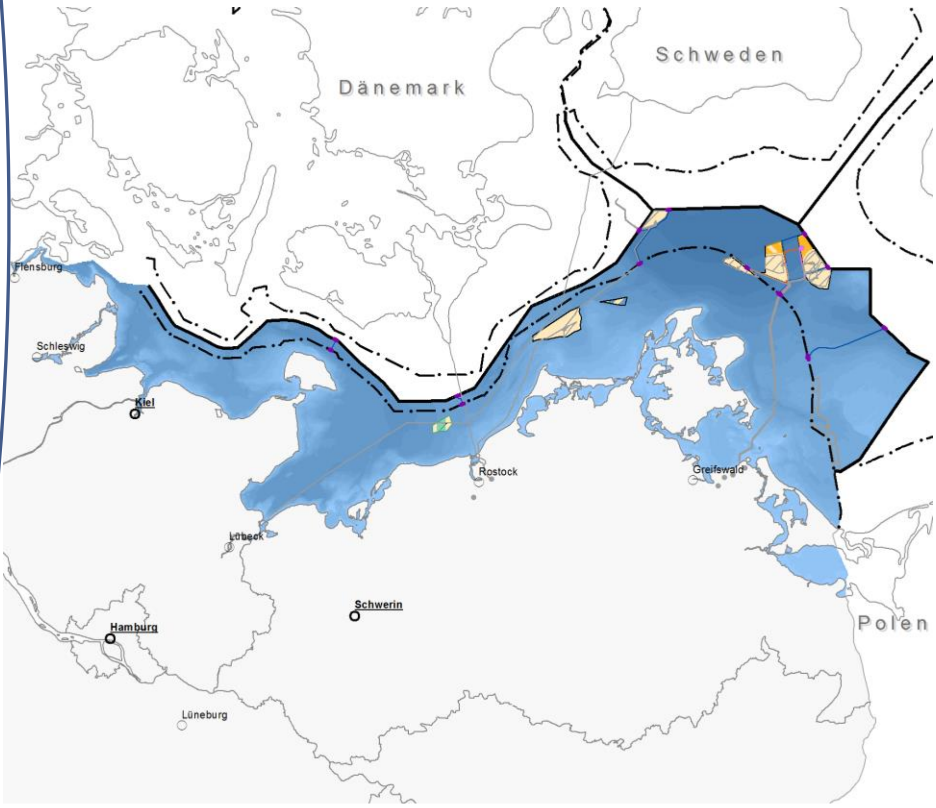
Environmental Report for the Site Development Plan 2019 for the German Baltic Sea

- unofficial translation -



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List of abbreviations

AC	Alternating current
AIS	Automatic Identification System (for ships)
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas
AWI	Alfred Wegener Institute for Polar and Marine Research
BBergG	Federal Mining Act
BfN	Federal Agency for Nature Conservation
BFO	Spatial Offshore Grid Plan
BFO-N	Spatial Offshore Grid Plan North Sea
BFO-O	Spatial Offshore Grid Plan Baltic Sea
BGBI	Federal Law Gazette
BIAS	Baltic Sea Information on the Acoustic Soundscape
BMUB	Federal Ministry for the Environment, Nature Conservation, Construction and Nuclear Safety
BNatSchG	Act concerning nature conservation and landscape management (Federal Nature Conservation Act)
BNetzA	Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railway
BSH	Federal Maritime and Hydrographic Agency
CMS	Convention on the Conservation of Migratory Species of Wild Animals
CTD	Conductivity, Temperature, Depth Sensor
DC	Direct current
DEPONS	Disturbance Effects on the Harbour Porpoise Population in the North Sea
DDT	Dichlorodiphenyltrichloroethane
EEZ	Exclusive Economic Zone
EIA	Environmental impact assessment
EIS	Environmental impact study
EMSON	Recording of marine mammals and seabirds in the German North Sea and Baltic Sea EEZs
ERASNO	Recording of resting birds in the German North Sea and Baltic Sea EEZs
EnWG	Act concerning electricity and gas supply (German Energy Act)
EUROBATS	Agreement on the Conservation of Populations of European Bats
FEP	Site Development Plan
FFH	Flora Fauna Habitat
FFH-RL	Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (Habitats Directive)
FFH-VP	Compatibility testing according to Art. 6 subsection 3 of the Habitats Directive or section 34 of the Federal Nature Conservation Act
FPN	North Sea Research Platform
HELCOM	Helsinki Convention
HCB	Hexachlorobenzene
IBA	Important bird area
ICES	International Council for the Exploration of the Sea

IfAÖ	Institute for Applied Ecosystem Research
IHC NMS	Noise mitigation System from IHC
IOW	Leibniz Institute for Baltic Sea Research, Warnemünde
IUCN	International Union for Conservation of Nature and Natural Resources
IWC	International Whaling Commission
K	Kelvin
CI	Confidence interval
kn	Knots
LRT	Habitat type according to the Habitats Directive
MARNET	Automated monitoring network of stations in the German Bight and western Baltic Sea
MARPOL	International Convention for the Prevention of Pollution from Ships
MINOS	Marine warm-blooded animals in the North and Baltic Seas: Foundations for assessment of offshore wind farms
MSRL	Directive 2008/56/EC of the European Parliament and the Council dated 17 June 2008 for the establishment of a Framework for Community Action in the field of Marine Environment (Marine Strategy Framework Directive)
NAO	North Atlantic Oscillation
n.m.	Nautical mile
NN	Sea level
O-NDP	Offshore network development plan
OSPAR	Oslo-Paris Agreement
OWP	Offshore wind farm
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyl
POD	Porpoise Click Detector
PSU	Practical Salinity Units
R&D	Research and Development
RL	Red List
SAMBAH	Static Acoustic Monitoring of the Baltic Sea Harbour Porpoise
SCANS	Small Cetacean Abundance in the North Sea and Adjacent Waters
SeeAnlV	Ordinance concerning offshore installations for defining German coastal waters (Offshore Installations Ordinance)
SEL	Sound event level
SPA	Special Protected Area
SPEC	Species of European Conservation Concern (important species for bird conservation in Europe)
SPLp-p	Peak emission sound pressure level (peak-peak)
StUK4	Standard "Investigation into the impacts of offshore wind turbines"
StUKplus	"Accompanying ecological research at the alpha ventus offshore test area project"
SEA	Strategic environmental assessment

1 Introduction

1.1 Legal basis and tasks of the environmental assessment

According to section 4ff. of the Offshore Wind Energy Act (Windenergie-auf-See-Gesetz, WindSeeG[1]), the Federal Maritime and Hydrographic Agency (Bundesamt für Seeschiffahrt und Hydrographie, BSH) is compiling a Site Development Plan (SDP) in agreement with the Federal Network Agency (Bundesnetzagentur, BNetzA) and in coordination with the Federal Agency for Nature Conservation (Bundesamt für Naturschutz, BfN), Generaldirektion Wasserstrassen und Schifffahrt (GDWS, the Directorate-General for Waterways and Shipping) and the coastal states. The Site Development Plan will be established for the first time and must be announced by 30 June 2019 in accordance with section 6, subsection 8 of the Offshore Wind Energy Act. An environmental assessment was carried out during the preparation of the Site Development Plan in accordance with the Environmental Impact Assessment Act (Umweltverträglichkeitsprüfungsgesetz, UVPG)[2]. This is known as the Strategic Environmental Assessment (SEA).

