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Saare Wind Energy
OFFSHORE WIND FARM
Environmental impact assessment

SUMMARY OF ENVIRONMENTAL IMPACT ASSESSMENT REPORT

14.08.2023

Contents

1. Introduction

Saare Wind Energy OÜ (hereinafter referred to as SWE or SWE OÜ) wishes to build an offshore wind farm consisting of a maximum of 100 wind turbines with a total capacity of up to 1,400 MW west of the coast of the island Saaremaa in the territorial waters of Estonia, as well as a transmission system up to the point of connection to the general grid for electricity transmission. The envisaged offshore wind farm site is located in wind energy development area No. 2 specified in the Estonian Maritime Spatial Plan (established by Order No. 146 of 12 May 2022).

On 9 April 2015, SWE OÜ submitted an application for the development permit to the Ministry of Economic Affairs and Communications for encumbering a public water body with a wind farm. By its Order No. 183 dated 28 May 2020, the Government of the Republic initiated the proceedings concerning the development permit and the environmental impact assessment (hereinafter referred to as EIA). The Consumer Protection and Technical Regulatory Authority is the body conducting the proceedings concerning the development permit and the Government of the Republic is the decision-maker. The authority overseeing the environmental impact assessment is the Ministry of Climate. The environmental impact assessment is carried out by OÜ Roheplaan and the lead expert for the EIA is Riin Kutsar (EIA licence No. KMH0131).

Based on the impact assessment carried out, there will be no direct transboundary impacts as a result of the construction of the planned wind farm. As regards presumable transboundary impacts, the following is noted:

- Possible negative transboundary impacts relate to the effects of the offshore wind farm during its operation on birds (in particular migratory birds) which are discussed in Chapter 3.5 of the report. The significance of these impacts will need to be further clarified in future monitoring during the period of operation of the wind farm. The significance of the impacts may increase through cumulative effects if additional offshore wind farm developments are planned and/or implemented in the vicinity.
- Theoretically, there could also be transboundary impacts on fish fauna, bats and seals. However, in view of the conclusions reached in Chapters 3.6, 3-7 and 3-8 and the mitigation measures specified there, it can be stated that the wind farm planned by SWE will not result in adverse impacts on marine biota. Therefore, no significant transboundary impacts are foreseen in these respects.

As the connecting cables of the offshore wind farm are not planned to be connected to any other country, no transboundary impacts are foreseen in this respect.

The wind farm planned by SWE will contribute to climate change mitigation. The use of offshore wind energy on a large scale will allow a significant reduction in the use of biomass in energy production. The use of fossil fuels for electricity generation can also be significantly reduced or completely abandoned.

This summary of the EIA report on the SWE's offshore wind farm focuses in particular on the issues where transboundary effects may occur, such as birds, fish fauna, bats and seals. The results of the assessment of other impacts are presented more concisely.

2. Description of the planned activity and its feasible alternatives

2.1. Planned activity

A detailed overview of the construction of the planned wind farm is given in:

- Construction of the Saaremaa Offshore Windfarm. An overview of anticipated construction activities for the Saaremaa Offshore Windfarm. Van Oord Offshore Wind B.V., 2023, (Annex 1).

The offshore wind farm will be constructed in the territorial waters of Estonia, west of the coast of the island Saaremaa (Figure 2.1-1). The site of the offshore wind farm will be located in an area defined in the National Spatial Plan Estonia 2030+ as a preferred area for construction of wind farms. The Maritime Spatial Plan (established on 12 May 2022) of the National Spatial Plan specifies the use of maritime space, and the offshore wind farm planned by SWE will be located in area No. 2 identified in the Maritime Spatial Plan as suitable for wind energy development.

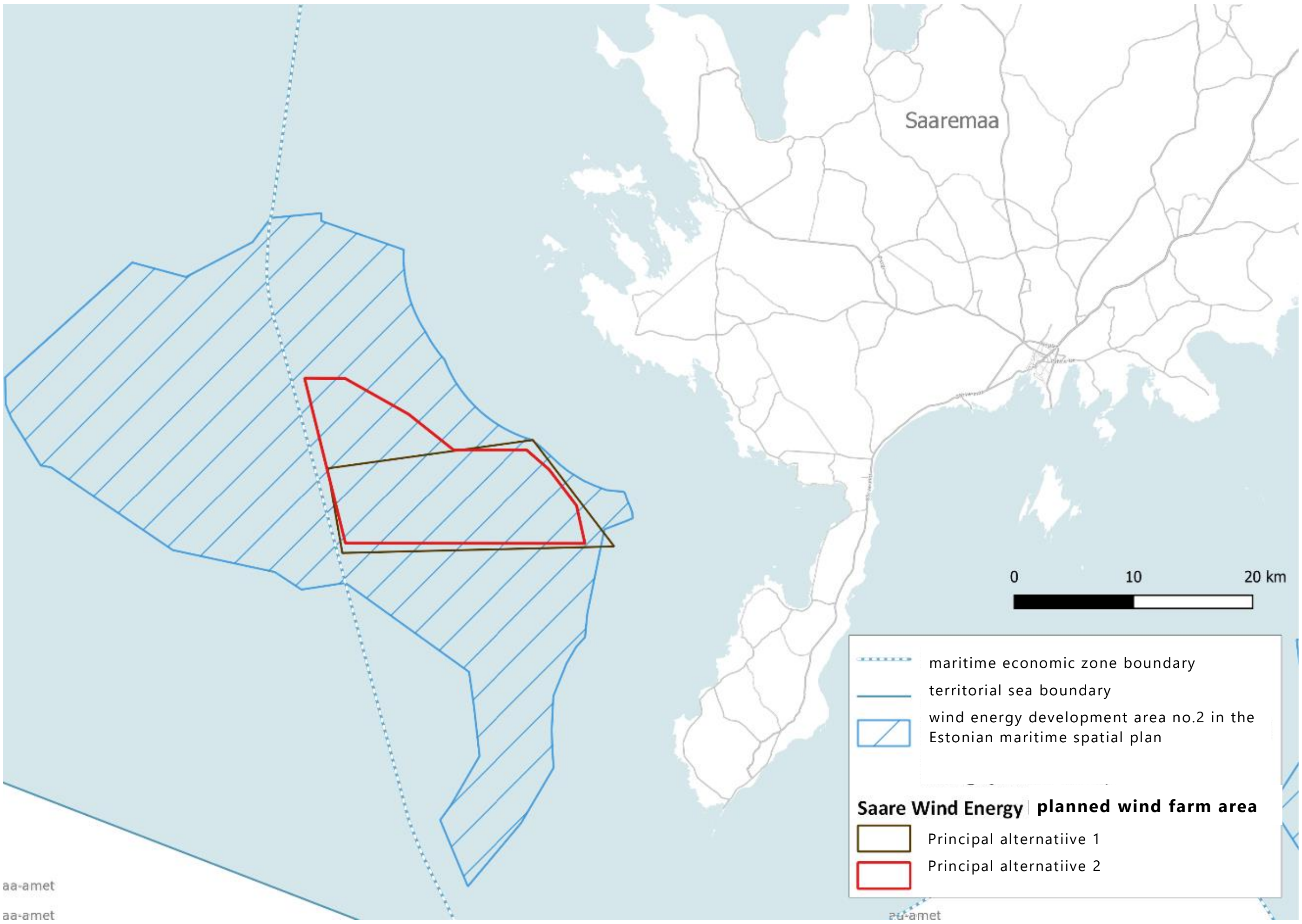


FIGURE 2.1-1. PROPOSED WIND ENERGY AREA NO. 2 IN THE ESTONIAN MARITIME SPATIAL PLAN, PRINCIPAL ALTERNATIVE 1 AND PRINCIPAL ALTERNATIVE 2. BASE MAP: ESTONIAN MARITIME SPATIAL PLAN PORTAL

The initial siting of the offshore wind farm (the application of 2015) took into account nature reserves and known natural values, shipping routes, radars, sufficient distance from the coast (>10 km), etc. The depth of the sea in the area is in the range of 20–35 metres.

The maximum planned number of wind turbines in the SWE's offshore wind farm is 100. Figure 2.2-2 shows the preliminary layout of the offshore wind farm with the maximum number of wind turbines. The planned number of wind turbines may change (decrease) depending on the final solution and the results of this assessment.

A system of submarine cable lines and a connection to the general grid for electricity transmission need to be constructed in order to operate the offshore wind farm and to feed the electricity produced into the grid. If possible, SWE would like to be connected to the Elering transmission network at the new substation in Western Saaremaa. The technical feasibility of this solution will require upgrading the existing 110 kV system starting from the Lihula substation to 330 kV and extending the new 330 kV system to the new substation.

Between the offshore wind farm and the connection point, a solution encompassing a submarine cable line and an onshore electricity transmission system will be built. The location and technical solution of the offshore wind farm's submarine cable is assessed as part of this EIA report (Figure 2.1-2).

The northern cable corridor shown in Figure 2.1-2 was considered as the principal location indicated in the Estonian Maritime Spatial Plan. The preferred cable route is as short as possible and technically feasible; in addition, sensitive areas are to be avoided (or mitigation measures are to be implemented when carrying out work there). For both environmental and technical reasons, the preferred sea depth for the cable route is 10–15 metres, but this is not always possible in shallow waters and areas close to the shore.

According to the fish fauna experts involved in the EIA, the northern cable corridor would run in shallow water close to Pilguse Bay and, in line with the precautionary principle, creating potential disturbance too close to Pilguse Bay should be avoided, as this bay has been an important spawning area for fish. Therefore, a possible cable corridor area was developed more towards the south as the main cable corridor alternative.

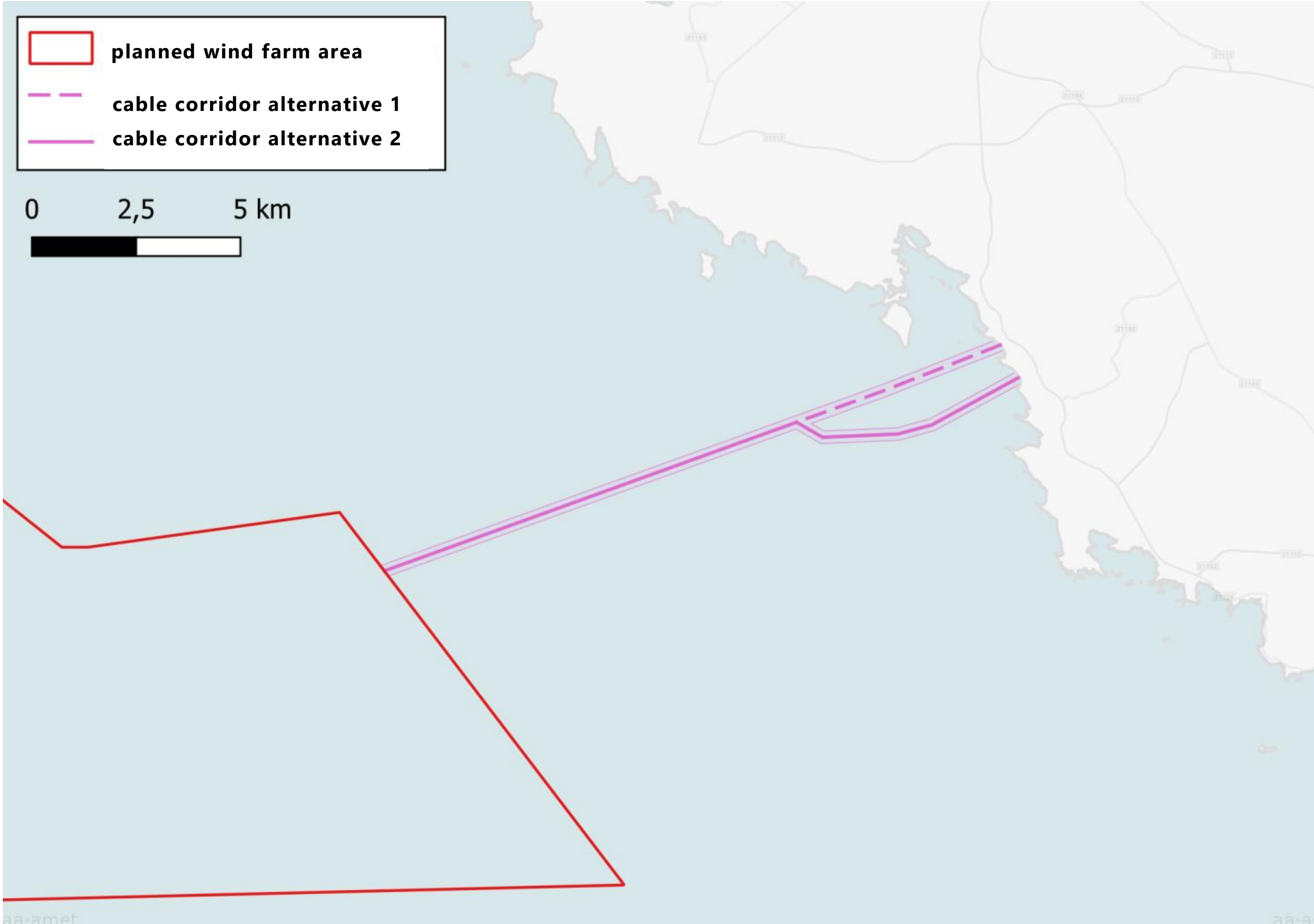


FIGURE 2.1-2. CONCEPTUAL LOCATIONS OF OFFSHORE CABLE CORRIDORS TO CONNECT THE WIND FARM PLANNED BY SWE

The location of the onshore transmission line will be specified and the associated impacts will be assessed through additional work (e.g. onshore planning or other relevant processes) separate from the EIA.

2.1. Alternatives

Among the realistic alternatives, two principal (main) alternative are considered in the EIA report (see Figure 2.1-1):

- **principal alternative 1** – the maximum planned activity according to the initial application for the development permit; and
- **principal alternative 2** – the revised area for the SWE's application for the development permit which is approximately 28% larger than the original area (see Figure 2.2-1). Based on specified information, a larger area (approximately 28% larger compared to that indicated in the initial application for the development permit) has been examined and addressed in the course of the impact assessment, as an adjustment of the development area has been requested to more closely correspond to the areas

identified as wind energy areas in the Maritime Spatial Plan of the National Spatial Plan and to the optimal solution for the offshore wind farm.

As sub-alternatives of the principal alternatives 1 and 2 (abbreviated as P1 and P2) of the planned offshore wind farm, the EIA report examines and assesses alternative technical solutions for the different components: the number of wind turbines, the arrangement of wind turbines in the wind farm, the rotor diameter of a wind turbine, the peak height of a wind turbine, the type of foundation, the transmission system, including the location of its elements (cables), etc.

TABLE 2.1-1. ASSESSED PARAMETERS AND ALTERNATIVES OF THE PLANNED OFFSHORE WIND FARM

PARAMETERS	CHARACTERISTICS ASSESSED
Principal alternatives of the wind farm	P1 and P2; see Figure 2.1-1
Number of wind turbines	Up to 100
Total capacity of the wind farm	Up to 1400 MW
Nameplate capacity of wind turbines	Presumably in the range of 14–18 MW
Annual production of the wind farm	Up to 6 TWh
Rotor diameter of a wind turbine	250–280 m (of the models actually produced today, wind turbines with a rotor diameter of 236 m are likely to be used)
Maximum peak height of a wind turbine	280–310 m
Movement margin between the tip of a blade and the water surface	Approximately 25–30 m
Number of blades	3
Distance between wind turbines	At least 4–6 times the rotor diameter
Positioning of wind turbines in the wind farm	Irregular positioning, aligned positioning
Type(s) of foundation	Monopile foundation, gravity foundation, jacket foundation
Foundation installation method	Drilling into limestone (monopile foundation and jacket foundation), installation on prepared seabed (gravity foundation)
Closest distance of the wind farm to the coast	At least 11 km
Connecting cables, km	Total estimated length to Saaremaa: 25 km, of which 8 km within the wind farm. Up to 4 cables, each with a transmission capacity of 350 MW. Presumably 220 kV (or 330 kV) AC (Figure 2.1-2)
Network cable within the wind farm, km	Total estimated length approximately 240 km, presumably 66 kV AC

An offshore wind farm is a sophisticated technological complex connected to an equally sophisticated and multifaceted electric power system. Therefore, the planned offshore wind farm has a number of technical and spatial alternatives within the proposed offshore wind farm development area. Where appropriate, the EIA report gives recommendations to adjust the location and spatial configuration of the offshore wind farm as planned according to the particular application for the development permit, based on the results of the studies carried out during the EIA process and in cooperation with the different authorities and stakeholders.

Each assessment subchapter of the EIA report indicates which alternatives are being considered in the assessment of a particular environmental element and topic. As a general rule, the spatial alternative being assessed is that corresponding to the maximum possible extent of the offshore windfarm (principal alternative 2) and comprising up to 100 wind turbines, i.e. the scenario with the highest possible impacts (*worst case scenario*) is assessed.

Where a specific topic requires the assessment of different technical alternatives, these alternatives are also compared according to the scale of significance of impact described in the table below.

TABLE 2.1-2. SCALE OF SIGNIFICANCE OF IMPACT USED FOR COMPARING ALTERNATIVES

Associated consequence/impact	Significance of impact
	-- i.e. significant negative impact
	- i.e. minor negative impact
	0 i.e. no impact, neutral
	+ i.e. minor positive impact
	++ i.e. significant positive impact

3. Results of the impact assessment

3.1. Hydrometeorology and hydrodynamics

Studies carried out:

- *Saaremaa Offshore Wind Farm, Estonia Meteocean Conditions*. DHI AS, 2023 (Annex 3.1)
- *Plume Dispersion Modelling and Morphodynamics Assessment. Assessment of the impact of the sediment spill during the installation works and the impact on local morphodynamics as part of the Environmental Impact Assessment.* DHI AS, 2023 (Annex 3.2)

The results of modelling showed that the difference in currents caused by the construction of the wind farm is less than 10% and the impact can be considered insignificant. Locally, currents may be faster in the immediate vicinity of wind turbine foundations. Also, the wind farm will reduce wave heights by up to 2%, and the change in wave direction will be less than 0.26 degrees. Therefore, the impact of the wind farm on waves can be considered insignificant.

In the sea area west of Saaremaa, ice cover is formed only in harsh winters and for no more than 30 days. Ice can impede or prevent the navigation of maintenance vessels for a limited period if they do not have an ice class. Maintenance vessels will be commissioned according to local needs, taking into account all weather factors, including the possibility of ice formation.

TABLE 3.1-1. IMPACT OF CONSTRUCTION OF THE WIND FARM, AND SIGNIFICANCE THEREOF

Associated consequence/impact	Significance of impact
Changes in currents	0
Changes in waves	0

Scale of the significance of environmental impacts used in the EIA report: -1 = minor negative impact, -2 = significant negative impact, 0 = no impact, neutral, + = minor positive impact, +2 = significant positive impact.

3.2. Geology of the seabed

Studies carried out:

- Marine Geophysical Survey. Saaremaa offshore wind farm development. VBW Weigt GmbH, 2022 (Annex 3.3)
- Plume Dispersion Modelling and Morphodynamics Assessment. Assessment of the impact of the sediment spill during the installation works and the impact on local morphodynamics as part of the Environmental Impact Assessment (EIA). DHI AS, 2023 (Annex 3.2)
- Saaremaa offshore wind farm. Onshore Geotechnical Survey. IPT Projektijuhtimine OÜ, 2022 (Annex 3.4)
- Sampling and analysis of seabed texture, heavy metals and total petroleum products. TalTech Institute of Marine Systems, GBA Gesellschaft für Bioanalytik mbH, 2023

SEDIMENT SPREAD

In order to assess the impact of the sediment released during the construction of the wind farm, a 3D hydrodynamic model of the study area (MIKE 3 FM) was created by DHI AS, based on a similar Baltic Sea-wide model HD_{DKBS2}. Based on geophysical surveys and soil samples, it was estimated that up to 80% of seabed sediment (glacial till, clay, sand, sandy loam) and up to 30% of limestone are fine-grained. Fractions of less than 0.6 mm were considered as fine grains. The maximum possible sediment thickness of 3.9 m, i.e. the maximum impact scenario, has been assumed in the model. In reality, the thickness of the sediment layer can vary from 0 to 3.9 m for each wind turbine location. As an output, dispersal maps were created for three different foundation alternatives, considering two different water layers for sediment/suspended sediment release – above seafloor and in the central part of the water column, thus for a total of six different scenarios (Table 3.2-3). The three foundation type options being assessed have the following differences in terms of sediment/suspended sediment release:

1. The installation of a gravity foundation requires dredging the seabed so as to create a suitable base for the foundation. Sediment will be released in the central part of the water column. Dredging operations take on average 7.8 hours per foundation.
2. A monopile foundation is driven/drilled into the seabed, with sediment being released at the point where the pile enters the seabed. Unless the mud/sediment generated during drilling is collected separately, additional suspended sediment will also likely be released in the central part of the water column. Drilling operations take on average 5 hours per monopile foundation (0.5 hours for seabed sediment and 4.5 hours for limestone).
3. To install a jacket foundation, piles are driven/drilled into the seabed. As in the case of a monopile foundation, sediment will be released at the point where the piles enter the seabed. Sediment is also expected to be released in the central part of the water column. Drilling operations take on average 5.7 hours (0.5 hours for seabed sediment and 5.2 hours for limestone).

TABLE 3.2-1. SCENARIOS ASSESSED IN THE MODELLING. FOR ALL SCENARIOS, IT IS ASSUMED THAT EACH WIND TURBINE FOUNDATION IS INSTALLED WITHIN 48 HOURS

	Assessed scenario	Sediment release time per wind turbine (hours)	Sediment release rate (kg/s)	Total sediment release rate for 100 wind turbines (tonnes)
1	Gravity foundation (likely case)	7.8	18.4	51,667
2	Gravity foundation (conservative case)	7.8	50	140,400
3	Monopile foundation (release of sediment only above seafloor)	Seabed sediment 0.5 Limestone 4.5	Seabed sediment 11.1 Limestone 4.7	9612
4	Monopile foundation (release of sediment above seafloor and in the central part of the water column)	Seabed sediment 0.5 Limestone 4.5	Seabed sediment 11.1 Limestone 4.7	9612
5	Jacket foundation (release of sediment only above seafloor)	Seabed sediment 0.5 Limestone 5.2	Seabed sediment 1.8 Limestone 0.8	1822
6	Jacket foundation (release of sediment above seafloor and in the central part of the water column)	Seabed sediment 0.5 Limestone 5.2	Seabed sediment 1.8 Limestone 0.8	1822

The results of modelling showed that scenario 2: gravity foundation (conservative case) has the highest negative environmental impact, followed by scenario 1: gravity foundation (likely case). Dredging operations required for the installation of gravity foundations will release 5–14 times more sediment compared to monopile foundations, and the sediment will be deposited over a much wider area, extending up to 5 km beyond the development area for sediment layers of up to 5 mm (Figure 3.2-1). In the case of monopile foundations, sediment will be released and deposited in the area immediately adjacent to the foundations

(Figure 3.2-1). The thickness of the sediment layer will start to decrease after the construction period, as muddy sediment is characterised by decreasing water content and increasing sediment density.

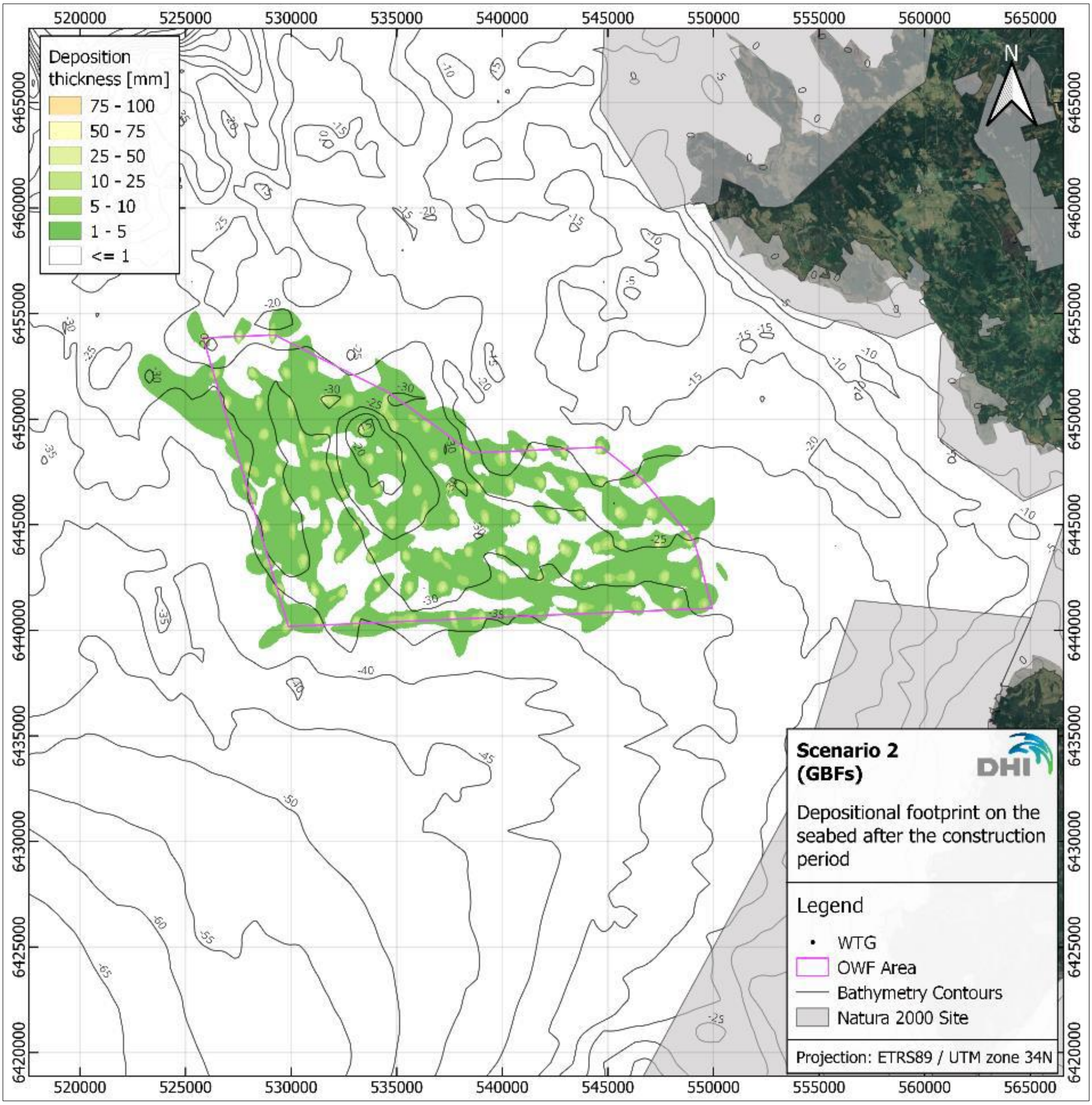


FIGURE 3.2-1. SEDIMENT DEPOSITION "FOOTPRINT" AND THICKNESS AFTER CONSTRUCTION (GRAVITY FOUNDATION, CONSERVATIVE CASE)

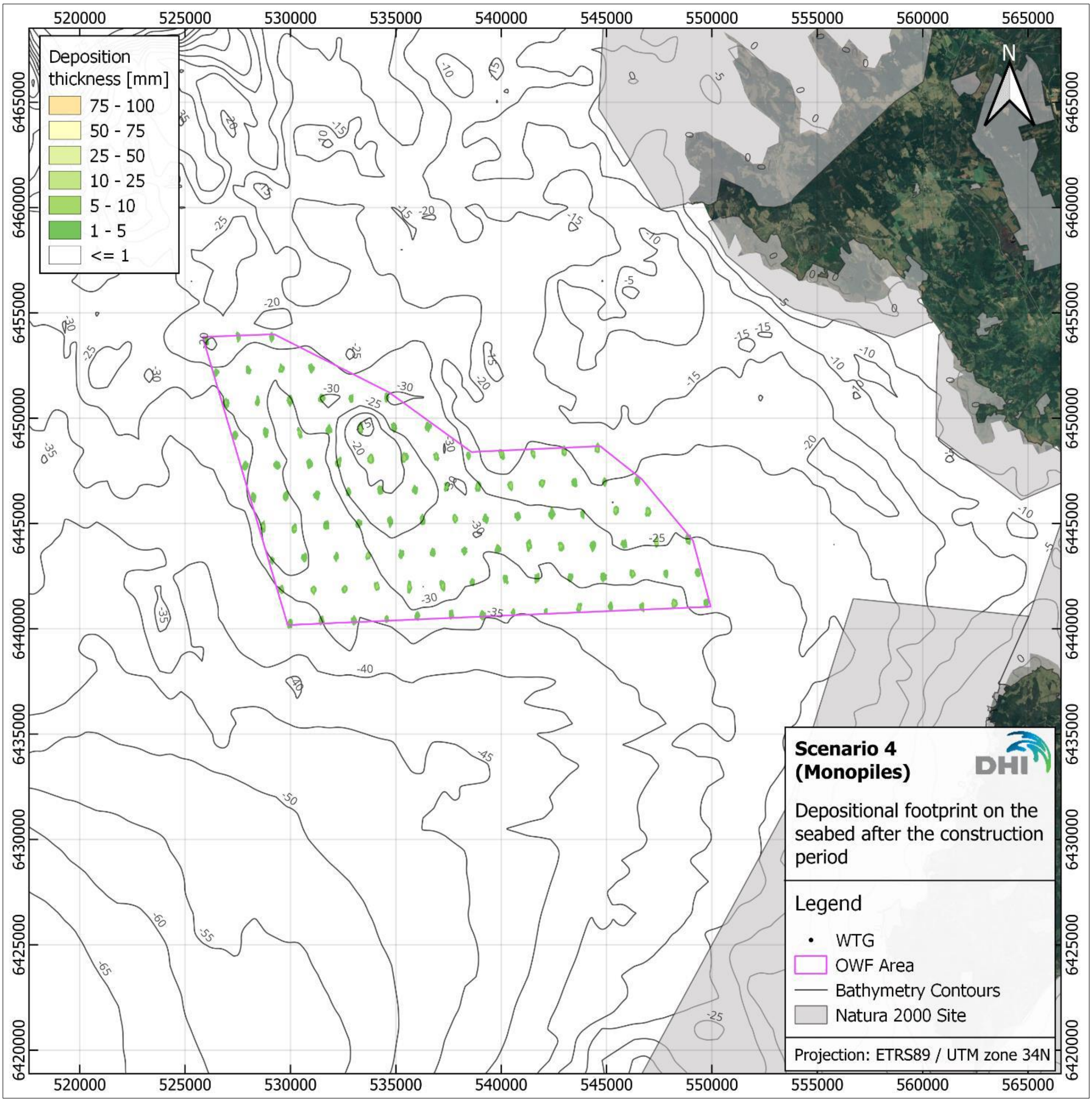


FIGURE 3.2-1. SEDIMENT DEPOSITION "FOOTPRINT" AND THICKNESS AFTER CONSTRUCTION (MONOPILE FOUNDATION)

SHORELINE PROCESSES

In the inshore zone, materials are carried by waves. Waves lift materials into the water column and carry it along the shoreline. Depending on the characteristics of the shoreline, erosion or accumulation of materials will occur. Rapid or even drastic shore erosion usually occurs during storms when both waves and water levels are high. Modelling shows that the wind farm will reduce wave heights by up to 2%, and the change in wave direction will be less than 0.26 degrees. Therefore, the wind farm will not lead to changes in shoreline processes.

