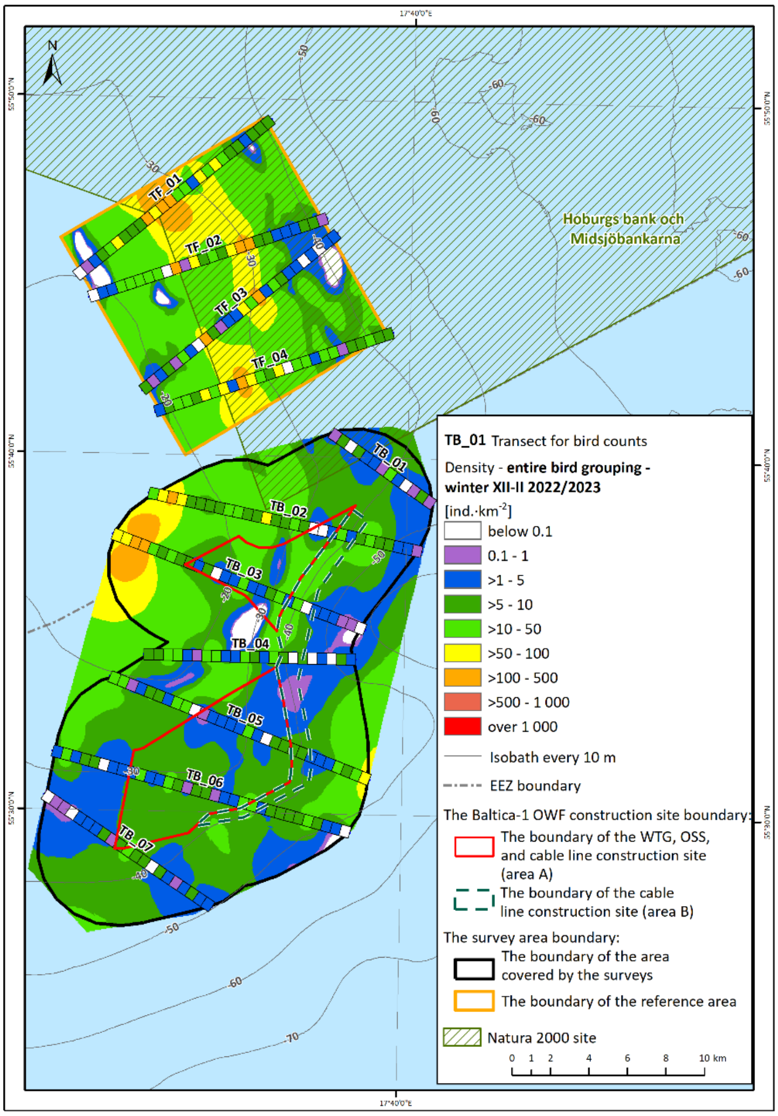

Figure 7.36. Spatial distribution of the average densities of all waterbirds in the areas surveyed during the wintering period

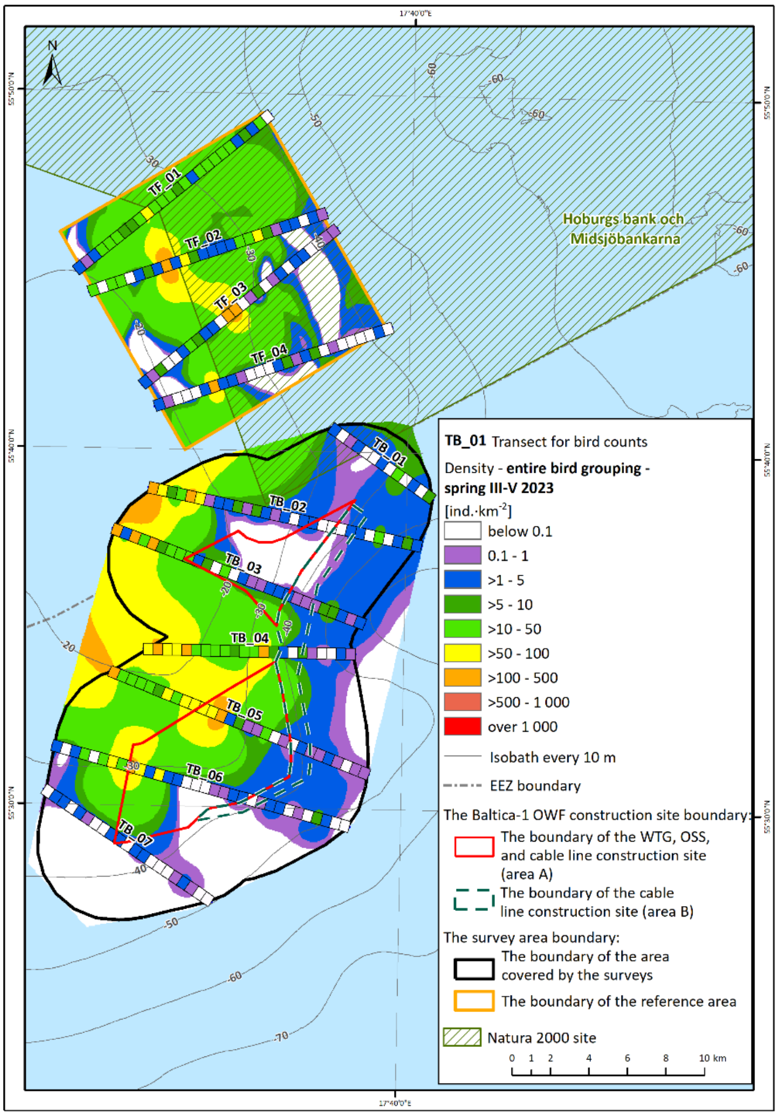

Figure 7.37. Spatial distribution of the average densities of all waterbirds in the areas surveyed during the spring migration

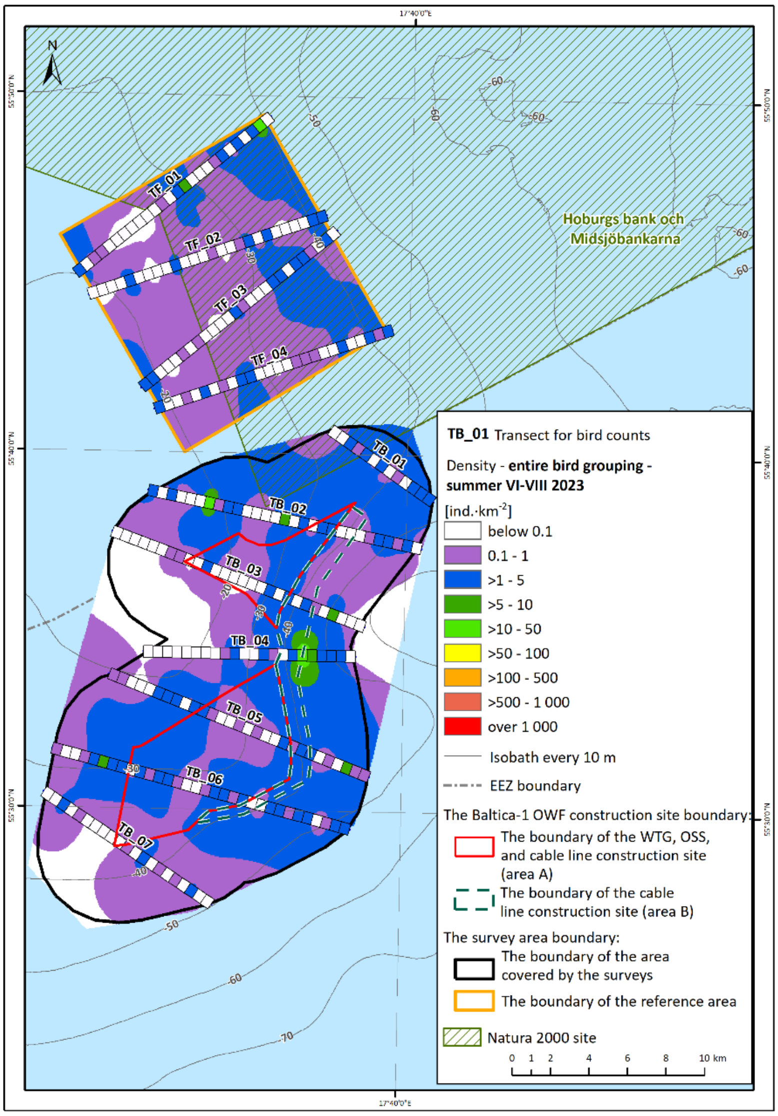

Figure 7.38. Spatial distribution of the average densities of all waterbirds in the areas surveyed during the summer period

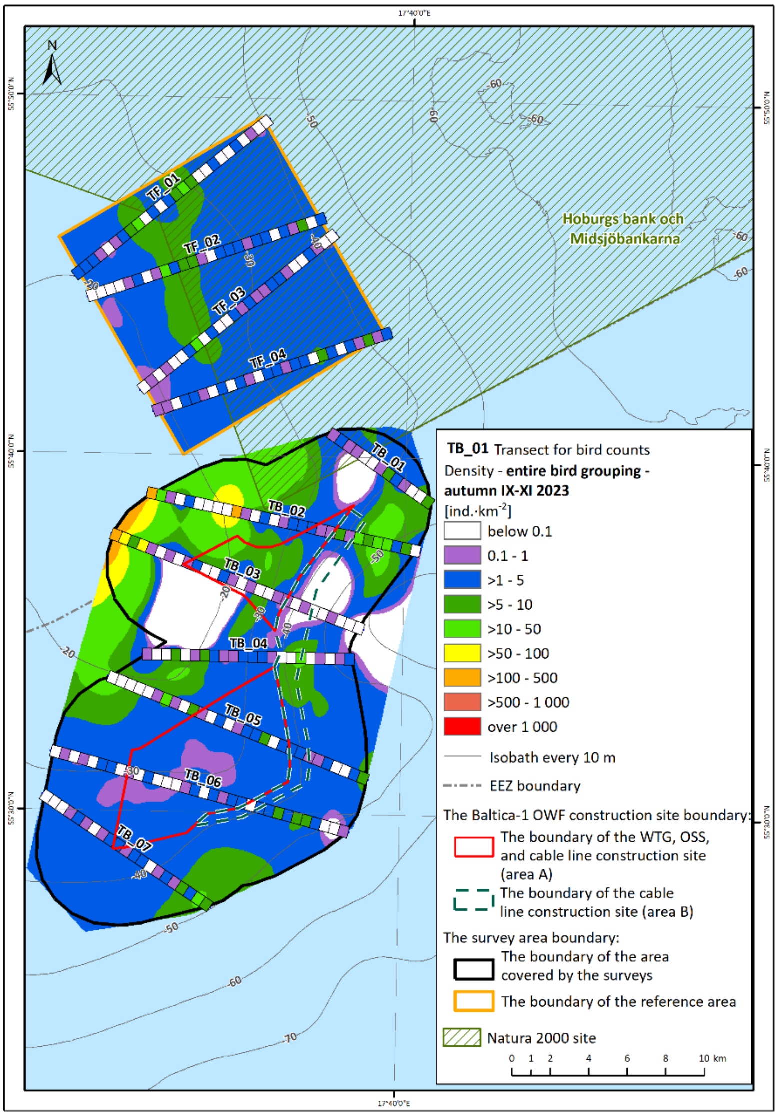

Figure 7.39. Spatial distribution of the average densities of all waterbirds in the areas surveyed during the autumn migration

The species under protection within the Natura 2000 site *Hoburgs bank och Midsjöbankarna* 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 recorded during the year-long survey cycle of the 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 OWFs. These are:

1. benthivorous birds:
   - the long-tailed duck *Clangula hyemalis,*
   - the common scoter *Melanitta nigra;*
2. piscivorous birds:
   - the razorbill *Alca torda,*

- the common guillemot *Uria aalge,*
- the black guillemot *Cepphus grylle,*
- the black-throated diver *Gavia arctica;*

3. gulls:
   - the European herring gull *Larus argentatus,*
   - the little gull *Hydrocoloeus minutus,*
   - the common gull *Larus canus,*
   - the 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 survey areas. 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 in waste generated as a result of fish catching and processing on fishing boats [Garthe, 1997; Garthe, 2003; SMDI, 2015]. Because of that, 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.

7.6.1.7 Bats

Bat activity recordings were made in 2023 as part of 35 all-night inspections during two bat migration seasons (April–May and August–October). The inspections covered a transect comprising four linear sections within the area surveyed and the buffer strip with a width of 1 nautical mile as well as acoustic monitoring at four fixed points. The presence of bats was established on the basis of recordings made using specialist recording equipment in favourable weather conditions. Figure 7.40 and Figure 7.41 show the location of survey transects and monitoring points during the spring and autumn surveys.

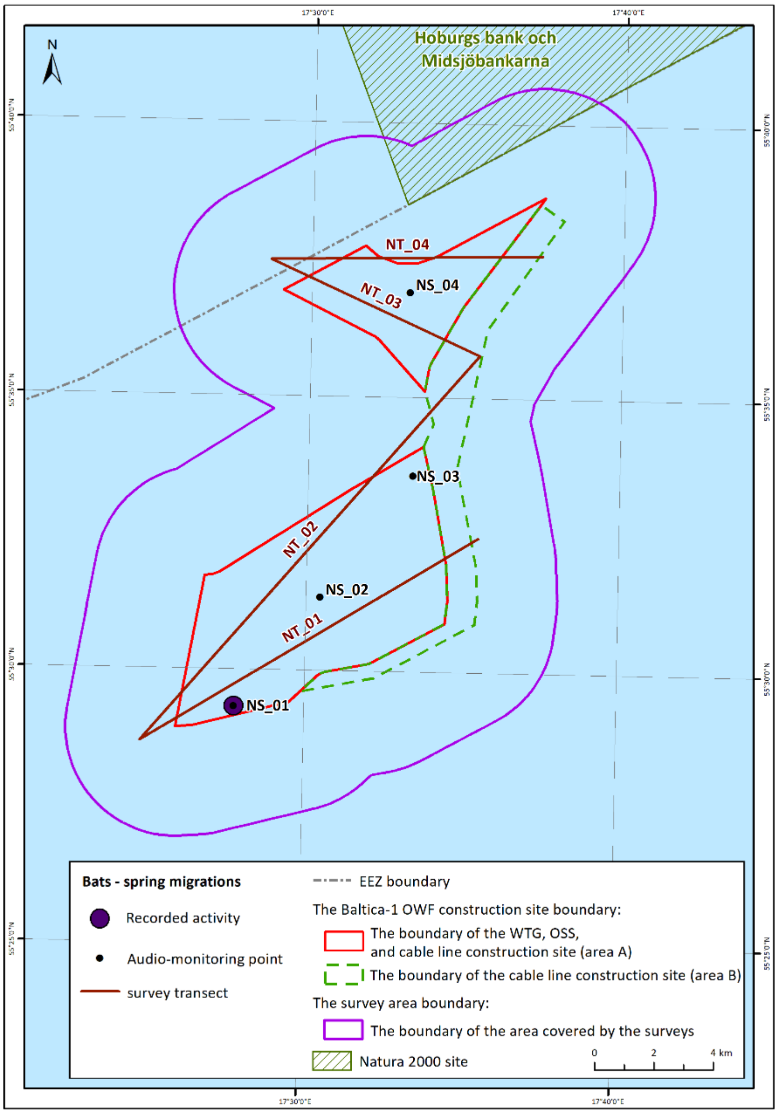

Figure 7.40. *Location of survey transects and bat monitoring points during spring migration surveys in the survey area*

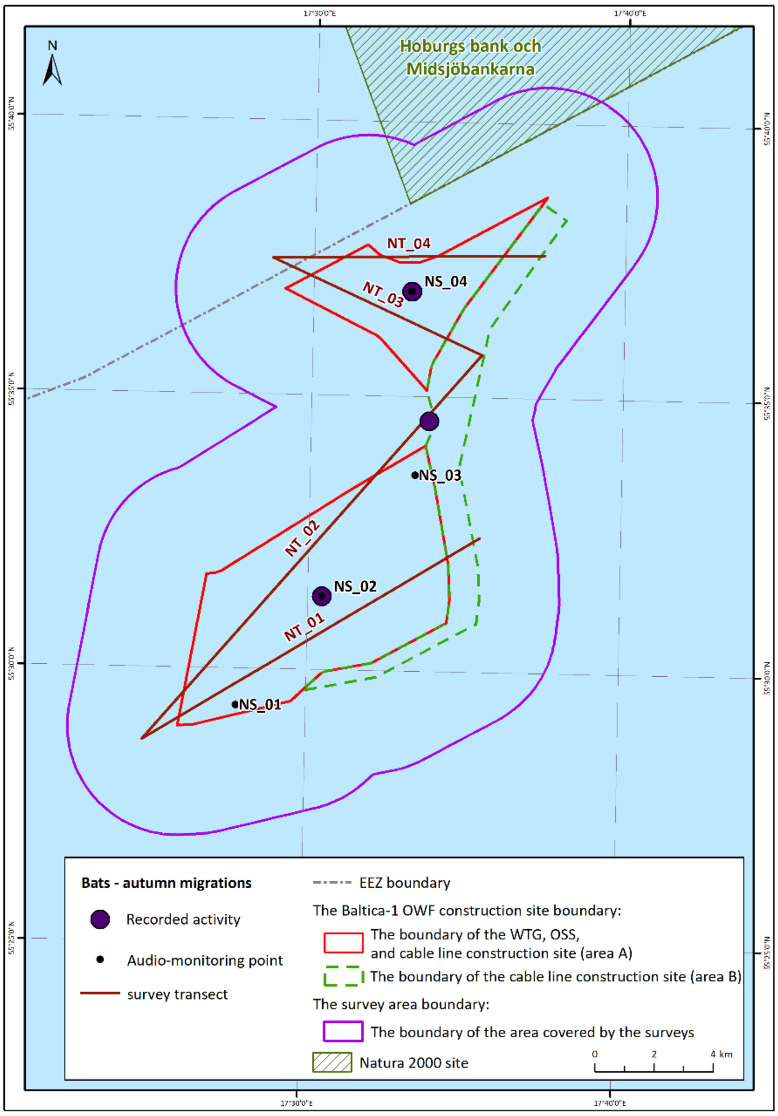

Figure 7.41. Location of survey transects and bat monitoring points during autumn migration surveys in the survey area

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 northern lake district belt, the northern bat is worth mentioning, found 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 occurrence of bats at a considerable distance from the shore is not a result of a search for feeding grounds [Ahlen *et al*., 2007; Ahlen I. 2009; Poerink B.J. 2013]. Nowadays, quite a few surveys for potential offshore projects confirm that the Baltic Sea region plays a significant role during the migration period of European bats [Gaultier *et al*., 2020].

The bat species recorded are classified as long-distance migrants, especially the Nathusius' pipistrelle, covering over two thousand kilometres during migrations [Peterson, 2004; Hutterer *et al*., 2005], is usually the most abundant species recorded [Rydell 2014].

Spring migration

During spring migrations, four activity units for the Nathusius' pipistrelle were recorded at monitoring point NS_01.

Autumn migration

During acoustic monitoring, a total of 107 activity units of bats from four species were recorded. Only one signal was recorded at transect NT_02, while the remaining signals were recorded at monitoring points NS_02 and NS_04. The common noctule dominated and the northern bat was the second abundant species.

7.6.1.8 Biodiversity

As shown by the results of the environmental inventory surveys, a synthesis of which can be found in Sections 7.6.1.1–7.6.1.7, and a detailed analysis in Appendix 1 of the EIA Report, the animal species composition was typical of open Baltic waters, the seabed of which is mainly covered by sandy sediments with overlying boulder areas. Due to the depth ranging from approximately 15 m to approximately 50 m, no **phytobenthos**, neither in the form of vascular plants nor macroalgae, was identified in the survey area. Vascular plants were not identified in the open waters of the Polish sea areas; their range is limited to shallow and calm bays. In the case of macroalgae, they were identified at depths of more than 20 m, i.e. up to the euphotic zone extent, but the presence of hard substrate (e.g. boulders) in this zone, which they can overgrow, is also a determinant of their occurrence. In the case of the survey area, the boulder areas occurred at greater depths where the amount of sunlight necessary for the development of periphytic flora was too low.

In the case of the soft bottom, 29 **macrozoobenthos** taxa belonging to two phyla and seven classes were recorded. The most common taxa were the small psammophilous polychaete *Pygospio elegans*, considered to be an indicator of a clean or medium clean seabed, which includes sediment with a small admixture of organic matter, and one species of bivalve, *Macoma balthica*, which constitutes food for many species of ducks (e.g. the common scoter and the common eider) and fish, such as flounder and viviparous eelpout. Only seven taxa of periphytic and phytophilic fauna were found on the hard bottom, which occurs in points in the northern part of the survey area, indicating the poor qualitative and quantitative composition of this community. In terms of abundance and biomass, the hard bottom benthic fauna was dominated by bivalves, bay mussels *Mytilus trossulus*. Neither dense bay mussel aggregations nor a diverse periphytic fauna were found in places where the hard bottom macrozoobenthos occurs. Neither rare nor protected species were found.

The results of ichthyological surveys indicated the presence of 15 taxa of **ichthyofauna**. Cod and flounder dominated, while great sand eel, plaice, shorthorn sculpin, fourhorn sculpin, pogge, mackerel, twaite shad, turbot, sprat, herring, lumpfish and lesser sand eel were less abundant. Four of the taxa recorded within the 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).

Marine mammal surveys indicated the presence of porpoises (audio detections) and grey seals (visual observations) in the area, as well as several seals unidentified as to the species. The highest number of porpoise detections were recorded in summer and early autumn, while seal sightings were most frequent in autumn and winter. All marine mammal species are under strict protection.

Avifauna surveys indicated that the survey area is used by birds throughout the year. The highest number of observations took place during the spring and autumn migration periods, when long-tailed ducks and the common scoter, passerines including pigeons, auks, geese, Charadriiformes, dabbling ducks and the common gull were most abundant. During the wintering period, long-tailed ducks and European herring gulls were the most abundant. During summer, the number of birds observed was very low compared to other periods of the year. The vast majority of observations were of the common guillemot and the European herring gull, while other species were very rarely identified. A total of 105 bird taxa were identified in the avifauna surveys, of which 89 were assigned to the species. Most of them are under strict or partial protection.

Bats identified during acoustic monitoring were classified into four species: the common noctule, the northern bat, the parti-coloured bat and the Nathusius' pipistrelle. Bats migrate during spring and autumn and were recorded in the survey area during these periods, although their detections were not very numerous. All recorded bat species are under strict protection.

7.7 PROTECTED AREAS AND THE SUBJECTS OF PROTECTION IN THESE AREAS

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].

Table 7.19 contains information on natural habitats and Table 7.20 on species of animals included in the Standard Data Form for the area

Table 7.19. Basic information on natural habitats present in the Hoburgs bank och Midsjöbankarna (SE0330308) site [Source: internal materials based on Standard Data Form for Natura 2000 site (2016)]

Habitat code	Name of habitat	Surface [ha]	Representativeness[1]	Relative surface[2]	Conservation status[3]	General assessment[4]
1110	sublittoral sandbanks	220 000	B	B	B	B
1170	reefs	20 000	B	C	B	B

[1]*Classification scheme for the representativeness assessment: A: excellent, B: good, C: significant, D: negligible representativeness*

[2] *Class ranges: A: 100 ≥ p > 15%, B: 15 ≥ p > 2%, C: 2 ≥ p > 0%*

[3]*Classification scheme for the conservation status assessment: A: excellent, B: good, C: average or reduced status*

[4]*Classification scheme for the general assessment: A: excellent, B: good, C: significant*

Table 7.20. Basic information on seabirds and the harbour porpoise present in the Hoburgs bank och Midsjöbankarna (SE0330308) site [Source: internal materials based on Standard Data Form for Natura 2000 site (2016)]

Species	Population type	Assessment of the area for the population*	Population size in the area [number of individuals]		Proportion of the wintering/migratory population
			minimum	maximum	
black guillemot *Cepphus grylle*	wintering	C	1000	5000	5.1–25.5%
long-tailed duck *Clangula hyemalis*	wintering	A	200 000	1 000 000	13.3–66.7%
common eider *Somateria mollissima*	passing	C	5000	50 000	0.005–5%
harbour porpoise *Phocoena phocoena*	mobile	A	100	100	20%

**class ranges: A: 100 ≥ p > 15%, B: 15 ≥ p > 2%, C: 2 ≥ p > 0%; area assessment for population D (species which are not the subject of protection in the area)*

*** values calculated on the basis of data from the SDF for Hoburgs bank och Midsjöbankarna (SE0330308)*

A number of threats with negative 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), 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).

Natura 2000 site ***Słupsk Bank* (PLC990001)**, located 59 km from the boundary of the Project area, may be within the range of the Project impacts. The area includes a subsea bank with a seabed significantly shallower than the areas surrounding it. 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 south-eastern 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 are 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 which 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*). Additionally, also birds, black-throated diver (*Gavia arctica*) and red-throated diver (*Gavia stellata*) as well as the porpoise (*Phocoena phocoena*) occur in the area. Due to the lowest assessment of the population abundance – D, these three species are not subjects of protection in the area [SDF 2024]. Table 7.21 contains information on natural habitats and Table 7.22 on species of animals included in the Standard Data Form for the area

Table 7.21. Basic information on the natural habitats within the Słupsk Bank (PLC990001) site [Source: internal materials based on the Standard Data Form for the Słupsk Bank PLC990001 (SDF 2024)]

Habitat code	Name of habitat	Surface [ha]	Representativeness[1]	Relative surface[2]	Conservation status[3]	General assessment[4]
1110	sublittoral sandbanks	30 926.65	A	A	A	A
1170	reefs	14,331.60	A	A	A	A

[1]Classification scheme for the representativeness assessment: A: excellent, B: good, C: significant, D: negligible representativeness

[2] Class ranges: A: 100 ≥ p > 15%, B: 15 ≥ p > 2%, C: 2 ≥ p > 0%

[3]Classification scheme for the conservation status assessment: A: excellent, B: good, C: average or reduced status

[4]Classification scheme for the general assessment: A: excellent, B: good, C: significant

Table 7.22. Basic information on seabirds and the porpoise occurring within the Słupsk Bank (PLC990001) site [Source: internal materials based on the Standard Data Form for the Słupsk Bank PLC990001 (2024)]

Species	Population type	Evaluation of the area for the population*	Population size in the area [number of individuals]		Proportion of the wintering/migratory population
			minimum	maximum	
black guillemot *Cepphus grylle*	wintering	C	98	556	0.5–2.8%
	passing	C	72	461	0.4–2.3%
long-tailed duck *Clangula hyemalis*	wintering	B	101 148	231 180	6.7–15.4%
	passing	B	76 440	214 374	5.1–14.3%
black-throated diver *Gavia arctica*	wintering	D	93	173	below 0.15%**
red-throated diver *Gavia stellata*	wintering	D	28	66	below 0.02%**
velvet scoter *Melanitta fusca*	wintering	B	5565	23 611	1.5–6.3%
	passing	C	910	1789	0.2–0.5%
harbour porpoise *Phocoena phocoena*	passing	D	no data available	no data available	unknown

**class ranges: A: 100 ≥ p > 15%, B: 15 ≥ p > 2%, C: 2 ≥ p > 0%; area assessment for population D (species which are not the subject of protection in the area)*

*** values calculated on the basis of data from the SDF for Ławica Słupska PLC990001 site (2024)*

Sublittoral sandbanks (1110) habitat within the PLC990001 site has the form of submerged, irregularly shaped shallows of high naturalness, formed mainly of sandy sediments. The seabed covered with sandy sediments of the Słupsk Bank is located at a depth of about 12 to about 35 m in the south-western part. The conventional boundary of habitat 1110 is the 20 m isobath. Species typical for the habitat are benthic invertebrates: *Bathyporeia pilosa*, *Mya arenaria*, *Pygospio elegans* and *Cerastoderma glaucum*. There are no rooted plants nor macroalgae.

Reefs (1170) habitat within the PLC990001 site is formed by an accumulation of postglacial boulders located in its north-western part and stretching at a depth of approximately 8 m. The habitat is highly natural and versified in terms of plant and animal taxonomy. The species typical for the habitat are macroalgae: *Furcellaria lumbricalis*, *Ceramium* spp. and *Vertebrata fucoides* as well as phytophilic fauna: *Amphibalanus improvisus*, *Einhornia crustulenta*, *Mytilus trossulus* and scuds of the genus *Gammarus* [SDF 2024].

7.8 WILDLIFE CORRIDORS

Pursuant to the Nature Conservation Act of 16 April 2004 (consolidated text, Journal of Laws of 2023, item 344), a wildlife corridor is an area which allows migration of plants, animals or fungi. More specifically, these are interconnected and overlapping areas enabling free migration of species for the purpose of maintaining their spatial range and spreading their populations. Wildlife corridors can form a system of areas subjected to low anthropogenic pressure and highly natural character, but they can also be highly urbanised areas, which nevertheless allow the movement of species. The basic criterion for the existence of a wildlife corridor is the passability of migration routes.

In the Baltic Sea area, the occurrence and spatial extent of wildlife corridors has not been determined. This is understandable as the sea area, unlike the terrestrial area, is not characterised by significant terrain obstacles and a high amplitude of physico-chemical parameters for the migration and dispersal of species populations. In a sea area, there are two important factors restricting the freedom of species to migrate and colonise new areas – salinity and oxygenation levels. Both these parameters change in a vertical profile, being characterised by a constant annual pattern or amplitude of change. Additionally, in the case of aquatic plant species, the extent of the euphotic zone is equally important, and for periphyton species such as bay mussel and macroalgae, also the presence of the so-called hard bottom. Nonetheless, salinity and water oxygenation remain the cardinal factors determining the extent of species population. As their values are generally characterised by a depth gradient, a possible attempt to designate wildlife corridors should also be based on changes in the bathymetry of the sea basin. Hence the objective difficulty in identifying marine wildlife corridors.

A separate aspect of marine wildlife corridors is bird migration areas. In this case, the sea area, and in fact the air space above it, is part of the route that birds follow from their breeding grounds to their wintering sites in autumn, and vice versa in spring. As demonstrated by bird migration surveys carried out for offshore wind farms in the Baltic Sea, migrations generally take place from north-east to south-west during autumn migration, and vice versa during spring migration. Flight routes are the shortest possible distances between landmarks on land.

According to the general classification of the migration system of aquatic and wetland birds in Eurasia, Poland, including its marine areas, is located within two large flyways, the East Atlantic and the Mediterranean/Black Sea flyways. The migration tactics, as well as the flyways of seabirds in the Baltic region are very poorly recognised. In summer (July and August), the migration of sea ducks (mainly the common scoter males) is observed, from the Gulf of Finland in the direction of the moulting grounds located in the Danish straits. They are accompanied by the common eiders and velvet scoters, however, the abundance of these two species is much lower than that of the common scoter. These birds make a stop in the sea areas of the Southern Baltic only in exceptional cases. The period of autumn migration of seabirds is greatly extended in time. Starting in August, a number of water bird species can be observed within the PSA. Some of them are only passing and do not winter there (e.g. the terns of the *Sterna* and *Chlidonias* genera), others are observed throughout the entire migration and wintering periods (sea ducks, razorbills, divers, grebes). In the spring, large flocks of sea ducks (long-tailed ducks, velvet scoters and common scoters) which stop in the Polish zone of the Baltic Sea while moving towards the breeding grounds are observed [Sikora *et al.*, 2011].

The maritime airspace is probably also a place of bat migration, since in the surveys for the Baltica-1 OWF and other offshore wind farms in the Baltic Sea they were found to be present at a considerable distance from the shore. However, there is no data to describe the extent and purpose of their migrations.

In the case of the marine mammals found in the Southern Baltic, no areas that could meet the criteria for wildlife corridors can be identified. Both seals, as well as porpoises travel in search of food with no preference for specific routes.

The migration behaviour of bats over the sea area is also unknown. Although individuals are recorded even in the survey areas far away from the shore, as in the case of the Baltica-1 OWF survey area, the spatial range and purpose of their migrations are not known.

7.9 Cultural heritage and other objects of anthropogenic origin

No objects of cultural heritage including wrecks, have been identified within the Baltica-1 OWF Area boundaries (based on the SIPAM data). The results of seabed surveys conducted in the Project area showed the presence of several hundred objects of potential anthropogenic origin, of which over a hundred were selected for visual inspection conducted using an ROV. Most of them were geomorphological forms and anthropogenic waste, other objects – tires, fishing nets and ropes, tree branches and logs. Among the objects covered by the visual inspection, fragments of ship wrecks and aircraft elements were also found on the seabed (examples: Figure 7.42 and Figure 7.43). The anthropogenic objects identified as part of the surveys were not found to be cultural heritage objects.

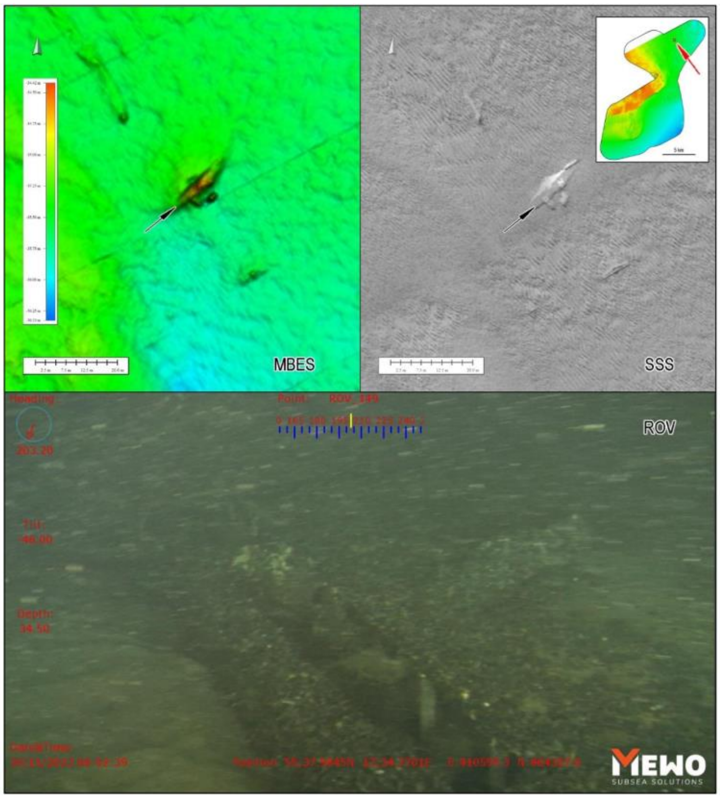

Figure 7.42. Aircraft wreck visible on video footage from a visual inspection of potential anthropogenic objects in the Baltica-1 OWF Area

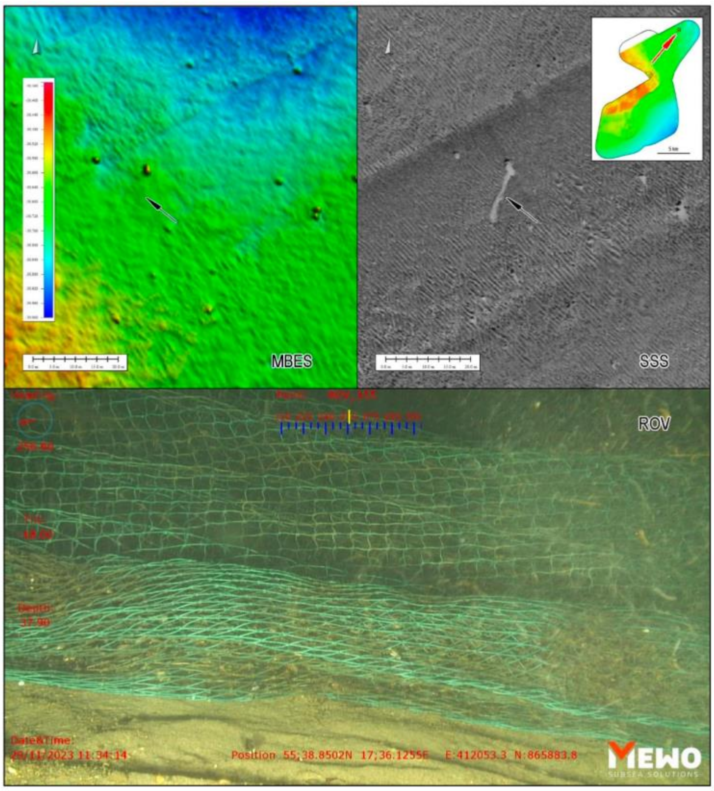

Figure 7.43. Fishing nets lying on the seabed on video footage from a visual inspection of potential anthropogenic objects in the Baltica-1 OWF Area

Among the identified impacts extending beyond the Project area, only the re-sedimentation of seabed sediments mobilised into the water column during the construction works could affect cultural heritage objects situated outside the construction area, also in the territory of another country. The results of the modelling of dispersion and sedimentation of suspended solids demonstrated that the highest levels of sedimentation will be recorded up to a distance of approximately 0.2 km from the boundary of the Baltica-1 OWF Area. The nearest shipwreck within the Polish sea area is located at a distance of 9.5 km to the west of the Project area boundaries, and in Swedish waters – at a distance of 13.1 km. The two wrecks are not classified as cultural heritage objects.

No conventional warfare agents from the period of either world war have been found in the area either. However, their presence on the seabed in the area analysed cannot be excluded. A similar approach should be applied to the potential occurrence of containers with chemical weapons, which were dumped after World War II, mainly in the Baltic deeps, the Gotland Deep and the Bornholm Deep, as well as in the Skagerrak, the Little Belt and the Gdańsk Deep [Knobloch *et al.* 2013, Bełdowski *et al.* 2014]. In the light of the recent analytical results and incidental discoveries, it is known that some chemical warfare agents were dumped from ships into the sea during transfer to their intended deposition sites [Knobloch *et al.* 2013] [Figure 7.44].

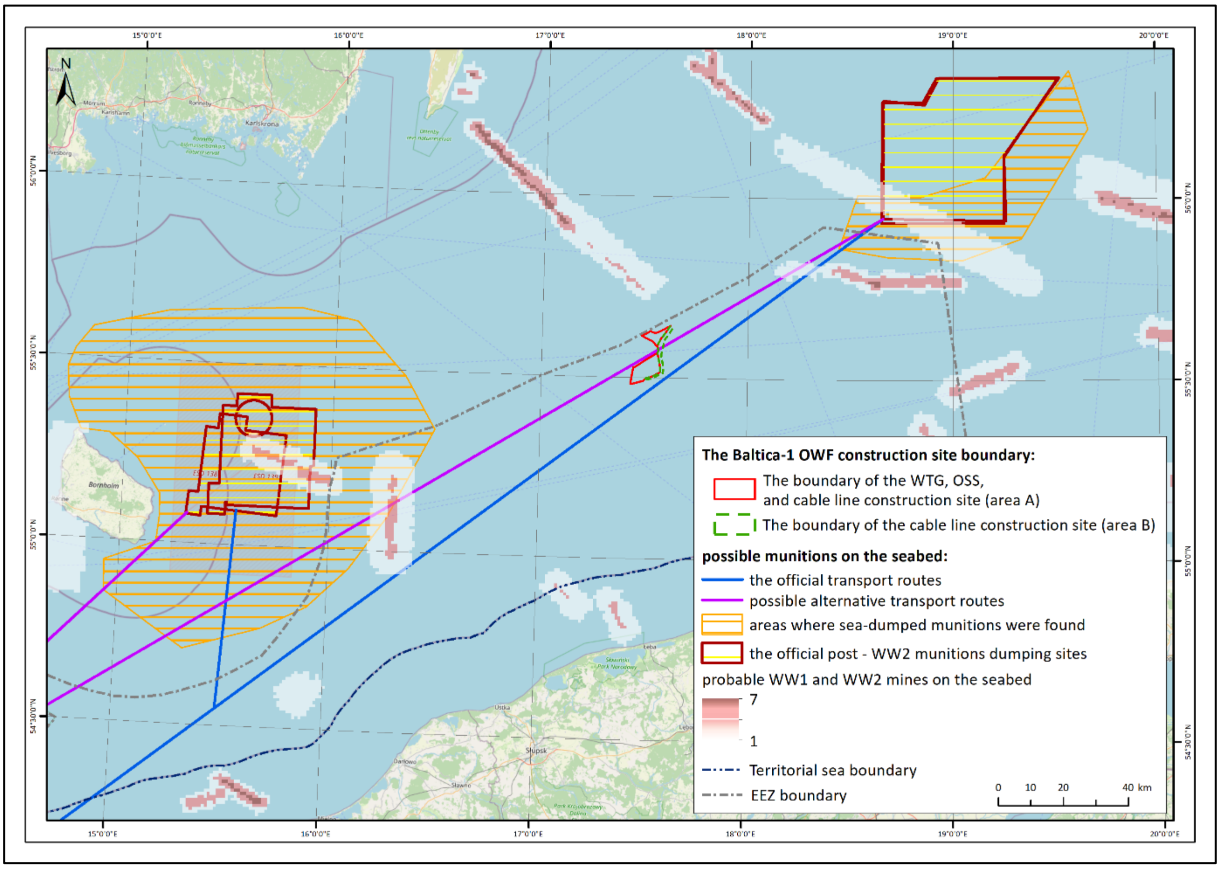

Figure 7.44. Location of the Baltica-1 OWF Area in relation to areas of warfare material dumping after World War II, official and possible alternative routes of warfare material transportation, areas where dumped warfare materials have been encountered, and areas where World War I and World War II mines may lie on the seabed [Source: internal materials based on HELCOM Map and data service]

Taking a precautionary approach, it should therefore be assumed that conventional and unconventional warfare agents from the periods of warfare may also be deposited on the seabed in the Baltica-1 OWF Area, posing a potential threat to the safety of the Project implementation. Before the commencement of the construction, the Project Owner will conduct detailed surveys on the presence of unexploded ordnance and duds (UXO surveys) on the seabed. In case any chemical warfare agents / UXOs are found during these surveys, the Project Owner will notify the relevant authorities and institutions, and will comply with their instructions.

Geophysical surveys did not reveal any objects on the seabed or in the water column within the survey area that would prevent or significantly impede the Project.

7.10 Use and Development of the Sea Area and Tangible Property

7.10.1 Maritime Spatial Plan of Polish Sea Areas

The entire territory of the Polish sea areas was included in the development plan implemented by way of the Regulation of the Council of Ministers of 14 April 2021 *on the adoption of the Maritime Spatial Plan for 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). The area of the Project is situated within the boundaries of the sea basin POM.60.E, the description of which is provided in Section 3.1.3.

7.10.2 Navigation

The proposed Baltica-1 OWF Area is located outside the main Baltic navigation routes; however, a customary navigation route leading to the port of Klaipėda runs through its southern part.

A general assessment of vessel traffic in the Polish sea areas was carried out on the basis of AIS-PL data for the period 01.07.2021–31.12.2022. Vessel traffic was visualised on a traffic density map [Figure 7.45].

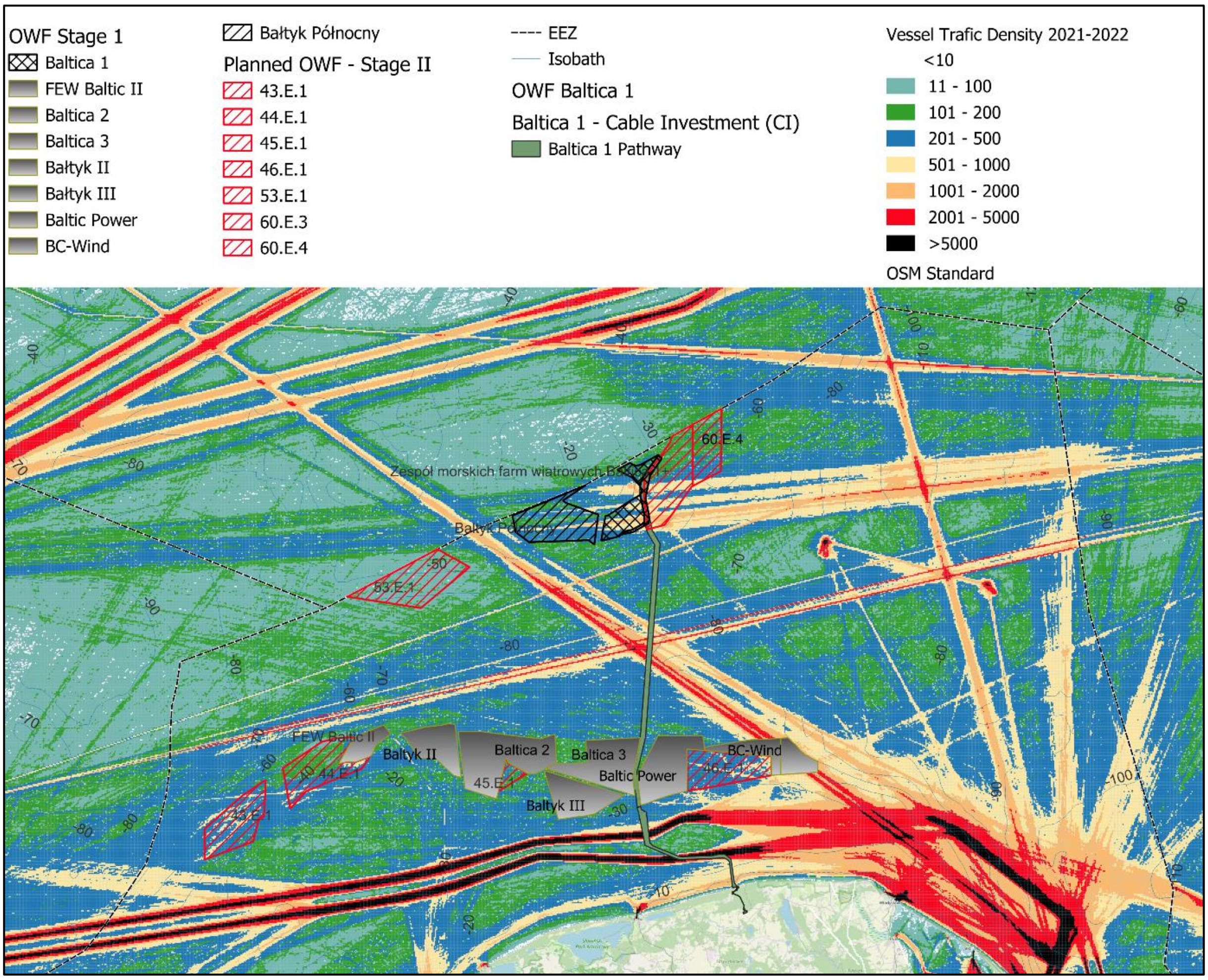

Figure 7.45. *Map of vessel traffic intensity in part of the Southern Baltic in the period 01.07.2021–31.12.2022 [Source: internal materials based on AIS-PL data]*

Vessel traffic in the immediate vicinity of the Project was assessed on the basis of HELCOM AIS data for the period 2021–2022. Data for all are presented in the figures below [Figure 7.46–

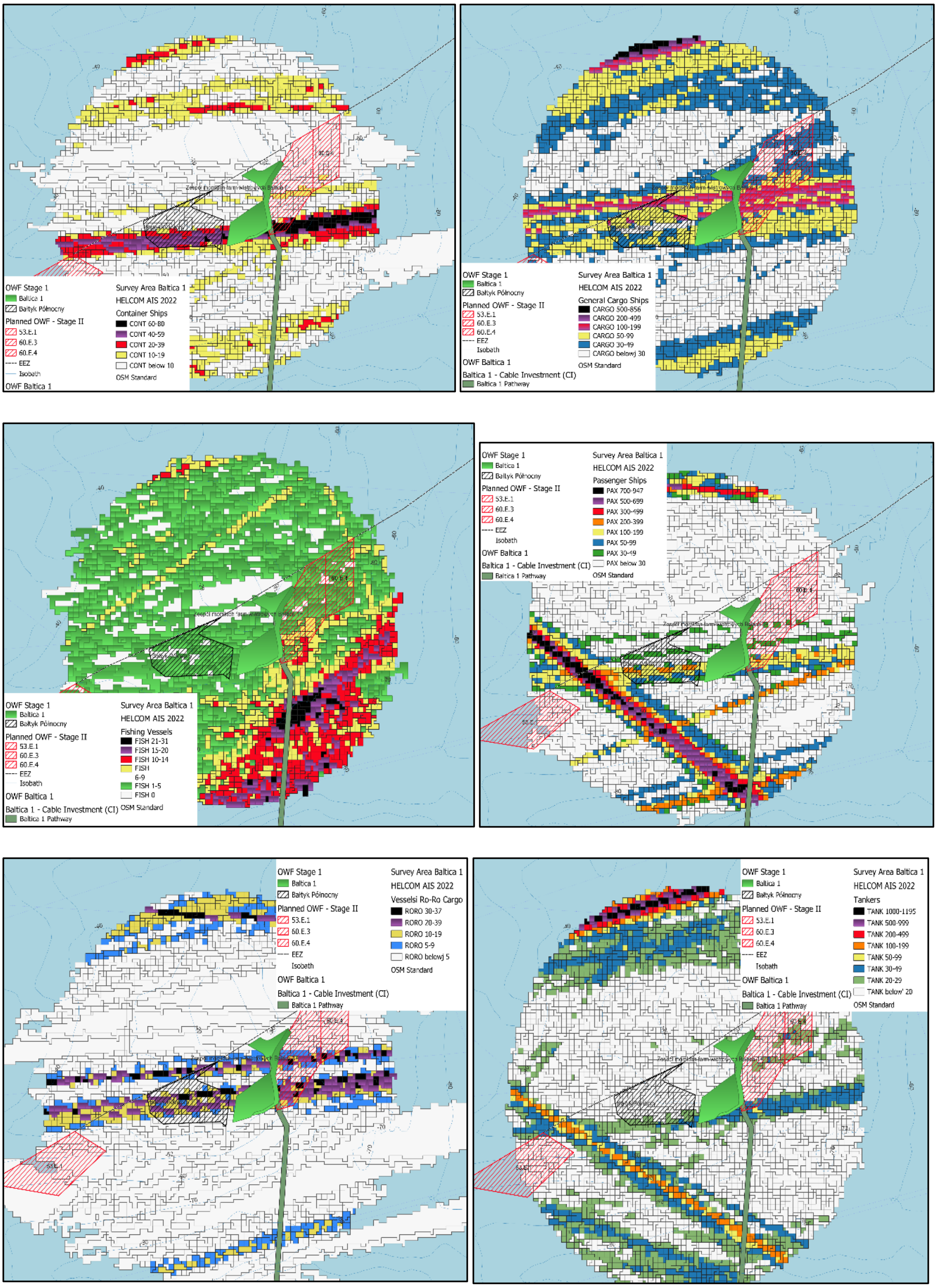
OWF Stage 1
Baltica 1
Bałtyk Północny
Planned OWF - Stage II
53.E.1
60.E.3
60.E.4
EEZ
Isobath
OWF Baltica 1
Survey Area Baltica 1
HELCOM AIS 2022
Container Ships
CONT 60-80
CONT 40-59
CONT 20-39
CONT 10-19
CONT below 10
OSM Standard
General Cargo Ships
CARGO 500-856
CARGO 200-499
CARGO 100-199
CARGO 50-99
CARGO 30-49
CARGO below 30
Baltica 1 - Cable Investment (CI)
Baltica 1 Pathway
Fishing Vessels
FISH 21-31
FISH 15-20
FISH 10-14
FISH 6-9
FISH 1-5
FISH 0
Passenger Ships
PAX 700-947
PAX 500-699
PAX 300-499
PAX 200-399
PAX 100-199
PAX 50-99
PAX 30-49
PAX below 30
Vessels Ro-Ro Cargo
RORO 30-37
RORO 20-39
RORO 10-19
RORO 5-9
RORO below 5
Tankers
TANK 1000-1195
TANK 500-999
TANK 200-499
TANK 100-199
TANK 50-99
TANK 30-49
TANK 20-29
TANK below 20

Figure 7.49].

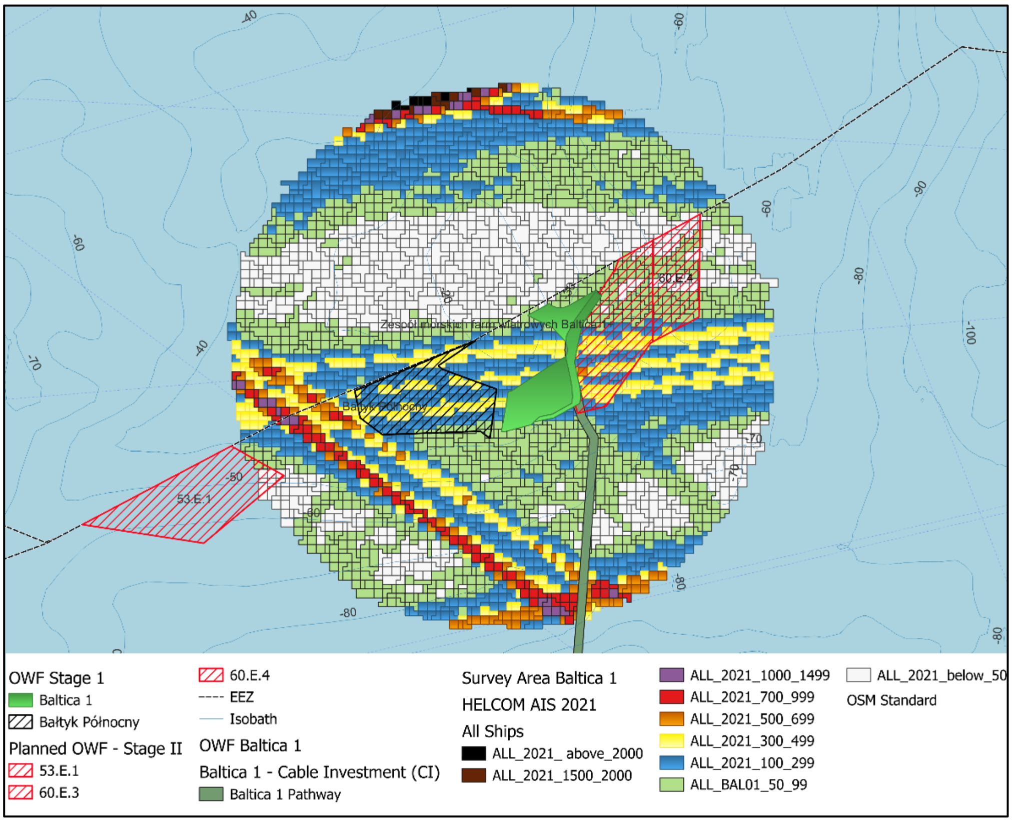

Figure 7.46. Vessel traffic in the vicinity of the Baltica-1 OWF in 2021 [Source: internal materials based on HELCOM data]

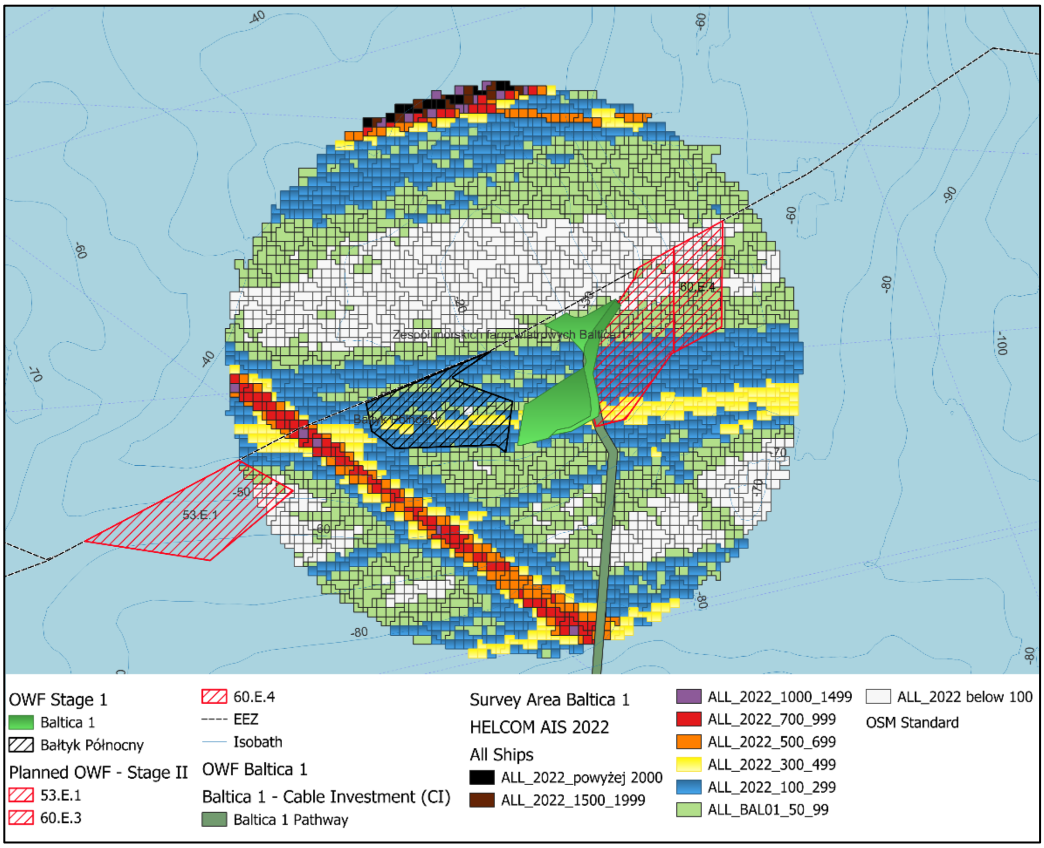

Figure 7.47. Vessel traffic in the vicinity of the Baltica-1 OWF in 2022 [Source: internal materials based on HELCOM data]

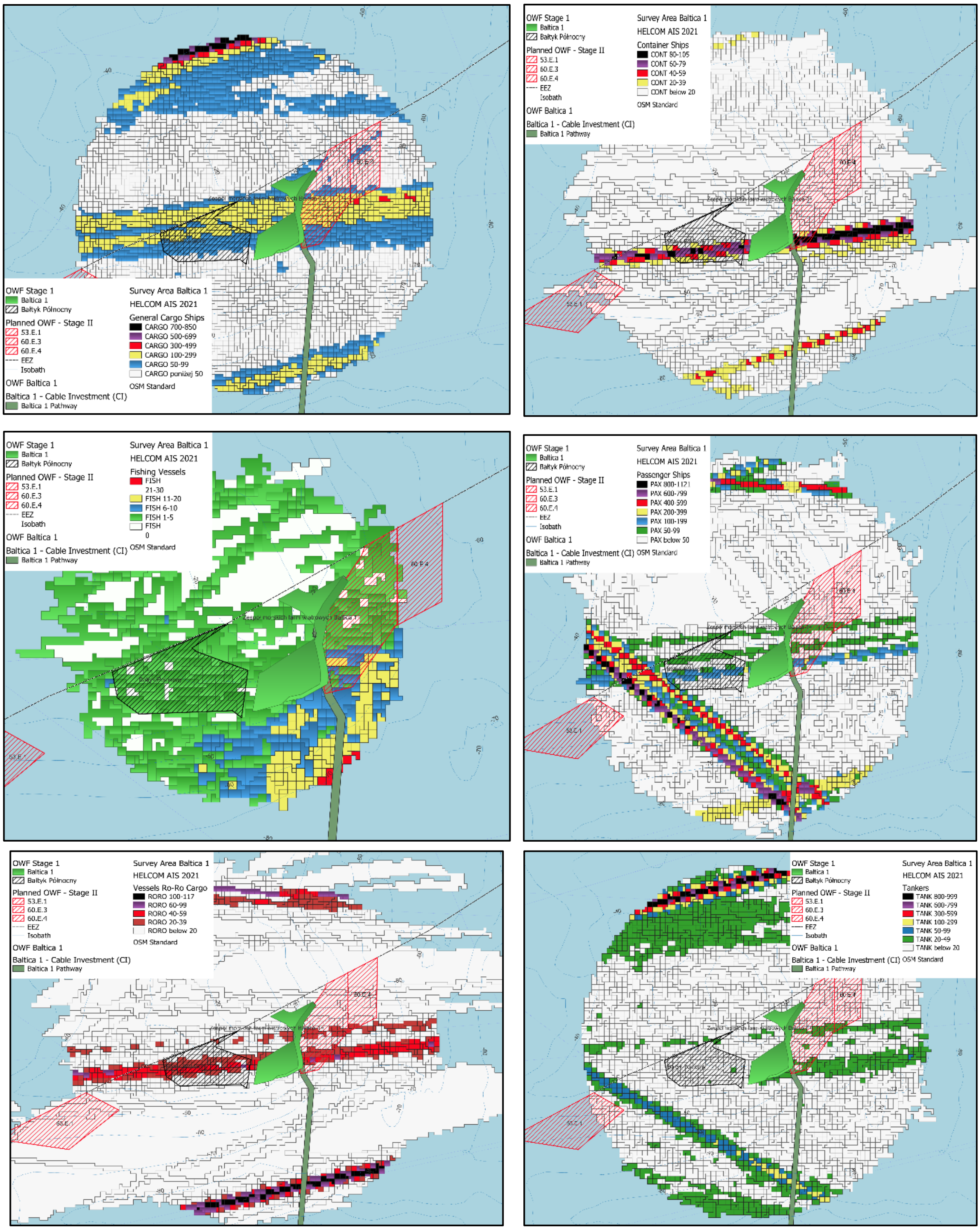

Figure 7.48. Vessel traffic in the vicinity of the Baltica-1 OWF in 2021, by category [Source: internal materials based on HELCOM data]

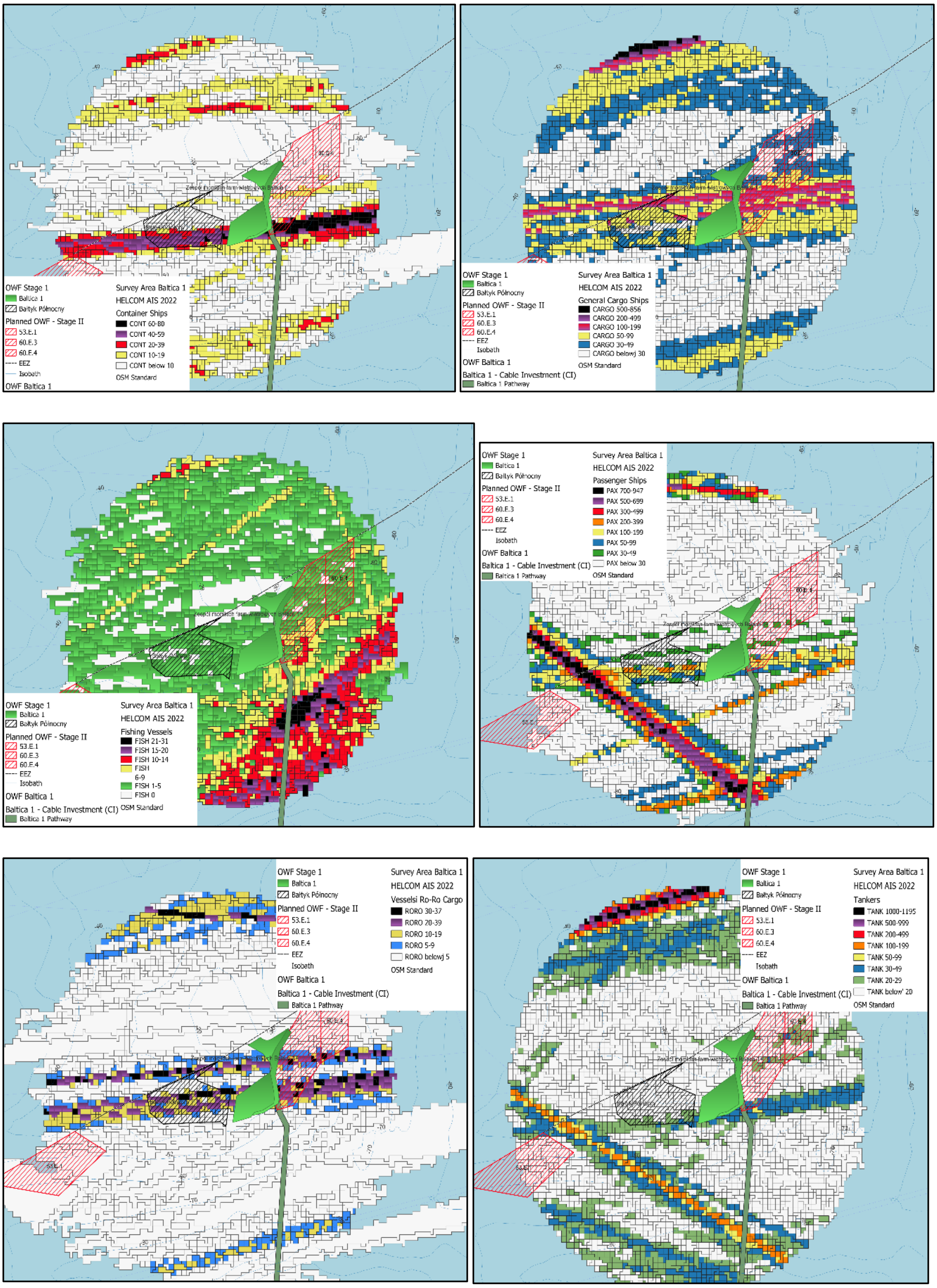

Figure 7.49. Vessel traffic in the vicinity of the Baltica-1 OWF in 2022, by category [Source: internal materials based on HELCOM data]

In accordance with the detailed provisions contained in § 69 of Annex 2 to the Regulation of the Council of Ministers of 14 April 2021 *on the adoption of the Maritime Spatial Plan for 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) (hereinafter referred to as: MSPPSA), navigation (defined in the regulation as "transport") in the sea basin POM.60.E, within the boundaries of which the Project is located, is not subject to restrictions until the commencement of operation of the OWF. From then on, pursuant to the MSPPSA, navigation will be restricted to vessels up to 50 m in length, until the conditions for safe navigation have been established by a decision of the territorially competent director of the maritime office, with the exception of vessels involved in the service and maintenance of OWF structures and equipment as well as aquaculture (if carried out within the farm area).

Figure 7.50 presents the Project considerations resulting from the MSPPSA. The figure features a model of shipping routes resulting from the vessel traffic analysis based on AIS-PL data, together with the proposed layout of new routes ensuring safety of navigation in the vicinity of offshore wind energy projects. The map also includes information on the proposed alternative vessel traffic related to the construction and operation of the Baltica-1 OWF.

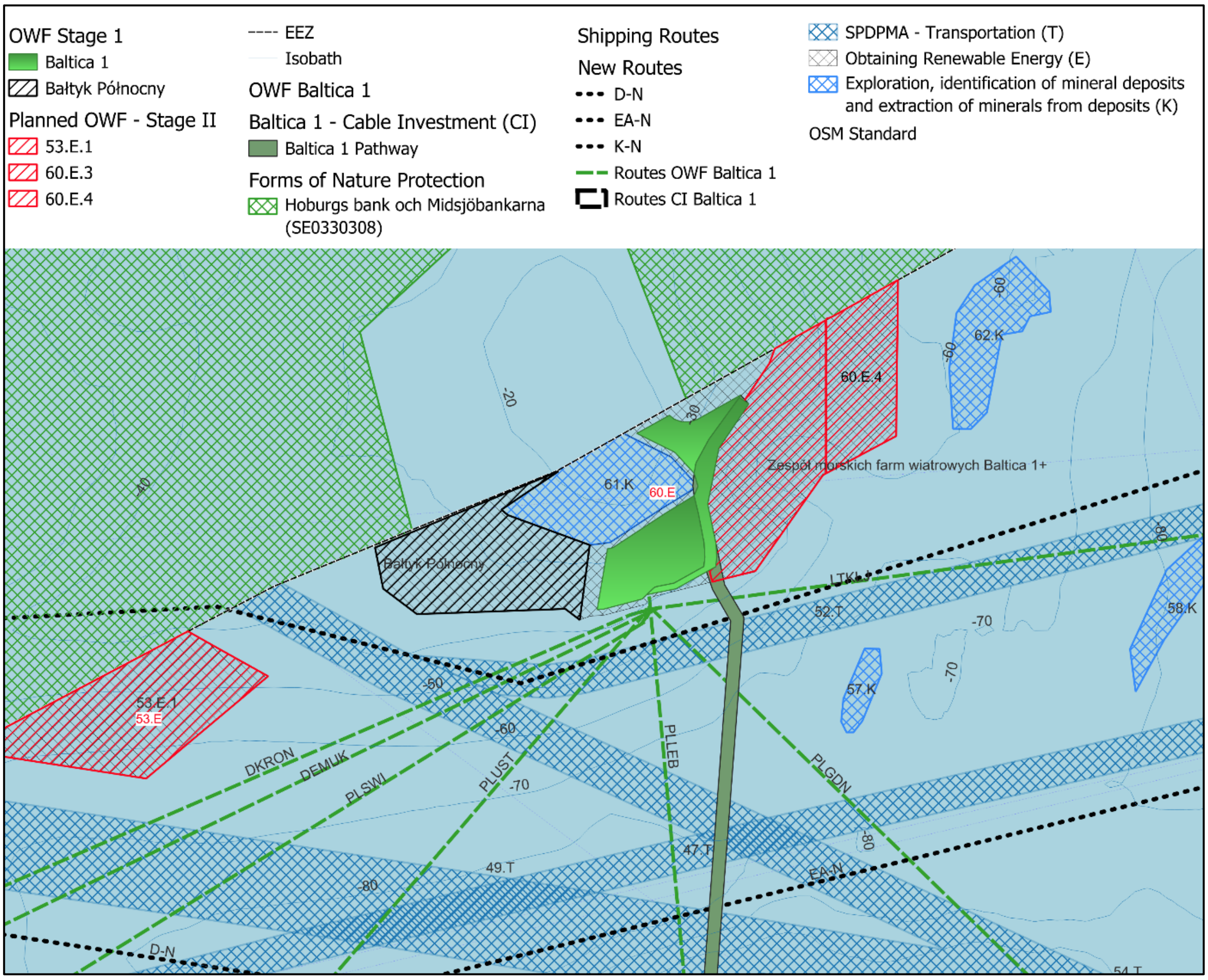

Figure 7.50. Shipping considerations resulting from the MSPPSA and the location of offshore wind farm construction areas, together with the proposed layout of new shipping routes [Source: internal materials based on AIS-PL data]

7.10.3 Fisheries

To determine the potential impact of the wind farm on fisheries, the volume and value of catches as well as fishing effort (catch days and number of fishing vessels) were analysed on the basis of data collected within the National Programme for Fisheries Data Collection (npzdr.pl), based on source data from fishing vessel catch reports including: catch location (statistical rectangle or geographical position), fish species, month of catch and vessel type (vessels up to 12 m and over 12 m)[13]. The analysis accounts for the catch data for 2018–2022. The value of catches was estimated on the basis of the average annual prices of the first sale of individual species of fish and the volume of catches.

Since more detailed data on the catches of the fishing fleet are available for the statistical rectangle areas (surface area of approx. 400 km^2, Figure 7.51) that do not coincide with the Baltica-1 OWF Area, the following was taken into consideration to determine, with the greatest possible accuracy, the impact of the Project on the fisheries within the area of the Project:

- for fishing vessels exceeding 12 m in length, equipped with a Vessel Monitoring System (VMS) – the catch volume assigned to a particular statistical rectangle or wind farm area, on the basis of the proportion of the number of vessel position reports provided within a particular statistical rectangle or within the Baltica-1 OWF Area to the overall number of VMS reports on a given day (the distribution of VMS points in the years 2018–2022 in relation to the rectangles and the OWF Area is presented in Figure 7.51);
- for fishing vessels below 12 m in length, for which VMS data are not available – the catch volume estimated on the basis of the relative proportion of the surface area occupied by the wind farm to the total surface area of the statistical rectangle. It is a simplified approach, omitting the possible diversification of the catch volumes within a particular statistical rectangle (e.g. in relation to the differences in depth or type of seabed); however, it is the only solution possible to apply.

The surface of the Baltica-1 OWF Area contained in statistical rectangle N10 is 2.77 km^2 and in statistical rectangle N11 – 21.39 km^2.

[13] The criterion of 12 m was adopted for the purpose of differentiating between the vessels which can be classified as small-scale coastal fishing vessel (<12 m) in accordance with the provisions of the Regulation (EU) No 508/2014 of the European Parliament and of the Council of 15 May 2014 on the European Maritime and Fisheries Fund and repealing Council Regulations (EC) No 2328/2003, (EC) No 861/2006, (EC) No 1198/2006 and (EC) No 791/2007 and Regulation (EU) No 1255/2011 of the European Parliament and of the Council.

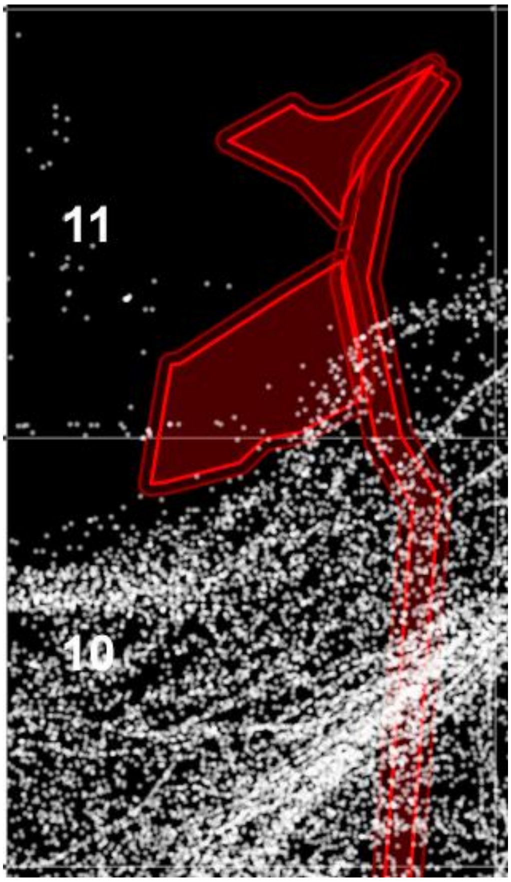

Figure 7.51. Location of VMS points for monitoring the catches of vessels >12 m in the years 2018–2022, in rectangles N10 and N11, in relation to the Baltica-1 OWF Area

Volume and value of fish catches

The average annual volume of fish catches in the area of rectangles N10 and N11 amounted to 1.9 thousand tonnes in 2018–2022, which represented 1.4% of the total volume of the Polish Baltic catches by the Polish fishery over that period. The value of catches amounted to approximately 2.2 million PLN or 1.3% of the total value of landings from the Polish catches in the Baltic Sea.

In the years 2018–2022, the estimated volume of catches within the Baltica-1 OWF Area (calculated on the basis of the proportion of the surface area covered by the wind farm in each statistical rectangle – for vessels with a length of <12 m, and on the basis of VMS data – for vessels with a length of ≥12 m) was considerably lower due to the uneven distribution of catches in the rectangles [Figure 7.51] and averaged 29.9 tonnes with a value of PLN 43.4 thousand.

The vessels registered in Ustka have the highest share in the weight of catches conducted in the area of the two statistical rectangles analysed, in relation to the total catches in the Baltic Sea – 6.6% [Table 7.23]. As for the vessels registered in the other ports, catches within the two rectangles analysed can be considered insignificant. Similarly, in terms of value, catches conducted between 2018 and 2022 in the two rectangles analysed were marginal. The significance of the two rectangles analysed was noticeable (5.5%) only for the vessels registered in Ustka. In the case of vessels registered in the other ports, the proportion of the catch value for rectangles N10 and N11 in relation to the total catches was insignificant [Table 7.24].

Table 7.23. Average volume of catches in statistical rectangles N10 and N11 in 2018–2022 in relation to the total Polish catches in the Baltic Sea, by registration port (in tonnes)

Port	N10, N11			OWF Area			Baltic Sea total	% in the statistical rectangles	% in the OWF Area
	<12 m	>12 m	Total	<12 m	>12 m	Total			
Ustka	2.9	981.7	984.6	0.5	4.1	4.5	14,939.0	6.6	0.0
Władysławowo	0.0	685.1	685.1	0.0	23.2	23.2	35,903.9	1.9	0.1
Kołobrzeg	5.4	38.4	43.8	1.2	0.0	1.2	40,099.7	0.1	0.0
Hel	0.0	33.5	33.5	0.0	0.9	0.9	11,276.1	0.3	0.0
Świnoujście	0.0	15.1	15.1	0.0	0.0	0.0	3279.5	0.5	0.0
Łeba	0.1	11.9	12.0	0.0	0.1	0.1	2542.4	0.5	0.0
Jastarnia	0.0	4.3	4.3	0.0	0.0	0.0	6412.8	0.1	0.0
Other*	0.0	112.0	112.0	0.0	0.0	0.0	18,343.1	0.6	0.0
Total	8.4	1882.1	1890.4	1.6	28.3	29.9	132,796.5	1.4	0.02

**For confidentiality reasons (single vessel), catches allocated to the port of Gdynia are not detailed in the table, being included under ‘Other’.*

Table 7.24. The average value of catches in the statistical rectangles N10 and N11 in 2018–2022 in relation to the average Polish catches in the Baltic Sea, by registration ports (PLN thousands)

Port	N10, N11			OWF Area			Baltic Sea total	% in the statistical rectangles	% in the OWF Area
	<12 m	>12 m	Total	<12 m	>12 m	Total			
Ustka	16.1	1108.2	1124.3	2.9	5.1	8.0	20 343.9	5.5	0.0
Władysławowo	0.0	832.1	832.1	0.0	31.4	31.4	36 413.9	2.3	0.1
Kołobrzeg	11.8	39.1	50.9	2.5	0.0	2.5	48 874.0	0.1	0.0
Łeba	0.4	40.4	40.8	0.0	0.3	0.3	10 615.1	0.4	0.0
Hel	0.0	40.4	40.4	0.0	1.2	1.2	4980.6	0.8	0.0
Świnoujście	0.0	17.8	17.8	0.0	0.0	0.0	3436.0	0.5	0.0
Jastarnia	0.0	5.4	5.4	0.0	0.0	0.0	6627.6	0.1	0.0
Other*	0.3	123.5	123.7	0.0	0.0	0.0	45 209.7	0.3	0.0
Total	28.5	2206.9	2235.4	5.4	38.0	43.4	176 500.9	1.3	0.02

**For confidentiality reasons (single vessel), catches allocated to the Port of Gdynia are not detailed in the table – they are included under ‘Other’.*

The volume and value of fish catches in the statistical rectangles in which the Baltica-1 OWF Area is situated varied in the period 2018–2022. As shown in Figure 7.52, the volume of catches in the statistical rectangles analysed varied from year to year, with an evident downward trend between 2018 and 2020 in rectangle N10 and throughout the analysed period in rectangle N11. The changes observed within rectangle N10 are difficult to explain by objective factors and were rather of a random (natural) character, resulting from a more or less intense activity of a relatively small group of fishing vessels. The increase in the catches in 2021 was associated with the activity of only 9 fishing vessels (with annual catches exceeding 100 tonnes) responsible for more than 70% of the catches conducted. By way of contrast, in 2020, catches above 100 tonnes were recorded by only three fishing vessels. The declining catches in rectangle N11 can be linked to the crisis condition of the cod stocks, which was ultimately the reason for the closure of cod-targeted fisheries in mid-2019.