The implementation of an SEA with the preparation of an environmental assessment is governed by section 35 subsection 1 no. 1 of the Environmental Impact Assessment Act in conjunction with no. 1.17 of Annex 5, as site development plans are subject to the SEA obligation according to section 5 of the Offshore Wind Energy Act.

According to Art. 1 of the SEA Directive 2001/42/EC, the objective of the SEA is to ensure a high level of environmental protection in order to promote sustainable development, and thereby to contribute to ensuring that environmental considerations are taken into account in an appropriate manner well in advance of concrete project planning when plans are compiled and adopted. The SEA has the task of identifying, describing and evaluating the likely significant environmental effects of the implementation of the plan. It serves as an effective environmental precaution in accordance with the applicable laws and is implemented according to consistent principles, and with public participation. All factors in accordance with section 2 subsection 1 of the Environmental Impact Assessment Act must be considered:

- Human beings, in particular human health,
- Fauna, flora and biodiversity,
- Area, soil, water, air, climate and landscape,
- Cultural heritage and other material assets, and
- Interrelationships between the above-mentioned factors.

The main content document of the SEA is this environmental report. This identifies, describes and assesses the likely significant environmental impact of the implementation of the Site Development Plan, as well as possible planning alternatives, taking into account the essential purposes of the plan.

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[1] Offshore Wind Energy Act of 13 October 2016 (Federal Law Gazette I p. 2258, 2310), as last amended by Article 21 of the Act of 13 May 2019 (Federal Law Gazette I p. 706).

[2] Environmental Impact Assessment Act in the version published on 24 February 2010 (Federal Law Gazette I p. 94), as last amended by Article 22 of the Act of 13 May 2019 (Federal Law Gazette I p. 706).

1.2 Brief description of the content and most important objectives of the Site Development Plan

According to section 4 subsection 1 WindSeeG, it is the purpose of the Site Development Plan (FEP) to draw up planning rules for the exclusive economic zone (EEZ) of the Federal Republic of Germany.

Section 4 subsection 2 WindSeeG stipulates that, for the expansion of offshore wind turbines and the offshore connecting cables required for this, the Site Development Plan draws up rules with the aim of

- achieving the expansion target according to section 4 no. 2b of the Renewable Energy Sources Act (EEG)[3].
- expanding the power generation from offshore wind turbines in a spatially ordered and compact fashion, and
- ensuring an ordered and efficient utilisation and loading of the offshore connecting cables, and planning, installation, commissioning and use of offshore connecting cables in parallel with the expansion of power generation from offshore wind turbines.

According to the statutory mandate of section 5 subsection 1 of the Offshore Wind Energy Act, the Site Development Plan contains provisions for the period from 2026 to at least 2030 for the German EEZ and in accordance with the following provisions for coastal waters:

1. areas; in the coastal waters, areas may only be defined if the country responsible has concluded an administrative agreement with the Federal Maritime and Hydrographic Agency pursuant to section 4 subsection 1 p. 3 WindSeeG and the areas have been designated as possible subjects of the Site Development Plan,
2. sites in areas specified according to point 1,
3. the chronological order in which the specified sites are put out to tender according to part 3 section 2 of WindSeeG, including the specification of respective calendar years,
4. the calendar years in which the allocated offshore wind turbines and the corresponding offshore connecting cables are to be commissioned in each of the specified sites,

[3] "Renewable Energy Sources Act (EEG) of 21 July 2014 (Federal Law Gazette I p. 1066), last amended by Article 5 of the Act of 13 May 2019 (Federal Law Gazette I p. 706).

5. the expected generation capacity of the offshore wind turbines to be installed in each of the specified areas and sites,
6. locations of converter platforms, collector platforms and, as far as possible, transformer platforms,
7. routes or route corridors for offshore connecting cables,
8. places at which the offshore connecting cables cross the border between the EEZ and coastal waters,
9. routes or route corridors for border-crossing power cables,
10. routes or route corridors for possible interconnections of the plants, routes or route corridors listed in points 1, 2, 6, 7 and 9, and
11. standardised technical and planning principles.

In the period starting from 2021, the Site Development Plan can identify available grid connection capacities in existing, or in the following years yet to be completed, offshore connecting cables in areas inside the German EEZ and in coastal waters, which may be assigned to pilot offshore wind turbines in accordance with section 70 subsection 2 of the Offshore Wind Energy Act. The Site Development Plan may provide spatial specifications for the installation of pilot offshore wind turbines in certain areas, and designate the technical conditions of the offshore connecting cable and the resulting technical prerequisites for the grid connection of pilot offshore wind turbines.

1.3 Tiered planning procedures – relationship to other relevant plans, programmes and projects (environmental assessment at the appropriate planning level)

1.3.1 Introduction

Within the framework of the central model, the Site Development Plan is the control instrument for orderly expansion of offshore wind energy in a staged planning process. The SEA for the Site Development Plan is related to upstream and downstream environmental assessments.

In the overall view of the central model, the planning process for the EEZ is divided into several stages:

The maritime spatial planning instrument is at the highest and primary level. The Spatial Plan is the forward-looking planning instrument that coordinates the various usage interests in the fields of economy, science and research, as well as protection claims. An SEA is to be carried out when the Spatial Plan is compiled.

The next level is the Site Development Plan. The Site Development Plan takes the form of a sectoral planning procedure. As an important control instrument, the sectoral plan is designed to plan the use of offshore wind energy in a targeted and optimal manner under the given framework conditions – in particular the requirements of spatial planning – by defining areas and sites as well as locations, route corridors and routes for grid connections and interconnectors. An SEA is carried out in parallel with the establishment of the Site Development Plan.

In the next step, the sites defined in the Site Development Plan for offshore wind turbines undergo preliminary investigation. The preliminary investigation will be followed by determination of the suitability of the area for the construction and operation of offshore wind turbines if the requirements of section 12 subsection 2 of the Offshore Wind Energy Act are met. An SEA is also carried out together with the site investigation.