TABLE 3.2-2. COMPARISON OF THE DIFFERENT TYPES OF FOUNDATIONS AND SIGNIFICANCE OF IMPACT

Associated consequence/impact	Monopile foundation	Gravity foundation	Jacket foundation
Construction phase			
- *Amount of sediment released during installation; seabed disturbance*	-	--/-	-/0
Operation phase	0	0	0

Scale of the significance of environmental impacts used in the EIA report: -1 = minor negative impact, -2 = significant negative impact, 0 = no impact, neutral, + = minor positive impact, +2 = significant positive impact.

3.3. Quality of seawater

Studies carried out:

- Study of benthic biota, habitats and water quality in the planned wind farm area. Estonian Marine Institute, University of Tartu, 2023 (Annex 3.6)
- Saaremaa Offshore Wind Farm, Estonia. Oil Spill Risk Assessment (DHI AS 2023) (Annex 3.7)
- Plume Dispersion Modelling and Morphodynamics Assessment. Assessment of the impact of the sediment spill during the installation works and the impact on local morphodynamics as part of the Environmental Impact Assessment (EIA) (Annex 3.2)

SPREAD OF SUSPENDED SEDIMENT

In order to assess the impact of the sediment released and suspended during the construction of the wind farm, a 3D hydrodynamic model of the study area (MIKE 3 FM) was created by DHI AS, based on a similar Baltic Sea-wide model HD_{DKBS2}. Modelling revealed that each of the concentration, persistence and spread of suspended sediment is the highest in the case of gravity foundations. In the case of a gravity foundation, the spread of suspended sediment with a concentration of 2–10 mg/l can reach 5–10 km beyond the development area (Figure 3.3-1). In the case of a monopile foundation, however, suspended sediment will spread in the area immediately adjacent to the foundation (Figure 3.3-2). The situation is similar for the persistence of the suspended sediment in water, as shown in Figures 3.3-3 and 3.3-4.

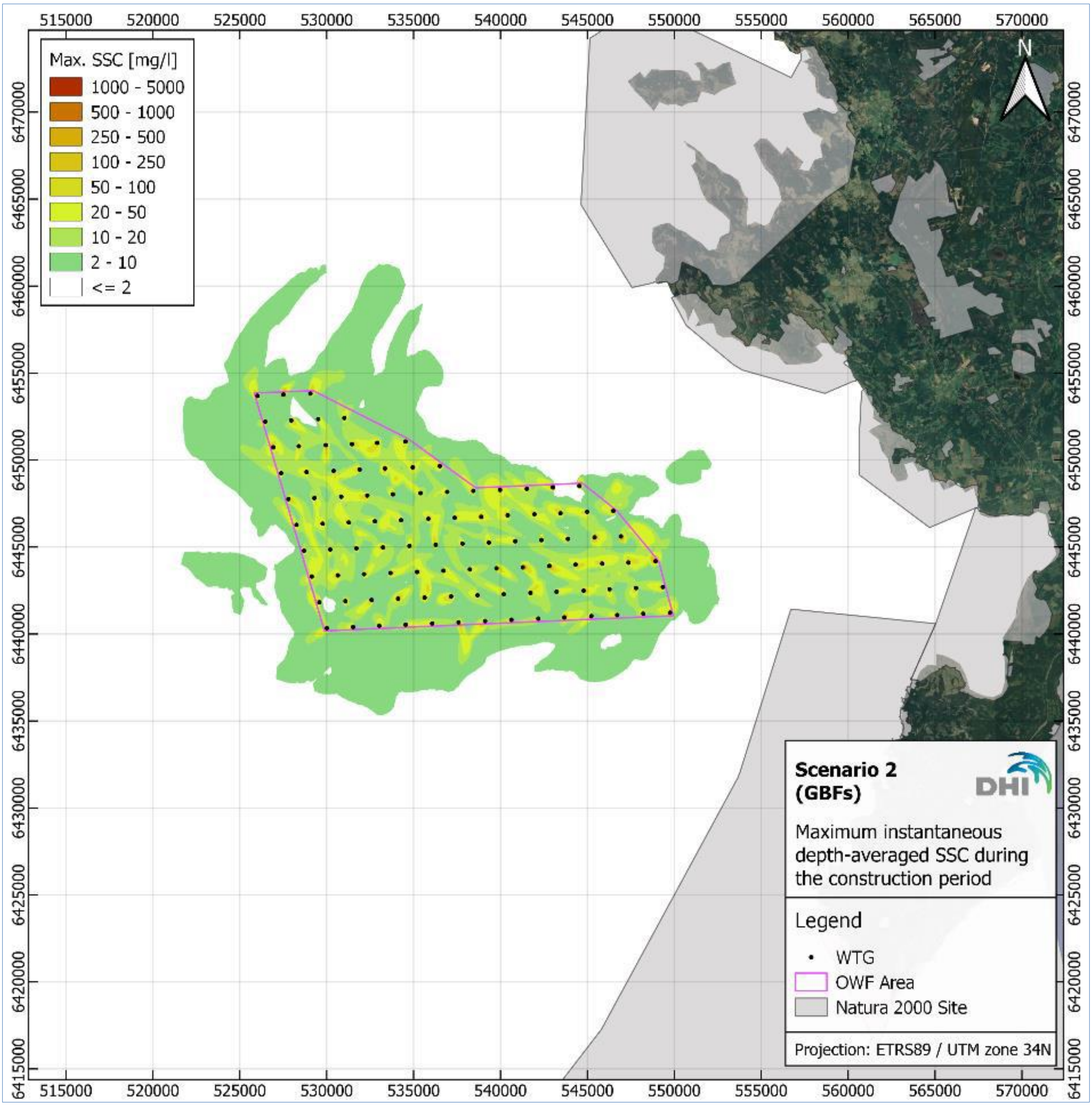


FIGURE 3.3-1. MAXIMUM CONCENTRATIONS OF SUSPENDED SEDIMENT IN THE WHOLE WATER COLUMN DURING THE CONSTRUCTION OF A GRAVITY FOUNDATION (CONSERVATIVE CASE)

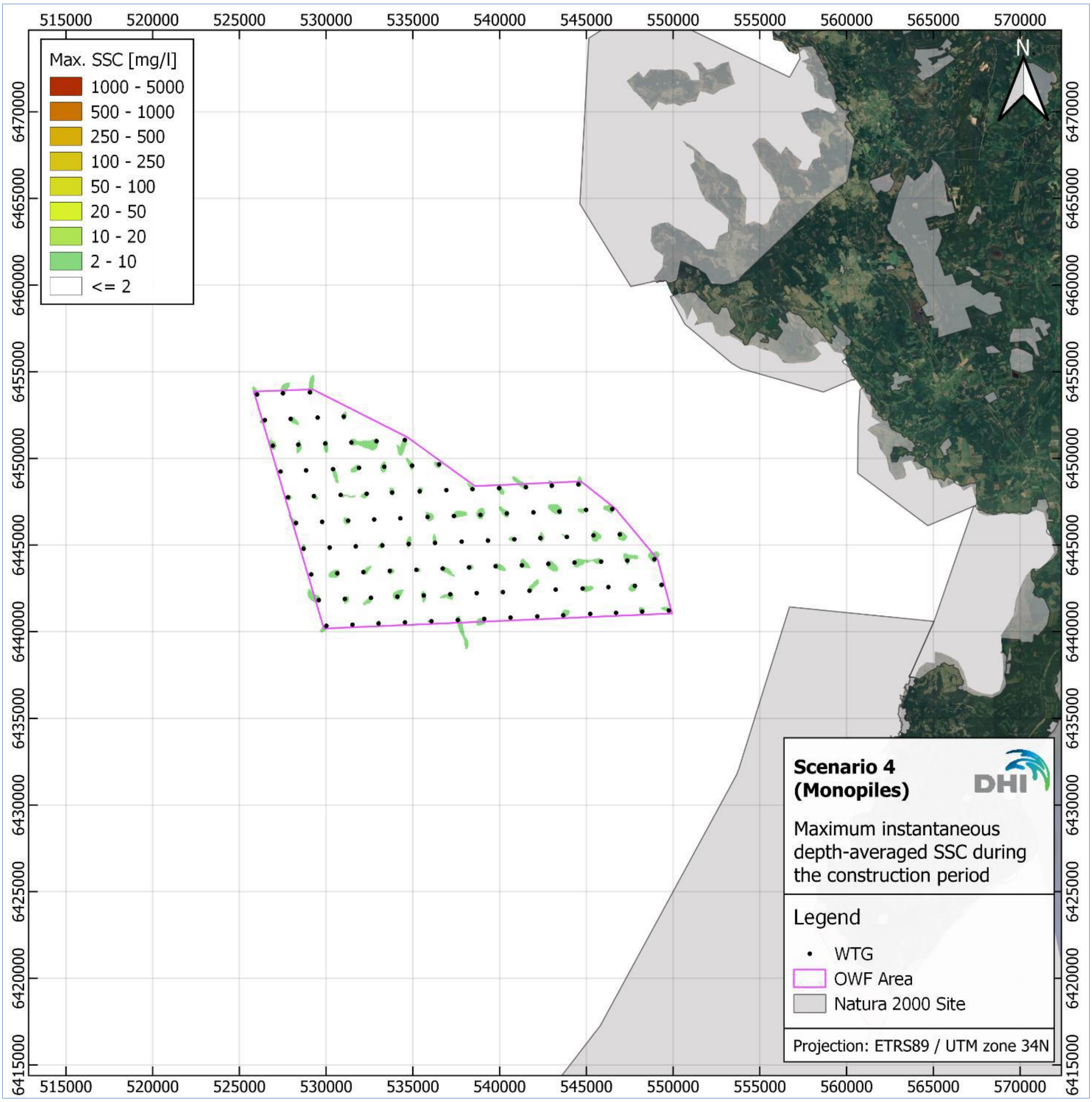


FIGURE 3.3-2. MAXIMUM CONCENTRATIONS OF SUSPENDED SEDIMENT IN THE WHOLE WATER COLUMN DURING THE CONSTRUCTION OF A MONOPILE FOUNDATION

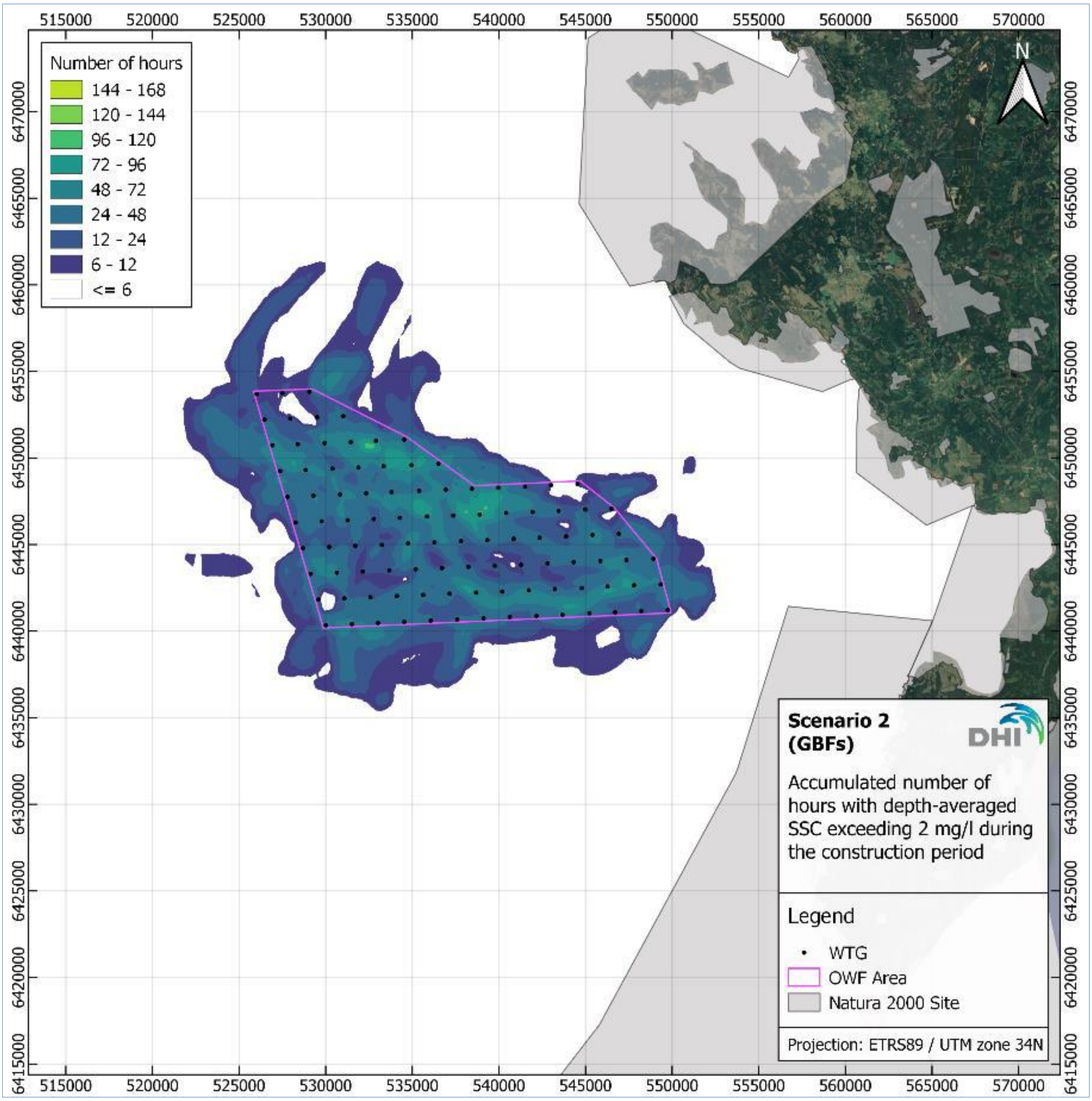


FIGURE 3.3-3. PERSISTENCE OF SUSPENDED SEDIMENT CONCENTRATION EXCEEDING 2 MG/L DURING THE CONSTRUCTION OF A GRAVITY FOUNDATION (IN HOURS)

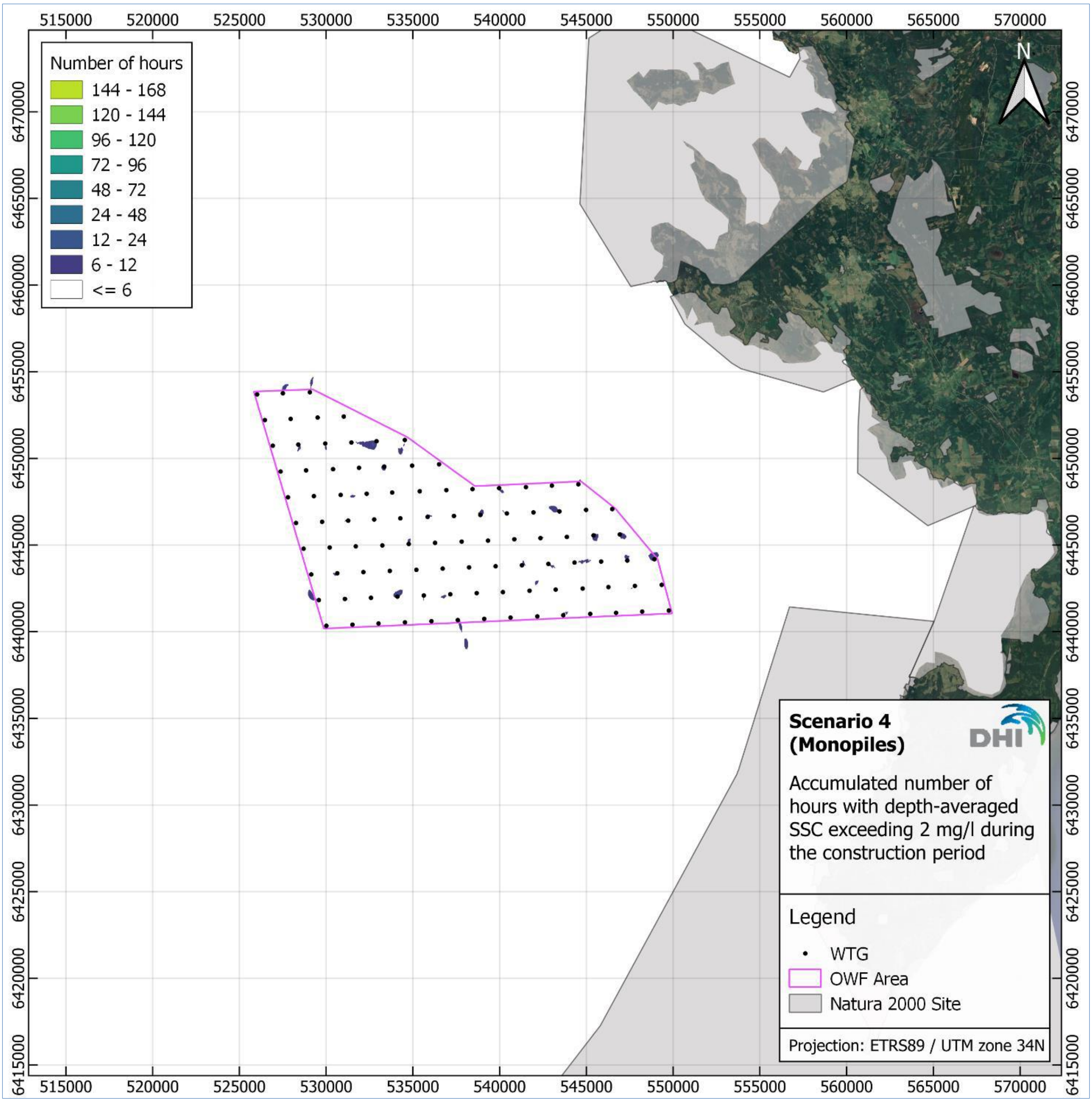


FIGURE 3.3-4. PERSISTENCE OF SUSPENDED SEDIMENT CONCENTRATION EXCEEDING 2 MG/L DURING THE CONSTRUCTION OF A MONOPILE FOUNDATION (IN HOURS)

SPREAD OF POSSIBLE OIL SPILL

Two possible risk scenarios were established to assess a possible oil spill and to model its spread. In the first scenario, the spill would occur during construction works (e.g. in the hydraulic system of a jack-up ship) near the northeasternmost wind turbine (position No. 68), in the shallowest water and closest to the coast (worst case scenario). In the second scenario, a drifting or powered general cargo vessel would collide with the foundation of the most northwesternmost wind turbine (position No. 98), and marine fuel would leak. The scenarios are characterised in Table 3.3-1.

TABLE 3.3-1. OIL SPILL SCENARIOS

Scenario	1	2
Oil type	Hydraulic oil (density 0.92 g/cm^3)	Low-sulphur marine fuel (density 0.86 g/cm^3)
Spill amount	1.26 m^3 = 1.1592 tonnes	21.0 m^3 = 18.06 tonnes
Spill duration	30 min	6 hours
Spill location	Turbine No. 68, northeast corner of the wind farm, 58.16247°N, 21.79017°E	Turbine No. 98, northwest corner of the wind farm, 58.22357°N, 21.44298°E

To predict the potential extent and spread of the oil spill, the stochastic model MIKE OS was used, which considers several hundred combinations of wind, current and wave conditions. For both scenarios, 360 different simulations were performed to determine:

- the maximum amount of oil leaking (kg);
- the maximum oil slick thickness (in microns);
- the shortest oil slick drift time (in days);
- the maximum amount of oil reaching the coast (kg/km of coastline);
- the probability of occurrence of the oil risk (%).

In scenario 1, the impact of the oil spill is limited to the area immediately around the source of the spill, as it is a relatively small spill and as it is a light oil that evaporates quickly (Figure 3.3-5). A maximum of up to 6.9 kg/km would reach the coast, which is a very small amount (Figure 3.3-6).

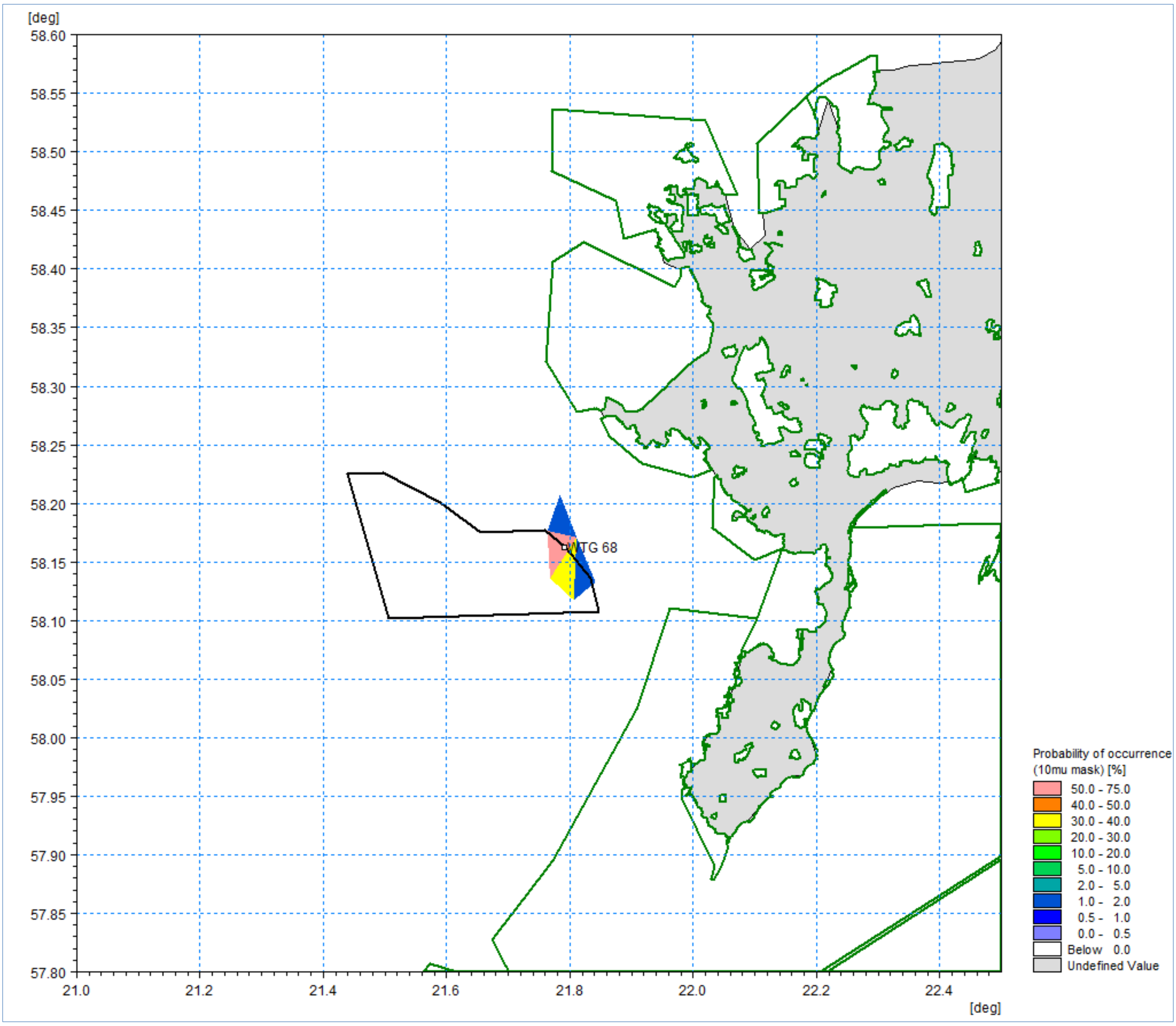


FIGURE 3.3-5. PROBABILITY OF OIL SLICK OCCURRENCE, SCENARIO 1

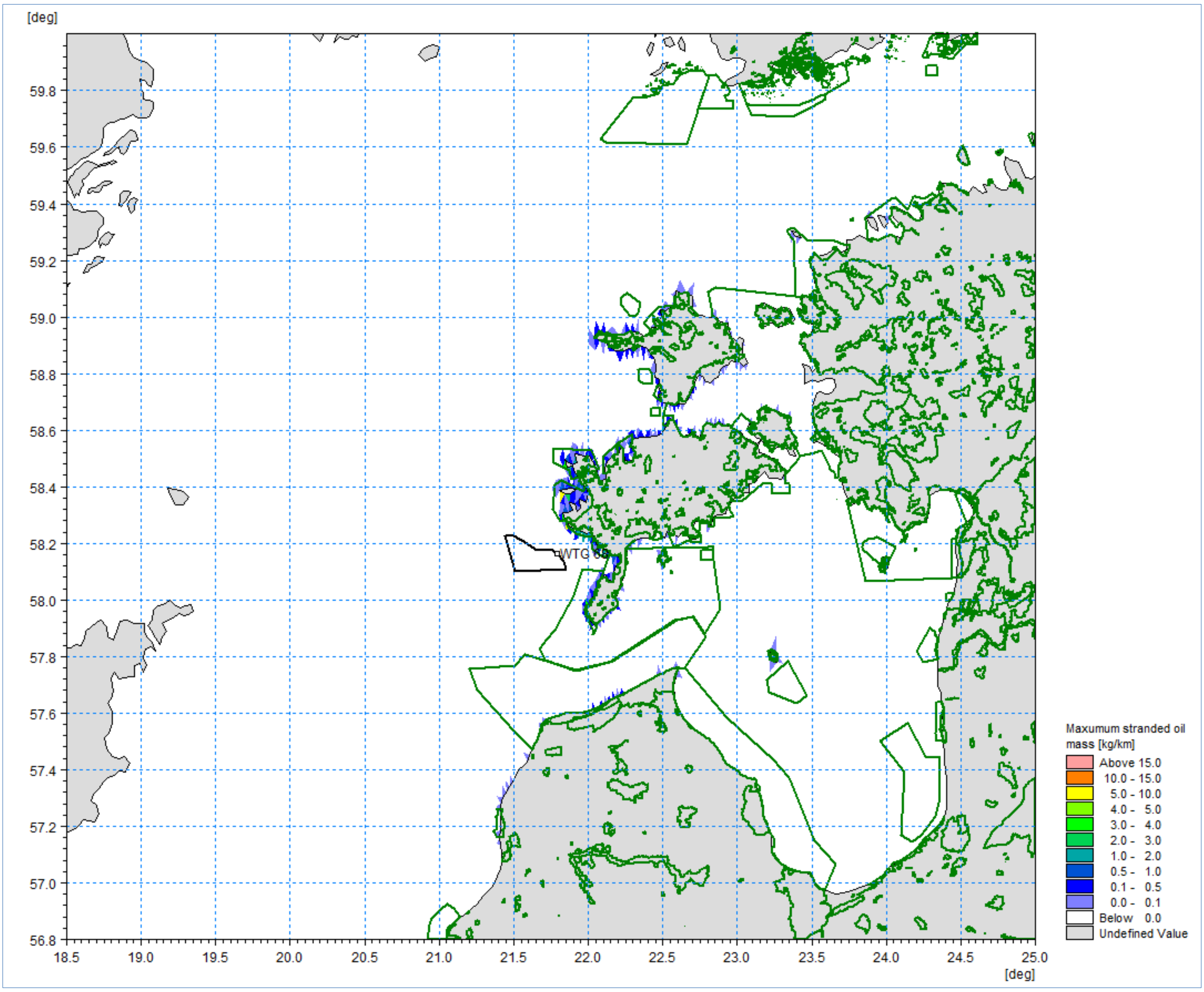


FIGURE 3.3-6. AMOUNT OF OIL REACHING THE COAST, SCENARIO 1

In scenario 2, the amount of leaking oil is higher and it is an oil that does not evaporate quickly. Given the prevailing wind directions, the oil slick could reach the coast to the northeast of the wind farm (Figure 3.3-7), but the probability of this occurring is less than 1%, and up to 5% in a few locations (Figure 3.3-8). The maximum amount of oil reaching the coast is 109 kg/km (Figure 3.3-8).