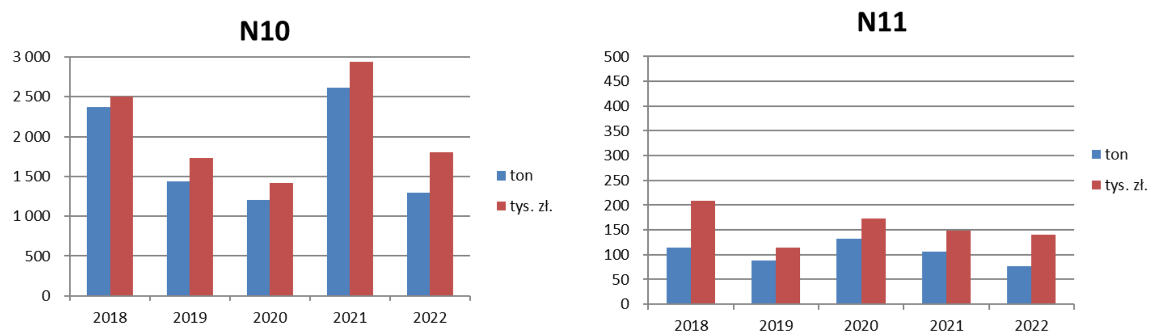

Figure 7.52. Volume and value of fish catches in the statistical rectangles N10 and N11

The main fish species caught within the four rectangles analysed in the years 2018–2022 were herring and sprat [Table 7.25], with 48% of the total catch volume, as well as 53% and 36% of the value of fish caught, respectively [Figure 7.53]. The proportion of the remaining species of fish did not exceed a few percent.

Table 7.25. Amount and value of catches in statistical rectangles N10 and N11 in 2018–2022, by the most important commercial species

Species	Catch parameter	Year				
		2018	**2019**	**2020**	**2021**	**2022**
herring	amount [tonnes]	977.4	1015.0	927.8	1112.2	496.3
	value [PLN thousands]	1085.7	1167.2	1181.2	1531.3	946.8
sprat	amount [tonnes]	1293.7	414.9	374.8	1555.9	857.2
	value [PLN thousands]	984.1	302.3	315.5	1486.7	952.2
flounder	amount [tonnes]	100.2	33.2	19.5	43.0	21.1
	value [PLN thousands]	162.5	49.4	25.9	48.3	31.0
other	amount [tonnes]	116.5	61.4	18.9	12.5	0.5
	value [PLN thousands]	480.5	322.1	71.8	20.8	11.7
Total: amount [tonnes]		2487.8	1524.5	1341.1	2723.6	1375.1
Total: value [PLN thousands]		2712.9	1840.9	1594.4	3087.1	1941.7

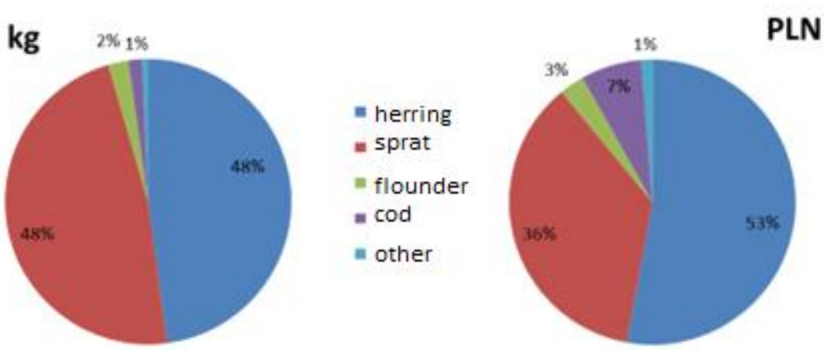

Figure 7.53. Species structure in the catches in statistical rectangles N10 and N11 in the years 2018–2022

In the period under analysis, the vast majority of the catches, both in terms of quantity and value, were made by vessels larger than 12 m in length [Table 7.26]. This was due both to the prevalence of large vessels in this area, as well as their higher fishing capacity. The low activity of fishing boats was due to the significant geographical distance of the two rectangles from the coastline. The average proportion of vessels larger than 12 m in the catch volume and value between 2018 and 2022 was 98–99%.

Table 7.26. Volume and value of fish catches in the statistical rectangles N10 and N11 in 2018–2022, by vessel length

Values	Length [m]	2018	2019	2020	2021	2022
tonnes	0–11.9	38.8	-	1.4	0.6	1.1
	12 and more	2449.0	1524.5	1339.7	2723.0	1374.1
thousand PLN	0–11.9	117.6	-	7.2	6.0	11.8
	12 and more	2595.2	1840.9	1587.2	3081.2	1929.9
Total: tonnes		2487.8	1524.5	1341.1	2723.6	1375.1
In total: thousand PLN		2712.9	1840.9	1594.4	3087.1	1941.7

The calculation results for catch volumes in individual statistical rectangles and the values of catches conducted in the OWF Area itself are presented in the Table 7.27. As mentioned earlier, for vessels under 12 m, the value of catches in the OWF area was calculated on the basis of the proportion of the surface to be occupied by the Baltica-1 OWF Area in relation to the surface area of the statistical rectangle. On the other hand, for vessels above 12 m, the value was calculated on the basis of VMS records. In the period 2018–2022, the average estimated value of fish caught in the area of the proposed OWF was only PLN 19 thousand for the group of vessels over 12 m, and PLN 3.4 thousand for vessels under 12 m.

Table 7.27. Value of fish catches in statistical rectangles N10 and N11 in the years 2018–2022, as well as the estimated value of catches in the Baltica-1 OWF Area (in PLN thousand)

Vessel group by length [m]	Year	Catches in the rectangles		Catches in the OWF		Average	
		N10	N11	N10	N11	Catches in the rectangles	Catches in the OWF
0–11.9	2018	15.7	102.0	0.4	21.8	58.8	11.1
	2019	-	-	-	-	-	-
	2020	1.4	5.8	0.0	1.3	3.6	0.6
	2021	1.3	4.7	0.0	1.0	3.0	0.5
	2022		11.8		2.5	11.8	2.5
average		6.1	31.1	0.2	6.6	18.6	3.4
12 and more	2018	2487.9	107.3	2.3	24.5	2595.2	26.8
	2019	1726.4	114.5	0.5	34.7	1840.9	35.3
	2020	1419.4	167.8	3.2	49.6	1587.2	52.9
	2021	2936.9	144.3	2.8	35.4	3081.2	38.1
	2022	1801.5	128.4	2.5	34.6	1929.9	37.0
average		2074.4	132.5	2.3	35.8	1103.4	19.0

Analysis of the monthly variability of fish catches in the Baltica-1 OWF Area indicates a concentration of fishing fleet activity mainly in the spring and autumn [Figure 7.54]. In the summer, mainly due to protective regulations for sprat and cod[14], catches decrease to negligible amounts.

[14] According to the Regulation of the Minister of Maritime Economy and Inland Navigation of 16 September 2016 on the protected dimensions and protection periods of marine organisms and detailed conditions for commercial fishing, targeted fishing for sprat is carried out from 11 September to 9 June. Additionally, due to the provisions of Council Regulation (EU) 2018/1628 of 30 October 2018 fixing for 2019 the fishing opportunities for certain fish stocks and groups of fish stocks applicable in the Baltic Sea and amending Regulation (EU) 2018/120 as regards certain fishing opportunities in other waters, cod fishing was prohibited in subareas 25 and 26, which, due to the existing landing obligation, made it practically impossible to conduct fishing for other fish species as well.

Given the relatively small area covered by the analysis, the fishing results observed in this area may be subject to natural, even very high fluctuations, which is related to lower or higher activity of individual fishing vessels. This was the case, for example, in February 2021, when four vessels caught more than 400 tonnes of fish (including one over 130 tonnes) or in April 2018, when three vessels caught approximately 440 tonnes of fish (including one over 200 tonnes).

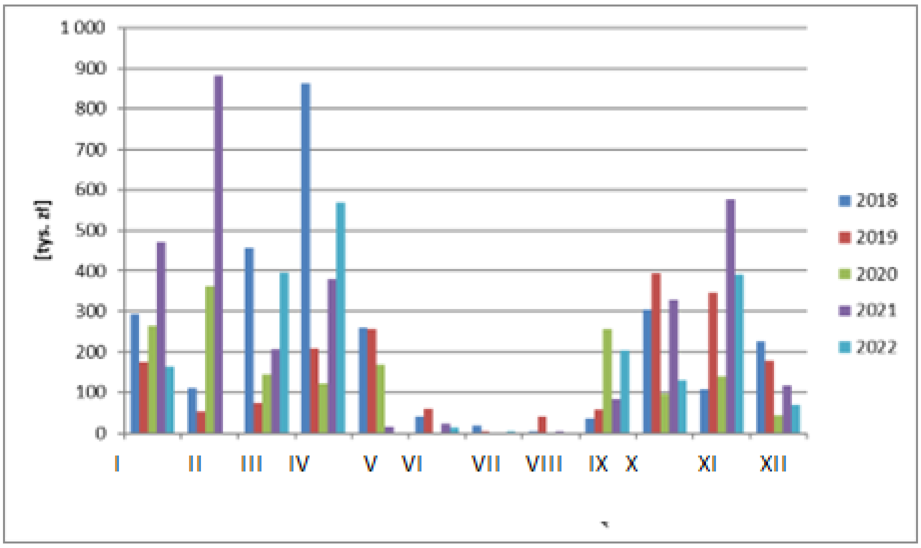

Figure 7.54. Monthly value of fish catches within rectangles N10 and N11 in the years 2018–2022

Pelagic trawls were the dominant gear used for fishing in the Baltica-1 OWF Area between 2018 and 2022, corresponding to a proportion of the total catch weight between 93% (2018) and 99% (2020–2022). As for the other gear types, only in 2018–2019 demersal trawls had some (minor) importance (5–7%), but in the subsequent years they were not used to any noticeable extent [Figure 7.55] due to the aforementioned restrictions on cod fishing (see the footnote 14).

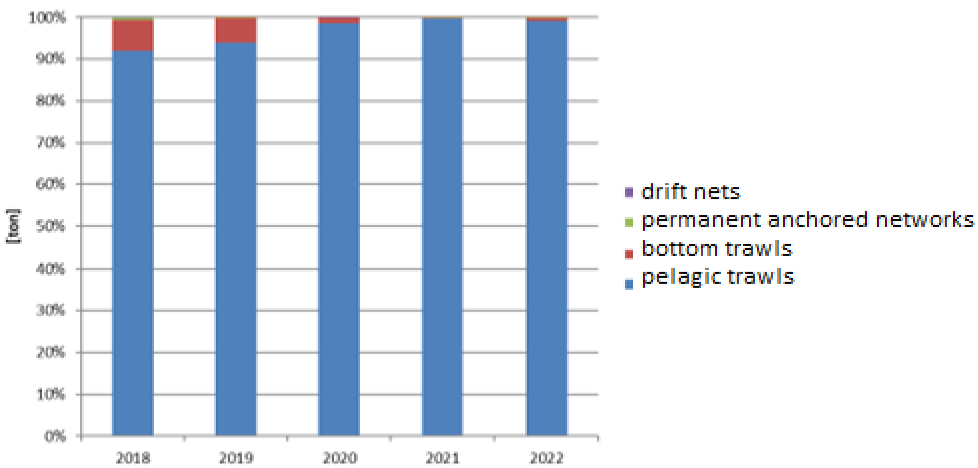

Figure 7.55. Catch volumes by gear type within statistical rectangles N10 and N11 in the years 2018–2022

Fishing effort

In the years 2018–2022, fish catches within statistical rectangles N10 and N11 were reported by 72, 57, 50, 41, and 37 vessels, respectively, compared to a total of 777, 786, 800, 805 and 798 active fishing vessels conducting catches in the Baltic Sea. Fishing vessels with a length exceeding 12 m prevailed, with an average of 97% in the entire period analysed; 69, 57, 50, 41, and 37 vessels in the years 2018–2022, respectively.

In the years 2018–2022, the total fishing effort (expressed as the number of fishing days) within the two rectangles ranged from 539 days (2018) to 215 days (2022). Of the two statistical rectangles analysed, rectangle N10 was characterised by a considerably higher activity of fishing vessels. The total number of fishing days in this rectangle in the years 2018–2022 was 1822, compared to 226 days recorded in rectangle N11. This variation results from the different bathymetric characteristics of the area of the two rectangles. Rectangle N11 lies in the shallow area of the Southern Middle Bank Area, whereas rectangle N10 (in the southern part) is situated in considerably deeper waters, which are more attractive from a fishing perspective.

The relative significance of the area of the two rectangles analysed in the total fishing effort of the Polish fishing fleet conducting catches in 2022 in the Baltic Sea (58 thousand days) was negligible and amounted to 0.4%, and in the remaining years under analysis – from 0.6% to 1% [Figure 7.56].

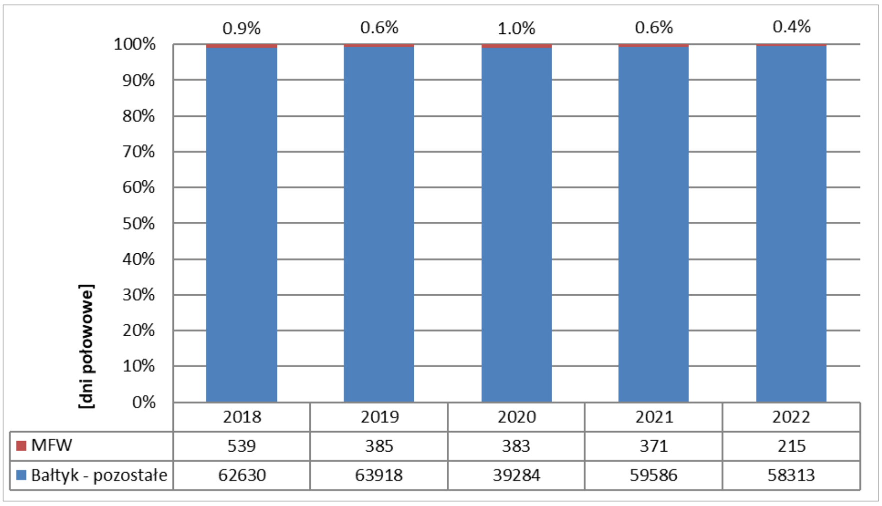

Figure 7.56. The number of fishing days within statistical rectangles N10 and N11 and the remaining part of the Baltic Sea, in the years 2018–2022

Figure 7.57 shows the movement of fishing vessels in relation to the Baltica-1 OWF Area. The location of the OWF at a considerable distance from the shoreline and fishing ports, as well as outside the routes between ports and fisheries, justifies the assumption that the impact of the OWF on the increase of distance to the fishing grounds is negligible.

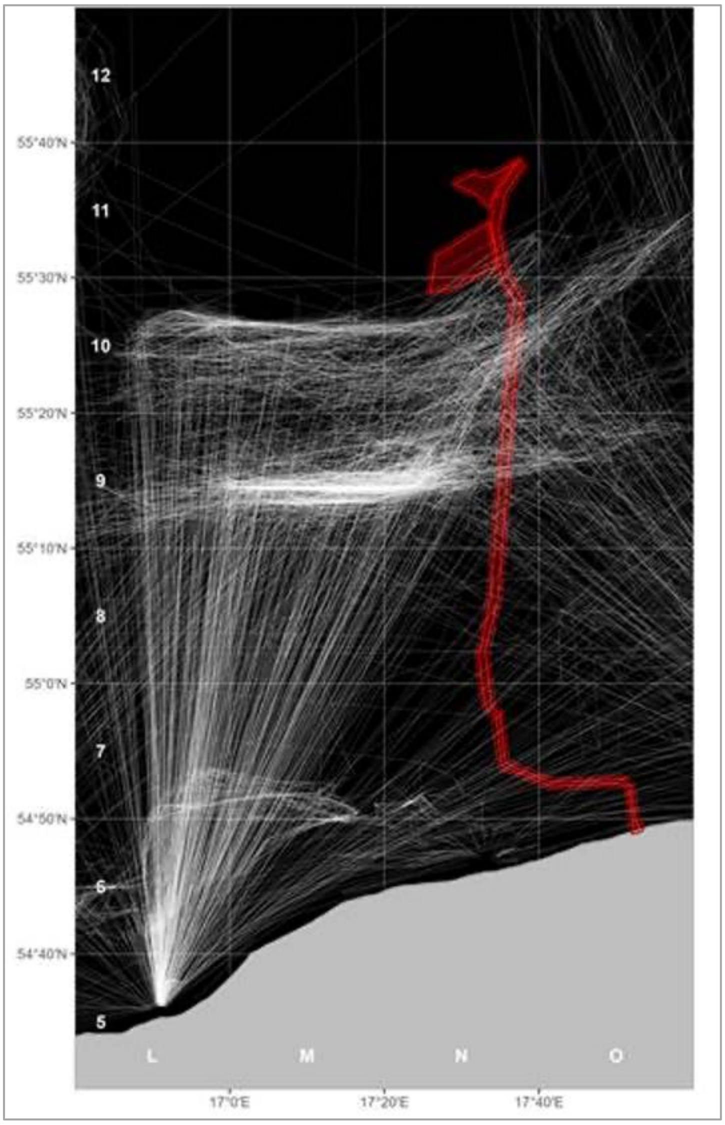

Figure 7.57. Fishing vessel navigation and activity routes in the Baltica-1 OWF Area [Source: internal materials based on VMS data, 2022]

7.10.4 Prospecting and extraction of minerals

The analysis of the data available in the Central Geological Database revealed that there are no mining areas or sites, nor any natural resource deposits located within the boundaries of the proposed Project area. On the western side of its boundary, at a distance of approximately 60 m, there is the 'Southern Middle Bank – Southern Baltic' sand-gravel deposit, the resources of which were put to use by designating three mining areas contained within one mining site [Figure 7.58]. The deposit development concession is valid until 15 November 2031. There are no areas indicated for prospecting the deposits of sand for artificial shore nourishment in the area.

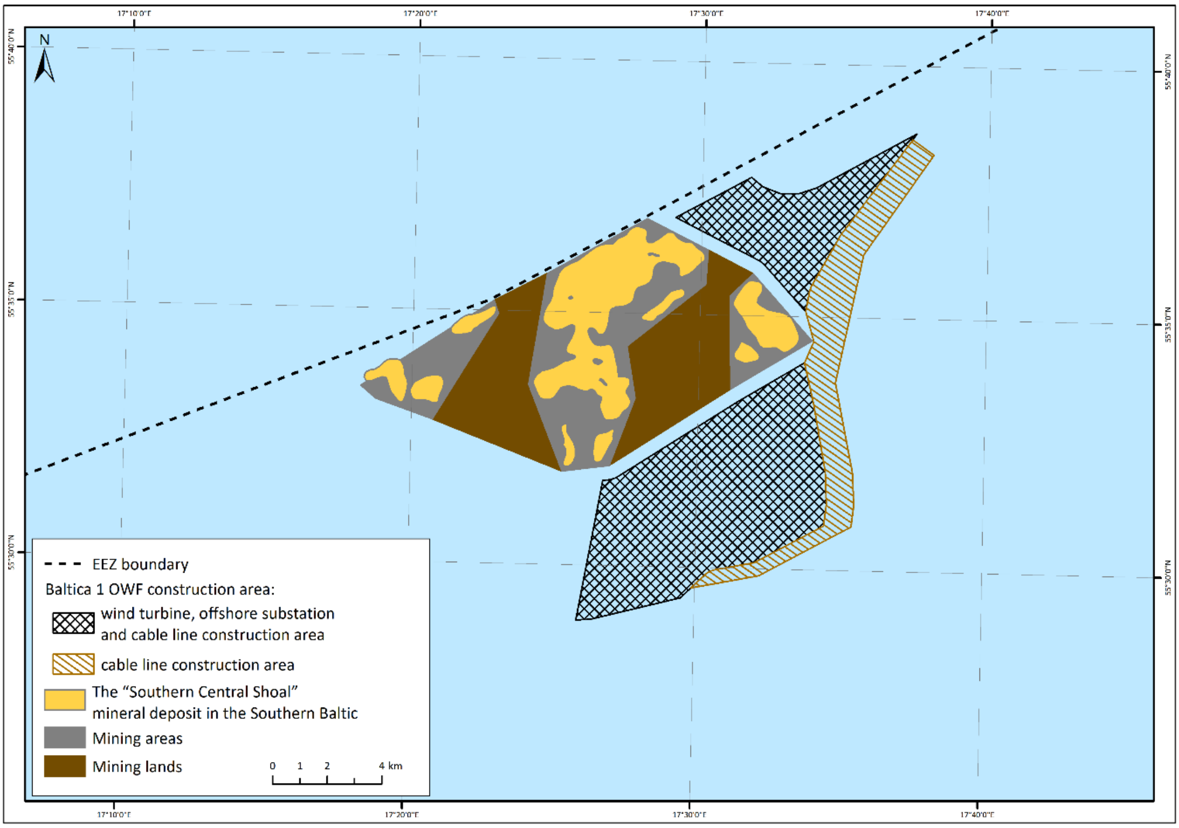

Figure 7.58. Location of the Baltica-1 OWF relative to mineral resource deposits as well as mining areas and sites [Source: internal materials based on the data from the Central Geological Database]

AIS-PL data for the period 2020–2024 (available data cover the first two months of 2024) indicate that most vessels exploiting the deposit on the Middle Bank operated from the port of Gdańsk (approximately 80% of all cruises, NW-SE direction). The remaining vessels conducting dredging works on the Middle Bank operated from ports in Denmark – Rodbyhavn and Stralsund (approximately 18% of all cruises, W-E direction). The vessels identified were mainly hopper dredgers classified as large vessels, ranging from 88 to 142.5 m in length, with a tonnage from 2756 to 8683, capable of travelling at a maximum speed of approximately 14 knots. Vessel traffic to and from the Middle Bank is variable, which most likely results from the execution of orders for aggregate deliveries to individual ports. In general, the intensity of vessel traffic related to deposit exploration is low, totalling 100–200 cruises per year.

On the Swedish side, there is a prospective area with natural aggregate deposits, situated on the Middle Bank. It has not been exploited so far and currently there are no plans to use it in the future [source: Geological Survey of Sweden].

7.10.5 National defence

The proposed Project area is not located within the boundaries of the zones permanently or periodically closed for shipping and fishing activity, as established by the Minister of National Defence by way of a regulation, in accordance with the Act of 21 March 1991 *on the maritime areas of the Republic of Poland and maritime administration* [consolidated text: Journal of Laws of 2023, item 960]. The area is not crossed by any of the Polish Navy fairways either.

7.10.6 Technical infrastructure

The analysis of the SIPAM data and the results of the geophysical surveys showed that there are no structures, including linear structures (e.g. power and telecommunication cables), within the Baltica-1 OWF Area.

7.10.7 Other forms of use

The Baltica-1 OWF Area is located in the open sea area, at a considerable distance from the shore. According to the MSPPSA, there are no restrictions of use in this area other than those resulting from separate regulations. It can be assumed that other forms of use of the sea basin are negligible, essentially narrowed down to tourist and recreational use, i.e. as a transfer area for yachts sailing between ports. Scientific research is permitted in the entire sea basin, but apart from the inventory surveys carried out for the Project, no other such work has been carried out over there to date. There are also no SEM or HELCOM monitoring stations in or near the area.

Other forms of space use within the area and in the vicinity of the Baltica-1 OWF were not included in the impact assessment due to their marginal character.

7.11 Landscape, including cultural landscape

According to the definition of the European Landscape Convention, opened for signature in Florence on 20.10.2000, landscape is an area, as perceived by people, the character of which is the result of the action and interaction of natural and/or human factors. The Baltica-1 OWF Area is located in the open waters of the Baltic Sea, at a considerable distance from the shore. The distance makes it invisible from land. The landscape is typical of open sea waters and can be regarded as not particularly varied and common, shaped almost exclusively by natural factors, i.e. changes in the sea surface caused by wind action and some atmospheric conditions – cloudiness and precipitation. Thus far, the human impact on the landscape of the area has been small, resulting mainly from the temporary presence of vessels along shipping routes (one of the routes to the port of Klaipeda runs through the OWF Area) and fishing vessels.

Taking into account the spatial layout of the Project – the construction of structures installed in the seabed and of cable lines, the subsea landscape should also be characterised. Again, it can be concluded that the landscape is not very varied – the seabed is mainly covered with sandy sediments and sparse boulder areas, with seawater above it. On the seabed, there are no plant communities that would add more value to the landscape. To date, there has been no intensive human activity within the Project area that would alter its natural relief. Environmental surveys have shown traces of furrows on the seabed, indicative of past aggregate exploitation.

Cultural landscape, as defined in the Act of 23 July 2003 *on the protection and care of historical monuments* (consolidated text: Journal of Laws of 2022, item 840, as amended), is a space perceived by people, containing natural elements and artefacts of civilisation, historically shaped by natural factors and human activity. In line with this definition, it should be concluded that cultural landscape is not to be found within the Baltica-1 OWF Area and its surroundings. After the construction of the offshore wind farm, the altered landscape will not meet this definition either. In the context of the scope of the act from which the definition is derived, human activity should involve the creation of objects and places that will contribute to the development of cultural heritage.

Given the distance from the shore of at least 75 km, the construction of wind turbines even 330 m above sea level will not disturb the perception of the landscape by people present on the seashore. From this distance, even the tallest proposed turbine structures will not be visible to the human eye.

8 MODELLING PERFORMED FOR THE PURPOSES OF THE PROJECT IMPACT ASSESSMENT

8.1 MODELLING OF SUSPENDED SOLIDS DISPERSION AND CONCENTRATION

8.1.1 Gravity based structures and cable lines

For the purposes of this report the modelling of suspended solids dispersion in the water depth and their deposition on the seabed was prepared. It contains a concise description of the numerical models used for calculations and a set of results of calculations carried out using such models including their interpretation.

The results presented show the dispersion of suspended solids, their concentrations in the water depth and the deposition of sediments on the seabed. The source of suspended solids generation is the work carried out in connection with the laying of offshore wind turbine foundations and the burying of power and telecommunication cables. The analysis covered both the work related to preparing the seabed for gravity base structures and, the much less invasive as far as suspended solids are concerned, methods related to laying the foundation of support structures using piles (monopiles and jacket foundations). The works related to cable laying, which include clearing the seabed of stones and boulders along cable routes, as well as the actual burying of cables into the seabed also generate suspended solids and numerical simulations were prepared also for these works in order to determine the parameters of the marine environment disturbance.

Suspended solids concentrations depend, among others, on the water depth, type of ground substrate as well as the type of underwater work performed and its speed.

A numerical model was created to reflect the transport of suspended solids in the dynamic marine environment during underwater and dredging works on the seabed in the area intended for the Baltica-1 OWF project implementation.

The results of numerical calculations enabled an analysis of the maximum ranges of impact of the suspended solids of specific concentrations (formed during a long-term work carried out in the seabed) as well as the thickness and spatial distributions of the sediments generated in the process of the suspended solids sedimentation on the seabed. Calculations were made which took into account differences resulting from different types of underwater works performed during the construction of the wind farm; the types of ground in which the works on the seabed will be carried out and the depth at which the works will be carried out.

Environmental forcings applied in the modelling were the impacts of winds blowing over the entire sea area surveyed, wind-generated wave motion, time-varying levels of the water table and sea currents, which are a natural factor generating water movement, and thus, the movement of suspended solids in the water column.

Previously performed calculations indicate clearly that work carried out in cohesive soils of the seabed causes greater suspended solids disturbance to the marine environment than work performed in non-cohesive soils (it should be noted that non-cohesive soils were identified in the upper layers of the seabed in the majority of the Baltica-1 OWF Area). The upper layers in the prepared numerical models (in which the underwater work is carried out) lying under the seabed are represented by both non-cohesive soils and cohesive soils according to geological investigation. In the envelope method, the analyses shall consider scenarios causing the greatest suspended solids disturbance to the marine environment, using conservative assumptions, striving to determine the values of the highest parameters of environmental disturbance.

The scope of the calculation scenarios analysed also includes the performance of works related to the preparation/replacement of soil for two gravity based structures carried out at the same time. The purpose of preparing calculations for such a scenario is to examine the effect of the cumulative impact of suspended solids.

On the basis of the analyses conducted it can be concluded that, for example, the greatest impact ranges of suspended solids occurred at moderate winds of constant direction, whereas the highest concentrations of suspended solids were generated at currents of the lowest velocities (around several $cm \cdot s^{-1}$) and of circulating nature. An equally important conclusion from the calculations is that suspended solids with a concentration exceeding 5 $mg \cdot dm^{-3}$ in the least favourable scenario, locally, in the marine environment do not remain longer than 14 hours from the commencement of work in which the source of suspended solids generation is mobile, and 26 hours from the completion of work in which the source of suspended solids is stationary, and its maximum range may reach from 2.7 to 8.2 km from the source.

Actions related to the disturbance of the seabed during the construction phase of the Baltica-1 OWF will cause an increase in the concentration of suspended solids in the water column and its sedimentation on the seabed surface. These activities will have an impact on biotic components in the marine area, i.e. on phytobenthos, macrozoobenthos, ichthyofauna, diving (benthivorous) birds and marine mammals. Disruptions resulting from these phenomena may deteriorate for a short-term the living conditions of these organisms. In the case of mobile organisms (fish and marine mammals), this disturbance will be less significant, since they can actively avoid the areas where the works are being carried out. The scale of the disturbance will be local and after a maximum of a dozen or so hours, as a result of suspended solids sedimentation, it will return to its original state. The suspended solids undergoing sedimentation will cause the deposition of a new layer of sediments. However, their thickness (up to a maximum of a dozen or so millimetres) will not disturb significantly the functioning of the phytobenthos and zoobenthos communities.

8.1.2 Spudcans for jack-up installation vessels

The native soils in the planned wind turbine locations may have very different strengths and in the case of soils with low bearing capacity, it will be necessary to use ground improvement methods in the locations where the spudcans of the installation vessel are placed. The ground improvement can be done using crushed stone bedding, however, in the case of soils with very low bearing capacity, it may be necessary to replace the weak soil. Such replacement would consist in making an excavation and filling it with crushed stone. Carrying out underwater excavations in cohesive soils characterised by low strength would generate the formation of suspended solids, the dispersion of which is subject to assessment in terms of the impact on the marine environment.

It is assumed that excavations could be carried out using trailing suction hopper dredgers (TSHD) with greater draughts or using cutter suction dredgers (CSD) characterised by smaller draughts. In the case of the former, the excavated soil goes into the dredger's own hold and is then transported to a designated dumping ground and dumped there. In the case of the latter type of dredgers, the excavated soil can be transported by a pipeline and deposited a short distance away, within the wind farm area. However, the soil pulp transported by a pipeline is in a liquid state, and all the soil fractions contained in it are mixed to a large extent. Therefore, when using dredging pipelines, significantly higher parameters of disturbance of the marine environment with suspended solids are achieved, because the highest volume of the excavated material becomes suspended in the water.

The excavations carried out for the spudcans for a jack-up installation vessel legs have smaller cubic capacities than the excavations for gravity based structures of wind turbines. Therefore, the interference in the environment during their execution, with the assumed deposition of the excavated material outside the farm area, will be smaller than during work related to the preparation of the ground for gravity based structures.

During work related to the preparation of the substrate for spudcans using a trailing suction dredger, two underwater operations are carried out at the same time at a small distance (of the order of several hundred meters) from each other, causing the formation of suspended solids. In the first location at the soil extraction site, small amounts of fine soil fractions become suspended in water, while in the second location, at a distance of at least 350 m from the edge of the excavation being made, significantly larger amounts of fine soil fractions cause the formation of suspended solids during the discharge of the soil pulp from the pipeline. The results of the calculations performed on the numerical model indicate that the scenario presented above, also related to the cumulative impact of the two sources of suspended solids, is responsible for the highest levels of environmental disturbance parameters caused by suspended solids.

Momentary point concentrations of suspended solids at a distance of approx. 150 m from the location of soil pulp discharge are high and can reach values of 1500 $mg{\cdot}l^{-1}$ in extreme cases, while at a distance of 500 m their value can in points reach 850 $mg{\cdot}l^{-1}$.

In environmental conditions (velocities, directions of currents and wind) at which the plume of suspended solids reaches its greatest ranges, concentrations exceeding 5 $mg{\cdot}l^{-1}$ extend to a distance of approx. 12 km, at the same time reaching a concentration of 92 $mg{\cdot}l^{-1}$ at a distance of 150 m from the end of the dredging pipeline.

In conditions at which the highest concentrations (of the order of 260 $mg{\cdot}l^{-1}$) occur in an area at a distance of approx.150 m from the dredging pipeline, the suspended solids plume is much smaller and the range of concentrations over 5 $mg{\cdot}l^{-1}$ does not exceed 3.5 km. It should be emphasised that when the highest suspended solids concentrations are reached (stationary hydrodynamic conditions), the disturbance does not extend over large distances.

Within majority of the area in which the disturbance occurs, the concentration ranges between 10–60 $mg{\cdot}l^{-1}$.

The maximum thickness of the new layer of sediments resulting from the sedimentation of suspended solids after the works are completed (at a distance of 150 m from the work site) reaches 35 mm.

The plumes of suspended solids caused by both types of works may merge and slightly strengthen the impact (the discharge/deposition of the excavated soil dominates). The calculated time of suspended solids with a concentration exceeding 5 $mg{\cdot}l^{-1}$ remaining in the water is up to 72 hours.

8.2 MODELLING OF UNDERWATER NOISE PROPAGATION

Underwater sound is generated at all stages related to the construction, operation and decommissioning of an offshore wind farm (OWF). The greatest concerns are related to the underwater noise emitted during construction, due to high levels of sound generated during pile driving into the seabed. Marine organisms, including fish and marine mammals, are sensitive to sound; therefore, the noise accompanying the construction of an OWF may have an impact on them at considerable distances.

For the purposes of the EIA Report, the acoustic emission accompanying piling in the Baltica-1 OWF Area was analysed. The impact of other noise sources, including vessel traffic, was assessed on the basis of the literature on the subject. Drilling the inside of a pile for the purpose of driving it into the ground, according to the literature [ASCOBANS 2020; OSPAR 2016], results in a lower underwater noise impact compared to piling. The noise generated during drilling depends to a large extent on the drilling rig used for drilling. Drillships generate the highest noise levels (up to 174–185 dB re 1 µPa in the 20–1000 Hz frequency band) [Redmond *et al.* 2012]. Erbe and McPherson (2017) recorded noise levels related to geotechnical drilling of 142–145 dB re 1 µPa in the 30–2000 Hz frequency band. The noise from drilling rigs anchored in the seabed, such as jack-up platforms, will probably be low both in terms of the sound source level as well as frequency [Erbe and McPherson 2017]. Kyhn *et al.* (2011) recorded the noise from Stena Forth drillship in Baffin Bay in Greenland. They noted that the broadband noise was 184 dB re 1µPa rms during drilling and 190 dB re 1µPa rms during maintenance. The spectral energy of the noise generated by two drillships is mainly below 1 kHz, and the impact on the local ambient noise shall be, to a large extent, related to low-frequency sound. Kyhn *et al.* (2011) found, however, increased noise levels and peaks at frequencies above 10 kHz, but they were correlated closely with the usage of deck machinery. In the Baltic Sea, the noise generated during drilling will increase the local acoustic field, which is already dominated by the noise generated by vessels. Underwater noise levels from drillships can also constitute an envelope for underwater noise of other types of vessels. Unlike piling, underwater noise from vessels (including drillships) is continuous and not impulse noise, and emits significantly lower acoustic energy (see assumptions for piling modelling below). Underwater impulse noise is considered to have a more negative impact on marine organisms than continuous noise. Evidence of this can be found in the approach of the Danish Energy Agency (2022), which, defining TTS/PTS levels for underwater noise based on all available research and literature, sets them at a lower level for impulse noise (140 dB re 1 µPa^{2}s/155 dB re 1 µPa^{2}s) than for continuous noise (153 dB re 1 µPa^{2}s/173 dB re 1 µPa^{2}s). This clearly indicates that the biggest source of noise during an OWF construction is piling.

The analysis was carried out for wind turbine locations in the northern, central and southern parts of the Baltica-1 OWF Area. The analyses for the northern point were carried out for the winter season, which was considered to be the largest impact range scenario due to better propagation of acoustic waves in winter. The analyses for all points were carried out for the summer season, in which, due to worse propagation conditions, the impact range is definitely smaller than in winter, but increased porpoise activity is recorded in 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 shift 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 (data provided by the Client). The calculated level of 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 µPa^{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 µPa^{2}s;

- SPL_{peak} for a single strike = 248.9 dB re 1 µPa;
- cumulative SEL for all strikes = 267.1 dB re 1 µPa^{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 impact ranges than those obtained for the summer.

Analyses carried out for the winter, without mitigation, indicate that the 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 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 impacts analysed.

With the application of a 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, similarly 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 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 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 further decrease in all 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 impact of TTS and PTS were at a similar level for both double mitigation systems.

Considering the fish with a swim bladder, the lowest 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 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*, 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 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 impact in the Natura 2000 site *Hoburgs bank och Midsjöbankarna* 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 piling. The further south the piling location is located, 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 impact up to a maximum of 3.8%. In summer, the percentage of the area covered by the potential impact is below 1% if any of the mitigation systems analysed is applied.

The detailed methodology and the results of noise propagation modelling are included in Appendix 3 to the EIA Report.

8.3 Modelling the risk of bird collision with the OWF elements

The modelling of the collision risk for birds migrating through the Baltica-1 OWF Area was carried out for two variants, with three scenarios for the APV. The APV assumes 60, 50 or 36 wind turbines with a unit capacity of 15, 20 and 25 MW, respectively, while the RAV assumes 64 wind turbines with a capacity of 14 MW. Detailed technical parameters of both variants are presented in Table 8.1.

Table 8.1. Baltica-1 OWF parameters in the two variants included in the modelling of the risk of collision

Parameter	Applicant Proposed Variant (APV)			Rational Alternative Variant (RAV)
	Scenario 1	Scenario 2	Scenario 3	
Installed capacity [MW]	15	20	25	14
Number of wind turbines	60	50	36	64
Rotor diameter [m]	236	250	310	236
Minimum clearance between the low rotor blade position and the water surface [m]	20			
Nacelle height [m]	138	145	175	138

The survey methodology, assumptions and the results of modelling are presented in Appendix 4 to the EIA Report.

Based on the data from the migratory birds inventory, the species that migrate through the Baltic Sea and are potentially subject to the OWF impact, and those that were observed most frequently during the surveys performed in spring and autumn migration periods were chosen. The migrations of birds over the Baltica-1 OWF Area were dominated by seabirds (common scoter, velvet scoter, long-tailed duck and auks) and birds which migrate over long distances such as geese and passerines. Among the species subject to impact assessment, there are species of low, through moderate to high significance (depending on: the size of the population potentially exposed to the impact, the species sensitivity to the impact and the level of protection – national and international scale). The species of great significance include sea ducks – the long-tailed duck, the common scoter, and the crane.

The OWF impact on migratory birds is considered through the barrier effect and the risk of collision with the OWF elements. As a result of the barrier effect, birds approaching the OWF perceive it as a barrier and change the direction of flight. In order to avoid the OWF, birds can adjust their flight, which extends their migration route. Analyses show, that in each of the project phases, the energy costs related to the extension of the migration route will be minimal (up to 3.8 % higher energy expenditure). The migration route is not the same for all individuals of a given species, and the differences resulting from individual route selection as well as the influence of weather phenomena may be greater than those resulting from the barrier effect. Therefore, the significance of the impact was assessed to be negligible. In the case of cumulative impact analysis, i.e. assuming that the remaining OWFs in the vicinity of the Baltica-1 OWF operate simultaneously, the additional energy expenditure would constitute a minimal part of the total energy needed during the seasonal migration. Thus, the cumulative barrier effect was assessed to be of little significance at most.

The impact in the form of the risk of collision, i.e. bird mortality resulting from collisions with OWF elements, is presented as the total number of collisions of a given species during the spring and autumn migration periods. The risk of collision 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 parameters of individual species such as body size, flight speed, flight altitude, collision avoidance index, as well as on the weather parameters. In the case of reduced visibility (low clouds, night, dense fog), birds are able to spot an OWF from a considerably shorter distance, which results in a higher risk of collision. During the analyses both the Applicant Proposed Variant (APV) and the Rational Alternative Variant (RAV) were tested. Among all of the species included in this analysis, the significance of the impact resulting from collisions was assessed to be low for the common scoter, the long-tailed duck, the crane and the little gull. The maximum number of collisions estimated for the crane is two individuals in spring and one in autumn regardless of the variant. For the remaining species, the significance of the risk of collision was assessed to be negligible. The estimation of the number of collisions possible in the case of cumulative impact was performed taking into account data from other EIA reports and, if such reports were not available, in proportion to the planned OWF capacity. For most species, mortality still remains at a very low level. Cumulative impact for the common scoter means a maximum of 98 individuals colliding, and for the common crane a maximum of 77 individuals in spring in the RAV. In the case of cumulative impact it should be noted that due to the flight trajectory (from north-east to south-west and vice versa) it is very unlikely that migrating birds will encounter more than the nearest neighbouring OWFs (e.g. Södra Victoria, Njord or Öland-Hoburg I). It is important, to emphasise that the cumulative impacts represent a deliberately overstated mortality should the birds actually encounter all the OWFs along their route. Therefore, the significance of the cumulative impact for cranes and geese was assessed as moderate. The good state of these species' populations, even at the maximum collision mortality rates, will not change. For all other bird species and groups, the cumulative collision risk was assessed as low or negligible.

8.4 Modelling of the propagation of underwater noise generated during the OWF operation

Underwater sound is generated at all stages related to the construction, operation and decommissioning of the Baltica-1 OWF.

For the purposes of this report, acoustic emissions associated with the operation of the proposed Baltica-1 OWF located in the Polish exclusive economic zone were examined. The modelling of underwater noise propagation during operation was performed for the following scenarios:

- one turbine operating within the farm area in the summer and winter seasons,
- all turbines operating in summer and winter.

Based on the acoustic modelling performed, the impact zones (in the form of distance from the sound source expressed in km) of noise on marine mammals (porpoises and seals) and fish with swim bladders were estimated. The considered noise impact effects concerned the behavioural response (changes in behaviour) and hearing damage in the form of temporary and permanent shift of the hearing threshold (TTS and PTS) and the reversible hearing damage in the case of fish. As a result, this report constitutes the substantive basis for the Environmental Impact Assessment of the Project in the scope of marine mammals and fish.

For modelling purposes, 72 transects with a maximum length of 150 km were selected, running in all directions. Bathymetric data were obtained from the EMODnet platform. The geological profile of the seabed and the profiles of sound propagation velocity in the ground were determined using publicly available databases.

All ranges calculated for the harbour porpoise during the single turbine operation stage were small, reaching a maximum of 0.1 km for the behavioural response, TTS and PTS. The impact ranges calculated for fish with a swim bladder regarding TTS were at a similar level to those obtained for the harbour porpoise, reaching a maximum range of 0.1 km in both the summer and winter seasons.

The results of noise propagation as a result of the operation of all 64 turbines did not show an increase in the impact ranges for both the harbour porpoise and fish. The sum of the impact ranges for all effects resulted in the areas of impact of 1.9 km^2 each for both taxa, in both seasons analysed.

It should be emphasised that similar results obtained for the harbour porpoise and fish, despite different threshold values or different seasons, can be attributed to the assumed model resolution. The range of 0.1 km is also the minimum range of impact generated by the model. Therefore, the results are identical for all the effects considered.

9 Description of the effects on the environment predicted in the case the Project is not implemented, taking into account environmental information and scientific knowledge available

The implementation of the Project in the variants adopted by the Project Owner will be associated with a number of impacts on the natural environment, most of which will have a negative influence, as shown by the impact assessment carried out. On the other hand, the launch of the Baltica-1 OWF and other planned offshore wind farms will trigger beneficial socio-economic changes at local, national and supra-national levels, considering its function in, for example, the implementation of EU goals related to improving the state of the environment and achieving zero greenhouse gas emissions.

Taking into account the natural environment, in the event of abandoning the Project implementation, the area of the proposed farm will remain intact and there will be no impacts accompanying the construction, operation and decommissioning phases of the farm, which will have a positive effect on all biotic and abiotic elements of the environment located within the range of impacts identified in this report. Considering the most important impacts for the environment, there will be no underwater noise generated that would scare away, and in extreme cases also damage the bodies of marine mammals and fish; as also, there will be no barrier which would hinder the migration of migratory birds and generate the risk of their collision with the farm structures, rising to a significant height above the sea level. In this context, failure to implement the Project will have almost exclusively a positive impact on the environment, including the Natura 2000 site *Hoburgs bank och Midsjöbankarna* located in Swedish waters and on its subjects of protection. Abandoning the construction of the farm and leaving the marine area undeveloped will not result in any changes in the current uses of this sea area, the most important of which are fishing and maritime transport. Fishermen will be able to continue fishing in the sea basin and sail through its area without restrictions resulting from the construction of the wind farm. Theoretically, there will also be no need to change the usual shipping route to the port of Klaipėda, but in this case the construction of other wind farms located in the area of the Middle Bank is significant, including the most advanced projects: the Bałtyk and the Södra Victoria OWFs.

Analysing the Project impact on the environment regarding society, the decision to abandon the construction of the Baltica-1 OWF may cause negative effects on a regional and national scale. On a regional scale, the most important negative factor will be the limitation of the development of the economy focused on the implementation and maintenance of offshore wind energy, i.e. a niche that has so far been a marginal part of the employment market and the allocation of financing. As a result, there will be a negative impact on socio-economic development, because this type of long-term, several-decade-long investments generate significant income (including for the local community) and require the involvement of specialist service units, the establishment of operational bases and the employment of qualified personnel to service them. The implementation of an offshore wind farm and the associated power connection, transmitting electricity to land, is also an essential component of the energy transformation of the region and the country. This will enable firstly, a gradual withdrawal from the production of energy from fossil fuels, secondly, diversification of electricity sources and directions of its acquisition (which in turn will allow for reduction or even independence from foreign suppliers and will affect the country's energy security) and thirdly, a drive for zero emission in energy production. The constantly growing demand for electricity in the absence of the Project implementation will result in further dependence on the extraction and combustion of fossil fuels, i.e. mainly lignite or hard coal, and will negate the energy transformation goals.

Abandoning the implementation of the Baltica-1 OWF, which is part of the country's energy transformation efforts in line with the directions set out in *Energy Policy of Poland until 2040*, will therefore be an impediment to meeting the requirements of Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 *on the promotion of the use of energy from renewable sources* (OJ L 328, 21.12.2018), which indicates the need to increase the share of renewable energy in gross national electricity consumption.

Massive combustion of fossil fuels is the main source of atmospheric pollution with harmful chemical compounds (mainly: carbon oxides, sulphur oxides, nitrogen oxides, hydrocarbons) and particulates, which contribute to the deterioration of air quality and, as a consequence, to the development of respiratory system and circulatory system diseases in humans. The impact of gases and particulates from the combustion of fossil fuels is also one of the main sources of global warming, and their large-scale extraction has a negative impact on the terrain relief, the devastation of soils and related plant and animal communities.

To sum up, the failure to implement the Baltica-1 OWF will have a positive impact on the local environment as it will not cause any negative impacts on its components. It will also not have a negative impact on the current use of this sea basin – fishing and maritime transport will be continued as before. However, the negative effects described above will impact the socio-economic aspects on a regional and national scale, and if the Project is included in the structure of the offshore wind energy development in the Baltic Sea as such, then negative impacts will also be noticeable on a supra-national socio-economic scale and there will be a general negative impact on the environment, resulting from the slower pace of energy transformation in the European Community countries and continued reliance on conventional energy sources.

10 PROJECT IMPACT IDENTIFICATION AND ASSESSMENT

10.1 METHODOLOGY OF THE PROJECT IMPACTS ASSESSMENT

The assessment of impact on individual receptors – the affected components of the environment, was conducted according to the diagram presented in Figure 10.1.

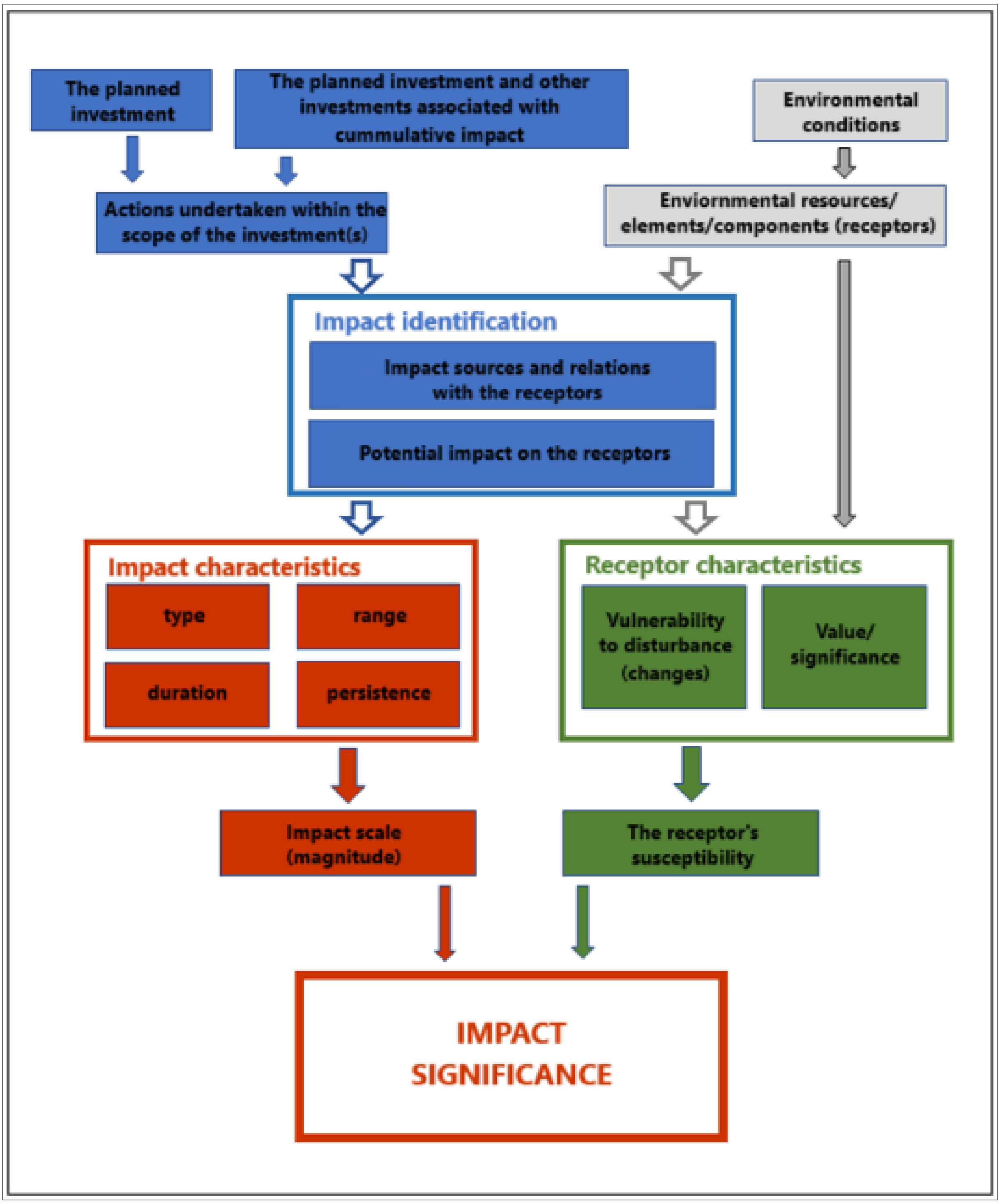

Figure 10.1. Diagram of the environmental impact identification and assessment including the determination of the impact significance [Source: internal materials based on the ESPOO REPORT (2017)]

An actual impact occurs only when a specific sensitive receptor is present within the impact range. Individual environmental components (e.g. species of plants and animals, natural habitats, abiotic components, landscape) but also people and tangible property will be considered receptors, in accordance with the EIA Act.

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

The impacts identified will be assigned features in four categories [Table 10.1]:

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

Table 10.1. Characteristics of the Project 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 with effects extending beyond the direct vicinity of the activities related to the proposed Project but not reaching outside the Polish Sea Areas or the commune area
	Local	Impact that takes place 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, the effects of which will not disappear after the cessation of activities related to the planned undertaking, resources do not return to the initial state

Category	Feature	Characteristics
	Reversible	Impact with effects that cease to be noticeable (measurable) after the activities related to the proposed Project are completed

Due to the overall characteristics of the individual impact features, in some cases, during the detailed assessments, individual concepts will be clarified further, taking into account the specificity of impacts. If good practices or generally accepted and applied methodologies indicated the need for other methodologies of assessment and/or definitions, these will be quoted directly in the place of their use.

As a result, each impact will be characterised and assessed in accordance with the scoring scale provided in Table 10.2.

Table 10.2. Method of assessing individual impacts on receptors

Impact	**Impact characteristics**													**Joint 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 impact characteristics, the size (scale) of the impact will be 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 impact and the receptor, the resistance of the receptors to individual impacts as well as their significance and role in the environment will be determined, including the conservation status in relation to environmental components. As a result, the resistance and significance of the receptors will contribute 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 impact and the receptor sensitivity, the significance of a given impact on the receptor will also be determined on a five-point scale [Table 10.3]:

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

Table 10.3. Matrix defining the significance of the impact in relation to the impact scale and the receptor sensitivity

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
	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 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 enables an effective comparative assessment of all impacts of the Project and the assessment of the Project as a whole. Due to the algorithm of the methodology adopted, it is necessary to quantify both the scale of impact and the sensitivity of the receptors (assigning the number of points from the pool available for individual evaluation criteria). Therefore, for each of the issues assessed in the tables in Sections 10.2 and 10.3, one should refer directly to the text preceding the tables with regard to the detailed assessment of the impact conditions.

A separate category, not subject to assessment with regard to impact characteristics, are cumulative impacts occurring in combination with the impacts resulting from other current and/or planned projects, concerning the same subjects of impact. They were identified regardless of their characteristics and assessment (see: Section 11).

10.2 Assessment of the Applicant Proposed Variant (APV) impact

10.2.1 Construction phase

10.2.1.1 Impact on geological and geomorphological structure

A significant aspect of the assessment of the Baltica-1 OWF impact on the processes taking place on the seabed and the seabed itself is to determine the scale of impact intensity and impact range. The impact significance is considered high or very high if the change to the character of the surface and the structure of the seabed is greater than the size of geomorphological forms potentially occurring on the seabed. The impact range determined as local, in geological and geomorphological terms, refers to point or linear changes (cable laying) to the topography and structure of the seabed and does not extend beyond the dimensions of the forms possibly created in a given area, in specific conditions. The local range refers to changes taking place in the immediate vicinity of the impact associated with the proposed Project.

The sensitivity, i.e. the response of the seabed topography and structure, is assessed on a five-point scale in accordance with the data contained in Table 10.4.

Table 10.4. Sensitivity of seabed relief to impacts resulting from activities related to the Baltica-1 OWF construction

Sensitivity	Description
Irrelevant	No changes in the topography and structure of the seabed or changes similar to the ones observed caused by natural processes
Low	Changes noticeable, but not altering the character of the topography and structure of the seabed; local range
Moderate	Changes noticeable, altering the character of the topography and structure of the seabed to a degree not affecting the general character of the area; local range
High	Changes affecting the topography and structure of the seabed, altering its character and affecting processes taking place on the seabed; local range, limited to the Project area, possible small impact on the character of the topography of adjacent areas
Very high	Changes significantly affecting the topography and structure of the seabed in the area analysed, which may significantly affect geological and geomorphological processes of the Project area and adjacent areas

Depending on its structure, the seabed may exhibit different sensitivity to the impact of the Project during the construction phase. The seabed made of till and till with a stony cover is difficult to wash out and withstands morphological changes. A sandy, sandy-silty, and silty seabed is more susceptible to being washed out and to material moving over it, e.g. in the form of mega-ripples. Thus, the elements of the OWF infrastructure may be exposed or buried, both as a result of natural processes involving the movement of rock material along the seabed and as a result of this movement being disrupted by the OWF infrastructure components.

Activities related to the Project construction may cause the following types of impact on the seabed:

- local, point changes in the seabed structure when it is necessary to replace/reinforce the ground where wind turbines and OSSs are to be located (some types of foundations or support structures require protective layers around their bases to prevent washout; crushed stone, stones and boulders are most often used for this purpose; these actions cause a change in the composition of seabed sediments), as well as jack-up vessel support legs;
- point disturbance of geological structure due to embedding elements of foundations of a power station (drilling or pile-driving of foundations, erection of support structures, laying or possible burying of cables, dredging works);
- changes in the seabed relief due to preparation of the seabed for the foundations, cable laying, levelling of the seabed along the cable route; changes in the seabed morphology will also occur as a result of the possible storage of rock material excavated during the seabed preparation for the foundations;
- seabed level changes due to the deposition of rock material raised and moved during preparatory and construction works (from suspended solids);
- pits forming in the seabed at the anchoring locations of vessels installing elements of the OWF infrastructure;
- disturbance and sedimentation of suspended solids − during construction works, suspended solids will be raised locally, which will result in water turbidity. Suspended solids generated as

a result of sediment disturbance during dredging works are deposited on the seabed depending on the water movement in the area. The disturbed sediment will propagate mainly within the OWF Area and no further than a dozen kilometres from its boundaries (in trace amounts), and while falling , it will cover the seabed with an average thickness of no more than a few millimetres (up to a maximum of 35 mm at distance of 150 m from the places of sediment replacement for jack-up vessel support legs).

The overall impact of the Project during its construction phase was assessed to be negligible for the general character of the seabed and its structure – the changes will be minor, over a small seabed area, local (foundations of wind turbines) or linear (along the cable route).

Table 10.5 and Table 10.6 present an assessment of the scale and of the significance of the impacts on geological structure, seabed relief, seabed sediments, access to raw materials and deposits identified for the construction phase of the Baltica-1 OWF.

Table 10.5. Assessment of the scale of impacts on geological structure and seabed relief during the Baltica-1 OWF construction phase

Impact	**Impact characteristics**													**Joint 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**
Local, point changes in the seabed structure	3					1					1	2		7
Point disturbance of geological structure	3					1					1	2		7
Changes in the seabed relief	3					1					1		1	6
Changes in the seabed level resulting from sedimentation	3					1					1		1	6
Disturbance of the seabed by anchoring vessels	3					1					1		1	6
Deposition of suspended solids		2				1					1		1	5

Table10.6. Assessment of the significance of impacts on geological structure and seabed relief during the Baltica-1 OWF construction phase

Impact	**Impact scale**	**Receptor sensitivity**	**Impact significance**
Local, point changes in the seabed structure	low	low	**Negligible**
Point disturbance of geological structure	low	low	**Negligible**
Changes in the seabed relief	low	low	**Negligible**
Changes in the seabed level resulting from sedimentation	low	low	**Negligible**
Disturbance of the seabed by anchoring vessels	low	low	**Negligible**
Deposition of suspended solids	irrelevant	irrelevant	**Negligible**

Taking into account the results of the impact assessment, the limited space in which the Project may be located and the possible technologies for its execution, no measures to minimise the negative impact of the Baltica-1 OWF on the geological structure and relief of the seabed are indicated.

10.2.1.2 Impact on seabed sediments

In geological terms, taking into account the character of deposits forming the seabed surface of the Baltica-1 OWF Area, no significant changes in the nature of deposits are expected. Possible changes may occur only locally, where it is necessary to replace weak soil with soil of appropriate parameters, but this will mainly depend on the technology selected. 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.). It is possible to use monopile foundations, gravity-based structures as well as suction bucket jacket foundations. In the vicinity of individual turbines and OSSs, the character of surface sediments will change and, locally, in places where the foundations or support structures are inserted into the seabed – sediments forming the seabed will change. The Baltica-1 OWF Area covers a surface area of 85.53 km^2. Changes in the character of the surface sediments will affect the seabed covered by the installation of foundations of up to 60 wind turbines and up to 4 OSSs with an area of 1.33 km^2 (including the area occupied by the erosion protection layer around the foundations and possible seabed area occupied by the stabilisation bedding for the jack-up vessel legs), i.e. a maximum of 1.56% of the Baltica-1 OWF Area. Therefore, the Project impact on the character of the surface sediments will be minor.

The changes in the character of surface sediments during cable laying, with an anticipated cable route length of 140 km and a maximum width of the strip occupied by the cables of 16 m, will affect an area of 2.24 km^2, which is a maximum of 2.62% of the Baltica-1 OWF Area. Taking into account the total area of the seabed surface covered by underwater works, it is assumed that the impact of the Baltica-1 OWF during the construction phase on the seabed sediments will be **negligible**.

10.2.1.3 Impact on raw materials and deposits

The west part of the Baltica-1 OWF Area lies east of the 'Southern Middle Bank – Southern Baltic' sand-gravel deposit, approximately 60 m from the boundary of the closest of three mining areas established on this deposit.

On the basis of the bathymetric and sonar data analysis and using the data from the analysis of surface sediment samples and core samples collected using a vibrocorer, as well as data from seismic and seismo-acoustic surveys, preliminary characteristics of the Baltica-1 OWF Area regarding the presence of sandy and sand and gravel covers was developed. Data from literature were also analysed. The Baltica-1 OWF Area lies within the range of occurrence of sands and sands and gravels of various grain sizes. On the surface of the seabed, there are fine and medium-grained sands, while in its northern part, there are medium and coarse sands as well as sands with gravel and gravels with sand. The thickness of the sand and gravel sediments in greater part of the Baltica-1 OWF Area is over 1 m. Almost the entire Baltica-1 OWF Area is indicated as prospective in terms of occurrence of aggregate resources. Their potential development will be possible according to the provisions of the MSPPSA for the sea basin POM.60.E (see Section 3.1.3).

The Baltica-1 OWF Area development will prevent or significantly reduce the access to and potential future extraction of sands and gravels pursuant to the provisions of the Regulation of the Council of Ministers of 14 April 2021 (Journal of Laws of 2021, item 935, as amended) for the sea basin POM.60.E in which the Project area is located: *'in the entire sea basin, the function of (prospecting and exploration of mineral resources and extraction of minerals from deposits) shall be limited to methods which do not disturb linear elements of technical infrastructure; do not jeopardise the ecological function of spawning grounds and the survival of the early development stages (eggs and larvae) of commercial species; in the entire sea basin the extraction of minerals from deposits is limited to projects agreed upon with the relevant project owners of offshore wind farms'*.

Despite the above information, the Project impact on possible mineral deposits exploitation was assessed to be **negligible**.

10.2.1.4 Impact on the seawater and seabed sediment quality

Seawater and seabed sediments as receptors of the proposed Project impact were analysed jointly in terms of mutual physico-chemical interactions.

Water depth and seabed sediments constitute very important elements of the aquatic ecosystem of the Baltic Sea, which is shallow and small with limited water exchange through the narrow and shallow Danish Straits. The surface of the sea is approximately 4 times smaller than that of its catchment area. Approximately 85 million people live in this area. Such conditions make each interference in the marine environment – fishing, shipping, discharge of municipal and industrial wastewater, surface water runoff from industrial and agricultural areas, but also activity related to the exploitation and development of the seabed – affect the delicate ecological balance of the sea [Uścinowicz 2011]. Water and sediments in water bodies are strictly connected with each other. A form of balance exists between the various components of the marine environment and, in particular, between water and seabed sediment. A change in one component (e.g. sediments) causes changes in the other (water) and vice versa.

Most POPs (heavy metals and toxic organic compounds characterised by low solubility and slow degradation) which are released into the environment as a result of human economic activity and reach surface waters are retained in sediments [Bojakowska, 2001]. Sediments, however, are not only a place of deposition of persistent and toxic pollutants reaching the environment but also a place of existence, source of nourishment, place of reproduction and growth of numerous aquatic organisms. Contaminated sediments pose high risks to the biosphere since some of the harmful substances contained in the sediments may transfer into the water as a result of chemical and biochemical processes and be accessible to living organisms [Frostner, 1980; Bourg and Loch, 1995].

This subsection identifies, characterises and evaluates the impact of the OWF on the quality of sea water and seabed sediments. It was found that during their construction phase, OWFs may cause various types of impacts on the receptors discussed (water and seabed sediments). These are:

- release of pollutants and nutrients from sediments into water,
- contamination of water and seabed sediments with petroleum products;
- contamination of water and seabed sediments with antifouling agents;
- contamination of water and seabed sediments by accidental release of municipal waste or domestic sewage;
- contamination of water and seabed sediments by accidentally released chemicals and waste from the construction of the OWF.

Release of pollutants and nutrients from sediments into water

The disturbance of the seabed sediments related to the construction (laying) of foundations and/or support structures for the OWF facilities, anchoring of vessels or burying of a cable is a process which contributes to pollutants passing from sediments into water [Frostner 1980; Bourg and Loch 1995; Bojakowska 2001; Dembska 2003; Uścinowicz 2011]. During construction works, substances including labile metal forms, POPs, i.e. PAHs and PCBs, nutrients (nitrogen and phosphorus compounds) will pass into the water.

The most important parameters influencing the impact level are the dimensions and number of foundations and/or support structures, the length of cable sections and the width and depth of the cable trench, the types and amount of pollutants accumulated in seabed sediments and the type of rock material forming the seabed.

The transfer of pollutants from sediments into water (and thus a change in water quality) and the formation of long-lasting suspended solids depend on the type of sediment. The largest amount of pollutants and nutrients will be transferred to water from sediments with an increased organic matter content (e.g. silty, clayey sediments with a higher concentration of metals and POPs). These deposits will also contribute to the formation of a greater amount of suspended solids, which will remain in the water for a long time. Intense resuspension may cause the release of nutrients immobilised in the sediment and contribute to eutrophication. In the case of sandy deposits with low organic matter content (e.g. coarse sandy sediments), the processes described will be less intense. These sediments are generally characterised by a small amount of fine fractions and low concentrations of metals and POPs. Therefore, it is estimated that the processes related to the release of nutrients and POP will occur at low intensity in the entire Baltica-1 OWF Area.

It should be emphasised that the substances released from the sediment will pass into water. However, within approximately 1 year from the completion of the construction activities, these substances will transfer back into sediments after reaching an equilibrium.

The most far-reaching scenario is the use of gravity based structures in the APV. Their construction requires the preparation of the seabed, which may involve the removal of a layer of seabed sediments, not only in the location of the foundation and/or support structure but also in its direct vicinity. The volume of the disturbed sediment for this technology in its two extreme options is given in Table 10.7.

In the case of other technologies analysed (large-diameter monopile, lattice structure, or jacket foundation), the volume of sediment disturbed will be many times smaller, because in most cases these structures do not require seabed preparation and also the diameter of the foundation piles driven will be many times smaller than the diameter of gravity based structures. The sediment around the piles driven will liquefy as a result of vibrations caused by the operation of the pile driver.

An example calculation of the amount of sediment disturbed for a monopile with a diameter of 12.00 m is presented below. Given that the piles of such diameter will be driven several dozen metres into the seabed, it can be assumed that sediments deposited at the depth of approximately 1 m will be disturbed within a radius of approximately 3 m from the pile. The volume of sediment disturbed during pile driving into the seabed was calculated using the following formula:

$$V_a = V_{tr\ cone} - V_{cyll.}$$

where:

V_a – volume of the sediment layer disturbed during pile driving into the seabed,

$V_{tr\ cone}$ – volume of the truncated cone,

$V_{cyll.\ III}$ – volume of the cylinder.

Once the values are substituted in the formula, the volume of sediment disturbed during the driving of one pile into the seabed amounts to approximately 66 m^3 of sediment per foundation and/or support structure.

If the installation of a pile foundation is hindered by the presence of hard rocks in the seabed, drilling may be necessary. Drilling can be performed inside the pile or in a casing pipe. Assuming that the entire pile volume has to be drilled, the volume of the sediment disturbed will be approximately 6000 m^3 per monopile with a diameter of 12 m and the need to drill to the full depth of seabed penetration. The spoil from drilling is usually excavated onto a barge. Once the foundation installation is complete, most of the spoil will be placed inside the monopile and the excess will be spread in a location agreed with the maritime authority. If the spoil is not classified as waste and there is an opportunity to do so, some of the excess spoil will be used to prevent the foundation from being washed out. In the event that the spoil becomes waste, it will be transported ashore or to a sea dumping site designated by the director of the maritime office.

Additionally, regardless of the type of foundation and/or support structure selected, sediment will be disturbed during cable laying. A power cable can be buried in the seabed using two main technologies:

- SLB – Simultaneous Lay and Burial of cable in the seabed sediment;
- PLB – Post Lay Burial – cable burying preceded by cable laying on the seabed.

The most far-reaching scenario is the application of the PLB technology in both the RAV and the APV, and the use of self-propelled remotely operated water jetting, ploughing and mechanical cutting equipment in construction activities. In the case of this technology, the volume of sediment disturbed will be larger than in the case of the SLB technology.

Seabed sediment will be disturbed during cable laying. The maximum width of the seabed strip covered by the construction works for a single cable line will be 16 m, which corresponds to the maximum spacing of the tracks of the equipment used for cable line construction.

However, the main disturbance of the sediment will take place to an average depth of 3 m and a width of 5 m using ploughing technology and to a maximum depth of 6 m and a width of 1 m using jetting technology. Thus, the maximum volume of the sediment disturbed during cable laying using ploughing technology will be 7.5 m^3 of sediment per 1 cable running metre and, with a length of 120–140 km in the APV, will result in between 900 000 and 1 050 000 m^3 of disturbed sediment. By contrast, using jetting, it will be 6 m^3 per 1 cable running metre, resulting in 720 000 to 840 000 m^3 of disturbed sediment.

Moreover, during the construction of foundations and/or supporting structures and the installation of towers, seabed sediment disturbance due to anchoring of vessels will be observed. The anchoring process itself is short-term, affecting a small area (local) to a depth of approximately 3 m, so the volume of the sediment disturbed will be small.

On the basis of the above assumptions and the concentrations of pollutants and nutrients found within the Baltica-1 OWF Area (see Subsection 7.1.4), an estimation was made of their release into the water in the RAV.

The most far-reaching scenario is the use of gravity based structures in the APV. Their construction requires the preparation of the seabed, which may involve the removal of a layer of seabed sediments, not only in the location of the foundation.

The calculations assume an average dry sediment density of 1.6 g·cm^{-3} (1600 kg·m^{-3}) and an average sediment moisture content of 23.3%. For the purpose of calculations, the volume of sediments necessary to be removed for the correct installation of the gravity based structure (the most unfavourable variant) was assumed to be between 16 500 m^3 and 22 000 m^3 (APV 25 MW and 15 MW, respectively). To calculate the weight of pollutants, which may be transferred into the water during the cable line construction, the most unfavourable variant from the point of view of the potential for generating suspended solids was adopted, i.e. the method of creating a trench using directed water jets, which can disturb 6000 m^3 of sediment per 1 km of cable and the jetting method of cable laying adopted as the preferred one, which will disturb smaller volume of sediment per one linear kilometre of the cable, i.e. 7500 m^3.

The estimated amount of heavy metals, pollutants and nutrients which may be released in the APV during its implementation as part of the Baltica-1 OWF Project is presented in Table 10.7 a Table 10.8.

In addition, envelope calculations were carried out in the situation of the seabed preparation for the installation of jack-up vessels at the location. This will involve replacing the surface sediment with an aggregate bedding layer. Such replacement will be required for each of the four jack-up ‘legs’. For each leg, up to 19 000 m^3 of sediment will be disturbed. The following are the calculations taking into account the volume of sediment disturbed for both the gravity based structures and the APV substations (construction phase) including the disturbance of the seabed for a jack-up vessel [Table 10.9].

In the case of indicators, the concentration of which during the environmental surveys conducted was below the lower limit of quantification (LOQ) of the survey methods applied to calculate the load (for illustrative purposes), the values of this limit (marked with "<" in the table) were adopted. The table also presents the loads annually entering the Baltic Sea with the rivers of Poland and with precipitation [Uścinowicz 2011; GUS 2023]. The results of the State Environmental Monitoring carried out by CIEP in the years 2003–2012 were also used. As it was shown, the estimated results obtained for the re-mobilisation of individual indicators are insignificant. In the case of aluminium, which is a metalloid and a macronutrient, due to its relatively low solubility in the range of pH prevailing in sea waters, the part of this element released during the raising of seabed sediments into the water depths will be relatively quickly sorbed by the seabed sediments. However, this part of aluminium may be activated as the acidity of the water increases [Kabata-Pendias and Pendias 1993; Uścinowicz 2011]. The values for aluminium may be justified by its ubiquity. Aluminium is one of the most common metals on the globe. Its content in the Earth's crust is estimated at approximately 7–8%, ranking third after oxygen and silicon, and first among metals. In its free state, the metal is not present, it is highly reactive and its compounds are present in almost all rocks, surface waters and living organisms. The complex chemical properties of aluminium, which regulate its mobility and transition from the solid to the aqueous phase, determine its important role in the environment. It forms numerous mineral and organic complexes with varying degrees of hydration. The common feature of these compounds is metastability, i.e. the ease of conversion to other forms and high solubility in an acidic environment [Migaszewski and Gałuszko 2007, Widłak and Widłak 2013]. Under natural conditions, aluminium can be found in the form of hardly soluble minerals – silicates and aluminosilicates. The total aluminium content in soils varies within a wide range from 1% to more than 25%. As the finer fraction (<0.02 mm) increases in the soil, the silicon content decreases and the aluminium content increases. Igneus rocks and shale tills (8% Al), as well as soils from mountainous and submontane areas, are examples of aluminium-rich soils. Sandstone and limestone are characterised by lower aluminium concentrations (2.5% and 0.4% Al, respectively) [Kotowska *et al*., 1994, Zuziak and Jakubowska 2016].

Table 10.7. Comparison of the mass of pollutants and nutrients which may be released into water during the seabed disturbance while laying the foundations for wind turbines and OSSs in the APV (construction phase) with the load entering the Baltic Sea through rivers and precipitation

Parameter	One gravity-based structure for the 25 MW rotor (GBS)	APV (36 foundations)	One gravity-based structure for the 15 MW rotor (GBS)	APV (60 foundations)	One OSS	Maximum 4 OSSs	Annual load entering the Baltic Sea through rivers	Annual load entering the Baltic Sea through precipitation
Volume of the sediment disturbed	22 000 m³	792 000 m³	16 500 m³	990 000 m³	40 000 m³	160 000 m³	no data available	no data available
Weight of the sediment disturbed	27 010 Mg	972 361 Mg	20 258 Mg	559 589 Mg	49 109 Mg	196 436 Mg	no data available	no data available
Dry weight of the sediment disturbed	20 726 Mg	746 121 Mg	15 544 Mg	1 243 536 Mg	37 683 Mg	150 732 Mg	no data available	no data available
Lead (Pb)	51.0 kg	1843 kg	38 kg	3072 kg	93 kg	372 kg	24 000 kg	200 000 kg
Copper (Cu)	21.3 kg	769 kg	16.0 kg	1281 kg	39 kg	155 kg	112 000 kg	no data available
Chromium (Cr)	20.7 kg	746 kg	15.5 kg	1244 kg	38 kg	151 kg	no data available	no data available
Zinc (Zn)	145 kg	5230 kg	109 kg	8717 kg	264 kg	1057 kg	122 000 kg	no data available
Nickel (Ni)	22 kg	806 kg	17 kg	1343 kg	41 kg	164 kg	687 000 kg	no data available
Cadmium (Cd)	<1.0 kg	<37 kg	<0.8 kg	<62 kg	<1.9 kg	<7.5 kg	2300 kg	7100 kg
Mercury (Hg)	<0.2 kg	<7.5 kg	<0.2 kg	<12 kg	<0.4 kg	<1.5 kg	2100 kg	3400 kg
Arsenic (As)	<26 kg	<933 kg	<19 kg	<1554kg	<47 kg	<188 kg	no data available	no data available
Aluminium (Al)	12 290 kg	442 450 kg	9217 kg	737 417 kg	22 346 kg	89 384 kg	no data available	no data available
PCB congeners	<0.010 g	<0.373 g	<0.008 kg	<0.622 g	<0.019 g	<0.0755 g	260 000 g	715 000 g
PAH analytes (PAH group)	23.8 g	858 g	17.9 g	1430 g	43 g	173 g	no data available	no data available
Available phosphorus (P)	1828 kg	65 808 kg	1371 kg	109 680 kg	3324 kg	13 295 kg	9 500 000 kg (P tot.)	163 000 000 kg
Nitrogen (N)	<415 kg	<14 922 kg	<311 kg	<24 871 kg	<754 kg	<3015 kg	136 000 000 kg (N tot.)	5 700 000 kg

Table 10.8. Comparison of the mass of pollutants and nutrients which may be released into water during cable line construction in the APV (construction phase) with the load entering the Baltic Sea through rivers and precipitation

Parameter	**1 km of cable (jetting)**	**APV Length of the cable route (120 – 140 km)**	**1 km of cable (ploughing)**	**APV Length of the cable route (120 – 140 km)**	**Annual load entering the Baltic Sea through rivers**	**Annual load entering the Baltic Sea through precipitation**
Volume of the sediment disturbed	6000 m³	720 000–840 000 m³	7500 m³	900 000 –1 105 000 m³	No data available	No data available
Weight of the sediment disturbed	7365.6 Mg	883 872–1 031 184 Mg	9280 Mg	1 104 955–1 289 114 Mg	No data available	No data available
Dry weight of the sediment disturbed	5652.8 Mg	678 336–791 392 Mg	7065.5 Mg	847 865–989 176 Mg	No data available	No data available
Lead (Pb)	13.6 kg	1632–1904 kg	17.5 kg	2094–2443 kg	24 000 kg	200 000 kg
Copper (Cu)	5.84 kg	700.8–817.6 kg	7.3 kg	873–1019 kg	112 000 kg	No data available
Chromium (Cr)	5.68 kg	681.6–795.2 kg	7.1 kg	848–989 kg	No data available	No data available
Zinc (Zn)	39.2 kg	4704–5488 kg	49.5 kg	5944–6934 kg	122 000 kg	No data available
Nickel (Ni)	6.1 kg	733–855 kg	7.6 kg	916–1068 kg	687 000 kg	No data available
Cadmium (Cd)	0.32 kg	38.4–44.8 kg	<0.4 kg	42–49 kg	2300 kg	7100 kg
Mercury (Hg)	0.056 kg	6.72–7.84 kg	0.07 kg	8.5–10.0 kg	2100 kg	3400 kg
Arsenic (As)	7.04 kg	844.8–985.6 kg	<8.8 kg	1060–1236 kg	No data available	No data available
Aluminium (Al)	3352 kg	402 228–469 266 kg	4190 kg	502 784–586 581 kg	No data available	No data available
PCB congeners	0.0032 g	0.384–0.448 g	<0.004 g	0.424-0.498 g	260 000 g	715 000 g
PAH analytes (PAH group)	6.48 g	777.6–907.2 g	8.1 g	975–1138 g	No data available	No data available
Available phosphorus (P)	498.4 kg	59 808–69 776 kg	623.2 kg	74 782–87 245 kg	9 500 000 kg (P tot.)	163 000 000 kg
Nitrogen (N)	112.8 kg	13 536–15 792 kg	<141 kg	16 957–19 784 kg	136 000 000 kg (N tot.)	5 700 000 kg

Table 10.9. Comparison of the mass of pollutants and nutrients which may be released into water during the seabed disturbance while laying the foundations for wind turbines and OSSs in the APV (construction phase), including the disturbance of the seabed for a jack-up vessel, with the load entering the Baltic Sea through rivers and precipitation

Parameter	**APV (60 foundations, 4 OSSs, aggregate seabed reinforcements under each of the 4 jack-up vessel legs)**	**Annual load entering the Baltic Sea through rivers**	**Annual load entering the Baltic Sea through precipitation**
Volume of the sediment disturbed	3 582 000 m^3	no data available	no data available
Weight of the sediment disturbed	4 397 722 Mg	no data available	no data available
Dry weight of the sediment disturbed	3 374 504 Mg	no data available	no data available
Lead (Pb)	8 335 kg	24 000 kg	200 000 kg
Copper (Cu)	3 476 kg	112 000 kg	no data available
Chromium (Cr)	3 375 kg	no data available	no data available
Zinc (Zn)	23 655 kg	122 000 kg	no data available
Nickel (Ni)	3 678 kg	687 000 kg	no data available
Cadmium (Cd)	<169 kg	2300 kg	7100 kg
Mercury (Hg)	<34 kg	2100 kg	3400 kg
Arsenic (As)	<4218 kg	no data available	no data available
Aluminium (Al)	2 001 081 kg	no data available	no data available
PCB congeners	<1.69 g	260 000 g	715 000 g
PAH analytes (PAH group)	3881 g	no data available	no data available
Available phosphorus (P)	297 631 kg	9 500 000 kg (P tot.)	163 000 000 kg
Nitrogen (N)	<67 490 kg	136 000 000 kg (N tot.)	5 700 000 kg

It was assumed that all sediments removed from the construction sites of foundations and/or support structures during seabed preparation will be left in the Baltica-1 OWF Area. If a different decision is made and the sediment removed is transported to shore, the level of heavy metals, pollutants and nutrients released will be lower. Similarly, if other types of foundations and/or support structures (large-diameter monopile, jacket structure, tripod structure, etc.) are used, for which the seabed area disturbed, including the sediments, is significantly smaller, the impact will be smaller.