If a site is deemed suitable for the use of offshore wind energy, the site is put up for tender and the winning bidder can apply for approval (planning permission or planning approval) for the construction and operation of offshore wind turbines on the site. As part of the planning approval procedure, an environmental impact assessment is carried out if the conditions are met.

While the sites defined in the Site Development Plan for the use of offshore wind energy undergo preliminary investigation and are put out for tender, this is not the case for established sites, route corridors and routes for grid connections or interconnectors. On application, a planning approval procedure and an environmental assessment are usually carried out for the construction and operation of grid connecting lines. The same applies to interconnector.

According to section 1 subsection 4 of the Environmental Impact Assessment Act, the Environmental Impact Assessment Act also applies insofar as federal or state regulations do not specify the environmental impact assessment in more detail or do not observe the essential requirements of the Environmental Impact Assessment Act.

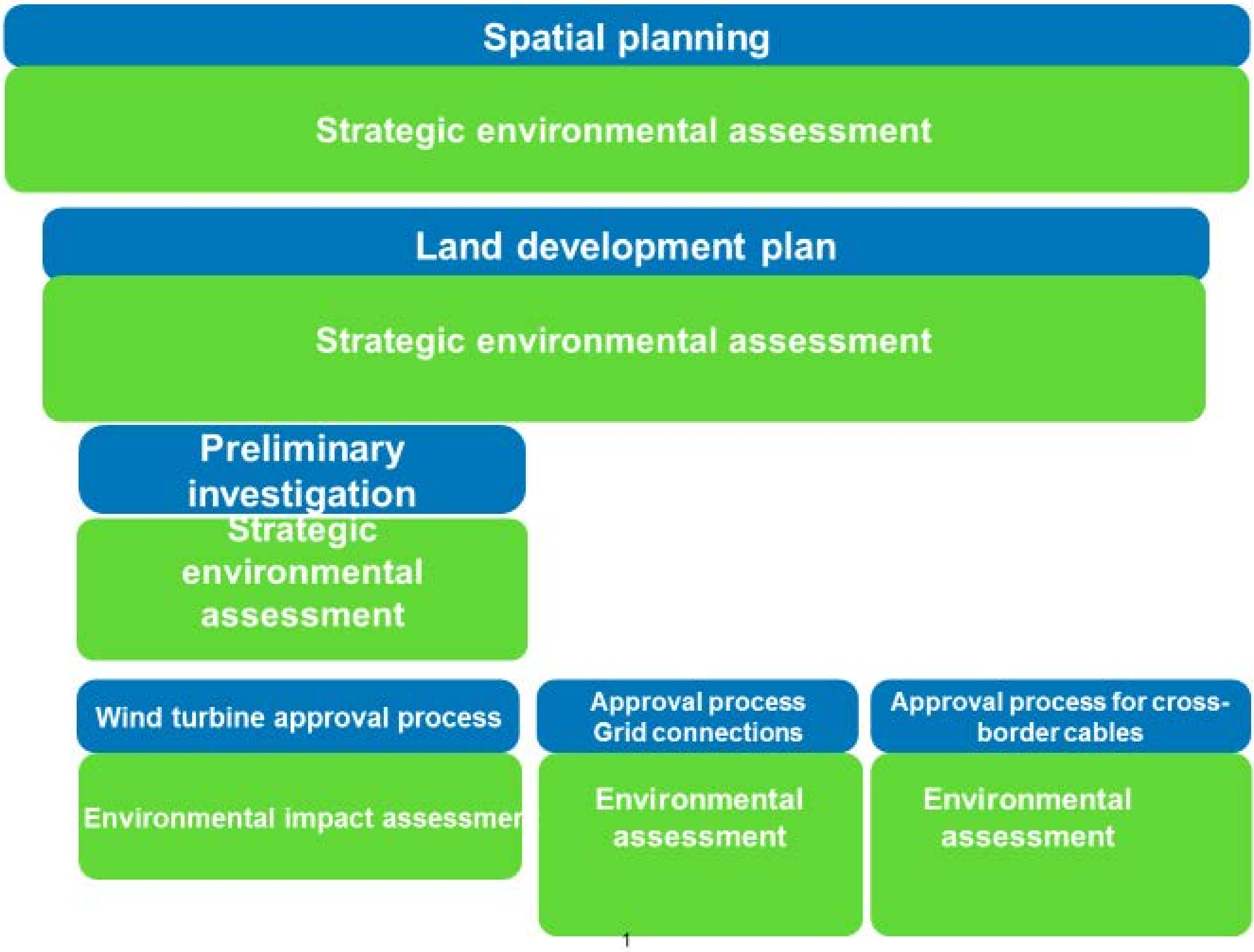

Figure 1: Overview of the staged planning and approval process in the central model.

For further details, please refer to chapter 2 of the Site Development Plan.

In the case of multi-stage planning and approval processes, it follows from the respective technical legislation (e.g. the Federal Spatial Planning Act, the Offshore Wind Energy Act and the Federal Mining Act) or, more generally, from section 39 subsection 3 of the Environmental Impact Assessment Act that, in the case of plans, the stages of the process at which particular environmental impacts are primarily to be assessed should be determined when the investigation framework is established. The aim of this is to prevent duplication of checks. The nature and scope of the environmental effects, technical requirements and the content and subject matter of the plan are to be taken into account in this regard.

In the case of subsequent plans and subsequent approvals of projects for which the plan provides a framework, the environmental assessment pursuant to section 39 subsection 3 sentence 3 of the Environmental Impact Assessment Act will be limited to additional or other significant environmental impacts, as well as to necessary updates and further details.

Within the framework of the staged planning and approval process, all tests have in common the fact that environmental impacts on the protected assets listed in section 2 subsection 1 of the

Environmental Impact Assessment Act, including their interactions, are considered.

According to the definition found in section 2 subsection 2 of the Environmental Impact Assessment Act, environmental impacts in the sense of the Environmental Impact Assessment Act are direct and indirect effects of a project or the implementation of a plan or programme on the protected assets.

According to section 3 UVPG, environmental assessments comprise the identification, description and assessment of the significant effects of a project or a plan or programme on the factors. They serve as an effective environmental precaution in accordance with the applicable laws and are implemented according to consistent principles, and with public participation.

In the offshore sector, the following components of the ecosystem have been established as subcategories of the legally protected assets animals, plants and biodiversity:

- Plankton
- Benthos
- Biotopes
- Fish
- Marine mammals
- Avifauna: resting birds and migratory birds
- Bats.