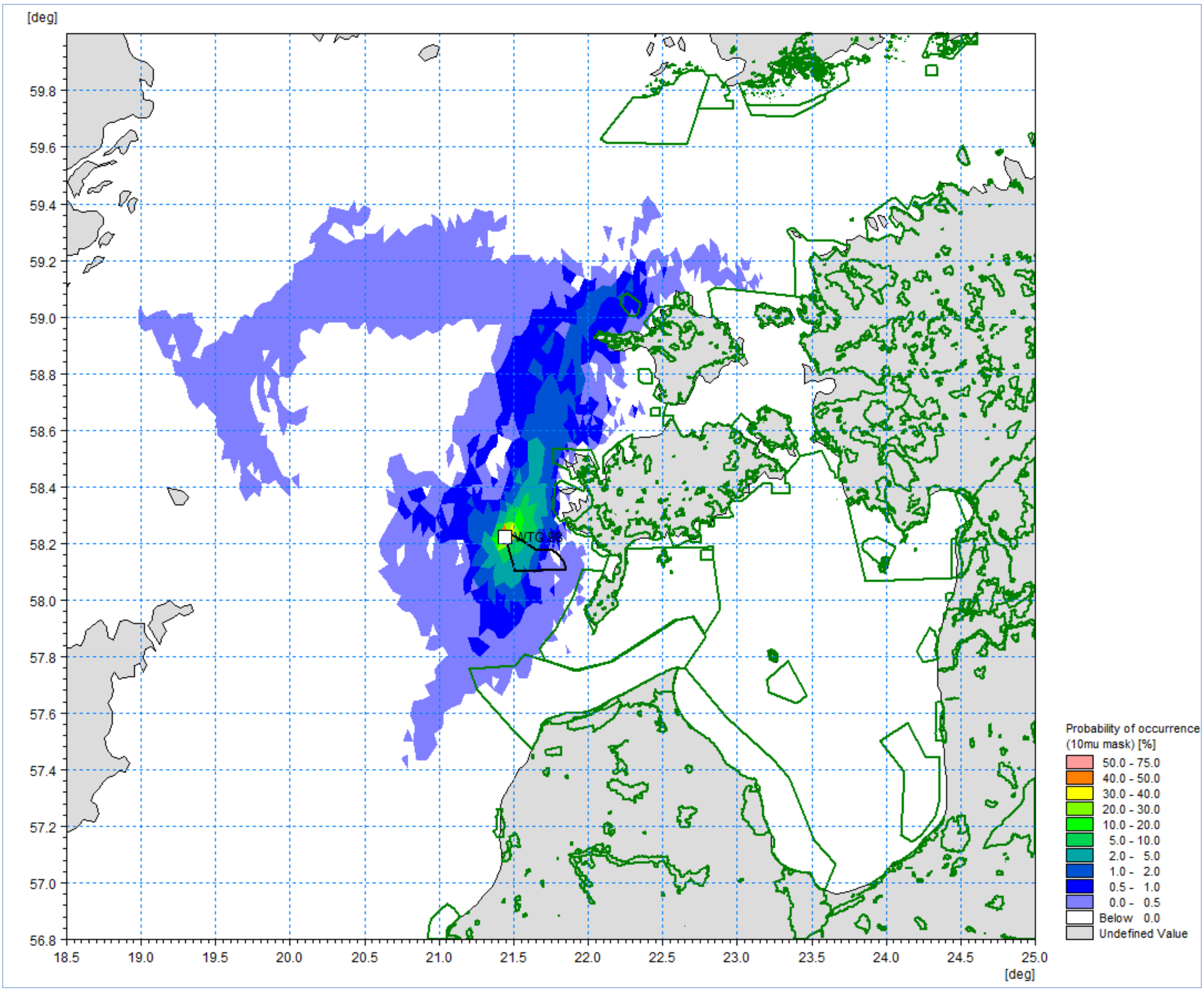


FIGURE 3.3-7. PROBABILITY OF OIL SLICK OCCURRENCE, SCENARIO 2

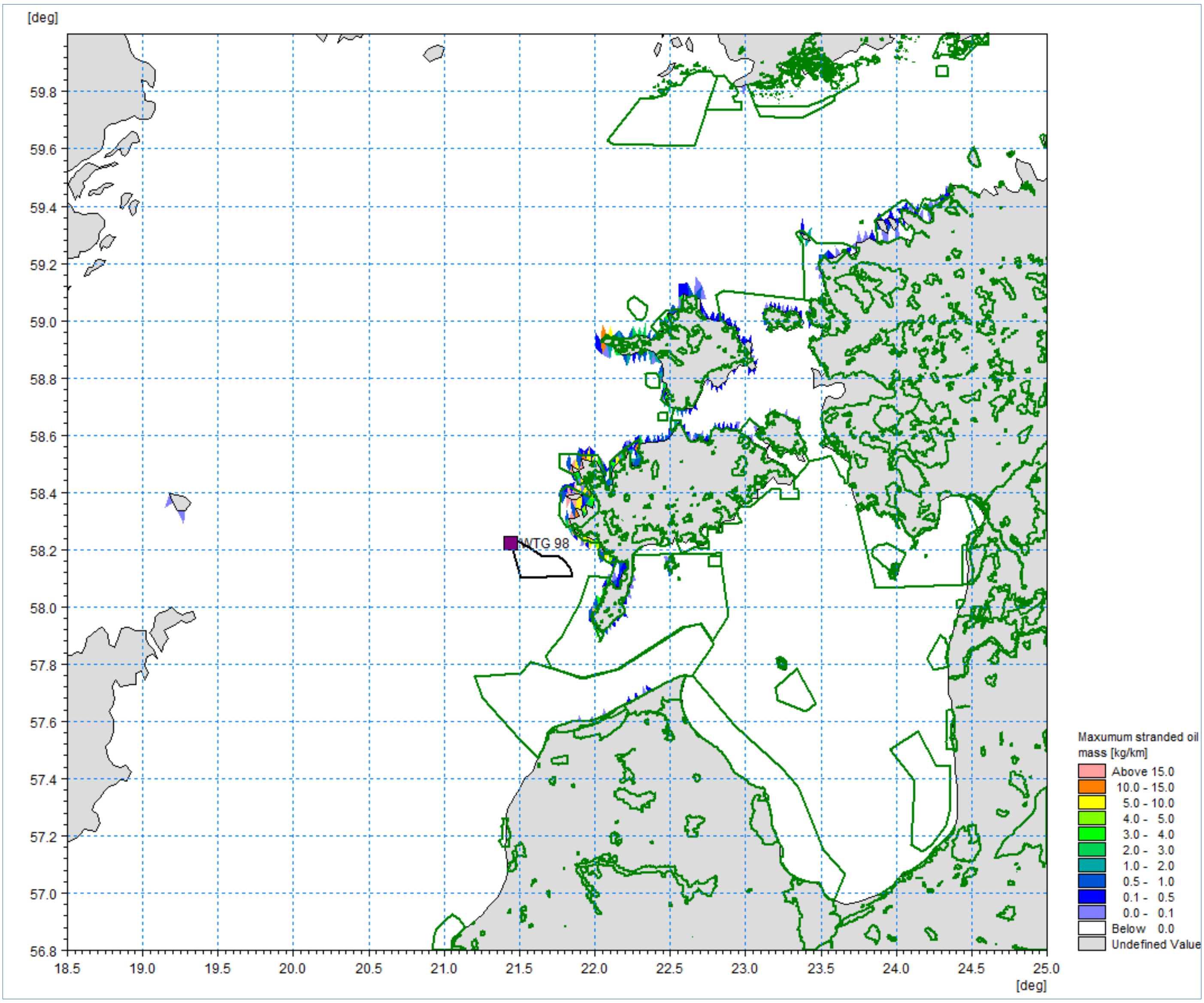


FIGURE 3.3-8. AMOUNT OF OIL REACHING THE COAST, SCENARIO 2

In terms of the spread of suspended sediment, the use of gravity foundations will have the greatest negative environmental impact. During the construction of monopile foundations, sediment will be released and deposited in the area immediately adjacent to the foundations. The lowest impact will be from the construction of jacket foundations.

TABLE 3.3-2. COMPARISON OF THE DIFFERENT TYPES OF FOUNDATIONS AND SIGNIFICANCE OF IMPACT

Associated consequence/impact	Monopile foundation	Gravity foundation	Jacket foundation
Construction phase			
- *Spread of suspended sediment*	-/0	-	-/0
Operation phase	0	0	0

Scale of the significance of environmental impacts used in the EIA report: -1 = minor negative impact, -2 = significant negative impact, 0 = no impact, neutral, + = minor positive impact, +2 = significant positive impact.

The construction of cable connections will release sediment close to the seafloor in a dispersed manner and the spread of the resulting suspended sediment will be insignificant and have a minor impact (-/0) compared to the construction of foundations.

3.4. Benthic biota and habitats

Studies carried out:

- Study of benthic biota, habitats and water quality in the planned wind farm area. Estonian Marine Institute of the University of Tartu, 2023 (Annex 3.6)

The study area is typical of the open coastal sea west of the western islands of Estonia, with typical marine biota. The area is highly exposed to wave action, with hard substrates dominating in the shallows and soft substrates in the deeper parts of the sea. Benthic biota is relatively poor in species compared to the shallow coastal sea. In the context of open seas, the shallowest parts of the study area (with a depth of less than 20 m) are areas that are rich in species and characterised by a high benthic productivity.

Changes in benthic habitat quality can be expressed in two categories: a) benthic habitat loss, which is an irreversible change where the existing benthic habitat is either completely destroyed or replaced by an artificial substrate; b) benthic habitat disturbance, where the benthic habitat is affected either mechanically or chemically to a varying extent, after which the habitat may, over a period of time, recover to the previous quality or close to the previous quality. Thirdly, the impact of potential introduction of a new substrate is highlighted.

The final decision on the type of foundations to be used for the wind turbines has not yet been taken. Therefore, it is not possible to accurately assess the precise impact of the planned foundations on the loss or disturbance of benthic habitats and the "reef effect" caused by a new artificial substrate. Table 3.4-1 below details the impact figures expected for the different types of foundations.

TABLE 3.4-1. TYPES AND DIMENSIONS OF PLANNED INSTALLATIONS (SUBSEA PARTS OF WIND TURBINES, CABLES WITHIN THE WIND FARM) AND CORRESPONDING ASSESSMENTS OF LOSS AND DISTURBANCE OF THE NATURAL SEABED

Element	Monopile foundation	Gravity foundation	Jacket foundation	Cables within the wind farm
Dimensions of installations				
Foundation base diameter (m)	10	50		
Foundation base diameter (m), with gravel pad		55		
Cable route width (m)				1
Total length of cable routes (km)				240
Loss of natural seabed				
Area under foundation (m^2) per wind turbine	79	2376	38	
Area under foundations or cable routes (km^2) per 100 wind turbines	0.0079	0.2376	0.0038	0.24
Area under foundations or cable routes in relation to the study area (%)*1	0.0035	0.11	0.0017	0.11
Loss of hard substrate due to dredging and installation of cabling within the wind farm (km^2)				0.178
Addition of artificial hard substrate*2				
Area (m^2) of underwater structures in water column per wind turbine	895	4477	895*4	
Area (km^2) of underwater structures in water column per 100 wind turbines	0.0895	0.4477	0.0895*4	
Area of underwater structures in relation to the study area (%)*1	0.04	0.2	0.04*4	

Element	Monopile foundation	Gravity foundation	Jacket foundation	Cables within the wind farm
Area of underwater structures in relation to the area of hard substrate mapped in the study area (%)	0.1	0.51	0.1*4	
Seabed disturbance*3				
Area of seabed disturbance (m^2) per wind turbine	9425	16,493	9425*4	
Area of seabed disturbance (km^2) per 100 wind turbines	0.9425	1.6493	0.9425*4	
Area of seabed disturbance in relation to the study area (%)*1	0.42	0.74	0.42*4	
Disturbance of hard substrate due to dredging and installation of cabling within the wind farm (km^2)				0.356

*1 The total area of the study area is estimated at 223.8 km^2, which is the total area of pixels resulting from 10 m-pixel modelling of the study area.
*2 The average depth of the study area is estimated at 28.5 m.
*3 The radius of disturbance is estimated at 50 m and the area directly under the foundations is subtracted from the disturbance area.
*4 The area of underwater structures is equated to that of monopile foundations.

Among the different types of foundations, gravity foundations have the highest impact. This impact translates into habitat loss and disturbance associated with the preparation of the seabed for installation of foundations. For the other two foundation types, the impact is significantly lower. Assuming an even or random distribution of wind turbines in the study area, the construction of the wind farm using monopile foundations would result in a loss of 0.00225 km^2 of reef habitats and disturbance of 0.27 km^2 of reef habitats. The use of gravity foundations would result in a loss of 0.07 km^2 of reef habitats and disturbance of 0.48 km^2 of reef habitats. These values do not result in a deterioration of the conservation status of the habitat type considering the whole of Estonian marine area, nor do they result in an exceedance of the good environmental status limit for this habitat type according to the assessment methodology specified in the Marine Strategy. The habitat loss and disturbance resulting from the dredging and installation of cabling within the wind farm are comparable in magnitude to the habitat loss and disturbance caused by the foundations of wind turbines.

TABLE 3.4-2. COMPARISON OF THE DIFFERENT TYPES OF FOUNDATIONS AND SIGNIFICANCE OF IMPACT

Associated consequence/impact	Monopile foundation	Gravity foundation	Jacket foundation
Loss of natural seabed	-	--/-	-
Addition of artificial hard substrate	-/0	-/0	-/0
- Associated effects on certain organism groups	-/0	-/0	-/0
Seabed disturbance	-	--/-	-

Scale of the significance of environmental impacts used in the EIA report: -1 = minor negative impact, -2 = significant negative impact, 0 = no impact, neutral, + = minor positive impact, +2 = significant positive impact.

The impact of installing cable connections can be considered to be equivalent in significance to that of gravity foundations.

3.5. Birds

Studies carried out:

- Bird study for Saare Wind Energy wind farm. Estonian Ornithological Society, 2023

As part of the study, aerial and ship-based censuses were carried out in 2021 and 2022. The areal censuses were carried out by Leho Luigujõe, ornithologist at the Estonian University of Life Sciences, in cooperation with members of the Estonian Ornithological Society. The ship-based censuses were carried out and their data analysed by BioConsult SH in cooperation with the Estonian Ornithological Society. The species composition, abundance, spatial location and seasonal distribution of waterfowl stopping over in the area were determined through aerial censuses. Visual observations, radar observations with horizontal and vertical radars, and audio recording of night vocalisations of birds flying over the area were carried out in the course of ship-based censuses. The study report, including its appendices, can be found in Annex 3.8.

The most important result of the aerial censuses is the numbers of waterfowl stopping over in the area. Their abundance in the wind farm area is detailed by census in Table 3.5-1. In addition, the study report (Annex 3.8) states the maximum abundance figures when using 1 km and 4 km wide buffers around the wind farm area. The only more abundant species was the little gull in the summer, the numbers of the rest of the waterfowl stopping over in the area were low.

TABLE 3.5-1. ABUNDANCE (NUMBER OF INDIVIDUALS) OF WATERFOWL STOPPING OVER IN THE WIND FARM AREA (CENSUS RESULT, WITH THE ABUNDANCE ESTIMATE GIVEN IN BRACKETS, FOUND USING THE DISTANCE SAMPLING METHOD; LUIGUJÕE AND KUUS, 2022)

Species	Spring	Summer	Autumn	Winter
Loons *(Gavia sp.)*	0	4	0	1
Great cormorant *(Phalacrocorax carbo)*	3	0	0	0
Long-tailed duck *(Clangula hyemalis)*	6 (23)	0	3 (15)	0
Velvet scoter *(Melanitta fusca)*	15	0	0	0
Common scoter *(Melanitta nigra)*	29 (51)	0	0	0
Common goldeneye *(Bucephala clangula)*	0	0	0	4
Red-breasted merganser *(Mergus serrator)*	2	0	0	8
Parasitic jaeger *(Stercorarius parasiticus)*	0	1	0	0
Great black-backed gull *(Larus marinus)*	0	0	1	0
Little gull *(Larus minutus)*	0	55 (625)	1 (3)	1
European herring gull, common gull and unspecified gulls *(Larus sp.)*	4 (24)	4 (40)	19 (100)	2 (14)
Common murre *(Uria aalge)*	0	1	0	0

In the course of visual observations a total of 67,955 overflying birds of 84 species were counted (Table 3.5-2). In spring, the most abundant species were the barnacle goose (21,447 ind.), the long-tailed duck (7442 ind.) and the common scoter (7034 ind.), while the number of geese of undetermined species was also high (7601 ind.). In autumn, the most abundant species were the Eurasian wigeon (1294 ind.) and the common scoter (890 ind.), with the numbers of ducks and geese of undetermined species being also high (932 and 858 ind., respectively).

TABLE 3.5-2. NUMBERS OF SPECIES AND INDIVIDUALS VISUALLY OBSERVED

Season	Number of census days	Number of birds (individuals)	Number of species
Spring 2021	7	31,490	53
Autumn 2021	12	7809	58
Spring 2022	10	28,656	68

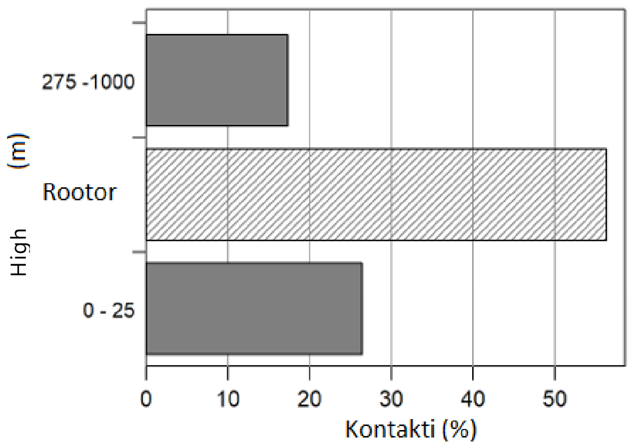
Season	Number of census days	Number of birds (individuals)	Number of species
Total	29	67,955	84

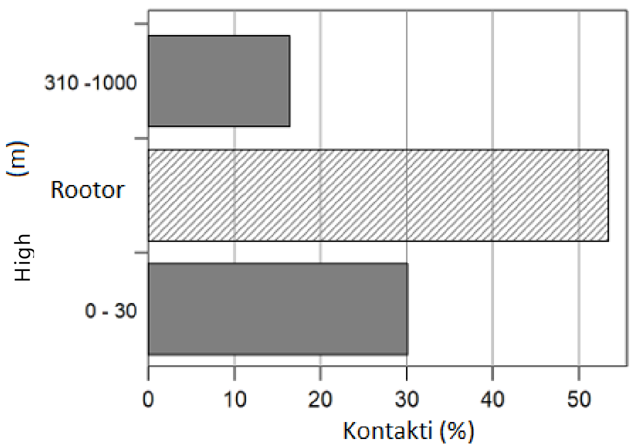
The study showed that during the day, birds prefer to fly at lower altitudes. The average daily flying intensity was up to 2352.9 ind./h (28.04.2022). The average flying intensity was significantly higher in spring, peaking in May 2021, and lower in autumn, with the lowest level observed in October 2021. The average flying intensity varied significantly between days, with greater variability observed in spring.

The average nighttime flying intensity in the altitude range 0–1000 m reached 1284.9 contacts/h*km (21.04.2022). The average nighttime flying intensity was highest in April 2022 and lowest in October 2021. There was significant variation in average flying intensity between nights, with the highest variability observed in April 2022.

Birds preferred to fly at lower altitudes during the day[1]. Between 36% (spring 2022) and 71% (autumn 2021) of vertical radar contacts were recorded in the lower (100 m) air layer. Within that air layer, visual observations indicated a preference for the lowest 0–5 m altitude. Visual observations also point to significant differences between species in terms of daytime altitudinal distribution. For example, the majority of long-tailed ducks and common scoters were flying in the lower 0–5 m layer, while common cranes preferred to fly at 50–100 m and Eurasian wigeons at 100–200 m altitude. At night, the vertical radar data also showed that the number of contacts was highest in the lower 100 m air layer in autumn 2021 and spring (May) 2021, with the proportion of contacts in this layer being lower than during the day (41% and 26%, respectively).

When planning an offshore wind farm, the proportion of birds flying at potential rotor working heights is particularly important. For the planned wind farm in question, two options of rotor working heights have been considered: alternative A – rotor diameter 250 m and overall height 275 m; alternative B – rotor diameter 280 m and overall height 310 m. Vertical radar data have been used to present the data in Figures 3.5-6, 3.5-7 and 3.5-8. The following figures describe situation in autumn 2021, when the proportion of birds flying at the rotor height was higher compared to other study periods, and spring 2022, when the abundance of birds was higher.





1 Vertical radar data (altitude range 0–1000 m at 100 m intervals) and visual observations (lower air layers at smaller intervals and species-specific altitudes) have been used to characterise daytime flying altitudes. Methodological differences do not allow for an exact comparison of the results obtained through these two methods. However, only by using data from both methods is it possible to obtain a more complete picture of the altitudinal distribution of daytime flights. Visual observations are particularly well suited to characterising flying altitudes in the lower 100 m layer, while vertical radar is poor at detecting birds flying in the lowest layers.

FIGURE 3.5-6. DAYTIME ALTITUDINAL DISTRIBUTION OF BIRDS IN AUTUMN 2021 ACCORDING TO VERTICAL RADAR DATA; ROTOR ALTERNATIVE A ON THE LEFT AND ROTOR ALTERNATIVE B ON THE RIGHT

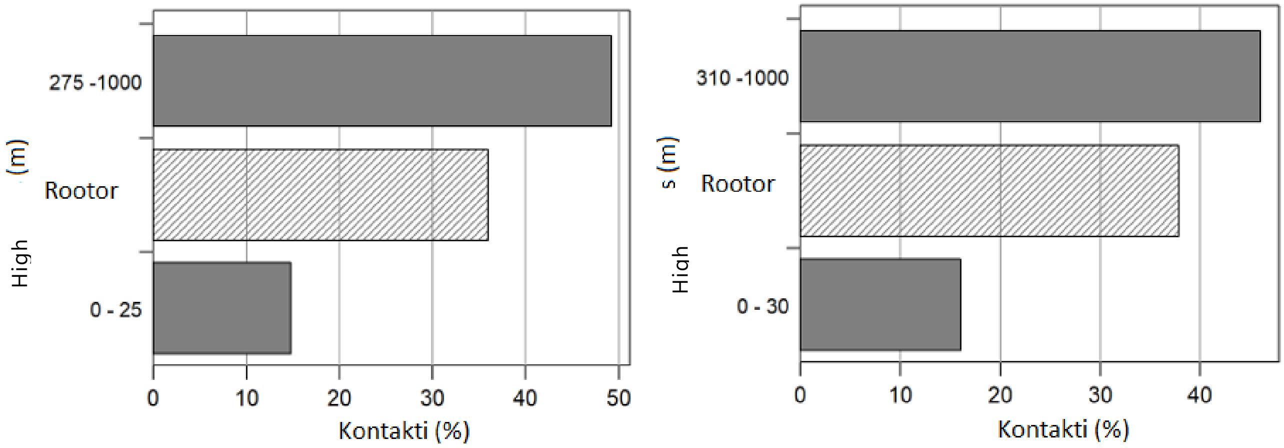


FIGURE 3.5-7. DAYTIME ALTITUDINAL DISTRIBUTION OF BIRDS IN SPRING 2022 ACCORDING TO VERTICAL RADAR DATA; ROTOR ALTERNATIVE A ON THE LEFT AND ROTOR ALTERNATIVE B ON THE RIGHT

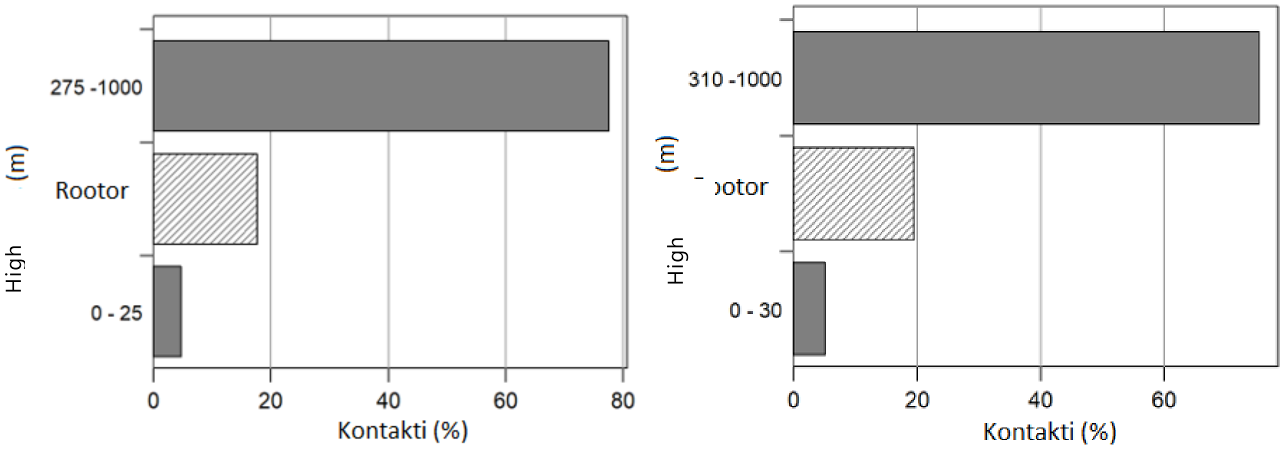


FIGURE 3.5-8. NIGHTTIME ALTITUDINAL DISTRIBUTION OF BIRDS IN SPRING 2022 ACCORDING TO VERTICAL RADAR DATA; ROTOR ALTERNATIVE A ON THE LEFT AND ROTOR ALTERNATIVE B ON THE RIGHT

In autumn, the predominant flight directions were southwest and south during the day, and northwest, west, southwest and south at night (Figures 3.5-9 and 3.5-10). In spring, northeast was clearly the predominant flight direction, with relatively high proportions of east and north during the day observed only in April 2022.