At the same time, disturbing seabed sediments may slightly improve their quality (increase in oxygenation and decrease in the amount of pollutants and nitrogen compounds in the sediment due to their transfer to water). The improved oxygenation of the sediments may, however, reduce (limit) the passage of phosphorus from the sediment, since this process occurs under anaerobic (reducing) conditions [Alloway and Ayres 1999].

The sensitivity of sea waters was assessed as moderate and that of the seabed sediments as low.

The release of pollutants and nutrients from seabed sediments during the construction phase is a direct negative impact of a local or regional range, short-term, reversible, repeating during the construction period, characterised by low intensity.

The significance of this impact during the construction phase in the APV was assessed as negligible for sea waters and as low for seabed sediments.

Contamination of water and seabed sediments with oil derivatives during normal operation of vessels in the course of construction and at the time of their breakdown or collision

Pollutants entering water during normal operation of vessels form the second largest source of oil pollution at sea. This is the source of approximately 33% of oil released into the environment (mainly due to increased maritime traffic in the Baltic Sea region) [Kaptur 1999]. In comparison, approximately 37% of oil entering the sea is a run-off from land brought by rivers, while the tanker disasters only rank third (12%).

During the construction phase, vessels (ships, barges, etc.) will be used, from which small leaks of petroleum products (lubricating oil, fuel oil, petrol, etc.) may occur during normal operation. To a minor extent, they may contribute to the deterioration of water quality.

It should be assumed that these will be small spills (Tier I), up to 20 m^3. Visible traces of such contaminants may disappear spontaneously in favourable conditions, as a result of evaporation and dissipation in water. In practice, the size of these spills will be limited to the Baltica-1 OWF Area.

The sensitivity of sea waters and seabed sediments to small spills of petroleum products occurring during normal operation of vessels was assessed as low.

Contamination of seawaters and seabed sediments with petroleum products released during normal operation of vessels is a direct negative impact of a local range, momentary or short-term, reversible, repeatable, of low intensity.

The significance of this impact during the construction phase in the APV was assessed as negligible for sea waters and seabed sediments.

The spillage of petroleum products resulting in the contamination of water and seabed sediments may also occur in emergencies (as a result of a breakdown or a collision of vessels, a structural collapse of one of the OWF facilities, as well as during maintenance works). Such events may contribute to the deterioration of coastal water quality (if the spill reaches the shore). 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 approximately 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 approximately 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 to 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. approximately 120−190 accidents at sea every year. The majority of 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 analysed Baltica-1 OWF Area can be included, the risk of a collision with a spill of over 5000 tonnes was estimated to be 1 incident in 1060 years, while the areas under the greatest threat are found around the Wolin and Rüggen islands as well as around the Hel Peninsula.

During construction 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 the total capacity of approximately 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 approximately 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 structural collapse at the OWF (a wind turbine falling over or a vessel colliding with the 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 type and amount of petroleum products released, weather conditions and the type of rock material forming the seabed.

The sensitivity of both receptors may be high in case of emergency or collision.

Furthermore, 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 of 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 negative impact of regional/transboundary range, which is mid-term, reversible, repeatable, and of high intensity.

The significance of this impact during the construction phase in the APV, due to the random and sporadic nature of breakdowns and collisions was assessed as low for sea waters and seabed sediments.

Accidental contamination of water and seabed sediments with anti-fouling agents containing organotin compounds (e.g. TBT)

Hulls of vessels are protected against fouling with biocides, which may contain e.g. copper, mercury and organotin compounds (e.g. TBT). These substances may pass into the water and eventually be contained in the sediment. It should be assumed that the releases of those compounds will be limited due to their dilution in the water. Among the substances listed, organotin compounds are the most harmful (toxic) to aquatic organisms. The use of TBT (the most harmful substance) in anti-fouling paints is now prohibited but the presence of those compounds in older vessels cannot be ruled out. The sensitivity of sea waters and seabed sediments to biocides released from hulls was assessed as medium.

Vessels (ships, barges, etc.) will be used at each phase of the project and their hulls may release certain amounts of anti-fouling substances into the water during normal operation. Consequently, they can contaminate sediments. To avoid this, at every stage of the project, it is recommended to use vessels the hulls of which have not been coated with anti-fouling paint containing TBT. This will eliminate this most harmful impact on aquatic organisms.

The most important parameters influencing the level of impact are the type and amount of anti-fouling substances released as well as the type of rock material forming the seabed.

The sensitivity of both receptors is moderate.

Contamination of water and/or seabed sediments with antifouling substances during the construction phase is a direct negative impact of a local or regional range, short-term, reversible, repeatable during the construction period, of low intensity.

The significance of this impact during the construction phase in the APV was assessed as of low significance for sea waters and seabed sediments.

Contamination of water and seabed sediments by accidental release of municipal waste or domestic sewage

At each Project stage, waste will be generated on vessels and at the onshore site facilities (located in the port supporting the Project implementation) – mainly municipal and other waste, not related to the construction process directly, as well as domestic sewage. Waste and sewage may be accidentally released into the sea while being received from vessels by another vessel and during a breakdown, resulting in a local increase in nutrient concentrations and the deterioration of water and sediment quality. However, the contaminants should rapidly disperse, which will stop them from contributing to a permanent deterioration of the environment in the Project area. The sensitivity of the seawater and seabed sediments to this type of impact is considered negligible.

The most important parameters affecting the level of this impact are the type and quantity of the waste or sewage released, the weather conditions as well as the type of rock material forming the seabed.

The contamination of seawater and/or seabed sediments with municipal waste or domestic sewage is a direct negative impact of a local range, short-term or momentary, reversible, repeatable during the construction period, of low intensity.

The significance of this impact during the construction phase in the APV was assessed as negligible for sea waters and seabed sediments.

Contamination of water and seabed sediments by accidentally released chemicals and waste from the construction of the OWF

During the construction of the OWF, waste directly related to the construction process will be generated on vessels, at onshore site facilities (located in the port handling the implementation of the Project) and at the Project site. These may include, among others, damaged parts of the OWF components, cement, joint grouts, mortars, machine fluids and other chemical substances used or replaced during construction works. These may be accidentally released into the sea.

This waste is mainly generated during the construction and decommissioning phases (most often the waste from group 17 of the Annex to the Regulation of the Minister of Climate of 2 January 2020 *on the waste catalogue* (Journal of Laws of 2020, item 10)). Waste produced during the construction phase will include e.g. cable scrap, sanitary waste from ships, flammable waste, oil and chemical waste, as well as construction waste. Waste should be neutralised in accordance with the applicable regulations concerning industrial waste.

The most important parameters affecting the level of this impact are the type and quantity of waste or sewage released, weather conditions and the type of rock material forming the seabed.

Bulk cement is packed in bags of approximately 1 m^3 each. It was assumed that during reloading activities, approximately 5 m^3 of this product may sink. Grouts, mortars and other binders often contain hazardous substances. For example, epoxy (two-component) binders contain various proportions of epoxy resin, alkyl-glycidyl ethers and polyaminoamides. When released into water, these substances, due to their high density (approximately 1.3 $g \cdot cm^{-1}$) sink and deposit on the seabed. They are considered a serious threat because they cannot be easily removed from the seabed and are toxic to marine organisms.

Generally, for projects such as the Baltica-1 OWF, a detailed plan is prepared to prevent the risks and contamination generated during the construction, operation and decommissioning of an OWF, which contains mitigating measures and a procedure to be followed in case of such events.

The sensitivity of both receptors in the case of this impact is moderate.

The contamination of seawater or seabed sediments connected with the OWF construction process is a direct negative impact of a local range, short-term or momentary, irreversible, repeatable during the construction period, of medium intensity.

The significance of this impact during the construction phase in the APV was assessed as negligible for sea waters and as low for seabed sediments.

It is worth noting that due to the proximity of the boundary of the Swedish EEZ, some of the identified impacts and pressures that could potentially have been classified as local or regional were considered as potentially transboundary. This would primarily concern activities related to the construction, operation and decommissioning of the farm components located in the northern part of its area, close to the boundary. Additionally, it should be noted that the Baltica-1 OWF Area is located near the Swedish Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308), which is not only an important wintering site for seabirds, but also the grey seal habitat and the main porpoise population area in the Baltic Sea. The dispersal of suspended solids from the sediments disturbed as well as the dispersal of petroleum products threatening protected areas and the objects of protection in that area is unlikely.

Table 10.10 and Table 10.11 present an assessment of the scale and of the significance of the quality of seawater and seabed sediments identified for the construction phase of the Baltica-1 OWF.

Table 10.10. Assessment of the scale of impacts on the quality of seawater and seabed sediment during the construction phase of the Baltica-1 OWF in the APV

Impact	**Impact characteristics**													**Joint 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**
Release of pollutants and nutrients from the sediments into the water (for water)	3				2				3				1	9
Release of pollutants and nutrients from the sediments into the water (for sediments)	3					1				2			1	7
Contamination of water and seabed sediments with petroleum products (normal operation of vessels)	3					1				2			1	7
Contamination of water and seabed sediments	3			3					3				1	10

Impact	Impact characteristics													Joint 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
with petroleum products (emergency situations and collisions)														
Contamination of water and seabed sediments with antifouling agents	3				2					2			1	8
Contamination of water and seabed sediments by accidental release of municipal waste or domestic sewage	3					1					1		1	6
Contamination of water and seabed sediments with accidentally released chemicals and waste	3					1				2			1	7

Table 10.11. Assessment of the impact significance on the quality of seawater and seabed sediments during the construction phase of the Baltica-1 OWF in the APV

Impact	Impact scale	Receptor sensitivity	Impact significance
Release of pollutants and nutrients from the sediments into the water (for water)	moderate	moderate	**Low**
Release of pollutants and nutrients from the sediments into the water (for sediment)	low	irrelevant	**Negligible**
Contamination of water and seabed sediments with petroleum products (normal operation of vessels)	low	low	**Negligible**
Contamination of water and seabed sediments with petroleum products (emergency situations and collisions)	high	low	**Low**
Contamination of water and seabed sediments with antifouling agents	moderate	moderate	**Low**
Contamination of water and seabed sediments by accidental release of municipal waste or domestic sewage	low	irrelevant	**Negligible**
Contamination of water and seabed sediments with accidentally released chemicals and waste	low	moderate	**Low**

Taking into account the results of the impact assessment, the limited space in which the Project may be located and the possible technologies for its execution, no measures to minimise the negative impact of the Baltica-1 OWF on the quality of seawaters and seabed sediments are indicated.

10.2.1.5 Impact on climatic conditions

As part of the identification of the impacts of the project involving the construction of the wind farm on the climatic conditions of the selected sea area, annual meteorological measurements including wind, pressure, humidity and air temperature were made and available information on air quality and climatic conditions of the Baltic Sea was analysed. This will allow for the determination of initial conditions to which it will be possible to relate the results of the monitoring surveys carried out during construction.

The climatic conditions of the Baltic Sea related to the course and nature of weather phenomena (mainly temperature, precipitation and wind) are subject to continuous changes over the years, which, although related to global climate changes, are generally of a regional character. Due to the fact that the projected scope and scale of these changes over the period of several decades, for which the operation of the Baltica-1 OWF is anticipated, is relatively small, its impact on climate change in the Baltic Sea region will be negligible. On the other hand, the impact of possible climate change on the operating conditions and safety of the Baltica-1 OWF must be taken into account. To ensure the proper operation of the wind farm, it is necessary to accept the possibility of extreme weather conditions on a larger scale than is currently observed, as well as the fact that the amplitude of change, both annually and over the years, will increase.

The increase in intensity and frequency of storm phenomena observed at sea should cause some increase in the productivity of the Baltica-1 OWF. However, on the other hand, it may result in a higher breakdown rate of turbines and a periodical deterioration of navigation conditions in the farm area. Therefore, the risk of more frequent occurrence of winds above Beaufort force 10 than in the current conditions should be foreseen. A possible increase of the mean sea level as well as changes in the thermal conditions and salinity of water will have no noticeable impact on the operation, operating conditions and safety of the Baltica-1 OWF equipment. The forecast increase of sea surface temperature will practically exclude the risks related to icing phenomena. However, the forecast increase in the amount of precipitation and humidity of the lower atmosphere layer will increase the risk of wind turbines being iced up (in the case of negative air temperatures, in this respect, however, it is expected that the number of frosty and very frosty days will decrease) as well as the frequency of periods of limited visibility.

For open sea areas, the shortening and easing of ice periods will have a beneficial impact on shipping conditions and the operation of the equipment at sea.

On the other hand, an increase in water temperature and intensive eutrophication of sea waters may cause some difficulties in the operation of the proposed OWF, particularly in summer. Temperature increase in the winter period may cause the disappearance of species typical for cold water and the occurrence of species present in warmer waters.

Considering the impact of the project involving the construction of a wind farm on the climatic conditions of the sea area proposed, its influence on two basic atmospheric parameters in the near-water layer should be considered:

- thermal conditions (taking into account the possibility of ice phenomena in winter)
- and wind conditions.

Table 10.12 presents an assessment of the scale of impacts while Table 10.13 present an assessment of the significance of impacts.

Table 10.12. Assessment of the scale of impact of the construction phase on the near-water atmosphere layer in the Baltica-1 OWF Area

Impact	**Impact characteristics**													**Joint 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**
Change in thermal conditions of the atmosphere			1			1					1		1	4
Change in wind conditions of the atmosphere	3					1				1			1	6

Table 10.13. Assessment of the impact significance of the construction phase on the near-water atmosphere layer in the Baltica-1 OWF Area

Impact	**Impact scale**	**Receptor sensitivity**	**Impact significance**
Change in thermal conditions of the atmosphere	irrelevant	irrelevant	**Negligible**
Change in wind conditions of the atmosphere	low	irrelevant	**Negligible**

Taking into account the results of the impact assessment, the limited space in which the Project may be located and the possible technologies for its execution, no measures to minimise the negative impact of the Baltica-1 OWF on the climatic conditions are indicated.

10.2.1.6 Impact on air and its quality

During the construction phase of the Baltica-1 OWF, an increased emission of pollutants into the atmosphere (including greenhouse gases) can be expected, due to the increased traffic of vessels involved in the Project construction. The actual magnitude of these atmospheric emissions cannot be assessed at this stage, as the number, type and duration of use of specialist vessels will only be determined in the detailed design. It was assumed that only vessels which comply with national standards and those resulting from international agreements on pollution emissions would be used. It can also be assumed that the expected exhaust emissions for the Baltica-1 OWF Area will be similar to those estimated for other planned wind farms.

Depending on the subsea cable line construction technology adopted, it is possible to employ vessels of different types and uses. Due to the limited possibilities of carrying out construction works in the sea area (environmental and weather-related aspects, etc.) the works are to be organised in a focused manner, being performed as briefly as possible and continuously in one sea area. Hence, the exhaust gas quantities emitted into the air will result from the number and types of vessels involved in the various stages of the Project as well as the duration of the offshore works planned. As the Project is in the early pre-development phase, i.e. before a detailed work schedule has been prepared and before suitable vessels have been selected and contracted, it is possible to present the quantities of gases and pollutants emitted into the atmosphere only as estimates, as provided in Table 10.14.

Table 10.14. Estimated data on the types and amounts of gases and particulate pollutants emitted to the atmosphere during diesel oil combustion on vessels engaged in the construction phase of the Baltica-1 OWF, per day

Substance	Emission factor [g/kg of fuel]	Emissions per day of work [Mg]
Nitrogen oxides (NOx)	13.01	1.5–6.2
Non-Methane Volatile Organic Compounds (NMVOC)	32.629	3.8–15.5
Carbon oxide (CO)	3.377	0.4–1.6
Total suspended particulate (TSP), including up to 100% of PM10 and PM2.5	10.774	1.3–5.2
Sulphur dioxide (SO2)	2.104	0.25–1.00
Aliphatic hydrocarbons (HC al.)	0.02	<0.01
Aromatic hydrocarbons (HC ar.)	2.195	0.26–1.04
Carbon dioxide (CO2)	3206	380–1550

As the Project work will be conducted in open sea areas, where the exhaust gases emitted will disperse very quickly over a wide area in the absence of terrain unevenness and obstacles, and thus their concentration will decrease quickly, the exhaust gases emitted by ships and other equipment over a limited period of time are not expected to cause a significant increase in atmospheric air pollution in the long term.

Considering the impact of the Project involving the construction of a wind farm on air quality within and surrounding the proposed sea area, it is necessary to consider the impact of exhaust emissions from the vessels involved in the construction on the amount of solid and gaseous pollutants in the near-water atmosphere layer:

- increase in particulate matter;
- increase in gaseous pollutants.

Table 10.15 presents an assessment of the scale of impacts and Table 10.16 present an assessment of the significance of impacts.

Table 10.15. Assessment of the scale of impacts of the construction phase on air quality in the Baltica-1 OWF Area related to exhaust emissions

Impact	Impact characteristics													Joint 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
increase in particulate matter	3					1				2			1	7
increase in gaseous pollutants	3					1				2			1	7

Table 10.16. Assessment of the impact significance of the construction phase on air quality in the Baltica-1 OWF Area related to exhaust emissions

Impact	Impact scale	Receptor sensitivity	Impact significance
increase in particulate matter	low	irrelevant	**Negligible**
increase in gaseous pollutants	low	irrelevant	**Negligible**

The impact of the proposed Project on the air quality in the construction phase will be temporary, spatially limited, and will virtually cease after the works are completed.

10.2.1.7 Impact on ambient noise

The results of ambient noise changes resulting from underwater noise emissions are described in sections relating to the impact of the Project on ichthyofauna, seabirds and marine mammals.

10.2.1.8 Impact on EMF

During the construction phase of the Baltica-1 OWF, power cables and OSSs will not yet be operational. For this reason, there will be no impacts that could affect the EMF levels in the Project development area and its vicinity.

10.2.1.9 Impact on animate nature components

10.2.1.9.1 Impact on phytobenthos

Due to the absence of phytobenthos in the Baltica-1 OWF Area there will be no impact on this environmental component during the construction phase.

10.2.1.9.2 Impact on macrozoobenthos

The works carried out on the seabed during the construction phase of the Baltica-1 OWF in the Applicant Proposed Variant (APV) will cause the following impacts, affecting the condition of the macrozoobenthos inhabiting the area:

- interference in the seabed – disturbance of seabed sediment structure;
- disturbance of seabed sediments – an increase in the concentration of suspended solids in the water depth;
- redeposition of sediments – suspended solids sedimentation on the seabed;
- redistribution of contaminants from sediment into the water column.

The most important technical parameters of the Baltica-1 OWF which are significant from the point of view of the assessment of the Project impact on macrozoobenthos during the construction phase are:

- development area the Baltica-1 OWF ;
- foundations of wind turbines and OSSs – type and number of foundations with the greatest seabed footprint;
- cable lines – their length and the seabed area disturbed during cable laying;
- spudcan foundations for jack-up vessels.

These data are presented in Table 10.17.

Table 10.17. Compilation of key parameters of the Baltica-1 OWF in the APV for the purpose of assessing the impact on macrozoobenthos during the construction phase

Parameter	Vessel	Value
Baltica-1 OWF Area	km^2	85.53
Maximum number of wind turbines of 15 MW capacity	-	60
Maximum number of offshore substations OSSs (offshore transformer substations and offshore conversion stations)	-	4
Maximum seabed footprint of one transformer-conversion substation installed on two jacket foundations including seabed strengthening	m^2	9600
Maximum seabed footprint of one gravity-based structure, including erosion protection	m^2	11 300
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
Maximum seabed surface area occupied by riprap (crushed rock bedding) per one jack-up vessel support leg	km^2	0.00478

The impact of the wind turbines in the Baltica-1 OWF Area during the construction phase was assessed separately for:

- soft-bottom macrozoobenthos;
- hard-bottom macrozoobenthos.

A separate assessment of the Project impact on macrozoobenthos is the result of these two benthic fauna communities (from the soft and hard bottoms) differing in the taxonomic composition, abundance and biomass of their taxa. Consequently, they differ in significance and sensitivity regarding the various types of impact. The assessment of impact scale (type, range, duration, permanence) affects the assessment of impact characteristics on the basis of which the impact magnitude (scale) is assigned. Taking into account the magnitude of the impact and the sensitivity of the receptor, i.e. the group of organisms being assessed (soft-bottom and hard-bottom macrozoobenthos) the significance of the impact on the receptor will be determined.

The sensitivity of macrozoobenthos depends on the impact characteristics and preferences resulting from the very biology of the species concerned. On the one hand, it is the ability of the population to adapt to various changes occurring in the environment as a result of the Project implementation and, on the other hand, the ability of a community of organisms to reconstruct the quantitative structure after the impact factor ceases to exist. The sensitivity of macrozoobenthos will differ in the subsequent stages of the Project. Table 10.18 presents the definitions of macrozoobenthos sensitivity on a five-point scale.

Table 10.18. Macrozoobenthos sensitivity to the OWF impacts [Source: internal materials based on Hiscock and Tyler-Walters 2006, Birklund 2007 and 2009]

Sensitivity	Description
Irrelevant	The influence of the stressor has a very little impact on the changes in the structure and functioning of the organism community
Low	The survival of some benthic species may be limited; the ability to restore the benthic community and return to its original state after the impact factor has ceased to exist will happen within a year
Moderate	Some species in the benthic community will be destroyed and the survival of the remainder may be limited; after the impact factor ceases to exist, the ability to restore the quantitative structure of the longest-living species in this community may take up to several years
High	Most species in the benthic community will be destroyed and the survival of the remainder may be limited; the ability to restore the benthic community may be possible many years after the impact factor has ceased to exist, however, the community may have a different qualitative structure than before the period in which the environment changed as a result of the project implementation
Very high	The benthic community will be destroyed under the impact of the stressor and it will not be possible to return it to its original state

The results of the inventory surveys conducted within the Baltica-1 OWF Area showed that neither the soft-bottom nor the hard-bottom macrozoobenthos communities are characterised by high quality status, nor are they unique in terms of qualitative and quantitative composition.

The soft-bottom macrozoobenthos community occupies mainly the sand and gravel seabed with the largest surface area (approximately 95% of the Baltica-1 OWF Area) in the vicinity of the proposed Project and is characterised by a moderate ecological quality status. It comprises species that are common and typical for this seabed type, inhabiting moderately deep, open waters of the Southern Baltic, their biomass being dominated by the bivalve *Macoma balthica*, with the polychaete *Pygospio elegans* prevailing in terms of abundance.

The hard-bottom macrozoobenthos complex inhabiting the surface of boulders, found in the northern parts of the proposed Baltica-1 OWF Area, occupies only approximately 5% of its surface area. The evaluation of this habitat type demonstrated a low ecological value (poor status in the north-eastern part of the buffer and good status in the northern part of the Project area). Neither dense aggregations of the bay mussel *Mytilus trossulus*, characterised by fairly low abundance and biomass, nor diverse associated fauna were found within the hard-bottom macrozoobenthos sites. Moreover, the distribution range of this complex is limited to only a small surface of the occupied boulder area, located at depths of approximately 25−40 m.

Interference with the seabed leads to a **disturbance of the seabed sediment structure**, being the most negative type of impact on macrozoobenthos of all those occurring during the OWF construction phase. Activities such as excavation of dredged material for wind turbine foundations, storage of the excavated material, burial in the seabed of power and telecommunication cables connecting individual OWF elements (wind turbines, OSSs), and performance of various works on the seabed (e.g. anchoring of jack-up vessels), lead to physical (mechanical) destruction of natural zoobenthos communities. To a lesser extent, an increased macrozoobenthos mortality is observed when invertebrates are brought to the surface of the sediment, in effect being subject to physical elimination or pressure from predators, mainly fish [Köller *et al.* 2006; Zucco *et al.* 2006]. Disturbance of the seabed sediment structure has the most severe impact on macrozoobenthos species inhabiting the sediment surface and organisms living in its upper layer of 4–5 cm, but some can be buried up to a depth of 35 cm, as determined by the biological characteristics of individual species [Brakelmann 2005; Braeckman 2010]. As a result of this impact, the soft-bottom macrozoobenthos, which plays an important role in bioturbation and bioirrigation, and thus, in the transport of oxygen and organic matter into the sediment, which is important in terms of microbiological decomposition and mineralisation processes, will be destroyed [Braeckman 2010]. Mobile macrozoobenthic species, i.e. crustaceans, will avoid adverse environmental conditions by escaping [Macnaughton *et al.* 2014]. The destruction of hard-bottom macrozoobenthos species can lead to a depleted food supply for fish and diving benthivorous birds that feed mainly on bivalves. According to Appendix 1 to the EIA Report, the proposed Baltica-1 OWF Area is not a region of abundant occurrence of diving benthivorous birds such as the long-tailed duck and the velvet scoter, which feed on macrozoobenthos, mainly mussels, because the great depths in this area make it difficult for sea ducks to access food. With a considerable depth of the sea basin, exceeding 30 m within most of the Baltica-1 OWF Area, it is more difficult for benthivorous birds to reach their food because they incur high energy costs when diving. For sea ducks, the most energy-efficient scenario is to forage in shallower (up to 20–25 m) sea basins [Kirk *et al.* 2008; Meissner 2010]. In the Baltica-1 OWF Area and in the reference area, in the summer and autumn migration periods, a very high proportion of piscivorous bird species, namely the common guillemot and the razorbill, was recorded [Appendix 1 to the EIA Report]. For this reason, the depletion of the food supply by the destruction of macrozoobenthos organisms in the Project area is not very significant for diving benthivorous birds, for which this area is not an important feeding ground.

In the APV, it should be assumed that among such types of wind turbine foundations as monopile foundations, lattice-frame jacket foundations, suction-bucket jacket foundations, and gravity-based structures, the last ones will occupy the largest surface area of the seabed in case of installation of 60 wind turbines with a capacity of 15 MW each, including also scour protection. Thus, the installation of these foundations will have the most unfavourable impact on macrozoobenthos. The surface of the Baltica-1 OWF is 85.53 km^2. The physical destruction of macrozoobenthos will take place on the seabed surface disturbed during the installation of foundations of up to 60 wind turbines and up to 4 OSSs, within an area up to 1.33 km^2 (including the area occupied by the scour protection layer around the foundations and possible seabed area occupied by the stabilising bedding for the jack-up vessel legs). The cable line construction area will cover a seabed area of 2.24 km^2, assuming a 140 km length of the cable routes and a maximum width of the strip covered by underwater works of 16 m. Altogether, the maximum damage to macrozoobenthos communities will cover an area of up to 3.57 km (assuming the use of gravity-based structures), i.e. up to 4.17% of the Baltica-1 OWF surface area.

The sensitivity of the soft-bottom macrozoobenthos complex within the Baltica-1 OWF Area to this impact is moderate. Although the abundance structure of this community of organisms is dominated by polychaetes *Pygospio elegans*, with a fairly fast ability to rebuild the population after the cessation of physical disturbance of the seabed [Bolam 2005], the ability to restore the entire community and return to its original state after the cessation of the impact factor will require between one and several years, because this is how long it will take to rebuild the quantitative structure of the longest-living species in this community, primarily the Baltic clam *Macoma balthica*, which prevails in terms of biomass, as well as the other bivalve species: *Mya arenaria*, *Cerastoderma glaucum* and *Mytilus trossulus* [Willmann 1989; Żmudziński 1990; Piechocki and Wawrzyniak-Wydrowska 2016]. This applies to areas where permanent mechanical destruction of benthos under the surface of wind turbine foundations and riprap will not take place.

Similarly, the sensitivity of the hard-bottom macrozoobenthos complex, in which the *Mytilus trossulus* bivalves constitutes a group of absolutely constant taxa dominant in abundance and biomass, the sensitivity to the disturbance of the seabed sediments will be moderate.

The disturbance of sediments will lead to an **increased concentration of suspended solids in the water**, and their dispersal [Leonhard 2006, Zucco *et al.* 2006]. Higher concentration of suspended solids and longer exposure time of mineral and organic particles in the water cause adverse effects on the condition of benthic fauna [Newcombe and MacDonald 1991, Hiscock *et al.* 2002]. When there is an excessive concentration of suspended solids in the water, filter-feeding organisms or organisms feeding on suspended solids and organic matter deposited in sediments may feed less effectively, once the species-specific threshold concentration of suspended solids in the water is exceeded. Some of the most vulnerable individuals, such as *Mytilus trossulus*, may experience clogging of the filtering apparatus and thus the survival of the organisms may be reduced. On the other hand, macroinvertebrates are naturally adapted to high concentrations of suspended solids arising during storm events, among others, and can survive for months at very high suspended solids concentrations of up to 100 mg·dm^{-3} [Miller *et al.* 2002; Birklund 2009]. However, bivalves from the Baltic Sea are physiologically less suited to filtering suspended solids at high concentrations because they are not adapted to life in conditions of strong currents or tides [Essink 1999; Coates *et al.* 2014].

The model analyses of suspended solids dispersal in the Baltica-1 OWF Area show that the least favourable scenario for the macrozoobenthos, and particularly for the hard-bottom community consisting of bay mussel aggregations, in terms of the impact of suspended solids introduced to the marine environment, will be the dispersal of suspended solids during soil displacement under the spudcans of jack-up vessels, together with the dumping of excavated soil in the Baltica-1 OWF Area, the installation of larger foundations with a diameter of 55 m (e.g. gravity-based structures), followed by the burial of cable lines at the speed of 200 m·h^{-1}, as well as boulder clearance at a speed of m·h^{-1} in cohesive soils using the hydraulic jetting method [Appendix 2 to the EIA Report]. It should be emphasised that sandy sediments, i.e. non-cohesive sediments, prevail in the seabed surface layers of the OWF Area considered. The highest instantaneous concentrations of suspended solids during the excavation works for the foundations of jack-up vessel spudcans and the pipeline-based dumping in the OWF Area may reach 1500 mg·dm^{-3} at a distance of approx. 150 m from the site, and 850 mg·dm^{-3} at a distance of 500 m. In the case of excavations for gravity-based structures, the highest instantaneous concentrations of suspended solids could reach 250 mg·dm^{-3} at a distance of approx. 150 m from the site, decreasing to 95 mg·dm^{-3} at a distance of 500 m. Suspended solids concentrations exceeding 250 mg·dm^{-3} result in reduced growth of macrozoobenthic organisms [Essink 1999] and even increased mortality of bivalves [Moore 1977; Miller et al. 2002]. Over most of the area affected by the disturbance, the concentrations of suspended solids range from 10−60 mg·dm^{-3} for jack-up vessel foundation works, and 6−20 mg·dm^{-3} for gravity-based structure works. A comparable range of suspended solids concentrations in the water over most of the area will be reached during cable burial and boulder clearance works, with values of 7–25 and 7–20 mg·dm^{-3}, respectively [Appendix 2 to the EIA Report].

The sensitivity of the soft-bottom macrozoobenthos community inhabiting the Baltic-1 OWF Area to this impact is low. The abundance structure of this community of organisms is dominated by organisms inhabiting the interior of the sediment, such as polychaetes, as well as the bivalve *Macoma balthica*, which, being facultative filter-feeding detritivores, demonstrate tolerance to increased concentrations of suspended solids [Olafsson 1986; Budd and Rayment 2001]. Under the influence of a stressor such as an increased concentration of suspended solids in the water, no significant changes are expected in the structure and function of this community of organisms.

The hard-bottom macrozoobenthos community consisting primarily of filter-feeding organisms, i.e. the *Mytilus trossulus* bivalve, will be also characterised by low sensitivity, since it cannot be ruled out that with the increased concentration of suspended solids in the water the functioning of the filtering system and hence the survival of some of the most exposed individuals will be reduced. Although the impact will be short-lasting, when the gravity-based structures are installed, instantaneous concentrations of suspended solids reaching approx. 250 mg·dm^{-3} may be lethal for part of the *Mytilus trossulus* population in the immediate vicinity of the works.

Moreover, sediment redeposition will result in the **sedimentation of suspended solids on the seabed**, thereby covering the benthic habitats with an additional layer of sediment. Numerous macrozoobenthic organisms are naturally adapted to living in sediment disturbance and precipitation conditions (as a result of storms or tide cycles) causing them to be covered; the natural response to such an adverse impact is the mechanical capability of some of the macroinvertebrates to move in the sediment towards the oxygenated above-seabed layer or the physiological resistance to hypoxic or even anoxic conditions [Miller *et al.* 2002, Hinchey *et al.* 2006; Birklund 2009]. Vagile infauna species (e.g. polychaetes and oligochaetes) are more tolerant to being covered with an additional sediment layer. They can move through a layer with a thickness of up to 10 cm, although that depends on the sediment grain fraction and the duration of the negative impact, but the infauna may be, in the short-term, exposed to anoxic conditions. The species representing the sedentary epifauna and macrozoobenthos larvae are more sensitive to this impact, since they have a limited capacity to move and reach the sediment surface, which is an essential condition for respiration; this leads to disrupted feeding. The bivalves can put their siphons above the sediment layer [Maurer *et al.* 1986, Hiscock *et al.* 2002, Miller *et al.* 2002, Gibbs and Hewitt 2004]. The Baltic clam (*Macoma balthica)* is among the macrozoobenthos species that are most resistant to the described impact, as it may survive for a month with the sediment layer increase by 7–20 cm [Turk and Risk 1981, Essink 1999]. The maximum tolerance of the sand gaper *Mya arenaria*, on the other hand, to the sedimentation of sand is 5 cm per month [Essink 1999]. The most important factor affecting the survivability of benthic fauna under the conditions described is access to oxygen dissolved in the water [Hinchey et al. 2006]. Typically, macrozoobenthos is fairly tolerant to being covered by an additional layer of suspended solids undergoing sedimentation, even up to 0.2–0.3 m thick, especially if this layer is composed of a fine sand fraction [Essink 1999, Miller *et al.* 2002, Gibbs and Hewitt 2004]. However, the long duration of the negative impact described contributes to increased mortality of all benthic species [Hiscock *et al.* 2002].

The thickness of the sediment layer generated during the sedimentation process related to the jack-up vessel installation works can reach 35 mm at a distance of 150 m from the site, which is at the tolerance limit of many macrozoobenthos species. The thickness of the additional sediment layer will also be greater, reaching 6.3 mm, when preparing excavation for a larger foundation with a diameter of 55 m (i.e. gravity-based structure) in cohesive soils, compared to the burial of cable lines by hydraulic jetting at a speed of 200 m/h, generating a layer of up to 1.5 mm at a distance of 100–800 m from the operating path of the jetting unit. At a distance of 500 m from these works, the sediment thickness will decrease to 9 mm during seabed preparation works for the installation of jack-up vessel support legs, then to 2.4 mm during the installation of, for example, a gravity-based structure, and to 0.8 mm during cable burial [Appendix 4 to the EIA Report]. Moreover, it should be emphasised that the assessment of the quality of water in the OWF Area, on the basis of the oxygen content in the near-seabed layer in the summer period (July) indicates good condition (no oxygen deficit) (Appendix 4 to the EIA Report).

It was determined that the sensitivity of the soft-bottom macrozoobenthos complex in the OWF Area to the sedimentation of suspended solids on the seabed is low. The structure of this community includes bivalves, primarily *Macoma balthica*, but also *Mya arenaria, Cerastoderma glaucum* and the epibenthic *Mytilus trossulus*. When covered by an additional layer of sediment, these organisms may experience an obstructed access to the oxygen dissolved in the water, and their filtration process can be restricted due to the clogging of the feeding structures. The *Macoma balthica* bivalve, which is dominant in the Baltica-1 OWF Area, is tolerant to being covered with an additional sediment layer that causes suffocation of benthic organisms [Budd and Rayment 2001]. Also, the infauna may be, in the short-term, affected by the arising anoxic conditions.

On the other hand, in the case of the hard-bottom macrozoobenthos complex, the *Mytilus trossulus* bivalve may be negatively affected due to the inhibition of the filtration process. The sensitivity of this complex was also assessed to be small.

Considering the fact that the Project works in the Baltica-1 OWF Area would generate a layer with a maximum sediment thickness of approximately 35 mm – but 500 m away from the site from 9 to 6.3 mm, which is a relatively low value – and bearing in mind the favourable oxygen conditions in the above-seabed layer, the scale of the negative impact on macrozoobenthos will be low. Although the sedimentation of suspended solids on the seabed may temporarily reduce the benthos resources, and thus reduce the food supply for the fish and seabirds in the affected area, the maximum sediment layer thickness, apart from the areas closest to the jack-up vessel spudcans or cables, will not exceed the lethal values specified in the literature for all the macrozoobenthos taxa identified within the Project area and besides, this impact will be short-term and reversible.

Redistribution of pollutants from sediments into the water leads to the exposure of benthic fauna to increased concentrations of pollutants, e.g. heavy metals, toxic organic compounds: polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), tributyltin (TBT) diffusing from the sediments into the water as a result of chemical and biochemical processes [Bourg and Loch 1995, Dembska 2003, Uścinowicz 2011]. Among the substances listed, organotin compounds are the most harmful (toxic) to benthic organisms. The use of TBT in antifouling paints is currently prohibited. Tributyltin is bioaccumulated by marine organisms, and the degree of its harmfulness depends mainly on the final concentration in tissues. Bivalves are not able to degrade TBT via debutylation like e.g. fish and some sea snails. Accumulation of toxic substances results in reproductive dysfunction, disease development and increased mortality of macrozoobenthos, as well as a decline in its abundance and biodiversity. In particular, filtering organisms, such as bivalves, are highly susceptible to this impact as they develop cancer due to the accumulation of toxic substances in soft tissues [Galer *et al.* 1997, Grant and Briggs 2002, Hummel *et al.* 2000, Gosz *et al.* 2011].

The impact on the macrozoobenthos was indirectly determined using surveys of the physico-chemical condition of benthic sediments in the Baltica-1 OWF Area with regard to their contamination. As a result of the surveys conducted, it was concluded that the seabed surface sediments analysed belong to inorganic deposits with the organic matter content (expressed as loss on ignition [LOI]) below 2%. The concentration of nutrients (total nitrogen and total phosphorus) in the survey area did not exceed the values typical for the sediments of the Southern Baltic. The concentrations of persistent organic pollutants (i.e. PAHs, PCBs and TBT) and hazardous substances, such as metals or mineral oils in the survey area, were low and did not deviate substantially from the data from literature regarding sandy seabed sediments of the Southern Baltic. The sediments tested were also characterised by low concentrations of the radioactive element ^{137}Cs, typical for sandy sediments. The concentration values obtained for labile metal forms responsible, among others, for their toxicity, bioavailability or accumulation in the seabed sediments of the OWF Area, as well as the PAH and PCB values, compared to normative values specified in the Regulation of the Minister of the Environment of 11 May 2015 *on the recovery of waste outside the installations and facilities* (Journal of Laws of 2015, item 796) were low in the seabed sediments tested and the sediments were not contaminated with the compounds belonging to those groups (Appendix 1 to the EIA Report).

Due to the possibility of redistribution of pollutants from sediment into water, the sensitivity of both the soft- and hard-bottom macrozoobenthos complex representatives to this impact will be irrelevant. It is expected that this phenomenon has very little impact on the changes in the structure and functioning of both macrozoobenthos complexes, taking into account the results according to which the concentrations of substances that are toxic and harmful to the benthic fauna in the survey area were low and the processes related to the release of labile metal forms, nutrients, PAHs and PCBs will occur with low intensity in the entire OWF Area.

Assessment of the scale of impact on soft-bottom macrozoobenthos is provided in Table 10.19 while on hard-bottom macrozoobenthos in Table 10.20. Assessment of the significance of impact is provided in Table 10.21 and Table 10.22.

Table 10.19. Assessment of the scale of impact on soft-bottom macrozoobenthos during the construction phase in the APV

Impact	**Impact characteristics**													**Joint 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**
Interference in the seabed – disturbance of seabed sediment structure	3					1			3				1	8
Disturbance of seabed sediments – an increase in the concentration of suspended solids in the water depth	3					1				2			1	7
Redeposition of sediments – suspended solids sedimentation on the seabed	3					1				2			1	7
Redistribution of pollutants from sediments into the water	3					1				2			1	7

Table 10.20. Assessment of the scale of impact on hard-bottom macrozoobenthos during the construction phase in the APV

Impact	**Impact characteristics**													**Joint 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**
Interference in the seabed – disturbance of seabed sediment structure	3					1			3				1	8
Disturbance of seabed sediments – an increase in the concentration of suspended solids in the water depth	3					1				2			1	7
Redeposition of sediments – suspended solids sedimentation on the seabed	3					1				2			1	7
Redistribution of pollutants from sediments into the water	3					1				2			1	7

Table 10.21. Assessment of the significance of impact on soft-bottom macrozoobenthos during the construction phase in the APV

Impact	**Impact scale**	**Receptor sensitivity**	**Impact significance**
Interference in the seabed – disturbance of seabed sediment structure	moderate	moderate	**Low**
Disturbance of seabed sediments – an increase in the concentration of suspended solids in the water depth	low	low	**Negligible**
Redeposition of sediments – suspended solids sedimentation on the seabed	low	low	**Negligible**
Redistribution of pollutants from sediments into the water	low	irrelevant	**Negligible**

Table 10.22. Assessment of the significance of impact on hard-bottom macrozoobenthos during the construction phase in the APV

Impact	Impact scale	Receptor sensitivity	Impact significance
Interference in the seabed – disturbance of seabed sediment structure	moderate	moderate	**Low**
Disturbance of seabed sediments – an increase in the concentration of suspended solids in the water depth	low	low	**Negligible**
Redeposition of sediments – suspended solids sedimentation on the seabed	low	low	**Negligible**
Redistribution of pollutants from sediments into the water	low	irrelevant	**Negligible**

The impact assessment conducted for the soft-bottom macrozoobenthos community and the hard-bottom macrozoobenthos community during the construction phase for the Baltica-1 OWF indicates that only physical disturbance of the seabed by disruption of the seabed sediment structure, due to moderate sensitivity of benthic fauna to this type of impact and moderate scale of impact, will be of **low** significance. Direct destruction of individuals may lead to long-term changes in the population structure. Changes in the structure of macrozoobenthos communities mainly involve an increase in the importance of opportunistic species and a reduction in specialised species and, in addition, changes in the seabed structure will result in changes in the proportion between mobile and sedentary species in a medium-term perspective. The pace and efficiency of recolonisation is the result of reproduction and migration processes, with reproduction playing a primary role in sedentary organisms (such as the bivalve *Mytilus trossulus*). Works causing the destruction of habitats and fauna communities are a one-off impact, affecting a relatively small area of the seabed, allowing the subsequent recovery of the destroyed community. It should also be emphasised that a major part of the area indicated is occupied by a sand and sand-gravel seabed inhabited by macrozoobenthos, comprising taxa characteristic and common in this depth range and representing a poor to moderate status of ecological quality. Taking into account the biological characteristics of benthic invertebrates inhabiting the area of the proposed Project, the analysis of this impact allows to conclude that the recolonisation of the disturbed seabed will be facilitated by the presence of the same species on the Southern Middle Bank and in the habitats adjacent to the proposed OWF Area. The remaining impacts are of **negligible** significance for the macrozoobenthos, both for the fauna complex inhabiting the sand and gravel seabed, and the rocky seabed. The parameters resulting from the modelling of suspended solids (the value of concentration in the water column and the thickness of the layer of suspended solids being deposited on the seabed) and the results of geochemical surveys (low concentrations of substances with a toxic and hazardous effect on the seabed fauna) in the survey area, taking into account the associated impact characteristics, will not result in significant changes in the physiology of macrozoobenthos of the soft and hard bottom inhabiting the Baltica-1 OWF Area.

Considering the results of the impact assessment, the restricted space within which the Project may be located and the feasible technologies of its execution, no measures mitigating the negative impact of the Baltica-1 OWF on the macrozoobenthos are recommended.

10.2.1.9.3 Impact on ichthyofauna

The works carried out on the seabed during the construction phase of the Baltica-1 OWF, will cause the following impacts, affecting ichthyofauna:

- noise and vibrations;
- increased concentration of suspended solids in the water;
- habitat change;
- emission of pollutants;
- physical barrier.

The most important technical parameters of the Baltica-1 OWF which are significant from the point of view of the assessment of the Project impact on ichthyofauna during the construction phase are:

- size of the Baltica-1 OWF Area;
- type and quantity of wind turbines and OSS foundations, installation technology;
- power cable length, laying technology and the surface area of the seabed disturbed during cable laying operations;
- number of vessels involved in the construction works

Noise and vibrations

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

The sound generated during piling is of pulsating nature, characterised by short duration (<1 s) and a band width 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 are, on the other hand, dependent on the environmental conditions (depth, type of sediment).

The noise emitted during pile driving depends on the pile diameter and can range from approx. 230 dB re 1 $\mu Pa^2 s$ (1.5 m pile diameter) [Thomsen *et al.* 2006] to nearly 260 (4.5 m pile diameter) [OSPAR Commission 2009].

A slightly lower noise level should be expected during cable laying works (178 dB re 1 $\mu Pa^2 s$) [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 movement of water particles and/or a change in pressure. For most fish, frequencies perceived range from below 50 Hz to approx. 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 the 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 approx. 500 Hz) as well as a higher sound sensitivity threshold. The range of sound sensitivity for plaice and common dab is between 30 and 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) [Popper and Hawkins 2019].

Depending on the noise intensity and the distance from its source, the impact can have various effects, ranging from behavioural changes to the death of fish [Table 10.23].

Table 10.23. Potential impact of noise on ichthyofauna [Source: internal materials based on Popper et al. 2014]

No.	Impact effect	Impact characteristics
1.	Death	Death due to the damage resulting from an 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, creating shoals, migration, leaving preferred areas, avoidance effect

The lethal effects of impulse sound, tissue damage and 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 tissue damage. Damage to the swim bladder reduces swimming efficiency and buoyancy maintenance ability and increases the risk of mortality related to predation. Also gases found in the dissolved state in the blood and tissues of fish. 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. According to Popper *et al.* (2014) the threshold from which TTS effect can be stated is a hearing loss of 6 dB. This effect is caused by the 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 of time, from a few hours to several days [Popper *et al.* 2014]. This time is primarily dependent on the intensity of the sound and the duration of sound exposure. 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. An example of these effects may include an increase in response time to a potential threat, as observed in cod, herring, flounder and plaice larvae [Blaxter and Fuiman 1990]. Determining the noise threshold at which such an effect may occur presents a number of difficulties. According to a review study by Popper and Hawkins (2019), the noise levels at which the TTS effect can occur are very difficult to specify. They can vary depending on the fish species, on the structure of the hearing system or even on different populations of the same species. The above-mentioned authors conclude that the surveys conducted to date have not fully confirmed the occurrence of the TTS effect, let alone for the purpose of making unambiguous conclusions on the level of its harmfulness. They also emphasise that all surveys to date have been conducted under laboratory conditions in which it was impossible to reduce the effect by fish escape.

A masking effect occurs when fish experience a reduction in the detectability of environmentally relevant sound stimuli as a result of co-existing noise of different origin. It can result in problems with spatial cognition, detection of prey and predator, or reproductive behaviours. Masking occurs when the level of the masking sound exceeds the hearing threshold of the species concerned. It can therefore be assumed that the masking effect will be much more pronounced in fish with higher sensitivity to sound. This can cause problems with spatial orientation and prey detection (masking effect).

The behavioural response to sound can be manifested by accelerated swimming, often combined with a directional response (escape), as well as accelerated heart rate and respiration. Such behaviours are usually transient and the fish return to their normal behaviour once the stimulus ceases. These impacts do not result in long-term negative effects at the individual level, but the effects of avoidance of noise-intensive areas at the level of local fish communities or at the population level may lead to the abandonment of feeding grounds, hiding places as well as changes in the spawning territory (Slotte *et al.* 2004), thus affecting the survival of individuals and their reproductive success. The avoidance effect may be particularly important in the case of spawning grounds, if there are no areas with equally favourable conditions for reproduction in the vicinity of the area abandoned.

Observations conducted by van der Knaap *et al.* (2022) showed relatively little change in the behaviour of cod inhabiting a wind farm near which piling had been carried out at a distance of 2.7–7.1 km, for 4 months. No individuals inhabiting the area prior to the works were found to have left it. Surveys conducted in the Baltic Sea by Thomsen *et al.* (2006) showed that cod can perceive sounds emitted during piling from a distance of 80 km and flounder – from several kilometres from the sound source [Thomsen *et al.* 2006]. During an experimental survey by Mueller-Blenkle *et al.* (2010), changes in the movement activity of cod and sole were observed already at noise levels of approximately 140 dB re 1µPa.

Analyses of the response of feeding herring shoals to air gun impulses during underwater seismic surveys showed no change in fish behaviour. There was no effect of noise ranging from 125 to 155 dB SELs on the speed and direction of fish movement or shoal size [Peña *et al*. 2013]. The authors of the surveys attributed the lack of response to the prevailing motivation to obtain food as well as a gradual increase in tolerance to the stimulus. A similar survey using sound sources imitating piling activities demonstrated that the intensity of the response of sprat and mackerel shoals depended on the sound level. As the sound level increased, the sprat shoals were more likely to change density and/or disperse, while the mackerel shoals responded by moving towards greater depths. This response occurred in 50% of the cases at a pressure level of 163 dB_{pp} (both species) and a sound exposure level (SEL) of 135 dB SEL_{ss} and 142 dB SEL_{ss} (prat and mackerel, respectively).

For sprat, differences in response between daytime and night-time were also recorded. In contrast to daytime, at night, when shoals would not form, individuals did not respond to sound. The authors explain this response by the suppression of the response to sound by food-oriented behaviours [Hawkins *et al.* 2014].

Determining the noise levels at which individual effects occur, on the basis of surveys conducted to date, is very difficult. In a publication summarising existing surveys on the effects of human-induced sounds on fish, Popper and Hastings (2009) highlight the scarcity of information available on this topic. At the same time, they argue against extrapolating the results of experiments conducted on individual fish species, and for different sound parameters, to other taxonomic groups or sound sources. It should also be taken into account that most surveys are conducted under laboratory conditions, where there is no possibility of fish escaping and thus reducing the impact. Similar conclusions are reached by the authors of the report entitled 'Overview of the impacts of anthropogenic underwater sound in the marine environment' [Ospar 2009]. 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[15] citing the individual threshold values determined by Popper *et al.* (2014) are presented in Table 10.24.

Table 10.24. 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

[15] https://dot.ca.gov/-/media/dot-media/programs/environmental-analysis/documents/env/hydroacoustic-manual-a11y.pdf

Type of organism	Mortality and potential lethal damage	Reversible hearing damage	Temporary Threshold Shift (TTS)	Masking	Behavioural changes
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

Similar values concerning noise levels resulting in lethal injury and tissue damage are adopted in the criteria developed by Andersson *et al.* (2017) for the Swedish Environmental Protection Agency. The variation in sound levels inducing behavioural changes and a temporary shift in the hearing threshold, originating from species-specific sensitivity, is much greater than in the case of lethal injury. Consequently, these authors do not recommend setting thresholds for these impacts as criteria for impact severity. They also emphasise that, given the current state of knowledge, it is difficult to determine unambiguously whether or not behavioural changes have an adverse effect on a species at the threshold population level (TTS).

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. Therefore, the determination of the extent should be based on modelling surveys specifying the extent of the different levels accounting for the local conditions of a given site and the levels of noise generated. An important factor shaping the extent of impact is the ability of fish to escape from the area of greatest noise intensity. With a soft-start procedure, involving a gradual increase in the strength and frequency of pile driver blows during the first phase of piling, individuals present in the area affected have a chance to flee.

Modelling surveys carried out for the Swedish Kriegers Flack farm indicate that the extent of impact causing lethal or potentially lethal injury (SEL_{cum} 204 dB) will be 370 to 3350 m for juvenile cod. These calculations take into account the capacity of cod to escape at a speed of 0.38 to 0.9 m/s. Assuming a worst-case scenario (juvenile individuals swimming at the lowest speed, in winter), the area of lethal impact would be 35 km^2. In the case of eggs and larvae, the lack of active movement results in a significant extension of this area to approximately 100–120 km^2 [BIOAPP 2018].

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 ploughing of trenches for cables was 178 dB re 1 $\mu Pa^2 s$ at a distance of 1 metre from the sound source. A higher value of 187 dB re: 1 $\mu Pa^2 s$, is given by Bald *et al.* [2015, qtd. in Taormina *et al.* 2018].

In the majority of studies [Meisner *et al.* 2006, OSPAR 2008, OSPAR 2012, Taormina *et al.* 2018], it is assumed that the impact of this factor on the 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 dB re: $\mu Pa^2 s$ [OSPAR Commission 2009] and is a lesser threat than 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 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.

It was assumed that impacts on ichthyofauna would occur in the case of reversible hearing damage.

The range of sound exposure at the level at which it causes reversible hearing damage (203 dB re 1 $\mu Pa^2 s$), in the variant assuming two noise sources, can exceed 13 km^2 in winter despite the use of 2 different mitigation methods. It can be assumed that the use of a soft-start procedure should allow time for at least some fish to escape from the area at risk of impact. The larval stages and eggs do not have this ability. In this case, however, the noise level at which damage to the body occurs is, according to the data from literature, higher (according to Andersson *et al*., 2017, it is 207 dB re 1 $\mu Pa^2 s$) and therefore a lower impact range is to be expected.

The impact of noise and vibration on adult fish will be negative, 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 impact was assessed as moderate for all the fish species examined.

Increased concentration of suspended solids

During the construction of the turbine foundations and the installation of the inter-array cables, dredging works are necessary, leading to an increase in the concentration of suspended solids in the water.

The significance of the suspended solids impact on fish depends both on physical factors resulting from local conditions of the abiotic environment and those related to the biological characteristics of ichthyofauna.

The former group of factors includes sediment characteristics such as grain size distribution, mineral composition, adsorption and absorption capacity, hydrological parameters (salinity, temperature, oxygen concentration), seabed morphology or area hydrodynamics (current direction, wave characteristics) [Engell-Sørensen and Skyt 2001]. The effect of suspended solids on fish depends also on the concentration of suspended sediment and the exposure time on an organism [Newcombe and MacDonald 1991]. It should be emphasised that the type of sediment is a very important factor affecting the intensity of the impact. In the case of sandy sediments, especially those with coarser grain-size distribution, both the spatial extent and the impact time will be much shorter than in the case of silty sediments or silt and sand sediments.

The effects of increased concentrations of suspended solids on fish can be classified into three categories [Newcombe and MacDonald 1991]:

- lethal effect;
- sub-lethal effect: tissue injury, disruption of physiological processes, reduced growth rate, increased susceptibility to disease;
- behavioural effect: changes in behaviour and reproductive performance, avoidance response, reduced efficiency of food acquisition.

Behavioural impacts are the result of reduced visibility caused by increased water turbidity. Lethal and sub-lethal effects, on the other hand, result from the deposition of sediment particles on various membranes and walls of organs such as gills or the digestive tract.

The basic factor shaping the intensity of the impact of suspended solids is the developmental stage of the organism. Particularly sensitivity to the effect of elevated concentrations is observed in the early life stages of fish, in which the lethal concentration is 100 to 1000 times lower than that needed to cause the effect in juvenile and adult fish [Engell-Sørensen and Skyt 2001]. This is primarily due to a higher oxygen demand than in adult fish, associated with a higher metabolic rate of the juvenile stages [Auld and Schubel 1978; Partridge and Michael 2010]. Consequently, larvae are much more sensitive to reduced oxygen availability caused by gill clogging by sediment particles [de Groot 1980].

Experimental surveys demonstrated the inhibition of herring larvae growth at suspended solids concentrations exceeding 500 $mg \cdot dm^{-3}$, whereas at the concentration of 19 g dm^{-3}, larvae mortality of 100% was observed [Messieh *et al.* 1981]. The earliest developmental stages are particularly sensitive. Surveys by Westerberg *et al.* (1996) showed an avoidance response of cod larvae with yolk sac already at the concentration of suspended solids of 3 $mg \cdot dm^{-3}$, with increased mortality at a concentration of 10 $mg \cdot dm^{-3}$.

High concentration of suspended solids may also limit visibility. Given the limited vision range of larvae, often reaching only their body length [Bone *et al.* 1987], this can negatively affect both the efficiency of food detection and acquisition, and the ability to avoid predation. According to Utne-Palm (2004), high turbidity (80 JTU) negatively affected the ability of herring larvae to obtain food. On the other hand, the same mechanism may indirectly positively affect larval survival by reducing predators' field of vision [Gregory and Northcote 1993].

Increased concentrations of suspended solids can adversely affect egg development and survival. Sediment particles adhering to the chorion may limit gas exchange and the removal of metabolites [Chapmann 1988; Argent and Flebbe 1999]. Suspended solids concentrations exceeding 100 mg·dm^{-3} may result in increased mortality of cod eggs [Rönnbäck and Westerberg 1996]. In the case of pelagic eggs, their buoyancy may also be reduced due to adhesion of sediment particles to their surface. This results in eggs falling to lower water levels or to the seabed. This may result not only in the deterioration of oxygen conditions, but also in increased pressure of predation of benthic organisms as well as physical and physiological stress. According to Rönnbäck and Westerberg (1996), concentrations of suspended solids remaining at the level of 5 mg·dm^{-3} for 4 days may cause cod eggs to descend to the seabed.

Demersal eggs (laid on the seabed) are much less sensitive to increased concentrations of suspended solids than pelagic eggs. Research carried out by Messieh *et al.* (1981) did not indicate any significant impact of suspended solids concentration of up to 7 g·dm^{-3} on herring eggs. Similar conclusions were reached by Kiørboe *et al.* (1981) during the experiments carried out for the suspended solids concentration of 300−500 mg·dm^{-3}. However, these authors suggested that the impact of the increased concentrations of suspended solids may be significant in the event of a deterioration of oxygen conditions. Nevertheless, an indirect negative impact on herring reproduction cannot be excluded. De Groot (1980) points to the possibility that individuals of this species may spawn in random places due to problems with finding traditional spawning grounds. Unless there is a clear negative impact of the increased suspended solids concentration on demersal roe, the harmfulness of covering the grains deposited on the sediment surface by a layer of particles undergoing sedimentation cannot be excluded. According to Dushkin (1981), the survival of herring eggs depends on the amount of clayey material precipitating from the water. A thin layer does not cause significant damage, sometimes only changing the rate of eggs development. A thick layer of clay, especially if it is rich in organic particles, may lead to considerable mortality, particularly if the eggs are deposited in multiple layers. In this case, only 40% of the larvae hatch from the two near-surface layers.

Increased concentrations of suspended solids rarely increase mortality of juvenile and adult ichthyofauna stages. This results from the possibility of active movement of fish to areas unaffected by this factor (avoidance effect). The values of suspended solids concentration which generate this effect vary depending on the species and developmental stage of fish. It can be assumed that pelagic fish will be far less resistant to the impact of suspended solids than demersal fish.

In the case of juvenile herring, the avoidance effect was observed at concentrations of 12 mg·dm^{-3} [Messieh *et al.* 1981], whereas in the case of adult fish, the response was recorded at a slightly lower level – 10 mg·dm^{-3} [Johnston and Wildish 1981]. According to Westerberg's surveys, referred to in the Environmental Impact Assessment Report for the Kriegers Flak Wind Farm [Sweden Offshore Wind AB 2007], the avoidance reaction for herring and sprat was already observed at concentrations above 3 mg·dm^{-3}, whereas according to Hansson (quoted therein) such a reaction should be expected only at concentrations above 100 mg·dm^{-3}. On the other hand, the studies conducted by Hammar *et al.* (2008) during the construction of the Lillgrund OWF located in the Danish Straits did not confirm a significant impact of the suspended solids concentrations reaching up to 10 mg·dm^{-3} on the distribution of fish in the project area.

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 10.25].

Table 10.25. 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
Pelagic	10 mg·dm^{-3}	>500 mg·dm^{-3}
Demersal	50 mg·dm^{-3}	>3000 mg·dm^{-3}

Bergström *et al.* (2014) assessed the impact level of increased suspended solids concentrations on fish as moderate for the Baltic Proper and the Danish Straits, and as low for the Gulf of Bothnia.

The results of the modelling of the suspended solids propagation for the Baltica-1 OWF Area indicate that the highest increase in suspended solids concentrations will be generated by trenching works for vessel supports (spudcans) and by the discharge of the dredged material via pipelines. The maximum momentary concentrations of suspended solids of 1500 mg·l^{-3} at a distance of 150 m from the work site and 850 mg·l^{-3} at a distance of 500 m from the work site exceed the limit values beyond which fish death may occur. In the case of adult fish, it may be assumed that they are likely to escape from the impact area, but fish larvae will not be able to leave the area affected by lethal concentrations. Moreover, increased mortality of pelagic eggs is possible. A thick layer of new sediment deposited on the seabed (maximum 35 mm and 9 mm at 150 m and 500 m from the work site, respectively) may cover the benthic eggs laid on the seabed. However, the depth range of the survey area excludes the spawning of gobies (a protected species) laying eggs on the seabed. A significant impact on herring eggs is also unlikely. Negative impact on eggs of this species could occur only in a small, shallowest part of the Baltica-1 OWF Area. However, there may be an increase in mortality caused by the burial of demersal eggs of the other protected species occurring in the Project area, namely the common seasnail. In most of the area, the predicted concentrations generated by these works will range from 10 to 60 mg·l^{-1}, so it can be assumed that they will cause a short-term avoidance response in this area.

Maximum instantaneous concentrations of suspended solids during the foundation-related excavation works may reach 250 mg·l^{-1} at a distance of 150 m from the site and 95 mg·l^{-1} at a distance of 500 m. Over the majority of the area affected, the concentrations are expected to range between 6 and 20 mg·l^{-1}. The maximum thickness of the new, resedimented layer following the works will reach up to 5.6 mm at a distance of 150 m from the site and 2.4 mm at a distance of 500 m.

In the case of cable burial, maximum concentrations will be slightly lower (160 mg·l^{-1} at a distance of 150 m and 65 mg·l^{-1} at a distance of 500 m) while the range of concentrations over most of the area affected will be between 7 and 25 mg·l^{-1}. The maximum thickness of the new sediment layer following the cable burial works may reach 1.0 mm at a distance of 150 m from the operating path of the jetting unit and 1.9 mm at a distance of 500 m.

Concentrations of suspended solids occurring during cable burial and foundation works may result in increased mortality of larvae, but lethal impacts are not expected in the case of adult fish. An avoidance response is likely to occur within a major part of the area – mainly among pelagic fish and, to a lesser extent, among demersal fish. However, this response will be short-term in nature.

The impact related to the increase of suspended solids content will be negative, direct, local, and short-term.

The sensitivity of cod, flounder, common seasnail, gobies, sprat and herring to the impact was assessed to be high. The significance of the impact is assessed to be moderate for all the fish species analysed.

Habitat alteration

During the works conducted in the construction phase, the habitat can be significantly altered, involving changes in the seabed morphology, the character of the sediment and the exclusion of certain parts of the habitat due to the impact of various adverse factors (noise, increased concentration of suspended solids, increased vessel traffic). These changes can result not in only the withdrawal of fish from the area, but also in the disruption of reproductive processes [ICES 1992; ICES 2001; Phua *et al.* 2004; Posford Duvivier Environment and Hill 2001; Birklund and Wijsman 2005], in extreme cases leading to spawning abandonment or failure. In the case of demersal spawners, a change in the nature of the sediment and destruction of the phytobenthos caused by the works may result in periodic spawning abandonment or may produce unfavourable egg development conditions. For example, such a response may concern herring requiring, for the purposes of spawning, a sediment-covered seabed enabling the attachment of eggs [Kiorboe *et al.* 1981, Posford Duvivier Environment and Hill 2002].

Dredging works may lead to the destruction of benthic organisms inhabiting the area where such works are carried out, thus negatively affecting the food supply of fish such as cod and flatfish. The scale of this loss depends on the number of wind turbines as well as on the type of foundations and length of the cable lines. It is assumed that the maximum surface area of the seabed covered by underwater works that will result in the destruction of macrozoobenthos will be approximately 3.57 km^2 – the total surface area of 64 gravity-based structures (for a maximum of 60 wind turbines and a maximum of 4 OSSs) together with the surface area of the scour protection layer as well as the area of the seabed prepared for the installation of jack-up vessels and the area of excavations for cable line installation, with a total length of 140 km). The seabed area represents approximately 4.17% of the total surface of the Project area. Given the active movement of fish in search for food, this loss of organisms comprising the benthivorous fish diet can be considered insignificant.

The sensitivity of the ichthyofauna to the loss of habitat, which may occur during the construction of the hard substrate elements on the seabed, is specific to individual fish species and life stages of fish. This is related to different habitat requirements of a given developmental stage and a given species [Wilson *et al.* 2010]. The scale of impact is influenced by the size of the area lost as well as the duration and season in which the works are carried out. It should be noted that when habitat alteration results in the cessation of spawning even in a small area that constitutes an important spawning ground, the effect of its exclusion from reproductive processes may be evident over a much larger sea basin [Bergstom *et al.* 2012].

The Baltica-1 OWF Area is not an ichthyofauna spawning ground. The impact was identified as long-term and related to relatively small areas in comparison with the entire area of the spawning and feeding grounds.

The impact related to the change of habitat will be negative, direct, temporary and local.

Cod, European flounder, common seasnail, sand goby, sprat and herring sensitivity to the impact was assessed to be high. The significance of the impact is assessed to be low for all the fish species examined.

Emission of toxic substances

Emissions of harmful substances during the construction phase can occur as a result of unplanned events such as vessel collisions, improperly conducted equipment disconnection and connection operations, errors in equipment operation or spills of domestic waste from vessels.

Toxic chemicals can also be released from sediments during dredging operations. According to the Helsinki Commission, these can include heavy metals (cadmium, chromium, copper, lead, mercury, nickel, zinc, and arsenic), chlorinated biphenyls, chloro- and phospho-organic pesticides, tributyltin (TBT) and its decomposition products, total petroleum hydrocarbons (TPH), polychlorinated dibenzodioxins (PCDDs), polychlorinated dibenzofurans and PCBs.

The effects of harmful chemical compounds on ichthyofauna can include cancerous changes, hormonal disturbances affecting reproductive processes, or morphological changes. Susceptibility to these effects depends on the developmental and physiological stage of fish. The most vulnerable stages are maturing females, young embryos, larvae just after yolk sac resorption, and early larval stages. A potentially high threat may be caused by the emission of petroleum products (hydrocarbons), including polycyclic aromatic hydrocarbons (PAHs), with light fractions posing a considerably higher threat than heavy ones. In the case of juvenile stages, a clear negative impact of even low concentrations of PAHs on embryonic growth was identified [Collier *et al.* 2013]. However, according to the NOAA (U.S. National Oceans and Atmosphere Administration), the impact of petroleum products on fish is largely limited to nearshore and enclosed sea basins, in which active risk avoidance is hindered. Also, the surveys of Koehler (2004) and Vethaak and Wester (1996) have not shown a statistically significant link between the PAH concentrations and the occurrence of liver tumours in flounder within Danish and German waters of the North Sea, although the researchers did not exclude the possibility of tumours being triggered by these substances [Koehler 2004, Vethaak *et al.* 2009].

Heavy metals are transferred from the water into the fish body mainly through the gills and, to a lesser extent, through the body surface. According to Garai *et al.* (2021) the most common sources of toxic effects in fish are cadmium, chromium, nickel, arsenic, copper, mercury, lead and zinc. They cause oxidative stress responsible for immune system impairment, tissue and organ damage, growth defects and reduced reproductive capacity.

It can be assumed that the risk of chemical emissions into the environment caused by unintentional activities is relatively low and can be reduced by following a detailed plan on hazards and pollution prevention plan that describes procedures and mitigation measures for such events. Part of such a plan should include monitoring compliance with the Shipboard Oil Pollution Emergency Plan (SOPEP) required by the International Convention for the Prevention of Pollution from Ships (MARPOL).

Surveys concerning the content of hazardous substances in sandy sediments in the Polish EEZ have not revealed concentrations that could cause a negative biological effect [Dąbrowska *et al.* 2013; Polak-Juszczak 2013; Szlinder-Richert *et al.* 2012]. Similar results were obtained in sediment surveys conducted in 2023 in the Baltica-1 OWF Area (Appendix 1 to the EIA Report). They demonstrate that concentrations of persistent organic pollutants (i.e. PAHs, PCBs and TBT) and toxic substances such as metals or mineral oils were low in the survey area and did not deviate substantially from the data from literature regarding sandy sediments of the Southern Baltic. The sediments tested were also characterised by low concentrations of the radioactive element ^{137}Cs, typical for sandy sediments. Therefore, it can be assumed that, as in the case of emissions caused by unintended events, the risk of a significant impact of substances released from the sediment on fish is low.

The impact related to releasing pollutants and nutrients from the sediments into water will be negative, direct, temporary and local.

The sensitivity of cod, flounder, common seasnail, gobies, sprat, herring and twaite shad to the impact was assessed as moderate.

The significance of the impact is assessed to be low for all the fish species examined.

Physical barrier

The construction of underwater structures may constitute a barrier for fish whose migration routes may run in this area. Intense maritime traffic during the construction period may also reinforce the effect. In surveys conducted during the operation of Danish OWFs, no significant disruption of fish migration processes caused by ship traffic was recorded [Leonhard *et al.* 2011]. It can be assumed that, despite potentially higher levels of vessel traffic during the construction period, the possibility of active fish movement should mitigate the impact of this factor. Unless similar impacts from neighbouring areas cumulate during the same period, it can be assumed that the scale of the impact is likely to be local and short-term, causing only temporary avoidance of the area during the works.

The impact related to the creation of the barrier will be negative, direct, local and temporary for all species.

The sensitivity of cod, flounder, common seasnail, gobies, sprat, herring and twaite shad to the impact was assessed as low. The significance of the impact is assessed to be negligible for all the fish species analysed.

Assessment of the scale of impact on ichthyofauna is provided in Table 10.26. Assessment of the impact significance is provided in Table 10.27.

Table 10.26. Assessment of the scale of impact on marine ichthyofauna

Impact	**Impact characteristics**													**Joint 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**
Noise emission	3			3							1		1	8
Increase in suspended solids concentration	3					1				2			1	7
Habitat change	3					1					1		1	6
Emission of pollutants	3					1					1		1	6
Physical barrier	3					1					1		1	6

Table 10.27. Assessment of the significance of impact on marine ichthyofauna

Impact	**Impact scale**	**Receptor sensitivity**	**Impact significance**
Noise emission	moderate	very high	**Moderate**

Impact	Impact scale	Receptor sensitivity	Impact significance
Increase in suspended solids concentration	low	high	Low
Habitat change	low	high	Low
Emission of pollutants	low	moderate	Low
Physical barrier	low	low	Negligible

Considering the results of the impact assessment, the restricted space within which the Project may be located and the feasible technologies of its execution, no measures mitigating the negative impact of the Baltica-1 OWF on the ichthyofauna are recommended.

10.2.1.9.4 Impact on marine mammals

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 a death of the organism [Thomsen *et al*., 2021].

Detection means that an organism is able to hear the signal but does not indicate a clear response. Masking occurs when noise interferes with the detection of biologically relevant signals used, for example, for communication and spatial orientation. This occurs when the frequency of sounds in the environment is within the species-relevant spectrum and exceeds the level of naturally occurring ambient noise. The behavioural response includes various types of behavioural changes under the influence of noise exposure, such as, for example, escape from the affected area, stopping foraging or resting, swimming faster or diving deeper. Under the influence of prolonged exposure to unwanted sounds, repetitive behavioural modifications can lead to a deterioration in the physiological condition of individuals and a change in their occurrence range. As a result, impacts may occur at a population level. Hearing impairments include temporary (TTS) and permanent threshold shifts (PTS). In the case of TTS, the animal may regain its original ability to perceive sounds after the impact factor has ceased to exist and a period of convalescence. PTS leads to irreversible damages in the hearing organ. For marine mammals relying primarily on the sense of hearing, impacts of this nature have a very significant negative effect and may result in a population-level impact. Noise-induced physiological changes involve damage to tissue or entire organs, which in extreme cases can lead even to death.

The above impacts occur in zones, the size of which depends on the sensitivity of the organisms exposed to the noise, the type of sounds emitted and the conditions for their propagation in a given location. To determine the zones of impact in the form of hearing damage (TTS and PTS) and behavioural changes for different groups of organisms, criteria that describe the noise level which cannot be exceeded to produce a given effect are used. Such criteria are used internationally, including for the description of noise impacts on porpoises and seals (e.g. NMFS 2018 and 2023).

Porpoises rely on sound for most aspects of their lives and hearing is their most important sense. These mammals can hear a wide range of frequencies – from well below 1 to 180 kHz, with the highest sensitivity in the ultrasonic range, between approximately 50–130 kHz [Andersen 1970; Popov *et al.*, 1986: Kastelein *et al*., 2002 and 2010]. They also use echolocation signals, with frequencies concentrated around 130 kHz [Villadsgaard *et al*., 2007].

Seals are diadromous animals with good hearing, both in the air and in the water. Underwater vocalisations of grey and harbour seals are characterised by low frequencies. In grey seals, the mating sounds studied were in the frequency range of 100 Hz to 1.3 kHz, while in harbour seals they were around 250 Hz to 1.4 kHz [Asselin *et al*., 1993; Van Parijs 2003 and Van Parijs *et al*., 2003].

Seals are generally considered to have a lower sensitivity to unwanted sounds than porpoises. Research also indicates that seals may become accustomed to exposure to certain types of noise [Edrén *et al*., 2010].

During the construction phase of a wind farm, two main sources of noise that may have a negative impact on marine mammals are identified – piling and increased vessel traffic.

Piling

The wind turbines will be installed 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 ambient noise levels around the development 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 these 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 a wind farms 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 $\mu Pa^2 s$ [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, may change their behaviour, for example by stopping feeding, or leave 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 have shown 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.

The way in which sounds from piling propagate depends on a number of factors, such as the type of seabed, depth of seabed penetration, water depth and hydrological conditions. Therefore, the degree of impact of the noise generated on marine organisms is strongly dependent on, among other things, the location of works. Numerical modelling of noise propagation was carried out in order to estimate the potential impact of sound from piling during construction of the Baltica-1 OWF on marine mammals. With its help, distance ranges and areas of potential impact on animals were calculated.

Analyses were conducted taking into account impulse noise exposure thresholds based on international criteria and survey findings. The values applied are presented in Table 10.28.

Table 10.28. Acoustic thresholds adopted for assessing the impact of impulse noise on marine mammals [Source: internal materials based on studies given in the table]

Animal species/group	Effect	SEL acoustic threshold [dB re 1 µPa^{2}s/ SPL [dB re 1 µPa]]	SPL peak acoustic threshold [dB re 1 µPa]	Source
Harbour porpoise	PTS cum	155 (HF-weighted SEL)	202	NMFS 2018, 2022
	TTS cum	140 (HF-weighted SEL)	196	NMFS 2018, 2022
	Behavioural change	103 (VHF-weighted SPL 125 ms)	-	Tougaard, 2021
Seals	PTS cum	185 (PW-weighted SEL)	218	NMFS 2018, 2022
	TTS cum	170 (PW-weighted SEL)	212	NMFS 2018, 2022
	Behavioural change	158 (unweighted SEL)	212	Russel *et al*., 2016

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. 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).