Within the scope of the environmental assessment, the ecosystem components referred to here are considered in detail so as to take into account the special characteristics and protection requirements of the respective elements with the necessary degree of detail.

Overview of factors

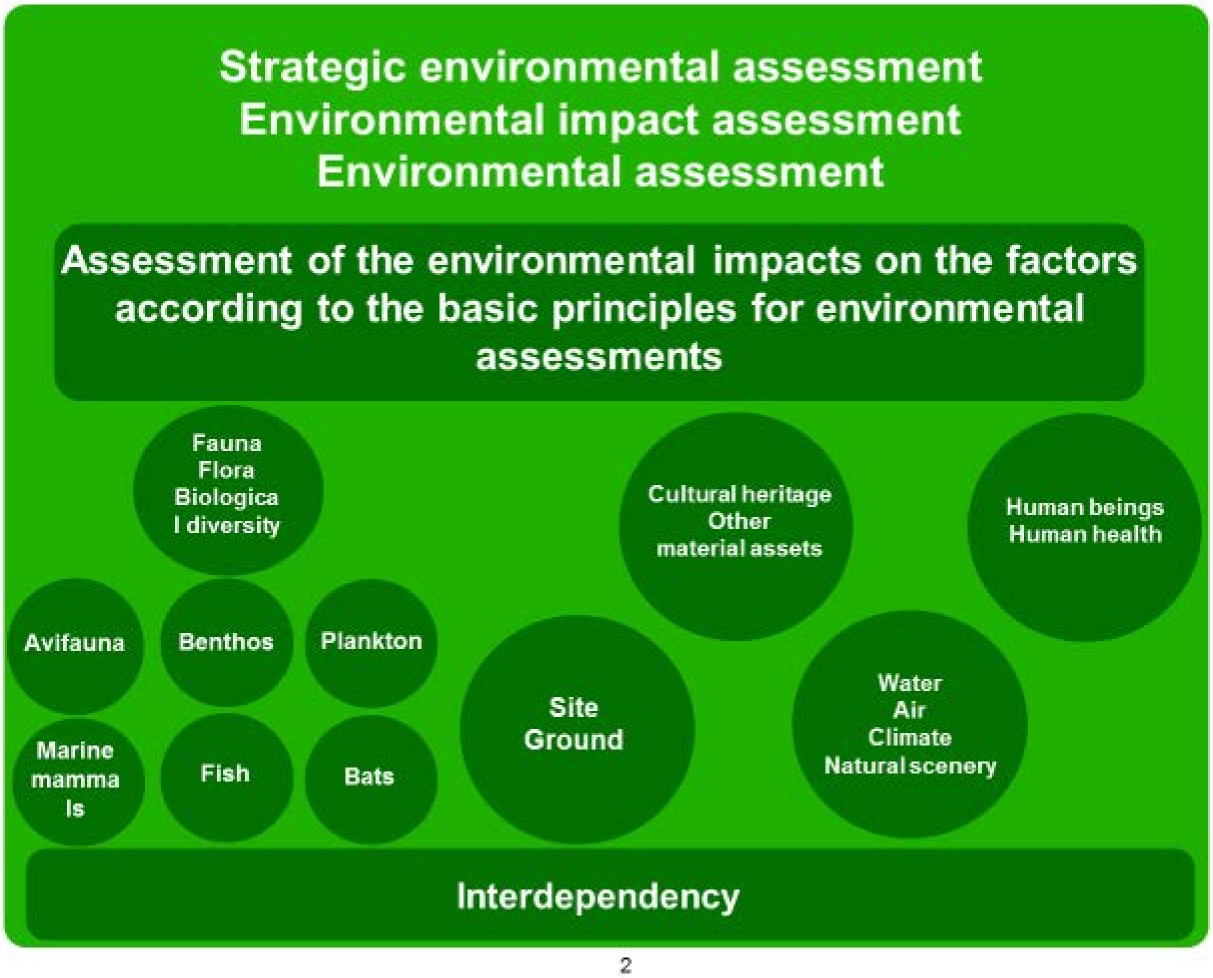

Figure 2: Overview of the protected assets in the environmental assessments.

In detail, the staged planning process is as follows:

1.3.2 Maritime spatial planning (EEZ)

The Maritime Spatial Planning instrument is at the highest and primary level. To achieve sustainable spatial planning in the EEZ, the Federal Maritime and Hydrographic Agency, by order of the competent federal ministry prepares Spatial Plans that come into force in form of ordinances. The Ordinance of (what was then) the Federal Ministry of Spatial Planning, Building and Urban Development (BMVBS) on the Maritime Spatial Plan for the German Exclusive Economic Zone in the North Sea (AWZ Nordsee-ROV) of 21 September 2009, Federal Law Gazette I p. 3107, came into force on 26 September 2009, and the Ordinance for the Spatial Offshore Grid Plan for the German Exclusive Economic Zone of the Baltic Sea (AWZ Ostsee-ROV) of 10 December 2009, Federal Law Gazette I p. 3861, came into force on 19 December 2009.

Taking into account any interactions between land and sea and safety aspects, the spatial development plans should define **specifications**

- for ensuring the safety and ease of movement of shipping traffic
- for further economic uses,
- for scientific uses and
- for the protection and improvement of the marine environment.

Within the framework of spatial planning, specifications are mainly defined in terms of priority and restricted areas, as well as objectives and principles. According to section 8 subsection 1 of the Federal Spatial Planning Act[4], when compiling spatial development plans, the body responsible for the spatial development plan shall conduct an SEA to identify, describe and assess the likely significant impacts of the spatial development plan in question on the protected assets, including their interactions, are to be identified, described and assessed.

The **objective** of the spatial planning instrument is to optimise overall planning solutions. A wider range of uses is considered. Strategic fundamental issues must be clarified at the start of a planning process. Thus, the instrument functions primarily as a controlling planning instrument for the planning administrative bodies so as to create an environmentally appropriate framework for all uses.

In the case of spatial planning, the **depth of investigation** is generally characterised by a wider scope of investigation, i.e. a generally larger number of alternatives, and a lower depth of investigation in the sense of detailed analyses. The main impacts taken into account are local, national and global impacts as well as secondary, cumulative and synergetic effects.

The **focus** of the SEA is therefore on possible cumulative effects, strategic and large-scale alternatives and possible transboundary impacts.

1.3.3 Land development plan

The next level is the Site Development Plan.

The **provisions** to be made by the Site Development Plan and reviewed in the context of the SEA are derived from section 5 subsection 1 of the Offshore Wind Energy Act. The plan mainly specifies areas and sites for wind turbines, as well as the expected generation capacity on the sites. The Site Development Plan also defines routes, route corridors and locations. Planning and technical principles are also established. Although these also serve to reduce environmental impacts, among other things, they may also lead to impacts. So, a review within the framework of the SEA is necessary.