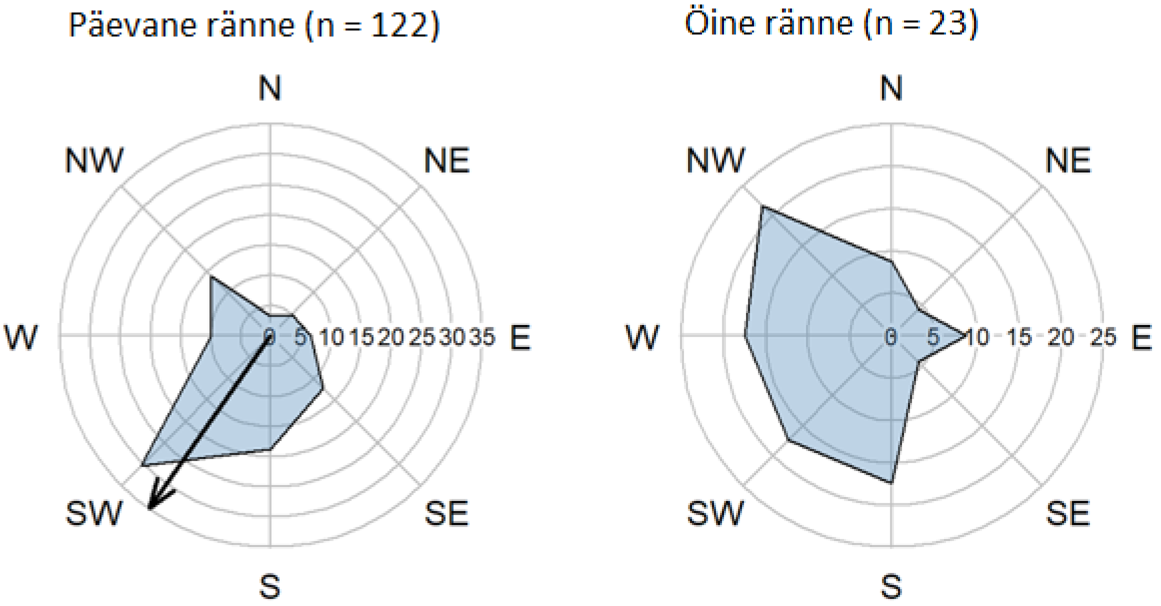


FIGURE 3.5-9. DAYTIME AND NIGHTTIME FLIGHT DIRECTIONS IN AUTUMN 2021 ACCORDING TO HORIZONTAL RADAR DATA (THE ARROW INDICATES THE MEAN FLIGHT DIRECTION)

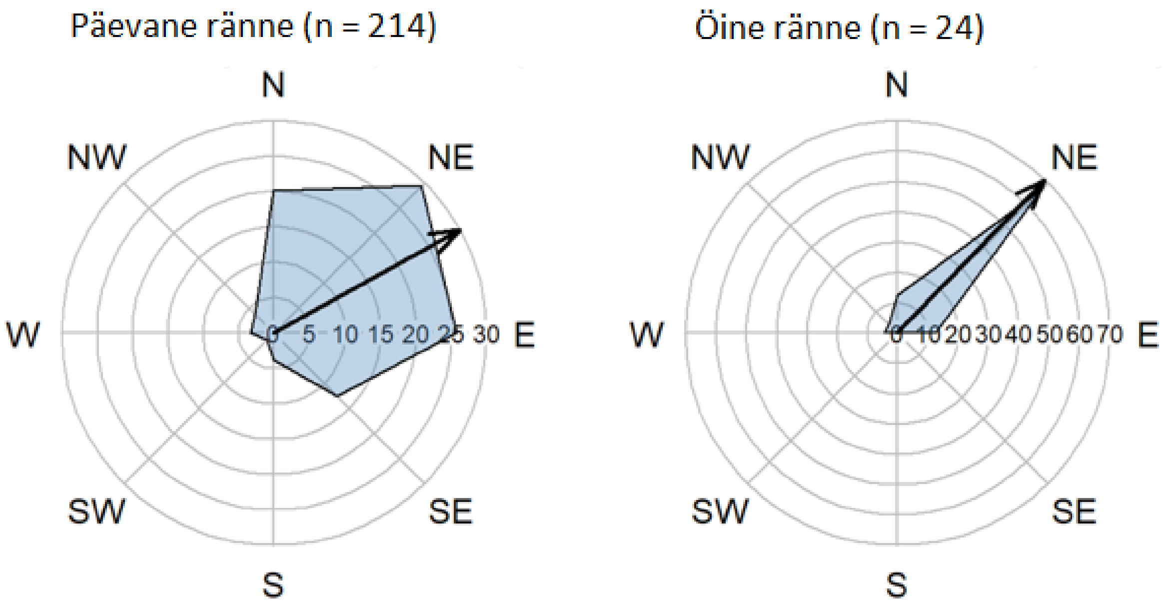


FIGURE 3.5-10. DAYTIME AND NIGHTTIME FLIGHT DIRECTIONS IN SPRING 2022 ACCORDING TO HORIZONTAL RADAR DATA

The impacts of wind farms on birds can be divided into three types: direct, indirect and cumulative impacts (Gode 2020[2]). Direct impacts are often further divided into four categories: habitat loss, displacement of birds from stopover areas, collision risk and barrier effect. Bird displacement and collision risk are the most important direct impacts.

The significance of impacts was assessed for individual species in the case of the most important risk factors and for all species taken together for the less important risk factors. The species-specific assessment of the

2 Gode, P. R. 2020. How to design future wind farms to best mitigate their disturbance effects on birds? (PDF) How to design future wind farms to best mitigate their disturbance effects on birds. (researchgate.net) significance of impacts was based on the importance of the area to the species in question and the vulnerability of the species to the specific risk factor. The importance of the area was determined by comparing the abundance of the species in the area against thresholds of international, national and local importance. For waterfowl, the common threshold for an area of international importance is 1% of the biogeographic population (Wetlands International[3]). Thresholds for areas of national and local importance have been developed by ornithologists at the Estonian University of Life Sciences (Luigujõe 2019[4]). For nesting birds, European and Estonian abundance estimates were used as thresholds (see detailed description of the methodology in Annex 3.8).

IMPACTS DURING CONSTRUCTION AND DISMANTLING PHASES

Disturbance

Disturbance and displacement will affect waterfowl stopping over in the area. Therefore, the wind farm area should be considered with a certain buffer when assessing impacts. The width of the buffer around the wind farm area (1 km or 4 km) did not influence the final result in this case: the overall assessment of the significance of the impact remained the same.

The impact assessment looked at all the species that stopped in the wind farm area during aerial censuses. The assessment was based on the maximum abundance estimate for the species, or the census result (if the abundance of the species in the area was too low to produce an abundance estimate). The numerical thresholds used to assess the importance of the area are set out in Annex 3.8.

The impact of disturbance during construction and dismantling will be short-term, limited to the length of the respective phases. The results of the assessment are detailed in Table 3.5-3.

TABLE 3.5-3. SIGNIFICANCE OF THE RISK OF DISTURBANCE WHEN USING A 1 KM/4 KM BUFFER

Species	Importance of the area*	Disturbance risk (Garthe & Hüppop 2004, Maclean et al. 2009, Furness et al. 2012)	Significance of disturbance risk**
Loons *(Gavia sp.)*	Low	Very high	Medium
Great cormorant *(Phalacrocorax carbo)*	Low	High	Low
Long-tailed duck *(Clangula hyemalis)*	Low	Medium-high	Low
Velvet scoter *(Melanitta fusca)*	Low	Very high	Medium
Common scoter *(Melanitta nigra)*	Low	Very high	Medium
Common goldeneye *(Bucephala clangula)*	Low	High	Low
Red-breasted merganser *(Mergus serrator)******	Low		Low
Parasitic jaeger *(Stercorarius parasiticus)*	Low	Very low	Insignificant
Great black-backed gull *(Larus marinus)*	Low	Low	Insignificant
Little gull *(Larus minutus)*	High/very high	Very low	Low
European herring gull, common gull and unspecified gulls *(Larus sp.)*	Low	Low	Insignificant
Common murre *(Uria aalge)*	Low	Medium	Low
Razorbill *(Alca torda)*	Low	Medium	Low

3 wetlands.org

4 Elts, J., Leito, A., Leivits, M., Luigujõe, L., Nellis, R., Ots, M., Tammekänd, I. & Väli, Ü. 2019. Eesti lindude staatus, pesitsusaegne ja talvine arvukus 2013–2017. Hirundo 32 (1): 1-39. Elts_et_al_2019-1.pdf (eoy.ee)

** Scale of importance of the area: very high – the area has international importance for the species; high – the area has national importance for the species; medium – the area has local importance for the species; low – remaining species.*
*** Significance of impact: high – the wind farm will pose a serious threat to birds and should not be constructed; medium – the impact on birds is noteworthy and needs a case-by-case approach; low – the impact on birds is undesirable but low; insignificant – the impact on birds is not significant.*
**** No disturbance risk is given in the sources for the red-breasted merganser. The abundance of the species is very low in the area and the significance of the disturbance risk cannot be more than low.*

The wind farm area is not an important stopover site; the only species of concern is the little gull. The sensitivity of the little gull to disturbance is very low and therefore the disturbance risk is also low. The significance of the disturbance risk is the highest for loons and scoters, but the abundance of these species in the area is low and the importance of the area as a stopover site of these species is also low. Overall, given the short-term nature of disturbance during construction and dismantling phases, the significance of the disturbance risk can be considered to be low.

Indirect impacts

Indirect impacts affect waterfowl stopping over in the area. The wind farm area in question is not an important stopover site. The risk associated with changes in the abundance of food has been assessed as medium for diving ducks, loons, cormorants, terns and auks; low for skuas and gulls (Langston 2010[5]). The importance of the area can be considered to be high or very high only for the little gull; for the other waterfowl the area is of low importance as a stopover site. Combining the importance of the area with the risk associated with changes in the abundance of food, the latter is of low significance (insignificant).

Overall, indirect impacts on birds cannot be completely ruled out, but they cannot be considered to be more than low.

IMPACTS DURING THE OPERATION PHASE OF THE WIND FARM

Displacement

The assessment of the impact of displacement is similar to the assessment of the impact of disturbance during construction. The same numerical thresholds have been used to assess the importance of the area, and the results of the assessment are detailed in Table 3.5-4.

TABLE 3.5-4. SIGNIFICANCE OF THE RISK OF DISPLACEMENT WHEN USING A 1 KM/4 KM BUFFER

Species	Importance of the area*	Displacement risk (Piggott, Vulcano & Mitchell 2021, Humphreys et al. 2015)	Significance of displacement risk**
Loons *(Gavia sp.)*	Low	High	Low
Great cormorant *(Phalacrocorax carbo)*	Low	Medium	Low
Long-tailed duck *(Clangula hyemalis)*	Low	Medium	Low
Velvet scoter *(Melanitta fusca)*	Low	Medium	Low
Common scoter *(Melanitta nigra)*	Low	High	Low
Common goldeneye *(Bucephala clangula)*	Low	High	Low
Red-breasted merganser *(Mergus serrator)*	Low	Medium	Low
Parasitic jaeger *(Stercorarius parasiticus)*	Low	Very low	Insignificant

5 Langston, R. H. W. 2010. Offshore wind farms and birds: Round 3 zones, extensions to Round 1 & Round 2 sites & Scottish Territorial Waters. RSPB Research Report No. 39. Offshore wind farms and birds: Round 3 zones, extensions to Round 1 & Round 2 sites & Scottish Territorial Waters (pnnl.gov)

Species	Importance of the area*	Displacement risk (Piggott, Vulcano & Mitchell 2021, Humphreys et al. 2015)	Significance of displacement risk**
Great black-backed gull *(Larus marinus)*	Low	Very low	Insignificant
Little gull *(Larus minutus)*	High/very high	Very low	Low
European herring gull, common gull and unspecified gulls *(Larus sp.)*	Low	Very low	Insignificant
Common murre *(Uria aalge)*	Low	Low	Insignificant
Razorbill *(Alca torda)*	Low	Low	Insignificant

** Scale of importance of the area: very high – the area has international importance for the species; high – the area has national importance for the species; medium – the area has local importance for the species; low – remaining species.*
*** Significance of impact: high – the wind farm will pose a serious threat to birds and should not be constructed; medium – the impact on birds is noteworthy and needs a case-by-case approach; low – the impact on birds is undesirable but low; insignificant – the impact on birds is not significant.*

The results of aerial censuses carried out in the wind farm area and their analysis confirm previous assessments that this area is not an important stopover site for waterfowl (Estonian Ornithological Society 2019, Estonian Ornithological Society 2022). The only species of concern is the little gull. The sensitivity of the little gull to the risk of displacement is very low and therefore the risk of displacement is also low.

The availability of suitable stopover sites in the vicinity has been considered in the assessment of the displacement risk in some studies (Sciara Offshore Energy LTD 2006). In this case, shallower marine areas to the northeast of the wind farm provide alternative stopover sites. Overall, therefore, the significance of the displacement risk can be considered to be low.

HABITAT LOSS

Direct habitat loss affects waterfowl stopping over in the area. The wind farm area in question is not an important stopover site. Habitat loss affects only a small proportion of the wind farm area. In addition, a certain number of habitats may be lost under the cable route. Overall, there is a certain risk of direct habitat loss (loss of stopover areas), but the impact cannot be considered to be more than low.

BARRIER EFFECT

Bypassing a single wind farm during migration has a relatively small effect on the length of the journey. For example, the length of autumn migration of long-tailed ducks was 623.5–2820.5 km, with an average of 1939.9 km, based on telemetry data from 12 individuals (Quillfeldt et al. 2021). The perimeter of the planned wind farm, incl. a 1 km buffer, is 70.3 km. Assuming that long-tailed ducks would fly around the wind farm and estimating the distance required to bypass the wind farm at half the circumference of the wind farm, the autumn migration of long-tailed ducks would increase by 1.8%. The actual lengthening of the migration route is likely to be smaller, as the distance to bypass the wind farm may be less than half the circumference of the wind farm and birds may partly fly between the wind turbines.

The barrier effect may prove to be significant if the wind farm is located between nearby nesting colonies and the feeding grounds of the birds nesting in these colonies. In the present case, the nesting islands are located to the northeast and east of the wind farm. On the other side of the wind farm, to the south, southwest and west, there are deep sea areas, with no shallows suitable for diving ducks for feeding. Foraging flights of terns and gulls, in particular, could reach the wind farm area. The assessment of the potential significance of the barrier effect for birds nesting in the vicinity is detailed in Table 3.5-5.

TABLE 3.5-5. RISK TO NESTING BIRDS FROM THE BARRIER EFFECT

Species	Average feeding distance, km	Importance of the area*	Risk from barrier effect (Langston 2010)	Significance of barrier effect**
Lesser black-backed gull *(Larus fuscus)*	71.9 ± 10.2	High	Low	Low
Little gull *(Larus minutus)*	23.6	High	Low	Low
Caspian tern *(Hydroprogne caspia)*	16	Low – medium	Low	Insignificant
Sandwich tern *(Thalasseus sandvicensis)*	11.5 ± 4.7	Low	Low	Insignificant

** Scale of importance of the area: very high – the area has international importance for the species; high – the area has national importance for the species; medium – the area has local importance for the species; low – remaining species.*
*** Significance of impact: high – the wind farm will pose a serious threat to birds and should not be constructed; medium – the impact on birds is noteworthy and needs a case-by-case approach; low – the impact on birds is undesirable but low; insignificant – the impact on birds is not significant.*

COLLISION RISK

The Band model and the software developed to implement it (Band 2012,[6] Caneco et al. 2022[7]) were used to assess the collision risk. The methodology and results of modelling are presented in a separate report (Liedtke & Welcker 2023,[8] see Annex 3.8). Collision risk was modelled for 13 key species or groups of species. An estimate of the number of collisions per year was provided per 100 turbines, and two possible options were considered for rotor operating heights: alternative A – rotor diameter 250 m and overall height 275 m; alternative B – rotor diameter 280 m and overall height 310 m.

The average annual collision estimates for the diurnal migratory species ranged from 0.38 (terns) to 184.08 (dabbling ducks). For nocturnal migrants (probably involving mainly passerine birds), the annual average number of collisions was estimated at 1891.46.

The importance of the area for migratory birds was assessed on the basis of spring or autumn abundance estimate, whichever was greater. In order to reduce the risk of overestimation, the seasonal abundance estimates were calculated by summing only the abundance estimates for the months in which observations were carried out (the "short version": April and May in spring and September and October in autumn).

In cases where the mortality risk was identified at the level of a species group, the proportion of unspecified individuals in the visual observations had usually been high and the size of the biogeographic population was calculated by summing the abundance estimates of the main species belonging to the group. For example, common or Arctic terns accounted for 85%, common terns accounted for 1%, unspecified terns accounted for 13%, Sandwich terns accounted for 0.7% and Caspian terns accounted for 0.2% of terns observed in spring; the size of the biogeographic population was considered to be the sum of the populations of common and Arctic terns. Eurasian wigeons accounted for 90% of dabbling ducks in the autumn, and the size of the biogeographical population of this species was used as the basis.

6 *Band, B. 2012. Using a collision risk model to assess bird collision risks for offshore wind farms.*

7 *Caneco, B., Humphries, G., Cook, A. S. C. P. & Masden, E. 2022. Estimating bird collisions at offshore windfarms with stochLAB.*

8 *Liedtke, J., Welcker, J. 2023. Collison risk models for Saare Wind offshore wind farm.*

For all waterfowl other than terns and the tufted duck, the seasonal estimate of the number of birds migrating through the wind farm area exceeded 1% of the total biogeographic population (Table 3.6-6). In the case of the tufted duck, the estimate of the number of individuals passing through the area exceeds the threshold for an area of national importance. As regards terns, no numerical thresholds have been set for areas of national or local importance. Given that the importance of the area for terns is not very high and the vulnerability of terns to the wind farm is very low, the impact of the wind farm on terns is insignificant according to the methodology used, irrespective of a more precise assessment of the importance of the area.

The exact species and numerical composition of nocturnal migration is unknown, with passerines likely representing the majority of these migrants. While this is not a staging area of migrating passerines, the abundance estimate is relatively high. Based on audio recordings of nighttime vocalisations made in April, the most abundant species were the redwing and the song thrush, which accounted for 34% and 15% of the recorded birds, respectively. Taking the April estimate of the abundance of nocturnal migrants as the basis and assuming that the percentages determined from the audio recordings apply to all nocturnal migrants, the total number of redwings migrating through the area in April can be estimated at 884,061 and that of song thrushes can be estimated at 129,957. Based on these abundance estimates, 4% of European redwings and 0.2% of European song thrushes pass through the wind farm in April. Consequently, the wind farm area may be of international importance at least for some species of nocturnal migrants, and the importance of the area must be regarded as very high based on the methodology used.

TABLE 3.5-6. ESTIMATES OF SEASONAL ABUNDANCE OF MIGRANTS AND ITS PROPORTION IN THE BIOGEOGRAPHIC POPULATION

Species/group	Seasonal abundance estimate	Season	1% of biogeographic population (Wetlands International)	Proportion of migrants in the biogeographic population, %
Barnacle goose and brant *(Branta leucopsis, Branta bernicla)*	1,086,966	Spring	16,100	67.51
Bean goose and greater white-fronted goose *(Anser fabalis, Anser albifrons)*	182,186	Spring	17,500	10.41
Terns	24,345	Spring	45,100	0.54
Common crane *(Grus grus)*	14,932	Spring	1500	9.95
Great cormorant *(Phalacrocorax carbo)*	21,030	Autumn	6200	3.39
Dabbling ducks	164,320	Autumn	14,000	11.74
Loons *(Gavia sp.)*	62,022	Spring	7800	7.95
Little gull *(Larus minutus)*	22,167	Autumn	1300	17.05
Long-tailed duck *(Clangula hyemalis)*	344,069	Spring	16,000	21.5
Mergansers *(Mergus sp.)*	9799	Spring	3400	2.88
Common scoter *(Melanitta nigra)*	274,257	Spring	7500	36.57
Tufted duck *(Aythya fuligula)*	5883	Autumn	8900	0.66
Nocturnal migrants	3,784,567	Spring	-	-

For all waterfowl, the modelled number of collisions is significantly less than 1% of the biogeographic population regardless of turbine type (Table 3.5-7). As regards nocturnal migrants, assumptions can be made for redwings in April. The number of nocturnal migrants' collisions in April accounted for 0.02% of the estimated abundance of nocturnal migrants passing through the wind farm area in April. Assuming that the same percentage holds true for each species, the numbers of redwings and song thrushes killed in April can be estimated at 177 and 26, respectively. These figures would account for 0.00083% and 0.000044% of the European total population, respectively. April represents only a part of the species' migration period, but the percentages obtained are so low that the estimate of the total number of individuals killed during the year would hardly exceed 1% of the European population.

TABLE 3.5-7. ESTIMATES OF THE SEASONAL NUMBER OF COLLISIONS AND ITS PROPORTION IN THE BIOGEOGRAPHIC POPULATION

Species/group	Annual estimate of the number of collisions	1% of biogeographic population (Wetlands International)	Proportion of collisions in the biogeographic population, %
Turbine A			
Barnacle goose and brant *(Branta leucopsis, Branta bernicla)*	98.96	16,100	0.006147
Bean goose and greater white-fronted goose *(Anser fabalis, Anser albifrons)*	115.54	17,500	0.006602
Terns	0.38	45,100	0.000008
Common crane *(Grus grus)*	11.46	1500	0.00764
Great cormorant *(Phalacrocorax carbo)*	7.97	6200	0.001285
Dabbling ducks	184.08	14,000	0.013149
Loons *(Gavia sp.)*	0.89	7800	0.000114
Little gull *(Larus minutus)*	1.2	1300	0.000923
Long-tailed duck *(Clangula hyemalis)*	0.68	16,000	0.000043
Mergansers *(Mergus sp.)*	0.76	3400	0.000224
Common scoter *(Melanitta nigra)*	3.88	7500	0.000517
Tufted duck *(Aythya fuligula)*	1.19	8900	0.000134
Nocturnal migrants	1891.46	-	-
Turbine B			
Barnacle goose and brant *(Branta leucopsis, Branta bernicla)*	78.42	16,100	0.004871
Bean goose and greater white-fronted goose *(Anser fabalis, Anser albifrons)*	105.65	17,500	0.006037
Terns	0.22	45,100	0.000005
Common crane *(Grus grus)*	9.77	1500	0.006513
Great cormorant *(Phalacrocorax carbo)*	6.59	6200	0.001063
Dabbling ducks	181.35	14,000	0.012954
Loons *(Gavia sp.)*	0.57	7800	0.000073
Little gull *(Larus minutus)*	0.89	1300	0.000685
Long-tailed duck *(Clangula hyemalis)*	0.36	16,000	0.000023
Mergansers *(Mergus sp.)*	0.57	3400	0.000168
Common scoter *(Melanitta nigra)*	2.75	7500	0.000367
Tufted duck *(Aythya fuligula)*	0.9	8900	0.000101
Nocturnal migrants	2174.05	-	-

Although the importance of the area for migratory birds is very high when using maximum abundance estimates, the numbers of projected collisions are mostly low and represent a very small fraction of the biogeographic population. The overall risk of collision can be regarded as low to insignificant (Table 3.5-8).

TABLE 3.5-8. SIGNIFICANCE OF COLLISION RISK

Species/group	Importance of the area*	Vulnerability to the wind farm	Significance of collision risk**
Barnacle goose and brant *(Branta leucopsis, Branta bernicla)*	Very high	Very low	Low
Bean goose and greater white-fronted goose *(Anser fabalis, Anser albifrons)*	Very high	Very low	Low
Terns	-	Very low	Insignificant
Common crane *(Grus grus)*	Very high	Very low	Low
Great cormorant *(Phalacrocorax carbo)*	Very high	Very low	Low
Dabbling ducks	Very high	Very low	Low
Loons *(Gavia sp.)*	Very high	Very low	Low
Little gull *(Larus minutus)*	Very high	Very low	Low
Long-tailed duck *(Clangula hyemalis)*	Very high	Very low	Low
Mergansers *(Mergus sp.)*	Very high	Very low	Low
Common scoter *(Melanitta nigra)*	Very high	Very low	Low
Tufted duck *(Aythya fuligula)*	High	Very low	Insignificant
Nocturnal migrants	Very high	Very low	Low

** Scale of importance of the area: very high – the area has international importance for the species; high – the area has national importance for the species; medium – the area has local importance for the species; low – remaining species.*
*** Significance of impact: high – the wind farm will pose a serious threat to birds and should not be constructed; medium – the impact on birds is noteworthy and needs a case-by-case approach; low – the impact on birds is undesirable but low; insignificant – the impact on birds is not significant.*

Based on the study of birds carried out and the analysis of the study report, the potential impact of the wind farm on birds will be low (Table 3.6-9), i.e. the activity will have a minor negative impact.

TABLE 3.5-9. POTENTIAL IMPACT OF THE WIND FARM ON BIRDS (ALTERNATIVE A – ROTOR DIAMETER 250 M AND OVERALL HEIGHT 275 M; ALTERNATIVE B – ROTOR DIAMETER 280 M AND OVERALL HEIGHT 310 M)

Risk factor/impact	Significance of impact*/**	
	Turbine A	Turbine B
Construction and dismantling phases		
Disturbance from construction activities and vessel traffic	Low/minor negative impact	Low/minor negative impact
Indirect impacts (impact on food availability and pollution risk)	Low/minor negative impact	Low/minor negative impact
Operation phase		
Displacement	Low/minor negative impact	Low/minor negative impact
Direct habitat loss	Low/minor negative impact	Low/minor negative impact
Collision risk	Low/minor negative impact	Low/minor negative impact

Risk factor/impact	Significance of impact*/**	
	Turbine A	Turbine B
Barrier effect	Low/minor negative impact	Low/minor negative impact
Indirect impacts (impact on food availability and pollution risk)	Low/minor negative impact	Low/minor negative impact

** Scale of the significance of impact based on the study on birds: high – the wind farm will pose a serious threat to birds and should not be constructed; medium – the impact on birds is noteworthy and needs a case-by-case approach; low – the impact on birds is undesirable but low; insignificant – the impact on birds is not significant.*

*** Scale of the significance of environmental impacts used in the EIA report: -1 = minor negative impact, -2 = significant negative impact, 0 = no impact, neutral, + = minor positive impact, +2 = significant positive impact.*

3.6. Bats

Studies carried out:

- Study on bats in the sea west of Saaremaa from May to October 2021. Lauri Lutsar (MTÜ Sicista Arenduskeskus), 202 (Annex 3.9)

To study the presence of bats in the area of the potential offshore wind farm, three Batcorder 3.1 automatic bat recorders (ecoObs GmbH, Nuremberg, Germany) were installed in the project area in 2021 (Figure 3.6-2). In addition to the surveyed project area, an additional recorder was installed to the east of the Sõrve peninsula, at the southern buoy of Veiserahu.

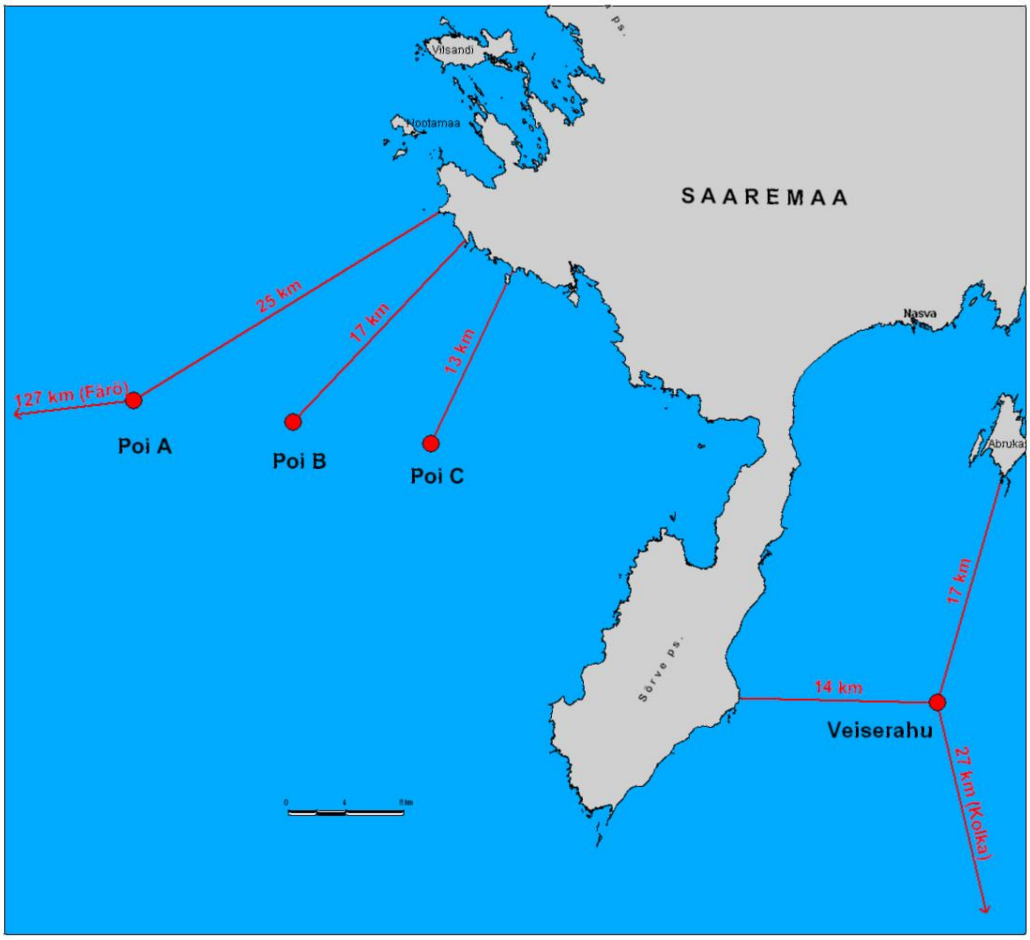


FIGURE 3.6-2. BAT ULTRASOUND RECORDER LOCATIONS (RED DOTS) AND THEIR DISTANCE FROM THE COAST

During the study, the three recorders installed in the project area detected bats on thirteen nights. Bats were recorded flying over the sea in late May, mid-July, August, September and October. The species identified in the project area included the Brandt's bat or the whiskered bat *(Myotis brandtii or Myotis mystacinus)*, the Nathusius' pipistrelle *(Pipistrellus nathusii)* and the common noctule *(Nyctalus noctula)*. Of these species, the first is a resident species and the latter two are long-distance migrants. In the reference area, at the Veiserahu buoy, the northern bat *(Eptesicus nilssonii)*, the parti-coloured bat *(Vespertilio murinus)*, the Nathusius' pipistrelle and the common noctule were identified, the first being resident species and the others being long-distance migrants.