Taking into account the assessment of impact on animals, the most important results obtained for the effect of hearing damage (TTS and PTS) during the piling of a single turbine were for a cumulative case, i.e. taking into account the time needed to drive a single pile. The expected time was 24 hours. For behavioural change, the animals' response to sound from a single hammer strike was taken into consideration. The results obtained made it possible to recognise the approximate extent and areas where a given impact may occur. Additionally, in the case of harbour porpoise, the extent to which the planned construction works may affect the population status of this species in the Baltic Proper was calculated on the basis of the values obtained. To this end, the number of animals potentially exposed to the effect and the proportion of the population that these individuals represent were estimated. Abundance and density data of porpoises from the north-eastern Baltic population were used for the calculations based on Amundin *et al*., (2022), taking into consideration the two seasons included in the modelling [Table 10.29].

Table 10.29. Estimated values of density and abundance of the Baltic Proper porpoise population adopted for the calculations of noise impact from piling [Source: internal materials based on Amundin et al., 2022]

Region	Season		Density [number of animals / 1000 km^2]		Abundance	
	References	Modelling	Value	95% CI	Value	95% CI
North-eastern Baltic	May – October	Summer	3.70	0.54–8.33	491	71–1105
	November – April	Winter	1.83	0.71–4.22	243	94–560

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 10.30]. In the case of behavioural response, the area of impact on the harbour porpoise may cover about 0.2% of the population in summer and about 1% 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*, in which 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 the 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 a 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 N2000 site. This means that a small number of porpoises will be covered by the range of the behavioural response.

Table 10.30. Anticipated ranges of noise impact from piling during construction works in the Baltica-1 OWF Area obtained for porpoises on the basis of 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 was calculated on the basis of 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 [km^2]	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

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 [%]
		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
		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 10.31]. 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 change in behaviour will not significantly affect the animals.

Table 10.31. Anticipated impact ranges of noise from piling during construction works in the Baltica-1 OWF Area obtained for seals on the basis of 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. On the basis of the modelling results, it was concluded that the use of NRS would significantly reduce the extent of the negative 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 in which the harbour porpoise is protected, but the area affected will not exceed 1% in summer and 3.8% in winter. The impact on the harbour porpoise at behavioural level is of particular importance 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 N2000 site will significantly reduce or completely eliminate the impact at the behavioural response level on the N2000 site and on the Swedish territory. In winter and throughout the period from September to May, the species activity in the survey area is lower, limiting the negative impact associated with behavioural changes.

Vessel traffic

It is assumed that the construction of the proposed Project will result in increased vessel traffic, which may increase the ambient noise level naturally occurring in the Baltica-1 OWF Area and adjacent waters.

Underwater noise generated by ships and boats comes from propulsion systems, among other things. Its intensity and characteristics depend on many factors, including the type and size of the vessel, the type of engine, the shape of the hull or the conditions at sea. Low-frequency sounds are mainly generated by large and slower vessels, while high frequencies are mainly associated with small and fast boats. A breakdown of vessels by frequency and intensity of noise generation according to OSPAR (2009) is provided in Table 10.32.

Table 10.32. Division of vessels based on OSPAR

Type of vessel	Length (m)	Frequency and intensity of sound generated
Small recreational vessels and boats	<50	160–175 dB re 1µPa at 1 m; <1kHz >10 kHz
Medium-sized vessels	50–100	165–180 dB re 1µPa at 1 m; <1 kHz
Large vessels	>100	180 – >190 dB re 1µPa at 1 m; <200 Hz

The sounds generated by ships have a large range of frequencies that can coincide with frequencies relevant to marine organisms. As the main noise energy from vessels is generally below 1 kHz (e.g. Richardson 1995; OSPAR 2009), the most affected organisms are those for which low frequencies are the most important (e.g. fish). However, an important part of the noise energy generated by ships is in the high frequency band (tens of kHz), which is very important for porpoises, among others.

Surveys on the ship noise impact on porpoises have been carried out in among others the Danish Straits, an area with high traffic of various vessel types. Analyses showed that under the conditions of a sudden increase in high-frequency noise generated by fast-moving vessels, the animals responded with behavioural changes including diving more frequently and stopping foraging. In some cases, a reduction in the frequency of echolocation was also reported, potentially affecting the efficiency of food acquisition [Wiśniewska *et al*., 2018]. Porpoise responses have also been studied in another area of high ship traffic, the Gulf of Istanbul (Turkey). Under the conditions of intensive vessel movement, reduced foraging of animals near the water surface was reported [Akkaya-Bas 2017b]. Porpoises were also observed to avoid the areas of the Gulf with the highest levels of ship traffic. It has been hypothesised that such interactions may affect the animals' energy budget and, consequently, the physiological condition of the individuals [Akkaya-Bas *et al*., 2017a]. It is worth noting, however, that for the cases analysed, it is not clear whether the porpoises reacted to the presence of the vessels themselves or the noise they generated.

With regard to the wind farm construction process, it is assumed that vessels generating low-frequency sounds with less impact on porpoises will be used primarily. However, it can be suspected that the animals will temporarily avoid an area with increased ship traffic. An example of ship noise surveys used in the development of a large-scale offshore infrastructure was carried out during the construction of the Nord Stream 2 pipeline. The monitoring carried out in the Swedish Project area has shown that noise emissions from vessels were comparable to commercial cargo ships passing in the area. This applied to both the levels and frequencies of the sounds generated. Conclusions were drawn that porpoises may have temporarily avoided the construction area, most likely at a short distance from the noise source [Tougard and Giffits, 2020].

In the case of seals, surveys indicate that low-frequency sounds generated by vessels can interfere with the vocalisations of these animals [Erbe *et al*., 2019]. However, it should be taken into account that in the area of the planned wind farm, seals are unlikely to appear in larger groups or for mating purposes, i.e. in situations when they use vocalisations. Therefore, it can be suspected that the sounds generated by the vessels used for construction should not interfere with the behaviour of the animals occurring there.

It is also worth noting that low-frequency noise levels resulting from ship traffic are generally high in the Baltic Sea [HELCOM 2018b]. As a result, both porpoises and seals are exposed to this factor in many areas where they occur. In the Polish EEZ, this is particularly evident in the case of seals, which are recorded in high abundances in the Gulf of Gdańsk area, where vessel traffic is heavy.

Habitat and food supply change

The construction of a wind farm may affect the chemical parameters of seawater due to, among other things, the lifting of suspended solids from the seabed. Such environmental fluctuations may affect marine mammals indirectly, mainly in terms of the impact on the food supply, i.e. fish populations. Changes in water parameters related to the construction process can negatively affect populations of plankton and benthic organisms on which fish feed. As a result, there may be a temporary decline in the numbers of these animals and a consequent loss of a potential food source and foraging habitat for marine mammals.

Assessment of the impact during the construction phase

A summary of the impact of the construction phase of the Baltica-1 OWF on marine mammals is presented in Table 10.33 and Table 10.34. The analysis was conducted with the assumption of the application of NRS in accordance with the provisions of Section 3.2.2.2.5. Due to the unlikely impact in the form of hearing damage (TTS and PTS) when NRS is taken into account, no assessment of the scale of impacts for this type of influence was carried out.

Table 10.33. Assessment of the scale of impacts of the Baltica-1 OWF construction phase on marine mammals with the assumption of NRS application during piling

Animal species/group	Impact	Impact characteristics													Joint 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
Harbour porpoise	Increase in noise level due to piling – PTS cum														None
	Increase in noise level due to piling – TTS cum														None
	Increase in noise level – ship traffic	3					1			3				1	8
	Habitat and food supply change		2				1			3				1	7
Seals	Increase in noise level due to piling – PTS cum														None
	Increase in noise level due to piling – TTS cum														None
	Increase in noise level – ship traffic	3					1			3				1	8
	Habitat and food supply change		2				1			3				1	7

Table 10.34. Assessment of the impact significance of the Baltica-1 OWF construction phase on marine mammals with the assumption of NRS application during piling

Animal species/group	Impact	Impact scale	Receptor sensitivity	Impact significance
Harbour porpoise	Increase in noise level due to piling – PTS cum	irrelevant	very high	Low
	Increase in noise level due to piling – TTS cum	irrelevant	very high	Low
	Increase in noise level – ship traffic	moderate	moderate	Low
	Habitat and food supply change	low	moderate	Low
Seals	Increase in noise level due to piling –	irrelevant	very high	Low

Animal species/group	Impact	Impact scale	Receptor sensitivity	Impact significance
	PTS cum			
	Increase in noise level due to piling – TTS cum	irrelevant	very high	Low
	Increase in noise level – ship traffic	moderate	low	Low
	Habitat and food supply change	low	moderate	Low

10.2.1.9.5 Impact on migratory birds

During the construction phase, there will be impacts on migratory birds due to the barrier effect and the risk of collision with the Baltica-1 OWF construction vessels. Underwater and above-water noise is not considered a potential impact on migratory birds.

Barrier effect

The presence of construction vessels in the Baltic area surveyed creates a physical barrier, which may affect the mode of movement of migratory birds. 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 impact also during the construction phase was assessed as negligible for all the species and groups of species analysed.

Collisions with construction vessels

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 onshore 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].

An assessment of the sensitivity of individual species and species groups is provided in Table 10.35.

Table 10.35. Sensitivity of migratory birds to disturbance in the form of the barrier effect and the risk of collision with construction vessels during the construction phase

Species/group of species	**Binomial nomenclature**	**Receptor value/significance**	**Resistance to disturbance (barrier effect)**	**Receptor sensitivity (barrier effect)**	**Resistance to disturbance (risk of collisions with construction vessels)**	**Receptor sensitivity (risk of collisions with construction vessels)**
Greylag goose	*Anser anser*	Low	High	**Irrelevant**	Moderate	**Low**
Greater white-fronted goose	*Anser albifrons*	Low	High	**Irrelevant**	Moderate	**Low**
Common wood pigeon	*Columba palumbus*	Low	High	**Irrelevant**	High	**Irrelevant**
Common swift	*Apus apus*	Low	High	**Irrelevant**	High	**Irrelevant**
Eurasian curlew	*Numenius arquata*	Low	Moderate	**Low**	Moderate	**Low**
Whooper swan	*Cygnus cygnus*	Low	High	**Irrelevant**	High	**Irrelevant**
Long-tailed duck	*Clangula hyemalis*	High	High	**Low**	High	**Low**
Common scoter	*Melanitta nigra*	Moderate	High	**Low**	High	**Low**
Little gull	*Hydrocoloeus minutus*	Moderate	Moderate	**Low**	Moderate	**Low**
Lesser black-backed gull	*Larus fuscus*	Low	Moderate	**Low**	High	**Irrelevant**
Black-throated diver	*Gavia arctica*	Low	High	**Irrelevant**	High	**Irrelevant**
Goosander	*Mergus merganser*	-	High	**Irrelevant**	High	**Irrelevant**
Greater scaup	*Aythya marila*	Low	High	**Irrelevant**	High	**Irrelevant**
Eurasian skylark	*Alauda arvensis*	Low	High	**Irrelevant**	High	**Irrelevant**
Eurasian wigeon	*Mareca penelope*	Low	High	**Irrelevant**	High	**Irrelevant**
Red-breasted merganser	*Mergus serrator*	-	High	**Irrelevant**	High	**Irrelevant**
Velvet scoter	*Melanitta fusca*	High	High	**Irrelevant**	High	**Irrelevant**
Common crane	*Grus grus*	High	Moderate	**Moderate**	Moderate	**Moderate**
Auks (razorbill, common guillemot, black guillemot)	*Alcidae (Alca torda, Uria aalge, Cepphus grylle)*	Low	High	**Irrelevant**	High	**Irrelevant**
Carnivorans	*Accipitriiformes*	Moderate	Moderate	**Moderate**	Moderate	**Moderate**
Geese	*Anserinae*	Low	Moderate	**Low**	Moderate	**Low**
Swans	*Cygnidae*	Low	High	**Irrelevant**	High	**Irrelevant**
Divers	*Gaviidae*	Low	High	**Irrelevant**	High	**Irrelevant**

Species/group of species	**Binomial nomenclature**	**Receptor value/significance**	**Resistance to disturbance (barrier effect)**	**Receptor sensitivity (barrier effect)**	**Resistance to disturbance (risk of collisions with construction vessels)**	**Receptor sensitivity (risk of collisions with construction vessels)**
Terns	*Sternidae*	Low	High	**Irrelevant**	High	**Irrelevant**
Charadriiformes	*Charadriidae*	Low	Moderate	**Low**	Moderate	**Low**
Owls	*Strigiformes*	Low	Moderate	**Low**	Moderate	**Low**
Passerines	*Passeriformes*	Low	High	**Irrelevant**	High	**Irrelevant**
Skuas	*Stercorariidae*	Low	High	**Irrelevant**	High	**Irrelevant**

The collision risk estimated for the operation phase is always considered to be as high as possible (as well as permanent) compared to the construction and decommissioning phase, and therefore the significance of the impact during the construction phase was considered to be negligible and low, depending on the species sensitivity to the impact.

Table 10.36. Assessment of the scale of impacts on migratory birds during construction phase

Impact	**Impact characteristics**													**Joint 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**
Barrier effect	3					1					1		1	6
Collisions with construction vessels	3					1					1	2		7

Barrier effect and collisions with vessels were classified as direct impacts, due to the fact that the presence of erected structures as well as construction vessels can directly alter the flight trajectory of migratory birds or cause collisions. The range of these impacts is considered to be local because, if impacts do occur, they will be confined to a small area where construction works will be conducted at that time. The temporal scope of both impacts was considered to be temporary. The barrier effect is reversible in nature as it disappears with the discontinuation of construction works, while collisions, due to the 100% mortality of birds in the event of a collision, are considered irreversible. Based on the analysis of impacts during the construction phase, the scale of the barrier effect was considered to be low and the scale of collisions with vessels to be moderate.

The significance of impacts on migratory birds during the construction phase was considered negligible for receptors with irrelevant and low sensitivity to both impacts, and low in the case of collisions with construction vessels for receptors with moderate sensitivity.

Table 10.37. Assessment of the impact significance on migratory birds during construction phase

Impact	**Impact scale**	**Receptor sensitivity**	**Impact significance**
Barrier effect	low	irrelevant	**Negligible**
Barrier effect		low	**Negligible**
Collisions with construction vessels	low	irrelevant	**Negligible**
Collisions with construction vessels		low	**Negligible**
Collisions with construction vessels		moderate	**Low**

10.2.1.9.6 Impact on seabirds

An assessment of the impacts identified for the construction phase of the Baltica-1 OWF on marine avifauna is presented below.

Habitats occupation

The construction of foundations or support structures and power cables will result in the disturbance of seabed communities in the Baltica-1 OWF Area. This process shall have a direct impact on the seabed and on 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). The scale of the impact shall mainly depend on the number of foundations or support structures of offshore wind turbines and their technical characteristics.

As a result of the construction works, the seabed sediments shall be agitated and the content of the suspended solids shall increase. The direct transfer of sediments and their re-suspension shall result in the decrease in the water transparency. If it exceeded the naturally occurring level, it could cause difficulties for birds using their eyes while foraging, i.e. piscivorous and benthivorous birds, and could result in the displacement of birds to clearer waters.

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 their propagation, will not pose a risk to fish. Instead, it will create temporary and local 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 local, medium term loss of the food supply for diving benthivorous birds.

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 impact from disturbance due to the presence of construction vessels will be the first impact in the construction works area, resulting in the displacement of sensitive species to other areas. As a result, these birds will not experience any additional 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 impacts on benthivorous and piscivorous birds, local in extent, medium-term and reversible.

Bird species vulnerable to works interfering in the seabed are mainly benthivorous and piscivorous birds. However, they are very sensitive to disturbance caused by the presence of vessels and other human activities at sea [Schwemmer *et al.*, 2016]. Therefore, it is estimated that the 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 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 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 waters. This 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.

Barrier effect and risk of collision

Offshore wind turbine structures protruding from the water, gradually appearing during the construction phase, can deter birds. This impact shall depend mainly on the rate of the OWF construction. Initially, individual offshore wind turbines will have little impact on birds, but the disturbance effect will gradually increase [Stewart, 2005]. The data from literature clearly indicate that birds avoid areas occupied by OWFs and their population decreases within a radius of up to 2 or even up to 4 km from OWFs [Christensen 2003; Petersen 2006; Krijgsveld 2011; Leopold 2011]. Birds will most likely be able, to some extent, get 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 their lesser experience. This 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. The distance between individual offshore wind turbines within the farm and with the neighbouring OWFs is also important [Stewart *et al*., 2005]. Both the construction and operation of the OWFs located in close proximity to the Baltica-1 OWF may cause a cumulative barrier effect for birds.

Construction 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 impact the change of the flight route of those bird species that do not use this area but only fly over it. However, it cannot be ruled out that such an impact will occur at night or during unfavourable weather conditions, especially if the construction site will be 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 an increased vessel traffic, also has an influence. The period in which the works take place is important, as most seabird species, including the long-tailed duck, indicate 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 of local nature, 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*.

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 impact. The extent of the impact was assessed as transboundary for benthivorous birds, regional for piscivorous birds and local for gulls.

The impact scale on gulls was assessed as low and on the piscivorous and benthivorous birds as high.

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]. Birds migrating at night use the stars to help them navigate and maintain their flight direction. The phenomenon of birds being attracted to artificial light has been known since the 19th century and mainly involved lighthouses and spot-lit ships [Allen 1880], hence collisions between birds and illuminated structures are referred to as the 'lighthouse effect'. 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 and precipitation [Thompson, 2013]. Furthermore, during surveys on bird behaviour near drilling rigs, it was observed that illumination causes seabirds to gather around such structures not only during the migration period. This is mostly the case for tubenoses (*Procellariiformes*) which are most often active at night, but the concentrations of several thousand little auks (*Alle alle*) have also been observed [Wiese, 2001] this species being closely related to the razorbill and the guillemot, which are recorded in the area of the proposed Project. However, in the case of the majority of typical seabirds (sea ducks, divers), the impact of artificial lighting on birds residing in the near and distant vicinity of light sources remains very poorly known.

The illumination of the Project site during the construction phase will result in a direct impact on seabirds, locally on gulls, regionally on piscivorous birds and in a transboundary impact on long-tailed ducks (due to the possible impact on the biogeographical population of the species). The impact will be medium-term and reversible in nature.

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

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 Polish sea areas, showed the potential for significant underwater noise impacts on fish which constitute the food supply for piscivorous birds. The use of mitigation in the form of a soft-start procedure for pile driving will result in minimising this negative impact [Lacroix *et al*, 2003; Leopold *et al*., 2007; Opioła *et al*., 2020].

The emission of surface noise, together with the movement and operation of construction vessels, will be one of the main causes of disturbance to seabirds in the sea area of the Baltica-1 OWF construction site. The noise phenomenon in the scenario considered is a typically anthropogenic impact that does not occur at sea without the presence of vessels. This impact will be more significant for seabirds than the underwater noise. Seabirds are very sensitive to disturbance caused by the presence of vessels and other human activities at sea. Therefore, the 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 displacement of the sensitive species to other areas. As a result, these birds will not experience additional impacts associated with the underwater noise emissions alone 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 to pile driving was demonstrated [Leopold, 2007].

The modelling of noise generated by pile driving was carried out for the purpose of preparation of the EIA Report for the Baltica-1 OWF. A simulation was carried out to define the most negative scenario for up to four piling locations, which were independent of the distance between the sources and the specific locations in the areas of Bałtyk I, Kriegers Flak I, Kriegers Flak II Nord, Kriegers Flak II Syd, Energy Island Bornholm, Njord, Öland-Hoburg I, Baltic Central, Baltic Offshore Beta, Virrus, Neptunus, Södra Victoria, Bornholm Bassin Øst and Baltic Edge OWFs. The noise modelling carried out confirmed that the planned pile driving in the Baltica-1 OWF Area could have a significant range and impact related to it on fish which constitute food for piscivorous birds. This is particularly true of the results obtained for the winter season, when the ranges of the behavioural response and the cumulative shift in hearing threshold (TTS) for fish remain high. It should be emphasised that there is considerable uncertainty regarding the effects of cumulative sound exposure levels (SEL). 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 high performance NRS leads to a significant reduction in the impact ranges. The combination of IQIP and DBBC systems has the most beneficial effect in reducing underwater noise levels for fish with a swim bladder.

The scenario of pile driving in one location only was characterised by the lowest impact. After the application of the most beneficial combination of noise reduction systems, the ranges of TTS in the northern part of the Baltica-1 OWF Area in winter will reach a maximum of 100 m for a single strike and, as a result of the cumulative noise dose from the pile driving from a single source, 8 km. The range of permanent threshold shift in fish (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 – 8.8 km for cumulative TTS and 1.2 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 and often multiples of the TTS and PTS ranges. In order to minimise the negative impacts on diving birds, it will be necessary to limit piling in the northern part of the proposed Project to only one site in winter and two sites in summer, covering both the Baltica-1 OWF and other OWFs in the Baltic Sea. 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. Pile driving should be avoided during the remaining period. In addition, a suitably effective NRS should be applied and environmental supervision. In the central part of the area, works should be carried out using a combination of the above-mentioned mitigation systems, and in the southern part, a single noise mitigation system should be applied, under environmental supervision.

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. 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. In addition, stunned or dead fish, due to noise and vibration emissions, can provide a rich and easily accessible food source for gulls. Gulls have long benefited from the availability of large quantities of scraps and offal removed from fishing boats, which they actively seek out [Garthe *et al.*, 1996]. This phenomenon may have contributed to the rapid population growth of some of the gull species [Dunnet *et al*., 1990, Lloyd *et al*., 1991]. The impact scale on piscivorous and benthivorous birds was assessed as moderate and as insignificant on gulls.

A summary of the magnitude assessment of the above mentioned impacts on seabirds during the construction phase of the Baltica-1 OWF is provided in tables below.

Table 10.38. Assessment of the scale of impacts on benthivorous birds in the construction phase

Impact	**Impact characteristics**													**Joint 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**
Habitats occupation	3					1			3				1	8
Barrier effect and risk of collision	3			3				4					1	11
Emission of artificial light	3			3					3				1	10
Noise and vibration emissions	3			3						2			1	9

Table 10.39. Assessment of the scale of impacts on piscivorous birds in the construction phase

Impact	**Impact characteristics**													**Joint 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**
Habitats occupation	3					1					1		1	6
Barrier effect and risk of collision	3				2			4					1	10
Emission of artificial light	3				2				3				1	9
Noise and vibration emissions	3			3						2			1	9

Table 10.40. Assessment of the scale of impacts on gulls in the construction phase

Impact	**Impact characteristics**													**Joint 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**
Habitats occupation		2				1					1		1	5
Barrier effect and risk of collision		2				1				2			1	6
Emission of artificial light	3					1			3				1	8
Noise and vibration emissions		2				1					1		1	5

Table 10.41. Assessment of the impact significance on benthivorous birds in the construction phase

Impact	**Impact scale**	**Receptor sensitivity**	**Impact significance**
Habitats occupation	moderate	high	**Moderate**
Barrier effect and risk of collision	high	moderate	**Moderate**

Impact	Impact scale	Receptor sensitivity	Impact significance
Emission of artificial light	high	moderate	**Moderate**
Noise and vibration emissions	moderate	high	**Moderate**

Table 10.42. Assessment of the impact significance on piscivorous birds in the construction phase

Impact	Impact scale	Receptor sensitivity	Impact significance
Habitats occupation	low	moderate	**Low**
Barrier effect and risk of collision	high	moderate	**Moderate**
Emission of artificial light	moderate	moderate	**Moderate**
Noise and vibration emissions	moderate	moderate	**Moderate**

Table 10.43. Assessment of the impact significance on gulls in the construction phase

Impact	Impact scale	Receptor sensitivity	Impact significance
Habitats occupation	irrelevant	low	**Negligible**
Barrier effect and risk of collision	low	low	**Negligible**
Emission of artificial light	moderate	low	**Low**
Noise and vibration emissions	irrelevant	low	**Negligible**

10.2.1.9.7 Impact on bats

Potential impacts may arise from works and activities carried out on the sea surface. The construction of a wind farm will certainly result in the increased presence of vessels, but also helicopter flights, which will involve an additional and unusual source of noise that may scare away bats. When assessing the potential for scaring bats away as a result of noise associated with the construction of the wind farm, it should be assumed with a high degree of probability that the work will mainly take place during daylight hours and will be carried out gradually (not all wind turbines will be built at the same time). The possible modification of the bat flight route should not be of great significance.

The results of the monitoring carried out should be taken into account when assessing the potential impact of the construction phase on bats. It showed that the area of the proposed offshore wind farm is used by bats to a limited extent, especially during the spring migration period.

On the other hand, ships anchored and illuminated by intense light during night work, as well as when stationary, can attract many nocturnal insects, which for migrating bats will provide an opportunity to replenish their energy during their migration across the sea. The vessels will also create a resting opportunity for the animals as a daytime hideout with numerous nooks and crannies, but also as a short-term night-time hideaway. This is confirmed by the findings of resting bats on anchored ships during the survey period in other areas and by numerous reports from seamen in other years and periods (own data).

Taking this into account, it can be assessed that the construction stage of the Baltica-1 OWF will not have a significant impact on bats.

An assessment of the scale of the impact is provided in Table 10.44 and an assessment of its significance in Table 10.45.

Table 10.44. Assessment of the scale of impacts of the Baltica-1 OWF construction phase on bats

Impact	**Impact characteristics**													**Joint 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**
Above-water noise	3					1				3			2	9

Table 10.45. Assessment of the impact significance of the Baltica-1 OWF construction phase on bats

Impact	**Impact scale**	**Receptor sensitivity**	**Impact significance**
Above-water noise	moderate	low	**Low**

10.2.1.9.8 Impact on biodiversity

The impact on biodiversity of the construction phase of the Baltica-1 OWF will be the cumulative effect of impacts on all animal groups included in this analysis. As individual groups and even taxa have different sensitivities and responses to a given impact, it is not reasonable to define the impact of the Project on biodiversity as such. For this reason, the assessment of impacts on biodiversity is consistent with the results of the analysis of impacts for all animal groups presented in Section 10.2.1.

10.2.1.10 Impact on protected areas and the subjects of protection in these areas

A protected area that is likely to be affected by the 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: sublittoral 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.

Pursuant to Article 33(1) of the Nature Conservation Act of 16 April 2004 (consolidated text: Journal of Laws of 2023, item 1336):

'It is prohibited, subject to Article 34, to undertake activities which, either individually or in combination with other activities, may have a significant negative impact on the conservation objectives of a Natura 2000 site, including in particular activities that may:

1) *deteriorate the condition of natural habitats or habitats of plant and animal species, for the protection of which the Natura 2000 site was established, or*
2) *negatively affect the species, for the protection of which the Natura 2000 site was established, or*

3) *deteriorate the Natura 2000 site integrity or its interconnection with other sites.'*

In order to determine whether the impacts generated during the construction phase of the Project will be significant, the following definitions contained in the Nature Conservation Act were taken into account:

- **favourable conservation status of a species** – the sum of the influences acting on the species concerned that may affect, in the foreseeable future, the long-term distribution and abundance of its populations within the country or the Member States of the European Union or the natural range of that species, for which population dynamics data on that species indicate that the species is maintaining itself on a long-term basis as a viable component of its natural habitat, the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis (Article 5(24) of the Act);
- **favourable conservation status of a natural habitat** – the sum of the influences acting on a natural habitat and its typical species that may affect its long-term natural distribution, structure and functions as well as the long-term survival of its typical species within the country or the Member States of the European Union or the natural range of that habitat, for which the natural range and areas it covers within that range are stable or increasing, the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist, and the conservation status of its typical species is favourable (Article 5(25)).

According to the 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 impacts, including those with the largest spatial extent, i.e. underwater noise propagation and suspended solids dispersion, do 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 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 SE0330308 site, hence the risk that underwater noise emitted from the seabed piling works 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.

The first type of analyses was to estimate whether noise emitted during piling could exceed the permissible sound levels in the Natura 2000 site *Hoburgs bank och Midsjöbankarna*. The analyses were performed for two seasons (summer, winter), for a scenario without mitigation and with mitigation measures 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 calculated SEL values and threshold values [Table 10.46–Table 10.49]. 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 10.46]. The use of one mitigation measure in the form of the BBC is not sufficient to reduce excessive sound emissions. The use of dual mitigation measures (HSD+DBBC or IQIP+DBBC) will reduce noise, if construction works are assumed to be performed in summer [Table 10.47]. However, it should be noted that the results of the impact analysis presented in previous sections indicate a high impact of piling during the period of greatest concern for the Baltic Proper population, i.e. from June to August. During the remaining period, even with dual mitigation measures (HSD+DBBC or IQIP+DBBC), thresholds associated with the occurrence of TTS in the harbour porpoise are expected to be exceeded. Therefore, pile driving in southern locations or the use of a more effective NRS will be necessary.

Table 10.46. Modelled noise levels at the boundary of the Natura 2000 site Hoburgs bank och Midsjöbankarna, 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 Natura 2000 site boundary [dB re 1 µPa²s]	No mitigation measures	
			Modelled value of HF-weighted SEL at 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 10.47. Modelled noise levels at the boundary of the Natura 2000 site Hoburgs bank och Midsjöbankarna, 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 Natura 2000 site boundary [dB re 1 µPa²s]	Modelled value of HF-weighted SEL at 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 without mitigation measures leads to exceedances of the hearing damage thresholds for the harbour porpoise in each of the scenarios analysed [Table 10.48]. The same is true for a single mitigation measure in the form of a BBC. In most cases, dual mitigation is also insufficient 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 10.49].

Table 10.48. Modelled noise levels at the boundary of the Natura 2000 site Hoburgs bank och Midsjöbankarna, 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 Natura 2000 site boundary [dB re 1 µPa²s]	No mitigation measures	
				Modelled HF-weighted SEL at 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 10.49. Modelled noise levels at the boundary of the Natura 2000 site Hoburgs bank och Midsjöbankarna, 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 Natura 2000 site boundary [dB re 1 µPa²s]	Modelled value of HF-weighted SEL at 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 –	TTS_{cum}	140	157.8	150.6	153.0	+17.8	+10.6	+13.0

Season	Sound sources	Effect	Threshold SEL value at Natura 2000 site boundary [dB re 1 µPa^{2}s]	Modelled value of HF-weighted SEL at Natura 2000 site boundary [dB re 1 µPa^{2}s]			Difference between the modelled value of HF-weighted SEL and the threshold value [dB].		
				BBC	HSD+ DBBC	IQIP+ DBBC	BBC	HSD+ DBBC	IQIP+ DBBC
	< 1 km	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 impact of underwater noise generated by the Baltica-1 OWF piling works on the Natura 2000 site *Hoburgs bank och Midsjöbankarna* included an analysis of the extent of 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 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.

On the basis of 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 of impact are larger, ranging from 3.8% for BBC to 2.5% for HSD+DBBC [Table 10.50].

Table 10.50. Extent of impact from underwater noise associated with changes in harbour porpoise behaviour within the Natura 2000 site Hoburgs bank och Midsjöbankarna 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 [Source: internal materials]

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

Season	Mitigation type	Effect	Threshold value	Average distance [km]	Max. distance [km]	Impact area [km^2]	Percentage of the Natura 2000 site coverage [%]
	IQIP + DBBC	Behavioural response	103 SPL VHF-weighted	7.5	9.0	178	0.5

On the basis of the above analyses, it was assessed that noise from piling may have a **moderate** impact on the harbour porpoise occurring within the Natura 2000 site *Hoburgs bank och Midsjöbankarna* and adjacent waters. In the case of birds protected within the SE0330308 site, the long-tailed duck, the black guillemot and the common eider, the impacts on these birds may result from underwater noise and from the barrier in the form of an above-water space 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 area for several months. Due to the fact that the listed bird species subject to protection within the 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)** from 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 impacts on birds that are present directly in the Project area. The results of the analysis of the impacts identified indicate that these impacts will be **moderate**.

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 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 SE0330308 site. Natural habitats 1110 and 1170 are located at a considerable distance from the Baltica-1 OWF development area, and the impacts on their structure and functioning will not occur. In the case of the protected populations, i.e. the porpoise, the long-tailed duck, the black guillemot and the common eider, the noise impacts will affect individuals of the 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. Bearing in mind the significance of the SE0330308 site for the harbour porpoise and the long-tailed duck, the latter being the most abundant species within the Natura 2000 site discussed, as well as the sensitivity of these species to underwater noise, the limited duration of the impact (with the strongest intensity 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 harbour porpoise and benthivorous birds, it was assumed that **the impact of underwater noise on the protected species within the SE0330308 site will be moderate for the harbour porpoise and the long-tailed duck, and negligible for the common eider**.

According to the Standard Data Form for the 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 the migrating and wintering long-tailed ducks and black guillemots. Therefore, it is likely that individuals of these species may migrate between these areas mainly during the wintering period. Construction works may affect 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 i**mpact on the link between the *Hoburgs bank och Midsjöbankarna* site (SE0330308) and the *Ławica Słupska* site (PLC 990001) was assessed as a negligible impact**.

No impacts, other than negligible, on the subjects of protection, the integrity and the link to the Natura 2000 *Ławica Słupska* site (PLC990001) are expected to occur during the construction phase of the Baltica-1 OWF. The minimum distance of this area from the Baltica-1 OWF Area is approximately 59 km, i.e. outside the spatial range of all the impacts that may be generated during this phase of the Project.

10.2.1.11 Impact on wildlife corridors

As described in Section 7.8, open sea waters are a space enabling free movement of aquatic organisms and the main factors that act as a barrier to such movement are the values of water salinity and temperature, and in the case of phytobenthos – also the extent of the euphotic zone and the type of seabed. The construction of the Baltica-1 OWF will not cause a local change in these parameters and will not affect the ability of marine organisms to move. Underwater works resulting in the emission of noise and mobilisation of suspended solids may cause local disturbance of animals, which will cease when the works are discontinued. The significance of this impact was assessed to be **negligible**.

The airspace above the Project area, similarly to most of the Southern Baltic area, is used by migratory birds in spring and autumn. The presence of vessels and the erection of above-water structures of the farm may pose an obstacle for migrating birds, forcing the correction of flight routes and a slight increase in their length. It was assumed that the assessment of the Project impact on bird migrations involving the disruption of flight routes during the construction phase is consistent with the assessment of the significance of the impact on migratory birds, i.e. **negligible** and **low for cranes and birds of prey**.

10.2.1.12 Impact on cultural heritage

There are no objects of cultural heritage in the Baltica-1 OWF Area and within the range of its impact which could be affected by the Project.

10.2.1.13 Impact on the use and management of the sea basin and tangible property

10.2.1.13.1 Fisheries

The analysis of the value of catches conducted by the fishing industry in the Baltica-1 OWF Area demonstrated a very limited activity of the fleet, both in the area of entire statistical rectangles, which will be only partially occupied by the Project area (0.4% of the total effort of the Polish Baltic fleet), as well as the volume and value of the catches conducted only in the area occupied by the Baltica-1 OWF (0.02%). Bearing that in mind, the impact of the Project on **fisheries**, although long-term in nature, will be local and **irrelevant** in terms of scale. The location of the wind farm at a considerable distance from the coastline and outside the routes of fishing vessels leading from the ports to the fishing grounds allows assessing the issue of the **increased distance to the fishing grounds** resulting from the necessity to bypass the farm area as **negligible**.

10.2.1.13.2 Navigation

Construction of the Baltica-1 OWF will probably involve **restrictions on navigation**. Thus far, the Project area has been used mainly by vessels navigating to and from the port of Klaipeda, and to a smaller extent by fishing vessels (see Section 7.10.2). The commencement of the construction phase works may be accompanied by the implementation of restrictions on the traffic of vessels not involved in the wind farm construction, implemented by decision of the territorially competent Director of the Maritime Office, in line with the provisions of the MSPPSA. This may necessitate the alteration of routes and increase in their length. However, the impact will not be significant and will not result in the exclusion of this route from use. Therefore, the significance of this impact was assessed as **negligible**.

10.2.1.13.3 Prospecting and exploration of mineral resources

During the Baltica-1 OWF construction phase there will be no impediments affecting the exploitation of the natural aggregate deposit 'Southern Middle Bank – Southern Baltic'. Restrictions concerning vessels exploiting the deposit may result from general restrictions on the traffic of vessels not involved in the wind farm construction, implemented by decision of the territorially competent Director of the Maritime Office, in line with the provisions of the MSPPSA. This may necessitate the alteration of routes and increase in their length. However, the impact will not be significant and will not contribute to a severe restriction in the navigation of dredgers. Therefore, the significance of this impact was assessed as **negligible**.

10.2.1.14 Impact on landscape, including the cultural landscape

To begin with, it should be noted that no cultural landscape – as defined in the Act on the protection and care of historical monuments (see: Section 7.11) – is present within the sea area in which Baltica-1 OWF is to be located. Therefore, throughout Section 10 the impact of the Project on the natural landscape will be assessed.

During the Baltica-1 OWF construction phase, potential impacts on the landscape will result from:

- the presence and traffic of vessels supporting the OWF construction;
- the erection of wind turbines and OSSs.

The implementation of the impact will result in a gradual transformation of the landscape from natural to industrial, but also subjective impacts, depending on individual characteristics of the observer, and may be perceived as negative, positive or neutral.

The offshore structures may be constructed one by one, in stages. According to estimates, the Baltica-1 OWF construction phase may last 2 years. The offshore structures will be painted, marked and illuminated at night to ensure maritime and aviation safety.

The impact of the OWF on the landscape during the construction phase depends on:

- the traffic of construction-related vessels, size of structures transported;
- the size of structures, the diameter of the rotor and its position in relation to the viewer;
- the number and location of wind turbines and facilities;
- meteorological conditions and the sea state;
- location of the landscape observer.

In the OWF Area, people not directly associated with the OWF are present temporarily. These are the workers on board of vessels, passengers of tourist ferries, fishermen and deep-sea anglers, tourists on recreational crafts, participants in search and rescue operations flying over the sea in airplanes, scientists and others. The planned OWF will be most visible to this group but more people will be able to observe the OWF during the day rather than at night when, for example, some of ferry crews and passengers will be asleep. During the construction, this group will be increased by the employees of the OWF construction vessels. The impacts on the landscape will be short-term, temporary, and will depend on how long the observer can see the construction of the OWF, and the transported components.

During the construction phase, the landscape will change not only at sea, but also in ports where offshore structures will be built. The impacts on the landscape in this respect will be short-term, temporary and, above all, they will take place in industrial and port areas, depending on the location of the production area, they will be more or less visible to a third-party observer; these will be medium and large ports. The landscape of ports and industrial areas is transformed, there are many facilities and structures changing the landscape to industrialised, anthropogenic; they may partially or even completely obscure the observer's view of the structures constructed for the needs of the OWF.

The impact was assessed to be negligible, although it varies depending on the distance of the observer from the OWF and the type of the landscape affected. In the open sea, the landscape is not disturbance-resistant, but its value is not high, as very few people and over a short period will be exposed to the landscape change and some of them (e.g. tourists) may perceive it as advantageous or interesting. The spatial extent of the impact will be large, decreasing with the distance from the OWF; the vessel traffic will increase periodically, whereas at ports the impact will be local.

The impact on the landscape was assessed as **negligible**.

10.2.1.15 Impact on population, health and living conditions of people

The construction of the Baltica-1 OWF will not directly affect human health and living conditions. It may cause impacts on the existing use of the sea basin, which were assessed in the sections on shipping and fishing – the two most important forms of use of the sea basin in which the Project will be located. Indirectly, the construction and subsequent operation of the wind farm will contribute to the development of coastal communes, whose residents may find employment in Project servicing, which can be considered a positive impact. This is one of the objectives of the Sectoral Agreement, but the declarative nature of this document does not indicate legal solutions for its implementation. In the context of this assessment it should be assumed that the impact of the Baltica-1 OWF construction will be **negligible** from the perspective of the population, health and living conditions of people.

10.2.2 Operation phase

10.2.2.1 Impact on geological and geomorphological structure

Changes within the seabed associated with the Project impact will be local and, within the entire area occupied by the Project, insignificant for the overall character of the seabed and its structure.

Depending on its structure, the seabed may exhibit different sensitivity to the impact of the project during its operation phase. The seabed made of till and till with a stony cover is difficult to wash out and withstands morphological changes. A sandy, sandy-silty, and silty seabed is more susceptible to being washed out and to material moving over it, e.g. in the form of mega-ripples. Thus, the elements of the OWF infrastructure may be uncovered or buried, both as a result of natural processes involving the movement of rock material along the seabed and as a result of this movement being disrupted by the OWF infrastructure components.

Activities related to the Project operation may cause the following types of impacts on the seabed:

- local changes in the seabed relief associated with the presence of the OWF infrastructure components and their impact on the processes of sediment transport and deposition: seabed washouts upstream/downstream of the OWF infrastructure components, formation of sediment accumulation upstream/downstream of the infrastructure components (sandy drifts), cavities in the seabed created at the anchoring places of the OWF maintenance vessels.

No changes in the seabed structure are expected during the Project operation phase. The overall impact of the Project during the operation phase can be assessed as **negligible**.

Assessment of the scale and significance of the impacts identified on the geological structure and seabed relief during the operation phase is presented in Table 10.51 and Table 10.52.

Table 10.51. Assessment of the scale of impacts on the geological structure and relief of the seabed

Impact	Impact characteristics													Joint 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
Local changes in seabed relief	3					1				2			1	7

Table 10.52. Assessment of the significance of impact on the seabed relief

Impact	Impact scale	Receptor sensitivity	Impact significance
Local changes in the seabed relief	low	low	Negligible

Taking into account the results of the impact assessment, the limited space in which the Project may be located and the possible technologies for its execution, no measures to minimise the negative impact of the Baltica-1 OWF on the geological structure and relief of the seabed are indicated.

10.2.2.2 Impact on seabed sediments

In geological terms, taking into account the nature of deposits forming the seabed surface of the OWF Area, no significant changes in the character of deposits are expected during the operation phase. During the operation phase, the impact of the Project on seabed sediments, in terms of their geological nature, can be assessed as negligible.

10.2.2.3 Impact on raw materials and deposits

During the operation of the Baltica-1 OWF, access to the mineral deposits in its area will be impossible or significantly limited pursuant to the MSPPSA provisions, according to which *'in the entire sea basin (POM.60.E), the function of (prospecting and exploration of mineral resources and extraction of minerals from deposits) shall be limited to methods which do not disturb linear elements of technical infrastructure; do not jeopardise the ecological function of spawning grounds and the survival of the early development stages (eggs and larvae) of commercial species; in the entire sea basin the extraction of minerals from deposits is limited to projects agreed upon with the relevant project owners of offshore wind farms'*. Since the main function in the sea area is generating energy from renewable sources while other functions, including mineral exploration and extraction, are subordinate to it, the impact on raw materials and deposits will be **negligible**. It should also be noted that the implementation of the Project will not result in a reduction in exploitable mineral resources.

10.2.2.4 Impact on the seawater and seabed sediment quality

During the operation of the Baltica-1 OWF, works affecting the quality of water and seabed sediments will be carried out in its area. These will mainly be service works and interventions in case of an emergency situation.

It was found that during their operation phase OWFs may cause various types of impacts on the receptors discussed (water and seabed sediments). These are:

- release of pollutants and nutrients from sediments into water,
- contamination of water and seabed sediments with petroleum products;
- contamination of water and seabed sediments with antifouling agents;
- contamination of water and seabed sediments by accidental release of municipal waste or domestic sewage;
- contamination of water and seabed sediments with accidentally released chemicals and waste from the OWF operation;
- contamination of water and seabed sediments with compounds from anti-corrosion agents;
- change of seabed sediment and water temperature through heat reception from transmission cables.

Release of pollutants and nutrients from sediments into water

During the Baltica-1 OWF operation, works causing the disturbance of seabed sediments, e.g. maintenance of foundations, cables or anchoring of vessels, will be carried out. They will aid the transfer of pollutants and nutrients from sediments to water.

Labile metal complexes, organic pollutants, i.e. PAHs and PCBs as well as nutrients (nitrogen and phosphorus) may enter the water.

Since the seabed sediment in the area surveyed is characterised by a low content of harmful substances (metals, PAH, PCB, TBT) and nutrients, the risk of their transfer to water is low (will slightly deteriorate the water quality). Sensitivity of water to the above impact was assessed as low while the sensitivity of seabed sediments was assessed as irrelevant.

The release of pollutants and nutrients from seabed sediments during the operation phase is a direct negative impact which is regional/local, short-term, reversible, repeatable during the operation period, and of low or medium intensity.

The significance of this impact during the operation phase in the APV was assessed to be low for sea waters and negligible for seabed sediments.

Contamination of water and seabed sediments with petroleum products during normal operation of vessels in the course of routine maintenance activities and during breakdowns or collisions.

During normal operation of vessels when carrying out service works on power stations, leakages of various types of petroleum products (lubricating and diesel oils, petrol) may take place.

These may contribute slightly to the deterioration of water quality. Heavier oil fractions may undergo sorption on the surface of organic and mineral suspended solids, which will increase their specific gravity and make them gradually fall to the seabed. There, they may also be bound within seabed sediments.

During the maintenance of the wind farm components, leakages of various types of petroleum products may occur while they are being replaced during the service works on wind turbines and substations. Transformers should be equipped with devices minimising such risk − tight oil pans, while the rainwater drainage system should be equipped with an oil separator [Stryjecki, 2011]. If such solutions are applied, no significant leakage outside the facility is expected.

The contamination of sea waters and seabed sediments with petroleum products released during normal operation of vessels during the OWF operation period is a direct negative impact which is local, temporary or short-term, reversible, repeatable, and of low intensity.

The significance of this impact during the operation phase in the APV was assessed as negligible for sea waters and seabed sediments, whereas in the case of a breakdown or collision, it was assessed as moderate.

Accidental contamination of water and seabed sediments with anti-fouling agents containing organotin compounds (e.g. TBT)

The contamination of water and/or seabed sediments with anti-fouling substances during the operation phase is a direct negative impact of local range, which is momentary, reversible, repeatable during the operation period, and of low intensity.

The significance of this impact during the operation phase in the APV was assessed as negligible for sea waters and seabed sediments.

Contamination of water and seabed sediments by accidental release of municipal waste or domestic sewage

The sensitivity of both receptors is negligible.

Contamination of water or seabed sediments with municipal waste or domestic sewage is a direct negative impact of local range, which is momentary, reversible, repeatable during the operation period, and of low intensity.

The significance of this impact during the construction phase in the APV was assessed as negligible for sea waters and seabed sediments.

Contamination of water and seabed sediments with accidentally released chemicals and waste from the OWF operation

During the OWF operation, the maintenance of its facilities will be carried out. The possibility of small quantities of waste or operating fluids being accidentally released into the sea cannot be excluded.

The waste most frequently generated in this phase of the Project is waste from groups 13, 15, 16 and 17 of the Annex to the Regulation of the Minister of the Environment of 9 December 2014 *on waste catalogue* (Journal of Laws of 2020, item 1923) [Stryjecki 2011]. It is necessary to comply with the procedures concerning waste handling.

The sensitivity of both receptors in the case of this impact is low.

The contamination of water and/or seabed sediments related to the process of the OWF operation is a direct negative impact of local range, which is short-term or momentary, non-reversible, repeatable during the operation period, and of low intensity.

The significance of this impact during the construction phase in the APV was assessed as negligible for sea waters and seabed sediments.

Contamination of water and seabed sediments with compounds from anti-corrosion agents

Steel elements of foundations and/or support structures of the wind turbines and substations will corrode in the marine environment. Therefore it will be necessary to apply appropriate protection measures.

The most common corrosion protection method used in the marine environment is cathodic protection. It can be implemented as galvanic or electrolytic protection.

Galvanic cathodic protection involves the installation of aluminium and/or zinc anodes on foundations or support structures. The anodes gradually wear out and the aluminium or zinc is transferred to water and accumulates in the seabed sediments.

Zinc is the most commonly used steel protector against seawater. Its current efficiency reaches 90% at a relatively low production cost. The disadvantage of zinc is a small potential difference compared to steel, amounting to approximately 0.25 V. Zinc (Zn) is used as pure metal (99.99%, with a limited pollutant content of Fe, Cu and Pb) or as a metallic matrix containing: Zn + 0.1–0.15% Hg, Zn + 0.12–0.18% Al + 0.05–0.1% Cd, Zn + approximately 0.5% Al + approximately 0.1% Si [Surowska 2002].

Aluminium is used only in the form of alloys: with zinc (3–6% Zn), with tin (0.1–1% Sn), with Zn + In, Zn + Hg, Zn + Sn. The current efficiency of these alloys is high, in the order of 80%. Aluminium alloys are used in the same manner as zinc. Next to zinc and its alloys, they belong to the low-potential protectors [Surowska 2002].

The advantages of the galvanic cathodic method are the independence from current sources, ease of installation, possibility of local protection and low impact on neighbouring structures. However, the most important disadvantages include the irreversible loss of anode material, the possibility of contamination of the environment with corrosion products of the protector, the limited use due to the environmental resistance and the low protective current.

In the initial period of operation, the emission of zinc and aluminium from anodes will not be observed. This process will take place over time and will progress with the increasing degree of damage to the protective coating on the components subject to corrosion protection. It is assumed that the anodes will dissolve completely over the period of approximately 20 years. The metals in question will first be transferred to water in which they can undergo precipitation and accumulate in the sediment. This applies in particular to aluminium compounds, as their solubility in natural waters (with pH of approximately 8) is very small. They will be largely adsorbed by seabed sediments in the form of stable compounds. Zinc compounds may be present in water longer than aluminium, as most of them are soluble in water. Zinc will be adsorbed and co-precipitated with hydrated Fe, Mn and Al oxides, present in sediments, however, this process will take place slowly due to the low content of silty minerals in the Baltica-1 OWF Area, which favour zinc adsorption [Alloway 1999; Rousseau 2009].

Ecotoxicity tests have shown a significant toxicity of aluminium to aquatic organisms such as algae, fish and first order consumers [Klöppel *et al.*, 1997; Migaszewski and Gałuszko 2007]. Excess aluminium causes decalcification and deformation of bones as well as anaemia and hardening of cellular membranes [Migaszewski and Gałuszko, 2007]. Harmful effects on fish are probably associated with the process of precipitation of this metal on gills as a result of defensive mechanisms (e.g. release of neutralising compounds Al^{+3}) [Kabata-Pendias and Pendias, 1993]. The biological role of aluminium for humans has not yet been fully clarified, but it is suspected that it may cause Alzheimer's disease. Aluminium accumulates in the brain [Epstein 1990; Migaszewski and Gałuszko, 2007].

Zinc is one of the more mobile metals in sediments, influenced by its replaceable forms as well as its binding with organic substances [Kabata-Pendias and Pendias 1993]. It regulates the metabolism of carbohydrates and proteins in plants. Its excess (100−400 $mg \cdot kg^{-1}$ depending on the species) causes the development of chlorosis and necrosis. This phenomenon is related to iron shortage and photosynthesis inhibition. In vertebrate organisms, zinc also contributes to the metabolism of proteins and carbohydrates, to the detoxification of heavy metals in cells and to the increases in the activity of enzymes and hormones. Zinc also has a positive effect on brain activity, tissue regeneration and wound healing. On the other hand, acute zinc poisoning may lead to copper deficiency in blood, hypocalcaemia, pancreatic inflammation, vomiting, diarrhoea and kidney damage [Migaszewski and Gałuszko, 2007].

In the electrolytic cathodic protection, the protected object becomes a cathode of an electrolytic cell supplied with direct current from an external source. The anode used in this circuit is most often insoluble. The most durable anode materials used in this method are platinum and titanium electrodes covered with a 2−3 µm platinum layer. When electrolytic cathodic protection is used, no impact on the quality of water and sediments is observed.

If electrolytic cathodic protection is used, metal (Al, Zn) emissions to the water environment will not be observed due to the use of insoluble anodes. This impact was not assessed.

The most important parameters affecting the impact level are the type and quantity of elements released, water quality in a project area and the type of rock material forming the seabed.

The sensitivity of both receptors regarding this impact is moderate.

The contamination of the environment with aluminium or zinc released during operation with the application of galvanic cathodic protection is a direct negative impact of local range, which is long-term, irreversible, permanent, and of medium intensity.

The significance of this impact during the operation phase in the APV was assessed as negligible for sea waters and seabed sediments.

Change of water and sediment temperature through heat reception from transmission cables

The electric current flowing through a power cable causes its heating related to power losses due to resistance, in accordance with Joule's law. As the temperature of the cable increases above the ambient temperature, the transfer of heat commences from the cable to the surrounding environment.

A precise quantification of the dissipated heat is difficult because of such phenomena as conductivity, convection and heat radiation, subject to various physical laws [Stiler, 2006].

Increasing the temperature of the sediments in which the cable is buried and the interstitial waters (water filling the spaces between sand grains in the sediment) may cause:

- increased bacterial activity resulting in accelerated decomposition of organic matter;
- decrease in water oxygen content;
- release of harmful substances, including metals, from sediment into water;
- adverse effects on benthic organisms.

The most important parameters affecting the impact level are the depth of cable burial and the type of seabed.

For example, in the operating Nysted Offshore Wind Farm, the temperature increase emitted by the transmission cable (132 kV) buried at a depth of 1 m did not exceed 1.4 °C in a layer of 20 cm above the cable, whereas on the seabed surface the temperature changes were already imperceptible [Merck 2009]. The cable was buried in gravel sediment, which favours much higher heat loss in interstitial spaces between sediment grains than in the case of fine-grained sediment [*ibidem*]. Both types of sediment are common in the Baltica-1 OWF Area. It should be assumed that the dissipation of heat ($24 \cdot h^{-1} \cdot m^{-1}$ on the cable surface) emitted by 66 or 132 kV power cables belonging to the Baltica-1 OWF will be smaller than (or, at most, similar to) that recorded in the Nysted OWF.

Heating of the seabed sediment and interstitial waters may also be conducive to the transfer of metals from the sediment to the water column and accelerate the processes of decomposition of organic pollutants in the seabed sediment. In fact, benthic fauna is naturally adapted to significant seasonal temperature changes and is insensitive or exhibits very low sensitivity to a temperature increase of 2°C [Burgund 2009]. According to the standards proposed by the German Federal Agency for Nature Conservation, the temperature increase due to the heat emission by OWF transmission cables in a layer 20 cm below the seabed, which is the main habitat of the infauna, must not exceed 2°C.

The heat emission above the Baltica-1 OWF cables in the sediment will be local and the effect will be imperceptible if the cable is buried deeper than 1 m, which is compliant with the technical assumptions of the Project for the inter-array power cables which are to be buried at a depth of up to 6 m. In the case of cable laying on the seabed, the effect of heat emission will be imperceptible due to the thermal properties of water.

Heat emission by the cables is a direct, negative impact of local range, which is long-term, reversible and constant during the operation period, but due to the lack of data it is difficult to determine its intensity. There is a limited number of field surveys and literature reports on operational submarine cables and the increase in temperature of the seabed sediment and the near-seabed water layer caused by them as well as the impact of this phenomenon on their quality.

Therefore, it is only possible to estimate the significance of this impact during the operation phase.

The significance of this impact during the operation phase in the APV was assessed as low for sea waters and seabed sediments.

Table 10.53 and Table 10.54 present an assessment of the scale and significance of the impacts on the quality of seawater and seabed sediments identified for the Baltica-1 OWF operation phase.

Table 10.53. Assessment of the scale of impacts on the quality of seawater and seabed sediments during the operation phase of the Baltica-1 OWF

Impact	**Impact characteristics**													**Joint 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**
Release of pollutants and nutrients from the sediments into the water (for water)	3				2					2			1	8
Release of pollutants and nutrients from the sediments into the water (for sediments)	3					1				2			1	7
Contamination of water and seabed sediments with petroleum products (normal operation of vessels)	3					1					1		1	6
Contamination of water and seabed sediments with petroleum products (emergency situations and collisions)	3			3					3				1	10
Contamination of water and seabed sediments with antifouling agents	3					1					1		1	6
Contamination of water and seabed sediments by accidental release of municipal waste or domestic sewage	3					1					1		1	6
Contamination of water and seabed sediments with accidentally released chemicals and waste	3					1				2			1	7
Contamination of water and seabed sediments	3					1		4				2		10

Impact	**Impact characteristics**													**Joint 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**
with compounds from anti-corrosion agents														
Change of water and sediment temperature through heat reception from transmission cables	3					1		4					1	9

Table 10.54. Assessment of the impact significance on the quality of seawater and seabed sediments during the operation phase of the Baltica-1 OWF

Impact	**Impact scale**	**Receptor sensitivity**	**Impact significance**
Release of pollutants and nutrients from the sediments into the water (for water and seabed sediments)	moderate	low	**Low**
Release of pollutants and nutrients from the sediments into the water (for sediment)	low	irrelevant	**Negligible**
Contamination of water and seabed sediments with petroleum products (normal operation of vessels)	low	low	**Negligible**
Contamination of water and seabed sediments with petroleum products (emergency situations and collisions)	high	moderate	**Moderate**
Contamination of water and seabed sediments with antifouling agents	low	low	**Negligible**
Contamination of water and seabed sediments by accidental release of municipal waste or domestic sewage	low	irrelevant	**Negligible**
Contamination of water and seabed sediments with accidentally released chemicals and waste	low	low	**Negligible**
Contamination of water and seabed sediments with compounds from anti-corrosion agents	high	irrelevant	**Negligible**
Change of water and sediment temperature through heat reception from transmission cables	moderate	low	**Low**

Taking into account the results of the impact assessment, the limited space in which the Project may be located and the possible technologies for its execution, no measures to minimise the negative impact of the Baltica-1 OWF on the quality of seawaters and seabed sediments are indicated.

10.2.2.5 Impact on climatic conditions

During the operation phase of the Baltica-1 OWF, the direct and local impact of the proposed Project (relating both to the ongoing operation of wind turbines as well as to the OWF maintenance with the use of vessels) will not have a significant impact on the change of climatic conditions. Despite a long-term impact, its range will be strictly local, manifesting itself mostly through slight decrease of wind force throughout the farm area.

Considering the impact of the wind farm during its operation period on the climatic conditions of the sea area proposed, its influence on two basic atmospheric parameters in the near-water layer should be considered:

- thermal conditions (taking into account the possibility of ice phenomena in winter),
- and wind conditions.

Table 10.55 presents an assessment of the scale of impacts while Table 10.56 presents an assessment of the significance of impacts.

Table 10.55. Assessment of the scale of impacts on climatic conditions of the area of the near-water atmosphere layer

Impact	Impact characteristics													Joint 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**
Change in thermal conditions of the atmosphere.			1			1			3				1	6
Change in wind conditions of the atmosphere	3					1		4					1	9

Table 10.56. Assessment of the impact significance on climatic conditions of the area of the near-water atmosphere layer

Impact	Impact scale	Receptor sensitivity	Impact significance
Change in thermal conditions of the atmosphere.	low	irrelevant	**Negligible**
Change in wind conditions of the atmosphere	moderate	irrelevant	**Low**

Taking into account the results of the impact assessment and the limited space in which the farm is expected to operate, no measures to minimise the negative impact of the Baltica-1 OWF on the climatic conditions are indicated.

10.2.2.6 Impact on air and its quality

During the operation phase, the Baltica-1 OWF direct impact on air quality will be limited to emissions into the atmosphere from service operation vessels engaged in maintenance and repair works. However, indirectly, the operation of the OWF will result in the reduction of greenhouse gas emissions to the atmosphere by other sources, e.g. coal-fired power plants located in other areas of the country. Therefore, due to the small scale of the Baltica-1 OWF impact in the APV during the operation phase, it may be concluded that the impact in terms of greenhouse gas emissions from vessels to the atmosphere will be negligible. The impact of the reduction of greenhouse gas emissions is positive but difficult to estimate. This is due to the fact that the emission reduction will be assigned to a completely different area (the location of an equivalent conventional, fossil fuel fired power plant).

Depending on the farm construction technology adopted, it is possible to employ vessels of different types and uses. Due to the limited possibilities of carrying out construction works in the sea area (environmental and weather-related aspects, etc.) the works are to be organised in a focused manner, being performed as briefly as possible and continuously in one sea area. Hence, the exhaust gas quantities emitted into the air will result from the number and types of vessels involved in the various stages of the Project as well as the duration of the offshore works planned. As the Project is in the early pre-development phase, i.e. before a detailed work schedule has been prepared and before suitable vessels have been selected and contracted, it is only possible to present the quantities of gases and pollutants emitted into the atmosphere as estimates, as provided in Table 10.57.

Table 10.57. Emission factors for diesel oil combustion by vessels and estimated emissions per day of work in the operation phase of the Project

Substance	Emission factor [g/kg of fuel]	Emissions per day of work – maintenance activities [Mg]	Emissions per day of work – repair activities [Mg]
Nitrogen oxides (NO_x)	13.01	25.37–71.56	5.53–13.66
Non-Methane Volatile Organic Compounds (NMVOC)	32.629	63.63–179.46	13.87–34.26
Carbon oxide (CO)	3.377	6.59–18.57	1.44–3.55
Total suspended particulate (TSP), including up to 100% of PM10 and PM2.5	10.774	21.01–59.26	4.58–11.31
Sulphur dioxide (SO_2)	2.104	4.10–11.57	0.89–2.21
Aliphatic hydrocarbons (HC al.)	0.02	0.04–0.11	0.01–0.02
Aromatic hydrocarbons (HC ar.)	2.195	4.28–12.07	0.93–2.30
Carbon dioxide (CO_2)	3206	6252–17 633	1363–3366

As the Project work will be conducted in open sea areas, where the exhaust gases emitted will disperse very quickly over a wide area in the absence of terrain unevenness and obstacles, and thus their concentration will decrease quickly. The exhaust gases emitted by ships and other equipment over a limited period of time are not expected to cause a significant increase in atmospheric air pollution in the long term.

Considering the impact of the Baltica-1 OWF during its operation period on air quality within the proposed sea area and around it, it is necessary to consider the impact of exhaust emissions from the vessels involved in maintenance and service works on the amount of solid and gaseous pollutants in the near-water atmosphere layer:

- increase in particulate matter,
- increase in gaseous pollutants.

Table 10.58 presents an assessment of the scale of impacts while Table 10.59 presents an assessment of the significance of impacts.

Table 10.58. Assessment of the scale of impacts on air quality in the Baltica-1 OWF Area related to exhaust emissions

Impact	**Impact characteristics**													**Joint 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**
increase in particulate matter	3					1					1		1	6
increase in gaseous pollutants	3					1					1		1	6

Table 10.59. Assessment of the significance of impact on air quality in the Baltica-1 OWF Area related to exhaust emissions

Impact	**Impact scale**	**Receptor sensitivity**	**Impact significance**
increase in particulate matter	low	irrelevant	**Negligible**
increase in gaseous pollutants	low	irrelevant	**Negligible**

Hence, the impact of the Baltica-1 OWF in the operation phase on the air quality will be temporary, spatially limited, and will virtually cease after the works are completed.

10.2.2.7 Impact on ambient noise

The results of ambient noise changes resulting from underwater noise emissions are described in sections relating to the impact of the Project on ichthyofauna, seabirds and marine mammals.

10.2.2.8 Impact on EMF

During the operation phase of the Baltica-1 OWF, the operating power cables will be emitting EMF into the environment. The electric field, being dependent on the magnetic field, will similarly diminish with distance from the cable. Based on the calculations for various AC transmission system designs, Tricas and Gill (2011) determined the average induction value of the magnetic field to be expected at different depths, depending on the distance from a cable buried in the seabed at the depth of 1 m [Table 10.60].

Table 10.60. Magnetic induction [µT] in relation to vertical distance from the seabed and horizontal distance from the cable (alternating current, cable burial depth 1 m) [Source: internal materials based on Tricas and Gill 2011]

Vertical distance from the seabed	Horizontal distance from the cable [m]		
	0 m	4 m	10 m
0 m	7.85 µT	1.47 µT	0.22 µT
5 m	0.35 µT	0.29 µT	0.14 µT
10 m	0.13 µT	0.12 µT	0.08 µT

During the Project construction phase, the power cables will be buried at a depth of 3 to 6 m, so that no EMF changes will occur on the sediment surface and in the water depth or they will be **negligible**.

10.2.2.9 Impact on animate nature components

10.2.2.9.1 Impact on phytobenthos

During the operation phase, the support structures of wind turbines and OSSs located under the water surface in the euphotic zone may be overgrown by macroalgae [Birklund and Petersen 2004, Birklund 2005, Horns Rev Offshore Wind Farm 2005, Köller *et al*. 2006, Leonhard and Pedersen 2006, Nielsen 2006, Petersen and Malm 2006, Zucco *et al*. 2006, Wilhelmsson and Malm 2008, Kerckhof *et al*. 2010, Bouma and Lengkeek 2012, Rostin *et al*. 2013]. Despite the fact that phytobenthos does not occur in the area of the planned OWF, macroalgae spores may appear in this area due to various natural and anthropogenic factors. The first group should include the transport of spores with the sea currents from the areas of macroalgae occurrence [Norton 1992, van den Hoek 1987, Gaylord *et al.* 2006, Brennan *et al.* 2014]. Macroalgae or their fragments brought with currents from their natural occurrence areas, separated from the substrate by, e.g. storms may also be the source of spores [Norton 1992, Gaylord *et al*. 2002]. The anthropogenic factors include mainly the transport of spores in ballast waters of vessels [Flagella *et al*. 2007, Leppäkoski 2008], e.g. vessels involved in the construction and maintenance of the wind farm infrastructure. They can also originate from the macroalgae growing on the hull of vessels [Lembi and Waaland 1988, Norton 1992]. To sum up, it is likely that the macroalgae spores are present in the Baltica-1 OWF Area and once a hard substrate appears in the euphotic zone, they will find favourable conditions for the development and will begin the colonisation process. This process is likely to begin already in the first vegetation season after the OWF structure is erected. The data from literature indicate that in the initial phase of colonisation, macroalgae with filamentous thalli appear first, to be displaced by species with compact thalli [Leonhard and Pedersen 2006]. At this stage, it is impossible to determine which species of macroalgae will inhabit the OWF structures, however, some preconditions may result from the surveys performed for the Utgrunden 1 OWF located in the southern part of the Kalmar Strait [Brodin and Andersson 2009]. In 2007, i.e. 7 years after the commencement of the OWF operation the presence of filamentous green algae (*Cladophora* sp.) and red algae (*Ceramium tenuicorne*, *Polysiphonia fucoides* and

Rhodocorton purpureum) was found on the support structures of wind turbines. The example of *C. tenuicorne* indicates that among the macroalgae growing on structures, there may also be species subject to strict protection under the Regulation of the Minister of the Environment of 9 October 2014 *on the protection of plant species* (Journal of Laws of 2014, item 1409).

Macroalgae and animal organisms (e.g. mussels) overgrowing the OWF components create the 'artificial reef', a factor causing a local increase in the biodiversity of plant and animal species *per se* and indirectly affecting the increase in the species richness and quantitative resources of the marine fauna – mainly fish and nekton crustaceans, which will search for food and places suitable for a refuge and reproduction within it [Ambrose and Anderson 1990, Wilhelmsson and Malm 2008, Andersson *et al*. 2009, Wilson and Elliott 2009, Wilson *et al*. 2010, Lindeboom *et al*. 2011]. Therefore, the effect of the underwater OWF structures overgrowth with macroalgae should be considered as positive, however it should also be noted that the natural character of the maritime area will be disturbed. The functioning of the marine ecosystem will be changed locally and in the long term, for which the anthropogenic factor will be responsible. This process will, however, be reversible. The assessment of the scale of impact on phytobenthos is presented in Table 10.61, and the assessment of the impact significance is presented in Table 10.62.

Table 10.61. Assessment of the scale of impact on phytobenthos

Impact	**Impact characteristics**													**Joint 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**
The occurrence of artificial structures in the water depth that can be overgrown by phytobenthos (the 'artificial reef' effect)		2				1		4					1	8

Table 10.62. Assessment of the impact significance on phytobenthos

Impact	**Impact scale**	**Receptor sensitivity**	**Impact significance**
The occurrence of artificial structures in the water	moderate	moderate	Low

Impact	Impact scale	Receptor sensitivity	Impact significance
depth that can be overgrown by phytobenthos (the 'artificial reef' effect)			

10.2.2.9.2 Impact on macrozoobenthos

The operation of the Baltica-1 OWF in the Applicant Proposed Variant (APV) will result in the following impacts on the macrozoobenthos inhabiting that area:

- new structures in the seabed – loss of a fragment of the macrozoobenthos habitat;
- new structures in the seabed – the artificial reef effect;
- emission of electromagnetic field by power cables;
- heat dissipation from power cables.

The most important technical parameters of the OWF [Table 10.17] which are important from the point of view of the assessment of the Project impact on macrozoobenthos during the operation phase are:

- the developed area of the Baltica-1 OWF Area;
- the foundations of wind turbines and OSSs – type, number and shape of foundations covering the seabed together with the erosion protection layer;
- the area taken by the riprap used to enforce the seabed for jack-up vessel support legs.

The assessment of the impact of wind turbines in the Baltica-1 OWF Area at the operation stage was carried out separately for:

- soft-bottom macrozoobenthos;
- hard-bottom macrozoobenthos.

A separate assessment of the Project impact on macrozoobenthos is the result of these two benthic fauna communities (from the soft and hard bottoms) differing in the taxonomic composition, abundance and biomass of their taxa. Consequently, they differ in significance and sensitivity to the various types of impact. The assessment of the impact scale (type, range, duration, persistence) influences the assessment of the impact features on the basis of which the impact magnitude (scale) is assigned. Taking into account the scale of the impact and the sensitivity of the receptor, i.e. the group of organisms assessed (the soft- and hard-bottom macrozoobenthos), the significance of a given impact on the receptor will be determined.

The definition of macrozoobenthos sensitivity is provided in Table 10.18.

The new structures in the seabed will result in **the loss of a fragment of the natural habitat of macrozoobenthos**. The seabed development will eliminate from biological life the sediment surface occupied by the foundations of offshore wind turbines and under the riprap deposited prior to the installation of jack-up vessels, which will not be removed after the construction phase. Different types of foundations will be possible for the Baltica-1 OWF, monopiles, jacket foundation – piled-jacket, suction bucket jacket foundation as well as gravity-based structures. The foundations on the seabed will exist throughout the entire operation period, which is up to 35 years. In the worst-case scenario, this will be the seabed surface on which the gravity-based structures will be placed, together with a scour protection layer, since they will occupy the largest seabed surface for the foundation of 60 wind turbines with 15 MW turbines. The foundations of the turbines will modify the distribution of the flow rate of surrounding sea currents. As a result of changes in hydrodynamic conditions, the grain distribution of seabed sediments may change in the direct vicinity of the foundations. This will, in turn, entail the shift in the quantitative and qualitative structure of the zoobenthos complexes where the benthos has not been completely destroyed. In addition, in the event of particularly unfavourable seabed conditions, the cables will be protected by means of riprap, rock bags, concrete covers, reinforced concrete half-shells, casing pipes and protective HDPE mouldings, among others. The natural habitat of soft and hard bottom macrozoobenthos at these sites will be permanently eliminated. Also, periodic destruction of benthos will occur during the service and repair works of the OWF underwater installations. All these impacts indirectly lead to a temporary reduction of the feeding grounds of benthivorous birds as well as fish, for which bivalves are a key diet component [Köller *et al*. 2006; Petersen and Malm 2006; Zucco *et al*. 2006; Degraer *et al*. 2012].

Estimated calculations indicating the magnitude of the loss of macrozoobenthos resources in the Baltica-1 OWF Area are presented below.

In the APV, the permanent loss of habitats with macrozoobenthos complexes under the foundations of up to 60 wind turbines and up to 4 OSS foundations, together with an erosion protection layer, will take place over an area of 0.79 km^2. In addition, the habitat will be lost on the seabed of up to 0.61 km^2 occupied by riprap reinforcing the seabed prior to the installation of jack-up vessels. In total, the loss of seabed with macrozoobenthos complexes will cover an area of 1.33 km^2, which is 1.55% of the Baltica-1 OWF Area (85.53 km^2). The loss of hard bottom habitat if any foundations are placed on this type of seabed will be very small, as the hard bottom located in the northern part of the OWF occupies approximately 5% of the Baltica-1 OWF development area. Assuming that the foundations of the wind turbines/OSSs are distributed evenly, a maximum of 3–4 foundations can be placed on the hard bottom. The loss of hard-bottom macrozoobenthos habitat would then amount to only 0.04–0.05 km^2 (0.05%–0.06% of the Baltica-1 OWF Area).

The sensitivity of both the soft- and hard-bottom macrozoobenthos complexes to this impact is high, since a part of the benthos complex will be permanently destroyed due to the impact of stress factor acting throughout the entire operation phase.

Additionally, when assessing the impact on the hard-bottom macrozoobenthos complex, it should be taken into account that an important component of the food supply of fish and benthivorous birds will be eliminated from the environment. In the case of the Baltica-1 OWF Area, however, no significant changes will take place in the food chain regarding the links between birds and benthos. Due to the great depth of the sea area (approximately 25–40 m), where there is a rocky seabed overgrown by the *Mytilus trossulus* bivalves, it is difficult for sea ducks to access this type of food (Appendix 1 to the EIA Report). Permanent destruction of the bay mussel *Mytilus trossulus* aggregation may occur only on the surface of 0.05 km^2 which corresponds to a biomass of approximately 70 000 kg, with an average biomass of the hard-bottom macrozoobenthos inhabiting the Baltica-1 OWF Area of approximately 1400 $gWW \cdot m^{-2}$, with the proportion of the *Mytilus trossulus* bay mussel being more than 99% in this complex. Besides, as regards the complex comprising the bay mussel *Mytilus trossulus* aggregations, despite their loss due to the laying of turbine foundations, these mussels typically are the first and quick to re-colonise the underwater parts of the turbines and their surrounding seabed environment during the OWF operation phase.

The 'artificial reef' effect is the colonisation of hard artificial substrates of supporting structures introduced to the environment by animal and plant periphyton complexes and by mobile epifauna. Although this impact is widely documented in literature [e.g. Birklund and Petersen 2004; Meissner and Sordyl 2006; Wilhelmsson and Malm 2008; Birklund 2009; Langhamer *et al*. 2009; Kerckhof *et al*. 2010; Janßen *et al*. 2013 Rostin *et al*. 2013; Bergström *et al*. 2014; Macnaughton *et al*. 2014; Mesel *et al*. 2015; Luedke 2017; Wilding *et al*. 2017], so far no OWFs have been built in the PSA of the Southern Baltic and it has been impossible to monitor the artificial reef phenomenon [Bergström *et al*. 2012; Topham *et al*. 2019 a and b; PWEA Report 2019]. Only experimental survey was conducted on an artificial structure installed in the environment [Dziubińska and Szaniawska 2010].

Based on literature, it is known that in places with hitherto no hard substrate , the qualitative and quantitative structure of the zoobenthos complex will be redeveloped within the entire microhabitat, i.e. on the surface of the underwater farm structures, on the surface of the erosion protective layer and on riprap reinforcing the seabed prior to the installation of jack-up vessels. The process of overgrowing support structures with periphyton organisms (invertebrates and macroalgae) begins after the reproduction of periphyton species and the settlement of larvae on the hard surface of a structure, most often in late spring. Periphyton communities have a significant impact on the marine environment at the ecosystem level, although it is difficult to clearly determine the nature of this impact. This depends on the local environmental conditions, reproductive potential of zoobenthos organisms and ecosystem management plans in the Baltica-1 OWF Area [Bergstrom *et al.* 2014, Mesel *et al.* 2015, Ojaveer *et al.* 2016].

On the one hand, this is a positive phenomenon, since there will be an increase in local biodiversity in terms of species and habitat diversity, an increase in biological production and a change in natural values of this micro-habitat. A new place of refuge for the fry and an attractive feeding ground and spawning ground for many fish species will appear, while the bay mussel (*Mytilus trossulus*) aggregations, a dominant species in the open waters of the Baltic Sea, quickly colonising the hard substrate and usually dominating on support structures, will constitute a new food supply for fish and seabirds, also acting as biofilters, especially in polluted and eutrophic waters [Vuorinen *et al*. 2002; Wilhelmsson and Malm 2008; Langhamer *et al*. 2009; Bergstrom *et al*. 2014; Mesel *et al*. 2015].

On the other hand, the ‘artificial reef’ effect can be considered a negative impact, as there will occur a loss of the original naturalness of a fragment of the seabed habitat as well as its fragmentation. Furthermore, the presence of underwater, hard structures will constitute a new microhabitat contributing to the increase in biomass of the gelatinous zooplankton (medusae) whose polyps (settled form) attach to hard structure surfaces [Janßen *et al.* 2013]. However, primarily it is an artificial environment which was created in the place of the natural sandy and gravelly seabed that is conducive to propagation of invasive foreign species that are not native to the PSA [Bulleri and Airoldi 2005, Brodin and Andersson 2009]. On the basis of the surveys carried out as part of the ‘Second update of the preliminary environmental assessment of the marine waters status’ [Zalewska 2024] in 2016–2021 in the Polish zone of the Baltic Sea, 6 new, introduced, foreign species were identified, of which 4 species represented macrozoobenthos (*Boccardiella ligerica*, *Callinectes sapidus*, *Chelicorophium robustum*, *Palaemon longirostris*). The introductions took place in the Gulf of Gdańsk and Szczecin Lagoon area and concerned mostly the port areas of Gdańsk, Gdynia and Szczecin. Current information on new foreign species is collected on an on-going basis in various databases, e.g. AquaNIS. Editorial Board 2015 (http://www.corpi.ku.lt/databases/index.php/aquanis) or Ballast Water Exemption Decision Support Tool (http://jointbwmexemptions.org/ballast_water_RA/apex/). Invasive alien species tend to rapidly displace native species, which can lead to undesirable changes in the existing balance in the trophic network, as well as loss of biodiversity and changes in the structure and functioning of inhabited ecosystems [Janas *et al*. 2014; Normant-Saremba *et al*. 2017; Krzymiński

2018]. This negative impact may also indirectly affect the economy, i.e. it may cause losses in the fishing and aquaculture industries [Tykarska and Janas 2017; Krzymiński 2018]. However, the areas particularly at risk of introduction of foreign species are sea ports that constitute destinations of ships with ballast tanks and hulls carrying various kinds of plant and animal species as well as pathogens brought from all over the world [Krzymiński 2018].

An unambiguous scenario of colonisation of artificial substrates during the operation phase in the Baltica-1 OWF Area is difficult to predict. Based on the experimental research [Dziubińska and Szaniawska 2010] it is assumed that underwater structures will be colonised first by barnacles (*Amphibalanus improvisus*) and bay mussels (*Mytilus* sp.), followed by mobile crustaceans (including *Gammarus* spp., *Corophium volutator* and *Monoporeia affinis*) as well as macroalgae. The 'artificial reef' will partially compensate for the destroyed macrozoobenthos complex occurring there before the human interference in the environment.