Moreover, the Site Development Plan defines specifications in terms of time, such as by determining the chronological order in which the sites for offshore wind energy are to be put out to tender and the calendar years for commissioning. These are not a focal point of the assessment as they have no further environmental impacts in respect of the spatial specifications.

[4] Federal Regional Planning Act of 22 December 2008 (Federal Law Gazette I p. 2986), as last amended by Article 2 subsection 15 of the Act of 20 July 2017 (Federal Law Gazette I p. 2808).

The Site Development Plan content that must be defined is described in greater detail in chapters 1.4 and 4.8 of the Site Development Plan.

The Site Development Plan specifications must be permissible in accordance with the requirements of section 5 of the Offshore Wind Energy Act. According to section 5 subsection 3 sentence 2 no. 2 of the Offshore Wind Energy Act, specifications are inadmissible in particular if they conflict with overriding public or private interests. In the context of the SEA, this means that the specifications to be assessed are inadmissible, in particular, if they

- endanger the marine environment or,
- pursuant to section 5 subsection 3 sentence 2 no. 5 of the Offshore Wind Energy Act, in the case of the designation of an or a site, are located within a conservation area designated pursuant to section 57 of the Federal Nature Conservation Act, or
- are located outside clusters 1 to 8 in the North Sea and clusters 1 to 3 in the Baltic Sea as defined by the Spatial Offshore Grid Plan pursuant to section 17a of the Energy Industry Act[5].

Something different only applies if sufficient areas and sites are specified in these clusters in order to achieve the expansion target according to section 4 no. 2b of the Renewable Energy Sources Act.

According to section 40 subsection 1 sentence 2 of the Environmental Impact Assessment Act, the environmental report must identify, describe and evaluate the likely significant environmental impacts due to implementation of the plan, as well as reasonable alternatives. According to section 40 subsection 3 of the Environmental Impact Assessment Act, the competent authority provisionally assesses in its environmental report the environmental impacts of the plan on the protected assets in accordance with the principles of the environmental assessment. The standards of the legislation and the Environmental Impact Assessment Act are essentially the same, as the environmental impacts in the environmental assessments are evaluated in accordance with the applicable laws.

As the Site Development Plan is continuing the task of Federal Offshore Planning pursuant to section 17a of the Energy Industry Act, the SEA builds on the assessments already implemented for the preparation and updating of the Spatial Offshore Grid Plans. Reference is therefore made to the environmental reports, in particular the latest Spatial Offshore Grid Plan 2016/2017 for the Baltic Sea EEZ[6].

With regard to the **objectives** of the Site Development Plan, the Site Development Plan deals with the basic issues for the use of offshore wind energy and grid connections based on the legal requirements, mainly according to the need, the purpose, the technology and the identification of locations and routes or route corridors. Thus, the primary function of the plan is to serve as a controlling planning instrument in order to create an environmentally sound framework for the implementation of individual projects, i.e. the construction and operation of offshore wind turbines, their grid connections, Interconnectors and interconnections.

[5] Energy Industry Act from 7 July 2005 (Federal Law Gazette I p. 1970, 3621), as last amended by Article 1 of the Act of 13 May 2019 (Federal Law Gazette I p. 706).

[6] https://www.bsh.de/DE/THEMEN/Offshore/Meeresfachplanung/Bundesfachplaene_Offshore/bundesfachplaene-offshore_node.html.

The **depth of the assessment** of likely significant environmental impacts is characterised by a wider scope of investigation, i.e. a larger number of alternatives and, in principle, a lower depth of investigation. At the sectoral planning level, no detailed analyses are being carried out as yet. The main impacts taken into account are local, national and global impacts as well as secondary, cumulative and synergetic effects in the sense of an overall assessment.

As with the maritime spatial planning instrument, the assessment **focuses** on possible cumulative effects and possible transboundary impacts. Moreover, the Site Development Plan focuses on strategic, technical and spatial alternatives, particularly for wind energy and power line applications.

1.3.4 Site investigation

The next step in the staged planning process is to perform a preliminary investigation of sites for offshore wind turbines. The Federal Maritime and Hydrographic Agency is working on behalf of the Federal Network Agency in accordance with the administrative agreement of March 2017 and investigating sites which the Site Development Plan is defining in the area of the EEZ.

The preliminary investigation of the sites defined in the Site Development Plan is taking place with the **objective** of providing bidders with the information necessary for competitive determination of the market premium pursuant to section 22 of the Renewable Energy Sources Act for Federal Network Agency tenders pursuant to sections 16 ff. of the Offshore Wind Energy Act. The suitability of the site is being determined and individual objects of investigation are being assessed in advance so as to accelerate the subsequent planning permission procedure in these sites. Moreover, the capacity to be installed is being determined on the site in question.

With regard to environmental concerns, section 10 subsection 1 sentence 1 no. 1 of the Offshore Wind Energy Act stipulates that the investigations of the marine environment required for an environmental impact assessment (EIA) in the planning permission procedure following the invitation to tender pursuant to section 45 of the Offshore Wind Energy Act for the construction of offshore wind turbines in this site are to be carried out and documented, and can be carried out irrespective of the later design of the project. The objective of the preliminary studies is, in particular, to describe and evaluate the environment and its components by means of

- stock characterisation
- the description of existing pollution, and
- stock assessment.

Furthermore, according to section 10 subsection 1 sentence 1 nos. 2 and 3 of the Offshore Wind Energy Act, a preliminary geotechnical survey is being carried out and documented, and reports are being prepared on the wind and oceanographic conditions for the site to be investigated.

According to section 10 subsection 1 sentence 2 of the Offshore Wind Energy Act, the investigations referred to in sentence 1 are to be performed in accordance with the state of the art in science and technology. According to section 10 subsection 1 sentence 3 of the Offshore Wind Energy Act, this is presumed to be the case if the investigation of the marine environment has been carried out in compliance with the applicable standard "Untersuchung der Auswirkungen von Offshore-Windenergieanlagen auf die Meeresumwelt" (StUK, Standard investigation of the effects of offshore wind turbines on the marine environment) or the preliminary geotechnical survey has been carried out in compliance with the applicable standard "Geotechnical survey – Minimum requirements for geotechnical surveys and investigations into offshore wind energy structures, offshore stations and power cables".