The results of previous studies using the same methodology, combined with the results of the study on bats carried out for the SWE's wind farm, show that the migration of bats over the sea, at the recording sites used so far, mostly falls in the same time period. The most frequent bat detections over the sea occur in the second half of August, with about half of the detections being concentrated in the last two weeks of August. Approximately 75% of bat detections occur between 1 August and 1 September, and approximately 50% between mid-August and 1 September. During the summer, bat feeding so far offshore is unlikely also due to the ecology of bats.

Migratory bat species, such as the common noctule, the soprano pipistrelle, the common pipistrelle and the Nathusius' pipistrelle, have accounted for the majority of bats recorded in surveys both in Estonia and elsewhere in Europe, with the latter species usually being the most numerous. Also in the SWE's wind farm area, the Nathusius' pipistrelle was the most frequently detected bat species, followed by the common noctule.

Based on current knowledge, the area planned by SWE can be considered suitable for wind farm development in terms of bat migration, as the abundance of bats detected in the project area was low and the migration frequency was rather low, as well. Negative impacts are more likely to occur in the eastern part of the wind farm which is closer to the land. The potential impact of wind turbines on bats is mitigated by the fact that the planned wind turbines will operate at higher wind speeds (average wind speed in the wind farm area above 9 m/s), when bats' flight activity is low or non-existent. The wind turbines will start to operate at wind speeds of around 5 m/s and, taking into account the migratory speed of bats of around 5-6 m/s, migration will mostly occur in relatively calm weather, when the wind turbines are not operating or are operating at slow speeds, with little risk to bats.

The area planned by SWE can be considered suitable for wind farm development in terms of bat migration, as the abundance of bats detected in the project area was low and the migration frequency was rather low, as well.

TABLE 3.6-1. IMPACT OF CONSTRUCTION OF THE WIND FARM, AND SIGNIFICANCE THEREOF

Associated consequence/impact	Significance of impact
Habitat loss	0
Collision risk	-
Barrier effect	0

Scale of the significance of environmental impacts used in the EIA report: -1 = minor negative impact, -2 = significant negative impact, 0 = no impact, neutral, + = minor positive impact, +2 = significant positive impact.

3.7. Seals

Studies carried out:

- Seal study for Saare Wind Energy wind farm. Mart Jüssi, Ivar Jüssi, 2022 (Annex 3.10)

The field study was carried out in 2021 and 2022. The objectives of the study were to identify seal abundance and its temporal and spatial variations and to measure seals' use of the sea with telemetry tags. In addition to the standard springtime aerial census, observations of rookeries were also carried out during other seasons to gain a better understanding of seasonal changes in the use of the rookeries. Whenever possible, a drone (*DJI Mavic Pro 2 Zoom*) was used for observations. An autonomous web camera operated in the Innarahu rookery, which gave the opportunity to monitor the use of the rookery at different times.

- Assessment of the impact of underwater anthropogenic noise in the SWE offshore wind farm area. Aleksander Klauson, TalTech, 2023 (Annex 3.11)

The study focused mainly on the impacts of underwater noise on seals and also on fish.

GREY SEAL ABUNDANCE IN THE BALTIC SEA AND IN MARINE WATERS ADJACENT TO WESTERN SAAREMAA

The impact assessment in the SWE's wind farm study area focuses on the grey seal, a local marine mammal. Only grey seals are permanently present in the area of the offshore wind farm planned by SWE. The closest permanently inhabited habitats of ringed seals are the Väinameri Sea and the Gulf of Riga.

Over the period of the international census carried out pursuant to the harmonised methodology, the number of grey seals has increased in Estonia from at least 1148 individuals in 2000 to 5131 individuals in 2021 (Pro Mare, 2021). During the spring moulting period, Estonia is inhabited by just 13% of the grey seals of the Baltic Sea. The main zone of grey seal abundance lies to the north of us, in the region of the southwest coast of Finland, the Åland Islands and the Stockholm archipelago.

The grey seals of the Baltic Sea predominantly inhabit coastal regions bordering high seas. Thus, grey seals can be found along the entire coast in Estonia, while large groups (more than a few dozen individuals) are rather rare in the inner parts of the Väinameri Sea. The distribution of grey seals in Estonia can be broadly divided into four sub-areas (five for the purposes of this assessment): the Gulf of Finland, northern Hiiumaa, the western coast of the islands (Hiiumaa and Saaremaa are considered separately in relation to the wind farm area) and the Gulf of Riga (Figure 3.7-1).

The hypothetical division into these sub-areas is based on the location of seal rookeries and the geography of the coastal sea, the general assumption being that these areas are spatially separated to such an extent that little movement of seals between them can be expected during inactive periods and that seals inhabiting these sub-areas can be expected to move mainly within the particular area during active periods.

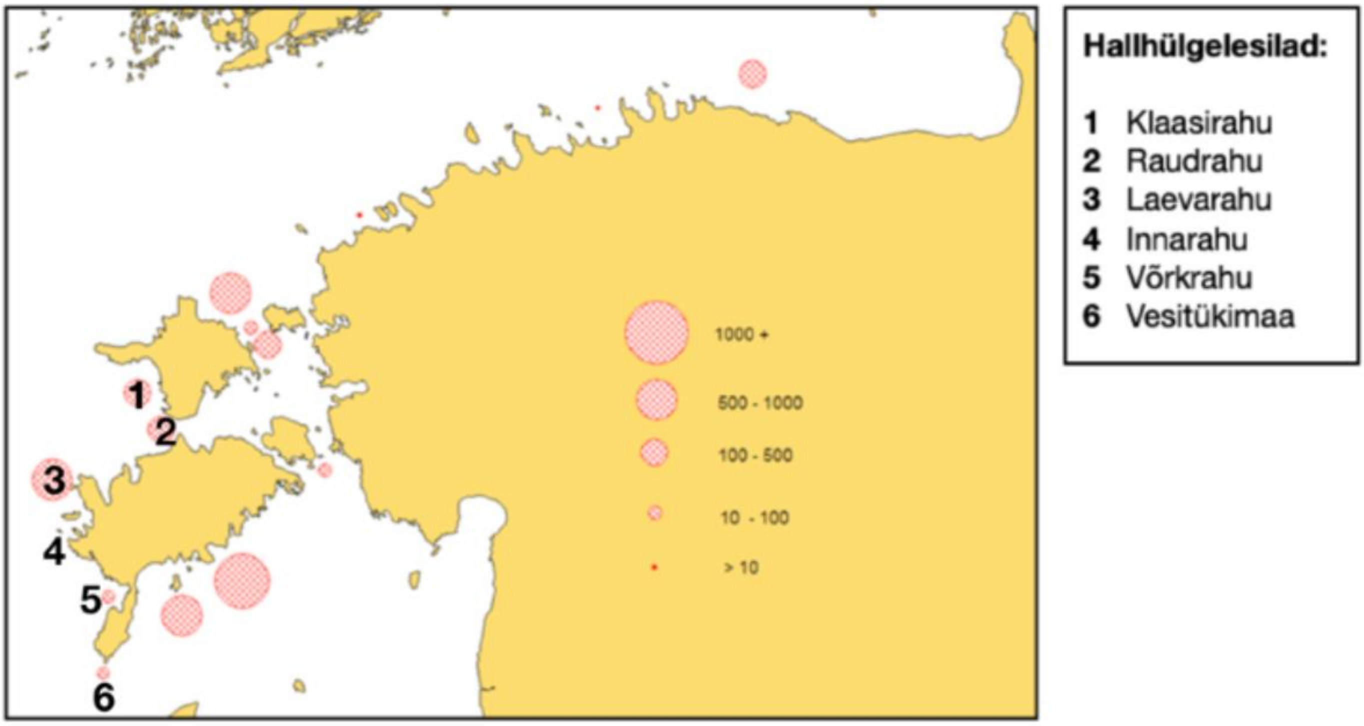


FIGURE 3.7-1. DISTRIBUTION GREY SEALS IN ESTONIAN COASTAL WATERS AND SIZES OF GROUPS COUNTED IN NATIONAL MONITORING. SEAL ROOKERIES ON THE WEST COAST OF THE MAIN ISLANDS ARE MARKED WITH NUMBERS.

A comparison of marine areas shows that the west coast of the islands ranks third among Estonian marine areas in terms of the grey seal abundance index, after the Gulf of Riga and northern Hiiumaa. Monitoring results indicate that a quarter of the grey seals inhabiting Estonian coastal waters live there. The most important of these areas is the west coast of Saaremaa, which is home to 20% of the total seal herd of Estonia. The largest groups, consisting of 1200-1600 individuals, are observed during the spring-summer moulting season. As Western Saaremaa is open to high seas, some movement of seals towards other parts of the sea - the Swedish coast, the Åland Sea, Latvia and Lithuania – has been observed.

A comparison of the results seal census and the number of pups born here shows that animals from all over the Baltic Sea flock here in spring, but the abundance is generally highest during the moulting season. Therefore, the SWE wind farm development area may potentially involve around 1000 grey seals, i.e. 2-3% of the total seal population of the Baltic Sea. Consequently, potential impacts from the construction and operation of the wind farm will affect a very small minority of the whole population.

Seals are known to regularly use four rookeries in the marine waters of Western Saaremaa (Figure 3.7-2). Of these, only Laevarahu, located on the northwestern boundary of the Vilsandi National Park, is used all year round, with the other rookeries having periods when no seals are present there.

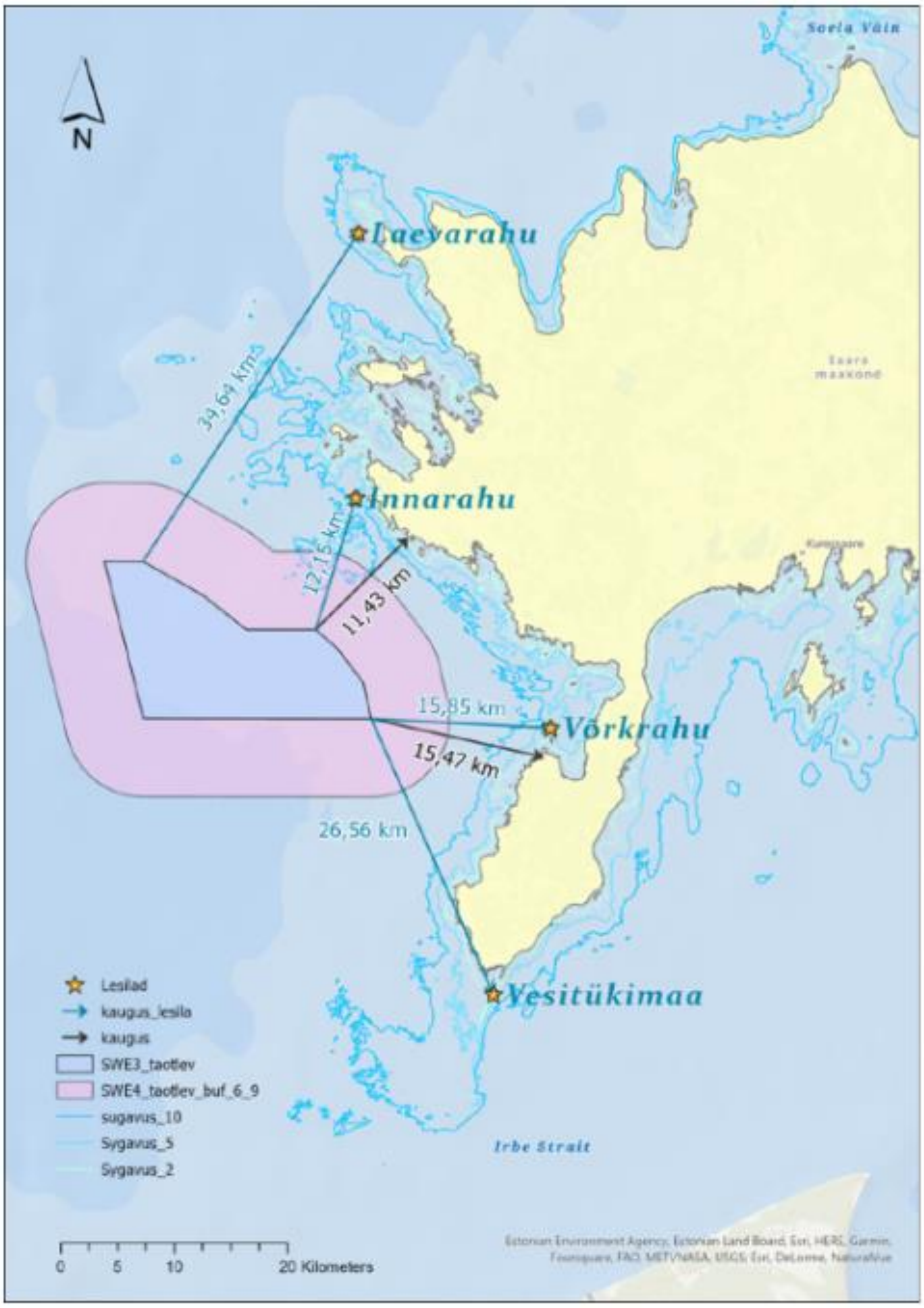


FIGURE 3.7-2. LOCATION OF SWE'S WIND FARM DEVELOPMENT AREA IN RELATION TO THE COAST AND SEAL ROOKERIES OF SAAREMAA

MOVEMENT OF SEALS AT SEA AND USE OF THE SEA

As regards the use of the sea, different key habitats – rookeries and feeding grounds – and migration routes between them is looked at.

Telemetry data (Figure 3.7-4) were successfully collected from nine seals. Six individuals used the wind farm development area and three moved outside that area. Identifying and describing the species-specific behaviour of grey seals within the wind farm development area bears no relevance; the data from all tags can be used to describe the use of the sea.

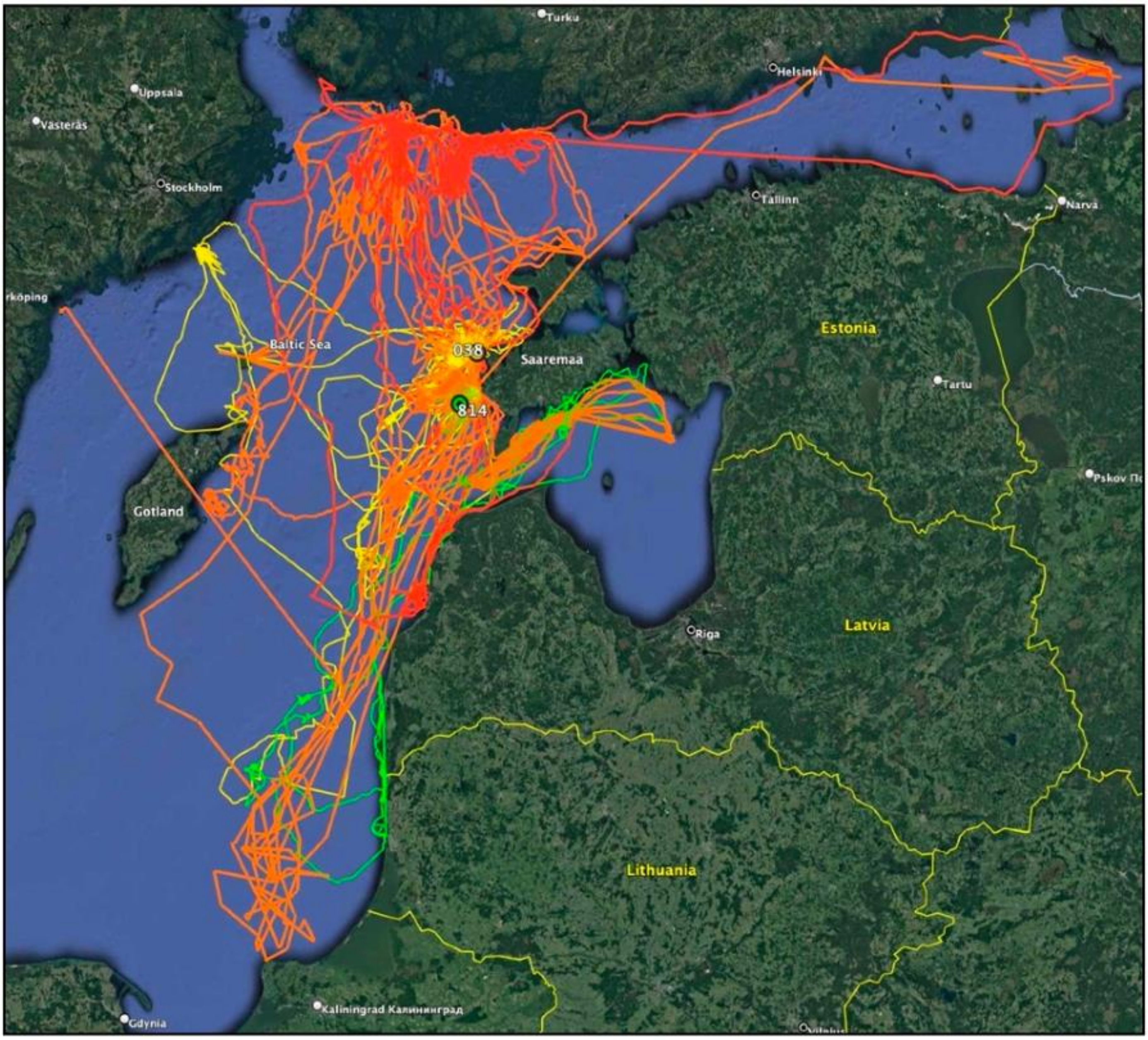


FIGURE 3.7-4. SPATIAL DISTRIBUTION OF GREY SEAL TELEMETRY DATA USED IN THE WORK IN TERMS OF MOVEMENT TRAJECTORIES

Among the four rookeries of grey seals in Western Saaremaa, all six seals with telemetry tags present in the area used the Laevarahu and Innarahu rookeries. Both are important resting areas for grey seals. It can even be concluded that these two rookeries form a complex used by seals according to seasonal patterns.

Although grey seals are able to move freely throughout the Baltic Sea, they are connected to particular rookeries. This means that the animals do not move randomly in the sea, but repeatedly use the same area to rest between foraging trips. The same animal can use several rookeries. Certain philopatry has been observed in adult females. There is also a tendency for all animals to repeatedly visit the same foraging area (central place foraging behaviour), which links the rookery or rookeries with a particular foraging area.

By classifying the telemetry data from six seals according to trajectories and speed of movement within SWE's wind farm area, three types of movement can be distinguished (Figure 3.7-5):

1) **Migration.** Migration is defined as a pattern of movement that is characterised by regularity and has a goal of reaching a specific marine area or resting place. Migration can be related to a change of rookery, foraging or breeding. In the majority of cases, seals migrated through the wind farm development area on their way to feeding

grounds or other parts of the sea. These purposeful movements from one place to another are characterised by a high linear speed of more than 1-2 m/s, indicating that the seals are using a steady, fast, straight-line movement to optimise the energetic costs associated with the journey.

Migration can be identified for all seals. The predominant direction in the wind farm development area is SE <> NW and movements are associated with the Innarahu rookery and feeding grounds on the Latvian, Lithuanian and Kaliningrad coasts, i.e. relatively far south. However, the recorded migratory movements in the wind farm development area do not point to a clearly defined corridor, with seals passing through the area in a relatively straight line and rapidly.

Another main migratory route used by all six seals is from Innarahu southwards along the coast of Saaremaa. Movements in this direction only partially pass the easternmost edge of the wind farm development area, with the majority of the movements occurring between the coast of Saaremaa and the development area.

The third main migratory route is from Innarahu towards shoals and sandbanks in the west and from there back to the rookery. Within this route, a corridor can be distinguished, the southern edge of which passes through the northern part of the wind farm development area.

2) **Search.** In a search, the trajectory of a seal is erratic and its speed can vary from staying in place to faster forward movements. The search trajectory is convoluted or forms a loop in the sea. The animal does not return to the same place in a single movement (passing an area). The purpose of a search is probably to find food in a particular area or to move slowly from one area of the sea to another while foraging.

3) **Feeding.** When a seal finds an area in the sea that is rich in fish, it will actively dive and hunt for fish in that area. The trajectory on the surface of the water contains a large number of turns and the linear speed between two points decreases. In the wind farm development area, it is possible to reliably detect the feeding behaviour in one animal only. Such a trajectory can be observed at the northern edge and in the northeastern corner of the area, and it coincides with a rugged terrain and slopes under the water which are diverse and potentially good feeding grounds.

   The grey seal is an opportunistic forager, not so much specialising in a particular fish species as feeding in locations and on species that provide the best catch efficiency, measured in terms of the number or total weight of fish. Its prey mainly consists of herring and sprat – mass shoaling fish in the Central Baltic, with juveniles also consuming many demersal species such as the eelpout. The study on fish fauna (Chapter 3.8.) shows that, in terms of fish, this is a typical sea area west of Saaremaa where flounders, sculpins, herrings and cods are the most abundant species. However, none of these species was present in the area en masse. The most abundant fish species, flounder, is not a preferred species for grey seals and its frequency in their menu averages less than 5%.

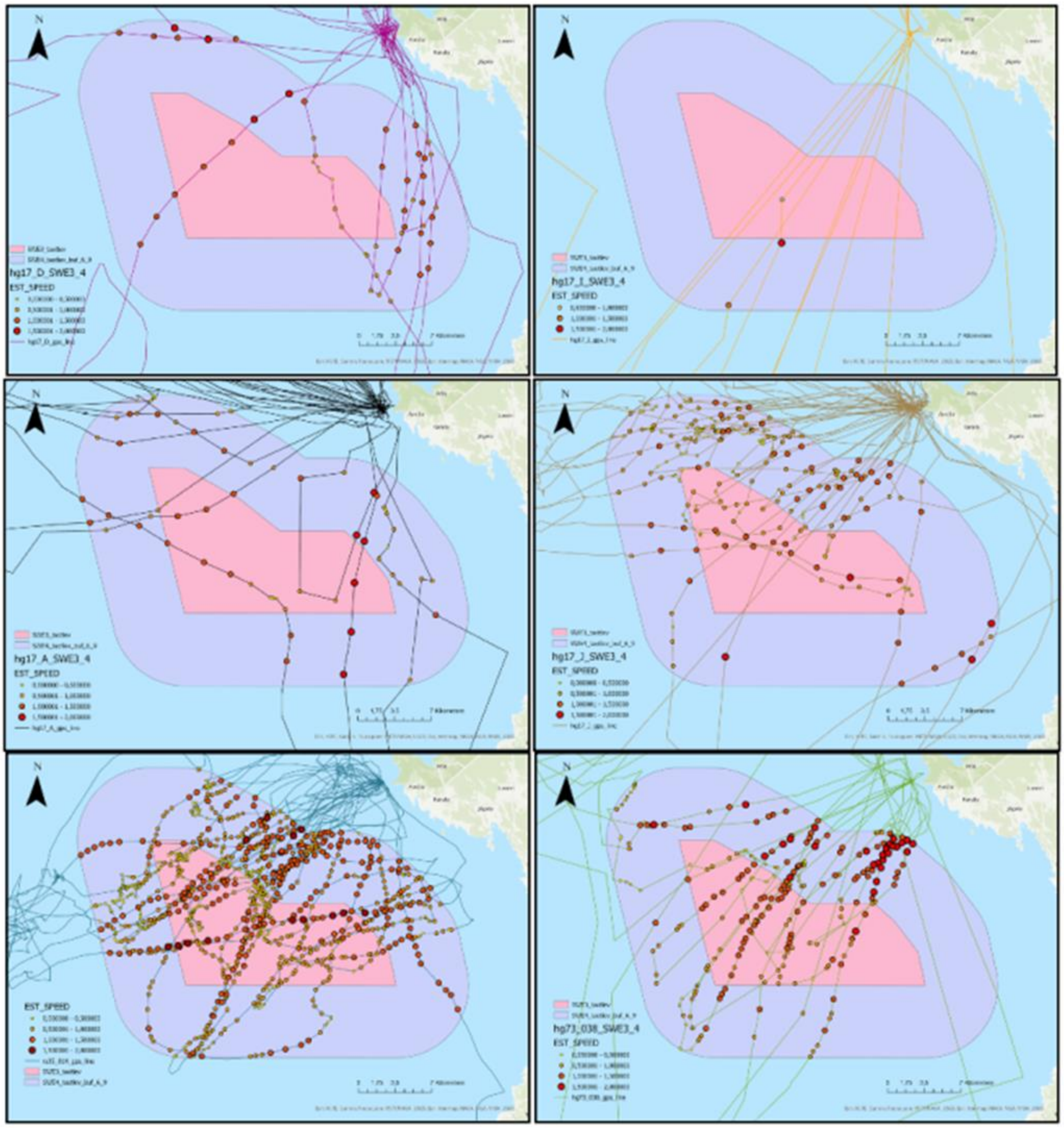


FIGURE 3.7-5. MOVEMENTS OF SIX GREY SEALS IN THE WIND FARM DEVELOPMENT AREA. TRAJECTORIES AND SPEEDS RECORDED BETWEEN GPS POINTS

DIRECT DISTURBANCE AND NOISE

The impact of human activities on grey seals can be categorised as direct and indirect disturbance, both during the construction of the wind farm and in the operation phase, i.e. after the wind farm has been built. In addition, the location of the planned wind farm and its impact on the use of key habitats important for grey seals – rookeries and feeding grounds – as well as migration routes between them must be assessed.

Direct disturbance is mostly associated with the animals' perception of danger or discomfort, leading to a change in behaviour: escape or avoidance. Such events are related to sensations – sudden sounds, smells or phenomena. They are mainly associated with wind farm construction activities, where the effects are more severe but of short duration.

Direct disturbance has the greatest impact on rookeries when the animals are resting or feeding their young, as any escape expends energy and, during the pupping season, can cause a break in the bond between a mother and her pup. Generally, direct disturbance does not have a very long-lasting effect, as animals ascertain whether what they are experiencing is directly dangerous to them; if not, the repeated disturbances will be given less attention – animals will adapt.

A form of direct disturbance with serious consequences is the movement of ice-breakers in ice fields used by seals for pupping. This is not even a disturbance, but a direct danger of seal pups being crushed by a ship or breaking ice. These impacts are more likely to occur during the period of operation of the wind farm, should ice fields occur within the wind farm area or in the paths of maintenance vessels during harsher winters and should seals use these ice fields for pupping. In average winters, there will be no ice in SWE's development area (Chapter 3.1 and Figure 3.1-2) and therefore no pupping on ice will occur. However, the formation of a permanent ice cover (February-March) in the wind farm area during winters that are colder than the long-term average may also attract seals, for which this type of ice is a suitable pupping platform. If seals make this choice, they are unlikely to be disturbed by wind turbines, but if ice is present, seals must be considered in the movement of ice-breakers or helicopters in the wind farm area, so as not to pose a direct threat to the seals caring for the pups or disturb them too frequently. In cases where maintenance work is unavoidable during such colder periods, an observation flight should be made over the ice to plan the movement of vessels and to steer them away from pupping seals.

Human presence in the marine area and the resulting environmental disturbance mainly takes the form of sensory impacts caused by visible and audible disturbances, smells and underwater sounds and vibrations. Above water, seals' sensations are primarily related to the installation of wind turbines and cables during the construction phase.

The appearance of ships or installation platforms and their prolonged presence in previously uninhabited marine areas may have some impact on animals' habitat use. In general, seals tend to be indifferent to the sight of large ships, as there is no clear threat to them from ships as such. The presence of a ship can become a "background disturbance", unless the ship emits impulsive sounds or light that may attract the animals' attention. Power units, diesel generators and compressors are likely to be constantly operating on construction-related platforms, emitting exhaust fumes or other strong technogenic smells in addition to the noise both above and under water. These can alert animals and cause behavioural changes. The area of impact is usually limited to a few hundred metres downwind from which animals would leave. In the case of intense noise or smells, this area may be larger. If such disturbance extends to a rookery, animals are more likely to leave than not.

Seals should be taken into account in the event of exceptional disturbances such as oil spills. For example, an oil spill in the open sea also involves a long-range (downwind) smell, and disturbance to animals that are sensitive to smells is not limited to the oil slick. It may imply temporal or spatial constraints on the use of feeding grounds, or longer distances (additional energetic cost) between resting and feeding grounds. The oil risk modelling carried out showed that, given the prevailing wind directions, an oil slick could reach the coast to the northeast of the wind farm (Chapter 3.3 and Figure 3.3-7), but the probability of this happening is less than 1%, and up to 5% in a few locations, i.e. extremely low.

Construction-related disturbance of the seabed will occur during the installation of both foundations and cables, which may lead to a temporary spread of suspended sediment and a reduction in water transparency (see also Chapter 3.3), but this is unlikely to directly affect seals, as underwater visibility is generally limited in the Baltic Sea and underwater sight is correspondingly less important for seals.

As regards impacts associated with the installation of connecting cables, environmental effects on seals can be expected to be insignificant, limited in space and time, as ship traffic is more likely to be a normal activity already occurring in the marine environment, also assuming that the connecting cables would be located at a sufficient distance from key habitats important for seals.

Potential direct impacts during operation will primarily be due to the location of the wind turbines in the sea and the processes associated with their operation and maintenance, which are perceived by seals. As with ships, seals will become accustomed to the physical presence of wind turbines (including cables) if they do not pose a direct threat.