An artificial reef may also occur locally on the seabed between wind turbines, where the cable line will be protected by hard substrate (e.g. riprap, rock bags, concrete covers, reinforced concrete half-shells) and on the surface of riprap used to reinforce the seabed prior to the installation of jack-up vessels.

However, during the operation phase, monitoring will be necessary to further investigate the 'artificial reef' effect. This will also verify whether foreign species found mainly in the ports visited by transatlantic ships will be spread by plankton larvae and will settle on the hard, artificial substrate in the open water zone of the Baltic Sea. It is assumed that this effect is unlikely, since the Baltica-1 OWF will be located approximately 80 km away from the land and will comprise a maximum of 60 wind turbines in the APV. On the other hand, also other OWFs will be located near this farm, thus expanding the surface area of the new 'artificial reef' in the PSA.

It should be noted that for this impact, it is not the original complex of benthic communities of the Baltica-1 OWF which is evaluated but the evaluation pertains to the impact of the 'artificial reef' on the natural environment. The assessment of the sensitivity of the soft-bottom macrozoobenthos complex is therefore not applicable. In contrast, the hard-bottom macrozoobenthos complex was given a high sensitivity due to the ambiguous nature of the impact, either beneficial or detrimental, but strongly altering the local benthic microhabitat, characterised by a different qualitative structure from the one prior to the period of environmental change as a result of the Project.

The operation of power cables connecting offshore wind turbines, groups of turbines or offshore substations with each other (maximum 140 km in the Baltica-1 OWF Area), will involve the **electromagnetic field emission**, which is another impact that may negatively affect benthic organisms. The literature reporting on the potential impact on the benthic fauna in the Baltic Sea is increasingly well documented, but it is still inconclusive as to whether this impact can alter the structure and functioning of the benthos in the Project area at all [Andrulewicz *et al*. 2003; Meissner and Sordyl, 2006; Danheim *et al*. 2020]. An important input information is the determination of cable laying depth, the cable type (AC or DC) and cable insulation method applied, as well as the magnitude of this radiation and time of exposure [Otremba and Andrulewicz 2014; Taormina *et al*. 2018]. In the APV, the Project in question requires the installation inside the OWF of up to 140 km of cable installation in an alternating current technology with a nominal voltage of 66 kV. The possibility of using 132 kV rated cable technology to connect 10 wind turbines with a capacity of 15 MW is also taken into consideration. The impact of electromagnetic field on individual species of benthic fauna, including bivalves, crustaceans or polychaetes, has so far been examined only on the basis of laboratory tests [Bochert and Zettler 2004; Jakubowska *et al*. 2019; Otremba *et al*. 2019; Stankeviciute *et al*. 2019], and their results vary depending on the input data of the electromagnetic field emitted and the organisms examined. In the worst case scenario, these impacts can lead to cancer in bivalves and changes in motor skills and bioturbation in polychaetes. In addition, the cable lines are planned to be buried up to 6 m below the seabed surface, effectively eliminating the impact of EMF emitted by the cables on macrozoobenthos. For this reason, the sensitivity of macrozoobenthos to EMF was assessed as irrelevant.

Heat emission by the cable causing an increase in the sediment temperature during the operation phase – is caused by the electric current flowing in the cable as the cable heats up according to Joule's law. The increase in sediment temperature may lead to adverse changes in the qualitative structure of macrozoobenthos living on and in the seabed in the immediate vicinity of the cables, as it modifies the chemical and physical properties of the seabed sediments and the availability of oxygen for benthic organisms, eliminating the most sensitive taxa [Taormina *et al*. 2018]. For example, in the Nysted Offshore Wind Farm (Western Baltic, Danish waters), the heat emitted by the transmission cable (132 kV) buried at a depth of 1 m resulted in a temperature rise of 1.4 °C in a layer of 20 cm above the cable, whereas on the seabed surface the temperature changes were already imperceptible [Merck 2009]. The maximum operating temperature of main power cable conductors will be 90°C. Cable lines will be buried up to 3 MBSB along the majority of the route and up to 6 MBSB due to local conditions. Burying the cables in the seabed sediment at such depths will exclude the possibility of a significant temperature increase in the surface sediment layer and in the near-seabed water that could affect the macrozoobenthos community. If power cables have to be laid on the sediment surface, the heat emitted by the cables will be effectively picked up and dissipated by seawater. As the environmental surveys have shown, the temperature of the near-seabed waters is characterised by natural seasonal variations – the values measured ranged from about 3 to about 14 °C. Benthic fauna is naturally adapted to significant seasonal temperature changes and is insensitive or exhibits very low sensitivity to a temperature increase of 2°C (Zucco *et al*. 2006; Birklund 2009). The possible slight changes in the temperature of the sediment and seabed water caused by heat emissions from operating power cables will therefore not disturb the natural changes in the temperature of the near-seabed waters in the area of the Project and will not affect eurythermal seabed organisms adapted to the significant temperature changes occurring in the environment.

Taking these arguments into account, a negligible sensitivity was assigned for the two macrozoobenthos communities assessed.

Assessment of the scale of impact on soft-bottom macrozoobenthos during the operation phase for the APV is provided in Table 10.63 while on hard-bottom macrozoobenthos in Table 10.64. Assessments of the impact significance during the operation phase for the APV is presented in Table 10.65 and Table 10.66.

Table 10.63. Assessment of the scale of impacts on soft-bottom macrozoobenthos during the operation phase in the APV

Impact	Impact characteristics													Joint 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
New structures in the seabed – loss of a fragment of the macrozoobenthos habitat	3					1		4					1	9
EMF emission by power cables		2				1		4					1	8
Heat dissipation from power cables		2				1		4					1	8

Table 10.64. Assessment of the scale of impacts on hard-bottom macrozoobenthos during the operation phase in the APV

Impact	Impact characteristics													Joint 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
New structures in the seabed – loss of a fragment of the macrozoobenthos habitat	3					1		4					1	9
New structures in the seabed – artificial reef effect			1			1		4					1	7

Impact	Impact characteristics													Joint 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
EMF emission by power cables		2				1		4					1	8
Heat dissipation from power cables		2				1		4					1	8

Table 10.65. Assessment of the significance of impact on soft-bottom macrozoobenthos during the operation phase in the APV

Impact	Impact scale	Receptor sensitivity	Impact significance
New structures in the seabed – loss of a fragment of the macrozoobenthos habitat	moderate	high	**Moderate**
EMF emission by power cables	moderate	irrelevant	**Negligible**
Heat dissipation from power cables	moderate	irrelevant	**Negligible**

Table 10.66. Assessment of the significance of impact on hard-bottom macrozoobenthos during the operation phase in the APV

Impact	Impact scale	Receptor sensitivity	Impact significance
New structures in the seabed – loss of a fragment of the macrozoobenthos habitat	moderate	high	**Moderate**
New structures in the seabed – artificial reef effect	low	high	**Low**
EMF emission by power cables	moderate	irrelevant	**Negligible**
Heat dissipation from power cables	moderate	irrelevant	**Negligible**

The impact assessment carried out for the soft-bottom macrozoobenthos complex and the hard-bottom macrozoobenthos complex during the operation phase indicates that the loss of a section of habitat through the laying of foundations of new structures on the seabed will be of moderate significance, due to the high sensitivity of benthic fauna to this type of impact and the moderate scale of the impact. However, it should be borne in mind that this will result in a loss of habitat of a small area of approximately 1.33 km^2 for the soft-bottom macrozoobenthos and an even smaller loss of up to 0.05 km^2 of seabed habitat previously occupied by the hard-bottom macrozoobenthos. The significance of the ‘artificial reef’ effect in the Baltica-1 OWF Area will be negligible, while the last two impacts (EMF and heat emissions by power cables) are characterised by negligible significance for macrozoobenthos.

10.2.2.9.3 Impact on ichthyofauna

The operation of the Baltica-1 OWF may cause the following impacts affecting ichthyofauna:

- noise and vibrations,
- electromagnetic field,
- habitat change,
- physical barrier.

The most important technical parameters of the Baltica-1 OWF which are significant from the point of view of the assessment of the Project impact on ichthyofauna during the construction phase are:

- the developed area of the Baltica-1 OWF Area,
- type and number of wind turbine and OSS foundations,
- the size of turbines,
- length and type of power cables, technical solutions used (transmission technology),
- number of support vessels.

Noise and vibrations

The impact of noise at the operation stage of the farm should be much lower than the one observed during construction and decommissioning. The noise caused by the wind turbines is generated by the gearbox and generator and transmitted into the water and sediment through the tower and foundation [Betke *et al*. 2004].

Its level will depend on the environmental conditions (depth, type of sediment, seabed morphology), the type and size of the turbines as well as wind speed. The average turbine noise value calculated from the model based on the data for 14 wind farms amounted to, after normalising for a measurement distance of 100 m from the source, a turbine power of 1 MW and a wind speed of 10 $m \cdot s^{-1}$, 109 dB re 1 µPa. According to Tougaard (2020), underwater noise emitted by individual wind turbines is about 10–20 dB lower than that emitted by cargo ships. The total source level of a large wind farm is smaller than or comparable to that of a large cargo vessel. However, the cumulative impact of wind farms resulting from their location on an increasing proportion of coastal and shelf waters may be large enough to raise concerns about the negative impact on fish, particularly in areas with low natural ambient noise and low vessel traffic [Tougaard 2020]. According to the information in Section 3, it is estimated that the sound power of a single wind turbine will not exceed 120 dB.

According to Anderson (2011), fish without swim bladder or other acoustic pressure detector, such as gobies and flatfish, will only pick up noise from offshore wind farms close (less than 10 m) to the foundations. Fish with swim bladder not connected to the hearing organs, e.g. salmon, trout, eel, perch and zander are likely to detect noise at distances of up to 1 km. In contrast, such species as cod, haddock and herring will register the sound of a wind farm at a distance of several to tens of kilometres. According to Thomsen *et al*. (2006), the sound generated by operating wind turbines will be audible to salmon and common dab at a distance of approximately 1 km, and 4−5 km for cod and herring. The masking of sounds associated with reproduction and warning sounds made by fish can occur in the immediate vicinity of the turbines. For example, the loudness of the reproduction sounds made by the Gadidae is within the range of 120–133 dB re 1µPa [Nordeide and Kjellsby, 1999; Wahlberg and

Westerberg 2005], which corresponds to the noise level occurring about 10 m from an operating turbine [Andersson 2011]. According to Wahlberg and Westerberg (2005), a reduction in the detection of the sound made by haddock can be assumed as a result of the noise emission from the operating turbine, but it will still be detectable from a distance of 4 m.

Very few data relate to possible avoidance and behavioural changes caused by noise generated by operating turbines. Observations carried out in the area of one of the Swedish wind farms showed no changes in the behaviour of eels swimming at a distance of 500 m from the operating turbine. Comparison of shrimp and cod catches in the vicinity of the non-operating wind turbine showed a significant accumulation of fish in the immediate vicinity of the structure (100 m) than at a distance of 800−1000 m, which can be attributed to the artificial reef effect. However, in the case of an operating turbine, the catch volume decreased twice within the 100 m zone. This result can be interpreted as the effect of the noise emitted, but other causes cannot be excluded [Westerberg 1994 and 2000, qtd. in Thomsen *et al*. 2006]. According to Wahlberg and Westerberg (2005), the avoidance effect can be expected at a distance of only a few metres from the turbine.

During the operation of the wind farm, ongoing and unforeseen operational and repair works will be carried out. This will involve a periodically increased vessel traffic. This impact may result in both the avoidance response and in the occurrence of temporary hearing threshold shift (TTS). According to the report of the International Council for the Exploration of the Sea (ICES 1995) on the impact of sound emitted by research vessels, the avoidance reaction may occur when the noise level exceeds the hearing threshold of a given species by 30 dB and the impact range usually reaches 100−200 m. The experimental surveys also found temporary hearing threshold shift (TTS) in freshwater fathead minnow exposed to sound emitted by a boat outboard engine [Scholik and Yan 2002]. According to Thomsen *et al*. (2006), there are no scientific grounds for determining the universal noise level of vessels that would not be detrimental to fish.

Bergstrom *et al*. (2014) assess the impact of noise during the operation phase on fish as moderate for both the Baltic Proper, as well as for the Danish Straits and Gulf of Bothnia.

The results of the operation noise modelling carried out for the Baltica-1 OWF Area indicate that the possible range of impact on fish at TTS level should not exceed 100 m from the sound source.

The Baltica-1 OWF Area is not a significant spawning ground for ichthyofauna at the population level. Emission of noise and vibrations generated during the Project operation may directly and negatively affect the ichthyofauna. These impacts will be of negative, direct, local, long-term and permanent nature.

The sensitivity to the impact for cod, sprat, herring, sand goby and twait shad was assessed to be high and for the flounder and common seasnail as moderate.

The significance of the impact is assessed to be negligible for all the fish species analysed.

Electromagnetic field

An electric current flowing through a conductor induces a magnetic field, the intensity of which depends on the current intensity. The field intensity decreases, both horizontally and vertically, with the distance from the current conductor. In the case of alternating current, the direction of flow changes, which entails changes in the magnetic field over time. As a result, the changing magnetic field induces an alternating electric field in seawater [Gill *et al.*, 2009]. The use of three-phase AC cables practically allows to eliminate the emission of the magnetic field outside the cable due to current phase shifts in individual conductors of the cable [OSPAR 2012].

The electric field, being dependent on the magnetic field, will similarly diminish with distance from the cable. Based on the calculations for various AC transmission system designs, Tricas and Gill (2011) determined the average induction value of the magnetic field to be expected at different depths, depending on the distance from a cable buried in the seabed at the depth of 1 m [Table 10.67].

Table 10.67. Magnetic induction [μT] in relation to vertical distance from the seabed and horizontal distance from the cable (alternating current, cable burial depth 1 m) [Source: internal materials based on Tricas and Gill 2011]

Vertical distance from the seabed	Horizontal distance from the cable [m]		
	0 m	4 m	10 m
0 m	7.85 μT	1.47 μT	0.22 μT
5 m	0.35 μT	0.29 μT	0.14 μT
10 m	0.13 μT	0.12 μT	0.08 μT

The spatial range of the induced electric field usually reaches up to several metres from its source [Orbicon 2014; Engell-Sørensen 2002].

The sensitivity of ichthyofauna to the EMF impact depends on:

- the species-specific detection threshold;
- the type of sensor in the fish (magnetic, electrical);
- the lifestyle (demersal, pelagic – seabed dwellers are exposed to a higher EMF force) [Engell-Sørensen 2002].

Magnetic field can impact both the physiology and behaviour of fish as well as their spatial cognition. Impacts at the physiological level may involve, for example, changing hormone levels in brook trout [Lerchl *et al*. 1998]. In sea trout and rainbow trout slower embryonic development was observed [Formicki and Winnicki 1998]. Laboratory studies conducted by Fey *et al*. (2019) do not confirm a direct impact of magnetic field (10 mT) on the mortality and growth in the latter species. However, an experiment demonstrated a faster absorption of the yolk sac in larvae, which may negatively affect their condition. Krzemieniewski *et al*. (2004) observed increased mortality of Wels catfish larvae exposed to a magnetic field of 0.4–0.6 T. On the other hand, no effect of long-term exposure to magnetic field (3.7 mT) was observed in juvenile flounder [Bochert and Zettler 2004]. A comparison of the magnetic induction values at which the above-mentioned reactions were observed with the values given in the table above indicates that no impact of the magnetic field generated inside the wind farm on ichthyofauna at the physiological level is to be expected.

Disturbances in the natural field may cause problems with the orientation of migratory fish, such as European eel. However, the previous field surveys do not indicate a significant impact of cable-induced EMF on the migration capabilities of this species. No disturbances in the migration of eels swimming 500 m away from a wind turbine have been observed in the surveys conducted in the Baltic [Ohman *et al.* 2007].

Also, during the experimental surveys on the halibut's response to electromagnetic field, no significant behavioural changes were observed [Woodruff *at al*. 2012].

The extensive studies on the impact of cables running across the Nysted OWF area (the Danish straits) on ichthyofauna have indicated that although they constitute no barrier for fish, however, they can be an obstacle to their movement, especially the migration of eel. The authors of the EIA Report conclude that although changes in the behaviour of fish along the cable route have been observed, their cause-and-effect relationship with EMF is unclear [DONG 2006].

According to Poleo *et al*. (2011), the Osteichthyes display a physiological response to an electric field of 7 $mV \cdot m^{-1}$ and a behavioural response in the range of 0.5–7.5 $V \cdot m^{-1}$. Research on the impact of the electric field on salmonids and eels indicate the possibility of the occurrence of such reactions as accelerated pulse (field strength of 0.007–0.07 $V \cdot m^{-1}$) as well as gills and fins vibration (field strength of 0.5–7.5 $V \cdot m^{-1}$) [Marino and Becker 1977]. Harmful effects such as paralysis and temporary loss of consciousness were observed in fish exposed to an electric field with a strength above 15 $V \cdot m^{-1}$ [Fisher and Slater 2010], i.e. at values significantly exceeding the ones generated by subsea cables. The values of electric field strengths shown above, at which a physiological response was observed, are several orders of magnitude greater than those generated by the offshore wind farm connection cables. Depending on the distance from a cable buried in the seabed at a depth of 1 m under the seabed, the strength of the electric component of the field is up to $8 \cdot 10^{-4}$ $V \cdot m^{-1}$ on the seabed, $3.4 \cdot 10^{-5}$ $V \cdot m^{-1}$ in the water column 5 m above the seabed and $1.24 \cdot 10^{-5}$ $V \cdot m^{-1}$ in the water column 10 m above the seabed. It can therefore be assumed that the response of fish to the electric field in the farm area will not be significant, especially since the strength of the electromagnetic field in the water, as observed in the water column, decreases with the depth at which the cable is buried.

In the environmental impact assessment of the OWF carried out by Bergström *et al*. (2014), the EMF impact was assessed as low. Also, in the environmental impact assessment of the Horns Rev 2 OWF, the impact was classified as low or negligible [Spanggaard 2006]. According to Taormina *et al*. (2018), the significance of this impact was classified as low for cables buried in the sediment and moderate for cables lying on the sediment surface.

The impact related to the EMF will be negative, direct, local, long-term and reversible.

During the construction phase, power cables are planned to be buried at depths of up to 6 m. For this reason, the sensitivity of ichthyofauna to EMF emitted by power cables was assessed as irrelevant.

The sensitivity to the impact was assessed as moderate for all the fish species examined. The significance of the impact is assessed to be low for all the fish species examined.

Habitat change

The introduction of foundations and erosion protections into the environment promotes the creation of a new habitat characterised by hard substrate. Such artificial structures form an 'artificial reef' – a new habitat. At the first stage, the reef is inhabited by periphyton organisms, macrophytes and invertebrates [Feger 1971]. As soon as several months later, numerous populations of fish [Turner 1969; Stone et al. 1979; Bohnsack and Tolbot 1980] appear in the reef area, both those returning after the cessation of the disturbances related to the construction [Rellini *at al*., 1994] as well as those previously absent in the area (increase in biodiversity). According to Bohnsack and Sutherland (1985), the process of creating a stable artificial reef system usually takes 1 to 5 years. The scale of this phenomenon depends both on the reef size and the complexity of its structure, as well as the environmental conditions in which it was created and the composition of ichthyofauna in its area [Hammar *et al*. 2016].

Artificial reef is an attractive habitat that can offer rich food resources, shelter and create favourable conditions for reproduction for many fish species, for adult stages as well as eggs, larvae and juvenile individuals. The submerged structural elements of turbines and erosion protection structures provide attractive hiding places for young, 2–3 year old cod [Reubens *et al*. 2011]. Here, they can find shelter from sea currents, predators [Bohnsack and Sutherland 1985; Wilhelmsson *et al.* 2006], as well as from fishing pressure. Artificial reefs may also provide favourable breeding conditions for numerous fish species such as herring, pogge, garfish, lumpfish, rock gunnel and turbot [Zucco *et al.* 2006]. According to Spanggaard (2006) the artificial reef area also provides preferable spawning conditions for gobies, which include species protected in Poland.

The positive impact of the OWF constructions is confirmed by observations in areas where farms already operate, indicating the attractiveness of these areas for ichthyofauna. Aggregations of small demersal and semi-pelagic fish near OWF monopiles have been observed in the south-western Baltic Sea [Wilson *et al*. 2010]. Larger densities of some of the species occur within a radius of 20 to 160 m around wind farms off the Swedish coast. The observations in the Danish and Belgian wind farm areas in the North Sea (Thornton Bank and Bligh Bank) indicate that these areas are highly attractive for Gadidae, especially among younger age groups, and flat fish.

Surveys conducted by Bergström *et al*. (2013) in the area of the Lillgrund farm located in the Öresund strait showed visible aggregations of such fish species as cod, shorthorn sculpin, black goby, viviparous eelpout and eel in the project area.

The assessment of whether the artificial reef effect is limited only to attracting fish to its area from the nearby sea area or whether there is a real increase in productivity is ambiguous. The results of surveys by Reubens et al. (2014) carried out in the area of Belgian wind farms located in the North Sea show not only the accumulation of cod in these areas, but also the increase in local production. However, it was limited to the area in the immediate vicinity of a farm, and this effect was not visible on a regional scale.

If restrictions on fishing and shipping are introduced in areas occupied by projects (e.g. wind farms), anthropogenic pressure will decrease and artificial reef areas may be a specific refuge for fish, both adult and their early developmental stages, larvae and fry, becoming an equivalent to protected areas [Degraer and Brabant 2009].

It is worth mentioning, however, that not all surveys conducted in the OWF areas unequivocally point to their role as a factor in increasing the abundance and diversity of ichthyofauna in these areas. The hydroacoustic surveys carried out in the Nysted (Baltic Sea) and Horns Rev (North Sea) OWFs did not indicate a statistically significant effect of the new habitat elements on fish distribution, neither locally nor regionally [Hvidt *et al*. 2005].

In the publication by Bergstrom *et al.* (2014) the significance of the positive impact of the reef effect in the Baltic Proper and the Gulf of Bothnia was assessed as medium.

Taking into account the local specificity of the Baltica-1 OWF Area, it can be assumed that the reef effect may play an important role in shaping the grouping of ichthyofauna. The magnitude of this impact is highly dependent on the area occupied by the structures of the OWF infrastructure, their number and level of spatial complexity.

The scale of this impact can be approximated by the ratio of the maximum area of the seabed occupied by all foundations to the total area of boulders currently occupying the area. According to the information in Section 3, the maximum total area of gravity-based structures, including erosion protection and seabed reinforced with crushed rock bedding for the installation of jack-up vessels, will be approximately 2 km^2. At the same time, the total number of boulders, according to the results of the inventory survey of the Baltica-1 OWF Area, is 17 000 and their roughly estimated area is about

0.79 km^2. It can therefore be assumed that due to the scale of habitat changes, the creation of an artificial reef is a potentially significant impact.

The impact related to the change of habitat will be positive, direct, local, long-term and reversible.

The sensitivity to the impact for the cod, European flounder and herring was assessed to be high and for the sprat, common seasnail, sand goby and twaite shad as moderate. The significance of the impact is assessed to be low for all the fish species examined.

Formation of a mechanical barrier

The construction of underwater structures may constitute a migration barrier for commercially important fish, the routes of which run in this location. However, the observations carried out in the areas of the Danish OWFs indicate that due to the possibility of an active movement of fish, these factors do not disturb the migration processes significantly [Stenberg *et al*. 2011].

The Baltica-1 OWF Area probably lies on the path of cod spawning and feeding migration routes. However, it can be assumed that due to the possibility of fish avoiding the potential impact area, the impact on migration will not be significant.

The impact related to the creation of the mechanical barrier will be negative, direct, local, primary, long-term, permanent and reversible. The resistance of all the analysed ichthyofauna species to the impacts associated with the formation of a mechanical barrier is high.

The impact related to the creation of a barrier will be negative, direct, local, long-term and permanent.

The sensitivity to the impact was assessed as low for all the fish species examined. The significance of the impact is assessed to be negligible for all the fish species analysed.

Assessment of the scale of impact on ichthyofauna is provided in Table 10.68. Assessment of the impact significance is provided in Table 10.69.

Table 10.68. Assessment of the scale of impact on marine ichthyofauna

Impact	**Impact characteristics**													**Joint 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**
Noise emission	3					1					1		1	6
EMF		2				1		4					1	8
Habitat change	3					1		4					1	9
Physical barrier	3					1					1		1	6

Table 10.69. Assessment of the significance of impact on marine ichthyofauna

Impact	Impact scale	Receptor sensitivity	Impact significance
Noise emission	low	high	Low
EMF	irrelevant	moderate	Negligible
Habitat change	low	high	Low
Physical barrier	low	low	Negligible

Taking into account the results of the impact assessment, the limited space in which the Project may be located and the possible technologies for its execution, no measures to minimise the negative impact of the Baltica-1 OWF on ichthyofauna are indicated.

10.2.2.9.4 Impact on marine mammals

Increase in underwater noise level – noise from operating turbines

The main source of underwater noise in the operation phase of the farm will be operating turbines.

Operation of a wind farm generates noise which is emitted both to air as well as to water. Its source are the moving mechanical parts of the nacelle – the generator and gearbox, as well as the tower vibrations caused by the wind. The sound is transmitted to the water via the turbine base and supporting structures. The noise produced is in the low frequency spectrum, with most of the energy below 1 kHz [Madsen *et al.* 2006; Thomsen *et al.* 2006]. The sounds produced are continuous and for the period of the wind farm operation (up to 35 years) are almost constantly present in the environment, which can contribute to an increase in the local ambient noise level. The level of noise generated by individual wind turbines depends on several factors, but is generally considered to be low. Based on measurements made for different wind farms, Tougaard *et al.* (2020) estimated that the noise from an operating turbine is 10–20 dB lower than the level of noise from a ship measured at the same distance. In another study, Stober and Thomsen (2021) concluded that the broadband peak operational noise level at 1 m from the sound source is between 129 and 166 dB re 1 µPa (nominal capacity: 0.45–6.15 MW). The main factors influencing the level of noise from operating turbines are turbine type and size, gearbox technology, distance from the turbine and wind speed [Tougaard *et al.* 2020; Stober and Thomsen 2021]. Tougaard *et al.* indicated that the noise level decreases significantly with distance – about 24 dB per decade and increases with wind speed – 18.5 dB per decade. Stober and Thomsen (2021) estimated that the shift from using gearbox technology to direct drive allowed for a 10 dB reduction in the sound level. The broadband sound level from the direct drive turbine is estimated at 160 dB re 1 µPa.

The impact of noise from operating wind turbines on marine organisms is still poorly identified, and knowledge in this field is being expanded. Field data are available for a small number of species and areas, providing insufficient information in relation to the huge scale of currently planned offshore wind farm projects. Due to the rapidly developing OWF industry worldwide, more and more attention is being paid to the potential cumulative effects resulting from the increasing size of turbines and their nominal capacity, and consequently – generated sound levels.

Currently available results of research on the impact of noise from operating wind turbines on marine mammals come mainly from European waters. The surveys have been conducted around farms located in the North Sea, taking into account three species – the harbour porpoise, the grey seal and the harbour seal.

In the case of porpoises, the surveys were based on passive acoustic monitoring, carried out within the operating wind farm and in adjacent waters, which allowed obtaining data on the acoustic activity of the animals during the OWF operation. At the Nysted farm, Tougard *et al.* (2006) noted that during the two years of the project operation, porpoises gradually accustomed themselves to the new environmental conditions and began to re-appear in the monitored area (after the previous construction phase). After 10 years of monitoring in the Nysted area, Teilman and Carstensen (2012) indicated that despite the slow return of the animals, their activity was lower than in the period before the OWF construction. On the other hand, in the nearby Rodsand 2 wind farm, Teilman *et al.* (2012) did not observe any changes in the overall level of porpoise detections between the baseline conditions and the operational phase. There were also no differences when comparing the animal activity between the OWF area and the reference area. The authors indicated that there were no cumulative impacts from the two neighbouring operating wind farms. The surveys conducted for the Egmond aan Zee OWF showed an increase in the level of acoustic detections of porpoises during the farm operation phase, which was consistent with the general trend of increasing numbers of the species in Dutch waters during the monitoring period. It was also found that the animal activity was much higher within the OWF than in the reference area. In all of the above surveys, the authors indicated a possible positive influence of the operating wind farm on the number of porpoises. The probable explanations for the phenomenon include the so-called reef effect, resulting in increased food availability, and reduced vessel traffic compared to other parts of the heavily used North Sea (refuge effect).

In relation to seals, the illustrative surveys were based on animal telemetry monitoring using haul-out sites near operating wind farms. McConnell *et al.* reported that grey and harbour seals repeatedly moved between haul-out sites through the Nysted and Rodsand II offshore wind farm areas. The operating turbines were not found to affect the behaviour of migrating animals. During surveys in a British wind farm, Russell *et al.* (2016) noted an increase in the use of the area around the OWF by harbour seals, which coincided with a general increase in seal numbers in the region. None of the above surveys found negative effects of operational noise on seals.

In contrast to the surveys described, recent analyses of the potential impact of noise from planned wind farms have raised increasing concerns. Tougaard *et al.* (2020) pointed to possible negative impacts related to the cumulative sound generated by all the turbines within the OWF. The authors estimated that under low ambient noise conditions, the cumulative noise from the turbines could exceed the ambient levels within a few kilometres from the farm. Consistent with this result, Stober and Thomsen (2021) calculated that a single 10 MW turbine could trigger a behavioural response in marine mammals at a distance of 1.4 to 1.6 km, depending on the technology used (direct drive / gearbox). This could mean that the entire wind farm constitutes an impact zone.

The above results indicate that the cumulative impact of noise from operating wind turbines can be noticeable. In order to estimate the potential impact of sounds generated during the Baltica-1 OWF operation on marine mammals, numerical modelling of noise propagation was carried out. With its help, distance ranges and areas of potential impact on animals were calculated. Analyses were conducted for the harbour porpoise, taking into account continuous noise exposure thresholds based on international criteria and survey results [Skjellerup 2015, NMFS 2018 and 2023]. The values applied are presented in Table 10.70. For seals, NMFS criteria for impact thresholds in the form of TTS and PTS are lower than the anticipated operational noise level. Therefore, the potential impact ranges were considered negligible. Regarding the behavioural response of seals, there is insufficient data to define a criterion for these animals' response to noise exposure from an operating OWF. Therefore, modelling was impossible.

Table 10.70. Acoustic thresholds adopted for assessing the impact of continuous noise on porpoises [Source: internal materials based on studies provided in the table]

Animal species/group	Effect	SEL acoustic threshold [dB re 1 μPa²s]	Source
Harbour porpoise	PTS	173 (weighted SEL)	NMFS 2018, 2022
	TTS	153 (weighted SEL)	NMFS 2018, 2022
	Behavioural change	140 (unweighted SPL)	Southall *et al.* [2007]

Since there are no environmental measurement data on noise levels from large-diameter turbines in operation (wind farms with this type of turbines are currently in the planning phase), the analysis used a value based on the latest literature data. The operational noise level used in the modelling was 159 dB re 1 μPa. The analysis assumed a 24-hour animal exposure to noise. The cumulative calculations assumed simultaneous operation of all turbines on the farm. The analysis was carried out for the summer season, due to the worst conditions of sound propagation in water, and for the winter season, due to the best conditions of sound propagation underwater.

The results of acoustic modelling showed that the range of noise impact from a single operating turbine on the harbour porpoise is negligible for each of the analysed effects [Table 10.71]. Taking into account the accumulation of sound during the operation of all turbines, the probability of negative impact on the harbour porpoise is also small. The obtained values of the impact zones are much smaller than the area of the entire wind farm. Moreover, the predicted scenario assumes 24-hour exposure to sound, which is unlikely given the behaviour of the species analysed. Therefore, based on the modelling, the negative impact of noise from operating turbines on porpoises can be considered negligible.

Table 10.71. Anticipated impact ranges of noise from turbines operating in the Baltica-1 OWF Area obtained for porpoises on the basis of numerical modelling. The results are presented for two seasons taking into account the operation of a single turbine as well as all turbines simultaneously. A 24-hour exposure to noise was adopted in the calculations

Modelling type	Season	Effect	Maximum impact range [km]	Impact area [km²]
Single turbine	Summer	PTS_{cum}	0.1	0.03
		TTS_{cum}	0.1	0.03
		Behavioural change	0.1	0.03
	Winter	PTS_{cum}	0.1	0.03
		TTS_{cum}	0.1	0.03
		Behavioural change	0.1	0.03
All turbines operating simultaneously (cumulative effect)	Summer	PTS_{cum}	-	1.9
		TTS_{cum}	-	1.9
		Behavioural change	-	1.9
	Winter	PTS_{cum}	-	1.9
		TTS_{cum}	-	1.9
		Behavioural change	-	1.9

Overall, due to the predicted low levels of noise from operating turbines, no significant impacts on marine mammals are anticipated, neither on seals nor porpoises.

Noise from vessels

The operation of the wind farm will involve the movement of probably large and medium-sized service vessels. Such vessels could potentially increase the noise level in the environment, including the frequencies important for marine mammals. However, it is expected that both the number of service operations as well as of vessels sailing at the same time will be low, thus having a minor impact on marine mammals.

Habitat and food supply change

It is assumed that there will be a gradual recovery process once the construction work, which causes the environmental disturbance and potential loss of feeding grounds for marine mammals, has ceased. It is likely that habitats for benthic organisms will be re-established around the wind farm area, attracting fish while restoring food availability for porpoises and seals. The concrete piles on which the turbines will be installed can also cause the so-called reef effect. Benthic organisms often settle in large numbers on additional underwater structures placed on the seabed. This causes an increase in local populations as well as in the biodiversity of fish, often attracting marine mammals as well. This kind of environmental redevelopment was identified in regions surrounding the offshore wind farms. The effect of attracting organisms to wind farm areas is additionally enhanced by the fact that those areas are excluded from fishing [Degraer *et al*. 2020].

Assessment of impacts during operation phase

A summary of the impact of the Baltica-1 OWF operation phase on marine mammals is presented in Table 10.72 and Table 10.73. Due to the unlikely negative impact resulting from vessel traffic as well as habitat and food supply change, no assessment of the scale of impacts was made for those effects.

Table 10.72. Assessment of the scale of impacts of the Baltica-1 OWF operation phase on marine mammals

Animal species/group	Impact	Impact characteristics													Joint 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
Harbour porpoise	Increase in noise level – wind turbine operation	3					1		4					1	9
	Increase in noise level – ship traffic														None
	Habitat and food supply change														None
Seals	Increase in noise level – wind turbine operation	3					1			3				1	8
	Increase in noise level – ship traffic														None
	Habitat and food supply change														None

Table 10.73. Assessment of the impact significance of the Baltica-1 OWF operation phase on marine mammals

Animal species/group	Impact	Impact scale	Receptor sensitivity	Impact significance
Harbour porpoise	Increase in noise level – wind turbine operation	moderate	moderate	Low
	Increase in noise level – ship traffic	low	low	Negligible
	Habitat and food supply change	low	moderate	Low
Seals	Increase in noise level – wind turbine operation	moderate	moderate	Low
	Increase in noise level – ship traffic	low	low	Negligible
	Habitat and food supply change	low	moderate	Low

10.2.2.9.5 Impact on migratory birds

During the operation phase, there will be impacts on migratory birds due to the barrier effect and the risk of collision with the Baltica-1 OWF structures. Underwater and above-water noise is not considered a potential impact on migratory birds.

Barrier effect

The presence of OWFs creates a barrier effect influencing the behaviour (movement) of migratory birds. The scale of the 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. The surveys conducted so far on this topic indicate that bypassing even a few OWFs increases slightly both the total length of the migration route and the energy expenditure associated with the migration. These results have been included as a reference for this document, but it should be emphasised that the surveys presented in the literature refer to other marine areas. Masden and Cook (2006) present the results for the Nysted OWF in the Baltic Sea (165 MW). In the report by Jensen *et al.* (2014) the situation of the Horns Rev 3 OWF is presented (400 MW, Horns Rev 3, North Sea). In the case of the Horns Rev 3 OWF, which borders two other OWFs – Horns Rev 1 OWF (160 MW) and Horns Rev 2 OWF (209 MW), it was concluded that cumulative impacts would not occur.

The magnitude of the barrier effect during the operation phase is considered moderate. Similarly to the construction and decommissioning phase, this impact is direct, while its range, due to the possible changes in the flight trajectory in some of the migratory birds, is considered regional. Due to the duration of the operation phase (a maximum of 35 years), the temporal scope is considered long-term.

Table 10.74. Assessment of the scale of impacts of barrier effect on migratory birds during the operation phase

Impact	**Impact characteristics**													**Joint 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**
Barrier effect	3				1			4					1	9

An assessment of the sensitivity of individual species and species groups is provided in Table 10.11.

Table 10.75. Sensitivity of migratory birds to disturbance in the form of barrier effect and the risk of collision

Species/group of species	Binomial nomenclature	Receptor value/significance	Resistance to disturbance (barrier effect)	Receptor sensitivity (barrier effect)	Resistance to disturbance (collision risk)	Receptor sensitivity (collision risk)
Greylag goose	*Anser anser*	Low	High	**Irrelevant**	Moderate	**Low**
Greater white-fronted goose	*Anser albifrons*	Low	High	**Irrelevant**	Moderate	**Low**
Common wood pigeon	*Columba palumbus*	Low	High	**Irrelevant**	High	**Irrelevant**
Common swift	*Apus apus*	Low	High	**Irrelevant**	High	**Irrelevant**
Eurasian curlew	*Numenius arquata*	Low	Moderate	**Low**	Moderate	**Low**
Whooper swan	*Cygnus cygnus*	Low	High	**Irrelevant**	High	**Irrelevant**
Long-tailed duck	*Clangula hyemalis*	High	High	**Low**	High	**Low**
Common scoter	*Melanitta nigra*	Moderate	High	**Low**	High	**Low**
Little gull	*Hydrocoloeus minutus*	Moderate	Moderate	**Low**	Moderate	**Low**
Lesser black-backed gull	*Larus fuscus*	Low	Moderate	**Low**	High	**Irrelevant**
Black-throated diver	*Gavia arctica*	Low	High	**Irrelevant**	High	**Irrelevant**
Goosander	*Mergus merganser*	-	High	**Irrelevant**	High	**Irrelevant**
Greater scaup	*Aythya marila*	Low	High	**Irrelevant**	High	**Irrelevant**
Eurasian skylark	*Alauda arvensis*	Low	High	**Irrelevant**	High	**Irrelevant**
Eurasian wigeon	*Mareca penelope*	Low	High	**Irrelevant**	High	**Irrelevant**
Red-breasted merganser	*Mergus serrator*	-	High	**Irrelevant**	High	**Irrelevant**
Velvet scoter	*Melanitta fusca*	High	High	**Irrelevant**	High	**Irrelevant**
Common crane	*Grus grus*	High	Moderate	**Moderate**	Moderate	**Moderate**
Auks	*Alcidae*	Low	High	**Irrelevant**	High	**Irrelevant**
Carnivorans	*Accipitriiformes*	Moderate	Moderate	**Moderate**	Moderate	**Moderate**
Geese	*Anserinae*	Low	Moderate	**Low**	Moderate	**Low**
Swans	*Cygnidae*	Low	High	**Irrelevant**	High	**Irrelevant**
Divers	*Gaviidae*	Low	High	**Irrelevant**	High	**Irrelevant**
Terns	*Sternidae*	Low	High	**Irrelevant**	High	**Irrelevant**
Charadriiformes	*Charadriidae*	Low	Moderate	**Low**	Moderate	**Low**

Species/group of species	**Binomial nomenclature**	**Receptor value/significance**	**Resistance to disturbance (barrier effect)**	**Receptor sensitivity (barrier effect)**	**Resistance to disturbance (collision risk)**	**Receptor sensitivity (collision risk)**
Owls	*Strigiformes*	Low	Moderate	**Low**	Moderate	**Low**
Passerines	*Passeriformes*	Low	High	**Irrelevant**	High	**Irrelevant**
Skuas	*Stercorariidae*	Low	High	**Irrelevant**	High	**Irrelevant**

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.

Table 10.76. Assessment of the barrier effect impact significance on migratory birds during the operation phase

Impact	Impact scale	Receptor sensitivity	Impact significance
Barrier effect	moderate	irrelevant	**Negligible**
		low	**Negligible**
		moderate	**Low**

Risk of collision

The impact in the form of the risk of collision, i.e. bird mortality resulting from collisions with OWF elements, has been presented in Appendix 1 to the EIA Report as the total number of collisions of a given species during the spring and autumn migration periods. The risk of a collision 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 are able to spot an OWF from a considerably shorter distance, which results in a higher risk of collision. During the analyses both the Applicant Proposed Variant (APV) and the Rational Alternative Variant (RAV) were tested. Among all the species included in the analysis, the impact significance resulting from the collision is assessed as negligible and low 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 results of modelling for the RAV show very similar results. The impact in the form of the risk of collision was assessed to be low for the long-tailed duck, the common scoter, the common crane and the little gull. For these species, the risk of collision did not exceed single individuals. 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 impact was assessed as negligible.

Table 10.77. Assessment of the scale of collision risk impacts on migratory birds during the operation phase

Impact	Impact characteristics													Joint 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
Risk of collision	3					1		4				2		10

Table 10.78. Assessment of the significance of collision risk impact on migratory birds during the operation phase

Impact	Impact scale	Receptor sensitivity	Impact significance
Risk of collision	high	irrelevant	**Negligible**
		low	**Low**
		moderate	**Moderate**

10.2.2.9.6 Impact on seabirds

An assessment of the impacts identified for the operation phase of the Baltica-1 OWF on marine avifauna is presented below.

Habitats occupation

The operation of the Baltica-1 OWF will cause the disturbance and displacement of some of the seabirds staying in the sea area occupied by the wind turbines and in the adjacent strip of waters with a width of from 2 km to 4 km. The degree and spatial extent of bird displacement from this sea area and its surroundings will depend on the bird species. A single offshore wind farm constitutes a barrier for birds, which, in the vast majority of cases, avoid a sea area with wind turbines. Such a behaviour minimises the risk of collision, especially during the day with good visibility. However, the farm area will become excluded as a feeding ground for a long time for a large part of the individuals, which may have a negative impact on the biogeographical populations of some of the species.

Habitat changes caused by the creation of artificial reef (underwater parts of OWF) may have a positive result on the development of benthic invertebrate macrofauna. Rich benthic communities shall form on the underwater parts of the construction as well as on the seabed of the area occupied by the Baltica-1 OWF, which may translate to the increase in the abundance of fish [Degraer 2020]. During the restoration of benthic habitats, both the recovery of their original species structure as well as changes caused by biological factors (e.g. invasive species) and physical factors (EMF, heat emission) may take place. However, these changes are difficult to predict and these resources will be used by birds to a small degree, or not used at all [Vicinanza 2012]. The bird-scaring effect of the ships and structures protruding from the water will be dominant there. The most important parameters affecting the level of impact are the shape, diameter of the base and the number of foundations or support structures.

The habitat occupation during the operation phase will cause a direct impact on seabirds of local range (of transboundary range for the long-tailed duck, due to a possible impact on the biogeographical population of this species), long-term and reversible. The impact on gulls was classified as irrelevant.

The scale of impact on benthivorous birds was assessed as high and on piscivorous birds as moderate, while on gulls – irrelevant.

Barrier effect and risk of collision

The offshore wind turbine structures will occupy part of the Baltica-1 OWF sea area, creating a barrier for seabirds migrating between the feeding grounds or resting places. Furthermore, the risk of bird collision with the offshore wind turbines will increase with the progressing Baltica-1 OWF construction, reaching its maximum during its operation. The number and density of the wind turbines, the clearance between the sea surface and the lower level of the rotor blade, the rotor diameter and the distance from the neighbouring OWFs will affect the impact scale. The adjacent wind farms intensify the barrier effect. It has been noted that seabirds clearly avoid the area occupied by OWFs and their abundance decreases in the vicinity of the turbines, e.g. for the long-tailed duck – within a radius of up to 2 and even up to 4 km [Christensen 2003; Petersen 2006; Leopold 2011]. Gulls and cormorants are an exception, since they often use the structures protruding above the water as their resting places, and as a result their abundance may even increase.

The risk of collision depends also on the bird species. Large species of waterbirds such as swans are at a higher risk of collision with wind turbines due to the difficulty in making sudden manoeuvres in the air [Brown *et al*. 1992]. The majority of waterbird species travel low above the water surface, and when between turbines, they lower their flight altitude and maintain equal distances from the obstacles [Devholm *et al*. 2005; Hüppop *et al*. 2006; Petersen *et al*. 2006]. This means that the risk of collision is affected by the clearance between the lower position of the rotor blade and the sea surface. The smaller the clearance, the higher the risk of bird collision with the operating rotor.

The modelling of the collision risk was carried out based on three scenarios, differing in the number of turbines (36, 50 and 60 pcs). In order to determine the collision risk of individual resident and migratory bird species, a commonly used collision risk model was applied (CRM)[Band 2012; Masden *et al*. 2016]. The maximum estimated number of collisions for the turbine complex during the migration period is:

- 0–2 collisions for the long-tailed duck, depending on the value of the avoidance rate from 99.3 [Johnston *et al*. 2014] to 99.9% [Garthe *et al*. 2012];
- 0–1 collisions for the common scoter, depending on the value of the avoidance rate ranging from 99.3% [Poot *et al*. 2011] to 99.9% [Smart Wind 2013];
- 0–1 collisions for the little gull, depending on the value of the avoidance rate ranging from 98.0% [Krijgsveld *et al*. 2011] to 99.9% [Forewind 2013];
- 0–4 collisions for the lesser black-backed gull, depending on the value of the avoidance rate from 98.0% [Krijgsveld I *et al*. 2011] to 99.9% [Forewind 2013].

Collision risk modelling was not carried out for the European herring gull, the common gull and piscivorous birds – the razorbill, the common guillemot, the black guillemot and the black-throated diver. This information will be updated after the second survey year.

The barrier effect that will be generated by the Baltica-1 OWF applies primarily to migratory birds. However, some of the seabirds migrating across the Baltica-1 OWF Area may fly to the nearby Natura 2000 sites, where they can have their stopover places, wintering or breeding grounds. The creation of a barrier in this area may also impede the movement of these populations between the wintering grounds, such as the Słupsk Bank, the Middle Bank and the Hoburgs Bank. Currently, there are no scientific data available on the significance of the links between these areas, but they cannot be excluded. The modelling of the barrier effect impact on birds was preceded by the formulation of hypothetical bird migration routes, determined from radar data. All migration routes were simplified to represent the shortest routes between breeding and wintering grounds, taking into account the habitats (e.g. sea ducks fly mainly above water), and to cross the Baltica-1 OWF Area. The same routes were assumed for spring and autumn migration, as there are no surveys proving that this should be different for the species analysed. Migration routes were then modified, assuming that birds perceive the Baltica-1 OWF Area as a barrier and avoid the farm at a distance of 1–2 km.

The calculations of bird energy expenditures as a result of the extended migration route, related to the OWF barrier effect, indicate a slight increase (max. 3.84% for the black guillemot). 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 OWF. Therefore, the significance of the barrier effect impact on all the bird groups included in the analysis was considered irrelevant. In the case of the cumulative impact of wind farms, for which very distant OWFs are included, the theoretical route bypassing the OWF results in a fairly significant increase in energy expenditure for the black guillemot (+24.61%). However, using expert knowledge, a situation where this species would choose such a route is unlikely, due to the large areas of open, undeveloped Baltic waters between the different groups of OWFs. The increase in energy expenditure due to the cumulative barrier effect for the remaining species will be small at most.

The operation of the Baltica-1 OWF will involve the traffic of various types of vessels and helicopters. Due to the fact that it is difficult to separate their impacts at the time (unknown number of equipment that can be used), these impacts are assessed jointly. Collisions of seabirds with vessels are possible at this stage of the Project. It was assumed that the highest intensity of vessel traffic in the Baltica-1 OWF Area will occur during construction and decommissioning, while the impact will be the smallest during the operation stage. The presence of ships will lead to a greater occurrence of gulls and cormorants searching for food near the ships. 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. During the operation phase, the Baltica-1 OWF Area may be totally or partially closed for commercial fishing. As a result, it may be expected that in the OWF Area, fish shall find very good habitat conditions (no fishing, rich benthic communities). However, birds shall use the food supply created to a limited extent, because the bird-scaring effect of the structures extending high above the water surface shall be dominant.

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The barrier effect and risk of collision are direct impacts on the benthivorous and piscivorous birds that are transboundary (benthivorous birds) or regional (piscivorous birds), long-term and reversible. The impact on gulls was assessed as direct of local extent, temporary and reversible.

The impact scale on gulls was assessed as irrelevant and on the piscivorous and benthivorous birds as high.

Noise and vibration emissions

During the operation phase, the primary source of noise will be the operation of wind turbines, i.e. the noise from the rotating rotor and the noise associated with the airflow at the edge of the wind turbine blades. With regard to fish, which constitute a food supply for birds (piscivorous birds), the results obtained regarding hearing damage indicate significant ranges of impacts. In the case of noise generated by a single turbine, the area of TTS impact, both in winter and summer, is a maximum of 0.03 km^2. The cumulative impact area generated by all turbines in the OWF is 1.9 km^2 in relation to fish.

However, due to the high sensitivity of seabirds to disturbance, the main effect of wind turbines will be disturbance and displacement of birds from their habitats, which will mask the effect of noise impacts as less significant. After the construction of the Baltica-1 OWF, the majority of bird species will avoid the site and the adjacent 2 to 4 km wide strip of water, due to the mere presence of offshore wind turbines [Christensen 2003, Petersen 2006, Leopold 2011]. The area will be excluded for the duration of the farm's operation as feeding grounds for some individuals, which may have a negative impact on seabirds. The degree and spatial extent of their displacement from this sea area and its surroundings will depend on the species and technical parameters of the OWF (number of turbines, density, rotor diameter).

The disturbance and displacement from habitat as a result of noise emissions from the proposed Project during the operation phase will result in a direct, local and reversible impact on seabirds. This is a long-term impact for piscivorous and benthivorous birds. Gulls are birds which benefit from human activities and are much less sensitive to noise impacts. Therefore, the impact on the above group of seabirds will be temporary.

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

Emission of light

The illumination of the Baltica-1 OWF may hinder seabirds navigation and increase the risk of their collision with the turbines. This is particularly true for migratory species that are active at night (piscivorous and benthivorous birds). During migration, birds navigate in relation to natural light sources such as stars and the sun. The phenomenon of birds being attracted to artificial light (ALAN, Artificial Light at Night) has been known since the 19^{th} century and mainly involved lighthouses and spot-lit ships [Allen 1880], hence collisions between birds and illuminated structures are referred to as the 'lighthouse effect' [Wiese *et al*. 2001]. During surveys on bird behaviour near drilling rigs, it has been observed that illumination causes seabirds to gather around such structures. This is mostly the case for tubenoses (*Procellariiformes*) which are most often active at night, but the concentrations of the little auk (*Alle alle*) have also been observed [Wiese *at al*. 2001]. This species are closely related to the razorbill and the guillemot, which are abundantly recorded in the area of the proposed Project. However, for the majority of seabirds the impact of artificial lighting on birds residing in the immediate and more distant vicinity of light sources remains very poorly known.

Birds encountering sources of artificial light in their path, i.e. lampposts, wind farms and cities, may change their flight trajectory to match its direction 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 and precipitation [Thompson 2013], when the stars are invisible and the birds lower their flight altitude. Attracted by the artificial light and disoriented, birds may collide with various pieces of infrastructure or fall from exhaustion while circling the light points. A 40-year monitoring survey of bird mortality in the United States has shown that most collision victims were birds calling intensively with other individuals in the flock using short contact voices during night migration, mainly thrushes, New World warblers and New World sparrows [Winger *et al*. 2019]. In Poland, species that vocalise intensively during migration are, for example, thrushes, or Charadriiformes migrating mainly at night [Pamuła *et al*. 2017]. Many species in this group are long-distance migrants breeding in far Siberia and wintering in Africa, encountering urbanised, ALAN-polluted areas along their migration route [Cabrera-Cruz *et al*. 2018].

The lighting of the Project site during the operation phase will result in direct, long-term and reversible impacts on seabirds. For benthivorous birds, this is a transboundary impact and for piscivorous birds – a regional impact. The impact on gulls will be local and temporary.

The impact scale on gulls was assessed as low and on the piscivorous and benthivorous birds as high.

Electromagnetic radiation

A distinction is made between electromagnetic field (EMF) of natural (such as the Earth's geomagnetic field) and anthropogenic origin. The intensity of the Earth's natural electric field in the marine environment is around 120 $V \cdot m^{-1}$. During the operation of the proposed Baltica-1 OWF, the electromagnetic radiation (EMF) will come from offshore wind turbines, power cables, OSSs and radio transmitters. The change in the electromagnetic field strength is significant in the vicinity of the cable, but at a distance of 20 m from the cable the field strength does not differ from the ambient strength. The impact of the electromagnetic field can have negative effects, although this depends, among other things, on the distance from the source, the intensity or the time spent in the vicinity of the source [CIEP 2021], as well as on the bird species and its sensitivity to EMF. The matter has so far been first observed in the homing pigeon [Keeton 1971; Mora 2004], followed by several species of songbirds, e.g. the European robin (*Erithacus rubecula*) [Ritz *et al*. 2004; Engels *et al*. 2014] and the Eurasian blackcap (*Sylvia atricapilla*) [Kobylkov *et al*. 2019].

Birds use the Earth's magnetic field for orientation, but the mechanism of detecting this weak interaction is still not fully understood. It has been discovered that European robins lose their ability to use the Earth's magnetic field when they are exposed to low levels of electromagnetic fields in the AM band from about 20 kHz to 20 MHz, the kind generated by electrical and electronic devices [Engels *et al*. 2014]. The results of the Eurasian blackcap survey showed that broadband electromagnetic fields in the 20–450 kHz frequency band disrupted the birds' magnetic compass orientations. It should be noted that, in accordance with the Regulation of the Council of Ministers of 27 December 2013, *on the National Frequency Allocation Table* (consolidated text: Journal of Laws of 2023, item 2518, as amended), this is a band reserved for radio communications at sea and in the air. It is not clear whether sea ducks, auks and gulls use Earth’s magnetism for orientation. In contrast, it has been found that some species of oceanic birds do not use Earth’s magnetism, e.g. migratory snowy albatrosses (*Diomedea exulans*) [Bonadonna *et al*. 2005], or the Cory's shearwater (*Calonectris borealis*) [Gagliardo 2013].

The electromagnetic field disturbances are direct impacts on seabirds that are local, temporary and reversible.

The scale of the impact was assessed as low for all the ecological groups of birds analysed.

A summary of the magnitude assessment of the above mentioned impacts on seabirds during the operation phase of the Baltica-1 OWF is provided in tables below.

Table 10.79. Assessment of the scale of impacts on benthivorous birds in the operation phase

Impact	**Impact characteristics**													**Joint 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**
Habitats occupation	3			3				4					1	11
Barrier effect and risk of collision	3			3				4					1	11
Noise and vibration emissions	3					1		4					1	9
Emission of artificial light	3			3				4					1	11
EMF	3					1					1		1	6

Table 10.80. Assessment of the scale of impacts on piscivorous birds in the operation phase

Impact	**Impact characteristics**													**Joint 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**
Habitats occupation	3					1		4					1	9
Barrier effect and risk of collision	3			3				4					1	11
Noise and vibration emissions	3					1		4					1	9
Emission of artificial light	3				2			4					1	10
EMF	3					1					1		1	6

Table 10.81. Assessment of the scale of impacts on gulls in the operation phase

Impact	Impact characteristics													Joint 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
Habitats occupation			1			1					1		1	4
Barrier effect and risk of collision			1			1					1		1	4
Noise and vibration emissions	3					1					1		1	6
Emission of artificial light	3					1					1		1	6
EMF	3					1					1		1	6

Table 10.82. Assessment of the impact significance on benthivorous birds in the operation phase

Impact	Impact scale	Receptor sensitivity	Impact significance
Habitats occupation	high	high	**Important**
Barrier effect and risk of collision	high	moderate	**Moderate**
Noise and vibration emissions	moderate	high	**Moderate**
Emission of artificial light	high	moderate	**Moderate**
EMF	low	high	**Low**

Table 10.83. Assessment of the impact significance on piscivorous birds in the operation phase

Impact	Impact scale	Receptor sensitivity	Impact significance
Habitats occupation	moderate	moderate	**Moderate**
Barrier effect and risk of collision	high	moderate	**Moderate**
Noise and vibration emissions	moderate	moderate	**Moderate**
Emission of artificial light	high	moderate	**Moderate**
EMF	low	moderate	**Low**

Table 10.84. Assessment of the impact significance on gulls in the operation phase

Impact	Impact scale	Receptor sensitivity	Impact significance
Habitats occupation	irrelevant	low	**Negligible**

Impact	Impact scale	Receptor sensitivity	Impact significance
Barrier effect and risk of collision	irrelevant	low	**Negligible**
Noise and vibration emissions	low	low	**Negligible**
Emission of artificial light	low	low	**Negligible**
EMF	low	low	**Negligible**

10.2.2.9.7 Impact on bats

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 their mortality [Kunz *et al*. 2007; Kepel *et al*. 2011]. Animals struck by rotor blades die from fractures, open wounds, multi-organ injuries or wing amputations [Kepel *et al*. 2011; Horn *et al*. 2008]. The considerable height of wind turbine towers does not protect against collisions. In the UK, the activity of bats from the genera of Nyctalus and Eptesicus at 30 m above the ground was not significantly different from that recorded at ground level [Collins and Jones, 2009]. Sattler and Bontadina [in: Collins and Jones 2009] recorded the signals of flying pipistrelles at an altitude of 150 m, serotine bats at 90 m, and Myotis bats at 30 m above the ground. Bat feeding was recorded there up to a height of 90 m.

It should be noted that collision mortality is further enhanced by unusual bat behaviour. During the migration, the common noctule's flight height of approximately 10 m above the surface of the water was confirmed with the use of a radar. However, each time the bats approached an obstacle (buoy, ship, mast) the flight altitude increased rapidly, up to 100 m. The use of offshore wind turbine towers as a resting place has also been confirmed by finding bats on the turbine nacelles, which has never been recorded on turbines located on land [Ahlen *et al*. 2007; Ahlen *et al*. 2009].

Newly constructed wind turbines can act as attractants for migrating bats in the open sea, 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].

In addition to the direct threat of collisions, actively flying up to the rotor blades (Horn *et al*. 2008) and suffering death from external impact injuries (Klug and Baerwald 2010; Rydell *et al*. 2010), 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 differences in pressure. This results in a decompression phenomenon inflicting barotrauma in bats that enter the area of reduced air pressure behind the mill 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.

The monitoring results indicate that the Baltica-1 OWF Area is used by bats to a small extent during spring migration and to a significant extent during autumn migration, but within a very narrow timeframe.

The Nathusius' pipistrelle and the common noctule are long-distance migrants [Dietz *et al*. 2009], accounting for the majority of such collision victims among European bats on offshore wind farms [Rydell *et al*. 2010]. They are also the species classified as highly vulnerable to collisions with wind turbines [Kepel *et al*. 2011]. The same is true for the northern and the parti-coloured bat found.

It cannot be ruled out that the migration routes of any of the species identified do not pass through the area of the planned offshore wind farm. So far, the surveys of the remaining potential areas, monitoring bat migration over Polish sea areas, have not shown the existence of bat migration corridors within these areas. There is also a lack of surveys into the identification of take off points along the Polish coast. However, the lack of such corridors should not be assumed.

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, but protected under national and international law.

An assessment of the impact scale is provided in Table 10.85 and of its significance in Table 10.86.

Table 10.85. Assessment of the scale of impacts of the Baltica-1 OWF operation phase on bats

Impact	**Impact characteristics**													**Joint 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**
Above-water noise	3					1				3			1	8
Barrier on the flight route	3					1				3		2		9
Mortality as a result of collisions and barotrauma	3			3				4				2		12

Table 10.86. Assessment of the impact significance of the Baltica-1 OWF operation phase on bats

Impact	**Impact scale**	**Receptor sensitivity**	**Impact significance**
Above-water noise	moderate	low	**Low**
Barrier on the flight route	moderate	moderate	**Low**
Mortality as a result of collisions and barotrauma	high	moderate	**Moderate**

10.2.2.9.8 Impact on biodiversity

The impact on biodiversity of the Baltica-1 OWF operation phase will be the cumulative effect of impacts on all plant and animal groups included in this analysis. As individual groups and even taxa have different sensitivities and responses to a given impact, it is not reasonable to define the impact of the Project on biodiversity as such. For this reason, the assessment of impacts on biodiversity is consistent with the results of the analysis of impacts for all groups of flora and fauna presented in Section 10.2.2.

10.2.2.10 Impact on protected areas and the subjects of protection in these areas

During the operation phase of the Baltica-1 OWF, the impacts associated with the emission of high levels of underwater noise will cease and there will be no impact on sensitive harbour porpoises and long-tailed ducks diving in search of food – the subjects of protection in the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308).

The erection of dozens of tall (a maximum of 330 m), above-water wind turbine structures can pose a significant navigational obstacle for the long-tailed duck, the black guillemot and the common eider, while also posing a risk of collision with the turbine rotors in operation. This impact was analysed in the context of the Project impact during its operation phase on migratory birds, which include the species listed above. The impact of the barrier on bird migration was assessed as a negative **negligible** impact and the risk of collision with the OWF structures was assessed as negative **negligible** and **low** for cranes and birds of prey. Although the Baltica-1 OWF Area is located at a distance of at least 2 km from the SE0330308 site, it should be assumed that the impact of the Project on the long-tailed duck, the black guillemot and the common eider should be the same as this assessment, also taking into account that the operation phase will be associated with a long-term impact of up to 35 years.

The presence of submerged and seabed-installed wind turbine structures and OSSs can cause local changes in the formation of sea currents, manifested mainly by their spatial fluctuations and a decrease in their velocity. However, these changes will most likely only affect areas in close proximity to the foundations and towers of the OWF installation due to the fact that the farm development will not be compact – the minimum distance between turbines will be 3.5 m. As a result, the cumulative impact of the development on changing the dynamics of the sea currents is not expected to occur. The use of a scour protection layer around the foundations of wind turbines and OSSs will also effectively eliminate the scouring of seabed sediment through hydrodynamic processes and the formation of secondary suspended solids. Therefore, impacts from changing currents on habitats 1110 and 1170 of the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308) are not expected.

In the context of the integrity and coherence of the SE0330308 site with other Natura 2000 sites (although no such links are indicated in the site's SDF, it appears that its relationship with the Słupsk Bank (PLC990001) should be considered, given the common subjects of protection, 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 impact of the Project on the migration ability of the long-tailed duck, the black guillemot and the common eider. Taking into account the extent of the SE0330308 site and how wide the airspace used by birds is during migrations, it should be assumed that the impact of the operation phase of the OWF on the integrity of the site and its possible link with the PLC990001 site will be of minor importance, but considering the long-term operation of the wind farm, a maximum of 35 years, it should be assessed as an impact of moderate significance.

10.2.2.11 Impact on wildlife corridors

The construction of the Baltica-1 OWF structures and their operation over a period of up to 35 years may cause some restrictions in the movement of birds on a local scale – navigational difficulties of local migrations within the farm area during the wintering period, as well as on an international scale – impact on the preservation of migration routes during spring and autumn migrations. It is anticipated that the development of the farm area will not completely exclude the area from bird movements, but will present a major navigational difficulty and risk of collision with the operating rotors of the wind turbines. For this reason, it was decided that in the context of the impact of the OWF construction on bird migration routes (which are migration corridors, so to speak), the assessment should be the same as the one in Section 10.2.2.9.5. Accordingly, the impact of above-water structures of considerable height on migration was assessed as **negligible** and the risk of collision on moving birds as **negligible** and **low** for cranes and birds of prey.

It should also be considered whether the occurrence of farm structures in the open sea and the occupation of their underwater surfaces by periphyton organisms will allow the spread of alien periphyton species or associated alien vagile organisms in the Baltic. So far, there have been no such so-called ‘stopping points’ in the Central Baltic area for territorial expansion of invasive species. Although the literature cited in Section 10.2.2.9.2 indicates that such a phenomenon may be likely, it is impossible to be estimated at this point. This assumption will be verified during the monitoring surveys, the assumed scope of which (see Section 16) will enable the detection and identification of species that have not yet been recorded in the Baltic Sea. At this stage, this potential impact can be assessed as **negligible**.

10.2.2.12 Impact on cultural heritage

There are no objects of cultural heritage in the Baltica-1 OWF Area and within the range of its impact which could be affected by the Project.

10.2.2.13 Impact on the use and management of the sea basin and tangible property

10.2.2.13.1 Fisheries

The analysis of the value of catches conducted by the fishing industry in the Baltica-1 OWF Area demonstrated a very limited activity of the fleet, both in the area of entire statistical rectangles, which will be only partially occupied by the Project area (0.4% of the total effort of the Polish Baltic fleet), as well as the volume and value of the catches conducted only in the area occupied by the OWF (0.02%). Bearing that in mind, the impact of the Project on **fisheries**, although long-term in nature, will be local and **irrelevant** in terms of scale. The location of the wind farm at a considerable distance from the coastline and outside the routes of fishing vessels leading from the ports to the fishing grounds allows assessing the issue of the **increased distance to the fishing grounds** resulting from the necessity to bypass the farm area as **negligible**.

10.2.2.13.2 Navigation

Operation of the Baltica-1 OWF will probably involve **restrictions on navigation**. Thus far, the Project area has been used mainly by vessels navigating to and from the port of Klaipeda, and to a smaller extent by fishing vessels (see: Section 7.10.2). The commencement of the operation phase works may be accompanied by the implementation of restrictions on the traffic of vessels not involved in the wind farm construction, implemented by a decision of the territorially competent director of maritime office, in line with the provisions of the MSPPSA. This may necessitate the alteration of routes and increase in their length. However, the impact will not be significant and will not result in the exclusion of this route from use. Therefore, the significance of this impact was assessed as **negligible**.

10.2.2.13.3 Prospecting and exploration of mineral resources

During the operation phase of the Baltica-1 OWF, there may be difficulties for the navigation of vessels exploiting the natural aggregate deposit in the Middle Bank. An analysis of the spatial considerations in terms of preserving navigational safety shows the need for changes in the course of the usual shipping routes associated with the exploitation of the Middle Bank deposit. In order to ensure a sustainable use of the marine resources, part of the vessel traffic streams should be diverted, with safety as the determining factor first and then the efficiency of navigation. Table 10.87 provides a list of the proposed changes to the navigation routes, together with a parameter to assess navigation efficiency, and Figure 10.2 illustrates the current routes and the proposed changes to their course.

Table 10.87. List of navigation routes associated with aggregate exploitation in the Baltica-1 OWF Area

Existing routes				Route change	Routes after changes				Difference	
ID	Name	Length [m]	Length [NM]		ID	Name	Length [m]	Length [NM]	[NM]	[%]
1	PLGDN	166420.9	89.9	YES	1	PLGDN1	169519.4	91.5	1.7	1.86%
2	PLGDN	166420.9	89.9	YES	2	PLGDN2	171751.7	92.7	2.9	3.20%
3	PLGDN	166420.9	89.9	YES	3	PLGDN3	167836.8	90.6	0.8	0.85%
4	DESTL	146140.3	78.9	YES	4	DESTL1	146893.9	79.3	0.4	0.52%
5	DKCPH	187108.2	101.0	NO	5	DKCPH	187108.2	101.0	0.0	0.00%

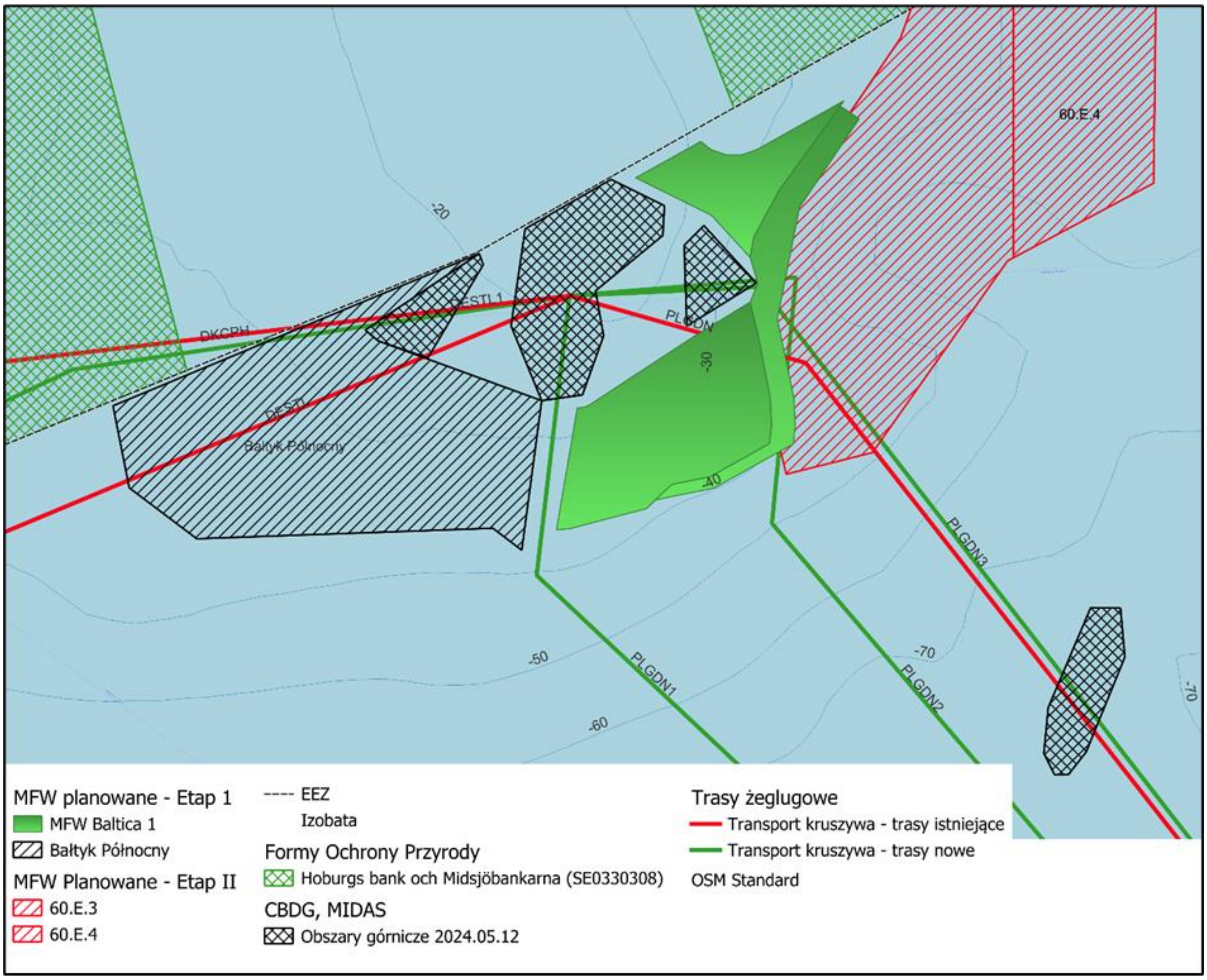


Figure 10.2. Model of aggregate transport route in the vicinity of the Baltica-1 OWF

The changes proposed above are for illustrative purposes to assess the impact of the Project on the conditions of navigation towards the Middle Bank deposit. The actual change in the customary routes will result from the spatial layout of the Baltica-1 OWF and the applicable restrictions on navigation resulting from the decision of the territorially competent director of maritime office. No constraints to the natural aggregate extraction process are expected during the operation phase.

Taking into account the expected minor impact of restrictions on navigation of vessels exploiting the 'Southern Middle Bank – Southern Baltic' deposit and the lack of anticipated restrictions on the process of exploitation of the deposit, the significance of the impact of the Baltica-1 OWF in the operation phase on mineral exploration and extraction was assessed as **negligible**.

10.2.2.14 Impact on landscape, including the cultural landscape

Due to the distance from the shore of at least 75 km, the Baltica-1 OWF will not be visible from the coast, so it will not affect people's subjective perception of space. In the case of the natural landscape, it will be disturbed in the above-water space. In this case, it is difficult to determine the significance of the farm's impact on the landscape because for people, if it is within their field of vision, its perception can be positive as well as negative. Given the disruption to the natural character of the seascape and underwater landscape and the long-term nature of this impact continuing throughout the life of the farm, the impact of the farm on the landscape was assessed as negative **low**.

The development of the Baltica-1 OWF will not affect the cultural landscape (see: definition in Section 7.11).

10.2.2.15 Impact on population, health and living conditions of people

The operation of the Baltica-1 OWF will not directly affect human health and living conditions. It may cause impacts on the existing use of the sea basin, which were assessed in the sections on shipping and fishing – the two most important forms of use of the sea basin in which the Project will be located. Indirectly, the operation of the wind farm will contribute to the development of coastal communes, whose residents may find employment in Project servicing, which can be considered a positive impact. This is one of the objectives of the Sectoral Agreement, but the declarative nature of this document does not indicate legal solutions for its implementation. In the context of this assessment it should be assumed that the impact of the Baltica-1 OWF operation on population, health and living conditions of people will be **negligible** .

10.2.3 Decommissioning phase

10.2.3.1 Impact on geological and geomorphological structure

During the decommissioning phase of the Baltica-1 OWF, its infrastructure elements buried in the seabed (cable lines and parts of foundations) will not be removed. Depending on its structure, the seabed may exhibit different sensitivity to the Project impact in the decommissioning phase. The seabed made of till and till with a stony cover is difficult to wash out and withstands morphological changes. A sandy, sandy-silty, and silty seabed is more susceptible to being washed out and to material moving over it, e.g. in the form of mega-ripples and sand waves. Thus, the elements of the OWF infrastructure left in the seabed may be uncovered or buried as a result of both the natural processes transporting rock material over the seabed and as a result of this transport being disturbed by the remaining components of the OWF infrastructure and changes in the seabed relief resulting from the removal of the OWF infrastructure components.

The assessments of the scale and significance of the impacts on geological structure and seabed relief identified for the Baltica-1 OWF decommissioning phase are contained in Table 10.88 and Table 10.89.

Table 10.88. Assessment of the scale of impacts on geological structure and seabed relief in the Baltica-1 OWF decommissioning phase

Impact	**Impact characteristics**													**Joint 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**
Local changes in seabed relief	3					1					1		1	6

Table 10.89. Assessment of the significance of impacts on geological structure and seabed relief in the Baltica-1 OWF decommissioning phase

Impact	Impact scale	Receptor sensitivity	Impact significance
Local changes in seabed relief	low	low	Negligible

Taking into account the results of the impact assessment, the limited space in which the Project may be located and the possible technologies for its execution, no measures to minimise the negative impact of the Baltica-1 OWF on the geological structure and relief of the seabed are indicated.

10.2.3.2 Impact on seabed sediments

During the decommissioning phase of the Baltica-1 OWF, its infrastructure elements buried in the seabed (cable lines and parts of foundations) will not be removed. Therefore, the Project impact on seabed sediments in terms of their geological character may be assessed as **negligible**.

10.2.3.3 Impact on raw materials and deposits

During the decommissioning phase of the Baltica-1 OWF, its infrastructure elements buried in the seabed (cable lines and parts of foundations) will not be removed. Therefore, the Project impact on raw materials and deposits in terms of their geological character may be assessed as **negligible**.

10.2.3.4 Impact on the seawater and seabed sediment quality

The OWF decommissioning process is complex and it proceeds in the opposite way to the construction stage. At the current stage, decommissioning assumes leaving those components of the farm infrastructure that do not have to be removed completely. It is assumed that the following will remain in the seabed:

- parts of foundations situated below the seabed surface;
- and cable lines.

If some components are left on the seabed, as will be the case with the Baltica-1 OWF, relevant surveys should be carried out to determine whether the remnants of the OWF will not interfere with vessel traffic and will not have a negative impact on biotic and abiotic elements of the environment. It must be ensured that the construction elements left will not start to relocate under the influence of waves, tides, currents and storm surges, posing a risk to marine navigation.

At this stage, there is no risk associated with an increase in sediment temperature as a result of cable line deactivation, nor is there a risk of impacts in the form of contamination by compounds from anti-corrosion agents.

Any impacts on seawater and seabed sediments during the decommissioning phase are expected to be **negligible** at best.

Release of pollutants and nutrients from sediments into water

During the construction of supporting structures and towers, seabed sediment disturbance due to anchoring of vessels will be observed. The anchoring process itself is short-term, affecting a small area (local) to a depth of approximately 3 m, so the volume of the sediment disturbed will be small.

If foundations and/or support structures and cables remain in the seabed sediments, the impact on the quality of sediments and water will be negligible.

The release of pollutants and nutrients from sediments during the decommissioning phase is a direct negative impact of a regional or local range, short-term, reversible, repeatable, and characterised by low intensity.

The significance of this impact in the decommissioning phase in the APV was assessed as **negligible** for the quality of sea waters and seabed sediments.

Contamination of water and seabed sediments with petroleum products during normal operation of vessels and in the case of a breakdown

As a result of intense traffic of ships and vessels during the OWF decommissioning, small oil spills and breakdowns or collisions may occur.

The contamination of seawaters and seabed sediments with petroleum products released during normal operation of vessels is a direct negative impact of a local range, momentary or short-term, reversible, repeatable, and of low intensity.

The significance of this impact during the decommissioning phase in the APV was assessed as negligible for the quality of sea waters and seabed sediments.

The contamination of seawater or seabed sediments with petroleum products released in an accident is a direct negative impact of regional range, which is short-term, reversible, repeatable, and of high intensity.

The significance of this impact in the decommissioning phase in the APV, due to random and sporadic nature of breakdowns and collisions, was assessed as **low** or **moderate** for the quality of sea waters and seabed sediments.

Contamination of water and seabed sediments with antifouling agents

The contamination of water or seabed sediments with anti-fouling substances during the decommissioning phase is a direct negative impact of local or regional range, which is short-term, reversible, repeatable during the construction period, and of low intensity.

The significance of this impact in the decommissioning phase in the APV was assessed as **low** for the quality of sea waters and seabed sediments.

Contamination of water and seabed sediments by accidental release of municipal waste or domestic sewage

The contamination of water or seabed sediments with municipal waste or domestic sewage is a direct negative impact of local range, which is short-term or momentary, reversible, repeatable during the decommissioning period, and of low intensity.

The significance of this impact in the decommissioning phase in the APV was assessed as **negligible** for the quality of sea waters and seabed sediments.

Contamination of water and seabed sediments with accidentally released chemicals and waste from the offshore wind farm decommissioning

During the OWF decommissioning, it seems inevitable that water and seabed sediments will become contaminated with waste from the process. The magnitude of this impact will depend on the implementation method adopted for these works (cf. description of the decommissioning phase), and the greatest pollution may occur in the case of the necessity to crush a GBS.