When determining suitability, there will be examination pursuant to section 10 subsection 2 of the Offshore Wind Energy Act to ensure that the criteria for the inadmissibility of the determination of a site in the spatial development plan pursuant to section 5 subsection 3 of the Offshore Wind Energy Act or, insofar as they can be assessed independently of the later design of the project, the interests relevant for the planning approval pursuant to section 48 subsection 4 sentence 1 of the Offshore Wind Energy Act do not conflict with the construction and operation of offshore wind turbines on the site.

Both the criteria of section 5 subsection 3 of the Offshore Wind Energy Act and the requirements of section 48 subsection 4 sentence 1 of the Offshore Wind Energy Act require assessment of whether the marine environment is endangered. With regard to the latter, it is necessary in particular to verify that pollution of the marine environment as defined in Article 1 subsection 1 no. 4 of the United Nations[7] Convention on the Law of the Sea is not a concern and that bird migration is not endangered.

The preliminary investigation is thus the instrument between the Site Development Plan and the individual approval procedure for offshore wind turbines. It refers to a specific site designated in the Site Development Plan and is therefore much more fragmented than the Site Development Plan. In contrast to the individual approval procedure, on the other hand, it is delimited by the fact that an assessment approach must be applied regardless of system type and layout.

Compared to the Site Development Plan, the SEA's **depth of assessment** for the suitability assessment is thus characterised by a smaller assessment area and a greater depth of investigation. In principle, the alternatives being seriously considered are smaller in terms of both space and number. The two primary alternatives are the determination of the suitability of a site and the determination of its unsuitability (see section 12 subsection 6 of the Offshore Wind Energy Act). However, the suitability assessment may also include specifications for the later project, in particular regarding the type and extent of development of the site and its location, if the construction and operation of offshore wind turbines would otherwise lead to impairments of the criteria pursuant to section 10 subsection 2 of the Offshore Wind Energy Act.

The **focus** of the environmental assessment is thus on the consideration of local impacts in relation to the site and its location.

1.3.5 Approval procedure (planning approval and planning permission procedure) for offshore wind turbines

The next stage after the preliminary assessment is the approval procedure for the construction and operation of offshore wind turbines. After the Federal Network Agency has invited tenders for the site considered during the preliminary investigation, the winning bidder may – with the awarding of the contract by the Federal Network Agency pursuant to section 46 subsection 1 of the Offshore Wind Energy Act – submit an application for planning permission or, if the conditions for planning permission are met, for the construction and operation of offshore wind turbines, including the necessary ancillary installations, on the site considered during the preliminary investigation.

In addition to the statutory specifications of section 73 subsection 1 sentence 2 of the

[7] Convention on the Law of the Sea of 10 December 1982, promulgated by the treaty law Convention on the Law of the Sea of 2 September 1994, Federal Law Gazette 1994 II p. 1798.

Administrative Procedure Act[8], the plan must include the information contained in section 47 subsection 1 of the Offshore Wind Energy Act. The plan may be adopted only under certain conditions as listed in section 48 subsection 4 of the Offshore Wind Energy Act, and only if the marine environment is not endangered, in particular if pollution of the marine environment within the meaning of Article 1 subsection 1 no. 4 of the Convention on the Law of the Sea is not a concern and bird migration is not endangered.

The responsible authority draws up a summary in accordance with section 24 UVPG (Environmental Impact Assessment Act)

- of the environmental impacts of the project,
- the characteristics of the project and site, the effect of which is to exclude, mitigate or offset significant adverse environmental impacts,
- the measures with which significant adverse environmental impacts are to be excluded, reduced or offset, as well as
- substitution measures for interventions in nature and the landscape.

According to section 16 subsection 1 of the Environmental Impact Assessment Act, the project developer must submit a report to the competent authority on the likely environmental impacts of the project (EIA report) which includes the following information as a minimum:

- a description of the project, with details on the location, type, extent and design, size and other essential characteristics of the project,
- a description of the environment and its components within the scope of the project,
- a description of the features of the project and the site, with a view to eliminating, reducing or compensating for the occurrence of significant adverse environmental impacts of the project,
- a description of the measures planned for eliminating, reducing or compensating for the occurrence of significant adverse environmental impacts of the project, and a description of any substitution measures planned,
- a description of the expected significant environmental impacts of the project,
- a description of the reasonable alternatives that are relevant to the project and its specific characteristics and have been assessed by the project developer, and an indication of the main reasons for the choice made, taking into account their environmental impacts, and
- a generally comprehensible, non-technical summary of the EIA report.

Pilot offshore wind turbines are processed exclusively within the framework of the environmental assessment in the approval procedure, and not at upstream stages.

1.3.6 Approval procedure for grid connections (converter platforms and submarine cable systems)

In the staged planning process, the construction and operation of grid connections for offshore wind turbines (converter platform and submarine cable systems, where applicable) are assessed at the approval procedure stage (planning permission and planning approval procedure) at the request of the relevant project developer, i.e. the responsible TSO (Transmission System Operator), in implementation of the Maritime Spatial Planning specifications and the Site Development Plan specifications.

[8] Administrative Procedure Act as amended by the announcement of 23 January 2003 (Federal Law Gazette I p. 102), as last amended by Article 7 of the Act of 18 December 2018 (Federal Law Gazette I p. 2639).

According to section 44 subsection 1 in conjunction with section 45 subsection 1 of the Offshore Wind Energy Act, the construction and operation of facilities for the transmission of electricity would require planning approval. In addition to the statutory specifications of section 73 subsection 1 sentence 2 of the Administrative Procedure Act, the plan must include the information contained in section 47 subsection 1 of the Offshore Wind Energy Act. The plan may only be adopted under certain conditions as listed in section 48 subsection 4 of the Offshore Wind Energy Act, and only if the marine environment is not endangered, in particular if pollution of the marine environment within the meaning of Article 1 subsection 1 no. 4 of the Convention on the Law of the Sea is not a concern and bird migration is not endangered.

Furthermore, according to section 1 subsection 4 of the Environmental Impact Assessment Act, the requirements for the environmental impact assessment for offshore wind turbines, including ancillary installations, apply accordingly to the performance of the environmental assessment.

1.3.7 Interconnectors

According to section 133 subsection 1 in conjunction with subsection 4 of the Federal Mining Act[9]**,** the construction and operation of a submarine cable in or on the continental shelf is subject to approval

- in respect of mining (by the competent State Mining Agency) and
- with regard to the arrangement of use and occupation of the waters above the continental shelf and the airspace above such waters (by the Federal Maritime and Hydrographic Agency).