Noise disturbance

Noise is known to be the most important of underwater sensations. Intense sounds with a significant impact will predominantly be related to the construction of foundations. In the construction phase, underwater impulse noise will be generated by pile drilling during the construction of the wind farm; in the operation phase, low-frequency continuous noise will be emitted into the water from the wind turbines. Vibration from a working wind farm, as an effect not reaching the sensory thresholds of seals, has not been considered as a disturbance and is largely unassessed.

Seals in the Baltic Sea are sound-sensitive animals that use vocal communication both in the air and in the water. Nowadays, marine animals are classified into hearing groups (Southall 2019[9]), and seals belong to the hearing group PCW (phocid carnivores in water). When assessing anthropogenic impacts on seals, the important periods of mating and pupping should also be considered. Seals vocalise a lot during the mating period, and intense anthropogenic noise can interfere with animals' communication by masking important signals. Therefore, a high masking risk is considered to occur when anthropogenic noise exceeds the natural background by 20 dB (500 Hz decidecade).

Impulse noise

The impacts of sounds are generally (e.g. Tougaard et al. 2009[10]) divided into four categories: audible, leading to behavioural responses, masking and damaging. Damage includes, in particular in mammals, temporary or permanent hearing loss. For marine mammals, the most dangerous underwater noise from construction activities, with the potential for severe disturbance and even injury to animals, is when it exceeds the level causing a temporary hearing threshold shift (TTS) or permanent hearing threshold shift (PTS) (Dietz et al. 2015[11]). The noise impact assessment should be based on the impulse noise limit value, which is the anthropogenic impulse noise at a level that does not cause PTS in seals, i.e. 185 dB SEL PCW weighted or 218 dB SPL peak (Southall 2019[12]).

A study of underwater noise has concluded that pile drilling can be considered a source of impulse noise that is less intense than the noise of pile driving strikes. In the pile drilling scenario, no mitigation measures are required as seals never reach PTS (see Annex 3.11).

Continuous low-frequency noise

During the operation phase, the wind turbines will emit underwater noise. For grey seals, the response level has been set at 110 dB re 1 µPa in the 500 Hz decidecade frequency band.

According to the recommendations of TG Noise, the acceptability criterion for the impact of continuous noise is that the median level of continuous anthropogenic noise should not exceed the limit values (response level) in more than 20% of the area of the marine waters being assessed. Modelling showed that

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9 Southall, B. L., et al. "Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations". Aquatic Mammals, 33: 411–521, 2007.

10 Tougaard, J., Hermannsen, L., and Madsen, P. T. (2020). "How loud is the underwater noise from operating offshore wind turbines?" J. Acoust. Soc. Am. 148(5), 2855–2893.

11 Dietz, R., Galatius, A., Mikkelsen, L., Nabe-Nielsen, J., Riget, F. F., Schack, H., Skov, H., Sveegaard, S., Teilmann, J. and Thomsen, F., 2015. Marine mammals – Investigations and preparation of environmental impact assessment for Kriegers Flak Offshore Wind Farm.

12 Southall, B. L., et al. "Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations". Aquatic Mammals, 33: 411–521, 2007.

although response levels are exceeded in the wind farm area, the noise affects less than 20% of the wider assessment area (see Annex 3.11).

INDIRECT DISTURBANCE JA HABITAT FRAGMENTATION

Based on telemetry data, grey seals can be found to have developed temporally and spatially stable behavioural patterns, which are linked to key biological functions and thus to the use of key habitats. Looking at the overall pattern of animals' use of the sea, it can be concluded that a very high level of optimisation of effort prevails. When a new factor is added to the environment that forces animals to change their established optimal behavioural patterns, the predominant consequence is higher energy expenditure. For example, the need to avoid a disturbing factor may lengthen a migration route only by a few percentage points, but, taking distances into account, the total length of foraging migrations can increase by several hundred kilometres in a single summer. This also has a cumulative effect on energy: in order to compensate for lost energy, the time spent on foraging must be extended at the expense of other essential functions, such as rest periods. All of this has energetic consequences, particularly for reproduction, because the energy supply of both the adult seal and the pup depends directly on the fat reserves stored in the adult's fat tissue during the summer.

The main types of seal movements in SWE's wind farm development area were migration and search. Given that, for most of the area and for the majority of seals, searching did not develop into feeding, it can be concluded that the development area is rather poor in terms of seals' food. Only one juvenile exhibited movement patterns indicative of intensive feeding here to a very limited extent. The area is relatively close to the Innarahu and Võrkrahu rookeries and so it is probably reasonable and potentially energy efficient to forage there, especially for younger animals, compared to long trips to the open sea. As regards foraging, this overall picture largely coincides with the conclusions of the study on fish fauna that the area in question is not very rich in fish. Energetically valuable feeding grounds, which are effectively used by seals in the northern parts of the study area, can be unambiguously identified from the movement trajectories and can be associated with a varied underwater relief – shoals or slopes – in the area of the planned wind farm.

Grey seals' pupping grounds are located in the rookeries, access to which (given known grey seal movement patterns) will not be significantly restricted by SWE's wind farm development area. From the field study carried out, it was found that seals using the Laevarahu and Innarahu rookeries very rarely visited the Võrkrahu and Vesitükimaa rookeries. Therefore, the wind farm area is not expected to have a spatial impact on grey seal pupping, resting and moulting on the islands and in the rookeries. Both islands, Innarahu and Vesitükimaa, which are used by grey seals for pupping, are far enough away from the wind farm area not to be affected by the farm, but given the evidence of relative fidelity of seals to certain sea areas, it is likely that seals may use the same sea area for pupping in colder winters when there is sufficient cover and duration of sea ice in Western Saaremaa. This must be taken into account both in the construction of the wind farm and in subsequent winter maintenance work, if ice-breakers are to be used.

Seal migration routes from Innarahu to the shoals in the waters west of Saaremaa and to the southern parts of the Baltic Sea run through the development area in the NE <> SW direction. Westbound migrations from Laevarahu run north of the study area, while the potential migration route from Innarahu and Laevarahu to the south runs along the coastline of Saaremaa and the Sõrve peninsula. The movements associated with migrations tended to follow linear and rapid trajectories. On the basis of studies carried out elsewhere, it can be assumed that the wind farm, when operated, will not act as a direct barrier to migration or movement for grey seals. Avoidance of the area of wind farms and lengthening of seals' journeys have only been observed in relation to pile driving strikes during the construction of foundations, but this method will not be used for the installation of wind turbines in SWE's wind farm.

However, there is a possibility that grey seals will start avoiding the wind farm and will move to feeding grounds along its perimeter. Based on the field study carried out, it can be concluded that, in such a case, foraging movements in the area of the wind farm would be reduced. The close proximity of a rich habitat must be taken into account in particular in the northern part of the wind farm; cumulative impacts in the food chain and underwater noise will potentially change the habitat characteristics compared to the current situation.

The study on seals and underwater noise did not identify any significant potential environmental impact on seals that could be caused by the wind farm development in this sea area, assuming that the drilling method will be used for the installation of piles.

TABLE 3.7-1. IMPACTS OF CONSTRUCTION OF THE WIND FARM, AND SIGNIFICANCE THEREOF

Associated consequence/impact	Significance of impact in the development of the wind farm
Construction phase	
Habitat loss	0
Impulse noise	-
Barrier effect	0
Operation phase	
Low-frequency noise	-/0
Indirect impacts (impact on food availability)	+

Scale of the significance of environmental impacts used in the EIA report: -1 = minor negative impact, -2 = significant negative impact, 0 = no impact, neutral, + = minor positive impact, +2 = significant positive impact.

During the construction phase, the installation of wind turbines and cables may lead to minor negative impacts (-), which are expected to be short-term. During the operation, the wind farm is not expected to have an impact on seals (0); seals are expected to be able to adapt to the new situation.

3.8. Fish fauna

Studies carried out:

- Study on fish fauna in the area of the offshore wind farm planned by Saare Wind Energy. Estonian Marine Institute of the University of Tartu, Tartu 2022 (Annex 3.12)
- Interim report on potential ichthyological and fishery impacts of the cable route of Saare Wind Energy's offshore wind farm. Estonian Marine Institute of the University of Tartu, Tartu 2022 (Annex 3.13)
- Assessment of the impact of underwater anthropogenic noise in the SWE offshore wind farm area. Aleksander Klauson, TalTech, 2023 (Annex 3.11)

The impacts associated with the construction of wind farms can be divided into impacts caused during construction, operation and dismantling. Operation-related and physical impacts are linked to the area where the turbines and submarine cables are located. However, fish fauna will also be impacted by the noise from the turbines and the electromagnetic fields of the submarine cables during the operation of the wind farm. According to current knowledge, the main potential negative impacts of offshore wind farms planned in the Estonian coastal sea are likely to occur during construction and dismantling activities. Construction activities may cause adverse impacts on fish, which are related to construction noise and to suspended sediment resulting from earthworks.

In some situations, the construction of wind farms may have a positive effect on fish abundance, as the turbine foundations and towers (including substations) represent additional hard substrate on the seabed, which often has a concentrating and/or production-enhancing local effect.

FISH COMMUNITIES IN THE WIND FARM AREA

During the stocktaking of fish fauna and spawning grounds, a total of 11,374 fish with a total mass of 1043.3 kg were caught in the wind farm area planned by SWE. Specimens of 15 different fish species were caught in the study area. Characteristic of an offshore location, the fish fauna in the area was predominantly composed of marine and estuarine species common to the Baltic Sea. In terms of abundance, flounder dominated the fish fauna of the area, accounting for around one third (33.44%) of the total number of fish caught. Herring (23.54%), shorthorn sculpin (18.81%) and cod (12.49%) were also abundant (10–25%). Common species also included sprat, round goby and eelpout. Common, but less abundant species (0.1–1% of the total number of fish caught) included long-spined bullhead, turbot, European smelt and great sand eel. Four-horned sculpin, river lamprey, lumpfish and black goby were present in small numbers. The results of the study thus did not indicate that the area is of particular significance for species of conservation importance (listed in the Annexes to the Habitats Directive, etc.).

Flounder dominated in terms of biomass, followed by shorthorn sculpin, cod, herring and round goby. Eelpout, sprat and turbot accounted for less than 1% of the biomass, while the biomass of the remaining species did not exceed 0.1%.

Based on the data obtained in this study and other studies carried out in the Baltic Sea, it can be concluded that the fish fauna of the wind farm area planned by SWE as a whole does not differ significantly from other marine waters of similar depths west of Saaremaa.

No spawning grounds of spring-spawning herring were found in the study area during extensive gill net fishing, a result supported by the hydroacoustic migration survey data.

HYDROACOUSTIC SURVEYS OF HERRING

Hydroacoustic surveys of the migration of spring-spawning herring were carried out in two years. Fish abundance was estimated using the post-processing output values of the sonar data (nautical area scattering coefficient (NASC), m^2/nm^2), which were used to draw conclusions about overall fish abundance. The results of the surveys were grouped in four time periods with different temperatures. Based on existing long-term experience of using this instrument for the assessment of herring shoals, it was assumed that the NASC value for herring shoals in spawning migration should be at least 5000 m^2/nm^2 (3000–20,000 m^2/nm^2 when using the average value for the 0.5 nm transect).

The earliest survey period was at the end of February 2022, when the water temperature was 0 degrees C° and the air temperature was 1 degree C°. During this period, only one small shoal of herring was observed in the study area at the boundary of the development area (NASC value 2500), which remained the only herring shoal recorded during the entire survey period (Figure 3.8-1).

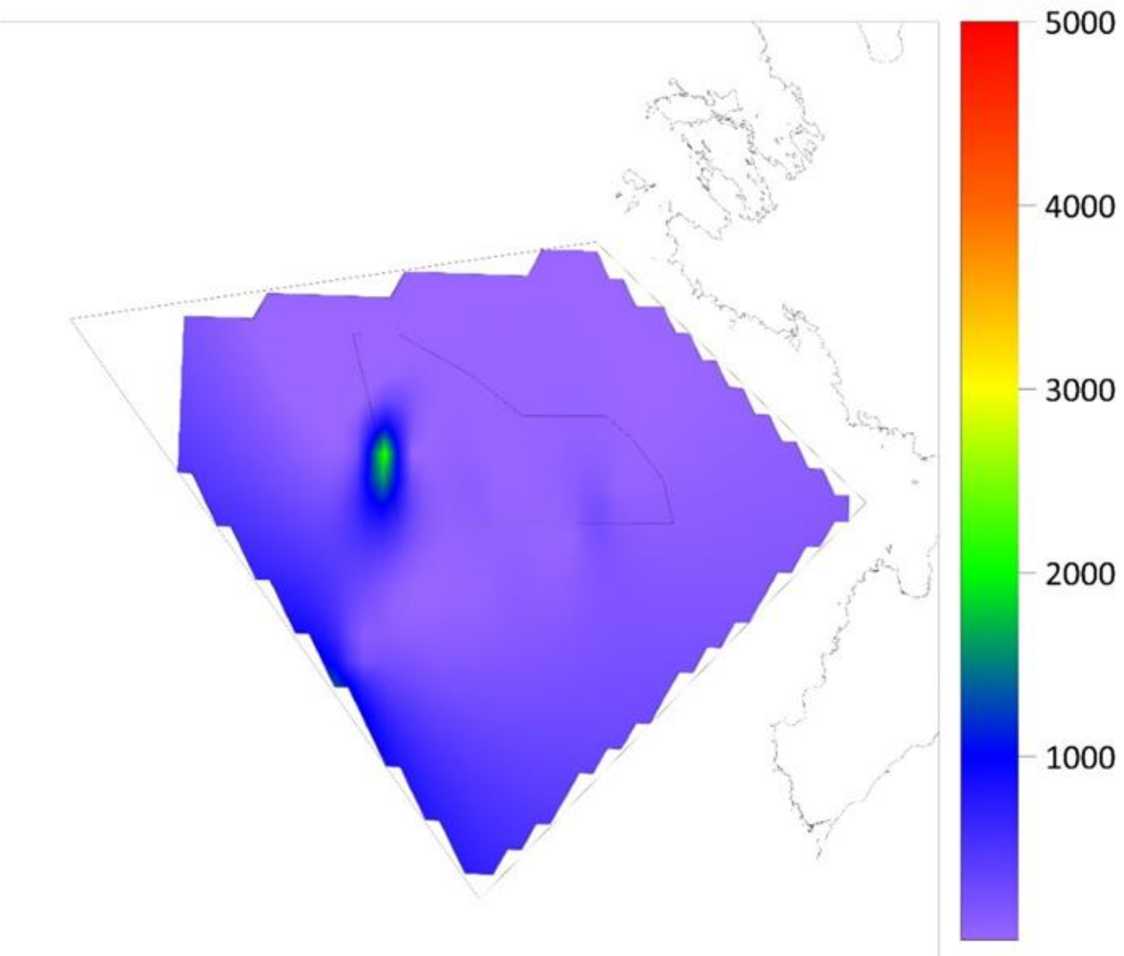

FIGURE 3.8-1. DISTRIBUTION OF HERRING SHOALS IN THE STUDY AREA IN THE SECOND HALF OF FEBRUARY 2022

Survey results and fish distribution maps (Annex 3.12) show a very homogeneous distribution pattern throughout the study area. No important migration corridors were identified in the study area. It is thus difficult to compare the results within the planned development area and in adjacent reference areas. Therefore, the results of the Gulf of Riga Acoustic Herring Survey (GRAHS), obtained from late July to early August 2021 with the same methodology and visualised with the same parameters, were considered. The GRAHS results clearly point to larger herring assemblages, with NASC values up to 13,700, which were not observed in the planned wind farm area or adjacent reference areas, giving a clear picture of the scarcity of fish in the study area.

HABITAT LOSS

Spatial and seasonal variations in fish abundance were observed in the planned wind farm site, indicating that it is not a completely homogeneous area. At the same time, the ichthyological survey did not indicate that the fish fauna present in the study area would preclude the construction of a wind farm or that the planned wind farm would have a significant negative impact on the fish fauna.

BARRIER TO MIGRATION

Based on the hydroacoustic surveys carried out in two consecutive springs (2022, 2023), the planned wind farm is not expected to constitute a barrier to migration of herring. As no mass migration of herring could be detected in the wind farm area during the migration period, it is unlikely that larger spawning assemblages would pass through the area. Migrating herring are likely to take the most direct route via the Irbe Strait to the Gulf of Riga, in deeper waters. The one smaller herring shoal recorded in February 2022 may have been a single autumn-spawning herring shoal in feeding migration or a smaller shoal migrating to the coast of Saaremaa to spawn. Therefore, the construction of a wind farm in this area is not expected to have a significant impact on spawning migration of herring, but if possible, construction works that generate more noise should be avoided during the main spawning migration period.

IMPACT FROM NOISE

Fish have two sensory systems for the perception of sounds. In addition to the ears, fish also have the so-called lateral line that enables fish to sense the movement of water particles. In this way, fish can use the lateral line to learn about the movements and location of other fish in the water.

- Fish that either do not have a swim bladder or whose swim bladder is not connected to the inner ear are classified as hearing generalists. Hearing generalists are better at detecting changes in sound pressure. Hearing generalists include pike, perch, eel, flounder, salmon and trout.
- Fish with a swim bladder connected to the inner ear have “sharper” hearing and are classified as hearing specialists. At the same time, the combined perception of sound pressure and of the movement of water particles sharpens the perception of hearing specialists (Baltic herring, Atlantic herring).

Among the fish present in the Baltic Sea, herring, which is classified as a hearing specialist, is probably the most susceptible to potential negative impacts of the noise of offshore wind farms, according to current knowledge.

Anthropogenic noise can affect spawning, long-term health and development of fish, as well as prey-predator relationships and communication between fish (masking).

Impulse noise

A study of underwater noise has concluded that pile drilling can be considered a source of impulse noise that is significantly less intense than the noise of pile driving strikes and does not cause fish mortality.

Continuous low-frequency noise

During the operation phase, the wind turbines will emit underwater noise. The 125 Hz decidecade frequency band is important for fish as it corresponds to the sensitivity of herring. The response level has been set at 122 dB re 1 μPa for fish.

According to the recommendations of TG Noise,[13] the acceptability criterion for the impact of continuous noise is that the median level of continuous anthropogenic noise should not exceed the limit values (response level) in more than 20% of the area of the marine waters being assessed. Modelling showed that although response levels are exceeded in the wind farm area, the noise affects less than 20% of the wider assessment area (see Annex 3.11).

IMPACTS FROM SUSPENDED SEDIMENT

Impacts associated with suspended sediment only occur during the construction phase of wind farms (installation of foundations and power cables on the seabed) and are therefore relatively short-term and avoidable, for example by carrying out construction works outside the spawning season (see Chapters 3.2 and 3.3).

Flounder was found to be the most common species in the area of the wind farm. According to current knowledge, flatfishes are one of the fish groups with the poorest hearing ability. As they are also relatively

13 Tougaard, J., Hermannsen, L., and Madsen, P. T. (2020). “How loud is the underwater noise from operating offshore wind turbines?” J. Acoust. Soc. Am. 148(5), 2855–2893.

tolerant of suspended sediment, neither construction noise nor suspended sediment is likely to affect the sustainability of the local flounder population.

TABLE 3.8-1. IMPACTS OF CONSTRUCTION OF THE WIND FARM, AND SIGNIFICANCE THEREOF

Associated consequence/impact	Significance of impact in the development of the wind farm
Habitat loss	0/-
Barrier to migration	0
Noise	0/-
Impact of electromagnetic fields	0/-
Indirect impacts (spread of suspended sediment)	0/-

Scale of the significance of environmental impacts used in the EIA report: -1 = minor negative impact, -2 = significant negative impact, 0 = no impact, neutral, + = minor positive impact, +2 = significant positive impact.

During the construction phase, the installation of wind turbines and cables may lead to minor negative impacts (-), which are expected to be short-term.

3.9. Protected natural sites

Protected natural sites are considered by type: 6 special conservation areas; 2 existing nature reserves and 1 planned nature reserve; 1 national park and its planned extension; 1 habitat registered in the EELIS database. In the case of nature reserves/special conservation areas overlapping with Natura sites, only those target species and habitats that differ from the conservation objects of the relevant Natura site are set out.

The following figure illustrates the location of protected natural sites considered in this assessment in relation to the planned activity.

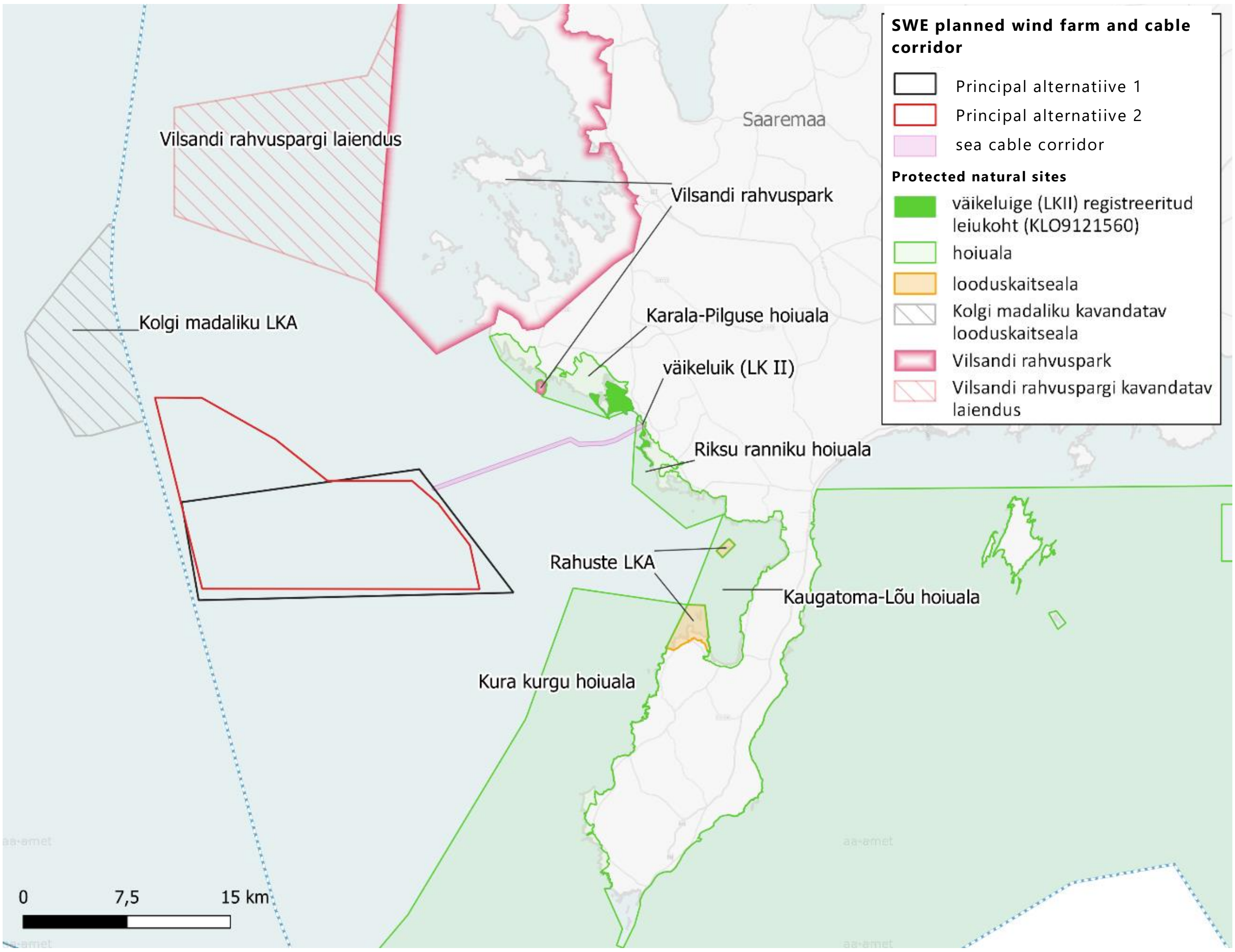

FIGURE 3.9.-1. PROTECTED NATURAL SITES WITHIN THE POTENTIAL AREA OF IMPACT OF THE PLANNED WIND FARM AND RELATED INFRASTRUCTURE

The implementation of the planned activity will not result in significant adverse effects on any protected natural site or on the conservation objects of the protected sites, and there is no need to take mitigation measures.

TABLE 3.9-1. IMPACT OF CONSTRUCTION OF THE WIND FARM, AND SIGNIFICANCE THEREOF

Associated consequence/impact	Significance of impact
Irbe Strait special conservation area (KLO2000316)	0
Kaugotoma-Lõu special conservation area (KLO2000313)	0
Rahuste nature reserve (KLO1000305)	0
Riksu special conservation area (KLO2000327)	0
Karala-Pilguse special conservation area (KLO2000310)	0
Vilsandi national park (KLO1000250) and its planned extension	0
Kolgi shoal nature reserve (planned new nature reserve)	0
Registered habitat of the tundra swan (KLO9121560)	0

Scale of the significance of environmental impacts used in the EIA report: -1 = minor negative impact, -2 = significant negative impact, 0 = no impact, neutral, + = minor positive impact, +2 = significant positive impact.

3.10. Natura assessment

Natura assessment is a process that is carried out in accordance with Article 6(3) and (4) of the Habitats Directive. In this work, assessment is based on the European Commission's guidance material "Assessment of plans and projects in relation to Natura 2000 sites – Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC".

Impacts on Natura sites have been assessed in the Natura Assessment Document (Annex 4).

<u>Relation of the planned activity to the management of Natura sites</u>

The planned activity is not related to, or necessary for, the management of any Natura 2000 site and will not contribute directly or indirectly to the conservation objectives of Natura sites.

<u>Characterisation of Natura 2000 sites affected by the planned activity</u>

During the preparation of the EIA programme for SWE's offshore wind farm, the following Natura sites were identified as being situated in the area of impact of the planned offshore wind farm: Kaugatoma-Lõu, Riksu, Karala-Pilguse, Vilsandi, Tagamõisa, Kasti Bay and Väinameri Sea special conservation areas, and Kasti Bay and Väinameri Sea special protection areas. In addition to the Estonian Natura 2000 network, the need for screening also involves a Latvian marine Natura site: the Irbes saurums special bird protection area.

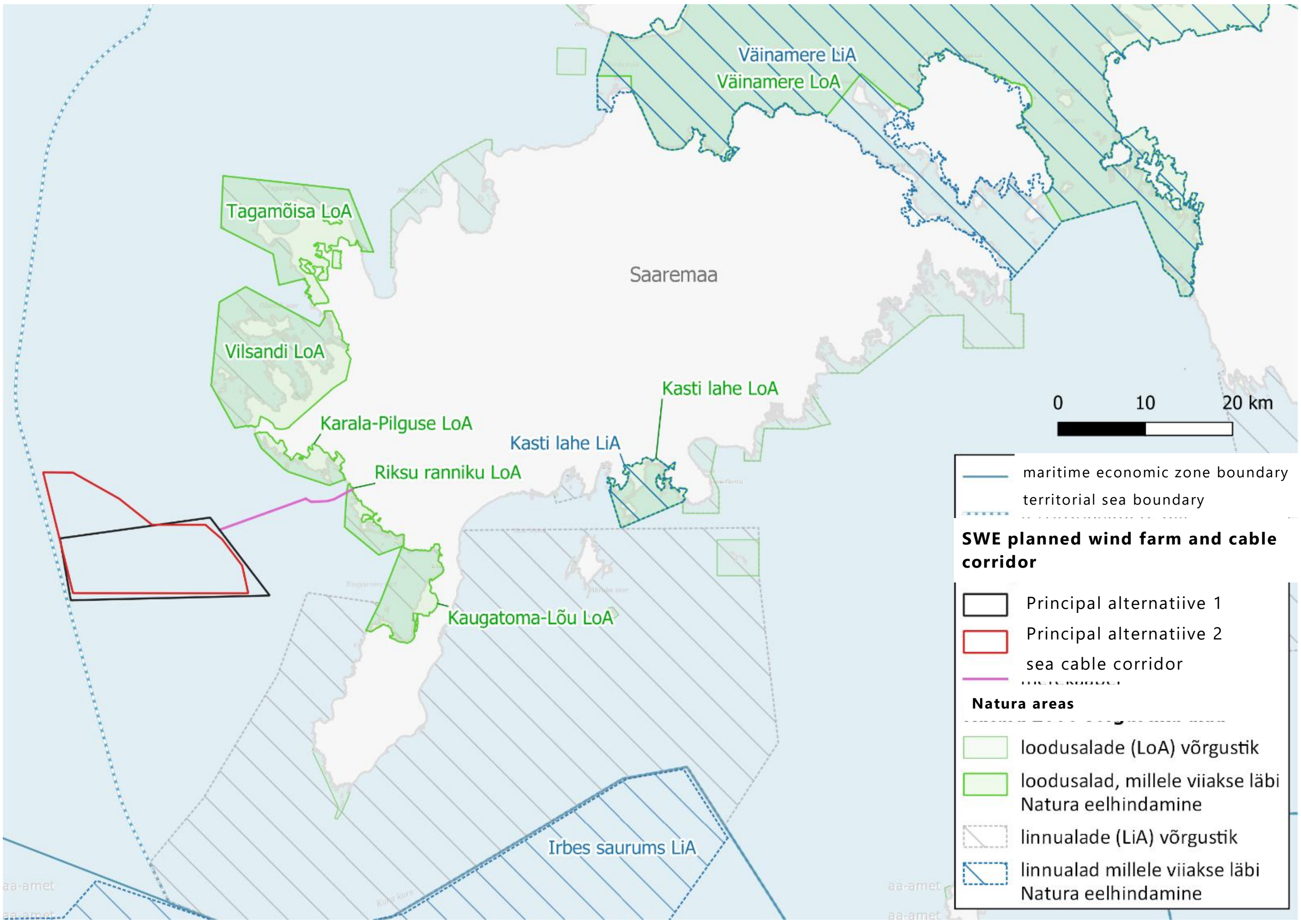

FIGURE 3.10-1. OVERVIEW OF NATURA 2000 SITES IN THE AREA OF IMPACT OF THE PLANNED WIND FARM AREA AND CABLE ROUTE (BASIS: LAND BOARD AND THE EELIS DATABASE, 2023)

Outcome and conclusions of Natura screening

As a result of Natura screening, it was concluded that the implementation of the planned activity will not have any adverse impact on the following Natura 2000 sites: Kaugatoma-Lõu, Tagamõisa, Kasti Bay and Väinameri Sea special conservation areas, and Kasti Bay, Väinameri Sea and Irbes saurums special protection areas. For these sites, it is not necessary to carry out an appropriate assessment.