Waste should be neutralised in accordance with the applicable regulations concerning industrial waste.

Contamination of water or seabed sediments related to the process of OWF decommissioning is a direct negative impact of local range, which is short-term or momentary, non-reversible, repeatable during the construction period, and of moderate intensity.

The significance of this impact at the decommissioning phase in the APV was assessed as negligible for the quality of sea waters and as low for seabed sediments.

Summary of the assessment of the impact on the quality of water and seabed sediment.

Table 10.90 and Table 10.91 present an assessment of the scale and of the significance of impacts on the quality of water and seabed sediments identified for the offshore part of the Baltica-1 OWF in the decommissioning phase.

Table 10.90. Assessment of the scale of impacts on the quality of seawater and seabed sediments during the decommissioning phase of the Baltica-1 OWF in the APV

Impact	**Impact characteristics**													**Joint 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**
Release of pollutants and nutrients from the sediments into the water (for water)	3					1					1		1	6
Release of pollutants and nutrients from the sediments into the water (for sediments)	3					1					1		1	6
Contamination of water and seabed sediments with petroleum products (normal operation of vessels)	3					1				2			1	7
Contamination of water and seabed sediments with petroleum products (emergency situations and collisions)	3			3					3				1	10
Contamination of water and seabed sediments with antifouling agents	3				2					2			1	8

Impact	Impact characteristics													Joint 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**
Contamination of water and seabed sediments by accidental release of municipal waste or domestic sewage	3					1					1		1	6
Contamination of water and seabed sediments with accidentally released chemicals and waste	3					1				2			1	7

Table 10.91. Assessment of the significance of impacts on the quality of seawater and seabed sediments during the decommissioning phase of the Baltica-1 OWF in the APV

Impact	Impact scale	Receptor sensitivity	Impact significance
Release of pollutants and nutrients from the sediments into the water (for water)	low	irrelevant	**Negligible**
Release of pollutants and nutrients from the sediments into the water (for sediment)	low	irrelevant	**Negligible**
Contamination of water and seabed sediments with petroleum products (normal operation of vessels)	low	low	**Negligible**
Contamination of water and seabed sediments with petroleum products (emergency situations and collisions)	high	moderate	**Moderate**
Contamination of water and seabed sediments with antifouling agents	moderate	moderate	**Low**
Contamination of water and seabed sediments by accidental release of municipal waste or domestic sewage	low	irrelevant	**Negligible**
Contamination of water and seabed sediments with accidentally released chemicals and waste	low	moderate	**Low**

Taking into account the results of the impact assessment, the limited space, the scope of dismantling works and the possible technologies for its execution, no measures to minimise the negative impact of the decommissioning of the Baltica-1 OWF on the quality of seawaters and seabed sediments are indicated.

10.2.3.5 Impact on climatic conditions

During the decommissioning phase of the Baltica-1 OWF, the impact of the activities carried out on the climatic conditions of the sea area will be similar to that during its construction, and therefore, it will practically be negligible.

Considering the impact of the Project involving the decommissioning of the OWF on the climatic conditions of the sea area proposed, its influence on two basic atmospheric parameters in the near-water layer should be considered:

- thermal conditions (taking into account the possibility of ice phenomena in winter);
- and wind conditions.

Table 10.92 contains an assessment of the scale of impacts while Table 10.93 contains an assessment of the significance of impacts.

Table 10.92. Assessment of the scale of impacts in the decommissioning phase on the climatic conditions of the near-water atmosphere layer in the vicinity of the Baltica-1 OWF Area

Impact	**Impact characteristics**													**Joint 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**
Change in thermal conditions of the atmosphere.			1			1					1		1	4
Change in wind conditions of the atmosphere	3					1				1			1	6

Table 10.93. Assessment of the significance of impacts in the decommissioning phase on the climatic conditions of the near-water atmosphere layer in the vicinity of the Baltica-1 OWF Area

Impact	**Impact scale**	**Receptor sensitivity**	**Impact significance**
Change in thermal conditions of the atmosphere.	irrelevant	irrelevant	**Negligible**
Change in wind conditions of the atmosphere	low	irrelevant	**Negligible**

Taking into account the results of the impact assessment, the limited space in which the Project may be located and the possible technologies for its execution, no measures to minimise the negative impact of the Baltica-1 OWF on the climatic conditions during farm decommissioning works are indicated.

10.2.3.6 Impact on air and its quality

The impact of the work related to the decommissioning of the Baltica-1 OWF on the air quality in the area of the farm will be comparable to the impact of the work related to its construction and will mainly result from the increased vessel traffic and the related exhaust emissions. If the OWF is fully dismantled after the completion of its operation, exhaust gases residue will be the only substances permanently introduced into the environment.

Considering the impact of the Project involving the decommissioning of a wind farm on air quality within the proposed sea area and around it, it is necessary to consider the impact of exhaust emissions from the vessels involved in decommissioning on the amount of solid and gaseous pollutants in the near-water atmosphere layer:

- increase in particulate matter,
- increase in gaseous pollutants.

Table 10.94 contains an assessment of the scale of impacts while Table 10.95 contains an assessment of the significance of impacts.

Table 10.94. Assessment of the scale of impacts in the decommissioning phase on air quality within the Baltica-1 OWF Area related to exhaust emissions

Impact	**Impact characteristics**													**Joint 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**
increase in particulate matter	3					1				2			1	7
increase in gaseous pollutants	3					1				2			1	7

Table 10.95. Assessment of the significance of impacts in the decommissioning phase on air quality within the Baltica-1 OWF Area related to exhaust emissions

Impact	Impact scale	Receptor sensitivity	Impact significance
increase in particulate matter	low	irrelevant	**Negligible**
increase in gaseous pollutants	low	irrelevant	**Negligible**

Thus, the impact of the proposed Project on the air quality in the decommissioning phase will be temporary, spatially limited, and will virtually cease after the decommissioning works are completed.

10.2.3.7 Impact on ambient noise

The results of ambient noise changes resulting from underwater noise emissions are described in sections relating to the impact of the Project on ichthyofauna, seabirds and marine mammals.

10.2.3.8 Impact on EMF

During the decommissioning phase of the Baltica-1 OWF, power cables and OSSs will be switched off. For this reason, there will be no impacts that could affect the EMF levels in the environment.

10.2.3.9 Impact on animate nature components

10.2.3.9.1 Impact on phytobenthos

The decommissioning phase may involve the removal of support structures of wind turbines and OSSs. In such a case, the macroalgae growing on the structures in the euphotic zone will also be removed, so the original conditions from before the Project implementation will be restored. Restoration of natural conditions is theoretically a positive phenomenon, however, it should be remembered that structural elements overgrown with organisms of flora and fauna will constitute the so-called artificial reef, which locally increases biodiversity and attracts numerous species of nekton fauna. The dismantling of structural elements of the OWF will, thus, result in the loss of the habitat of anthropogenic origin, but significantly shaping the functioning of the local marine ecosystem. Taking into account the fact that the artificial factor will cause a local and relatively long-term (the wind farm operation period may be 35 years) increase in biotic qualitative (taxonomic composition) and quantitative (abundance and biomass) resources of phytobenthos, it should be considered that its removal, despite its artificial origin, will have a negative impact on the marine environment in the region of the proposed OWF. Taking into account the possibility of the presence of species under protection among the macroalgae growing on underwater OWF structures, the sensitivity of this receptor to the impact analysed was assumed to be high.

The assessment of the scale of impact on phytobenthos is contained in Table 10.96, while the assessment of the impact significance – in Table 10.97.

Table 10.96. Assessment of the scale of impact on phytobenthos

Impact	**Impact characteristics**													**Joint 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**
Removal from the water column of the structures which could have been overgrown by phytobenthos	3					1	5					2		11

Table 10.97. Assessment of the significance of impact on phytobenthos

Impact	**Impact scale**	**Receptor sensitivity**	**Impact significance**
Removal from the water column of the structures which could have been overgrown by phytobenthos	high	moderate	**Moderate**

10.2.3.9.2 Impact on macrozoobenthos

During the decommissioning phase of the Baltica-1 OWF in the Applicant Proposed Variant (APV) the following impacts on macrozoobenthos are expected:

- removal from the marine environment of artificial substrates of underwater wind turbine installations – clearing of the 'artificial reef'.

The definition of macrozoobenthos sensitivity is provided in Table 10.18.

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, leaving those elements that are in the seabed as they are (see: Section 4.4.1). The decommissioning process of the OWFs built in Europe is not widespread, hence the experience in carrying out this process from the technical, legal, logistic, economic let alone environmental impact perspective is very limited. In Europe, there are no legal regulations and guidelines that would be adjusted to local environmental conditions and based on the experience gained from the decommissioning of the oil and gas platforms and expert knowledge [Bergstrom *et al*. 2012; Smith and Lamont 2017; Flower *et al*. 2018; Kruse 2019; Topham *et al*. 2019 a and b; Raveling

2020]. The manner of decommissioning of the underwater OWF structures (full or partial removal of foundations, removal of cables or leaving the cables buried in the seabed) is of crucial importance for the impact on the environment and its biotic elements, among others, the benthic fauna.

Removal from the marine environment of artificial substrates of underwater wind turbine installations will result in irreversible, permanent elimination of the periphyton complexes of the 'artificial reef' and destruction of benthos around each foundation and yet another restructuring of the qualitative and quantitative structure of the macrozoobenthos community which inhabited the seabed at this location during several dozen years of the OWF operation. At the current state of knowledge, it is difficult to clearly predict how quickly the environment will return to the state from before the impact of the factor and what nature of this impact (negative or positive) will prevail. Drawing on the experience of the decommissioning of OWF foundations and, above all, oil and natural gas platforms, which began in the past few years, some scientists argue that leaving the underwater installations together with the 'artificial reef' will be more beneficial to the environment because of the maintaining of biodiversity in that area and not depriving it of new resources of ecological value (the positive importance of benthos in the trophic network) and even commercial value (fish). However, it should be taken into account that these scenarios refer to environmental conditions from i.a. sea areas with higher salinity than the Baltic Sea and to an 'artificial reef' forming on lattice foundations [Sommer *et al.* 2016; Flower *et al.* 2018; Topham *et al.* 2019b]. Only the monitoring of the underwater farm installations carried out in the PSA during the operation phase will provide sound scientific evidence against the aforementioned arguments. Currently, it is known that the removal of artificial substrates will result in a reduction in biodiversity and a local reduction in zoobenthos resources that can provide additional food supply for fish and seabirds at this site. On the other hand, the original natural status of seabed habitats in the OWF Area will be restored.

For this impact, moderate sensitivity was assigned to the periphytic fauna and the associated fauna.

Assessment of the scale of impact on hard-bottom macrozoobenthos is provided in Table 10.98. Assessments of the impact significance are provided in Table 10.99.

Table 10.98. Assessment of the scale of impact on hard-bottom macrozoobenthos during decommissioning phase in the APV

Impact	**Impact characteristics**													**Joint 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**
Removal from the marine environment of artificial substrates of underwater wind turbine installations – clearing of the 'artificial reef'	3					1	5					2		11

Table 10.99. Assessment of the significance of impacts on hard-bottom macrozoobenthos during decommissioning phase in the APV

Impact	Impact scale	Receptor sensitivity	Impact significance
Removal from the marine environment of artificial substrates of underwater wind turbine installations – clearing of the 'artificial reef'	high	moderate	Low

The impact assessment carried out for the hard-bottom macrozoobenthos complex during the decommissioning phase indicates that the removal of the artificial reef will be an impact of low significance.

10.2.3.9.3 Impact on ichthyofauna

The decommissioning phase assumes the dismantling of the Baltica-1 OWF, leaving in the environment those of its elements that are in the seabed (cable lines, buried foundation parts). Therefore, a different set of impacts will occur during the decommissioning phase than during the construction phase of the OWF.

Noise and vibration emissions

The effect of the impact shall depend on the size of the structure and the technology of dismantling. The currently available technologies of cutting/fragmentation of structural components are diamond wire cutting and waterjet cutting [Topham and McMillan 2017]. Explosive charges are not expected to be used in the dismantling of the OWF components. In the case of the first two types of technology, there is no information on the noise levels generated, but they will certainly be lower than the levels generated in the construction phase during possible piling. The effect of fish avoiding the area of work is probable. The estimated decommissioning time for the Baltica-1 OWF will be up to 3 years.

Emission of noise and vibrations generated during the removal of the OWF foundation piles may directly affect the ichthyofauna. These will be negative, direct, short-term, and local impacts.

The sensitivity to the impact was assessed to be very high for all the fish species surveyed. The significance of the impact is assessed to be moderate for all the fish species surveyed.

Habitat change

During the decommissioning, a significant part of the artificial reef will be destroyed, which provides the habitat, feeding grounds, shelter and reproduction places for many fish species. This may result in a decrease in the abundance and diversity of ichthyofauna. The end of operation and the removal of elements constituting navigational obstacles will enable fishing in this area. This may reduce the beneficial impact on ichthyofauna of the fishing activities cessation, in particular on the reproduction processes of certain fish species (the common seasnail, gobies).

The concept of leaving at least some of the infrastructural elements is popular in the United States, where the 'rigs to reef' programme is implemented. It involves leaving the oil exploration infrastructure elements in the environment as a substratum enabling the formation of artificial reef [Kaiser and Pulsipher 2005]. Fowler *et al.* (2018) advocate suspending the mandatory complete removal of OWF infrastructure to allow for research into its environmental impacts and role in the ecosystem and allowing for partial removal of OWF elements and then monitoring the environmental impacts after the partial removal. In the case of OWFs, this role could be played primarily by the scour protection elements.

The impact related to the change of habitat will be negative, direct, local, long-term and permanent.

The sensitivity to the impact was assessed to be high for all the fish species examined. The significance of the impact is assessed to be low for all the fish species examined.

The assessment of the scale of impacts is contained in Table 10.100, while the assessment of the impact significance – in Table 10.101.

Table 10.100. Assessment of the scale of impact on marine ichthyofauna

Impact	Impact characteristics													Joint 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
Noise emission	3					1					1		1	6
Habitat change	3					1					1		1	6

Table 10.101. Assessment of the significance of impact on marine ichthyofauna

Impact	Impact scale	Receptor sensitivity	Impact significance
Noise emission	low	very high	**Moderate**
Habitat change	low	high	**Low**

Taking into account the results of the impact assessment, the limited space in which the Project may be located and the possible technologies for its execution, no measures to minimise the negative impact of the Baltica-1 OWF on ichthyofauna are indicated.

10.2.3.9.4 Impact on marine mammals

It is assumed that some of the impacts associated with the decommissioning phase of the Baltica-1 OWF will be similar to the construction phase of the wind farm and may include increased vessel traffic and associated introduction of underwater noise, as well as habitat change and loss of food supply. The vulnerability of marine mammals to the factors listed is likely to be the same as during the construction phase.

Moreover, in the case of the removal of large-diameter monopiles, it is expected that seabed drilling and pile cutting will be carried out. Both processes can be a source of underwater noise with potential impacts on porpoises and seals.

The impact associated with the removal of piles driven into the seabed is not yet well understood in relation to marine mammals, and there is little data available. There are several surveys that have measured the noise generated during pile cutting from wind farms and when drilling into the seabed (from a ship and from oil rigs). The measurements showed the propagation of mainly low-frequency noise [Richardson *et al*. 1998; Kyhn *et al*. 2011; Erbe and McPherson 2017; Hinzmann *et al*. 2017]. It can therefore be assumed that the processes associated with the removal of large-diameter piles will increase locally the intensity of ambient noise in the environment, primarily in relation to low-frequency sounds. Presumably, these conditions will result in an avoidance response from porpoises and seals. Changes in animal behaviour are likely to be short-term and limited to the time of decommissioning works.

A summary of the impact of the decommissioning phase of the Baltica-1 OWF on marine mammals is presented in Table 10.102 and Table 10.103.

Table 10.102. Assessment of the scale of impacts in the decommissioning phase of the Baltica-1 OWF on marine mammals

Animal species/group	Impact	Impact characteristics													Joint 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
Harbour porpoise	Increase in noise level – ship traffic	3					1				2			1	7
	Increase in noise level – drilling	3					1				2			1	7
	Increase in noise level – pile cutting	3					1				2			1	7
	Habitat and food supply change		2				1			3				1	7
Seals	Increase in noise	3					1				2			1	7

Animal species/group	Impact	Impact characteristics													Joint 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
	level – ship traffic														
	Increase in noise level – drilling	3					1				2			1	7
	Increase in noise level – pile cutting	3					1				2			1	7
	Habitat and food supply change		2				1			3				1	7

Table 10.103. Assessment of the significance of impacts in the decommissioning phase of the Baltica-1 OWF on marine mammals

Animal species/group	Impact	Impact scale	Receptor sensitivity	Impact significance
Harbour porpoise	Increase in noise level – ship traffic	low	moderate	Low
	Increase in noise level – drilling	low	moderate	Low
	Increase in noise level – pile cutting	low	moderate	Low
	Habitat and food supply change	low	moderate	Low
Seals	Increase in noise level – ship traffic	low	low	Low
	Increase in noise level – drilling	low	moderate	Low
	Increase in noise level – pile cutting	low	moderate	Low
	Habitat and food supply change	low	moderate	Low

10.2.3.9.5 Impact on migratory birds

The impact on birds during the decommissioning phase is assumed to be similar to the one estimated for the construction phase. Little is known on the impacts occurring in the decommissioning phase since most of OWFs are still operating. Some conclusions can be drawn from the example of the Dutch wind farm, Lely [Lely… 2006], although the nature of the project was different (the wind farm was built on Lake Ijsselmeer). Taking the significance of impacts occurring in the operation phase as a reference point, the scale of impacts during the construction and decommissioning phases should be many times smaller. Taking into account that the decommissioning phase does not have a permanent effect, the barrier in the form of the decommissioned turbines will decrease, and with the decreasing number of turbines, the risk of collision will also gradually decrease. Moreover, during the decommissioning period the turbines will not be used, which further reduces the risk of collisions caused by the movement of the turbine blades. On this basis, the significance of impacts during the decommissioning phase of the Project is assessed similarly to the construction phase as negligible and low.

An assessment of the sensitivity of individual species and species groups is presented in Table 10.104. The assessment of the scale of impacts is presented in Table 10.105.

Table 10.104. Sensitivity of migratory birds to disturbances in the form of a barrier effect and the risk of collisions with construction vessels during the decommissioning phase

Species/group of species	Binomial nomenclature	Receptor value/significance	Resistance to disturbance (barrier effect)	Receptor sensitivity (barrier effect)	Resistance to disturbance (risk of collisions with construction vessels)	Receptor sensitivity (risk of collisions with construction vessels)
Greylag goose	*Anser anser*	Low	High	**Irrelevant**	Moderate	**Low**
Greater white-fronted goose	*Anser albifrons*	Low	High	**Irrelevant**	Moderate	**Low**
Common wood pigeon	*Columba palumbus*	Low	High	**Irrelevant**	High	**Irrelevant**
Common swift	*Apus apus*	Low	High	**Irrelevant**	High	**Irrelevant**
Eurasian curlew	*Numenius arquata*	Low	Moderate	**Low**	Moderate	**Low**
Whooper swan	*Cygnus cygnus*	Low	High	**Irrelevant**	High	**Irrelevant**
Long-tailed duck	*Clangula hyemalis*	High	High	**Low**	High	**Low**
Common scoter	*Melanitta nigra*	Moderate	High	**Low**	High	**Low**
Little gull	*Hydrocoloeus minutus*	Moderate	Moderate	**Low**	Moderate	**Low**
Lesser black-backed gull	*Larus fuscus*	Low	Moderate	**Low**	High	**Irrelevant**
Black-throated diver	*Gavia arctica*	Low	High	**Irrelevant**	High	**Irrelevant**
Goosander	*Mergus merganser*	-	High	**Irrelevant**	High	**Irrelevant**
Greater scaup	*Aythya marila*	Low	High	**Irrelevant**	High	**Irrelevant**
Eurasian skylark	*Alauda arvensis*	Low	High	**Irrelevant**	High	**Irrelevant**
Eurasian wigeon	*Mareca penelope*	Low	High	**Irrelevant**	High	**Irrelevant**
Red-breasted merganser	*Mergus serrator*	-	High	**Irrelevant**	High	**Irrelevant**
Velvet scoter	*Melanitta fusca*	High	High	**Irrelevant**	High	**Irrelevant**
Common crane	*Grus grus*	High	Moderate	**Moderate**	Moderate	**Moderate**
Auks	*Alcidae*	Low	High	**Irrelevant**	High	**Irrelevant**
Carnivorans	*Accipitriiformes*	Moderate	Moderate	**Moderate**	Moderate	**Moderate**
Geese	*Anserinae*	Low	Moderate	**Low**	Moderate	**Low**
Swans	*Cygnidae*	Low	High	**Irrelevant**	High	**Irrelevant**
Gaviiformes	*Gaviidae*	Low	High	**Irrelevant**	High	**Irrelevant**
Terns	*Sternidae*	Low	High	**Irrelevant**	High	**Irrelevant**
Charadriiformes	*Charadriidae*	Low	Moderate	**Low**	Moderate	**Low**

Species/group of species	**Binomial nomenclature**	**Receptor value/significance**	**Resistance to disturbance (barrier effect)**	**Receptor sensitivity (barrier effect)**	**Resistance to disturbance (risk of collisions with construction vessels)**	**Receptor sensitivity (risk of collisions with construction vessels)**
Owls	*Strigiformes*	Low	Moderate	**Low**	Moderate	**Low**
Passerines	*Passeriformes*	Low	High	**Irrelevant**	High	**Irrelevant**
Skuas	*Stercorariidae*	Low	High	**Irrelevant**	High	**Irrelevant**

Table 10.105. Assessment of the scale of impacts on migratory birds during the decommissioning phase

Impact	**Impact characteristics**													**Joint 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**
Barrier effect	3					1					1		1	6
Collisions with construction vessels and structures erected	3					1				2		2		8

Barrier effect and collisions with vessels were classified as direct impacts, due to the fact that the presence of erected structures as well as construction vessels can directly alter the flight trajectory of migratory birds or cause collisions. The range of these impacts is considered to be local because, if impacts do occur, they will be confined to a small area where decommissioning works will be conducted at that time. The temporal extent of the barrier effect was considered temporary and in the case of collisions – short-term. The barrier effect is reversible in nature as it disappears with the discontinuation of construction works, while collisions, due to the 100% mortality of birds in the event of a collision, are considered irreversible. Based on the analysis of impacts during the construction phase, the scale of the barrier effect was considered to be low and the scale of collisions with vessels to be moderate.

The significance of impacts on migratory birds during the decommissioning phase was considered negligible for receptors with irrelevant and low sensitivity to both impacts, and low in the case of collisions with construction vessels for receptors with low and moderate sensitivity [Table 10.106].

Table 10.106. Assessment of the significance of impact on migratory birds during the decommissioning phase

Impact	**Impact scale**	**Receptor sensitivity**	**Impact significance**
Barrier effect	low	irrelevant	**Negligible**
Barrier effect		low	**Negligible**
Collisions with construction vessels and structures erected	moderate	irrelevant	**Negligible**
		low	**Low**
		moderate	**Low**

10.2.3.9.6 Impact on seabirds

The OWF impact on the marine avifauna in the decommissioning phase shall be similar to the one in the construction phase of the proposed Project. The factors identified and the assessment of their impact on the marine avifauna in the decommissioning phase are presented below.

Habitats occupation

The impacts associated with the decommissioning of the Baltica-1 OWF on seabirds will be associated with the dismantling of offshore wind turbines and OSSs. With the gradual decommissioning of the above-water structures, the negative impact involving the scaring away of the birds from the area occupied by the structures protruding high above the water shall decrease. An increased traffic of vessels and the noise related to the disassembly of the farm shall continue to disturb the birds. However, it is to be expected that once all the turbines and OSSs have been completely removed, birds will gain access to the rich benthic resources developed during the lifetime of the facility, or partially destroyed and rebuilt during its decommissioning. The benthivorous birds have a very strong impact on the population of their prey, leading to a significant reduction in the prey abundance and biomass [Guillemette 1996; Lewis 2007]. The decrease in the abundance of birds in the area occupied by the offshore wind turbines during their operation shall result in a high zoobenthos biomass, since their populations shall not be exploited by birds as much as would be the case during their normal presence in the sea area. This effect shall probably be temporary in nature, however, it is difficult to predict for how long the area left after the OWF removal shall constitute an attractive feeding ground for this group of birds.

Barrier effect and risk of collision

The installation structures during the dismantling works of the OWF, and the presence of vessels carrying out dismantling works, will be a source of negative impacts on seabirds. The vessels will disturb seabirds through their physical presence, noise and light emissions. The impact characteristics will be similar to the one in the Project construction phase. The impact shall gradually decrease with the progress of dismantling works.

Collisions between birds and vessels used during the dismantling of the Baltica-1 OWF may also occur, mainly at night or during unfavourable weather conditions (mist, high cloud cover) when birds are attracted by the emitted light. The impact scale will depend on the number of vessels involved at that stage, their size, the configuration of light and their intensity, construction duration and the phenological period, in which the work is carried out. As during the construction and operation phases of the Project, the presence of ships will lead instead to a greater presence of gulls.

The increased vessel traffic associated with dismantling works is a direct, long-term and reversible impact on benthivorous and piscivorous birds. In the case of gulls, this will be an indirect, short-term and reversible impact. The extent of the impact was assessed as transboundary for benthivorous birds, regional for piscivorous birds and local for gulls.

The impact scale on gulls was assessed as low and on the piscivorous and benthivorous birds as high.

Emission of artificial light

During migration, birds navigate in relation to natural light sources such as stars and the sun. Illumination of the dismantling work site as well as the operation, movement and presence of ships will be a source of artificial light. Nevertheless, the impact characteristics will be similar to those at the construction stage of the Project, yet it will gradually decrease as the dismantling progresses.

The illumination of the Project site during the dismantling works will result in a direct impact on seabirds, of local range for gulls, regional for piscivorous birds and transboundary for the long-tailed duck (due to the possible impact on the biogeographical population of the species). The impact will be medium-term and reversible. The impact scale on benthivorous birds was assessed as high and on the piscivorous birds and gulls as moderate.

Noise and vibration emissions

The works associated with the dismantling of the Baltica-1 OWF, will be a source of noise emissions, both underwater and above-water as well as vibrations. The impact characteristics will be smaller than during the Project construction phase – there will be no piling, but the cutting of farm components protruding above the seabed and will gradually decrease as the dismantling works progress.

Noise and vibration emissions during dismantling works are a direct impact on benthivorous and piscivorous birds, regional in scope, short-term and reversible. No significant impact on gulls is anticipated. The presence of vessels will be a factor in attracting the above-mentioned group of birds, which seek food in the vicinity of the vessels. In addition, stunned or dead fish, due to noise and vibration emissions, can provide a rich and easily accessible food source for gulls. Gulls have long benefited from the availability of large quantities of scraps and offal removed from fishing boats, which they actively seek out [Garthe *et al*., 1996]. This phenomenon may have contributed to the rapid population growth of some of the seabirds [Dunnet *et al*. 1990, Lloyd *et al*. 1991].

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

A summary of the magnitude assessment of the above mentioned impacts on seabirds during the decommissioning phase of the Baltica-1 OWF is provided in tables below.

Table 10.107. Assessment of the scale of impacts on benthivorous birds in the decommissioning phase

Impact	Impact characteristics													Joint 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
Habitats occupation	3					1			3				1	8
Barrier effect and risk of collision	3			3				4					1	11
Emission of artificial light	3			3					3				1	10
Noise and vibration emissions	3				2					2			1	8

Table 10.108. Assessment of the scale of impacts on piscivorous birds in the decommissioning phase

Impact	**Impact characteristics**													**Joint 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**
Habitats occupation	3					1					1		1	6
Barrier effect and risk of collision	3				2			4					1	10
Emission of artificial light	3				2				3				1	9
Noise and vibration emissions	3				2					2			1	8

Table 10.109. Assessment of the scale of impacts on gulls in the decommissioning phase

Impact	**Impact characteristics**													**Joint 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**
Habitats occupation		2				1					1		1	5
Barrier effect and risk of collision		2				1				2			1	6
Emission of artificial light	3					1			3				1	8
Noise and vibration emissions		2				1					1		1	5

Table 10.110. Assessment of the significance of impacts on benthivorous birds in the decommissioning phase

Impact	**Impact scale**	**Receptor sensitivity**	**Impact significance**
Habitats occupation	moderate	high	**Moderate**
Barrier effect and risk of collision	high	moderate	**Moderate**
Emission of artificial light	high	moderate	**Moderate**
Noise and vibration emissions	moderate	high	**Moderate**

Table 10.111. Assessment of the significance of impacts on piscivorous birds in the decommissioning phase

Impact	Impact scale	Receptor sensitivity	Impact significance
Habitats occupation	low	moderate	**Low**
Barrier effect and risk of collision	high	moderate	**Moderate**
Emission of artificial light	moderate	moderate	**Moderate**
Noise and vibration emissions	moderate	moderate	**Moderate**

Table 10.112. Assessment of the significance of impacts on gulls in the decommissioning phase

Impact	Impact scale	Receptor sensitivity	Impact significance
Habitats occupation	irrelevant	low	**Negligible**
Barrier effect and risk of collision	low	low	**Negligible**
Emission of artificial light	moderate	low	**Low**
Noise and vibration emissions	irrelevant	low	**Negligible**

10.2.3.9.7 Impact on bats

Impacts resulting from the decommissioning of the Project will be similar to those resulting from its construction. Similarly, any impact of underwater works can be ignored. Potential impacts may arise from works and activities carried out on the sea surface. The decommissioning of the wind farm will certainly involve an increased presence of vessels. The impacts resulting from the works and the presence of vessels are described in Section 10.2.1.9.7.

An assessment of the scale of the impact is provided in Table 10.113 and an assessment of its significance in Table 10.114.

Table 10.113. Assessment of the scale of impacts of the Baltica-1 OWF decommissioning phase on bats

Impact	Impact characteristics													Joint 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
Above-water noise	3					1				2			1	7

Table 10.114. Assessment of the significance of impacts of the Baltica-1 OWF decommissioning phase on bats

Impact	Impact scale	Receptor sensitivity	Impact significance
Above-water noise	low	low	**Negligible**

10.2.3.9.8 Impact on biodiversity

The impact on biodiversity of the Baltica-1 OWF decommissioning phase will be the cumulative effect of the impacts on all plant and animal groups included in this analysis. As individual groups and even taxa have different sensitivities and responses to a given impact, it is not reasonable to define the impact of the Project on biodiversity as such. Therefore, the assessment of impacts on biodiversity is consistent with the results of the impact analysis for all flora and fauna groups presented in Section 10.2.3.

10.2.3.10 Impact on protected areas and the subjects of protection in these areas

The decommissioning of the Baltica-1 OWF by dismantling its infrastructure will free up the above-water and on the water space occupied throughout the entire operation phase. The impacts affecting the migration and local flight of birds will therefore disappear. Leaving cable lines and foundations buried in the seabed will allow for the avoidance of high levels of underwater noise and the formation of suspended solids. Therefore, there will be a significant reduction in the spatial extent of the impacts of the decommissioning phase compared to the construction phase. The impact of the decommissioning phase on the bird sanctuaries of the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308) could theoretically result in their disturbance as a result of the presence of vessels involved in the decommissioning works, but due to the distance of at least 2 km between the Project area and the boundary of the SE0330308 site this is unlikely. In the case of the harbour porpoise, it is likely that the southern part of the Natura 2000 site may be affected by underwater noise emitted during the cutting of towers above the seabed sediment. This will not be an impact that could cause TTS and PTS in porpoises in the Natura 2000 site, but the effect of scaring (behavioural response) cannot be ruled out. Certainly out of the range of the impacts will be habitats 1110 and 1170, located, according to the conservation plan for the site SE0330308 in its central part, at a distance of about 40 km from the boundary of the Baltica-1 OWF Area.

An assessment of the scale of the impact is provided in Table 10.115 and an assessment of its significance in Table 10.116.

During the decommissioning phase of the Baltica-1 OWF, there will be no impacts that could affect the integrity and coherence of the Natura 2000 sites.

Table 10.115. Assessment of the scale of impacts of the Baltica-1 OWF decommissioning phase on Natura 2000 site Hoburgs bank och Midsjöbankarna (SE0330308)

Impact	**Impact characteristics**													**Joint 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 of underwater noise scaring away the harbour porpoise	3					1				2			1	7

Table 10.116. Assessment of the significance of impacts of the Baltica-1 OWF decommissioning phase on protected areas Hoburgs bank och Midsjöbankarna (SE0330308)

Impact	Impact scale	Receptor sensitivity	Impact significance
Impact of underwater noise scaring away the harbour porpoise	low	high	Low

The decommissioning of the Project will not directly affect the subjects of protection, integrity and coherence with other areas of the Natura 2000, *Ławica Słupska* site (PLC990001). However, the dismantling of the Baltica-1 OWF above-water installation will improve passages along migration routes, so this can be considered a positive **low** impact.

10.2.3.11 Impact on wildlife corridors

The removal of above-water and underwater installations will remove navigational obstacles for migrating animals. Marine organisms will not be significantly affected due to the large distances between the foundations of the farm structures. In the case of migrating birds and bats, the effect of removing the turbines will disable the impact of navigational obstacles to their migration and eliminate the risk of collision with the operating turbines. It will therefore be a positive impact. During decommissioning works, however, the significance of the impact on ecological corridors will be the same as the impact on migratory birds during the decommissioning phase, i.e. **low**.

10.2.3.12 Impact on cultural heritage

There are no objects of cultural heritage in the Baltica-1 OWF Area nor within the range of its impact which could be affected by the Project decommissioning phase.

10.2.3.13 Impact on the use and management of the sea area and tangible property

10.2.3.13.1 Fisheries

The analysis of the value of catches conducted by the fishing industry in the Baltica-1 OWF Area demonstrated a very limited activity of the fleet, both in the area of entire statistical rectangles, which will be only partially occupied by the Project area (0.4% of the total effort of the Polish Baltic fleet), as well as the volume and value of the catches conducted only in the area occupied by the Baltica-1 OWF (0.02%). Bearing that in mind, the impact of the Project on **fisheries**, although long-term in nature, will be local and **negligible** in terms of scale. The location of the wind farm at a considerable distance from the coastline and outside the routes of fishing vessels leading from the ports to the fishing grounds allows assessing the issue of the **increased distance to the fishing grounds** resulting from the necessity to bypass the farm area as **negligible**. In the case of the period after the decommissioning of the farm, the renewal of fishing opportunities will be a positive impact.

10.2.3.13.2 Navigation

The decommissioning of the Baltica-1 OWF is likely to involve restrictions on navigation due to the presence of vessels involved in the dismantling work. The commencement of the decommissioning phase works may be accompanied by the implementation of restrictions on the traffic of vessels not involved in the wind farm decommissioning, implemented by decision of the territorially competent Director of the Maritime Office. However, the impact will not be significant and will not result in the exclusion of this route from use. Therefore, the significance of this impact was assessed as **negligible**.

Once the decommissioning phase is complete, the original traffic on the shipping route will be restored.

10.2.3.13.3 Prospecting and exploration of mineral resources

The decommissioning of the Baltica-1 OWF is likely to involve restrictions on the navigation of vessels involved in the exploitation of the 'Southern Middle Bank – Southern Baltic' deposit, resulting from the dismantling of the Project's structures. The commencement of the decommissioning phase works may be accompanied by the implementation of restrictions on the traffic of vessels not involved in the wind farm decommissioning, implemented by decision of the territorially competent Director of the Maritime Office. However, the impact will not be significant and will not result in a significant reduction in the navigation of vessels exploiting the deposit. The decommissioning phase will also have no impact on the process of deposit exploitation. Therefore, the significance of this impact was assessed as **negligible**. Once the decommissioning phase is complete, the original traffic on the usual shipping routes leading to the Middle Bank will be restored.

10.2.3.14 Impact on landscape, including the cultural landscape

The decommissioning of underwater and above-water components will result in the restoration of the natural landscape of this part of the Baltic Sea area. In this view, it will be an impact with **a positive effect of low importance**. There will be no impact on the cultural landscape (see definition in Section 7.11).

10.2.3.15 Impact on population, health and living conditions of people

Decommissioning of the Baltica-1 OWF will not directly affect human health and living conditions. It may cause impacts on the existing use of the sea basin, which were assessed in sections on shipping and fishing – the two most important forms of use of the sea basin in which the Project will be located. Indirectly, the decommissioning of the farm may contribute to a decline in the employment of the residents of the coastal municipalities who were employed to support this investment, which can be considered a negative impact. In the context of this assessment it should be assumed that the impact of the Baltica-1 OWF decommissioning will be **negligible** from the perspective of the population, health and living conditions of people.

10.3 Assessment of the Reasonable Alternative Variant (RAV) impact

Below is the environmental impact assessment of the Baltica-1 OWF in the Reasonable Alternative Variant, in all phases of the Project. Given the similar envelope technical parameters of the APV and RAV:

- APV: construction of up to 60 turbines with a capacity of 15 MW each, and up to 4 OSSs, i.e. a maximum of 64 structures in total, and construction of cable lines with a total maximum length of 140 km,
- RAV: construction of up to 64 turbines with a capacity of 14 MW each, and 5 OSSs, i.e. a maximum of 69 structures in total, and construction of cable lines with a total maximum length of 150 km,

a very large proportion of impacts are characterised by the same assessment of their significance for both variants. Theoretically, an important difference in the assessment of the scale, and consequently the significance of the impacts, is the surface area of the seabed covered by underwater works, i.e. the seabed area occupied by the foundations of the wind turbines, OSSs and jack-up vessel support legs as well as the surface area covered by the cable line construction works. Therefore, interference in the seabed over a larger area in the RAV may result in a greater impact on those environmental components that will be directly affected and, importantly, will not be able to defend themselves from the impact, e.g. by leaving the area affected by the impact. This particularly applies to macrozoobenthos, but it is also important to determine whether a difference in the surface area of the seabed covered by underwater works may result in a considerably greater impact on the natural character of the seabed. A larger surface area and hence greater volume of disturbed seabed sediment will result in larger loads of contaminants released into the water column, which may consequently also affect the assessment of water quality and seabed sediment status.

10.3.1 Construction phase

10.3.1.1 Impact on geological and geomorphological structure

The differences between the APV and the RAV are irrelevant for geological issues. The assessment of the significance of the impact of wind turbines in the Baltica-1 OWF Area on the seabed in the APV is identical to the assessment in the RAV. Changes within the seabed associated with the impact of the Project during the construction phase are of a local nature and, in the scale of the entire area occupied by the Project, insignificant for the overall seabed character and its structure.

The identified impacts on ichthyofauna and the assessment of their significance are identical to the results of the analysis for the APV, i.e. they are **negligible** in each case.

It should be noted that despite the impact significance being the same as in the APV, its strength (while still maintaining this assessment) will be greater in the RAV due to a greater seabed area taken for foundations as well as larger number of OSSs and greater volume of sediment shifted.

10.3.1.2 Impact on seabed sediments

The differences between the APV and the RAV are irrelevant for geological issues. The total seabed surface covered by underwater works in the RAV will be a maximum of 3.68 km^2, i.e. a maximum of 4.30% of the Baltica-1 OWF Area, while in the APV it will be a maximum of 3.57 km^2 and a maximum of 4.17%, respectively. The impacts identified and the significance assessment of the Baltica-1 OWF impact on the seabed during the construction phase in the RAV are the same as for the APV, i.e. **negligible**. Changes within the seabed associated with the impact of the Project during the construction phase are of a local nature and, in the scale of the entire area occupied by the Project, insignificant for the overall seabed character and its structure.

10.3.1.3 Impact on raw materials and deposits

The differences between the APV and the RAV are irrelevant for geological issues. The assessment of the significance of the Baltica-1 OWF impact on the seabed in the APV is identical to the assessment in the RAV, i.e. **negligible**. Changes within the seabed associated with the impact of the Project during the construction phase are of a local nature and, in the scale of the entire area occupied by the Project, insignificant for the overall seabed character and its structure.

10.3.1.4 Impact on the quality of seawater and seabed sediments

Seawater and seabed sediments as receptors of the proposed Project impact were analysed jointly in terms of mutual physico-chemical interactions.

This subsection considers the OWF impact on the quality of water and seabed sediments during the implementation of the RAV, identical to that in Section 10.2.1.4.

Release of pollutants and nutrients from sediments into water

At the Baltica-1 OWF construction stage, the seabed sediments will be disturbed by the installation of foundations and cable lines, which will lead to the agitation of sediments as well as pollutants and nutrients present in them and their transfer into the water column. In the case of gravity based structures, the seabed will be prepared by dredging and levelling the substrate. The impact will occur during the construction period and during the preparation of the seabed. More extensive descriptions, common to the APV and the RAV, are provided in Section 10.2.1.4.

The most far-reaching scenario in the RAV is the use of gravity based structures. Their construction requires preparation of the seabed, which may involve the removal of a layer of seabed sediments, not only in the location of the foundation and/or support structure but also in its direct vicinity. The volume of the sediment stirred for that technology is presented in Table 10.7 In the case of other technologies analysed (large-diameter monopile, lattice structure, or jacket foundation), the volume of sediment disturbed will be many times smaller, because in most cases these structures do not require seabed preparation and also the diameter of the foundation piles driven will be many times smaller than the diameter of gravity based structures. The sediment around the piles driven will liquefy as a result of vibrations caused by the operation of the pile driver.

An example calculation of the amount of sediment disturbed for a monopile with a diameter of 11.00 m is presented below. Given that the piles of such diameter will be driven several dozen metres into the seabed, it can be assumed that sediments deposited at the depth of approx. 1 m will be disturbed within a radius of approx. 3 m from the pile. The volume of sediment disturbed during pile driving into the seabed was calculated using the following formula:

$$V_a = V_{tr\ cone} - V_{cyll.}$$

where:
V_a – volume of the sediment layer disturbed during pile driving into the seabed,
$V_{tr\ cone}$ – volume of the truncated cone,
$V_{cyll.}$ – volume of the cylinder.

Once the values are substituted in the formula, the volume of sediment disturbed during the driving of one pile into the seabed amounts to approx. 61 m^3 of sediment per foundation and/or support structure, i.e. 3904 m^3 of seabed sediments will be disturbed during the installation of 64 monopile structures planned in the RAV.

The most far-reaching scenario is the application of the PLB technology in cable laying.

Seabed sediment will be disturbed during cable laying. The maximum width of the seabed strip covered by the construction works for a single cable line will be 16 m, which corresponds to the maximum spacing of the tracks of the equipment used for cable line construction.

However, the main disturbance of the sediment will take place to an average depth of 3 m and a width of 5 m using ploughing technology and to a maximum depth of 6 m and a width of 1 m using jetting technology. The cable line length during cable laying in the RAV will be 150 km. Using ploughing technology, the volume of the sediment disturbed will be 1 350 000 m^3, while using jetting technology – 900 000 m^3.

On the basis of the above assumptions and the concentration of pollutants and nutrients found in the OWF Area (see: Section 7.1.4) the volume of their emission into the water in the RAV was estimated.

The most far-reaching scenario in the RAV is the use of gravity based structures. Their construction requires the preparation of the seabed, which may involve the removal of a layer of seabed sediments, not only in the location of the foundation.

The calculations assume an average dry sediment density of 1.6 g·cm^{-3} (1600 kg·m^{-3}) and an average sediment moisture content of 23.3%. For the purpose of calculations, the volume of sediments necessary to be removed for the correct installation of a gravity based structure (the most unfavourable variant) was adopted, i.e. 22 000 m^3 (RAV).

In addition, envelope calculations were carried out in the situation of seabed preparation for the installation of jack-up vessels at the location. This will involve replacing the surface sediment with an aggregate bedding layer. Such replacement will be required for each of the four jack-up ‘legs’. For each leg, up 19 000 m^3 of sediment will be disturbed. The following are the calculations taking into account the volume of sediment disturbed for both the gravity based structures and the substations in the RAV (construction phase) including the disturbance of the seabed for a jack-up vessel [Table 10.118].

To calculate the weight of pollutants, which may be transferred into the water during cable line construction, the most unfavourable variant from the point of view of the potential for generating suspended solids was adopted, i.e. the method of creating a trench using directed water jets, which can disturb 6000 m^3 of sediment per 1 km of cable and the ploughing method of cable laying adopted as the preferred one, which will disturb smaller volume of sediment per one linear kilometre of the cable, i.e. 7500 m^3.

The estimated amount of heavy metals, pollutants and nutrients that may be released in the RAV during its implementation as part of the Baltica-1 OWF project is included in Table 10.117.

In the case of indicators, the concentration of which during the environmental surveys conducted was below the lower limit of quantification (LOQ) of the survey methods applied to calculate the load (for illustrative purposes), the values of this limit (marked with '<' in the table) were adopted.

Table 10.117 also presents, for comparison purposes, the loads annually entering the Baltic Sea with the rivers of Poland and with precipitation [Uścinowicz 2011; GUS 2023]. The results of the State Environmental Monitoring carried out by CIEP in the years 2003–2012 were also used. As it was shown, the estimated results obtained for the re-mobilisation of individual indicators are insignificant. In the case of aluminium, which is a metalloid and a macronutrient, due to its relatively low solubility in the range of pH prevailing in sea waters, the released part of this element during the disturbance of seabed sediments into the water depths will be relatively quickly sorbed by the seabed sediments. However, this part of aluminium may be activated as the acidity of the water increases [Kabata-Pendias and Pendias 1993; Uścinowicz 2011].

Table 10.117. Comparison of the mass of pollutants and nutrients that may be released into water during the sediment disturbance while laying the foundations for wind turbines and OSSs as well as the cable line construction in the RAV (construction phase) with the load entering the Baltic Sea through rivers and precipitation

Parameter	One gravity based structure (GBS) for 14 MW turbine	RAV (64 foundations)	1 OSS	5 OSSs	1 km of cable (burial by ploughing)	Cable routes (150 km)	1 km of cable (burial by jetting)	Cable routes (150 km)	Annual load entering the Baltic Sea through rivers	Annual load entering the Baltic Sea through precipitation
Volume of the sediment disturbed	22 000 m³	1 408 000 m³	40 000 m³	200 000 m³	7500 m³	1 125 000 m³	6000 m³	900 000 m³	No data available	No data available
Weight of the sediment disturbed	27 010 Mg	1 728 641 Mg	49 109 Mg	245 546 Mg	9208 Mg	1 381 194 Mg	7365.6 Mg	1 104 840 Mg	No data available	No data available
Dry weight of the sediment disturbed	20 726 Mg	1 326 438 Mg	37 683 Mg	188 415 Mg	7065.5 Mg	1 059 832 Mg	5652.8 Mg	847 920 Mg	No data available	No data available
Lead (Pb)	51 kg	3 276 kg	93 kg	465 kg	17.5 kg	2618 kg	13.6 kg	2040 kg	24 000 kg	200 000 kg
Copper (Cu)	21.3 kg	1 366 kg	39 kg	194 kg	7.3 kg	1092 kg	5.84 kg	876 kg	112 000 kg	No data available
Chromium (Cr)	20.7 kg	1 326 kg	38 kg	188 kg	7.1 kg	1060 kg	5.68 kg	852 kg	No data available	No data available
Zinc (Zn)	145.3 kg	9 298 kg	264 kg	1321 kg	49.5 kg	7429 kg	39.2 kg	5880 kg	122 000 kg	No data available
Nickel (Ni)	22.4 kg	1433 kg	41 kg	203 kg	7.6 kg	1145 kg	6.1 kg	916 kg	687 000 kg	No data available
Cadmium (Cd)	<1.0 kg	<66 kg	<1.9 kg	<9.4 kg	<0.4 kg	<53 kg	0.32 kg	48 kg	2 300 kg	7 100 kg
Mercury (Hg)	<0.2 kg	<13.3 kg	<0.4 kg	<1.9 kg	<0.07 kg	<10.6 kg	0.056 kg	8.4 kg	2 100 kg	3 400 kg
Arsenic (As)	<25.9 kg	<1 658 kg	<47 kg	<236 kg	<8.8 kg	<1325 kg	7.04 kg	1056 kg	No data available	No data available
Aluminium (Al)	12 290 kg	786 578 kg	22 346 kg	111 730 kg	4190 kg	628 480 kg	3352 kg	502 800 kg	No data available	No data available
PCB congeners	<0.010 g	<0.663 g	<0.019 g	<0.094 g	<0.004 g	<0.53 g	0.0032 g	0.48 g	260 000 g	715 000 g
PAH analytes (PAH group)	23.8 g	1 525 g	43.3 g	217 g	8.1 g	1219 g	6.48 g	972 g	No data available	No data available
Available phosphorus (P)	1828.0 kg	116 992 kg	3 324 kg	16 618 kg	623.2 kg	93 477 kg	498.4 kg	74 760 kg	9 500 000 kg (P tot.)	163 000 000 kg
Nitrogen (N)	<414.5 kg	<26 529 kg	<754 kg	<3 768 kg	<141 kg	<21 197 kg	112.8 kg	16 920 kg	136 000 000 kg (N tot.)	5 700 000 kg

Table 10.118. Comparison of the mass of pollutants and nutrients that may be released into water during the seabed disturbance while laying the foundations for wind turbines and OSSs in the RAV (construction phase), including the disturbance of the seabed for a jack-up vessel, with the load entering the Baltic Sea through rivers and precipitation

Parameter	**RAV (60 foundations, 5 OSSs, ground improvements with aggregate for each of the 4 legs of a jack-up vessel)**	**Annual load entering the Baltic Sea through rivers**	**Annual load entering the Baltic Sea through precipitation**
Volume of the sediment disturbed	4 268 000 m^3	no data available	no data available
Weight of the sediment disturbed	5 239 943 Mg	no data available	no data available
Dry weight of the sediment disturbed	4 020 766 Mg	no data available	no data available
Lead (Pb)	9 931 kg	24 000 kg	200 000 kg
Copper (Cu)	4 141 kg	112 000 kg	no data available
Chromium (Cr)	4021 kg	no data available	no data available
Zinc (Zn)	28 186 kg	122 000 kg	no data available
Nickel (Ni)	4 383 kg	687 000 kg	no data available
Cadmium (Cd)	<201 kg	2300 kg	7100 kg
Mercury (Hg)	<40.2 kg	2100 kg	3400 kg
Arsenic (As)	<5 026 kg	no data available	no data available
Aluminium (Al)	2 384 314 kg	no data available	no data available
Congeners from the PCB group	<2.01 g	260 000 g	715 000 g
Analytes from the PAHs group	4 624 g	no data available	no data available
Available phosphorus (P)	354 632 kg	9 500 000 kg (P tot.)	163 000 000 kg
Nitrogen (N)	<80 415 kg	136 000 000 kg (N tot.)	5 700 000 kg

Other types of impacts identified for the RAV, i.e.:

- contamination of water and seabed sediments with petroleum products;
- contamination of water and seabed sediments with antifouling agents;
- contamination of water and seabed sediments by accidental release of municipal waste or domestic sewage;
- contamination of water and seabed sediments by accidentally released chemicals and waste from the construction of the OWF;

are identical as in the APV and their significance is **low** at most. The impact scale in the RAV may be larger due to the larger number of offshore operations during the construction phase; however, these differences do not affect the assessment of impact significance in the RAV.

10.3.1.5 Impact on climatic conditions

The identified impacts on climatic conditions and the assessment of their significance in the RAV are identical to the results of the analysis for the APV, i.e. they are **negligible**.

10.3.1.6 Impact on air and its quality

The identified impacts on air and its quality as well as the assessment of their significance in the RAV are identical to the results of the analysis for the APV, i.e. they are **negligible**.

10.3.1.7 Impact on ambient noise

The results of ambient noise changes resulting from underwater noise emissions are described in sections relating to the impact of the Project on ichthyofauna, seabirds and marine mammals.

10.3.1.8 Impact on EMF

During the construction phase of the Baltica-1 OWF, power cables and OSSs will not yet be operational. For this reason, there will be no impacts that could affect the EMF levels in the Project development area and its vicinity.

10.3.1.9 Impact on animate nature components

10.3.1.9.1 Impact on phytobenthos

Due to the absence of phytobenthos in the Baltica-1 OWF Area there will be no impact on this environmental component.

10.3.1.9.2 Impact on macrozoobenthos

The same impacts on the soft- and hard-bottom macrozoobenthos as for the APV construction phase were identified for the RAV, i.e. at most **low** for the hard-bottom and soft-bottom macrozoobenthos.

The surface of the Baltica-1 OWF is 85.53 km^2. The physical destruction of macrozoobenthos will take place on the seabed surface disturbed during the installation of gravity based structures of up to 64 wind turbines and 5 OSSs, within an area up to 1.43 km^2 (including the area occupied by the scour protection layer around the foundations and possible seabed area occupied by the stabilising bedding for the jack-up vessel legs). The cable line construction area will cover a seabed area of 2.4 km^2, assuming a 150 km length of the cable routes within the OWF and a maximum width of the strip covered by underwater works of 16 m. Altogether, the maximum damage to macrozoobenthos complexes will cover an area of 3.83 km^2 (assuming the use of gravity-based structures), i.e. 4.48% of the Baltica-1 OWF Area.

The difference between the APV and the RAV in the seabed area affected by the impact is not significant, therefore the assessment of the impact significance for the RAV construction phase is the same as for the APV.

10.3.1.9.3 Impact on ichthyofauna

The identified impacts on ichthyofauna and the assessment of their significance in the RAV are identical to the assessment results for the APV, i.e. in the case of noise emissions assessed as **moderate**, in the case of an increase in suspended solids, habitat change and emission of pollutants assessed as **low**; and in the case of physical barrier as **negligible**. For all the RAV impacts identified there may be slightly larger impacts on demersal fish due to the larger area of the seabed disturbed (habitat change) as well as on pelagic fish due to the larger amount of suspended solids and pollutants in the water column. These differences do not, however, affect the assessment of impact significance in the RAV.

10.3.1.9.4 Impact on marine mammals

The identified impacts on marine mammals and the assessment of their significance in the RAV are identical to the assessment results for the APV, i.e. in each case assessed as **low**. The impact scale in the RAV may be slightly larger due to the larger number of offshore operations during the construction phase; however, these differences do not affect the assessment of impact significance in the RAV.

10.3.1.9.5 Impact on migratory birds

The identified impacts on migratory birds and the assessment of their significance in the RAV are identical to the assessment results for the APV, i.e. in the case of barrier effect – **negligible**, while in the case of collisions with construction vessels – **low** at most. The impact scale in the RAV may be slightly larger due to the larger number of offshore operations; however, these differences do not affect the assessment of impact significance in the RAV.

10.3.1.9.6 Impact on seabirds

The identified impacts on seabirds and the assessment of their significance in the RAV are identical to the assessment results for the APV, i.e. in the case of habitats occupation and emission of noise and vibrations it was assessed as **moderate** at most; in the case of barrier effect and risk of collision as well as artificial light emission it was assessed as **important** at most including separate assessment for benthivorous birds, piscivorous birds and gulls. The impact scale in the RAV due to a larger area of occupied habitat and larger number of offshore operations may be larger; however, these differences do not affect the assessment of impact significance in the RAV.

10.3.1.9.7 Impact on bats

The identified impacts on bats and the assessment of their significance in the RAV are identical to the assessment results for the APV, i.e. for the above-water noise it is **low**. The impact scale in the RAV may be larger due to the larger number of offshore operations; however, these differences do not affect the assessment of impact significance in the RAV.

10.3.1.9.8 Impact on biodiversity

The impact on biodiversity of the Baltica-1 OWF construction phase will be the cumulative effect of the impacts on all plant and animal groups included in this analysis. As individual groups and even taxa have different sensitivities and responses to a given impact, it is not reasonable to define the impact of the Project on biodiversity as such. Therefore, the assessment of impacts on biodiversity is consistent with the results of the impact analysis for all flora and fauna groups presented in Section 10.3.1.

10.3.1.10 Impact on protected areas and the subjects of protection in these areas

The identified impacts on protected areas and the subjects of protection in these areas as well as the assessment of their significance in the RAV are identical to the assessment results for the APV, i.e. in the case of noise emissions assessed as **moderate** at most for the subjects of protection, while for the connections between the Natura 2000 areas and their integrity as **negligible**. The impact scale due to the differences between the APV and the RAV may be slightly larger in the RAV; however, it does not affect the assessment of significance of individual impacts in the RAV.

10.3.1.11 Impact on wildlife corridors

The identified impacts on wildlife corridors and the assessment of their significance in the RAV are identical to the assessment results for the APV, i.e. **negligible**.

10.3.1.12 Impact on cultural heritage

There are no objects of cultural heritage in the Baltica-1 OWF Area nor within the range of its impact which could be affected by the Project.

10.3.1.13 Impact on the use and management of the sea area and tangible property

The identified impacts on the use and management of the sea area and tangible property as well as the assessment of their significance in the RAV are identical to the assessment results for the APV, i.e. **negligible** for fisheries, navigation as well as prospecting and extraction of aggregates. Due to the larger number of offshore operations in the RAV, the impact scale may be slightly larger; however, this does not change the impact significance.

10.3.1.14 Impact on landscape, including the cultural landscape

The identified impacts on landscape and the assessment of their significance in the RAV are identical to the assessment results for the APV, i.e. **negligible**. Due to the larger number of offshore operations in the RAV, the impact scale may be slightly larger; however, this does not change the impact significance.

10.3.1.15 Impact on population, health and living conditions of people

The identified impacts on population, health and living conditions of people and the assessment of their significance in the RAV are identical to the assessment results for the APV, i.e. **negligible**. Due to the larger number of offshore operations in the RAV, the impact scale may be slightly larger; however, this does not change the impact significance.

10.3.2 Operation phase

10.3.2.1 Impact on geological and geomorphological structure

The identified impacts on geological and geomorphological structure and the assessment of their significance in the RAV are identical to the assessment results for the APV, i.e. **negligible**. Due to the larger number of offshore structures as well as greater length of the inter-array cable lines in the RAV, the scale of the impact may be slightly larger, however this does not change the impact significance.

10.3.2.2 Impact on seabed sediments

The identified impacts on seabed sediments and the assessment of their significance in the RAV are identical to the assessment results for the APV, i.e. they are **negligible**.

10.3.2.3 Impact on raw materials and deposits

The identified impacts on raw materials and deposits and the assessment of their significance in the RAV are identical to the assessment results for the APV, i.e. they are **negligible**.

10.3.2.4 Impact on the quality of seawater and seabed sediments

The identified impacts on seawater and seabed sediments quality and the assessment of their significance in the RAV are identical to the results of the analysis for the APV, i.e. they are **moderate** at most. Due to the larger number of offshore structures, greater length of the inter-array cable lines as well as number of potential offshore operations in the RAV, the scale of the impact may be slightly larger; however, this does not change the impact significance.

10.3.2.5 Impact on climatic conditions

The identified impacts on climatic conditions and the assessment of their significance in the RAV are identical to the assessment results for the APV, i.e. **low** at most. Due to the larger number of offshore structures in the RAV, the impact scale may be slightly larger; however, this does not change the impact significance.

10.3.2.6 Impact on air and its quality

The identified impacts on air and its quality as well as the assessment of their significance in the RAV are identical to the results of the analysis for the APV, i.e. **negligible**. Due to the larger number of offshore operations in the RAV, the impact scale may be slightly larger; however, this does not change the impact significance.

10.3.2.7 Impact on ambient noise

The results of ambient noise changes resulting from underwater noise emissions are described in sections relating to the impact of the Project on ichthyofauna, seabirds and marine mammals.

10.3.2.8 Impact on EMF

The impacts on EMF and the assessment of their significance are identical to the assessment results for the APV, i.e. they will not occur or will be **negligible**. Due to the greater length of the inter-array cable lines in the RAV, the scale of the impact may be slightly larger; however, this does not change the impact significance.

10.3.2.9 Impact on animate nature components

10.3.2.9.1 Impact on phytobenthos

The identified impacts on phytobenthos and the assessment of their significance in the RAV are identical to the assessment results for the APV, i.e. **low**. Due to the larger number of underwater structures in the RAV, the scale of the impact may be slightly larger, however this does not change the significance of the impact.

10.3.2.9.2 Impact on macrozoobenthos

The identified impacts on macrozoobenthos and the assessment of their significance in the RAV are identical to the assessment results for the APV, i.e. **moderate** at most for the benthos complexes of the soft bottom and hard bottom. Due to the larger area of the changed habitat as well as greater length of the inter-array cable lines in the RAV, the scale of the impact may be larger; however, this does not change the impact significance.

10.3.2.9.3 Impact on ichthyofauna

The identified impacts on ichthyofauna and the assessment of their significance in the RAV are identical to the results of the analysis for the APV, i.e. **low** at most. Due to the larger area of the changed habitat, larger number of underwater structures as well as greater length of inter-array cable lines in the RAV, the scale of the impact may be larger; however, this does not change the impact significance.

10.3.2.9.4 Impact on marine mammals

The identified impacts on marine mammals and the assessment of their significance in the RAV are identical to the results of the analysis for the APV, i.e. **low** at most. Due to the larger number of underwater structures as well as larger number of offshore operations in the RAV, the scale of the impact may be larger; however, this does not change the impact significance.

10.3.2.9.5 Impact on migratory birds

The identified impacts on migratory birds and the assessment of their significance in the RAV are identical to the results of the analysis for the APV, i.e. **moderate** at most. Taking into account the larger number of above-water structures in the RAV, the scale of the impact may be larger; however, this does not change the impact significance.

10.3.2.9.6 Impact on seabirds

The identified impacts on seabirds and the assessment of their significance in the RAV are identical to the assessment results for the APV, i.e. **important** at most for benthivorous birds, **moderate** at most for piscivorous birds and **negligible** for gulls. Due to the larger number of above-water structures as well as greater length of the inter-array cable lines in the RAV, the scale of the impact may be larger; however, this does not change the impact significance.

10.3.2.9.7 Impact on bats

The identified impacts on bats and the assessment of their significance in the RAV are identical to the assessment results for the APV, i.e. **moderate** at most. Taking into account the larger number of above-water structures in the RAV, the scale of the impact may be larger; however, this does not change the impact significance.

10.3.2.9.8 Impact on biodiversity

The impact on biodiversity of the Baltica-1 OWF operation phase will be the cumulative effect of the impacts on all plant and animal groups included in this analysis. As individual groups and even taxa have different sensitivities and responses to a given impact, it is not reasonable to define the impact of the Project on biodiversity as such. Therefore, the assessment of impacts on biodiversity is consistent with the results of the impact analysis for all flora and fauna groups presented in Section 10.3.2.

10.3.2.10 Impact on protected areas and the subjects of protection in these areas

The identified impacts on protected areas and the subjects of their protection as well as the assessment of their significance in the RAV are identical to the results of the analysis for the APV, i.e. **low** at most for the subjects of protection while in the case of the integrity and coherence of the Natura 2000 network areas the impact significance is **moderate**. Taking into account the larger number of above-water structures in the RAV, the scale of the impact may be larger; however, this does not change the impact significance.

10.3.2.11 Impact on wildlife corridors

The identified impacts on wildlife corridors and the assessment of their significance in the RAV are identical to the assessment results for the APV, i.e. **low** at most. Taking into account the larger number of farm structures in the RAV, the scale of the impact may be larger; however, this does not change the impact significance.

10.3.2.12 Impact on cultural heritage

There are no objects of cultural heritage in the Baltica-1 OWF Area nor within the range of its impact which could be affected by the Project.

10.3.2.13 Impact on the use and management of the sea area and tangible property

The identified impacts on the use and management of the sea area and tangible property as well as the assessment of their significance are identical to the assessment results for the APV, i.e. **negligible** for each aspect analysed (fisheries, navigation as well as prospecting and extraction of minerals).

10.3.2.14 Impact on landscape, including the cultural landscape

The identified impacts on landscape, including the cultural landscape, and the assessment of their significance in the RAV are identical to the assessment results for the APV, i.e. **low**.

10.3.2.15 Impact on population, health and living conditions of people

The identified impacts on population, health and living conditions of people and the assessment of their significance are identical to the assessment results for the APV, i.e. **negligible**.

10.3.3 Decommissioning phase

10.3.3.1 Impact on geological and geomorphological structure

The identified impacts on geological and geomorphological structure and the assessment of their significance in the RAV are identical to the assessment result for the APV, i.e. **negligible**. Taking into account the larger number of the farm structures as well as greater length of the inter-array cable lines, the impact scale in the RAV may be larger; however, this does not change the impact significance.

10.3.3.2 Impact on seabed sediments

During the decommissioning phase of the Baltica-1 OWF, its infrastructure elements buried in the seabed (cable lines and parts of foundations) will not be removed. Therefore, the Project impact on seabed sediments in terms of their geological character may be assessed as **negligible**.

10.3.3.3 Impact on raw materials and deposits

During the decommissioning phase of the Baltica-1 OWF, its infrastructure elements buried in the seabed (cable lines and parts of foundations) will not be removed. Therefore, the Project impact on seabed sediments in terms of their geological character may be assessed as **negligible**.

10.3.3.4 Impact on the quality of seawater and seabed sediments

The identified impacts on the quality of seawater and seabed sediments as well as the assessment of their significance in the RAV are identical to the results of the analysis for the APV, i.e. **moderate** at most. Taking into account the larger number of the farm structures as well as greater length of the inter-array cable lines, the impact scale in the RAV may be larger; however, this does not change the impact significance.

10.3.3.5 Impact on climatic conditions

The identified impacts on climatic conditions and the assessment of their significance in the RAV are identical to the assessment result for the APV, i.e. **negligible**. Taking into account the larger number of offshore operations in the RAV, the impact scale may be larger; however, this does not change the impact significance.

10.3.3.6 Impact on air and its quality

The identified impacts on air and its quality as well as the assessment of their significance in the RAV are identical to the assessment result for the APV, i.e. **negligible**. Taking into account the larger number of offshore operations in the RAV, the impact scale may be larger; however, this does not change the impact significance.

10.3.3.7 Impact on ambient noise

The results of ambient noise changes resulting from underwater noise emissions are described in sections relating to the impact of the Project on ichthyofauna, seabirds and marine mammals.

10.3.3.8 Impact on EMF

During the decommissioning phase of the Baltica-1 OWF, power cables and OSSs will be switched off. Therefore, there will be no impacts that could affect the EMF levels in the environment.

10.3.3.9 Impact on animate nature components

10.3.3.9.1 Impact on phytobenthos

The identified impacts on phytobenthos and the assessment of their significance in the RAV are identical to the assessment results for the APV, i.e. **moderate**. Taking into account the larger number of underwater structures, the impact scale in the RAV may be larger, however this does not change the impact significance.

10.3.3.9.2 Impact on macrozoobenthos

The identified impacts on macrozoobenthos and the assessment of their significance in the RAV are identical to the assessment results for the APV, i.e. **low**. Taking into account the larger number of underwater structures, the impact scale in the RAV may be larger; however, this does not change the impact significance.

10.3.3.9.3 Impact on ichthyofauna

The identified impacts on ichthyofauna and the assessment of their significance in the RAV are identical to the assessment results for the APV, i.e. **moderate** at most. Taking into account the larger number of underwater structures, the impact scale in the RAV may be larger; however, this does not change the impact significance.

10.3.3.9.4 Impact on marine mammals

The identified impacts on marine mammals and the assessment of their significance in the RAV are identical to the results of the assessment for the APV, i.e. **low**. Taking into account the larger number of underwater structures as well as larger number of offshore operations, the impact scale in the RAV may be larger; however, this does not change the impact significance.

10.3.3.9.5 Impact on migratory birds

The identified impacts on migratory birds and the assessment of their significance in the RAV are identical to the results of the assessment for the APV, i.e. **low** at most. Taking into account the larger number of the farm structures as well as larger number of offshore operations, the impact scale in the RAV may be larger; however, this does not change the impact significance.

10.3.3.9.6 Impact on seabirds

The identified impacts on seabirds and the assessment of their significance in the RAV are identical to the assessment results for the APV, i.e. **important** at most for benthivorous birds, **moderate** at most for piscivorous birds and **low** at most for gulls. Taking into account the larger number of the farm structures as well as larger number of offshore operations, the impact scale in the RAV may be larger; however, this does not change the impact significance.

10.3.3.9.7 Impact on bats

The identified impacts on bats and the assessment of their significance in the RAV are identical to the results of the analysis for the APV, i.e. **negligible**. Taking into account the larger number of offshore operations in the RAV, the impact scale may be larger; however, this does not change the impact significance.

10.3.3.9.8 Impact on biodiversity

The impact on biodiversity of the Baltica-1 OWF decommissioning phase will be the cumulative effect of the impacts on all plant and animal groups included in this analysis. As individual groups and even taxa have different sensitivities and responses to a given impact, it is not reasonable to define the impact of the Project on biodiversity as such. Therefore, the assessment of impacts on biodiversity is consistent with the results of the impact analysis for all flora and fauna groups presented in Section 10.3.3.

10.3.3.10 Impact on protected areas and the subjects of protection in these areas

The identified impacts on protected areas and the subjects of protection as well as the assessment of their significance in the RAV are identical to the results of the analysis for the APV, i.e. **low** and positive.

10.3.3.11 Impact on wildlife corridors

The identified impacts on wildlife corridors and the assessment of their significance in the RAV are identical to the results of the analysis for the APV.

10.3.3.12 Impact on cultural heritage

There are no objects of cultural heritage in the Baltica-1 OWF Area and within the range of its impact which could be affected by the Project decommissioning phase.

10.3.3.13 Impact on the use and management of the sea area and tangible property

The identified impacts on the use and management of the sea area and tangible property as well as the assessment of their significance are identical to the assessment results for the APV, i.e. **negligible** for each aspect analysed (fisheries, navigation as well as prospecting and extraction of minerals).

10.3.3.14 Impact on landscape, including the cultural landscape

The identified impacts on landscape including the cultural landscape and the assessment of their significance in the RAV are identical to the results of the analysis for the APV, i.e. **low** and positive.

10.3.3.15 Impact on population, health and living conditions of people

The identified impacts on population, health and living conditions of people and the assessment of their significance in the RAV are identical to the result of the analysis for the APV, i.e. **negligible**.

10.4 Impact on the possibility of achieving the environmental objectives referred to in Article 56, Article 57, Article 59 and Article 61(1) of the Water Law Act of 20 July 2017

Articles 56, 57, 59 and 61(1) of the *Water Law* Act of 20 July 2017 (consolidated text: Journal of Laws of 2023, item 1478) refer to the environmental objectives for surface and groundwater bodies and for protected areas. The Project area is not situated within the boundaries of any SWB or protected area; it is at a distance of at least 59 km from the nearest protected area – *Ławica Słupska* (PLC990001) and 73 km from the boundaries of the nearest SWB.

Considering the type of impacts of the construction, operation and decommissioning phases of the Baltica-1 OWF, along with their spatial extent, it should be assumed that they will have an impact on the possibility of achieving the environmental objectives for the water bodies and protected areas referred to in the above-mentioned articles of the Water Law Act.

10.5 Environmental impact assessment in case of a major industrial accident or a natural or construction disaster

As described in Section 6, the highest risk of a major accident with a significant impact on the environment will result from a collision of two large vessels or a large vessel with the OWF structure, which will cause a Tier 3 oil spill, i.e. a catastrophic spill, the removal of which will require considerable effort and resources as well as a coordinated action to counteract its effects. The anticipated extent of the oil spill could reach up to approximately 20 km, thus covering a sea area of at least several dozen square kilometres. The spread of the oil spill will depend on the existing wind and wave conditions at sea. Given the location of the Project, it is reasonable to assume that the extent of the oil spill impact may extend into the southern part of the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308). The negative impact of the oil spill may affect various components of the biotic and abiotic environment and may cause significant changes in the functioning of the Middle Bank ecosystem. Organic compounds contained in the oil will cause deterioration in the quality of seawater. Absorption of these compounds by organic matter and its subsequent sedimentation may also cause deterioration in the quality of seabed sediments. Among marine organisms, birds wintering in the Middle Bank area, sitting on the water within the spill zone, will be most affected. Oil can cause birds' feathers to stick together preventing them from flying, and the chemical compounds in the oil can poison their bodies, leading to mass bird deaths. Although birds represent the group of animals most vulnerable to the impact of an oil spill, considering its spread on the sea surface, the impact of such spill can also adversely affect plankton and ichthyofauna due to the deterioration of water quality and exposure to poisoning by organic chemicals, at the same time affecting benthic organisms exposed to oil-contaminated suspended solids deposited on the seabed. The oil slick may also cause fouling of bodies and poisoning of marine mammals emerging to take air, if they are within the range of the spill, which is probable given the results of surveys indicating that both seals and porpoises are present in the Baltica-1 OWF Area throughout the year.

During the construction and decommissioning phases, shipping operations will take place from various seaports, involving the transport of wind farm structural components and materials to the construction site, as well as their subsequent return to the ports for disposal at the end of their lifetime. These may be installation ports located in Poland (currently an installation port is under construction in Gdańsk), as well as ports located in other Baltic countries and outside the Baltic region. The transport of personnel will be carried out using smaller vessels and will particularly concern the operation phase, when inspections, maintenance and possible repairs of the OWF infrastructure will be performed.

Therefore, there is a probability of vessel breakdowns resulting in oil spills of various sizes, also far away from the Project area and outside the Baltic Sea. Although the risk of such a situation will be lower than in the OWF Area, where collisions with OWF structures will pose an additional danger, it cannot be excluded. The impact of a spill due to an emergency situation will result in a similar range of environmental impacts as described above, and the effect and intensity of the impact will depend mainly on the size and location of the spill, as well as the existing meteorological conditions determining the extent of the spill. It should be noted that in the case of an oil spill occurring close to land, the biotic and abiotic environment of the coastal waters and the shore itself may be adversely affected.

At a minimum, the measures described in Sections 6.5 and 6.6 will be implemented to minimise the risk of emergency situations resulting in negative impacts on the environment. All vessels will be subject to the requirements of the Law of the Sea, including the MARPOL Convention, national regulations for ensuring safety at sea, as well as the safety standards and emergency prevention solutions developed for the Project by the Project Owner. This will minimise the risk of major accidents resulting in significant impacts on the marine and coastal environment.

Table 10.119 provides an assessment of the scale of impact on the marine environment in the event of an emergency resulting in a Tier 3 oil spill, whereas Table 10.120 provides an assessment of the effect of this impact. Given the vast extent of such a spill and its impact on a variety of biotic and abiotic environmental factors, the assessment was performed from an ecosystem perspective, accounting for the relationships between the various environmental components. The sensitivity of the marine ecosystem to an oil spill was classified as very high. The assessment applies to both the APV and the RAV, as no significant differences indicating a need to diversify the assessment were found between the variants.

Table 10.119. Assessment of the scale of impact of oil spill Tier 3 (catastrophic) on the marine environment

Impact	**Impact characteristics**													**Joint 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 of oil spill Tier 3 (catastrophic) on the marine environment in the vicinity of the Baltica-1 OWF	3			3						2			1	9
Impact of oil spill Tier 3 (catastrophic) on the marine environment	3			3						2			1	9

Impact	Impact characteristics													Joint 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
outside the development area of the Baltica-1 OWF														

Table 10.120. Assessment of the significance of oil spill Tier 3 (catastrophic) for the marine environment

Impact	Impact scale	Receptor sensitivity	Impact significance
Impact of oil spill Tier 3 (catastrophic) on the marine environment in the vicinity of the Baltica-1 OWF	moderate	very high	**Moderate**
Impact of oil spill Tier 3 (catastrophic) on the marine environment outside the development area of the Baltica-1 OWF	moderate	very high	**Moderate**

The impact assessment demonstrated that a Tier 3 (catastrophic) oil spill could in each case cause a significant impact on the environment within its range. It should be noted that the risk of an emergency situation resulting in such a serious spill is very low and has not occurred so far in the implementation of any offshore wind farm. This is due to the fact that the implementation of such projects always involves attaching great importance to developing the best possible safety standards at sea and categorical compliance with the general provisions of maritime law and those prepared for a given project by the relevant maritime administration authorities.

10.6 Assessment of the impact of the Project implementation on the possibility of achieving environmental objectives resulting from the implementation of the Marine Strategy Framework Directive

Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 *establishing a framework for community action in the field of marine environmental policy* (OJ L 164, 25.6.2008, p.19, as amended) – Marine Strategy Framework Directive (MSFD) does not refer directly to offshore wind energy, but its development, including the implementation of the Baltica-1 OWF, may be important in the context of achieving the environmental objectives for the Baltic Sea resulting from this Directive. The adoption of the MSFD resulted in the development of national environmental targets, the current set of which results from the Regulation of the Minister of Infrastructure of 25 February 2021 on the adoption of an update of the set of environmental objectives for marine waters (Journal of Laws of 2021, item 569). The methods of achieving good environmental status for each objective are described in the National Marine Waters Protection Program (NMWPP), adopted by the Resolution of the Council of Ministers on 11 December 2017 (Journal of Laws of 2017, item 2469). Table 10.121 includes a list and description of environmental objectives resulting from the 11 individual features described in the Regulation on the update of environmental targets, which correspond to the 11 descriptors included in Annex 1 to the MSFD.

Table 10.121. Baltica-1 OWF impact on the possibility of meeting the environmental objective features listed in Annex I to the Marine Strategy Framework Directive

MSFD descriptor	Objective for the descriptor	Baltica-1 OWF impact on the possibility of meeting the objective
D1 (Biodiversity) *Biological diversity is maintained. The quality and occurrence of habitats and the distribution and diversity of species are in line with prevailing physiographic, geographic and climatic conditions of the Baltic Sea region*	Reduce or maintain anthropogenic pressure at a level that ensures the maintenance of natural habitats in which the natural biodiversity of existing biotic elements is preserved, including fisheries, and habitat protection within Natura 2000 protected areas is ensured.	The construction of the Baltica-1 OWF will involve a change in the functioning of benthic and pelagic habitats within the wind farm area. On the one hand, the natural state of these habitats will be disturbed as part of the seabed within the area will be occupied by wind turbine and OSS foundations, and on the other hand the hard surfaces of the structures below the waterline may be overgrown by plant and animal periphyton organisms. The resulting new habitat will enrich the biodiversity of the Baltica-1 OWF Area, becoming a convenient shelter, as well as a breeding and feeding ground for other marine organisms. The environmental surveys did not indicate the presence of unique or rare habitats, in the Baltic Sea context, within the Baltica-1 OWF development area. Most of the seabed area is covered by sand or sand and gravel sediments. As demonstrated in the impact analysis, the implementation of the Baltica-1 OWF will not result in deterioration of the natural habitats in the Natura 2000 sites situated within the Project impact range. Assessment: **the implementation of the Project will not affect the achievement of the objective for descriptor D1**.
D2 (Non-indigenous species) *Maintaining non-indigenous species introduced by human activities at levels that do not adversely alter the ecosystems.*	Limit the possibility of spreading of non-indigenous species introduced to the environment as a result of human activities in order to ensure the occurrence of non-indigenous species at levels which do not disturb the structure and functioning of the ecosystem, in particular in relation to individual groups of species, areas particularly vulnerable to introduction and general types of habitats, by taking appropriate actions.	All vessels involved in the Project will be subject to the International Convention for the Control and Management of Ships' Ballast Water and Sediments, and therefore there will be no risk of accidental introduction of alien species into the Baltic Sea. Project monitoring during the operation phase may reveal the occurrence of alien species e.g. periphyton species on underwater components of the wind turbines and OSSs. In such a case, appropriate measures will be taken in accordance with the requirements of the Alien Species Act of 11 August 2021 (consolidated text: Journal of Laws of 2023, item 1589).