Under section 133 subsection 2 of the Federal Mining Act, the above permits may only be withheld if there is a threat to the life or health of persons or property, or impairment of overriding public interests that cannot be prevented or offset by a time limit, conditions or requirements. In particular, impairment of overriding public interests exists in the cases referred to in section 132 subsection 2 no. 3 of the Federal Mining Act. According to section 132 subsection 2 no. 3 b) and d) of the Federal Mining Act, there is in particular impairment of overriding public interests with regard to the marine environment if the flora and fauna are impaired in an unacceptable manner or if pollution of the sea is a concern.

According to section 1 subsection 4 of the Environmental Impact Assessment Act, the essential requirements of the Environmental Impact Assessment Act must be observed for the construction and operation of transboundary submarine cable systems.

[9] Federal Mining Act of 13 August 1980 (Federal Law Gazette I p. 1310), last amended by Article 2 section 4 of the Act of 20 July 2017 (Federal Law Gazette I p. 2808).

1.3.8 Summary overviews of environmental assessments

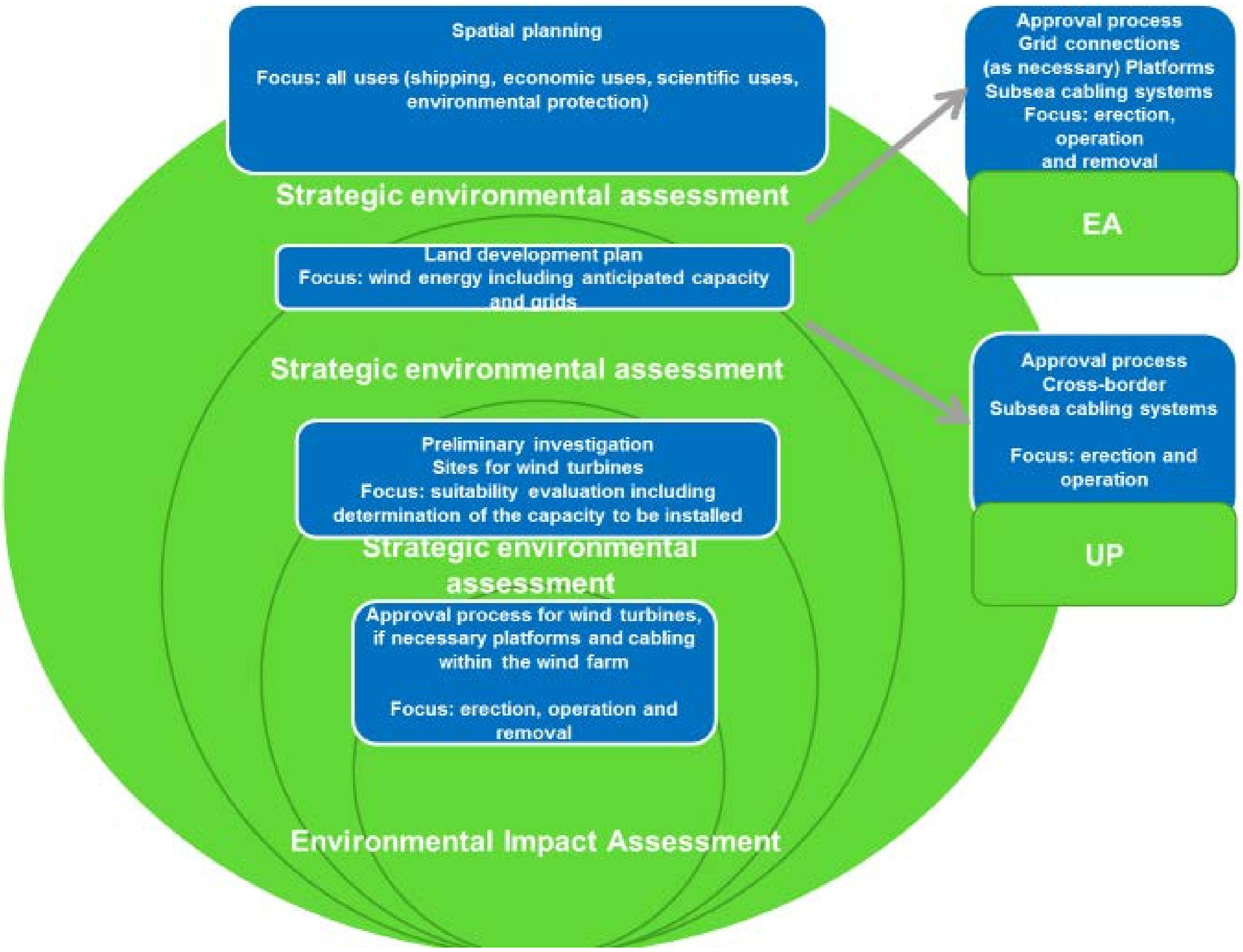

Figure 3: Environmental assessments in the staged planning and approval process, with emphasis on the assessment in question.