As a result of Natura screening, it was concluded that an adverse impact from the implementation of the planned activity cannot be excluded for the following Natura 2000 sites: **Riksu special conservation area, Karala-Pilguse special conservation area and Vilsandi special conservation area**. For these sites, the appropriate or full Natura assessment must be carried out.

Outcome and conclusions of the appropriate Natura assessment

As a result of the appropriate Natura assessment, it was concluded that the **implementation of the activity will not have any adverse impact on any of the following Natura 2000 sites assessed** or on their conservation objectives: Irbe Strait special protection area; Kaugatoma-Lõu special protection area; Riksu special conservation area and Riksu special protection area; Karala-Pilguse special conservation area and Karala-Pilguse special protection area; Vilsandi special conservation area and Vilsandi special protection area; and Tagamõisa special protection area. The integrity of Natura 2000 network sites will not be affected by the implementation of the planned activity. Mitigation measures are not required for any Natura sites.

3.11. Visual disturbances

Studies carried out:

- Assessment of the landscape and visual impact of Saare Wind Energy's offshore wind farm. Artes Terrae AB, 2023

The theoretical area of visibility of the wind farm is the area within a 50 km radius from the perimeter of the wind farm. However, due to abundant vegetation, the actual visibility of the wind farm will be mostly limited to the coastal zone (Figure 3.11-1).

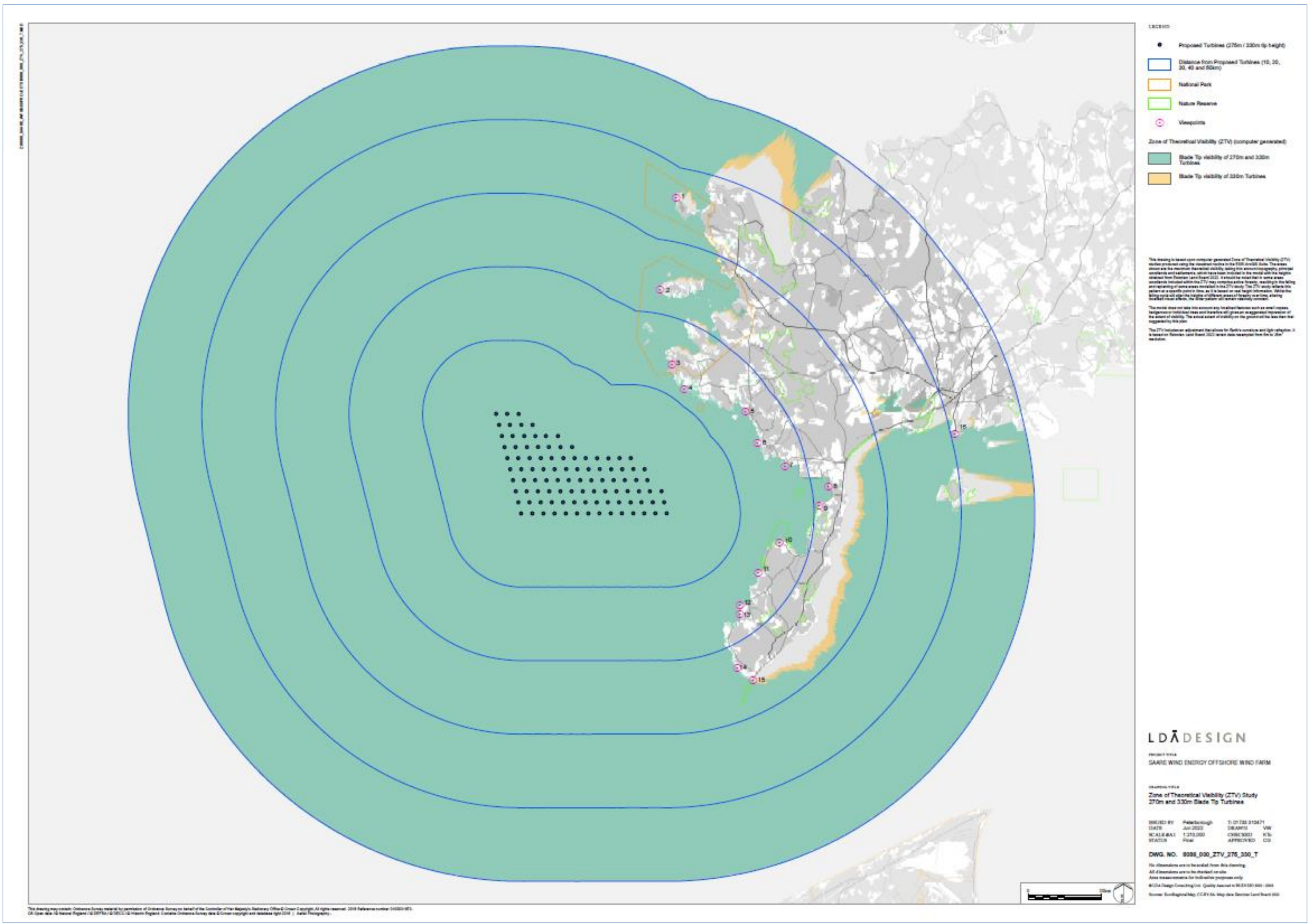

FIGURE 3.11-1. AREA OF THEORETICAL VISIBILITY OF THE WIND FARM

A total of 16 vantage points were selected along a 150 km stretch of the coastline of Saaremaa to carry out the assessment and illustrate the wind farm's visibility. These represent the most valued sites and illustrate the changes in the panorama when moving along the west coast. The different vantage points make it possible to present the extent of the wind farm’s impact and how its nature changes over the area of visibility of the wind farm.

Distance is the determining factor in the extent of the wind farm’s impact. In this case, the distance of at least 11 km is an important buffer, reducing the visibility of the wind farm, its dominance in the landscape and hence the extent of its visual impact. In addition to distance, the extent of the visual impact depends on a number of other factors, including:

- the proportion, size and height of the wind turbines,
- the extent to which wind turbines fill the field of view,
- the extent to which the wind farm is clearly visible and prominent in the surrounding context,
- the extent to which the wind farm contrasts with the surrounding landscape (contrast principle),
- the distance of the wind farm from the viewer and the context of the foreground landscape in which the wind farm is viewed,
- the background of the wind farm and the landscape context in which the wind farm is viewed,
- the number of viewers, their location and the situation (home, holiday, etc.) in which the wind farm is viewed.

Photomontages were composed for each vantage point to determine the extent of the visual impact. An above-average impact was identified at three of them. Above-average impacts occur in the views from the north and north-east, where the wind farm occupies the widest field of view, for example at the vantage point near Vilsandi lighthouse (see Figure 3.11-2) and at Roopa port in Austla village, which is in the same direction, i.e. to the north-east of the wind farm (see Figure 3.11-3). This is the direction most affected by the wind farm.

FIGURE 4.1-2. EXAMPLE: VIEW FROM VILSANDI LIGHTHOUSE – PHOTOMONTAGE OF A 53.5-DEGREE FIELD OF VIEW; PRINCIPAL ALTERNATIVE 2 WITH A PEAK HEIGHT OF 275 M

FIGURE 4.1-3. EXAMPLE: VIEW FROM ROOPA PORT IN AUSTLA VILLAGE – PHOTOMONTAGE OF A 53.5-DEGREE FIELD OF VIEW; PRINCIPAL ALTERNATIVE 2 WITH A PEAK HEIGHT OF 275 M

The assessment considers two alternatives of arrangement of the wind turbines: aligned diagonals (Figure 3.11-1) and irregular positioning (Figure 4.1-2). Both alternatives are illustrated in technical drawings at several vantage points and comparatively in Annex 3.14.

TABLE 3.11-1. COMPARISON OF THE DIFFERENT TECHNICAL ALTERNATIVES AND SIGNIFICANCE OF IMPACT

Associated consequence/impact	Aligned diagonals or grid	Irregular placement
Operation phase		
- *Visual disturbance*	0/-	0/-
	Peak height 275 m	Peak height 310 m
Operation phase	0/-	0/-

Scale of the significance of environmental impacts used in the EIA report: -1 = minor negative impact, -2 = significant negative impact, 0 = no impact, neutral, + = minor positive impact, +2 = significant positive impact.

3.12. Noise

When new wind turbines are being planned, the assessment of noise to be emitted by them is based on computation, which provides an overview of noise propagation over a large area. Noise measurements cannot be carried out for a planned wind farm, but even for existing wind turbines, measurements are often complicated because, at the measurement points (several hundred metres from the wind turbines) the level of noise from the source of interest (the wind turbines) is significantly lower than traffic noise or noise from conventional heavy industry, and in practice it may be difficult to distinguish between wind turbine noise and background noise (e.g. in windy coastal areas).

Figure 4.2-1 shows the results of noise propagation calculations (noise map) in the case of regular placement of wind turbines. Figure 4.2-2 shows the results of noise propagation calculations (noise map) in the case of irregular placement of wind turbines (with more wind turbines situated on the periphery of the wind farm, which is somewhat more efficient in terms of productivity).

A hypothetical wind turbine with a noise emission or sound power level (L_{WA}) of 115.3 dB (the initial sound power level according to the potential supplier of wind turbines) was used to generate the maps of noise propagation modelled with the special software WindPRO. This noise level characterising the wind turbines is higher than that of the largest wind turbines currently in series production. In addition, a correction factor of +3 dB was added to the noise level of each wind turbine to take into account possible additional uncertainties for prospective wind turbines and to describe the worst-case scenario. The noise modelling was based on a tower height of 150 m and a rotor diameter of 236 m. However, there is no significant difference in the noise propagation calculation results when changing the height of the tower by a few dozens of metres (the differences are generally less than 1 dB).

The noise map of the wind farm is based on the total noise emission of all the wind turbines, i.e. the cumulative noise of the turbines. Each wind turbine is treated as a separate point source and the noise map shows the maximum noise propagation in all directions simultaneously. In real life, the situation depicted on the noise map only occurs in one specific sector at a given moment in time.

Noise propagation is given according to the worst-case scenario, with the wind turbines operating at maximum power (this operating mode is generally reached at a wind speed of 8–10 m/s (reference height: 10 m above ground)). Noise maps show the extent of noise propagation in all directions simultaneously.

The modelling of noise propagation also takes into account the absorption or reflection of sound on surfaces. Sound absorption is defined on a scale of 0 (acoustically “hard” sound-reflecting surfaces: roads, water bodies, concrete) to 1 (acoustically “soft” sound-absorbing surfaces: fields, bushes, meadows, snow-covered surfaces), depending on the characteristics of the surface and land use. In this case, an acoustically “hard” surface, i.e. water surface reflecting the sound waves, dominates the entire study area and the most conservative value, i.e. a coefficient of 0 (100% reflective surface), was therefore used in the calculations.

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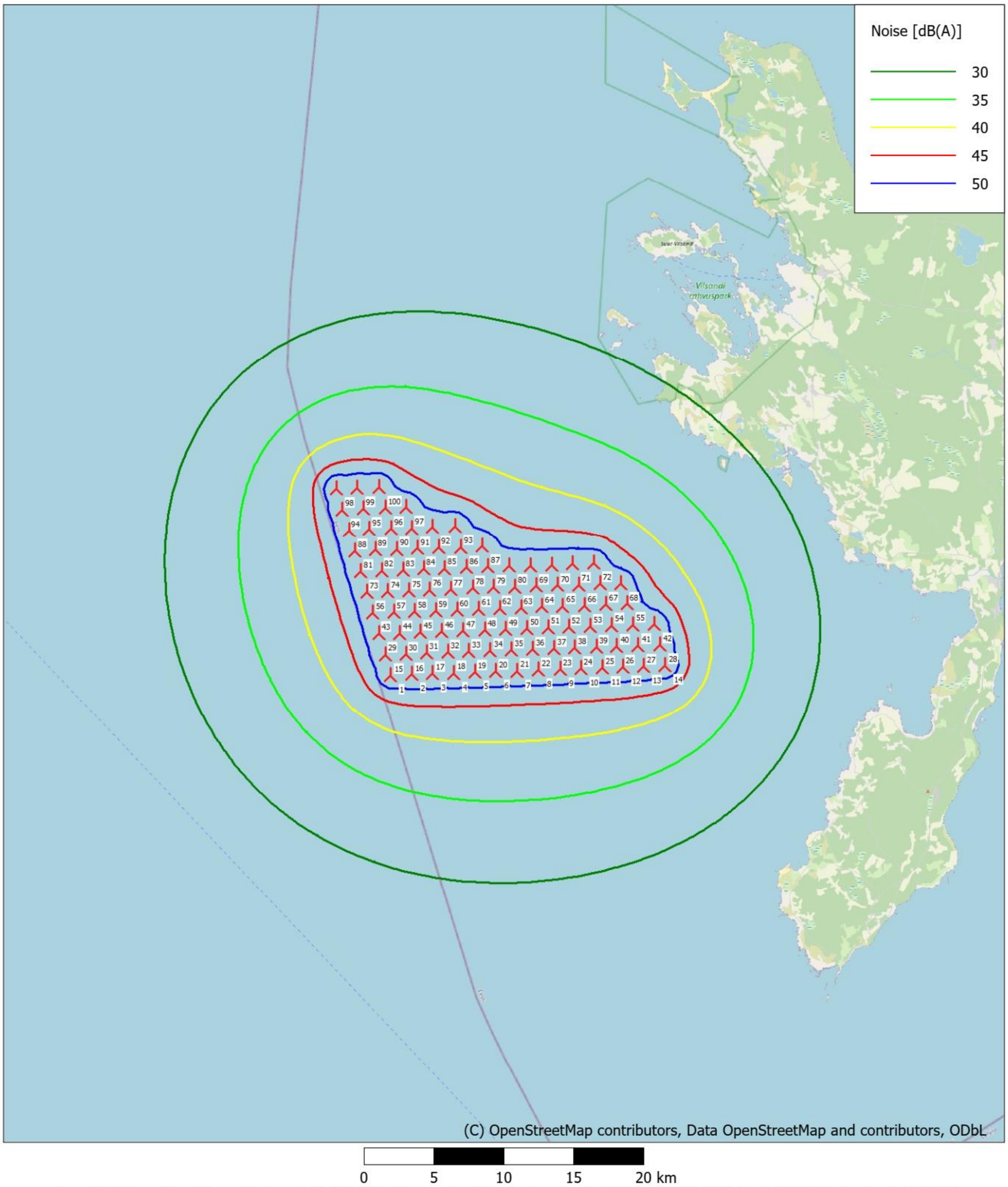
Raekoja plats 8
EE-51004 Tartu
+372 7 409 806
Hendrikson & Ko
Calculated:
15.05.2023 10:32/3.4.415

DECIBEL - Map Highest noise value

Calculation: Korrapärane asetus: 100 tuulikut, 15MW, LwA 115,3 dB, ISO9613-2 (G0+3dB)



Map: EMD OpenStreetMap , Print scale 1:400 000, Map center Estonian Lambert L-EST97-EST97 (EE) East: 361 363 North: 6 449 734

New WTG

Noise calculation model: ISO 9613-2 General. Wind speed: Highest noise value (3,0 dB uncertainty added)
Height above sea level from active line object

windPRO 3.4.415 by EMD International A/S, Tel. +45 96 35 44 44, www.emd.dk, windpro@emd.dk 15.05.2023 10:32 / 1 windPRO

FIGURE 3.12-1. NOISE PROPAGATION MAP IN THE CASE OF REGULAR PLACEMENT OF WIND TURBINES

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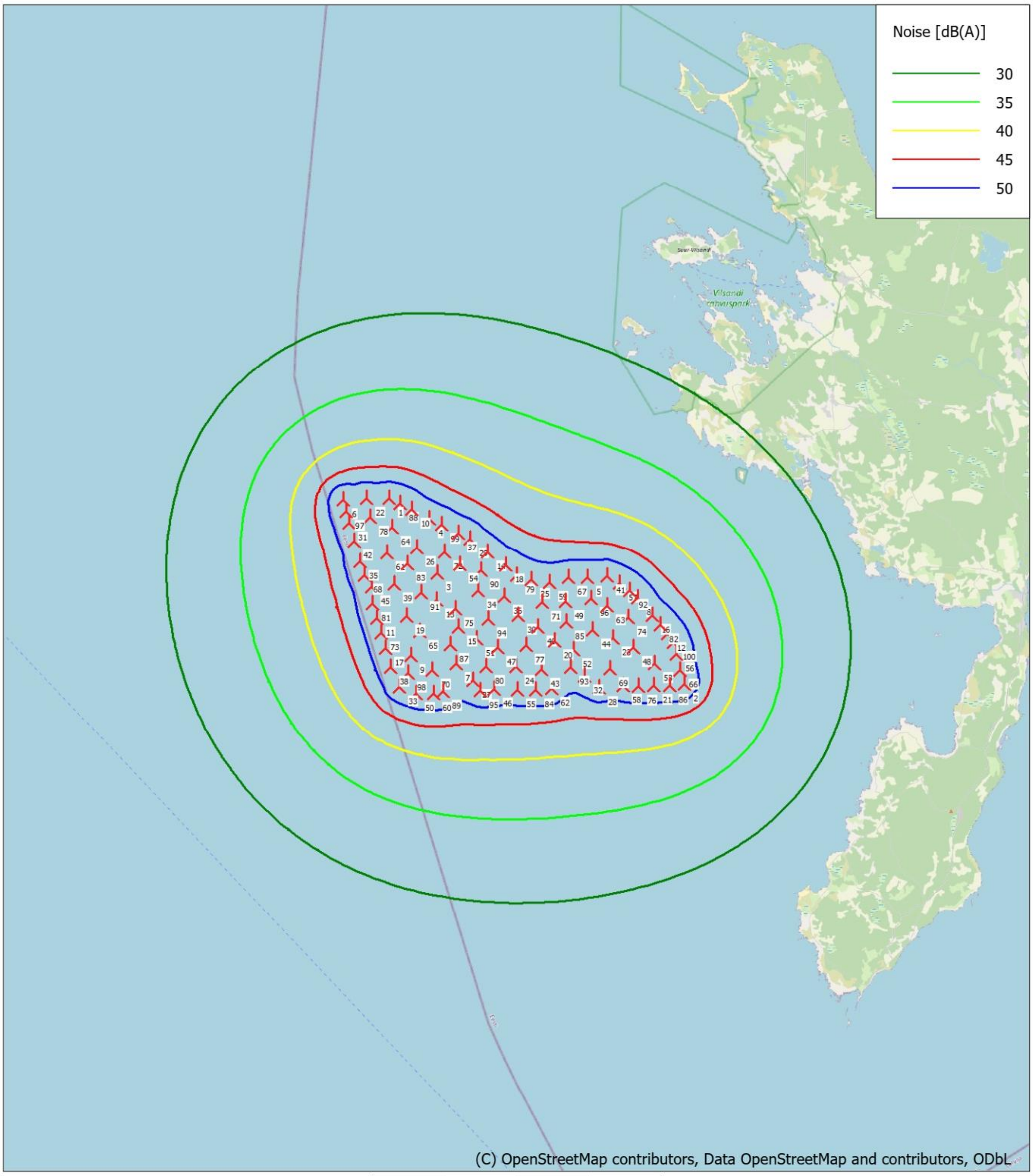
+372 7 409 806
Hendrikson & Ko
Calculated:
15.05.2023 10:29/3.4.415

DECIBEL - Map Highest noise value

Calculation: Ebakorrapärane asetus: 100 tuulikut, 15MW, LwA 115,3 dB, ISO9613-2 (G0+3dB)



0 5 10 15 20 km

Map: EMD OpenStreetMap , Print scale 1:400 000, Map center Estonian Lambert L-EST97-EST97 (EE) East: 361 394 North: 6 449 729

New WTG

Noise calculation model: ISO 9613-2 General. Wind speed: Highest noise value (3,0 dB uncertainty added)
Height above sea level from active line object

FIGURE 3.12-2. NOISE PROPAGATION MAP IN THE CASE OF IRREGULAR PLACEMENT OF WIND TURBINES

In the case of the proposed maximum number of wind turbines and their arrangement alternatives, noise levels in the coastal areas will not exceed 35 dB. Theoretically (using conservative calculation parameters and the added correction factor of +3 dB), the level of the wind farm's noise reaching the coast of Saaremaa would be in the order of 31–32 dB.

With the proposed number and positioning of wind turbines, noise levels in the coastal areas will not exceed 35 dB. Theoretically (using conservative calculation parameters and the added correction factor of +3 dB), the level of the wind farm's noise reaching the coast of Saaremaa would be in the order of 31–32 dB.

TABLE 3.12-1. COMPARISON OF DIFFERENT ALTERNATIVES OF POSITIONING OF TURBINES IN THE OFFSHORE WIND FARM

Associated consequence/impact	Regular positioning or grid alternative	Irregular or dispersed positioning
Noise disturbance	0	0

Scale of the significance of environmental impacts used in the EIA report: -1 = minor negative impact, -2 = significant negative impact, 0 = no impact, neutral, + = minor positive impact, +2 = significant positive impact.

Somewhat higher noise levels would occur in the coastal zone in the case of irregular positioning of turbines in the wind farm (due to the fact that more wind turbines would be situated on the periphery of the wind farm area), but differences at distances of more than 10 km from the wind turbines would be small (less than 1 dB difference). This indicates that the total impact of the wind farm located more than 10 km away does not depend significantly on the positioning of turbines within the wind farm.

Therefore, from the point of view of the protection of human health, both alternatives for the positioning of wind turbines considered can be regarded as suitable, and certain changes in the number, positioning and type of the turbines (including the noise level generated by a particular turbine type) will not significantly alter the situation.

3.13. Social and economic impacts

The impacts of the offshore wind farm planned by SWE on various socio-economic aspects and the significance of these impacts are summarised in the table below.

TABLE 3.13-1. IMPACT OF CONSTRUCTION OF SWE'S WIND FARM, AND SIGNIFICANCE THEREOF

Associated consequence/impact	Significance of impact
Impact on the economy of Saaremaa Rural Municipality	
- *Transition to a climate neutral economy*	+
- *Employment*	+
- *Education and research*	++
- *Electricity network capacity*	++
- *Future technologies*	+
- *Maritime rescue capacity*	++
Impact on coastal communities	
- *Local benefits*	+
Impact on fisheries	
- *Impact on coastal fishery*	0
Impact on tourism	
- *Coastal tourism*	0

Associated consequence/impact	Significance of impact
- *Maritime tourism (current tourism, sailing, boating, etc.)*	0
- *Business tourism*	+

Scale of the significance of environmental impacts used in the EIA report: -1 = minor negative impact, -2 = significant negative impact, 0 = no impact, neutral, + = minor positive impact, +2 = significant positive impact.

3.14. Impact on cultural heritage

Studies carried out:

- Identification of objects of cultural value in the area of the Saaremaa wind farm. Report on the analysis of sonar data. Kaido Peremees, Priit Lätt, 2023

Scanning of SWE's offshore wind farm area, using multibeam and side-scan sonars, and a magnetometer survey were carried out in February and March 2022 by VBW Weigt GmbH.

A shipwreck is known to lie within the area of the wind farm, at 58°8.6337′ N and 21°28.7314 ′E, at the western boundary of the area. This wreck probably dates back to the 20th century.

Other objects detected in the wind farm area include, for example, chains/ropes on the seabed, as well as a number of smaller elongated objects the exact nature of which cannot be determined from sonar data and which will certainly need to be checked if construction work on wind farm installations is to take place in their immediate vicinity.

TABLE 3.14-1. IMPACT OF CONSTRUCTION OF THE WIND FARM, AND SIGNIFICANCE THEREOF

Associated consequence/impact	Significance of impact
Impact on objects protected under heritage conservation/ archaeological values	0

Scale of the significance of environmental impacts used in the EIA report: -1 = minor negative impact, -2 = significant negative impact, 0 = no impact, neutral, + = minor positive impact, +2 = significant positive impact.

3.15. Impacts on navigation systems, vessel traffic and maritime safety

Studies carried out:

- Maritime safety risk analysis for SWE's offshore wind farm, Tallinn University of Technology, Estonian Maritime Academy, 2022 (Annex 3.17)

The closest vessel traffic management measure of the IMO (International Maritime Organisation) to the planned offshore wind farm is the deep-water shipping route in the Central Baltic, the width of which is around 6 nautical miles and which is located approximately 19 nautical miles (35 km) west of the wind farm area. All vessels with a draught of more than 12 metres passing Gotland to the east and south and moving to or from the north-eastern part of the Baltic Sea are advised to use this deep-water route.

According to AIS (Automatic Identification System) data, vessel traffic in the area of the offshore wind farm is generally of low intensity (Figure 3.15-1). The area is mostly used by cargo vessels, as one of the links between the Gulf of Riga and the Gotland fairway runs along the western boundary of the wind farm. Fishing vessels and recreational craft rarely enter the area of the planned offshore wind farm.

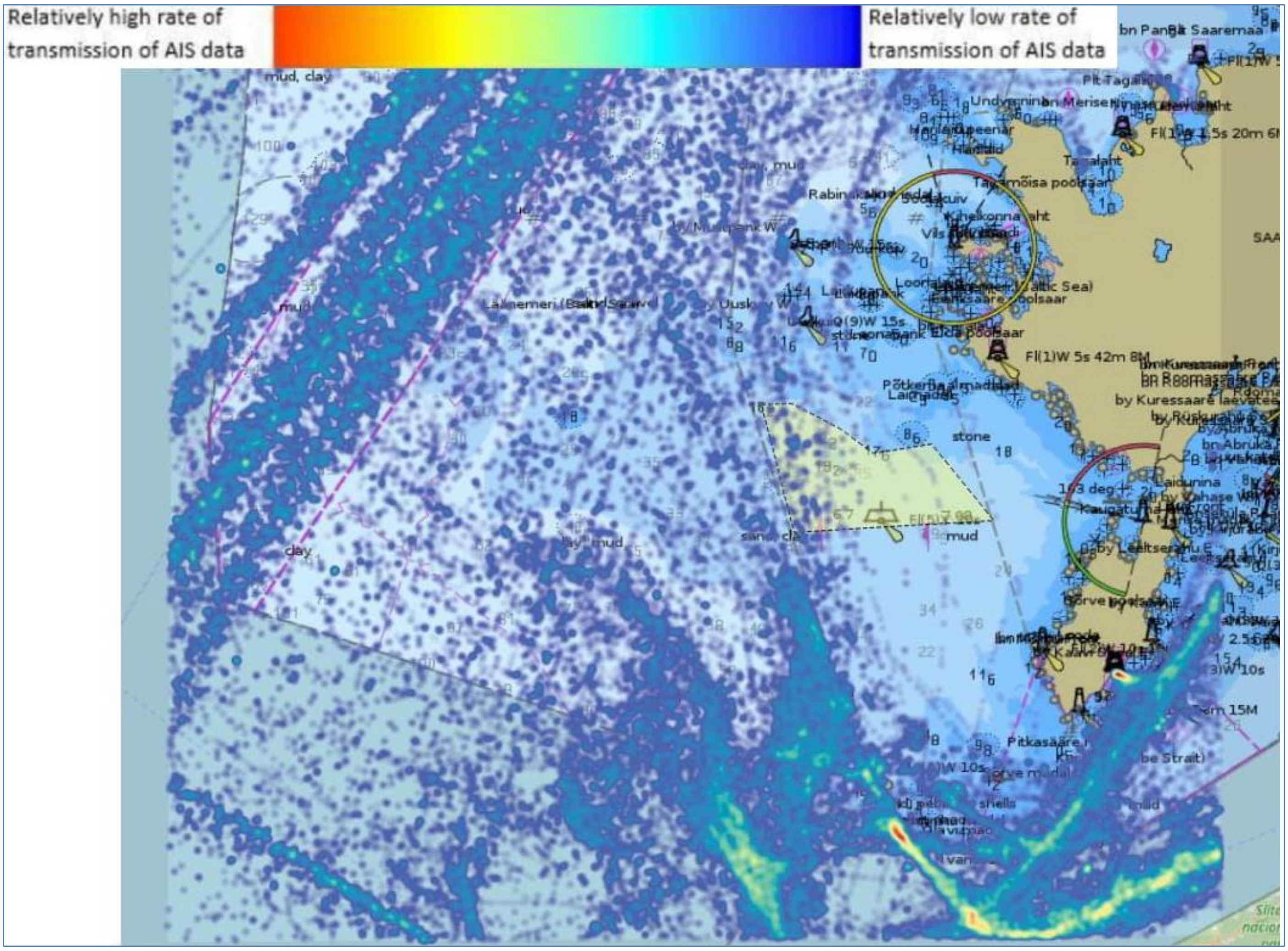


FIGURE 3.15-1. HEAT MAP OF VESSEL TRAFFIC ACCORDING TO AIS DATA FOR 2018

In the vessel traffic risk analysis, the objective is to generate a worst-case scenario based on maritime safety parameters. The most conservative realistic scenario is the one in which cargo vessels pass the wind farm at a distance of at least one nautical mile. In practice, this distance is safe and reasonable for vessels to pass. The minimum distance between a shipping route and the wind farm must allow vessels to make safety manoeuvres (e.g. turning around) and it is calculated as follows:

- to the right, on any route: 0.3 nautical miles + 6 vessel lengths + 500 metres;
- to the left, on any route: 6 vessel lengths + 500 metres.