MSFD descriptor	Objective for the descriptor	Baltica-1 OWF impact on the possibility of meeting the objective
D3 (Commercially exploited fish and shellfish) *Maintaining populations of all commercially exploited fish and shellfish within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.*	The objective is to maintain populations of commercially exploited fish and shellfish within safe biological limits corresponding to natural conditions by ensuring that all commercially exploited fish stocks are exploited at or below the maximum sustainable yield level ensuring that all commercially exploited fish remain within safe biological limits, and by limiting or maintaining the exploitation of fish stocks at a level which ensures the maintenance of their full reproductive capacity as well as full range of ages and individual sizes.	The implementation of the Baltica-1 OWF will not cause a decrease in the size of the commercially-exploited fish population. Possible restrictions of fishing activity in the area of the wind farm, together with favourable conditions for the development of ichthyofauna within the farm area (the so-called artificial reef effect), may potentially lead to a local growth of the population. Assessment: **the implementation of the Project will not affect the achievement of the objective for descriptor D3 or may increase the chances of achieving that objective.**
D4 (Food web) *All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.*	Limit the impact of human activities to the level allowing the ecosystem to reach the state in which all the elements of the marine trophic chain will show a natural and stable level of abundance and diversity, and the productivity of biotic components will guarantee the correct functioning of the trophic web.	The implementation of the Baltica-1 OWF will not disturb trophic chains in the Project area nor in a broader spatial context. The flow of matter and energy will be preserved. The development of communities of habitat-forming species during the operation phase, and the occurrence of the so-called artificial reef effect, may have a positive effect on species diversity and on the flow of matter and energy in the trophic chain within the wind farm area and in its vicinity. Assessment: **the implementation of the Project will not affect the achievement of the objective for descriptor D4 or may increase the chances of achieving that objective.**
D5 (Eutrophication) *Minimising human-induced eutrophication, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.*	Maintain the influx of annual loads of nitrogen and phosphorus deposited in the Baltic Sea by rivers and in the form of atmospheric deposition below the Maximum Allowable Inputs (MAI) determined within the framework of regional agreements (HELCOM), in order to help reduce the concentration of nutrients in the sea to the level not exceeding permissible threshold values which are in accordance with recommendations of the currently applicable national and European Union legal acts, and which guarantee the achievement or maintenance of good environmental status and do not cause negative effects in the form of excessive algal growth, increased concentrations of chlorophyll *a* in the water column, decrease in seawater transparency and the level of oxygenation of the seabed waters,	The implementation of the Baltica-1 OWF will not result in the influx of nutrient loads to the ecosystem, which might affect eutrophication levels. Assessment: **the implementation of the Project will not affect the achievement of the objective for descriptor D5.**

MSFD descriptor	Objective for the descriptor	Baltica-1 OWF impact on the possibility of meeting the objective
	which in turn promotes proper development of pelagic and benthic habitats.	
D6 (Sea-floor integrity) *Maintaining sea-floor integrity at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.*	Reduce the accumulated pressure on the seabed to the level enabling benthic habitats to function close to their natural state.	The surface area covered with structures will constitute approximately 4% of the Baltica-1 OWF Area. The structures developed will not be compact and will not produce a strong negative impact causing deterioration of benthic habitats. Assessment: **the implementation of the Project will not affect the achievement of the objective for descriptor D6.**
D7 (Alteration of hydrographical conditions) *Permanent alteration of hydrographical conditions that does not adversely affect marine ecosystems*	Limit activities altering hydrographical conditions to a minimum that ensures no adverse impact on marine ecosystems and undertake activities aimed at improving hydrographical conditions in permanently altered areas.	Bearing in mind: • the number of wind turbines and OSSs, the distance between them and their distribution; • the dimensions and shapes of individual structures; • the type and dimensions of foundations or support structures; • flow field characteristics (velocities, prevailing directions, etc.); • seabed relief with particular consideration of surface gradients and natural obstacles, it was demonstrated in the EIA Report that the impact on hydrographical conditions within the Baltica-1 OWF will be negligible. Assessment: **the implementation of the Project will not affect the achievement of the objective for descriptor D7.**
D8 (Contaminants) *Maintaining concentrations of contaminants at levels not giving rise to pollution effects*	Reduce or maintain the influx of (hazardous) contaminants from various marine and terrestrial sources, which enter the marine environment, in order to achieve or maintain the concentrations of (hazardous) contaminants in biotic and abiotic elements of the marine ecosystem at levels not exceeding the permissible values, below which the probability of undesirable effects of (hazardous) contaminants on marine organisms is minimal and which are in accordance with the recommendations of the applicable national and international legislation, and which guarantee the achievement of good environmental status.	The implementation of Baltica-1 OWF will not involve the introduction of substances that may cause permanent contamination of the environment. Seabed sediments within the wind farm area are characterised by a very low content of harmful chemical substances, and therefore their mobilisation during the construction phase will not cause pollution of the marine environment. Also, the wind farm components will not release hazardous chemicals into the environment. In the extremely unlikely event of an emergency, the most significant of which in the context of this descriptor will be those resulting in oil spills, immediate action will be taken to prevent and minimise the effect of such spills.

MSFD descriptor	Objective for the descriptor	Baltica-1 OWF impact on the possibility of meeting the objective
		Assessment: **the implementation of the Project will not affect the achievement of the objective for descriptor D8.**
D9 (Contaminants in fish and other see food for human consumption) *Maintaining contaminants in fish and other seafood for human consumption at a level which does not exceed levels established by legislation or other relevant standards.*	Reduce or maintain at the present level the influx of contaminants from various marine and terrestrial sources into the marine environment in order to achieve or maintain the concentrations of pollutants in fish and seafood intended for human consumption at the levels not exceeding permissible values, which are in accordance with the standards and recommendations of the existing national and European Union legislation, and which guarantee the safety of consumption as well as the achievement or maintenance of good environmental status.	The implementation of Baltica-1 OWF will not involve the introduction of substances that may cause permanent contamination of the environment and their accumulation in the trophic chain, resulting in increased concentrations of harmful chemical compounds in commercially-exploited fish stocks. Seabed sediments within the wind farm area are characterised by a very low content of harmful chemical substances, and therefore their mobilisation during the construction phase will not cause pollution of the marine environment. Also, the wind farm components will not release hazardous chemicals into the environment. In the extremely unlikely event of an emergency, the most significant of which in the context of this descriptor will be those resulting in oil spills, immediate action will be taken to prevent and minimise the effect of such spills. Assessment: **the implementation of the Project will not affect the achievement of the objective for descriptor D9.**
D10 (Marine litter) *Maintaining properties and quantities of marine litter at a level which does not cause harm to the marine, transitional and coastal water environment.*	Reduction of the volume of newly arising solid waste deposited in the marine environment, originating from various terrestrial and marine sources, to the levels guaranteeing the proper functioning of the ecosystem, taking into account its natural resistance, or to the total elimination of the newly arising waste.	All litter produced in each phase of the Baltica-1 OWF implementation will be segregated, properly secured and transferred to the ports for disposal in accordance with applicable regulations. They will not pose a threat to the marine environment. Assessment: **the implementation of the Project will not affect the achievement of the objective for descriptor D10.**
D11 (Underwater noise) *Maintaining the energy introduced into marine waters, including underwater noise, at a level that does not negatively impact the marine environment.*	Achieve underwater noise levels that guarantee the proper functioning of marine organisms by taking measures to reduce the sources and intensity of noise and by defining protection (buffer) zones with a ban on activities constituting sources of noise.	There are no noise exclusion/buffer zones in the Project area nor within its impact area. The greatest noise emissions will occur during the construction phase, during the installation of wind turbine and OSS foundations. Appropriate noise reduction measures and systems will be implemented to reduce the extent, intensity and consequently the harmful effects of noise on the marine environment.

MSFD descriptor	Objective for the descriptor	Baltica-1 OWF impact on the possibility of meeting the objective
		This will ensure that noise impacts will be short-term and limited in extent. Assessment: **the implementation of the Project will not affect the achievement of the objective for descriptor D11.**

The analysis showed that the Baltica-1 OWF will not affect the achievement of environmental objectives resulting from the implementation of the Marine Strategy Framework Directive.

10.7 Assessment of the impact of the Project on the possibility of achieving environmental objectives in the various segments of the present Baltic Sea Action Plan (HELCOM)

Developed by the Helsinki Commission in 2007 and updated in 2021, the Baltic Sea Action Plan (BSAP) is the primary document addressing the need for Baltic Sea states to take action in order to improve the condition of the Baltic Sea environment. The document identifies four main segments based on environmental objectives, reflecting the main anthropogenic pressures on the Baltic Sea environment. Table 10.122 lists the ecological objectives assigned to each BSAP segment, together with an assessment of the Baltica-1 OWF impact on the possibility of their achievement.

Table 10.122. Impact of the implementation of the Baltica-1 OWF on the possibility of achieving the environmental objectives assigned to the individual segments of the Baltic Sea Action Plan [Source: internal materials based on BSAP 2021].

Segment of the Baltic Sea Action Plan (HELCOM)	Ecological Objective	Baltica-1 OWF impact on the possibility of meeting the objective
Biodiversity	– viable populations of all native species; – natural distribution, occurrence and quality of habitats and associated communities; – functional, healthy and resilient food webs.	Implementation of the Baltica-1 OWF will not cause deterioration and loss of population resources that could result in a reduction in their size. The development within the wind farm area will not have a compact character – individual turbines and OSSs will be situated at a distance of approximately 1 km to approximately 2.5 km from one another. The seabed area occupied by the foundations and scour protection solutions will be approximately 4% of the wind farm area. Owing to this wind farm design, the integrity of benthic habitats will not be deteriorated, and there will be no significant hindrance to the movement of benthic and pelagic organisms. The construction of the wind farm may result in the development of new habitats – benthic organisms will inhabit the submerged structures of the wind farm, which will become a favourable habitat for other organisms in terms of availability of shelter, feeding and breeding sites. In this way, the wind farm area can locally contribute to an increase in biodiversity and quantitative stock of species populations. In this

Segment of the Baltic Sea Action Plan (HELCOM)	Ecological Objective	Baltica-1 OWF impact on the possibility of meeting the objective
		context, although the introduction of anthropogenic structures will involve a local disturbance of the natural environment, they may also have a positive effect on the development of biodiversity in the area where the farm will be built. Assessment: **the implementation of the Baltica-1 OWF will not have a negative impact on biodiversity, and it may contribute to its local development.**
Eutrophication	– nutrient concentrations close to natural levels; – clean waters; – natural level of algal blooms; – natural distribution and occurrence of plants and animals; – natural oxygen levels.	The implementation of the Baltica-1 OWF will not involve the introduction of nutrients into the marine environment. The analyses of seabed sediments demonstrated that they contain negligible amounts of nitrogen and phosphorus salts, and therefore their mobilisation during the construction works will not cause an increase in the amount of nutrients in the water column. Consequently, it should be assumed that the Baltica-1 OWF will not affect the eutrophication of the sea basin. The Project is not expected to cause changes in oxygen concentration and deterioration of water purity. Again, the key factor is the low contamination of sediments, with a very low proportion of organic matter, the decomposition of which after release from the sediments could locally cause a deterioration in oxygen conditions. Assessment: **the implementation of the Baltica-1 OWF will not affect the eutrophication of the environment.**
Hazardous substances and litter	– marine life is healthy; – concentrations of hazardous substances are close to natural levels; – all sea food is safe to eat; – healthy wildlife; – minimal risk to humans and the environment from radioactivity,	The implementation of the Baltica-1 OWF will not involve the introduction of hazardous substances into the environment. Also the materials from which the wind farm elements will be made will be neutral for the environment and will not release harmful substances. No radioactive materials will be used in the construction of the wind farm. All litter produced in each phase of the Baltica-1 OWF implementation will be segregated, properly secured and transferred to the ports for disposal in accordance with applicable regulations. They will not pose a threat to the marine environment.

Segment of the Baltic Sea Action Plan (HELCOM)	Ecological Objective	Baltica-1 OWF impact on the possibility of meeting the objective
		Assessment: **the implementation of the Baltica-1 OWF will not affect the concentrations of hazardous substances in the environment and will not involve the introduction of litter into the environment.**
Sea-based activities	– no or minimal disturbance to biodiversity and the ecosystem; – activities affecting seabed habitats do not threaten the viability of species' populations and communities; – no or minimal harm to marine life from man-made noise.	As demonstrated in the environmental impact analysis, the implementation of the Baltica-1 OWF will not cause deterioration of the environment and ecosystem functioning. The most significant impact may result from the barrier effect on migrating birds, but the adopted mitigation measures will reduce this effect, allowing birds to pass freely and safely. The greatest noise emissions will occur during the construction phase, during the installation of wind turbine and OSS foundations. Appropriate noise reduction measures and systems will be implemented to reduce the extent, intensity and consequently the harmful effects of noise on the marine environment. This will ensure that noise impacts will be short-term and limited in extent. Assessment: **the implementation of the Baltica-1 OWF will be in line with the objectives adopted for the 'Sea-based activities' segment.**

As demonstrated in the analysis, the Baltica-1 OWF will not affect the achievement of the environmental objectives indicated for the individual segments of the Baltic Sea Action Plan.

11 CUMULATIVE IMPACTS OF THE PROJECT

The Baltica-1 OWF Area is located in the northern part of the Polish sea areas, near the boundary of exclusive economic zone. In Sections 10.2 and 10.3 of the EIA Report, various types of potential impacts of the Project in all phases and variants of its implementation considered were identified and analysed in terms of their impact on the environment.

Accepting the results of this analysis, three groups of impacts were identified, which in their spatial scope may exceed the boundaries of the Project area and potentially, in synergy with the impacts of other projects implemented in the Baltic Sea, cause a cumulative impact on the environment. These are:

- the increase of suspended solids and their sedimentation;
- underwater noise;
- spatial disturbances, including barrier preventing free movement of birds and bats as well as disturbance to fishing and navigation.

11.1 IDENTIFICATION OF PROJECTS WHICH MAY CAUSE CUMULATIVE IMPACTS

In order to determine the maximum range of cumulative impact, a review was carried out of scientific documents and articles on the impact of suspended solids, underwater noise and bird barrier, which were quoted in Section 10.2 of this EIA Report and other documents reviewed for this analysis. Firstly, the range of the impact of suspended solids was excluded, because their impact on the environment, assessed as anything other than negligible, does not occur at a distance greater than a maximum of 3 km from the source of their creation. The impact of the physical barrier on avifauna and chiropterofauna is also not a good point of reference in this case. Although the phenomenon of the impact of offshore wind farms on flights and the risk of collisions resulting from their presence at sea may be significant, in the vast majority of cases the range of this impact on the open sea is assessed as regional, international or transboundary, i.e. without assigning a measurable boundary to its spatial range. The situation is different in relation to underwater noise, the spatial range of which can be effectively estimated on the basis of the results of modelling of sound propagation in the environment and the sensitivity of receptors to its intensity.

In the case of most offshore investments, the impact of underwater noise on porpoises and fish with swim bladders, which are the most sensitive among marine organisms to sound levels in the water, is assessed. The negative impact on harbour porpoises and fish is manifested by a change in their behaviour (behavioural response), a temporary shift in the hearing threshold (TTS) and a permanent shift in the hearing threshold (PTS), also causing bodily injuries and, in extreme cases, death. The threshold sound values causing their occurrence have been well described in literature and are a standard indicator for estimating the range of underwater noise impact for various types of offshore projects.

In this analysis, in order to determine the range of cumulative impacts, the ranges of TTS and PTS occurrence, as well as the range of behavioural response, were adopted due to the proximity of the Project area to the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308), in which the harbour porpoise is one of the subjects of protection. Further analysis will address the range of the underwater noise impact on the harbour porpoise as an extremely endangered species within the entire Baltic Sea.

In environmental impact assessment reports, noise propagation modelling usually includes the use of noise reduction systems (NRS), the application of which significantly reduces its levels in the environment and its spatial extent. NRS are commonly used for piling in offshore areas and, as the analysis of the EIA reports for the planned offshore wind farms in Poland and abroad has shown, they will also be used in the implementation of these projects. For this reason, the analysis of the range of cumulative impacts was based on the results of noise propagation modelling with the application of NRS. Among the projects the documentation of which was analysed for the identification of cumulative impacts, only the EIA report for the FEW Baltic II OWF did not present the results of noise propagation modelling including the application of NRS.

The analysis also assumed the condition that the connection infrastructure, the implementation of which will involve the appearance of suspended solids impact, must be located at a maximum of 3 km from the boundary of the Baltica-1 OWF Area because, as it results from the modelling carried out for the purposes of the Baltica-1 OWF and other projects, this is the maximum range of their impact in the context of significant water turbidity and, importantly, it concerns only their generation due to the disturbance of cohesive fine-grained sediments (e.g. tills, clays and silts). The significant impact range of suspended solids sedimentation is much smaller and is up to several hundred meters from the source of the seabed sediment disturbance.

In order to select the projects the implementation of which may result in impacts which may be noticeable in the Baltica-1 OWF Area or which may overlap with the impact range of this Project, available data and information from the EIA reports for these projects or, if they have not yet been prepared, other available materials about these projects were analysed.

The analysis carried out showed that the areas of such investments are located in the offshore area 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[16]:

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

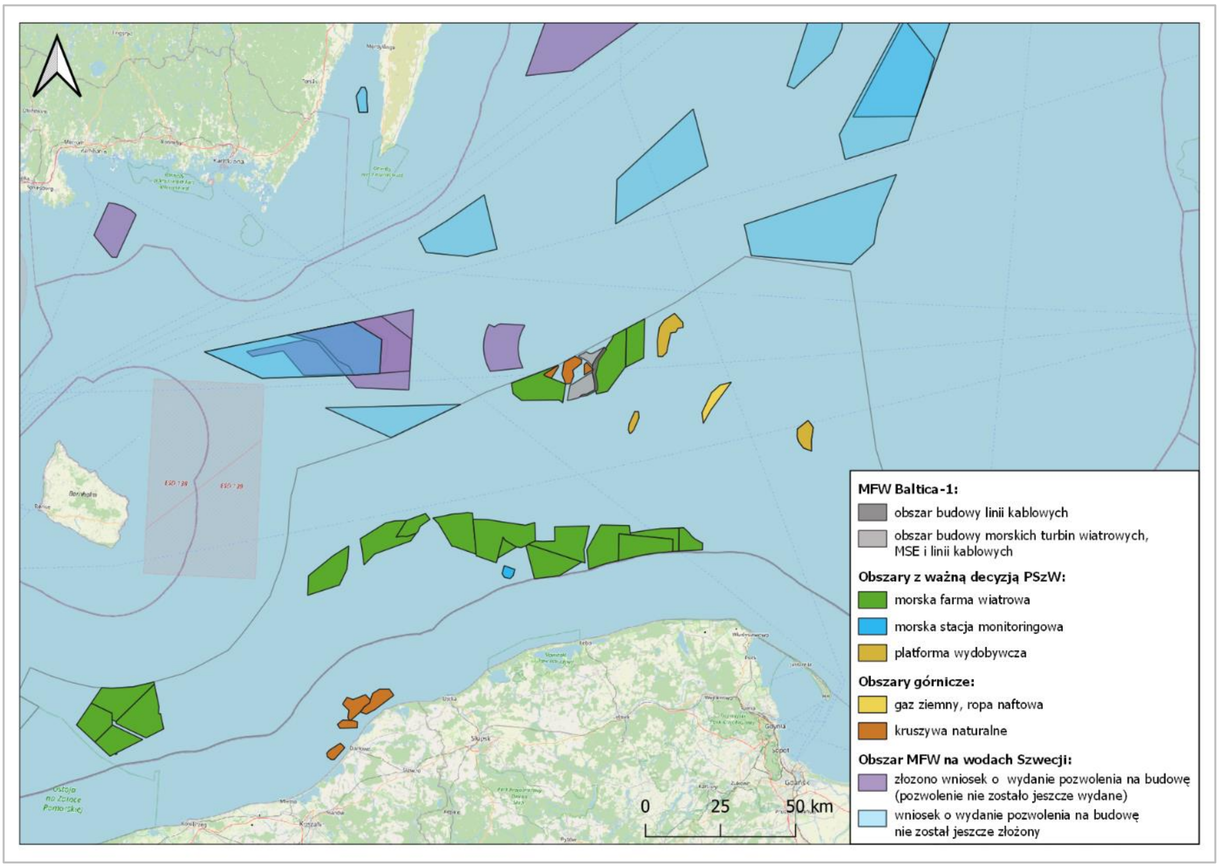
The Baltica-1+ OWF construction area is also within the cumulative impact range, but due to the early stage of this project and the lack of information on the extent of its impacts, it was not included in the cumulative impact analysis.

[16]Data on the 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 21.06.2024)

There are also other areas of the planned offshore wind farms on the Swedish side that may potentially result in the creation of cumulative impacts from underwater noise. These are the Cirrus OWF, the Neptunus OWF, the Ymer OWF (the areas of these three 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 impacts.

While analysing the cumulative impact of suspended solids also the exploitation of the natural aggregate deposit 'Southern Middle Bank – Southern Baltic' situated in the Polish part of the Middle Bank was taken into consideration.

Figure 11.1 presents the location of the Baltica-1 OWF relative to other areas with PSzW permits issued and areas of mineral extraction in the Polish sea areas as well as areas of proposed offshore wind farms in Swedish waters.



PL	EN
MFW Baltica-1 -	Baltica-1 OWF
Obszar budowy linii kablowych	Cable line construction area
Obszar budowy morskich turbin wiatrowych MSE i linii kablowych	WTG, OSS, and cable line construction area
Obszary z ważną decyzją PSzW:	Arras covered by valid PSzW permits
Morska farma wiatrowa	Offshore Wind Farm
Morska stacja monitoringowa	Offshore monitoring station
Platforma wydobywcza	Mining platform
Obszary górnicze:	Mining areas
Gaz ziemny, ropa naftowa	Natural gas, crude oil
Kruszywa naturalne	Natural aggregates
Obszar MFW na wodach Szwecji,	The OWF area within the Swedish waters

Złożono wniosek o wydanie pozwolenia na budowę (pozwolenie nie zostało jeszcze wydane)	An application for the construction permit has been lodged (the permit has not been granted yet)
Wniosek o wydanie pozwolenia na budowę nie został jeszcze złożony	No application for the construction permit has been lodged to date

Figure 11.1. Baltica-1 OWF location in relation to other areas with PSzW permits issued and mining areas in Polish sea areas as well as areas of proposed offshore wind farms in Swedish waters [Source: internal materials based on SIPAM, CBDG and Länsstyrelserna Geodatakatalogen data]

The analysis of the potential cumulative impacts identified this way is presented below.

11.2 Assessment of cumulative impacts

Cumulative impact of suspended solids

Suspended solids appear as a result of underwater works and seabed sediments agitation during seabed clearing and dredging as well as cable line construction. As the modelling results have shown, the range of suspended solids, in terms of water turbidity, in the worst environmental conditions will be most pronounced at a distance of up to 1 km (concentration of suspended solids in water up to 30 mg/l) from the site of underwater works, while the range of its sedimentation will mainly cover the nearest area of the underwater works, i.e. at a distance of up to 200 m (increase in the thickness of the new sediment layer exceeding 5 mm) from the site of their performance (Appendix 2 to the EIA Report).

The range of suspended solids impact resulting from the formation of suspended solids covers three potential projects:

- development area of the Baltica-1 Offshore Wind Farm Connection Infrastructure;
- development area of the Bałtyk I Offshore Wind Farm project;
- natural aggregate deposit 'Southern Middle Bank – Southern Baltic'.

The cumulative impact of suspended solids generated from disturbed seabed sediments will most likely be the result of the construction of the Baltica-1 OWF connection infrastructure (Baltica-1 OWF CI). This project is subject to a separate procedure for obtaining a decision on environmental conditions. It is expected that this project may be implemented parallel to the construction of the Baltica-1 OWF, thus it is possible that underwater works will be conducted simultaneously resulting in the formation of suspended solids in the area of the farm and its connection. The Baltica-1 OWF CI Area is located among others in the same area within which the construction area of the Baltica-1 OWF cable lines is located. Export cables transporting the generated electricity towards the onshore area will also be located within the farm area. A maximum of three interlinks will be built within the Baltica-1 OWF Area in the APV (assuming the construction of a maximum of four OSSs, and in the case of the construction of only one OSS, no connections between stations will be made) and a maximum of four interlinks in the case of the implementation of the RAV, in which the construction of five OSSs is assumed. The maximum length of interlinks in the APV is expected to be 22 km, and in the RAV – 25 km. The number of export cable lines in the area and in the southern part of the farm area will be up to four in the APV and up to five in the RAV. Their length within the farm area is not known at this stage, but it should not exceed 22 km in the APV and 25 km in the RAV. Taking into account the results of the modelling of the suspended solids propagation for the Baltica-1 OWF and the Baltica-1 OWF CI (data provided by the Project Owner), it should be assumed that even in the case of simultaneous construction of the farm and the connection elements, the total impact on the environment will not be significantly higher than the impact of the suspended solids created only during the construction phase of the farm. The table includes an analysis of the cumulative impact of the suspended solids on individual elements of the marine environment which may remain under their negative influence.

Another project the impacts of which related to the formation of suspended solids may cause accumulation of impacts on the environment with the impacts of the Baltica-1 OWF is the Bałtyk I Offshore Wind Farm. According to the EIA report for that project, suspended solids will appear during work related to clearing the seabed before the installation of the farm structure foundations and building cable lines. According to the results of the impact analysis, the impact of suspended solids and their sedimentation on various environmental components will be low/negligible.

Table 11.1 contains a summary of the results of the analysis of the suspended solids impact on various components of the environment together with an assessment of their potential impact on the environment. Due to differences in the methodology of assessing the environmental impact in the EIA report of the Bałtyk I Offshore Wind Farm, the summary assessment was unified by using a higher impact value, i.e. 'low' instead of 'negligible'.

Table 11.1. Assessment of the environmental impact of the suspended solids generated during the construction of the Baltica-1 OWF, the Baltica-1 OWF CI and the Bałtyk I OWF including the assessment of their cumulative impact

Environmental component	**Impact assessment**			
	Baltica-1 OWF	**Baltica-1 OWF CI**	**Bałtyk I OWF**	**Summary assessment of the cumulative impact**
macrozoobenthos	low	low	low, negligible	low
ichthyofauna	low	low	low, negligible	low
diving birds (benthivorous)	low	low	low, negligible	low
marine mammals	low	low	low, negligible	low
seabed and water column (including cleanliness status and ecological quality status)	low	low	low, negligible	low

The nearest mining area, designated on the ‘Southern Middle Bank – Southern Baltic’ sand and gravel deposit is located at a distance of 60 m from the Baltica OWF Area boundary. Its resources were put to use by designating three mining areas contained within one mining site. The deposit development concession is valid until 15 November 2031. On 05.02.2024, the Regional Director for Environmental Protection in Gdańsk issued a decision establishing the scope of the environmental impact assessment report for the project entitled ‘Geological works plan for the exploration and prospecting of the Southern Middle Bank – Southern Baltic sand and gravel aggregate deposit’. Once the decision on environmental conditions is obtained, the entity implementing the project will be able to conduct surveys for the purpose of carrying out analyses of the volume and spatial layout of the unexploited part of the deposit, but the commencement of exploitation of this part will require a separate decision on environmental conditions. What is currently unavailable is the information necessary to carry out an analysis of the cumulative impacts resulting from the formation of suspended solids and their impact on the environment as a result of the exploitation of natural aggregates from the deposit situated on the Middle Bank. However, the obligation to account for the analysis of cumulative impacts will rest on the holder of the mining concession in the event that it decides to utilise the deposit and proceed with the analysis of environmental impacts. In this situation, the entity will be obliged to include the impacts of other projects including, among others, the Baltica-1 OWF, which is located in the vicinity of the deposit.

An analysis of the cumulative impact of suspended solids on the environment demonstrated that even if such impact occurs, it will be **negative** and **low**.

Due to the limited spatial extent of the impact of suspended solids in the water column and their sedimentation, no cumulative impact is expected on the natural habitats 1110 and 1170 of the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308), which, according to the site conservation plan, are situated at a minimum distance of approximately 40 km from the boundary of the Baltica-1 OWF Area (Bevarandeplan för Natura 2000.... 2021 – Site Conservation Plan for Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308)).

During the operation and decommissioning phase (the designs of all the OWFs included in this analysis assume that the foundations and cable lines will remain in the seabed), no works will be conducted that would result in significant sediment mobilisation into the water column and the formation of suspended solids with a large spatial extent. Therefore, the cumulative impact of suspended solids will not occur in either of these phases .

Cumulative impact of underwater noise

The sound emitted during the piling of the wind turbine support structures in the construction phase may propagate in the water column over considerable distances and may adversely affect marine mammals and ichthyofauna, in particular fish with a swim bladder.

In order 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 an 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*, bordering with the Baltica-1 OWF, possible noise exceedances in the area were also taken into account in the assessment of cumulative impacts.

In addition, modelling results obtained for seals were included in the study to verify whether or not 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, a single mitigation measure in the form of a BBC is insufficient. In both the summer and winter scenarios, the noise impact zones are very large for cumulative TTS and behavioural change, in the case of both the harbour porpoise and seals [Table 11.2]. An analysis assuming an 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 significant area. This applies to both the scenarios with two and three sound sources. Furthermore, even dual mitigation, even in the form of HSD+DBBC as well as IQIP+DBBC, is not sufficient to avoid 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 11.2].

Table 11.2. 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 on the basis of 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
			Behavioural change	807	126	30.7

The results above demonstrate that simultaneous piling at two or more sites may generate significant negative 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* in summer. Noise propagation modelling results 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 may occur at the population level. In order to mitigate the cumulative impacts from underwater noise, in the piling planning the NRS accounted for other piling processes within 50 km of the Baltica-1 OWF.

It is also important to note the results of the analysis on exceedances of permissible noise levels in the Swedish Natura 2000 site in relation to the occurrence of TTS and PTS in the harbour porpoise [10.2.1.10]. Calculations for both summer and winter showed that simultaneous piling works in two or more locations will lead to significant 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 [Table 10.49].

By relating the results described to the scenario in which simultaneous piling works are carried out in different locations of the OWF, it was analysed in which situations cumulative noise impacts on marine mammals can occur. The acoustic modelling performed assumed, among others, that the sound source located outside the Baltica-1 OWF is within a range of 20 km. This means that the impact range values obtained can be related to the situation when simultaneous piling works are conducted within the nearby Bałtyk I OWF (west of the Baltica-1 OWF) or the Swedish Södra Victoria OWF (northwest of the Baltica-1 OWF). It can be assumed that if construction works at these planned wind farms were carried out at the same time as at the Project discussed, the negative impacts on marine mammals would be significant.

An important area of the Polish part of the Baltic Sea, in terms of OWF project processes, is the strip of open water in the central part of the EEZ. The construction of neighbouring offshore wind farms, most of which already have investment plans approved, is assumed in that area. In order to analyse the potential cumulative noise impact from simultaneous piling at the Baltica-1 OWF and at one of the OWF locations in the central EEZ, the modelling results obtained in the EIA processes for a single turbine were compared. Two examples of locations were selected for the analysis, for which the noise propagation modelling was conducted in the most similar manner – the Baltic Power OWF and the BC-Wind OWF, situated more than 40 km south of the Project area. The results obtained in these projects were related to the impact ranges obtained for the Baltica-1 OWF. The analysis accounted for the impact ranges with reference to the harbour porpoise behaviour. The results are summarised in Table 11.3 and Table 11.4.

Table 11.3. Maximum ranges and areas of the impact of underwater noise resulting in behavioural response, TTS and PTS in the harbour porpoise, obtained on the basis of numerical modelling for the Baltic Power OWF and the BC-Wind OWF [Source: internal materials based on environmental impact assessment reports for the projects]

Species	OWF	Mitigation type	Season	Effect	Maximum range [km]	Impact area [km²]
Harbour porpoise	Baltic Power	BBC	Spring	PTS_{cum}	9.1	203
				TTS_{cum}	20.0	1020
				Behavioural change	15.6	552
	BC-Wind	BBC	Spring	PTS_{cum}	12.0	250
				TTS_{cum}	36.0	1500
				Behavioural change	28.0	870

Table 11.4. Maximum ranges and areas of the impact of underwater noise resulting in behavioural response, TTS and PTS in the harbour porpoise, obtained on the basis of numerical modelling for the Baltica-1 OWF

Species	OWF	Mitigation type	Season	Effect	Maximum range [km]	Impact area [km²]
Harbour porpoise	Baltica-1	BBC	Summer	PTS_{cum}	0.1	0.03
				TTS_{cum}	0.6	0.7
				Behavioural change	10.7	233
			Winter	PTS_{cum}	0.1	0.1
				TTS_{cum}	0.8	1.2
				Behavioural change	28.1	1394
		HSD + DBBC	Summer	PTS_{cum}	0.1	0.03
				TTS_{cum}	0.2	0.1
				Behavioural change	8.6	164
			Winter	PTS_{cum}	0.1	0.03
				TTS_{cum}	0.3	0.23
				Behavioural change	20.8	863
		IQIP+DBBC	Summer	PTS_{cum}	0.1	0.03
				TTS_{cum}	0.3	0.14
				Behavioural change	9.0	178
			Winter	PTS_{cum}	0.1	0.03
				TTS_{cum}	0.4	0.3
				Behavioural change	20.8	956

Since in the locations of the Baltic Power OWF and the BC-Wind OWF the modelling was performed for a different season than in the case of the Baltica-1 OWF, the results presented in Table 11.3 and Table 11.4 cannot be unambiguously compared as one scenario. However, taking into account the values presented as well as the location of the OWFs discussed and piling sites modelled, it is possible to make some assumptions related to potential sound accumulation. Relying on the assumptions made in the model analyses, it may be predicted that in summer, when the sound propagation is the weakest, there will be no cumulative effects of piling noise from the locations analysed. This is the case if at least BBC mitigation is applied during the construction of the proposed OWFs. However, in seasons characterised by better sound propagation, the likelihood of cumulative effects in the form of behavioural changes cannot be dismissed.

In order to mitigate the cumulative impacts from underwater noise, in the piling planning the NRS accounted for other piling processes within 50 km of the Baltica-1 OWF, which results in the significance of the cumulative noise impact from simultaneous piling at several locations being assessed as **low** for marine mammals. The analyses carried out showed that even with the application of dual mitigation in the form of HSD+DBBC the impact ranges are large for both the harbour porpoise and seals.

The 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.

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 during the operation and decommissioning phases will be **negligible**.

Impact of spatial disturbance on avifauna (barrier effect)

The possibility of cumulative impacts during the construction phase can only occur when works generating similar impacts are carried out concurrently or consecutively over a short time interval. 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 a similar or 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 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 operation phase. Cumulative impacts from the above-mentioned phenomena on birds can be minimised at this stage.

Cumulative risk of bird collisions

Calculation of the cumulative collision risk 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 Appendix 5 to the 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:

- 29–35 collisions for the long-tailed duck;
- 145–166 collisions for the common scoter;
- 53–60 collisions for the common guillemot;
- 77–81 collisions for the little gull;
- 136–155 collisions for the lesser black-backed gull.

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 a receptor of the impacts of all the OWFs. Instead, the most likely cumulative impacts relate to several OWFs in the immediate vicinity of the Baltica-1 OWF, such as the Baltic 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.

The presence of construction vessels also poses a risk of increased bird mortality due to collisions. This impact on birds may be cumulative in the event of concurrent implementation of other OWFs or the excavation and transport of spoil at a nearby natural aggregate mining site (Southern Middle Bank – Southern Baltic deposit, 3/2006). It should be noted that the deposit is currently not exploited. The effect will be at most be of low significance for birds. Considering the proximity of shipping lanes, the traffic will not considerably deviate from the standard ship traffic in the Central Baltic area. In addition, the attracting effect of the light generated by ship traffic can be minimised by avoiding the use of lights directed upwards.

In the case of exploration and exploitation of mineral resources, there are a number of potentially cumulative factors. They are mainly related to interference in the benthic environment, spatial disturbance and noise emissions as a result of mining and prospecting activities using deep seismic and seismo-acoustic profiling.

The impacts related to the Baltica-1 OWF operation, which may cumulate with other projects of a similar nature, are the impacts related to the barrier effect and increased risk of collision. The space disturbance resulting from the OWF implementation consists in the presence of structures above the water surface, in the sea areas previously free from any physical barriers. The effectiveness of the barrier effect and the frequency of collisions will depend on the area occupied by similar projects within nearby sea basins. The OWF-related development of adjacent sea basins may obstruct or even prevent the migration of seabirds and migratory birds between wintering grounds and breeding sites. In the context of maintaining the continuity of bird migration routes, first of all, it is important to maintain the possibility of bird movement without the risk of significant population depletion or significant energy expenditure, which could affect the population ecology and biology, including the survival of the individuals from those populations. It has been noted that seabirds clearly avoid the area occupied by offshore wind turbines and their abundance decreases in the vicinity of the turbines, e.g. for the long-tailed duck – within a radius of up to 2 and even up to 4 km [Christensen, 2003; Petersen, 2006; Leopold, 2011]. In the case of cumulative impacts, in which very distant OWFs have been included at the request of the RDEP, the theoretical route bypassing the OWF results in a fairly significant increase in energy expenditure for the black guillemot. However, based on expert knowledge, a scenario in which this species would choose such a route is unlikely, given the large areas of open undeveloped Baltic Sea waters between the individual wind farm areas. The migration of the long-tailed duck and the common scoter takes place across the entire width of the Baltic Sea. Therefore, only a small percentage of birds will be forced to change their flight routes because of the barrier in the form of the Baltica-1 OWF. The energy expenditure associated with the potential route extension is of negligible significance to them since migration routes vary between populations, depending on the way selected (along the coast of southern Sweden, across the Southern Baltic, etc.) and the weather conditions during migration. Divers are likely to avoid flying into an OWF area and can be expected to avoid the Baltica-1 OWF Area, extending their migration route. The associated consequences in terms of increased energy expenditure will be relatively minor. The migration route is similar to that of the long-tailed duck, from the wintering grounds in the Baltic Sea towards the Kara Sea and the Arctic, and therefore the change in the route represents an equally small percentage of the total migration distance. Migrating auks are comparable to divers and sea ducks in terms of body volume and movement patterns. They also move in a broad front and the natural variation in migration route length may be greater than the bypass caused by the presence of the proposed OWF on the migration route of some of their populations. All migrating gull species (the little gull, the black-headed gull, the lesser black-backed gull, the common gull) pass through the Southern Baltic en route between their nesting grounds in eastern Europe and wintering grounds off the Atlantic coast. As with other seabirds, there is no specific migration corridor over the Baltic Sea waters and the sea basin is crossed in a broad front. The energy needs of these birds are lower than those of, for example, sea ducks, so the increase in energy expenditure due to the route extension will be negligible in terms of their well-being. Therefore, the magnitude of the impact of the cumulative barrier effect on the above-mentioned seabird species or groups is assessed as low at most.

On the other hand, during adverse weather conditions with low visibility (migration at night, in foggy and/or cloudy conditions), birds may alter their flight trajectory by adjusting their flight direction to a source of artificial light, which they misinterpret as stars [Atchoi *et al.* 2020]. The cumulative effect of this impact can be minimised by limiting sources of strong light at night, particularly those directed upwards – this applies in particular to bird migration periods. In addition, illuminating OWFs at night with small, weak, pulsating light sources is recommended. It is also helpful to change the lighting during reduced visibility from continuous to pulsating with a long interval between the flashes. In order to increase the visibility of offshore wind turbines during daytime, it is recommended to paint the blade tips in bright colours to increase the visibility of operating offshore wind turbines. By ensuring increased visibility of offshore wind turbines during the day and reducing light pollution at night, the possible cumulative barrier effect for birds will be of low significance at most. The current regulations concerning wind turbine markings, resulting from 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), prevent the full application of the proposed solutions to reduce collision risks, but their inclusion in the Report is justified, given the distant date for the beginning of the Baltica-1 OWF construction and the possibility of changes in the law before the construction works start.

The implementation of several OWFs in the Polish and Swedish EEZs will have a cumulative effect in terms of the loss of habitats of the long-tailed duck. The seabird inventory survey carried out for the preparation of the EIA Report for the Baltica-1 OWF confirms low attractiveness of the OWF development area for birds during winter, as well as during autumn migration and post-breeding dispersal. Nevertheless, due to the uncertainty related to the recording of a large flock of the long-tailed duck (more than 11 000 individuals) during the spring migration, it is impossible to state after one cycle of seabird surveys whether the area of the proposed Project is attractive for the long-tailed duck, or whether the observed congregation of this species was a one-off event caused by weather factors that forced the birds to temporarily stop their migration.

Vessel traffic in the OWF Area during the operation phase will mainly take place in order to ensure continuity of operation. Therefore, the significance of impacts associated with the presence of vessels during this period will be lower than during the construction phase. Similarly, there will be a lower likelihood of cumulative impacts with other OWFs and vessels involved in the excavation and transport of spoil from the nearby aggregate mine.

The impact of the OWF Baltica-1 on seabirds and migratory birds at the decommissioning stage will be similar to the impact during the construction of the proposed Project. Along with the gradual removal of the wind turbine towers, the negative impact involving the scaring away of the birds from the area occupied by the structures protruding high above the water will decrease. Increased traffic of vessels and noise associated with the dismantling of the OWF will still disturb birds, but over time the intensity of this factor will decrease. Therefore, even if decommissioning is carried out simultaneously in several locations within one or more OWFs, no cumulative impacts will occur.

To summarise, the impacts associated with the cumulative impact of the barrier effect were assessed as **moderate**.

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 operation 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.

The impact of offshore wind farms on bats is poorly known due to the difficulty in identifying individuals within the wind farm itself and the exposure to barotrauma. This is particularly difficult for wind farms located far away from the shore, where bat numbers are low, and it is extremely difficult to detect the death of individuals due to their small body size.

When attempting to assess the cumulative impact of wind farms on chiropterofauna, it is important to note that any increase in the number of operating offshore turbines 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 impact on bats, the impact was assessed as **negative with moderate** significance.

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

Impact of spatial disturbance on fisheries

The cumulative impact assessment takes into account the proposed locations of OWFs and connection lines in close proximity to the Baltica-1 OWF [Figure 11.2].

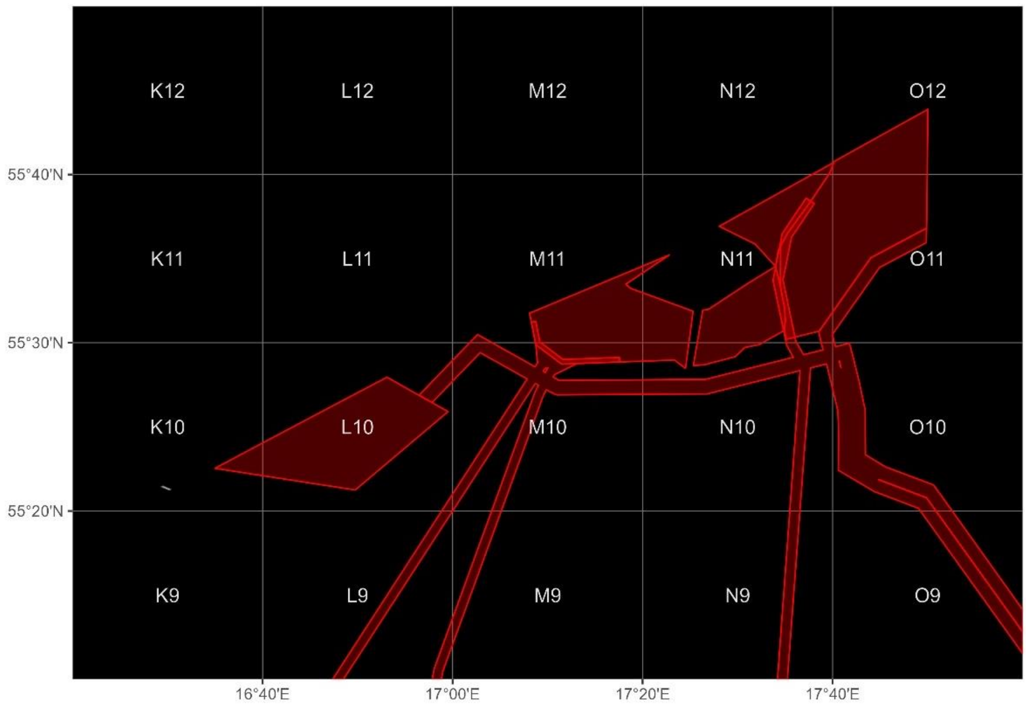


Figure 11.2. Proposed offshore wind farms and connection infrastructure in the area of the Baltica-1 OWF [Source: internal materials based on SIPAM data]

The analysis of fishing activities took into account the area of 14 statistical rectangles: K10, L10, L9, M10, M11, M9, N10, N11, N12, N9, O10, O11, O12, and O9. The total surface area of the rectangles analysed is 7.8 thousand km^2 whereas the total area to be occupied by the OWF and the connection infrastructure is 1.3 thousand km^2 (16.9% of the surface area of the rectangles). In the years 2018 to 2022, in the rectangles in which wind farms are to be established, between 114 and 67 fishing vessels were conducting fishing activities, to a greater or lesser extent, which accounted for between 8 and 15% of the total number of fishing vessels active in the Baltic Sea [Table 11.5].

Table 11.5. Number of vessels fishing in the statistical rectangles to be occupied by OWFs and connection infrastructure, and the total number of active Polish vessels in the Baltic Sea, in 2018–2022

Specification	2018	2019	2020	2021	2022
OWFs and connection infrastructure	114	97	79	67	67
Total	777	786	800	805	798
OWF proportion / total	15%	12%	10%	8%	8%

The value of catches in the statistical rectangles within the Baltic Sea in which the wind farms will be located ranged from PLN 9 million (2020) to PLN 15.8 million (2018), with an average of PLN 12.7 million between 2018 and 2022. On average, this represented between 7.2% of the value of Polish catches in the Baltic Sea. The value of catches in individual statistical rectangles varied considerably. It was highest in rectangles M9, N9 and N10 with PLN 3.1 million, PLN 2.7 million and PLN 2.1 million, respectively (on average in 2018–2022). The surface area occupied by the OWF and connection infrastructure represents 7%, 10% and 16% of the surface area of these rectangles, respectively.

Table 11.6. The value of catches conducted in 2018–2022 in the Baltic Sea statistical rectangles within the area of the selected rectangles in which offshore wind farms and connection infrastructure are to be located

Rectangle	2018	2019	2020	2021	2022	Average
K10	197	270	73	102	750	278
L10	160	89	482	469	476	335
L9	670	1038	335	1130	708	776
M10	531	397	1129	1057	848	792
M11	58	7	34	4	18	24
M9	3082	4815	2265	3212	2306	3136
N10	2504	1726	1421	2938	1801	2078
N11	209	115	174	149	140	157
N12	92	-	3	2	-	32
N9	3917	3806	1792	1898	2117	2706
O10	1312	791	334	603	873	783
O11	987	1406	554	252	463	732
O12	1097	210	243	119	15	337
O9	1029	342	132	488	897	578
Total:	15 844	15 013	8974	12 422	11 411	12 733

The value of fish catches in the area of the wind farms and connections alone – estimated on the basis of the proportion of the area to be occupied by the wind farms with the connection infrastructure in relation to the area of the Baltic Sea rectangles (for fishing vessels up to 12 m) and VMS data for the remaining vessels – ranged from PLN 1.7 million (2020) to PLN 2.3 million (2018), with an average of PLN 2 million between 2018 and 2022. This represented 1.2% of the value of Polish catches in the Baltic Sea.

The main fish species caught in the area of the 14 rectangles analysed, in 2018–2022, were sprat (56%) and herring (32%). Due to the restrictions on cod fishing introduced in 2019, the significance of these fish was marginalised in subsequent years (0.5% share in 2022), which in turn resulted in an increased significance of other fish species, including flounder [Table 11.7].

Table 11.7. Species structure of the catches within the area of the 14 Baltic Sea statistical rectangles in which offshore wind farms and the associated transmission infrastructure will be located (in tonnes)

Species	2018	2019	2020	2021	2022
Sprat	6320.6	5911.3	2949.7	7559.1	5591.3
Herring	4380.0	3683.7	3306.9	3124.5	1679.5
Flounder	668.0	965.5	545.7	453.6	1026.6
Cod	862.1	926.3	181.3	17.8	39.4
Other	144.6	79.2	233.2	85.3	87.4
Total	12 375.3	11 566.0	7216.8	11 240.4	8424.2

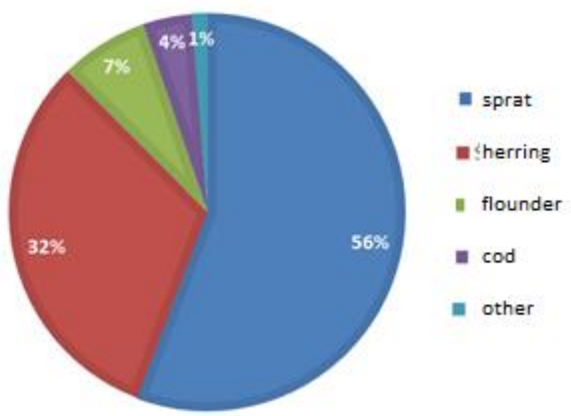


Figure 11.3. Species structure of the catches within the area of the 14 statistical rectangles in which offshore wind farms and the associated transmission infrastructure will be located (2018–2022)

Within the 14 rectangles analysed, pelagic trawls accounted for the dominant proportion of the catch, which is a direct consequence of the effort focus mainly on pelagic species (herring and sprat). Between 2018 and 2022, pelagic trawls accounted for more than 80% of the catch volume – up to even 98% (2021).

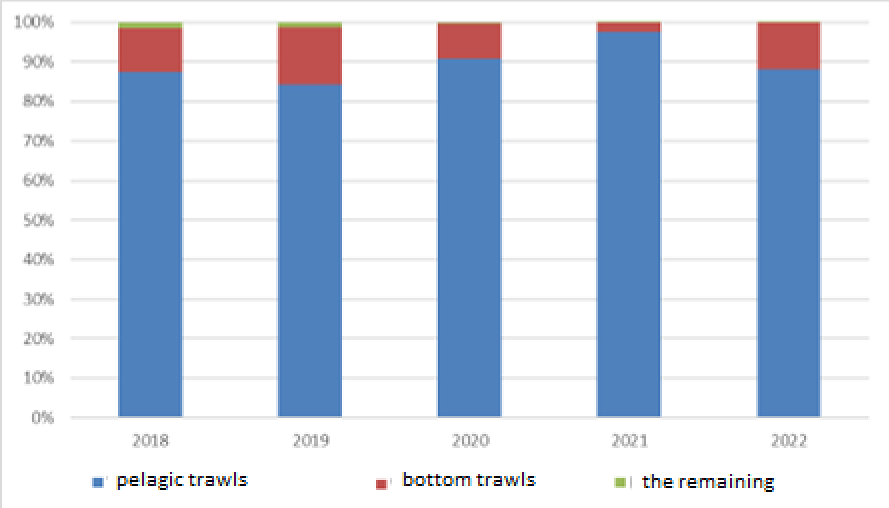


Figure 11.4. Structure of catches within the area of the 14 statistical rectangles analysed, by fishing gear (2018–2022)

The resultant assessment of the cumulative impact of the wind farms and connection infrastructure located in the vicinity of the Baltica-1 OWF showed their limited, and relatively low, negative impact on marine fisheries. The value of lost revenue (assuming complete exclusion of the OWF Area and connection infrastructure from fishing use) – estimated on the basis of 2018–2022 data – is approximately PLN 2 million per year, which would constitute approximately 1.2% of the total value of Baltic fisheries. From the perspective of the attractiveness of conducting fishing activities, the most sensitive areas are the three statistical rectangles: M9, N9 and N10, in the area of which fish with a total value of approximately PLN 40 million were caught between 2018 and 2022, which accounted for over 60% of the catch value in the 14 rectangles analysed. Since only a limited part of the surface area of the rectangles is to be occupied by the OWFs or the transmission infrastructure, the value of catches limited only to that area is much lower. For the three rectangles mentioned above, in the 5 years under analysis, it amounted to PLN 3.9 million (PLN 790 thousand per year on average). In addition, the negative effect of the impact may be completely eliminated if the connection infrastructure is buried in the seabed, which will enable undisturbed fishing activities in the area of its installation. This applies in particular to the three most sensitive statistical rectangles mentioned above, in which mainly (M10) or exclusively (M9 and N9) transmission cables are located. As the vast majority of fish in the area under analysis are caught with pelagic trawls, enabling the use of this gear in the area where the transmission cables are located will considerably minimise the negative impact of the OWF infrastructure on fisheries.

The cumulative impacts of offshore wind farms on fisheries in the Middle Bank area were assessed as **negative** and **low**.

Impact of spatial disturbance on shipping

Within the Batica-1 OWF Area and its immediate vicinity, no IMO-approved shipping routes are designated. The usual shipping route to the port of Klaipeda runs through the area of the Project discussed and the area of the Bałtyk I OWF to the west, which is mainly used by cargo and passenger vessels. The construction and operation of these wind farms will necessitate an alteration of this route, should restrictions be imposed on ship traffic through their area. Due to the location of the Södra Victoria OWF area to the northwest of the Baltica-1 OWF, it is likely that vessels travelling along that route will bypass the Baltica-1 and Bałtyk I OWF areas from the south. This will extend the shipping route by a maximum of 10 km and will result in a slight increase in sailing time compared to existing conditions, as well as increased fuel consumption. The cumulative effect of the OWF construction in the Middle Bank area will therefore have a **negative** effect, but due to its relatively small extent it will be **negligible**. It should be noted that navigation within POM.40.E sea basin is subordinate to its primary function, i.e. renewable energy generation, and will be subject to restrictions under the provisions of the MSPPSA Regulation: '*during the operation of offshore wind turbines, until the conditions for safe navigation have been established by a decision of the territorially competent director of the maritime office, sailing is restricted to vessels up to 50 m in length, with the exception of vessels involved in the service and maintenance of offshore wind farm structures and installations as well as aquaculture*'.

The extent of cumulative impacts – underwater noise impacts – will only affect the southern part of the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308). Due to the considerable distance of 59 km from the Baltica-1 OWF Area, this extent will not be noticeable in the Natura 2000 site *Ławica Słupska* (PLC990001).

12 TRANSBOUNDARY IMPACTS

The Baltica-1 OWF Area is situated in the north-central part of the EEZ of the Republic of Poland, at a distance of approximately:

- 550 m from the boundary of the Swedish EEZ;
- 60.0 km from the boundary of the Danish EEZ;
- 84.3 km from the boundary of the Russian EEZ;
- 92.9 km from the boundary of the Lithuanian EEZ;
- 101.7 km from the boundary of the Latvian EEZ;
- 203.7 km from the boundary of the German EEZ;
- 391.5 km from the boundary of the Finnish EEZ.

The impact assessment conducted for individual environmental components indicates that its range will be local, i.e. limited to the Baltica-1 OWF development area. The impacts with spatial range exceeding the EEZ of the Republic of Poland will result from:

in construction phase:

- emission of underwater noise as a result of piling;
- propagation and deposition of suspended solids generated as a result of dredging and clearing the seabed as well as cable line construction;

in operation phase:

- presence of tall, above-water structures of the farm (turbines and OSSs).

During decommissioning phase, no transboundary impacts are expected. Dismantling works will not interfere in the seabed – support structures will be cut off above the sediment surface while cable lines after deactivation will remain in the seabed. The wind turbines and OSSs will be removed, thus eliminating the barrier effect for migratory birds and the risk of collision with the above-water structures of the farm.

Underwater noise impact

Sound emitted during work involving piling of support structures of turbines and OSSs may cause negative impacts on marine animals in the form of such effects as scaring, changing behaviour, hearing damage in the form of a temporary or permanent shift of the hearing threshold, and also, in the case of exposure to high-intensity noise, damage to other body organs (e.g. swim bladder in fish).

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. In the case of behavioural changes, even the application of double mitigation will not be sufficient to avoid a transboundary effect. This applies especially to harbour porpoises. The modelled noise impact ranges related to behavioural changes in these animals will also cover the Swedish Natura 2000 site *Hoburgs bank och Midsjöbankarna*, in which the harbour porpoise is subject to protection (The impact of underwater noise on fish and marine mammals is described in Sections 10.2.1.9.3 and 10.2.1.9.4).

Analyses were also carried out for the central and southern locations (Appendix 3 to the EIA Report). In the case of the locations discussed, after the application of NRS, no transboundary impact is expected at the level of cumulative TTS.

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 fall onto the seabed near the locations of the 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 particularly large in the cohesive sediments area, characterised by a high proportion of small grain size fractions. The suspended solids created through mobilisation of this type of sediments 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 over a large sea area. 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/l 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/l. The maximum point concentration of suspended solids in the water at a distance of 150 m from the source may be 1500 mg/l. Sedimentation of suspended solids may cause a 35-mm thick overlay of the seabed sediment at a distance of 150 m from the source. 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 over 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 significant 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 SE0330308. 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 negligible. 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. The analysis demonstrated that the impact on the environment of the suspended solids generated by underwater works and their sedimentation will be irrelevant or low even at a small distance from the location 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 SE0330308 will be negligible.

Impact of spatial disturbance (barrier effect)

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* 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 Baltic population size of the European herring gull. However, since these birds accompany fishing boats at fisheries, their occurrence in the open sea is strongly dependent on human activity. Therefore, no significant transboundary impacts shall occur. Thus, no significant transboundary impacts are expected from a single project consisting in the construction of the Baltica-1 OWF.

However, there are plans to build at least 3 neighbouring OWFs and more than 40 within the Baltic region. While there is information in literature on the responses of birds to single wind farms, there is no data on their responses to such an extensive barrier. This includes both arrival/departure from wintering grounds and movements between feeding grounds. It is known from the studies in Western Europe that birds respond to a barrier by changing their direction and avoiding it. In the case of sea ducks and divers, i.e. species with a high conservation status, only a small proportion of them (several percent per year) fly into the OWFs and move between wind farms. For those species, bypassing begins at a distance of approximately 1.5–2 km from the farm. The calculations of the cumulative risk of collision for the Baltica-1 OWF in a transboundary context with other proposed wind farms for most seabirds were assessed as **negligible** and **of low importance**.

The calculations of bird energy expenditures resulting from the extended migration route, associated with the cumulative effect of the OWF barrier with 14 other OWF projects, indicate a slight increase. The highest cumulative impact of wind farms in a transboundary context was calculated for the black guillemot, which would need to increase its energy expenditure by 24.61% in order to travel its migration route. However, using expert knowledge, a situation where this species would choose such a route is unlikely, due to the large areas of open, undeveloped Baltic waters between the different groups of OWFs. The increase in energy expenditure due to the cumulative barrier effect for the remaining species will be small at most.

The seabird inventory for the preparation of the Baltica-1 OWF EIA Report, was conducted both within the Baltica-1 OWF survey area and in the reference area, located in the Natura 2000 site *Hoburgs bank och Midsjöbankarna* SE0330308. The areas were established in a way that allows direct comparison of the results obtained. 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 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 12.1. 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.

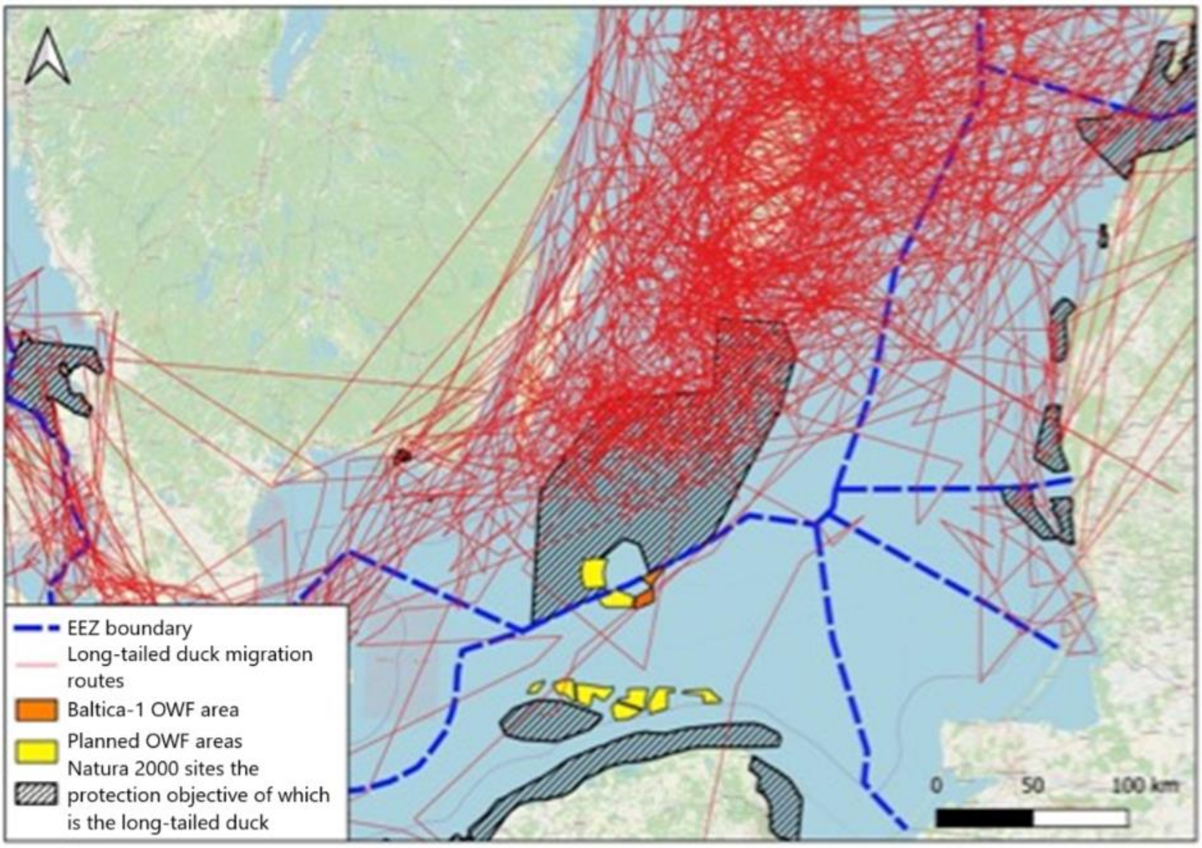


Figure 12.1. Migration routes of the long-tailed duck Clangula hyemalis in the Baltic Sea area [Source: internal materials based on Žydelis et al., 2010; Žydelis et al., 2013; Karwinkel et al., 2018]

Furthermore, the planned pile driving in the Baltica-1 OWF Area may generate underwater noise of significant range and associated impacts on fish which constitute food for piscivorous birds. This is particularly true of the results obtained for the winter season, when the ranges of the behavioural response and the cumulative TTS in fish remain high. The application of NRS leads to a significant reduction in the impact ranges.

Taking into account the above information, it should be assumed that the implementation of the Baltica-1 OWF will involve the occurrence of transboundary impacts on:

- marine mammals, mainly the harbour porpoise, and fish, especially species with swim bladders, during the construction phase, as well as on:

- migratory and water birds and bats – barrier effect and risk of collision with the above-water structures of the farm.

The scale of these impacts will be minimised through the application of appropriate mitigation measures, which are described in Section 15.

It should be noted that the minimisation measures indicated will not eliminate the transboundary extent of the impacts, but will contribute to reducing their scale and effects. This will be particularly noticeable in the case of underwater noise impacts, the intensity and spatial extent of which will be significantly reduced by the use of NRS. According to the modelling results, during the piling of the monopiles in the extreme northern part of the Baltica-1 OWF Area, the extent of noise causing PTS and TTS will not extend to the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308). In contrast, the extent of the behavioural response may reach the southern part of the site at a maximum distance of 23.3 km into the site. The impact area on this Natura 2000 site will not exceed 1% in summer and 3.8% in winter. This impact will cease when piling is completed in the northern part of the area. The use of a soft-start procedure will not reduce the extent of the noise impact, but will allow for the marine mammals and fish to swim away from the noise impact area before the maximum piling energy is reached. Thanks to the environmental supervision carried out during the construction works, it will be possible to evaluate the level of threat to benthivorous birds on an ongoing basis and suspend operations if diving birds appear in the noise hazard zone.

No minimisation measures will be able to exclude the transboundary barrier effect caused by the development of the above-water space with the farm structures. It is anticipated that the bypassing of the OWF areas located in the Middle Bank area by migrating birds will result in the extension of migration routes by up to 15 km. Equipping the turbines with a system to shut them down remotely will significantly reduce the risk of collisions for cranes flying in the rotor zone.

In summary, the implementation of the Baltica-1 OWF will involve transboundary impacts on the Swedish water environment and impacts on bird migrations extending across more than one country. Due to the nature and extent of the Project as well as the location of its area close to the EEZ border of Poland and Sweden, it is not possible to eliminate transboundary impacts, but only to minimise their extent. The most important transboundary impact will be the negative impact of the farm's above-water structures on crane flights. It will be active throughout the entire farm operation period and will only cease when the turbines and OSSs are dismantled. The mitigation measures can only reduce the strength of this impact, but there is no possibility of reducing its spatial extent.

13 COMPARISON OF THE IMPACTS OF THE ANALYSED PROJECT VARIANTS AND IDENTIFICATION OF THE MOST BENEFICIAL VARIANT FOR THE ENVIRONMENT

Taking into account the current Maritime Spatial Plan of Polish Sea Areas (Journal of Laws of 2021, item 935, as amended), it would be unreasonable to analyse another location variant of the proposed Project. Therefore, both the APV and the RAV were considered for the same area.

The differences between the APV and the RAV were based on the existing and the technological solutions feasible in the coming years, resulting from the intensive development of offshore wind energy. The maximum installed capacity of the Baltica-1 OWF, i.e. 900 MW, was adopted as the limit parameter in both variants considered. Hence, the number of wind turbines included in the farm will be based on the rated capacity of the selected units. The detailed description of the APV and the RAV is provided in Section 2.2.

The analysis of the environmental impacts during the different phases of the Project has shown that the significance of the identified impacts will be the same in the APV and RAV [Table 13.1]. This is due to the APV implementation assumption, which includes the construction of a maximum of 60 15 MW wind turbines, a maximum of 4 OSSs and a maximum of 140 km of cable lines. This is therefore a very similar assumption to the implementation of the Project in the RAV, i.e. the construction of 64 wind turbines of 14 MW, 5 OSSs and 150 km of cable lines. Such minor differences have translated into the same assessment of the impact significances of both options, although the quantitative characterisation of impacts may differ. The greater number of offshore structures in the RAV and the greater length of the cable lines would consequently result in longer lead times and more offshore operations being required if this option was to be implemented, which would directly increase environmental impacts in a number of aspects, e.g. greater area of disturbed seabed, greater vessel emissions, greater consumption of materials and raw materials. Hence, in most cases, the scale of impacts on an individual receptor would be greater than for the APV.

It should be noted, however, that the APV assumes that 36 wind turbines can be built if 25 MW wind turbines are already available in the market at the time of contracting supplies and services, thus reducing the effect of the impact. For example, the modelling analysis of the risk of collisions between migratory birds and the farm structures showed, in the case of the cumulative impacts of this impact, that there is little difference in the number of collisions. Thus, the RAV is characterised by the highest number of collisions.

Even when comparing the APV, which assumes the construction of 60 wind turbines, and the RAV, it can be seen that the implementation of the APV will result in a slightly lower interference with the seabed – 4.11% of the Baltica-1 OWF Area, than the implementation of the RAV – 4.34%, which will result in a slightly smaller impact on benthic organisms.

The smaller seabed surface disturbed by underwater works will also result in smaller amounts of pollutants accumulated in seabed sediments released into the water column (see: Table 10.7 and Table 10.117).

Construction and operation of a smaller number of wind turbines in the APV in relation to the RAV, means, consequently, less interference in the environment as a result of: i) shorter duration of the construction and decommissioning phases, ii) lower number of risky lifting and offshore operations, iii) lower consumption of construction materials and consumables. Also, during the OWF operation phase, a smaller number of wind turbines in the APV will require a smaller number of maintenance and operation activities in relation to the RAV, and consequently, it will contribute to a smaller environmental impact.

Taking into account the results of the environmental impact assessment of the Project and the possibility of reducing the strength of the APV impacts, in the case of the very likely selection of wind turbines with a capacity greater than 15 MW, the implementation of the Baltica-1 OWF in this variant will result in a lower environmental impact than the implementation of the RAV. Therefore, **the APV is** indicated as **the most beneficial option for the environment.**

Table 13.1. Comparison of the significance of the APV and RAV impacts on individual receptors during construction, operation and decommissioning phases

Receptor	**Construction phase**		**Operation phase**		**Decommissioning phase**	
	APV	**RAV**	**APV**	**RAV**	**APV**	**RAV**
Geological and geomorphological structure	negligible	negligible	negligible	negligible	negligible	negligible
Seabed sediments	negligible	negligible	negligible	negligible	negligible	negligible
Raw materials and deposits	negligible	negligible	negligible	negligible	negligible	negligible
Seawater and seabed sediment quality	low	low	moderate	moderate	moderate	moderate
Climatic conditions	negligible	negligible	low	low	negligible	negligible
Air and its quality	negligible	negligible	negligible	negligible	negligible	negligible
Ambient noise*	moderate	moderate	moderate	moderate	moderate	moderate
EMF	-	-	negligible	negligible	-	-
Phytobenthos	-	-	low	low	moderate	moderate
Macrozoobenthos	low	low	moderate	moderate	low	low
Ichthyofauna	moderate	moderate	low	low	moderate	moderate
Marine mammals	low	low	low	low	low	low
Migratory birds	low	low	moderate	moderate	low	low
Seabirds	moderate	moderate	Important	Important	moderate	moderate
Bats	low	low	moderate	moderate	negligible	negligible
Biodiversity**	moderate	moderate	Important	Important	moderate	moderate
Protected areas and the subjects of protection in these areas	moderate	moderate	low	low	low	low
Wildlife corridors	low	low	low	low	low	low
Cultural heritage	-	-	-	-	-	-
Fisheries	negligible	negligible	negligible	negligible	negligible	negligible
Navigation	negligible	negligible	negligible	negligible	negligible	negligible
Prospecting and exploration of mineral resources	negligible	negligible	negligible	negligible	negligible	negligible
Landscape, including cultural landscape	negligible	negligible	low	low	low	low
Population, health and living conditions	negligible	negligible	negligible	negligible	negligible	negligible

** as the highest impact significance on ichthyofauna, marine mammals and seabirds in terms of underwater noise*

*** as the highest impact on the elements of flora and fauna*

14 Comparison of the technology proposed with the technology compliant with all the requirements stated in Art. 143 of the Environmental Protection Law

Pursuant to Article 143 of the Act of 27 April 2001 – *Environmental Protection Law* (consolidated text: Journal of Laws of 2022, item 2556), technologies used in newly launched installations should meet the requirements the determination of which takes into special consideration the following issues:

- use of substances with a low hazard potential;
- efficient production and use of energy;
- ensuring rational consumption of water and other raw materials as well as consumables and fuels;
- use of waste-free and waste-to-waste technologies and the possibility of waste recovery;
- determination of the type, range and size of emissions;
- use of comparable processes and methods that have been successfully applied on an industrial scale;
- scientific and technical progress.

This catalogue of requirements refers to newly launched industrial installations and equipment that are the source of environmental hazards. Due to the process specificity of the construction, operation and decommissioning phases as well as the special conditions of operation in the marine environment, offshore wind farms require verification of these requirements at an early stage of project planning.

Use of substances with a low hazard potential

Due to the specific nature of the offshore wind farm – the generating of electricity from wind power by wind turbines and transformation of the generated electricity by a substation or substations, no chemical substances and mixtures in quantities which would determine the classification of the OWF facilities as an installation with an increased or high risk of a serious industrial accident, pursuant to the Regulation of the Minister of Development of 29 January 2016 *on the types and quantities of hazardous substances present in an industrial plant, which determine the plant classification as a plant with an increased or high risk of a major industrial accident* (Journal of Laws of 2016, item 138) will be used in the Baltica-1 OWF Area. If it becomes necessary to store small quantities of chemicals within the OSS (e.g. lubricants, oils, cleaning agents), these will be stored in dedicated storage areas under the conditions specified in material safety data sheets for those substances and mixtures. Tanks and containers containing chemicals will be chemical resistant, single or double wall, kept in suitable drip trays, in ventilated areas, protected from the elements.

The ways in which chemical substances and mixtures will be stored and handled will be included in the instructions and procedures implemented in the Project area, as well as in the Oil Management Risk and Pollution Prevention Plan. The areas for the storage and use of chemical substances and mixtures, will be appropriately marked and equipped with cleaning agents and sorbents for use in case of spillage.

Efficient generation and use of energy

Offshore wind farms are installations for the production of electricity from wind power that do not require the supply of external energy to function. The electricity produced by the Baltica-1 OWF is expected to be used for own consumption in the amount of approximately 1% of the total capacity of the farm during OWF downtime (i.e. when poor wind conditions prevent turbine operation) and a total of up to 3% of the total annual production during the OWF operation. The Baltica-1 OWF's own needs are the electricity required to supply the systems and equipment necessary for the proper and safe operation of the farm. These are:

- control and monitoring systems for wind turbine and OSSs operation as well as operational data collection;
- communication systems, such as radio communication systems, data transfer between the farm and the operations centre;
- navigational warning systems, i.e. light signals and other warning lights;
- security systems, including fire and safety detection;
- equipment for the generation of thermal energy for OSS heating purposes on the premises, used by station staff during periodic and *ad hoc* servicing and maintenance.

In addition to these sources of electricity consumption, the vast majority of the power produced by the Baltica-1 OWF will be transmitted via a power connection onshore, where it will be connected to the National Power System.

Ensuring rational use of water and other resources as well as materials and fuels

During each phase of the Project, potable water is expected to be consumed for the welfare of the staff carrying out their tasks. Fuels will be utilised to power vessels, helicopters and equipment used during the Project implementation. Natural aggregates and concrete will be used to build the farm's foundations. The quantities of materials and raw materials required for the Project will be accurately specified in the construction design in order to manage their consumption rationally. Water and fuel resources on ships and helicopters, will also be subject to rational resource management, according to the current demand during operations.

Water management will involve the generation of domestic sewage. The domestic sewage generated will be collected, treated and discharged into the sea or transported on land, in accordance with the MARPOL 73/78 Convention. The sewage and industrial waste generated will not be discharged into the environment, but will be secured (selectively segregated in the case of sewage) and transferred to the ports for disposal in accordance with current legislation.

Efficient utilisation of water, fuels and raw materials is assumed, according to the requirements of the construction, maintenance and decommissioning of the Baltica-1 OWF.

Use of waste-free and low-waste technologies as well as possibility of waste recovery

The structural elements of the OWF will be made of materials neutral to sea water and soil substratum (seabed). The resistance to erosion, corrosion or the activity of chemical compounds that may occur in the water is a basic condition for failure-free operation of the OWF.

During each phase of the Project, waste management will be carried out in accordance with the applicable regulations, in particular the MARPOL 73/78 Convention and the Waste Act of 14 December 2012 (consolidated text: Journal of Laws of 2023, item 1587). Production and waste management systems will be developed and implemented to prevent and minimise waste generation.

In order to control the types and quantities of waste generated, a database on products, packaging and waste management (BDO) will be maintained as required by the Waste Act. The waste generated will be collected separately and handed over on land to specialised operators for the recovery of the raw materials from which it was made.

The general approach in this aspect will be to minimise the types and quantities of waste generated and to recycle where possible.

Type, range and volume of emissions

The main emissions during the Project implementation include:

- gas and dust emissions from fuel combustion by vessels during the construction and decommissioning phases, when the workload will be the greatest;
- underwater noise emissions during piling of support structures – monopile and jacket foundations.

The environmental impact analysis shows that exhaust emissions will not significantly affect the atmospheric air quality. They will be dispersed by the movements of the air masses and will not accumulate in the area of the works. High levels of underwater noise will be reduced by minimisation systems to limit their harmful effects on the marine environment.

Use of comparable processes and methods which have been effectively applied on an industrial scale

The Project will be based on technologies and technical solutions that, at the time of contracting services and supplies, will be widely used and certified by specialist classification societies. The implementation of the Baltica-1 OWF will follow good practices developed over many years of offshore wind energy development, adapted to the environmental conditions of the Baltic Sea.

Scientific and technical progress

The implementation of the Project will take into account the current scientific and technical advances, at the time of approval of the final design of the farm, contracting of services and supplies, in the dynamically developing offshore domestic energy industry. The envelope method used in the assessment of impacts in this EIA Report takes into account the dynamics of those changes (e.g. the availability on the market of certified wind turbines with capacities significantly higher than the units currently in use) and will enable the farm to be implemented in accordance with the most modern technical and technological solutions at the time of commencement of its construction.

15 Description of the actions planned with an aim to avoid, prevent, mitigate or environmentally compensate for the adverse impacts on the environment, along with assessing their effectiveness

The environmental impact assessment carried out for the Baltica-1 OWF shows that the Project implementation will not result in significant negative impacts. Nevertheless, impacts of lesser significance are unavoidable. Hence, the rational measures to avoid, prevent and limit the negative environmental impacts resulting from the implementation of the Baltica-1 OWF Project are presented below broken down into individual phases.

The mitigation measures proposed for the construction phase include:

- the use of a Noise Reduction System during piling as described in Section 3.2.2.2.5;
- 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, so 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);
- 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 aim of the supervision is 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 raft 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 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 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 negative impacts on the water and seabed sediments.

The mitigation measures proposed for the operation phase include:

- limiting sources of strong light at night, directed upwards and, where possible, to the sides. This applies in particular to bird and bat 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 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 negative 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 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 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 negative impacts on the water and seabed sediments.

16 Proposal of the monitoring of the proposed Project impact and information on the available results of other monitoring, which may be important for establishing responsibilities in this area

Pursuant to the Article 66 of the EIA Act, a proposal to monitor the impact of the proposed Project in its construction and operation phases is presented in this section, particularly concerning the impact on the forms of nature protection referred to in Article 6(1) of the *Nature Conservation Act* of 16 April 2004 (Journal of Laws of 2023, item 1336), including the objectives and the subject of protection of the Natura 2000 site, and the continuity of the wildlife corridors connecting them as well as the information on other monitoring results available which may be relevant for the determination of responsibilities in this respect.

16.1 Proposal of the monitoring of the proposed Project impact

The temporal and spatial scope of monitoring has been developed in such a way that its implementation will enable detecting the Project 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 survey methodologies will be presented to the Regional Director for Environmental Protection in Gdańsk at least two months before the beginning of the surveys.

16.1.1 Seawater and seabed sediment monitoring

Monitoring during the construction phase

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.

Monitoring during the operation phase

During operation, the monitoring of seawater and seabed sediments should be carried out in parallel with the monitoring planned for macrozoobenthos surveys. This monitoring will provide data which will be compared with the data from pre-investment surveys to confirm the conclusions of the EIA Report that the implementation of the Baltica-1 OWF project will not change the basic conditions of the seabed sediments. Therefore, water samples will be collected at the same time and in the same places as under the macrozoobenthos monitoring plan and then sent for analysis. The analysis of water and sediment samples should include:

- physico-chemical tests of the water column: conductivity, temperature, depth and turbidity; oxygen conditions (dissolved oxygen), total organic carbon (TOC), acidification (pH), DIN, total nitrogen, DIP and total phosphorus;
- tests of nutrients in seabed sediments: loss on ignition, ammonium nitrogen, nitrates, **total nitrogen**, nitrites, **total nitrogen**, phosphates and total phosphorus;
- tests of metals and non-metals in seabed sediments: mercury (Hg), nickel (Ni), lead (Pb), cadmium (Cd), arsenic (As), total chromium ($Cr_{tot.}$), chromium (VI) (Cr IV), aluminium (Al);

- tests of hydrocarbons in seabed sediments: mineral oils (THC), polycyclic aromatic hydrocarbons (16 PAHs).

Data collected within the Baltica-1 OWF Area and analysed in the above scope as well as using reference methods will allow for their comparison with other data collected in the Southern Baltic region for other OWF projects. The reference methods are the survey methods presented in the marine water monitoring program compliant with HELCOM guidelines (e.g. in the Marine Water Monitoring Update published in Monitor Polski (M.P. of 2021, item 414, Annex 1) and in the Regulation of the Minister of Infrastructure of 25 February 2021 on the adoption of an update of a set of properties typical of the good environmental status of marine waters (Journal of Laws of 2021, item 568)).

Monitoring duration

After the completion of the construction stage (operation phase); The monitoring should be carried out one year, and five years after the laying of the wind turbine foundations.

Monitoring during the decommissioning phase

No monitoring of water nor seabed sediments is planned to be conducted during the decommissioning phase.

16.1.2 Underwater noise monitoring

Monitoring during the construction phase

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 omni-directional 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 the 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 from four monitoring components:

a) a mobile survey station located at a distance of 5.5 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^{2}s SEL_{cum} HF-weighted (HF-weighting function for marine mammals with high sensitivity to high frequency sounds – porpoise) and 170 dB re 1 µPa^{2}s 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^{2}s 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 June–August. At the measurement location, the maximum cumulative level of underwater noise of 140 dB re 1 $\mu Pa^2 s\ SEL_{cum}$ 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 $\mu Pa^2 s\ SPL_{rms\ 125\ ms}$). The location of the station 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 them to the competent authority at least 2 months before the piling commences.

After the completion of piling, within 3 months, a report on the actual range of underwater noise impact for piling in the Baltica-1 OWF Area will be submitted to the competent authority .

Monitoring during the operation phase

The data from the measurements conducted at a minimum of 10% of wind turbines should be collected at random. The sound measurement should be conducted at a distance of approximately 100 m from the source of sound and in the central part of the OWF.

Additionally, the measurements should be conducted at a minimum of one station outside the OWF Area at a distance of 1000 m and at a minimum of one station in the area of the nearest protected area, under the condition 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 force 2, 4, 6 on the Beaufort scale and in each season (spring, summer, autumn and winter).

Monitoring during the decommissioning phase

No monitoring of underwater noise is planned to be conducted during the decommissioning phase.

16.1.3 Ichthyofauna monitoring

Monitoring during the construction phase

No monitoring of ichthyofauna is planned during the construction period.

Monitoring during the operation phase

The monitoring of ichthyofauna will be carried out during the OWF operation and after its decommissioning.

During operation phase, the long-term impact of the 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 must 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. 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 in the Baltica-1 OWF Area should be established in the same number as during the surveys for the purposes of this EIA Report preparation.

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.

Monitoring during the decommissioning phase

No monitoring of ichthyofauna is planned to be conducted during the decommissioning period.

Monitoring after the completion of the decommissioning phase

After the completion 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 a 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 decommissioning phase. 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 this EIA Report preparation.

16.1.4 Migratory birds monitoring

Monitoring during the operation phase

The post-investment monitoring should include radar monitoring as well as visual observations during daytime and acoustic monitoring at night. 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. 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. Optimal post-investment monitoring should consist of simultaneous visual, radar and acoustic observations (at night, to identify species) enabling the identification of not only the direction of flight and reaction, but also of the species. A survey station should be located on a permanent platform (e.g. on a substation) or an anchored vessel and should allow observing the OWF from the direction from which birds arrive during a given migration stage, i.e. in spring, it should be located at the south-western edge of the OWF, and in autumn, at the north-eastern edge of the OWF. In each of the migration seasons, no less than 20 days of observation should be carried out in 2- to 5-day sessions, spaced evenly in time during the migration season. Taking into account the experiences from similar projects in the Baltic Sea and the North Sea areas [i.a. EIA Report for Bałtyk II 2015; Bednarska *et al.* 2017; DOF 2024], the authors of the report propose 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 (spring migration) and from July to November (autumn migration), in 4 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 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 during the autumn migration period.

Monitoring during the construction and decommissioning phases

No monitoring is planned to be conducted during the construction nor decommissioning phases.

16.1.5 Monitoring of seabirds

Pre-investment monitoring (before construction begins)

The pre-investment monitoring of the Baltica-1 OWF regarding seabird surveys should include the daytime counting of birds present in the OWF Area and in a reference area. The surveys should be conducted at least once a month 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 route 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. This regards in particular the possibility of the designation of a reference survey area in sea areas not intended for offshore wind energy, but characterised by similar parameters of the marine environment (depth, distance from the shore, etc.). Moreover, only at the building permit design stage, it will be possible to designate the course of seabird survey transects in the OWF Area, in a way to meet the condition of conducting the surveys at different distances from wind turbines.

Monitoring during the operation phase

The post-investment monitoring for the purpose of seabird surveys should include daytime counting of birds present in the OWF Area and in the reference area.

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 in 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 two consecutive years (the first two years of the OWF operation phase after completing the construction and launching the operation), if the construction is not staged. Otherwise, these surveys should be performed after completing 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. During the first season, birds will gradually become acclimatised to the situation in which the sea area designated for the project becomes inaccessible to them (the so-called habituation), which will result in changes in their distribution. Therefore, this period can be treated as a transitional one and only in the second year the scale of the Baltica-1 OWF impact on the seabirds staying in this area will stabilise.

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.

Monitoring during the construction and decommissioning phases

No monitoring is planned to be conducted during the construction nor decommissioning phases.

16.1.6 Monitoring of marine mammals

Due to the confirmed occurrence of porpoises in the area of the proposed OWF and in 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.

Monitoring during the construction phase

In the area of the proposed OWF, at least 5 C-PODs/F-PODs should be placed, preferably in the same or similar locations as during the environmental monitoring. Additionally, 6 C-PODs/F-PODs should be installed in a gradient system covering an area up to 20 km from the boundary of the Baltica-1 OWF Area. The gradient system requires the classification of samples according to the distance and excludes the question of selecting a control site [Bailey *et al.* 2014]. It is also more effective than randomly selecting checkpoints to detect changes caused by noise. It has been shown to be more effective in studying the movement of the harbour porpoise in response to the piling process and in examining how temporary impacts vary with the change in distance [Dähne *et al.* 2013]. Precise distribution of these stations in the gradient system requires the indication of a detailed range. The monitoring should begin no later than six months before the beginning of piling and should be continued during the piling and at least six months after its completion.

Monitoring during the operation phase

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 (in the same locations, if possible) that were used during the construction phase in order to determine if the farm operation influences porpoises to avoid its area.

Monitoring during the decommissioning phase

No monitoring is planned to be conducted during the decommissioning phase.

16.1.7 Monitoring of benthic organisms

Monitoring during the operation phase

Due to the occurrence of local changes in the seabed biocenosis structure caused by the OWF construction, the post-implementation monitoring of benthic organisms should be carried out. 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 a project in this part of the Baltic Sea is not supported by the knowledge gained during the post-implementation monitoring. At least 12 OWFs are planned for construction by 2040 in the Polish part of the open waters of the Southern Baltic [PWEA 2019]. An important aspect of the monitoring of benthic organisms is also to organise the hitherto random knowledge on the colonisation of artificial hard bottom substrates by animal and plant periphyton complexes in the PSA (see Subsection 10.2.2.9.2). An important strategy of monitoring surveys is the possibility to compare them with the data obtained during the inventory surveys. For this reason, the planned monitoring should cover the seasons similar to the inventory surveys. Due to the lack of standard, commonly used guidelines for the implementation of this type of surveys in the PSA, an original monitoring methodology was proposed, based primarily on the life cycle of benthic organisms in the Southern Baltic. The benthic monitoring proposal developed herein was also based on the literature of 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, in accordance with the methodology of Kruk-Dowgiałło *et al.* 2010. The proposed scope of methodology for benthic organisms is presented in Table 16.1.

Table 16.1. Programme of benthos monitoring surveys in the Baltica-1 OWF Area

Time	Parameter	Methodology
After the first year since the installation of wind turbine foundations	Macrozoobenthos	Surveys of macrozoobenthos complexes (soft-bottom – with a van Veen grab sampler, hard-bottom – with an ROV) in the area of 5 foundations / support structures of wind turbines. In the vicinity of a single foundation / support structure, 6 stations should be designated, including 3 stations along the main profile transect (along the near-seabed current axis) at a distance of 20, 50 and 100 m from the foundation, and 3 stations along the transect perpendicular to the main profile (reference profile) at the same distances. Additionally, for each of the foundations covered by the survey, one station should be designated located in the central point (outside the cable route) between the adjacent foundations / support structures. The surveys will be carried out after the construction of all structures has been completed, once, in a period similar to the period of inventory surveys.
After the first year since the installation of wind turbine foundations	Periphytic fauna and flora	The surveys of periphytic fauna and flora will be carried out on five underwater structural components of wind turbines. At each object surveyed, a video (or photographic) documentation of the entire section covered with macroalgae and periphytic fauna will be made (note: the depth of periphytic flora occurrence may differ from the range of periphytic fauna occurrence). Beginning from the water surface to the depth of the maximum range established for the periphyton occurrence, at particular depths, within a maximum interval of 2 m, samples from a specific area will be collected by a scuba diver or an ROV for the surveys on taxonomic composition and biomass of periphytic flora and fauna. The surveys will be carried out once a year in June.
After the third year since the installation of wind turbine foundations	Macrozoobenthos	Continuation of the monitoring surveys from the second year at the same stations, during the restoration and formation of the originally damaged macrozoobenthos complex.
After the third year since the installation of wind turbine foundations	Periphytic fauna and flora	Continuation of the survey from the second year on the same stations during the formation of a new periphytic fauna and flora complex.

Time	Parameter	Methodology
After the fifth year since the installation of wind turbine foundations	Macrozoobenthos	Continuation of the monitoring surveys from the second year at the same stations, during the restoration and formation of the originally damaged macrozoobenthos complex.
After the fifth year since the installation of wind turbine foundations	Periphytic fauna and flora	Continuation of the survey from the second year on the same stations during the formation of a new periphytic fauna and flora complex.

Monitoring during the construction and decommissioning phases

No monitoring of macrozoobenthos is planned during the construction nor decommissioning periods.

16.1.8 Monitoring of bats

Monitoring during the operation phase

The purpose of the post-implementation monitoring is to verify the assessment assumptions in terms of changes in the use of the Baltica-1 OWF Area by 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. The devices can be mounted on e.g. a ship, OSS, buoy or on a wind turbine [Poerink *et al.* 2013].

Post-implementation monitoring should cover the period of three years, in the first year after the wind farm has been put into operation and in the second and third year 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].

Monitoring during the construction and decommissioning phases

No monitoring of bats is planned during the construction nor decommissioning phases.

16.2 Information on the available results of other monitoring, which may be important for establishing responsibilities in this area

The environmental monitoring of the Polish part of the Baltic Sea is carried out as part of the State Environmental Monitoring (SEM). This monitoring includes the surveys of the following parameters:

- physico-chemical: temperature, salinity, oxygen concentration, Secchi disc visibility, content of nutrients, heavy metals and persistent organic pollutants;
- biological: phytoplankton, zooplankton, phytobenthos and macrozoobenthos.

The level of harmful substances in the water and in marine organisms as well as the content of radionuclides in the water and in sediments are also monitored. In addition, ichthyofauna and optional microbiology surveys are carried out, as well as the surveys of hydrographic conditions, waste in the marine environment and underwater noise [SEM Program, 2020]. The results of this monitoring are collected and stored in the Oceanographic Database at the Gdynia Maritime Branch of the IMWM-NRI and in the "ICHTIOFAUNA" database at the Chief Inspectorate for Environmental Protection in Warsaw [SEM Program, 2020].

Moreover, since 2015, the Monitoring of Marine Habitats and Species has been carried out covering 8 species of fish and lampreys (sea lamprey, river lamprey, twaite shad, asp, weatherfish, spined loach, sabrefish and European bitterling), 4 species of marine mammals (harbour porpoise, grey seal, harbour seal and ringed seal) and 5 natural habitats connected to marine areas (Sublittoral sandbanks (1110); Estuaries (1130), Coastal lagoons (1150); Large shallow inlets and bays (1160) and Boulder areas and rocky reefs, Reefs (1170)). The results of the Monitoring of Marine Habitats and Species are collected and made available by the Chief Inspectorate for Environmental Protection in Warsaw.

Within the framework of SEM, as part of the task entitled "Bird monitoring including Natura 2000 Special Protection Areas", a number of bird monitoring surveys is carried out, which may be important for establishing the obligations of monitoring the impact of the proposed Project, including:

- the Flagship Bird Species Survey, covering the monitoring of 12 bird species with the characteristics of the so-called flagship species such as, the mute swan, red-necked grebe, black-necked grebe, Eurasian bittern, grey heron, white stork, western marsh harrier, common crane, black-headed gull, common tern, black tern and rook;
- the Monitoring of Wintering Seabirds (MWS), covering the monitoring of species of average abundance and the abundant species of Anseriformes wintering in the Polish zone of the Baltic Sea, including primary species (the red-throated diver, the black-throated diver, the horned grebe, the red-necked grebe, the long-tailed duck, the velvet scoter, the common scoter, the black guillemot, the razorbill, and the common guillemot) as well as additional species (the great crested grebe, the European herring gull, the great black-backed gull, the common gull, and the black-headed gull).

The results of these monitoring surveys are also collected and made available by the Chief Inspectorate for Environmental Protection in Warsaw.

The Fisheries Monitoring Centre collects data on the volume of fish catches carried out in the PSA. The analysis of these data will enable the future assessment of the proposed Project impact on fishery.

In the perspective of several dozen years, for which the implementation of the Baltica-1 OWF is planned, the survey results obtained as part of the monitoring conducted and the information on other activities carried out in the sea areas can be used to monitor the Project impact on the environment. This is due to the fact that the scope of these monitoring surveys and information covers those elements of the marine environment which the proposed Project may affect directly and indirectly. In addition, the long-term series of data, will allow eliminating from the assessment the short-term changes in the environment resulting from the complex marine ecosystem characteristics, and not being a consequence of the proposed Project impact.

In the Baltic Sea area, several monitoring programmes concerning marine mammals have been conducted. Probably the most comprehensive surveys of the Baltic population of the harbour porpoise have been carried out as part of the SAMBAH project, during which the data on the harbour porpoise echolocation frequencies at 304 C-POD stations located in the Baltic Sea and the adjacent waters were collected from May 2011 to April 2013 [SAMBAH 2016].

The SAMBAH project methodology was also used in the monitoring of the harbour porpoise status in the Polish sea areas by CIEP in Poland as part of the project 'Pilot implementation of species and marine habitats monitoring in 2015–2018' [Malinga *et al.* 2018]. The monitoring campaign covered two areas that were located within the Pomeranian Bay and the Stilo Bank. Additionally, the current information on the marine mammals observations at Polish coast are collected by WWF and the Hel Marine Station IO UG [WWF Poland, 2024].

What is more, the monitoring of marine mammals is conducted for all the planned OWFs. This constitutes a supplementary source of information to the SAMBAH and CIEP projects. Access to the results of those surveys would enrich the knowledge on the topic of seasonal occurrence of these animals within the Polish exclusive economic zone over a longer period of time.

17 LIMITED USE AREA

The issue of establishing limited use area (hereinafter: LUA) is regulated by the provisions of Article 135(1) of the *Environmental Protection Law* (consolidated text: Journal of Laws of 2022, item 2556): '*If from the ecological review or from the project environmental impact assessment required by the provisions of the Act of 3 October 2008 on the provision of information on the environment and environmental protection, public participation in environmental protection and on environmental impact assessment or from the post-implementation analysis, it appears that despite the use of the available technical, technological and organisational solutions, environmental quality standards cannot be observed outside the factory or other facility for wastewater treatment plants, landfill sites, composting sites, communication route, airport, overhead power line and power substation as well as radiocommunication, radionavigation and radiolocation installations, an area of limited use is created*'.

From among the above mentioned tasks, one prepared for implementation within the proposed Project, i.e. a power substation may require the creation of an LUA.

The reasonableness of establishing LUA with reference to the planned OWF should be considered by analysing whether the environmental quality standards outside the planned OWF cannot be met, as understood for a plant within the meaning of Article 3(48) of the Environmental Protection Act: '*plant – is understood as a single or many installations including the premises, to which the operator has the legal title, as well as the equipment situated thereat*'.

This EIA Report indicates that at the current stage of the Project preparation, there are no grounds to determine the possibility of exceeding the environmental quality standards either in relation to air, noise, wastewater or the EMF – the intensity of the magnetic field and the electric field. The permissible values will not be exceeded outside the area to which the Applicant holds a legal title. The nearest areas for which environmental quality standards were specified in the aforementioned scope are located onshore, at a distance of over 75 km from the proposed Project.

18 INFORMATION ON DEMOLITION WORKS CONCERNING PROJECTS LIKELY TO HAVE A SIGNIFICANT IMPACT ON THE ENVIRONMENT

There are no structures nor installations within the area intended for the construction of the Baltica-1 OWF. Therefore, it will not be necessary to perform any dismantling work prior to the commencement of the construction phase.

19 Analysis of possible social conflicts related to the proposed Project, including the analysis of impacts on the local community

In connection with the implementation of the Baltica-1 OWF, two types of social conflicts may arise, which, due to their spatial extent, can generally be divided into two types – national, which may be caused by a general lack of public confidence in the production of energy from renewable sources and the development of domestic offshore energy, and local, the basis of which will be a conflict resulting from a change in the current use of the sea area in the Project implementation vicinity.

Large-scale renewable energy production is a relatively new sector of the economy, and its rapid development in the country began in the last decade. On a national scale, offshore wind energy shows the greatest potential as a leading industry in the energy transformation, directed by the global drive to reduce carbon dioxide emissions in order to prevent ongoing climate change and to fulfil international obligations resulting from the signed agreements. Support of the society for its development is strong, as shown by the results of a study commissioned by the Ministry of Climate and Environment in 2020 and published in the document entitled '*Jednotematyczne badanie świadomości i zachowań ekologicznych mieszkańców Polski*' [Single-theme study of ecological awareness and behaviour of the residents of Poland]. As many as 83% of respondents support or strongly support the development of offshore wind farms in Poland, and 76% would like to use electricity produced by offshore wind farms in their homes. Sixty five percent of respondents expressed the opinion that offshore wind energy has a definitely or rather positive impact on the environment. Although this was not indicated in the report, it probably referred to the reduction of carbon dioxide emissions compared to the production of energy from conventional energy sources. In addition, 81% of respondents indicated that the development of offshore wind farms will definitely or rather increase Poland's energy security. Support for the development of offshore wind energy is strong, but it should be noted that as many as 71% of the people surveyed stated that their knowledge of offshore wind energy is average or lower. The lack of knowledge on the subject is revealed in the answers provided, since from 10 to 25% of respondents were unable to provide any answer to the questions asked. Although it is important that Polish society supports the development of domestic offshore energy, it is also important to disseminate knowledge about it, which will allow for a better understanding of its specificity and potential.

Contrary to the general acceptance by the country's society, the reception of the Baltica-1 OWF implementation by local communities of coastal communes may be negative and result in protests. The Project implementation may be perceived as a possible cause of future financial losses of specific social groups using the sea area in which the farm is to be built, mainly fishermen and people involved in fish processing. The implementation of other offshore wind farm projects in Polish sea areas so far indicates great interest from local communities of coastal communes and social groups using the sea area, however, no protests have been reported. To that end, a number of educational and promotional activities are being carried out, the aim of which is to raise social awareness, especially among local communities.

In order to properly assess the possibility of social conflicts, it is necessary to determine which forms of use and which social groups will be directly exposed to the Project impact. The starting point for this analysis should be the card for the sea basin POM.60.E, in which the Baltica-1 OWF development area is located. According to the card, the sea basin is the most important for maritime transport and fishing. Both of these activities have been described in greater detail in relation to the Project development area in Sections 7.10.2 and 7.10.3. Due to the significant distance from the coast, it does not seem probable that the Project impact on maritime and coastal tourism could be a source of social conflict – as shown in the analysis, the wind farm, due to its distance from the shore, will not be visible from the coast.

Summing up the analysis of the impact on **fishery**, it can be stated that the construction of the Baltica-1 OWF will exclude a certain part of the area from the possibility of fishing and will limit the possibility of using certain fishing gear. Pursuant to the Act of 21 March 1991 *on the maritime areas of the Republic of Poland and maritime administration* (consolidated text: Journal of Laws of 2023, item 960), *'around artificial islands, structures and devices or their complexes understood as a group of artificial islands, structures or devices located no further than 1000 m apart, as well as cables or pipelines or their groups, the relevant director of the maritime office may, by way of a regulation, establish safety zones adapted to the type and purpose of artificial islands, structures and devices or their complexes, cables or pipelines, extending no further than 500 m from each point of their outer edge, unless a different range of the zone is permitted by generally accepted international standards or recommended by the relevant international organisation'*, in order to ensure the safety of the farm and other users of the maritime space. Restrictions on fishing and navigation resulting from the established safety zones will be the main cause of potential social conflicts.

The construction of offshore wind farms in the Baltic Sea is in the pre-investment phase and the cooperation with fishing communities so far has been based mainly on meetings and consultations initiated by project owners or representatives of the fishing sector. Hitherto, the issues of maritime space occupation have been the subject of dialogue and joint development of solutions beneficial to both parties. There are no legal instruments that would clearly indicate the course of action, the obligations and rights of the parties and the possibilities of obtaining compensation for material losses incurred. The first EU document to highlight the incompatibility between the development of offshore wind energy and fishing activities is the European Parliament resolution of 7 July 2021 *on the impact on the fishing sector of offshore wind farms and other renewable energy systems* (OJ C.2022.99.88). The main objective of this document was to indicate to the Member States ways of protecting the interests of fishermen by outlining possible systemic solutions. The authors of the resolution noted that although fishing has a relatively small impact on GDP, it is of great importance to fishing communities in many Member States, because most of them are small family businesses, often passed down from generation to generation. It indicated the need to ensure such provisions in maritime planning which would guarantee the coexistence and synergy of offshore wind farms and fisheries in the same area. It also called for dialogue and cooperation between project owners and fishermen at the early stages of designing offshore wind farms. It was emphasised that it is necessary to award fishermen appropriate compensation should the construction of offshore wind farms affect their activities. Although the adoption of the resolution is of a declarative nature only, the very creation of the document indicates that the protection of fisheries, especially traditional coastal fisheries of great cultural value, is important for the European community. The authors of the resolution, aware of the low rank of the document, the adoption of which is of a declarative nature only, noted that further measures at the EU level, including regulations, may be necessary, as there is evidence that the spatial planning of sea areas by the Member States does not guarantee fair consideration of fishing and, where appropriate, compensation for fishermen.

The basic national document referring to the sharing of maritime space by the fishing and offshore wind energy sectors is the *Maritime Spatial Plan for the Internal Marine Waters, Territorial Sea and*

Exclusive Economic Zone at a scale of 1:200 000 (MSPPSA). Its adoption allowed for the first time in Polish legislation to implement general legal solutions relating to the possibility of implementing various forms of use of maritime space by establishing a hierarchy of functions in sea basins and specifying the principles and conditions under which they can be applied. In the sea basin POM.60.E, in which the Project area is located, it has been specified that fishing can be carried out without changes until the commencement of the construction of offshore wind turbines, while during their operation, fishing is prohibited in the safety zone of each structure and in places in which the internal connection infrastructure safety may be at risk until the rules for conducting fishing in the sea basin are developed. The provisions of the MSPPSA are, therefore, not a revolution, because they result directly from the existing rules for the implementation of artificial structures at sea – platforms for the exploration and extraction of hydrocarbons, but what is important, they introduce a third party into the dialogue – the state administration. In the case when it is difficult or impossible to develop solutions which satisfy project owners of offshore wind farms and fishermen, both of these groups will be able to turn to the state administration bodies to resolve the disputes on the basis of the applicable regulations. The MSPPSA does not refer to possible compensation for fishermen when they prove losses caused by the construction of offshore wind farms. However, this issue can be secured when developing the rules for conducting fishing in the sea basin. Although the MSPPSA does not specify clearly who should develop these rules, considering that they are to apply to the entire sea basin POM.60.E, this obligation will most likely rest with the maritime administration body with the participation of fishermen and project owners of offshore wind farms.

Another document raising the issue of sharing the maritime area by fisheries and offshore wind energy is *Porozumienie sektorowe na rzecz rozwoju morskiej energetyki wiatrowej w Polsce (Porozumienie Sektorowe)* [the Sectoral Agreement for Offshore Wind Energy Development in Poland (Sectoral Agreement)], signed on 15 September 2021. The primary objective of this document is to support the development of the offshore sector in Poland and ensure the greatest possible participation of Polish entrepreneurs in the supply chain for offshore wind farms. In accordance with Article §4.3(8), the signatories of the Agreement are obliged to develop the Code of Good Practice for the Coexistence of Offshore Wind Farms and Fisheries, which will contain recommendations, principles and conditions for conducting fishing activities in the area of OWF projects and within the export infrastructure area, including:

- a description of the method of verifying possible losses and possible and adequate methods and scale of their compensation for documented, lost fishing opportunities for owners and operators of fishing vessels;
- potential possibilities of using fishing vessels for the construction or operation of OWF projects;
- potential possibilities for fish stocking and breeding fish in selected and agreed areas of OWF projects;
- insurance conditions for fishing vessel owners;
- description of communication methods between project owners and the fishing community.

According to the information from July 2023, the Code is being prepared by the Polish Wind Energy Association[17].

[17] Full record of the meeting of the Maritime Economy and Inland Navigation Committee (No. 158) of 7 July 2023. Chancellery of the Sejm, Sejm Committees' Bureau.

Until the development and implementation of potential rules of conducting fishing in the sea area, the need for which was specified in the MSPPSA and the Code resulting from the provisions of the Sectoral Agreement, the issue of potential conflict resulting from the current use of the Baltica-1 OWF development area remains open and it is necessary to address it in this EIA Report.

The impact of the Baltica-1 OWF on fishing in its development area may include:

- reduction of the area of fishing grounds due to the physical exclusion of a part of the area from fishing and the restrictions resulting from the establishment of safety zones;
- change in commercial fish stocks as a result of the Project impacts;
- change of these shipping routes to fishing grounds which run through the area in which the Project will be located.

The impact on fishing will directly affect people involved in commercial fishing activities, owners of companies involved in fishing and/or fish processing and employees of these companies. The majority of people employed in fishing and fish processing are residents of coastal communes. The reduction in catches due to spatial restrictions and increased fishing costs may negatively affect their earnings and employment security. In this context, it is necessary to estimate the losses of the fishing sector due to the establishment of the Baltica-1 OWF, however, this is a difficult task to perform without the knowledge of the scope of restrictions that will be introduced at the construction stage and later stages of the Project.

Surveys carried out for existing offshore wind farms have shown that limiting the fishing space may have a twofold effect. The first is a decrease in the size of the catches of demersal fish, because within an OWF the greatest restrictions on use concern demersal fishing gear. The second, opposite effect is an increase in the catches of pelagic fish, which may be caused by the so-called 'artificial reef' effect. This phenomenon results from the appearance in the environment of artificial structures with a hard surface, which can be overgrown by periphytic fauna and flora. Objects submerged in water, inhabited by plant and animal communities, constitute feeding grounds, places for rearing of fry and shelter for fish, providing them with a convenient habitat influencing the development of their population. In the case of the Baltica-1 OWF, these will mainly be the submerged structures of wind turbines and OSSs as well as seabed corrosion protection around the foundations made of natural aggregate. The Baltica-1 OWF Area may therefore become a refuge for many species of fish, including the commercially caught ones. Favourable environmental conditions for the development of ichthyofauna may contribute to the development of the Baltic fish population through increased recruitment of fry, and thus increase fishing resources outside the Baltica-1 OWF Area. However, such an effect of the implementation of the farm will be measurable only at the operation stage after at least several years of its operation, when the qualitative and quantitative structure of the periphytic organisms has stabilised and the fish have adapted to the new conditions in the environment. Concluding, the construction of the Baltica-1 OWF may contribute to an increase in fish catches in the Baltic Sea, but the verification of whether this will happen will only be possible during the operation phase. Restrictions on fishing in the Project area and the financial losses thus caused will appear with the commencement of the construction phase and will not subside until the end of its operation, the dismantling of the farm structures and the revocation of the safety zones.

They may force a change in the fishing location and the method of its performance (e.g. taking up pelagic fishing instead of demersal fishing), which may affect the profitability of fishing and indirectly fish processing activities. The coverage of potential financial losses may be ensured by awarding compensation on the principles to be specified in the *Code of Good Practice for the Coexistence of*

Offshore Wind Farms and Fisheries. At the later stages of the Project, the Project Owner intends to hold consultation meetings with fishermen from coastal communes in order to develop solutions for the shared use of the Baltica-1 OWF sea area that will meet the expectations of both parties, with the overriding objective resulting from the obtained decisions, permits and MSPPSA provisions, in order to ensure the effective and safe operation of the farm.

The second important form of use of the Baltica-1 OWF Area is **maritime transport**. In **the west-east direction, the area is crossed by the customary shipping route leading to the port of Klaipėda (Lithuania**). Pursuant to the MSPPSA, during the operation of an offshore wind farm, until the conditions for safe navigation have been established by a decision of the territorially competent director of the maritime office, sailing is restricted to vessels up to 50 m in length, with the exception of vessels involved in the service and maintenance of offshore wind farm structures and installations as well as aquaculture. However, in accordance with the MSPPSA, sea basins the main function of which is transport have been designated to ensure transit through Polish sea areas for ships sailing to ports in Lithuania, Latvia and the Kaliningrad Oblast (POM.47.T, POM.52.T, POM.69.T and POM.81.T). The sea basin with a main function of transportation – POM.52.T has been delineated south of the Baltica-1 OWF Area, in order to ensure a safe route for ships sailing on routes leading to Klaipėda. After the Baltica-1 OWF is put into operation, the farm area will be available for navigation with restrictions on the type and size of vessels. Detailed rules for navigation in the farm area in individual stages of its implementation will be established by the relevant director of the maritime office. At present, the farm area is an open sea area allowing a free passage of ships. The OWF will be designed and built with particular consideration of issues regarding the safety of construction, operation and decommissioning of the OWF, ship navigation and protection of the marine environment, including the need to ensure free passage through the OWF Area in accordance with applicable legal regulations and administrative decisions and the need to conduct rescue operations.

20 Indication of difficulties resulting from technical shortcomings or gaps in the state of the art encountered during the preparation of the report

Environmental impact assessment is an instrument of environmental protection based, among others, on the precautionary principle and the principle of preventive action, which are enshrined in Article 191(2) of the Treaty on the Functioning of the EU. The consequence of the precautionary principle is, above all, the necessity to examine and consider all foreseeable effects of the implementation of planned activities (projects), which may manifest themselves primarily as negative impacts on the environment. The obligation resulting from the EIA Directive, and then the EIA Act, is for the person planning to implement a project to provide appropriate information about the project itself, as well as data on the environmental conditions for the project implementation location and the area in which impacts may occur. Data and information in the above-mentioned scope should allow for the environmental impact assessment to be carried out to a degree that allows for the identification and assessment of all possible negative impacts of the project before the consent for its implementation is issued. The sources of data allowing for the description of the state of individual environmental components are primarily surveys, but also any other information which allows the assessment of the impact on the environment.

In the case of the proposed Project in question, firstly, the scope of information and data needed to conduct an environmental impact assessment was analysed. The information regarding this subject was presented in the Environmental Scoping Report, which constituted the basis for issuing a decision specifying the scope of the environmental impact assessment report as well as the surveys and data that should be carried out and collected in order to prepare it. On that basis, the performance of the surveys determined as necessary to be conducted was planned and commenced.

The decision indicated that the condition for ensuring the effectiveness of the environmental impact assessment is the provision of data and information of appropriate quality. Experience related to the preparation and implementation of projects shows that there are situations which, due to various circumstances, may constitute an objective obstacle to obtaining or providing information from the sources assumed to be basic or most appropriate at the time of their planning. In such cases, both the community and national legislators have introduced regulations allowing for obstacles encountered in the preparatory work for certain knowledge deficiencies. What is more, it can be said that these regulations even indicate the need to present such information. The EIA Act, in Article 66(1)(17), states that an EIA Report should include an indication of difficulties resulting from technical shortcomings or gaps in current knowledge encountered during the preparation of the Report. The EIA Directive, in Annex IV, states that the Report should include ‘A description of the methods or evidence of forecasting used to indicate and assess significant environmental impact, including details of the difficulties (for example, technical deficiencies or lack of knowledge) encountered in collecting the necessary information as well as a presentation of the main uncertainties’. From the provisions of the Directive itself, it can be clearly concluded that knowledge deficiencies may not only result from technical deficiencies (as indicated by the words 'for example'). By citing the presented provisions, the authors of this report, referring to the cited regulations, describe below the difficulties they had to face in preparing this report. It should be noted here that the inability to include in the report the information expected by the body issuing the decision on environmental conditions for the reasons presented does not in any way constitute an obstacle to an effective performance of an environmental impact assessment due to the possibility of extrapolating the data collected as a result of the surveys which were possible to carry out. It should be emphasised that the extrapolation procedure can be applied thanks to the identical subject scope of the survey results, the data currency, the immediate vicinity of the area covered by the surveys conducted, the characteristics of the components examined and the scientific knowledge allowing for the claim that extrapolation in this case is an effective research tool and the basis for further analyses.

Taking the above into account, it should be indicated that the scope of the EIA Report, in accordance with the provision defining the scope of the Report, should include surveys that had to be performed in buffer zones around the development area and some of these surveys should also cover Swedish waters. In the Swedish EEZ, the surveys carried out covered:

- physico-chemical properties of water;
- ambient noise monitoring;
- marine mammals monitoring;
- seabird monitoring.

In relation to the ichthyofauna surveys, the relevant Swedish public authorities refused to grant the permit applied for in December 2022 to carry out the desired surveys, referring to the possibility of their negative impact on the subject of the surveys.

The permit for seabed surveys (geophysical) as well as phytobenthos and zoobenthos surveys, has not been obtained yet, despite the fact that the application was submitted to the Swedish authorities in due time (November 2022). As of the date of submission of the EIA Report, the case is pending and it is not known when and whether such a permit will be obtained. It is worth noting that the application to obtain the required consent of the Affected Party was submitted approximately 20 months ago, and together with the application, the Affected Party authorities were informed of the purpose of the surveys, as well as the manner and time limits for its performance and the planned date for the preparation of the EIA Report (and therefore its submission to the authority). As a result, the survey contractor is faced with obstacles that are beyond their control and which they cannot overcome by their own actions. It should be added that despite the ongoing procedure for granting consent to surveys on inanimate nature elements, the circumstances surrounding it and the approach of the authorities of the Affected Party do not indicate the possibility of obtaining it within a reasonable time, what is more, there is a high probability that this consent will not be issued at all. Therefore, performance of the discussed surveys may be completely impossible or impossible in such a way that they could be included in the EIA procedure, because the deadline for obtaining consent, if it is issued at all, will be very late and will go beyond the prospect of obtaining the DEC. In this case, it should be underlined that the surveys not carried out were to be conducted only within a small area, in a buffer of up to 1852 m from the Baltica-1 OWF Area. Despite this, based on the surveys conducted and the knowledge of the properties of the component in question, it can be stated with full responsibility that the lack of this surveys in the marine area of the Affected Party (Sweden) would not change the conclusions drawn from the surveys conducted (presented in Appendix 1) nor the results of the environmental impact assessment. It should be pointed out that for ichthyofauna as a mobile aspect of the environment, data from the Polish EEZ can be adopted as representative. In the case of other aspects, the impact caused by suspended solids will be negligible for both abiotic components (seabed, raw materials, habitats) and biotic components (phytobenthos and zoobenthos).

The greatest difficulty which appeared while preparing the EIA Report was the wide range of technologies and devices possible to be applied during the implementation of the Project which subsequently 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 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 assuming that units with a capacity of 14 MW 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, this EIA Report adopted the concept of envelope conditions, i.e. the assessment included those of the technological solutions and parameters of the Project considered that may cause the greatest 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 PSzW decision, etc.). Thanks to such approach, the impact analysis always assesses the final scope of the Project, regardless of the technical parameters and technologies selected. For this reason, it can be assumed that the impact assessment is reliable because it takes into account 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 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, 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 were carried out for the Baltica-1 OWF. 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.

21 SUMMARY AND CONCLUSIONS

The analysis included in this EIA Report demonstrated that the implementation of the Baltica-1 OWF in both the APV and the RAV is possible and will be characterised by the same set of impacts. The assessment of these impacts proved that their impact will have the same significance for individual components of the environment in both variants. The analysis carried out indicated the possibility of negative impacts. However, with the application of the indicated mitigation measures, the implementation of the Project will not cause significant negative impacts.

The analysis of cumulative impacts demonstrated that the cumulative impact of underwater noise generated during the construction phase of the Baltica-1 OWF, Bałtyk I OWF and Södra Victoria OWF, if the construction phases of these projects overlap in time, may cause negative impacts, which, however, will not be significant with the application of NRS. The synergy of the barrier effect for birds and bats from individual wind farms built both in Polish and Swedish waters during their operation phase may cause negative impacts of moderate significance.

Moderate environmental impact will also be caused by extensive oil spills (Tier III, catastrophic) in the event of an unlikely but impossible to rule out collision of large ships involved in the Project implementation (including collisions of vessels transporting farm elements far from the development area) or a collision of a ship with the farm structure. However, the risk of such events occurring is extremely low and very unlikely to occur in any phase of the Project.

In order to minimise the impacts on environmental components, as well as cumulative and transboundary impacts, a number of mitigation measures is proposed. A proposal for environmental monitoring is also presented to determine the actual range of impacts during the construction and operation phases and to develop optimal methods for counteracting their effects.

Due to the location of the Project area near the boundary of the Swedish EEZ, transboundary impacts on the area of this country may occur, the most serious of which concerns the impact of underwater noise causing a behavioural response of porpoises, which was not classified as a significant transboundary impact. The results of the modelling of underwater noise propagation did not show that the sound levels generated during the construction phase causing TTS and PTS in harbour porpoises with the application of NRS were significant in the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308) and the significance of the impact on marine mammals was assessed to be low. According to the modelling results, the propagation of noise causing a behavioural response of harbour porpoises may cover an area at a distance of up to approximately 20 km – noise generated in one location and more in the case of at least two sources of underwater noise from the boundary of the Baltica-1 OWF Area, and therefore it will also be significant in Swedish waters, including the Natura 2000 site *Hoburgs bank och Midsjöbankarna* (SE0330308). The transboundary impact may also include birds, mainly diving benthivorous birds and to a lesser extent piscivorous birds. In the construction phase, this impact may result from the barrier effect, the risk of collision, the emission of artificial light, noise and vibrations. In the operation phase, it will result from the occupation of habitats (feeding grounds), the barrier effect and collision risk as well as artificial light emission, while in the decommissioning phase, the barrier effect, the risk of collision and artificial light emission.

The analysis of social conflicts indicated that the greatest impact of the Baltica-1 OWF implementation may concern the adverse effect on fishing and navigation. However, the implementation of offshore wind farm projects in Polish maritime areas to date has not caused social conflicts. In the case of fishing, restrictions resulting from the presence of the farm structures and the established safety zones may result in a reduction in the catches in this region of the Baltic Sea and financial losses for the fishing sector. The occupation of the sea area may also contribute to changing and extending the length of the shipping route leading to the port of Klaipėda. These issues were raised in the MSPPSA, which states that in the sea basin POM.60.E (in which the farm will be located), the forms of use other than renewable energy generation are secondary to it and will be subject to restrictions from the moment of the offshore wind farms construction.

The analysis of the technology adopted for the implementation of the Project, the resources of abiotic and biotic components of the environment and the conditions resulting from the current and planned use of the sea area in the vicinity of the proposed OWF, as well as the results of the analysis of the impacts on the natural environment and the development of the sea area, showed that the Baltica-1 OWF can be implemented both in the APV and the RAV. As indicated above, both variants will be characterised by the same impacts, which will have a very similar scale and significance of impact. The implementation of the RAV will involve a slightly higher implementation expenditure of forces and resources, which will translate into a larger number of ships and maritime operations in all phases of the Project and into greater generation of waste, fuel and material consumption. The APV assumes the construction of the farm also based on the most up-to-date and efficient wind turbine designs that will be available at the stage of contracting supplies. For this reason, the assumptions adopted in this EIA Report for this variant constitute an envelope of the worst environmental impact conditions, but there is a possibility of their reduction, mainly due to the possibility of reducing the required number of wind turbines. In contrast to the implementation of the RAV, which was based on narrow assumptions of one turbine capacity – 14 MW, which are currently being implemented in OWFs under construction, the APV assumes the possibility of using units with a higher nominal capacity of up to 25 MW. Thanks to this, the maximum development of the area will be reduced compared to the envelope assumptions included in the EIA Report, which may reduce the negative impact of the Project on the environment. Therefore, the implementation of the APV was also considered the most beneficial option for the environment.

The implementation of the Baltica-1 OWF is in line with the international and national aims of diversification of electricity sources and energy security, resulting from the documents indicated in Section 1.6. The operation of the Baltica-1 OWF with a maximum capacity of 900 MW will also contribute to fulfilling the obligations of the energy transformation of the European Union countries, i.e. moving away from conventional sources of electricity production and obtaining it from renewable sources.

The impact assessment conducted for the Baltica-1 OWF, taking into account mitigation measures, did not indicate significant negative impacts on the environment, and the identified impacts and their effects are acceptable.

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24 NON-SPECIALIST ABSTRACT

The Environmental Impact Assessment Report was prepared to determine the impact of the Baltica-1 Offshore Wind Farm (hereafter: Baltica-1 OWF or the Project) implementation on various components of the natural environment as well as the hitherto and the planned usage of the sea area in which the Baltica-1 OWF construction is planned. The scope of the Report results from the provisions of Article 66 of the Act of 3 October 2008 *on the provision of information on the environment and environmental protection, public participation in environmental protection and on environmental impact assessments* (consolidated text: Journal of Laws of 2023, item 1094, as amended).

The Baltica-1 OWF is located in the maritime areas of the Republic of Poland, covering the area of 85.53 km^2, at a distance of approximately 75 km from the seashore. The electricity produced by the Baltica-1 OWF will be exported from the offshore area to land by means of connection infrastructure, which constitutes a project entitled the Baltica-1 OWF Connection Infrastructure (hereafter: Baltica-1 OWF CI), which is covered by a separate application for a decision on environmental conditions.

In order to classify the Project, each element of the Baltica-1 OWF infrastructure was verified in terms of compliance with the criteria set out in 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).

The planned total capacity of the Baltica-1 OWF will be 900 MW. Pursuant to § 2(1)(5)(b) of the above-mentioned regulation, '*plants using wind energy for electricity generation, located in maritime areas of the Republic of Poland*' are classified as projects that are always likely to have a significant impact on the environment.

The possibility of installing a helipad on the offshore substation (OSS) platform is considered. According to § 3(1)(61) of the aforementioned regulation, '*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.

The proposed Project is a public purpose project because according to Article 6(4)(a) of the Act of 21 August 1997 *on real estate management* (consolidated text: Journal of Laws of 2023, item 344), a public purpose is '*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 evacuation within the meaning of this Act*.'

Two options for the Project implementation – the Applicant Proposed Variant (APV) and the Rational Alternative Variant (RAV) are analysed in the EIA Report.

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 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. The inter-array cable infrastructure will comprise power cables of medium- or high voltage and telecommunication cables the total length of which will be from 120 to 140 km.

The RAV was selected as an alternative based on technologies which 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. Considering that the maximum capacity of the Baltica-1 OWF will be 900 MW, a maximum of 64 wind turbines is expected to be erected. The RAV will be implemented in the same area, but due to the larger number of wind turbines to achieve a farm capacity of 900 MW, it will require a different layout within its boundaries.

Irrespective of the variant, the Applicant allows for the implementation of the Project in a continuous process as well as in stages.

The sea area in which the proposed Project is located fulfils various functions resulting from the existing human activity and the natural resources present there. The Baltica-1 OWF Area is located entirely within the boundaries of sea basin POM.60.E, the boundaries of which are specified in Annex 1 to the Regulation of the Council of Ministers of 14 April 2021 *on the adoption of the Maritime Spatial Plan for 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).

The sea basin card provided in Annex 2 to the above-mentioned regulation indicates that the main function of the sea basin, is renewable energy generation which governs the remaining forms of use, called the allowed functions. The set of sea basin functions results from its existing and planned use. The sea basin card also includes the prohibitions and restrictions as well as conditions for the sea basin usage, which mainly regulate the possibility of implementing the allowed functions along with other forms of shared use, in order to subordinate them to the main function.

For the purpose of the EIA Report preparation, the surveys of abiotic and biotic conditions of the environment were conducted in the Project development area in the period from the end of November 2022 to the end of November 2023. The environmental survey results obtained provided a complete set of data of sufficient representativeness, temporal and spatial resolution required to conduct 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. The spatial scopes of the surveys conducted for individual elements have been based on the assumed scopes of the Project potential impact on such elements in each phase of the Project implementation. Detailed results of the environmental surveys are contained in Appendix 1 to the EIA Report while brief information on the scope of these surveys is provided below.

As part of the geophysical surveys within the Baltica-1 OWF development area including a zone with a width of approximately 1 NM the following surveys were carried out once − bathymetric surveys, sonar surveys, magnetometer surveys, surveys of man-made objects and shallow seismo-acoustic profiling of the seabed sediment; whereas, within the Baltica-1 OWF development area, the following surveys were carried out − single- and multi-channel seismic surveys as well as core sampling and seabed sediment sampling.

As part of the hydrological and meteorological surveys including sea currents over 12 full months, through continuous monitoring in the Baltica-1 OWF development area including a zone with a width of not less than 1 NM, measurements of the following parameters were carried out − air humidity, atmospheric pressure, wind speed and direction, air temperature, water flow velocity and direction, wave height and period, water column thickness, water electrical conductivity, water turbidity and water temperature. Moreover, within the Baltica-1 OWF Area including a zone with a width of not less than 1 NM, the ice conditions were determined, on the basis of the available information from the Baltic Sea ice service, for the period of the meteorological and hydrological parameter recording in winter.

As part of the physico-chemical surveys of water in the Baltica-1 OWF development area including a zone with a width of not less than 1 NM, the oxygen conditions were determined six times per year by measuring the dissolved oxygen concentration, five-day oxygen demand (BOD_5) and total organic carbon (TOC) concentration. Additionally, measurements of the water acidity (pH) and alkalinity as well as the nutrient content – ammoniacal nitrogen, nitrate nitrogen, nitrite nitrogen, total nitrogen, mineral nitrogen, phosphates, total phosphorus and total suspended solids were carried out. The content of harmful substances, i.e. mercury, nickel, lead, cadmium, arsenic, total chromium, chromium (VI), phenols, cyanide, aluminium, mineral oils, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs) was determined once. In the summer, the radioactivity of caesium (^{137}Cs) and strontium (^{90}Sr) isotopes was measured.

As part of physico-chemical surveys of the seabed sediment in the Baltica-1 OWF development area, the measurements of the following parameters was carried out in the winter − humidity, loss on ignition (LOI), organic carbon content, heavy metal content (lead, copper, zinc, nickel, cadmium, chromium, arsenic, mercury and aluminium) as well as their labile form content; concentrations of polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs); the content of nutrients (total nitrogen and total phosphorus), mineral oils, butyltin (BT) compounds and the radioactivity of caesium (^{137}Cs). In the summer, the content of nutrients (total nitrogen and total phosphorus) as well as *in situ* resistivity was measured.

Within the Baltica-1 OWF Area, the measurements of ambient noise were carried out for one year at three survey stations, including one located within the Baltica-1 OWF development area and two outside that area, at a distance of approximately 4 and 31 km from the boundary of the Baltica-1 OWF development area. The frequency band of the sounds recorded was from 2 Hz to at least 22 kHz. This range is sufficient to record the vast majority of underwater sounds, both of natural and anthropogenic origin.

Within the Baltica-1 OWF development area including a zone with a width of approximately 1 NM, surveys of phytobenthos and zoobenthos were conducted in order to obtain information on qualitative and quantitative composition of these groups of marine organisms.

Within the Baltica-1 OWF development area including a zone with a width of not less than 4 km, surveys of ichthyofauna covering ichthyoplankton, pelagic fish and demersal fish, were carried out four times (i.e. one inspection covering all elements in each season of the year). In the case of ichthyoplankton, its taxonomic composition and abundance was determined. In the case of fish, in both pelagic and demersal catches, the following were determined − taxonomic composition, number of fish from individual species, species distribution, density and catch efficiency. Biological data such as length, age, sex, weight, sexual maturity, degree of fish stomach fullness was also acquired with particular focus on the target species. Moreover, surveys regarding the concentration of herring, including the determination of their weight and total length, were carried out twelve times, i.e. 4 inspections in the period March–April and 8 inspections in the period August–November.

The marine mammal surveys were carried out by continuous monitoring using C-PODs and F-PODs for one year in the Baltica-1 OWF development area and in the adjacent area with a monitoring device situated furthest from the boundary of the Baltica-1 OWF development area at a distance of approx. 35 km. Passive acoustic monitoring enabled the assessment of the occurrence and activity of harbour porpoises in the survey area. On its basis, the variability in the occurrence of harbour porpoises throughout the year was determined. Moreover, aerial observations of marine mammals were carried out eight times throughout the year. Additionally, the observations for the presence of marine mammals were carried out from aboard vessels during the seabird surveys (twice a month throughout one year). The survey area characteristics included also the literature data and the results of other international surveys, e.g. *'*SAMBAH *Static Acoustic Monitoring of the Baltic Sea Harbour Porpoise'*.

The avifauna surveys covered seabirds (sitting on the water and in flight) and migratory birds. The survey area for the seabird surveys covered the Baltica-1 OWF development area including a zone with a width of not less than 4 km and the reference area within the Swedish EEZ. The surveys were conducted twice a month throughout one year and included determining the taxonomic composition, abundance and distribution of the birds sitting on the water as well as recording the birds in flight. The surveys of the migratory birds and the birds in flight were carried out at two survey stations, from which visual observations were conducted to determine the taxonomic composition, flight intensity and directions of bird flights. Moreover, at two survey stations, observations were conducted using a horizontal radar, to determine flight trajectories, and using a vertical radar, to determine flight altitudes. Acoustic recordings were also made during migration periods in order to identify the taxonomic composition. Surveys of migratory birds were carried out throughout a single year, including during winter period (December–February) – 9 all-day inspections; and during spring (March–May) and autumn migrations (15 July–November) – 20 all-day observations in each migration period.

As part of the chiropterofauna surveys, the taxonomic composition and bat activity were determined in the Baltica-1 OWF development area including a zone with a width of not less than 1 NM. The surveys were carried out during two survey periods in one year, i.e. during the spring migration (April–May) and the autumn migration (August–October). At least seven all-night inspections along transects and two all-night inspections at survey stations were carried out in each of those migration periods. The surveys carried out at survey stations and at the same time along transects, enabled spatial coverage of the entire Baltica-1 OWF Area including its potential impact zone.

The basic infrastructure of the Baltica-1 OWF includes:

- 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 cable lines together with accessories.

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:

- seabed preparation for laying foundations or support structures for wind turbines, jack-up installation vessels and OSSs. The type of preparation works will result from 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 individual wind turbines and wind turbines with the OSS.

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

Seabed surveys aimed at identifying the presence of hazardous objects (UXO) using bathymetric, sonar and magnetometer surveys will constitute a part of preparatory works. The strategy for approaching unexploded ordnance will be determined in the OWF construction project in consultation with a consultant/expert in this field. The information contained therein will specify how to handle the UXO encountered.

Wind turbines and OSSs will be installed on foundations. Among the solutions available, monopile foundations, piled or caisson jacket foundations, and gravity based structures were adopted. Stone corrosion protection will be laid around the foundations as erosion control measure.

Inter-array cables are to be buried in the seabed at a depth of up to 3 MBSB. Considering local conditions related to the structure of the seabed, the 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.

Due to the location of the proposed Project within the maritime area, all related activities, in all project phases, will be conducted in a maritime operation mode, 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 – large construction and installation vessels (including jack-up vessels), transport vessels and barges (transporting i.a. foundations or support structures, towers, nacelles and blades), rock dumping vessels, dredgers, push-boats and tugboats as well as service vessels. The use of helicopters is also anticipated for transporting personnel to and from vessels. Transport of the Baltica-1 OWF structural components will be carried out from ports with extensive storage and warehousing space for materials and components. At the current development stage of the Project, the following ports are considered as ports of installation: 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.

During the construction phase, it is not expected that electricity will be drawn from the grid. Energy will be produced from the combustion of fuels by vessel, helicopters, and machinery. The water will be used for the welfare of the crews of vessels involved in the construction works. The total water demand throughout the construction phase is expected to be approximately 1000 m^3. The drinking water tanks will be refilled during port stopovers. After use, water will be stored in wastewater tanks and handed over for treatment during the next port call. During the construction phase, aggregates are to be used for preparing scour protection for the foundations of the wind turbines and OSSs, and concrete – for filling the gaps between the walls of the holes drilled above the piles. Filling the gaps with concrete will most probably apply only to a small number of pile foundations, only if their installation has to be preceded by drilling. If it is necessary to carry out such works, the material from the seabed dredging and levelling will be managed in accordance with the conditions of the permit of the territorially competent director of the maritime office, within the Project development area or in another part of the sea area indicated in the permit. Obtaining a permit for the disposal of the material from dredging into the sea will be subject to a separate procedure resulting from the Regulation of the Minister of Transport and Construction of 26 January 2006 *on the procedure for issuing permits for sea disposal of dredged material and for dumping waste or other substances at sea* (Journal of Laws of 2006, No. 22, item 166). It is also acceptable to spread the material from the inside of a pile in the immediate vicinity of the foundation, without loading it onto a barge. The sediment resulting from excavating trenches for laying cable lines will be used for burying the cable lines laid in trenches.

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 to be 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.

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 the OWF operation and maintenance will be recorded in this phase. Three variants of operation are 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 trips will significantly increase the intensity of navigation on navigation routes and in ports;
- the use of helicopters for transporting service crews from land to the OSS with an installed helipad.

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. Therefore, the number of operations and their effects (e.g. fuel consumption, emissions related to transport) will be smaller for the APV than in the case of the RAV.

During the Baltica-1 OWF operation phase, it will be possible to use smaller ports located closer to the area of the proposed Project, i.e. the ports in Władysławowo, Ustka, Łeba, Hel, Darłówek, as well as Kołobrzeg or Dziwnów, than the ports indicated above. PGE Baltica is implementing the construction of an operation and maintenance base in Ustka, which is eventually expected to provide services for offshore wind farms constructed by the PGE Group.

During the operation phase, the OWF energy demand for own needs at the OWF's downtime (wind conditions too weak to allow turbines to operate) will be approximately 1% of the total capacity and a maximum of 3% of the total annual production during the OWF operation. The only demand for potable water will be for the welfare of the personnel performing maintenance and repair works on the vessels conducting these works. The consumption of freshwater on the vessels will be approximately 70 l/person/day. The only raw materials and consumables used during the operation phase will be vessel and aviation fuel (in the case of using helicopters to transport service teams to and from the OSS platform).

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 of the wind farm structure and leaving in the environment those components, the removal of which would be too expensive and/or might generate stronger negative 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.

The offshore wind farm decommissioning process is complex and it proceeds in the opposite direction 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 the 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 seabed – only partial decommissioning is possible. The part of foundation extending above the seabed will be cut right above its surface. The cut-off foundation part will be transferred 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 after the end of the OWF operation, they will be decommissioned and left in the seabed. The estimated decommissioning time for the Baltica-1 OWF structures 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.

The electricity required to power the vessels, machinery and equipment will not be drawn from the grid. Energy will be produced from the combustion of fuels by vessels and machinery. The water will be used for the welfare of the crews of vessels involved in the dismantling works. The total water demand throughout the decommissioning is expected to be approximately 1000 m^3. The drinking water tanks are refilled during port stopovers. After use, the water is stored in wastewater tanks and handed over for treatment during the next port call. The only raw material used in the decommissioning phase will be vessel and aviation fuel.

In each phase of the Baltica-1 OWF implementation, mandatory legal requirements and good practices will be applied regarding waste and sewage treatment. All vessels involved in the Project during its entire lifetime will meet the requirements and will comply with the regulations resulting from the

International Convention for the Prevention of Pollution from Ships (MARPOL 73/78), including, in particular, the procedures contained in 'Shipboard Oil Pollution Emergency Plans'.

Moreover, throughout the Baltica-1 OWF installations, should the Project Owner be unable to use dry transformers, measures will be applied to prevent the spillage of hazardous substances along with measures to eliminate the effects of a possible spillage of hazardous substances (e.g. trays capturing possible spillages of transformer oil) as well as measures to eliminate the effects of spillage of these substances (e.g. sorbents). The oil-polluted water produced during the works will be collected and separated to obtain oil-derivative concentrations below 15 ppm and the oil obtained from the separation process will be stored and transferred in appropriate containers to specialised waste disposal companies.

The same shall apply in the case of other waste, including other hazardous waste – it shall be sorted, collected in specially marked and secured containers, transported ashore and transferred to specialised companies for utilisation.

Pursuant to Article 24(1) of the Act of 21 March 1991 *on the maritime areas of the Republic of Poland and maritime administration* (consolidated text: Journal of Laws of 2023, item 960), a director of the maritime office managing the given area will be able to establish, by way of a regulation, safety zones around all OWF structures or around complexes of these structures located at a distance of up to 1000 m from one another, adjusted to the type and purpose of artificial islands, structures and devices or their complexes, reaching out not more than 500 m from each point of their external edge, unless a different range of the zone is permitted by generally accepted international standards or recommended by a competent international organisation. In the regulation issued, the director of the maritime office shall define the conditions for navigation within the established zones, including, in particular, restrictions regarding navigation, fishing, water sports, diving and underwater work.

The information about activities conducted during the OWF construction phase, the establishment of safety zones around the OWF structures, as well as a total or partial decommissioning of the OWF will be published in official publications of the Hydrographic Office of the Polish Navy.

The Baltica-1 OWF development area lies within the south-eastern part of the Southern Middle Bank and on its southern, south-eastern and eastern slopes. It covers the seabed with depths ranging from approximately 14.0 to approximately 50.0 MBSL (the maximum depth within the area is 51.8 MBSL). In the bathymetric image, the shallower central and western parts of the survey area are more distinct. The seabed surface of that part of the area is located at a depth of approximately 14.0–23.0 MBSL, and it is separated from the rest of the survey area by a slope reaching, in places, up to 12.0 m in height in and an inclination of several degrees. Below the slope, the seabed gently declines towards the south, south-east and east to a depth of approximately 50.0 m. In the case of the Baltica-1 OWF development area, the depth range is from 17.1 m to 47.2 m. The western and central parts of the seabed surface in the area (accumulation platform) are formed by sandy sediments. The seabed surface is slightly undulating, with minor changes in seabed elevation related to the presence of sandy formations. The seabed relief shows signs of sand extraction. The eastern and north-eastern parts of the area (abrasive-accumulative plain) are formed by cohesive sediments with a thin discontinuous sand cover, erosive pavement and single boulders on the surface. The seabed is uneven, with 0.5–1.0 m changes in elevation due to the presence of sand accumulations and outcrops of older sediments (glacial and fluvioglacial sediments). Bathymetric and sonar data show areas of the seabed within which a series of ripple marks and mega-ripples are present on the surface. According to the literature data, the Baltica-1 OWF Area lies within the range of occurrence of sands as well as sands and gravels of various grain sizes. Mainly fine- and medium-grained sands are deposited on the seabed surface while in the northern part of the area analysed, medium- and coarse-grained sands as well as gravelly sands and sandy gravels. These are mainly fluvioglacial sands and gravels as well as marine sands and gravels. In most part of the survey area, the thickness of the sand and gravel sediments is greater than 1 m. Nearly the entire Baltica-1 OWF Area is identified as prospective in terms of sand and gravel occurrence (area V – Southern Middle Bank). On the western side of the Baltica-1 OWF Area, at a distance of approximately 60 m, there is the nearest mining area, 'Southern Middle Bank – Southern Baltic' sand and gravel deposit, the resources of which were put to use by designating three mining areas contained within one mining site. The deposit development concession is valid until 15 November 2031. There are no areas indicated for prospecting the deposits of sand for artificial shore nourishment in the area.

The analysed surface seabed sediments from the Baltica-1 OWF Area belong to the inorganic deposits with organic matter content expressed as loss on ignition (LOI) below 2%.

Seabed sediments collected during the environmental surveys were analysed in terms of nutrient, metal and POPs (i.e. PAHs, PCBs, TBT, and mineral oils) content.

None of the sediment samples tested exceeded the limit values specified for the concentration of metals (As, Pb, Cu, Zn, Ni, Cd, Cr, Hg), PAHs and PCBs listed in the Regulation of the Minister of the Environment of 11 May 2015 *on the recovery of waste outside installations and facilities* (Journal of Laws of 2015, item 796), which allows the classification of a sediment as clean in the context of practical applications, and although the limit values do not relate to a sediment transferred within water, they may form the basis for assessing the seabed sediment contamination with chemical compounds. The nutrient content in the area surveyed did not exceed the values typical for the sediments of the Southern Baltic. The amount of phosphorus that may be released into the water (the so-called available phosphorus) is estimated at 10–20 % of the total amount of phosphorus contained in the sediments. The sediments surveyed were characterised by a low activity of the radioactive isotope of caesium ^{137}Cs, typical for sandy sediments.

The results of tests of individual chemical parameters of water in the Baltica-1 OWF 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 approx. 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 Area, on the basis of the oxygen content in the near-seabed layer in summer (July–September), indicates a good water status (no oxygen deficit). The mean contents of dissolved oxygen during this period were above the limit value of 6.0 $mg \cdot dm^{-3}$.

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 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 values of ^{137}Cs and ^{90}Sr activity, typical for the waters of the Southern Baltic, which confirms a slow downward trend of ^{90}Sr and ^{137}Cs concentrations in the Baltic Sea area.

The marine water environment status in terms of eutrophication in the Baltica-1 OWF Area is bad (subGES), according to the WFD and MSFD status assessment indicators. The elevated concentrations of phosphates in winter were responsible for this status. No concentration limits for mineral nitrogen in winter nor for total nitrogen and total phosphorus expressed as annual averages (GES) were 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). The concentrations of persistent organic pollutants (fluoranthene, benzo(ghi)perylene and indeno(1,2,3-cd)pyrene, on the other hand, 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.

The Project area lies within the waters of the Southern Baltic which is located in a humid-moderate climate belt, where the influence of atmospheric circulation and winds from the North and Central Atlantic remains important. The vicinity of the Atlantic Ocean, due to the large air masses inflow, largely determines the climate of the Baltic Sea. As a result, the winters are mild and warmer, while the summers are cooler. In addition, it is characterised by predominantly westerly and south-westerly winds and, during storms, strong winds from northern, north-western and north-eastern sectors and a large variation in air humidity. Taking into account the conclusions and recommendations related to the coast and the adjacent areas of the Baltic Sea, it was concluded that the observed and projected climate changes will have a negative impact on the functioning of coastal zones. An adverse influence of the periodic sea level rises is predicted, resulting mainly from the increase in frequency and intensity of heavy storms, particularly in the autumn–winter period. In the case of the Baltic Sea, this refers to a possible increase in the number, intensity and duration of storms, with an increase in the irregularity of their occurrence, i.e. after long periods of relative calm, series of rapidly succeeding heavy storms may occur.

The average wind speed in the Baltica-1 OWF Area measured during surveys was approximately 7.3 $m \cdot s^{-1}$, and the maximum speed exceeded 20 $m \cdot s^{-1}$ (with gusts of 28 $m \cdot s^{-1}$). Winds from the western and south-western sectors prevailed, although the presence of north-eastern winds was also frequently observed. Air temperature ranged from -2.9 to 23.3°C. Atmospheric pressure varied from 980.0 to 1041.5 hPa. Relative humidity was characterised by high variability, oscillating from approximately 42% to 100%. The values presented do not differ significantly from the same atmospheric parameters recorded in previous years at other locations in the Polish Baltic Sea areas.

The results of ambient noise monitoring demonstrated that noise level values vary in time, depending on the seasonally changing 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.

There are no aquatic plants (phytobenthos) in the Baltica-1 OWF Area nor in its vicinity.

In the case of the soft bottom, 29 macrozoobenthos taxa belonging to two phyla and seven classes were recorded. The most common taxa were the small psammophilous polychaete *Pygospio elegans*, considered to be an indicator of a clean or medium clean seabed, which includes sediment with a small admixture of organic matter, and one species of bivalve, *Macoma balthica*, which constitutes food for many species of ducks (e.g. the common scoter or the common eider) and fish, such as flounder or viviparous eelpout. Only seven taxa of periphytic and phytophilic fauna were found on the hard bottom, which occurs in points in the northern part of the survey area, indicating the poor qualitative and quantitative composition of this community. In terms of abundance and biomass, the hard-bottom benthic fauna was dominated by bivalves, bay mussels *Mytilus trossulus*. Neither dense bay mussel aggregations nor a diverse periphytic fauna were found in places where the hard-bottom macrozoobenthos occurs. Neither rare nor protected species were found.

The results of ichthyological surveys indicated the presence of 15 taxa of ichthyofauna. Cod and flounder dominated, while great sand eel, plaice, shorthorn sculpin, pogge, mackerel, twaite shad, turbot, sprat, herring, lumpfish, lesser sand eel, viviparous eels and fourhorn sculpin were less abundant. Four of the taxa occurring within the survey area – 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).

Marine mammal surveys indicated the presence of porpoises (audio detections) and grey seals (visual observations) as well as several seals unidentified as to the species. The highest number of porpoise detections were recorded in summer and early autumn, while seal sightings were most frequent in autumn and winter. All marine mammal species are under strict protection.

Avifauna surveys indicated that the survey area is used by birds throughout the year. The highest number of observations concerned the spring and autumn migration periods, when the long-tailed duck and the common scoter, passerines including pigeons, auks, geese, charadriiformes, dabbling ducks and the common gull were the most abundant. During the wintering period, long-tailed ducks and European herring gulls were the most abundant. During summer, the number of birds observed was very low compared to other periods of the year. The vast majority of observations were of the common guillemot and the European herring gull, while other species were very rarely identified. A total of 105 bird taxa were identified in the avifauna surveys, of which 89 were assigned to the species. Most of them are under strict or partial protection.

Bats identified during acoustic monitoring were classified into four species – the common noctule, the northern bat, the parti-coloured bat and the Nathusius' pipistrelle. Bats migrate during spring and autumn and were recorded in the survey area during these periods, although their detections were not very numerous. All recorded bat species are under strict protection.

In the Baltic Sea area, the occurrence and spatial extent of wildlife corridors has not been determined. This is understandable since the sea area, unlike the terrestrial area, is not characterised by significant terrain obstacles nor a high amplitude of changes of physico-chemical parameters for the migration and dispersal of species populations. In a sea area, there are two important factors restricting the freedom of species to migrate and colonise new areas – salinity and oxygenation levels. Both these parameters change in a vertical profile being characterised by a constant annual pattern or amplitude of change. In the case of aquatic plant species, the extent of the euphotic zone is equally important, and for periphyton complexes such as e.g. bay mussel and macroalgae, also the presence of the so-called hard bottom. Nonetheless, salinity and water oxygenation remain the cardinal factors determining the extent of species population. As their values are generally characterised by a depth gradient a possible attempt to designate wildlife corridors should also be based on changes in the sea basin bathymetry. Hence the objective difficulty in identifying marine wildlife corridors. A separate aspect of marine wildlife corridors are bird migration areas. In this case, the sea area, and in fact the air space above it is part of the route that birds follow from their breeding grounds to their wintering sites in autumn, and vice versa in spring. As demonstrated by bird migration surveys carried out for offshore wind farms in the Baltic Sea, migrations generally take place from the north-east to the south-west during autumn migration, and vice versa during spring migration. Flight routes are the shortest possible distances between landmarks on land. In the case of the marine mammals found in the Southern Baltic, no areas that could meet the criteria for wildlife corridors can be identified. Both seals, as well as porpoises travel in search of food with no preference for specific routes. The migration behaviour of bats over the sea area is also unknown. Although individuals are recorded even in the survey areas far away from the shore, as in the case of the Baltica-1 OWF survey area, the spatial range and purpose of their migrations are not known.

No objects of cultural heritage including wrecks, have been identified as yet within the Baltica-1 OWF Area boundaries. The results of seabed surveys conducted in the Project area showed the presence of several hundred objects of potential anthropogenic origin, of which over a hundred were selected for visual inspection conducted using an ROV. Most of them were geomorphological forms and anthropogenic waste, other objects – tires, fishing nets and ropes, tree branches and logs. Among the objects covered by the visual inspection, fragments of ship wrecks and aircraft elements were also found on the seabed. The man-made objects identified as part of the surveys were not found to be cultural heritage objects.

No conventional warfare agents from the period of either world war have been identified in the area either. However, their presence on the seabed of the area analysed cannot be excluded. A similar approach should be taken to the potential occurrence of containers with chemical weapons, which were dumped after World War II, mainly in the Baltic deeps – the Gotland Deep and the Bornholm Deep – as well as in the Skagerrak, the Little Belt and the Gdańsk Deep. In light of the current analytical results and incidental discoveries, it is known that some chemical warfare agents were dumped from ships into the sea during transfer to their intended deposition sites. Taking a precautionary approach, it should therefore be assumed that conventional and unconventional warfare agents from the periods of warfare may also be deposited on the seabed in the Baltica-1 OWF Area, posing a potential threat to the safety of the Project implementation. Before the commencement of the construction, the Project Owner will conduct detailed surveys on the presence of unexploded ordnance and duds (UXO surveys) on the seabed. In case any chemical warfare agents / UXOs are found during these surveys, the Project Owner will notify the relevant authorities and institutions, and will comply with their instructions.

Geophysical surveys did not reveal any objects on the seabed or in the water column within the survey area that would prevent or significantly impede the Project.

The entire territory of the Polish sea areas was included in the development plan implemented by way of the Regulation of the Council of Ministers of 14 April 2021 *on the adoption of the Maritime Spatial Plan for 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) (MSPPSA). The Project area lies within the boundaries of sea basin POM.60.E. The proposed Baltica-1 OWF Area is located outside the main Baltic navigation routes; however, a customary navigation route leading to the port of Klaipėda runs through its southern part. In accordance with the detailed provisions of the MSPPSA, navigation (defined in the regulation as 'transport') in the sea basin, within the boundaries of which the Project is located, is not subject to restrictions until the commencement of the OWF operation. From then on, in accordance with the MSPPSA, navigation will be restricted to vessels up to 50 m in length, until the conditions for safe navigation have been established by a decision of the territorially competent director of the maritime office, with the exception of vessels involved in the service and maintenance of the OWF structures and equipment as well as aquaculture (if performed within the farm area). The Baltica-1 OWF Area is not intensively used for fishing activities as a fishing ground and a transfer area to other fishing grounds.

The proposed Project area is not located within the boundaries of the zones permanently or periodically closed for navigation and fishing activity, established by the Minister of National Defence by way of a regulation, in accordance with the Act of 21 March 1991 *on the maritime areas of the Republic of Poland and maritime administration* (consolidated text: Journal of Laws of 2023, item 960). The area is not crossed by any of the Polish Navy fairways either.

The analysis of the SIPAM data and the results of the geophysical surveys showed that there are no structures, including linear structures (e.g. power and telecommunication cables), within the Baltica-1 OWF Area.

The landscape of the Baltica-1 OWF Area is typical of open sea waters and can be regarded as not particularly varied and common, shaped almost exclusively by natural factors, i.e. changes in the sea surface caused by wind action and some atmospheric conditions – cloudiness and precipitation. Thus far, the human impact on the landscape of the area has been small, resulting mainly from the temporary presence of vessels navigating along shipping routes (one of the routes to the port of Klaipeda runs through the OWF Area) and fishing vessels. Also the subsea landscape is not very varied – the seabed is mainly covered with sandy sediments and sparse boulder areas, with seawater above it. On the seabed, there are no plant communities that would add more value to the landscape. To date, there has been no intensive human activity within the Project area that would alter its natural relief. Environmental surveys have shown traces of furrows on the seabed, indicative of past aggregate exploitation.

Cultural landscape, as defined in the Act of 23 July 2003 *on the protection and care of historical monuments* (consolidated text: Journal of Laws of 2022, item 840, as amended), is a space perceived by people, containing natural elements and artefacts of civilisation, historically shaped by natural factors and human activity. In line with this definition, it should be concluded that cultural landscape is not to be found within Baltica-1 OWF Area and its surroundings. After the construction of the offshore wind farm, the altered landscape will not meet this definition either. In the context of the scope of the act from which the definition is derived, human activity should involve the creation of objects and places that will contribute to the development of cultural heritage. Given the distance from the shore of at least 75 km, the construction of wind turbines even 330 m above sea level will not disturb the perception of the landscape by people present on the seashore. From this distance, even the tallest proposed turbine structures will not be visible to the human eye.

The analysis included in this EIA Report demonstrated that the implementation of the Baltica-1 OWF in both the APV and the RAV is possible and will be characterised by the same set of impacts. The assessment of these impacts proved that their impact will have the same significance for individual components of the environment in both variants. The analysis carried out indicated the possibility of negative impacts. However, with the application of the indicated mitigation measures, the Project implementation will not cause significant negative impacts.

The analysis of cumulative impacts demonstrated that the cumulative impact of underwater noise generated during the construction phase of the Baltica-1 OWF, Bałtyk I OWF and Södra Victoria OWF, if the construction phases of these projects overlap in time, may cause negative impacts, which, however, will not be significant with the application of noise reduction systems. In the event of cumulative noise impact during operation and decommissioning phases its significance was assessed to be **negligible**.

Environmental impact may also be caused by extensive oil spills (Tier 3, catastrophic) in the event of collision of large ships involved in the Project implementation (including collisions of vessels transporting farm elements far from the development area) or a collision of a ship with the farm structure. However, the risk of such events occurring is extremely low and very unlikely to occur in any phase of the Project.

In order to minimise the impacts on environmental components, as well as cumulative and transboundary impacts, a number of mitigation measures is proposed. A proposal for environmental monitoring is also presented to determine the actual range of impacts during the construction and operation phases and to develop optimal methods for counteracting their effects.

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 at a distance of up to approximately 20 km – one source of noise, and further, in the case of at least two sources of underwater noise, from the boundary of the Baltica-1 OWF Area, and therefore it will also be significant in Swedish waters, including 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.

The analysis of social conflicts indicated that the greatest impact of the Baltica-1 OWF implementation may concern the adverse effect on fishing and navigation. In the case of fishing, restrictions resulting from the presence of the farm structures and the established safety zones may result in a reduction in the catches in this region of the Baltic Sea and financial losses for the fishing sector. The occupation of the sea area may also contribute to changing and extending the length of the shipping route leading to the port of Klaipėda. These issues were raised in the MSPPSA, which states that in sea basin POM.60.E (in which the farm will be located), the forms of use other than renewable energy generation are secondary to it and will be subject to restrictions from the moment of the offshore wind farms construction.

The analysis of the technology adopted for the implementation of the Project, the resources of abiotic and biotic components of the environment and the conditions resulting from the current and planned use of the sea area in the vicinity of the proposed OWF, as well as the results of the analysis of the impacts on the natural environment and the development of the sea area, showed that the Baltica-1 OWF can be implemented both in the APV and the RAV. As indicated above, both variants will be characterised by the same impacts, which will have a very similar scale and significance of impact. The implementation of the RAV will involve a slightly higher implementation expenditure of forces and resources, which will translate into a larger number of ships and maritime operations in all phases of the Project and into greater generation of waste, fuel and material consumption. The APV assumes the construction of the farm also based on the most up-to-date and efficient wind turbine designs that will be available at the stage of contracting supplies. For this reason, the assumptions adopted in this EIA Report for this variant constitute an envelope of the worst environmental impact conditions, but there is a possibility of their reduction, mainly due to the possibility of reducing the required number of wind turbines. In contrast to the implementation of the RAV, which was based on narrow assumptions of one turbine capacity of 14 MW, which is currently being implemented in OWFs under construction, the APV assumes the possibility of using units with a higher nominal capacity of up to 25 MW. Thanks to this, the maximum development of the area will be reduced compared to the envelope assumptions included in the EIA Report, which may reduce the negative impact of the Project on the environment. Therefore, the implementation of the APV was also considered the most beneficial option for the environment.