Based on AIS data and possible developments in shipping, the length of a vessel is assumed to be 320 m in this case. Consequently, SWE's offshore wind farm should be designed with a safety zone of two nautical miles (Figure 3.15-2). In this case, vessels will be able to react (manoeuvre) in an emergency, and safety and rescue operations can be carried out.

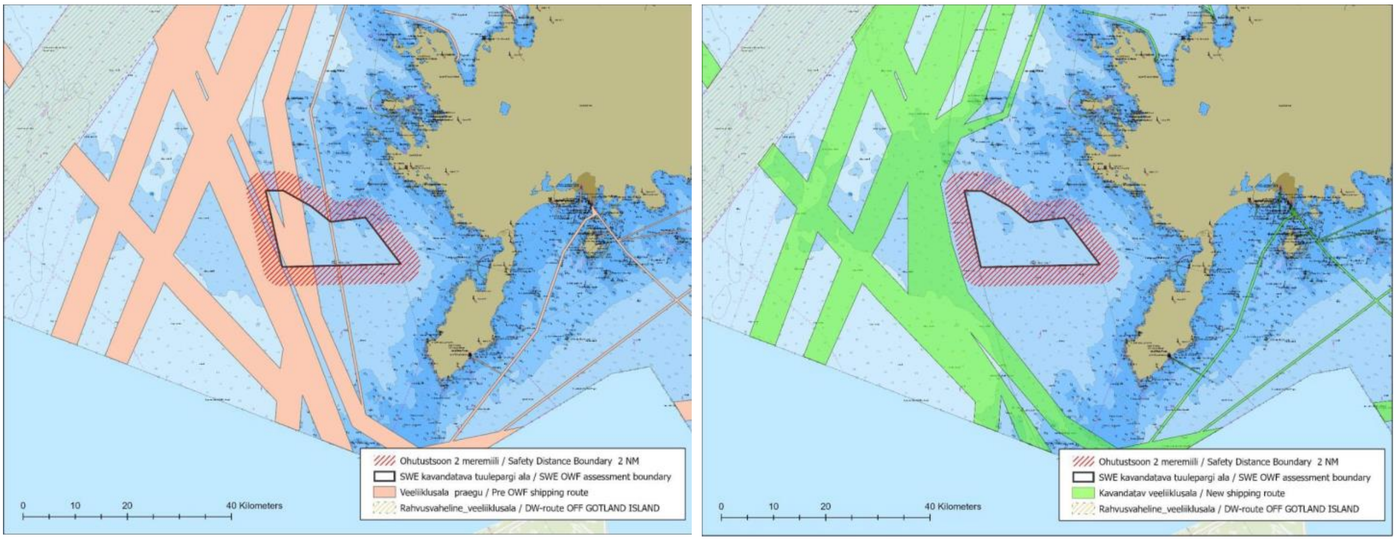


FIGURE 3.15-2. MAIN SHIPPING ROUTES BEFORE AND AFTER THE CONSTRUCTION OF THE WIND FARM

Vessel positioning and communication systems, including VHF, NAVTEX, radio communication, GPS receivers, mobile phones, AIS, vessel-borne radars, sonars, are not significantly affected by offshore wind farms, based on studies carried out so far.

With the implementation of the necessary safety measures, any anticipated risks are minimised and the likelihood of a collision of vessels after the construction of the wind farm is very low or non-existent.

TABLE 3.15-1. IMPACT OF CONSTRUCTION OF THE WIND FARM, AND SIGNIFICANCE THEREOF

Associated consequence/impact	Significance of impact
Risk of collision of vessels	0/-
Impact on vessel positioning and communication systems, including VHF, NAVTEX, radio communication, GPS receivers, mobile phones, AIS, vessel-borne radars, sonars	0/-

Scale of the significance of environmental impacts used in the EIA report: -1 = minor negative impact, -2 = significant negative impact, 0 = no impact, neutral, + = minor positive impact, +2 = significant positive impact.

3.16. Impact on air traffic

Studies carried out:

- Impacts of Saare Wind Energy's offshore wind farm on aviation. Estonian Aviation Academy, 2023 (Annex 3.18)

The area under consideration is uncontrolled airspace where flights are operated in accordance with the common rules for air navigation as laid down in Commission Implementing Regulation (EU) No. 923/2012[14]. According to the common rules for air navigation, when flying in this area under visual flight rules, an obstacle must be passed at a minimum distance of 150 m horizontally and 500 ft vertically. Under instrument flight rules, an obstacle within 8 km of the estimated position of the aircraft must be passed at a level that is at least 1000 ft (305 m) above the obstacle.

The offshore wind farm will have a minor impact on area minimum altitudes (AMA). The planned offshore wind farm will be located in two longitude-latitude quadrangles, with AMA rising from 1100 ft to 2100 ft in

14 European Commission (2012). Commission Implementing Regulation (EU) No. 923/2012, updated on 15.02.2023. Accessed on 24.05.2023. https://www.easa.europa.eu/en/document-library/easy-access-rules/easy-access-rules-standardised-european-rules-air-sera the first of them and from 1500 ft to 2100 ft in the second. This change will affect instrument flights. The altitude of 2100 ft will be the new minimum flight altitude for these areas to ensure the minimum obstacle clearance (MOC) required under instrument flight conditions.

With the implementation of mitigation measures, the offshore wind farm planned by SWE will have a moderate impact on aviation in the area.

TABLE 3.16-1. IMPACT OF CONSTRUCTION OF THE WIND FARM, AND SIGNIFICANCE THEREOF

Associated consequence/impact	Significance of impact	
Impact on aviation		
- *Impact on area minimum altitudes (AMA)*	-	
- *Prohibited, restricted and danger areas*	0	
- *Impact on the obstacle limitation surface (OLS) of Kuressaare airport*	0	
- *Impact on approach procedures at Kuressaare airport*	--	
- *Wake turbulence*	-	
	Regular positioning or grid alternative	Irregular or dispersed positioning
- *Search and rescue (SAR) and medical emergency evacuation (MEDEVAC) flights*	-	--

Scale of the significance of environmental impacts used in the EIA report: -1 = minor negative impact, -2 = significant negative impact, 0 = no impact, neutral, + = minor positive impact, +2 = significant positive impact.

3.17. Climate impact

During the 21st century, climate change is expected to result in rising temperatures, increased precipitation, more frequent storms and rising sea levels in Estonia. In order to mitigate climate change, the European Union has set a target to reduce net greenhouse gas emissions by 55% by 2030 compared to 1990 and to become climate neutral by 2050. Climate neutrality or net zero CO_2 emissions would mean a balance between CO_2 emissions and capture of carbon from the atmosphere. Today, however, neither natural nor man-made sinks are capable of removing anthropogenic emissions from the atmosphere, and the main method to achieve climate neutrality is to reduce CO_2 emissions. As the largest CO_2 emissions come from the energy sector, it is this sector that also has the greatest potential to reduce CO_2 emissions. One option is to replace fossil sources, such as oil shale, in electricity generation with renewable sources, such as solar and wind.

The wind farm planned by SWE will contribute to climate change mitigation. Assuming an annual energy production of approximately 6 TWh from SWE's offshore wind farm, $CO_{2\text{-eq}}$ savings can be estimated at 4.4 million tonnes per year, using the electricity emission factor of 0.735 for 2019. This is almost one third of the total $CO_{2\text{-eq}}$ emissions of Estonia in 2019 and 41 times the $CO_{2\text{-eq}}$ emissions of Saaremaa municipality in 2019.

The use of offshore wind energy on a large scale will allow a significant reduction in the use of biomass in energy production. The use of fossil fuels for electricity generation can also be significantly reduced or completely abandoned. The use of offshore wind energy would enable Estonia to reach climate neutrality on balance, as electricity generation from renewable sources will be in large surplus and will also cover the use of fossil fuels in heating and transport sectors.

TABLE 3.16-1. IMPACT OF CONSTRUCTION OF THE WIND FARM, AND SIGNIFICANCE THEREOF

Associated consequence/impact	Significance of impact
Climate impact	++

Scale of the significance of environmental impacts used in the EIA report: -1 = minor negative impact, -2 = significant negative impact, 0 = no impact, neutral, + = minor positive impact, +2 = significant positive impact.

4. Environmental measures

4.1. Mitigation measures

A list of mitigation measures to minimise any potential adverse effects on the environmental and other aspects assessed in the EIA report is provided in Table 4-1 below. The mitigation measures include both those that should be considered during the design phase and those that should be implemented during the phases of construction and operation of the wind farm.

The mitigation measures are suggested in the light of the results of existing studies and current knowledge on offshore wind farms. Should an ex-post evaluation result in new or additional knowledge based on which it is concluded that the projections set out in the EIA report have underestimated the expected associated impacts, further possible measures to ensure that the expected negative impacts are avoided or mitigated should be implemented based on the results of monitoring.

TABLE 4.1-1. POSSIBLE MITIGATION MEASURES

Environment compartment	Implementation phase	Mitigation measures
Geology of the seabed	*Design phase*	• Wind turbines should preferably be sited in areas where very fine-fraction sediments such as clay and clay sands are absent or are present in thin layers. For this reason, wind turbines are not installed in areas where the thickness of seabed sediments lying on limestone exceeds 4 metres. • The preferred type of foundation is the monopile foundation in the case of which the amount of sediment released is many times smaller than in the case of a gravity foundation. • A detailed engineering-geological survey of the wind turbine sites must be carried out before the start of construction activities.
	Construction phase *Operation phase*	• -
Seawater quality	*Design phase*	• Wind turbines should preferably be sited in areas where very fine-fraction sediments such as clay and clay sands are absent or are present in thin layers (maximum 4 m). • The preferred type of foundation is the monopile foundation in the case of which the amount of sediment released and the resulting suspended sediment is many times smaller than in the case of a gravity foundation.
	Construction phase	• In order to prevent and/or reduce the spread of suspended sediment in Riksu special conservation area, connecting cables should not be installed if westerly and/or north-westerly winds with an average speed exceeding 6 m/s have prevailed during the preceding day.
	Operation phase	• With a view to quick elimination of a possible oil spill, a pollution control plan must be in place (similar to ports).

Environment compartment	Implementation phase	Mitigation measures
Benthic habitats and biota	*Design phase* *Construction phase*	• Within the study area, it is possible to distinguish areas of higher priority for marine biodiversity and ecological processes – reef habitats at depths of less than 22 and 20 m. It is desirable to minimise disturbance of the seabed in these areas. It is recommended to exclude construction activities in the range of the reef habitats at depths of less than 20 m.
	Operation phase	• -
Birds	*Design phase*	• Positioning of wind turbines. Where possible, it would be advisable to install wind turbines in rows aligned with the predominant migration direction. In this case, the predominant migration direction is from northeast to southwest.
	Construction phase *Operation phase*	• Making wind turbines more visible. There are a number of methods that can be used to make wind turbines more visible to birds. As regards the effectiveness of the various methods, the need for additional research is mostly noted. One of the most recent recommendations is to paint the rotor blades and the support tower of the wind turbine in contrasting black and white stripes. Striping part of the wind turbines would make it possible to monitor the effectiveness of this method during the operation of the wind farm. Manufacturers of wind turbines could also be interested in such data. • Choice of time for construction and maintenance operations. This timing will help reduce disturbance to stopover waterfowl. According to the available data, the abundance of stopover waterfowl in the area is the highest in late summer (August), which makes this period the most unsuitable time for carrying out construction operations. • Lighting of the wind farm. The risk of bird collisions could be reduced by turning off flight-safety lighting when there are no low-flying aircraft in the area, if this is technically and legally possible. • Stopping wind turbines during periods of intensive bird migration. For this report, the collision risk has been estimated using the Band model and it has been suggested that the number of casualties may be overestimated. However, if monitoring results were to indicate the opposite, it will be possible to reduce the collision risk by reducing the rotor speed or stopping rotors during the most intensive migration. For the sake of accuracy and efficiency, high-tech tools should be used to determine the times when this measure needs to be implemented.
Bats	*Design phase* *Construction phase*	• -
	Operation phase	• If follow-up monitoring determines that the operation of the wind farm has a high impact on bats, appropriate mitigation measures should be implemented. Currently, the only effective mitigation measure for offshore wind farms is to stop the wind turbines during the bat migration period at wind speeds below 5 m/s.
Seals	*Design phase*	• -
	Construction phase	• If possible, noisy operations should be timed according to the sea use periods of seals and scheduled for the periods when the majority of adult grey seals mostly stay on land: the pupping period from early February to mid-March or the moulting period from mid-May to mid-June.

Environment compartment	Implementation phase	Mitigation measures
	Operation phase	• -
Fish	*Design phase* *Construction phase* *Operation phase*	• It is recommended to exclude construction activities in the range of reef habitats at depths of less than 20 m, which are also important habitats for fish species. • If possible, the installation of connection cables in shallow waters should be scheduled for a period outside the fish spawning season from 15 April to 15 June. • -
Visual disturbance	*Design phase* *Daytime visibility* Nighttime visibility	The wind farm should be visible as a definable set of elements in the sea area, i.e. the pattern of wind turbines as installed should be clearly legible. To reduce the visual impact, it is recommended to avoid: • the disturbing view resulting from the topography of the seabed and the arrangement of wind turbines, where towers "bounce" against the sky at different heights, creating a "broken silhouette"; • a dense cluster of visually overlapping wind turbines on the horizon where rotor blades create a "spinning wheel" against the sky; • the formation of small clusters of wind turbines on the peripheries of the wind farm, which appear to be isolated from the main row of wind turbines; • lone wind turbines isolated from a cluster, which unduly extend the field of view occupied by the turbines and create an additional focal element; • completely covering the horizon with the wind farm; the horizon should preferably be articulated. • Reduction of nighttime lighting.
Objects protected under heritage conservation	*Design phase* *Construction phase* *Operation phase*	• -
Vessel traffic, maritime safety	*Design phase* *Construction phase* *Operation phase*	• - • In order to ensure maritime safety and to mitigate risks, it is necessary to ensure that offshore installations are marked in accordance with the requirements and with the maritime markings agreed with the Transport Administration, during both construction and operation of the wind farm.
Air traffic	*Design phase* *Construction phase* *Operation phase*	• There will be a significant impact on approach procedures at Kuressaare airport in terms of an increase in the minimum sector altitude (MSA). Therefore, as a mitigation measure, the approach procedures need to be amended. • If wind turbines are not positioned in a grid, the minimum width of the SAR access lane must be at least 1 km. The SAR access lane must be marked separately. • If necessary, a helicopter refuge area needs to be established (over 10 km is required for an offshore wind farm). • A clear marking system on wind turbines, visible to vessels and aircraft. • Potential disturbance from nighttime lighting can be avoided and reduced by existing technical means. ADLS and ARC-SIRIL systems are being used in Europe and they are being developed further. According to the developer of SWE's offshore wind farm, solutions

Environment compartment	Implementation phase	Mitigation measures
		will be developed to ensure aviation safety which at the same time avoid nighttime visual disturbance extending to the west coast of Saaremaa. • During the construction phase, it is recommended to establish a restricted zone for flying in the construction area. The information on the restricted zone will enable airspace users to avoid the area, which will enhance aviation safety. *Cooperation with the Ministry of the Interior and the Police and Border Guard Board.*
Maritime surveillance, operational communications	*Design phase* *Construction phase* *Operation phase*	*Cooperation with the relevant authorities*

Table 4-1 lists all possible recommended mitigation measures that help minimise the environmental impacts and disturbances resulting from the planned wind farm and its infrastructure. Although no significant adverse impacts on any of the environmental aspects assessed were identified in the course of preparation of this EIA report, the expert group for this EIA suggests that the construction and installation of wind turbine foundations, cables and other structures be excluded in areas of high ecological and nature conservation value, i.e. the range of reefs, a habitat type specified in the Habitats Directive, at depths of up to 20 m. This suggestion is based on the results of the studies on benthic habitats and biota, as well as on other biota components (fish fauna) carried out for this report.

4.2. Knowledge gaps

The history of development of offshore wind farms is relatively short. The first monitoring assessments of previously developed offshore wind farms in England, Denmark, Germany and the Netherlands have been published. These assessments cover relatively short monitoring periods and thus cannot provide certainty regarding long-term impacts yet.

However, current research and development programmes provide tools for predicting impacts and are identified in this EIA report. As regards the exploration and prediction of impacts for this EIA, there are various knowledge gaps that may limit understanding of the nature and magnitude of the impacts. This does not mean, however, that a good idea of anticipated impacts within the study area of SWE's wind farm cannot be obtained. Understanding the uncertainties that played a role in predicting impacts is important in the decision-making process. Some of the knowledge gaps identified and mentioned in the EIA report are listed below:

- To date, the biggest knowledge gaps concerning benthic biota and habitats include the "reef effect" arising from wind turbine foundations; the impact of wind turbine foundations on the movement of water and the resulting changes in benthic communities near the wind turbine foundations; and the impact of disturbed habitat (substrate) in the cable route corridor on seabed communities (experiments at the Neugrund Shallow pointed to the duration of the impact of the disturbance of more than 5 years).
- As regards birds, the potential impact resulting from the wind farm has been assessed as low, but the effects of any of the discussed risk factors cannot be completely excluded. While the assessment is based on the best available data and knowledge, it is nevertheless surrounded by rather considerable uncertainties. In particular, it should be taken into account that data on the actual impact of wind turbines of this power and height are not yet available, and predictions can only be made on the basis of data collected in wind farms composed of smaller wind turbines, and theoretical assumptions. It is therefore important and necessary to carry out bird monitoring during operation.
- Erected wind turbines alter the landscape, and in the case of onshore wind turbines, it is known that wind turbines can affect the behaviour of bats by attracting them (Guest et al. 2022) or scaring them away (Leroux et al. 2022).

Therefore, acoustic surveys conducted prior to the construction of wind farms do not always predict the real impact of wind farms or the abundance of bats in the area after the wind farms are erected (Solick et al. 2020). For this reason, follow-up monitoring should be conducted after the wind farm is completed to assess the abundance of bats in the area and, where possible, the number of individuals killed.

- The main application of the study on seals is the determination of the abundance of grey seals on the west coast of Saaremaa in different seasons. While it is not possible to know the exact number, the proportion in relation to the total abundance of grey seals in all of Estonia or the Baltic Sea gives an indication of how many animals could theoretically be affected by the activities in the wind farm area and how this relates to other areas. To obtain scientifically reliable results on movement in open areas through a telemetry survey, a large number – hundreds – of tags would be needed. This is not cost-effective from the perspective of a single development and will not guarantee that a tagged animal would be using the study area. On the other hand, however, animal behavioural patterns are largely species-specific and ecological determinants of behaviour have evolved over a long period of time. Thus, behaviour patterns identified in other areas can be transferred, albeit with reservations, to the context of a particular area. When relying on species-specific behaviours, we also consider the fact that, in the case of seals as herding animals, a single telemetry tag actually describes the activities of a group of seals. This is borne out by observations in rookeries and at sea, where it is possible to see grey seal pods of a few dozen individuals moving or foraging together in a given area.
- As regards the impact of underwater noise on marine life, it should be noted that simplifying assumptions were made in describing noise propagation losses in this study. If actual propagation losses turn out to be lower, the current estimate may underestimate the actual risks. In order to verify this study, it is recommended to carry out propagation loss measurements during construction and operation in the future. Any modelling needs measurements for calibration and verification. Such verification will help reduce the uncertainties surrounding the prediction of the acoustic properties of the environment and the acoustic sources. Measurements should be made before construction starts, during the construction period and during operation.

4.4. Follow-up evaluation

It would be important to develop a common follow-up evaluation plan for offshore wind farms in cooperation with authorities in order to enable and accelerate the implementation and monitoring of renewable energy targets. A detailed follow-up evaluation plan will need to be established after the development permit has been issued, in cooperation with experts of the relevant fields.

The following table sets out the environmental aspects that the expert group recommends to monitor in the further design of the offshore wind farm, in order to obtain additional information on the different environment compartments.

TABLE 4.3-1. FOLLOW-UP ACTIVITIES REQUIRED IN THE PLANNING AND OPERATION OF THE WIND FARM

Environment compartment	Ex-post evaluation
Geology of the seabed	• Comprehensive geophysical surveys covering 100% of the wind farm development area have been conducted and their quality is excellent. In a later construction design phase, a geological engineering study will be carried out at the site of each specific wind turbine for engineering purposes (detailed design).
Quality of seawater	• Offshore wind farms installed on soft sediment (e.g. seabed covered with a thick layer of sand), particularly in the North Sea where tides and significant currents are present, may be subject to erosion of sediment (sand) from the bases of turbine foundations, which may jeopardise the stability of the foundations in the marine sediment over a longer period of time. To prevent erosion, rocks are placed at the base of turbine foundations. It is not anticipated that significant erosion protection will be required in SWE's offshore wind farm, but this will be specified during the engineering design phase. As a rule, the technical condition of turbine foundations and cable routes is regularly monitored during the operation of an offshore wind farm.

Environment compartment	Ex-post evaluation
	• The spread of suspended sediment will have to be monitored in the section where connection cables are installed, i.e. in Riksu special conservation area. Monitoring must be carried out when digging connection cable trenches.
Benthic habitats and biota	• A monitoring programme is needed to clarify the magnitude of the potential impact arising from the creation of a new substrate in the water column and to implement mitigation measures. To this end, the colonisation of the foundations of wind turbines in different parts of the wind farm (e.g. the westernmost and easternmost parts) should be monitored over the entire depth range. As colonisation of a new substrate is a long-term process involving different stages and various types of communities, monitoring should be carried out over a period of at least 10 years, up to four times a year in the first three years and thereafter once a year. The parameters to be monitored should include the species composition, cover (flora and fauna) and abundance (fauna) of the biota attaching to the substrate. In the course of the development and subsequent operation of the wind farm, other monitoring of benthic communities and biota and of the water column/water quality needs to be carried out both during and after construction operations and during operation. • This monitoring should comprise regular observations with a view to documenting the immediate effects of construction operations as well as monitoring the recovery of disturbed communities during operation. Before the construction activities, habitats in the area of connection cables need to be mapped so as to minimise impacts on benthic habitats. • **Birds**
The area in question is not a very important stopover area for birds and the distribution of the only significant species, the little gull, varied within the area already before the development of any wind farms. Thus, no further monitoring is necessary.	• Also, once the wind farm is operational, it would no longer be possible to implement additional mitigation measures, should any negative impacts occur. As part of the ex-post evaluation, it will be important to collect data on the behaviour of overflying birds when they encounter a wind farm consisting of so tall wind turbines. • Data on the number of actual collisions would also provide valuable information. Once the wind farm is completed, at least the monitoring of birds flying over the wind farm should be carried out during the operation of the wind farm. • It is recommended to base the methodology of monitoring on the STUK4 methodology, which has already been used in an adapted manner for pre-construction monitoring. The monitoring of overflying birds should include both radar and visual observations from an anchored vessel, with the additional use of cameras for automatic detection of collisions. As to the scope of the monitoring, the German standard recommends carrying out observations for a minimum of 3 years and 7 days per month during the main migration periods (from March to May and from the 2nd half of July to November). When planning the monitoring, it should be taken into account that it will take several years to complete the wind farm and thus the follow-up monitoring period will probably not start before 2030. It is therefore reasonable to use the technology available at that time and to update the monitoring methodology if necessary.
Bats	• As part of the follow-up monitoring of the offshore wind farm, an acoustic survey needs to be carried out over a two-year period to compare bat flight activity around the wind turbines before and after the construction of the wind farm. In order to avoid side effects resulting from the location of the recorders, the recorders should be installed in the same areas of the planning area. Instead of temporary buoys, it is advisable to place the recorders used for follow-up monitoring on the maintenance platforms of the wind turbines. Given that it will take several years to complete the wind farm, the follow-up monitoring period will probably not start before 2030. It is therefore reasonable to use the monitoring technology available at that time and to update the monitoring methodology if necessary.
Seals	• To verify the assumptions made in the underwater noise study, further measurements of noise propagation losses need to be made during the construction and operation of the wind farm. The source of noise can be either impulsive or continuous broadband and should be located at the place where piles will be installed. Measurements of noise transmission should be made on a decidecade basis, paying particular attention to the low frequencies of 100–300 Hz at which significant noise radiation occurs during both construction and operation. Spring is the best time for measurements, as noise propagation losses are lowest during this period, providing a more conservative estimate of noise propagation.

Environment compartment	Ex-post evaluation
	• During the construction period, it is important to measure the source level generated by the installation of piles. Measurements should be made according to ISO 18406 standard and preferably at the same measurement points as during the pre-construction phase. Care must be taken to ensure that the dynamic range of the hydrophones is sufficient to allow the highest expected sound pressure to be recorded without distortion. The installation of at least four piles should be monitored throughout the installation period. • During the operation period, data should be collected on a random basis for the individual wind turbines in the wind farm. Noise measurements should be performed at a distance of about 100 m from the noise source and in the centre of the wind farm. In addition, measurements should be made outside the wind farm at a distance of 1000 m and in the nearest nature reserve, provided that it is not more than 5 km from the project site.
Fish	• Prior to the start of construction operations, fish fauna studies should be continued in the inshore study area where connection cables are to be installed in order to identify potential spawning grounds of fish (e.g. European whitefish) so as to avoid construction operations during periods of importance for fish fauna.

5. Cumulative impacts

The area of the offshore wind farm planned by SWE is located in wind energy development area No. 2 specified in the Estonian Maritime Spatial Plan. It is the first wind farm development project in this area to have reached the development permitting process, including environmental studies and impact assessment. By now, various developers have submitted several applications for development permits for wind energy development area No. 2 specified in the Estonian Maritime Spatial Plan (outside the SWE project area), but development permitting processes have not yet been initiated in respect of these. Therefore, in this assessment process, there is no knowledge about the size, layout or technological solutions of the other potential wind farm sites to assess cumulative impacts. In the environmental impact assessments carried out in respect of further offshore wind farm development processes planned for the same area, the results of the impact assessments completed by that time must be taken into account.

Cumulative impacts on marine life may occur in the marine waters where, for example, several large-scale activities are planned in close proximity – if the development of the entire wind energy development area No. 2 specified in the Estonian Maritime Spatial Plan is realised. Any simultaneous construction of large wind farms will certainly be a major threat to marine life, which should be taken into account when granting building permits in the future.

Summary

The report on the EIA carried out addresses the impacts on all the environmental aspects set out in the national law and previously specified in the EIA programme. The assessment results are presented in Chapter 3. The EIA did not identify any significant environmental impacts for any of the environmental aspects assessed. With a view to avoiding and minimising potential environmental impacts, possible environmental measures (Table 4.1-1) and ex-post evaluation needs (Table 4.3-1) were identified.

In most cases, the maximum spatial alternative (principal alternative 2) comprising up to 100 wind turbines, i.e. the scenario with the highest possible impacts (*worst case scenario*), was assessed. Where a specific thematic area required the assessment of different technical alternatives, these alternatives were also compared with each other.

The comparison of technical alternatives showed that the installation of monopile foundations would have a lower environmental impact, both in terms of seabed disturbance and sediment dispersion. According to the developer, monopile foundations are more likely to be used for wind turbines, but the EIA also looked at the alternative use of gravity foundations and jacket foundations (the latter being more likely for the substation). The area of SWE's offshore wind farm has a limestone seabed (covered with soft sediment of varying thickness), which means that pile driving is not technically feasible, and drilling will be needed for the installation of foundations. The drilling method will not cause significant noise disturbance to marine life during the construction phase.