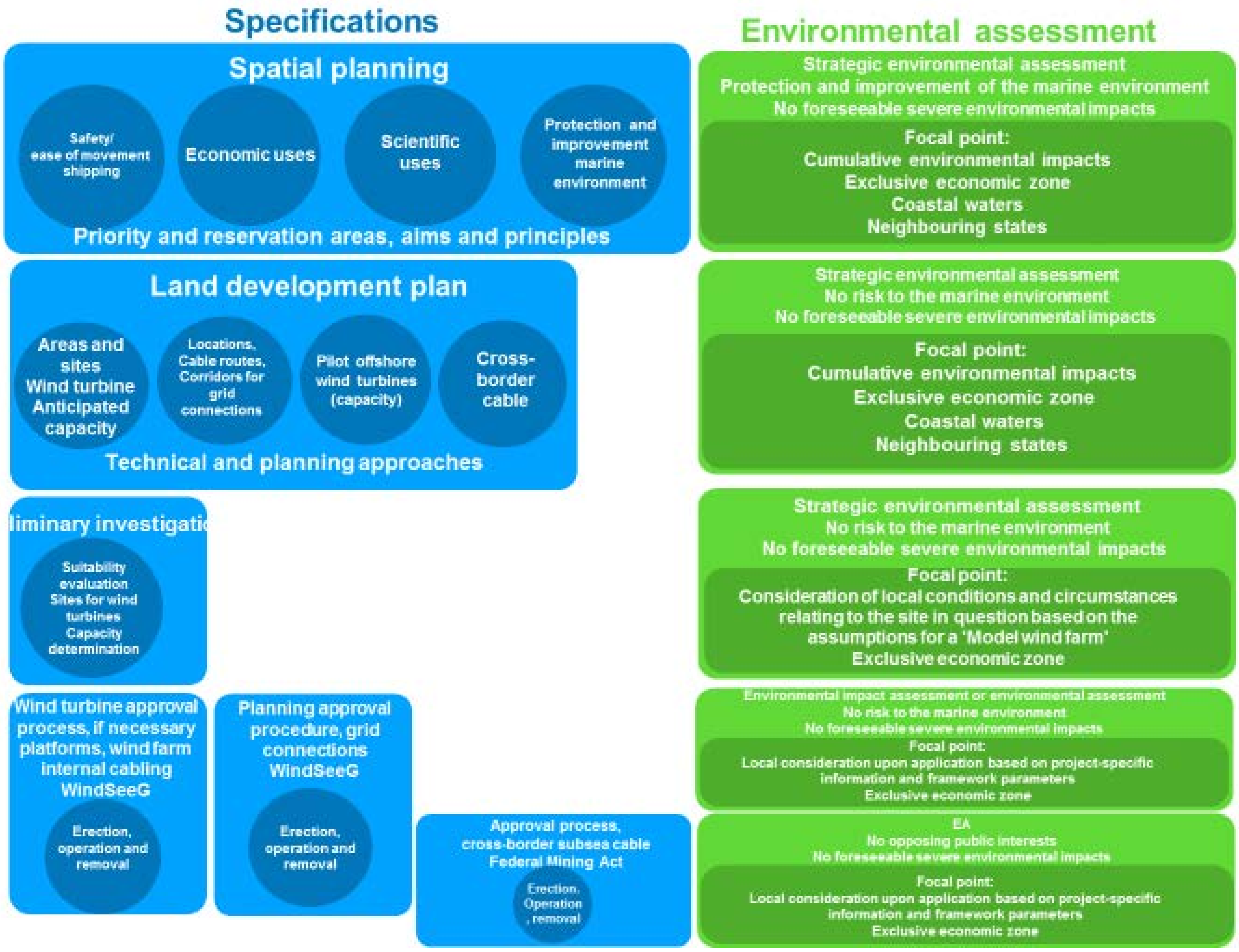

Figure 4: Object of the planning and approval procedures, with emphasis on environmental assessment.

Raumordnung SUP	FEP SUP	Voruntersuchung SUP Eignungsprüfung	Zulassungsverfahren (Planfeststellung bzw. Plangenehmigung) Netzanbindungen UP	Genehmigungsverfahren Grenzüberschreitende Seekabelsysteme UP
ategische Planung für die Festlegungen	Strategische Planung für die Festlegungen	Strategische Eignungsfeststellung für Flächen mit WEA	Umweltprüfung Antrag auf	Umweltprüfung Antrag auf
Festlegungen und Prüfungsgegenstand				
g- und Vorbehaltsgebiete Gewährleistung der Sicherheit und Leichtigkeit des ffsverkehrs, eiteren wirtschaftlichen Nutzungen, insbesondere hore-Windenergie und Rohrleitungen issenschaftlichen Nutzungen sowie : und zur Verbesserung der Meeresumwelt nd Grundsätze dung des Ökosystemansatzes	• Gebiete für Windenergieanlagen auf See • Flächen für Windenergieanlagen auf See, einschl. der voraussichtlich zu installierenden Leistung • Standorte Plattformen • Trassen- und Trassenkorridore für Seekabelsysteme • Technik- und Planungsgrundsätze	• Prüfung der Eignung der Fläche für die Errichtung und den Betrieb von Windenergieanlagen, einschließlich der zu installierenden Leistung • Auf Grundlage der eingereichten und erhobenen Daten (STUK)	• die Errichtung und den Betrieb von Plattformen und Anbindungsleitungen • nach den Vorgaben der Raumordnung und des Flächenentwicklungsplans	• die Errichtung und den Betrieb von grenzüberschreitenden Seekabelsystemen • nach den Vorgaben der Raumordnung und des FEP
Analyse Umweltauswirkungen				
iert (ermittelt, beschreibt und bewertet) die sichtlichen erheblichen Auswirkungen des Plans Meeresumwelt.	Analysiert (ermittelt, beschreibt und bewertet) die voraussichtlichen erheblichen Umweltauswirkungen des Plans auf die Meeresumwelt.	Analysiert (ermittelt, beschreibt und bewertet) die voraussichtlichen erheblichen Umweltauswirkungen für die Errichtung und den Betrieb von Windenergieanlagen, die unabhängig von der späteren Ausgestaltung des Vorhabens beurteilt werden können.	Analysiert (ermittelt, beschreibt und bewertet) die Umweltauswirkungen des konkreten Vorhabens (ggf. Plattform und Anbindungsleitung).	Analysiert (ermittelt, beschreibt und bewertet) die Umweltauswirkungen des konkreten Vorhabens.
Zielrichtung				
uf die Optimierung planerischer Gesamtlösungen, mfassender Maßnahmenbündel, ab. htung eines größeren Spektrums an Nutzungen. m Beginn des Planungsprozesses zur Klärung von jischen Grundsatzfragen ein, also zu einem frühen nkt, zu dem noch größerer Handlungsspielraum	Behandelt für die Nutzung Offshore-Windenergie die Grundsatzfragen nach • Bedarf bzw. gesetzlichen Zielen • Zweck • Technologie • Kapazitäten • Findung von Standorten für Plattformen und Trassen.	Behandelt für die Nutzung Windenergieanlagen die Grundsatzfragen nach • Eignung der Fläche Stellt die für die Angebotsabgabe gesetzlich geregelten Informationen über die Fläche zur Verfügung.	Behandelt Fragen nach der konkreten Ausgestaltung („Wie“) eines Vorhabens (technische Ausstattung, Bauausführung – Baufreigaben). Beurteilt die Umweltverträglichkeit des Vorhabens und formuliert dazu Auflagen.	Behandelt Fragen nach der konkreten Ausgestaltung („Wie“) eines Vorhabens (technische Ausstattung, Bauausführung – Baufreigaben). Beurteilt die Umweltverträglichkeit des Vorhabens und formuliert dazu

t.	Sucht nach umweltgerechten Maßnahmenbündeln, ohne die Umweltverträglichkeit der Planung absolut zu beurteilen.	Sucht nach umweltgerechten Maßnahmenbündeln, ohne die Umweltverträglichkeit des konkreten Vorhabens zu beurteilen.		Auflagen.
rt im Wesentlichen als steuerndes gsinstrument der planenden Verwaltungsstellen, inen umweltgerechten Rahmen für sämtliche gen zu schaffen.	Fungiert überwiegend als steuerndes Planungsinstrument, um einen umweltgerechten Rahmen für die Realisierung von Einzelvorhaben (WEA und Netzanbindungen, grenzüberschreitende Seekabel) zu schaffen.	Fungiert als Instrument zwischen FEP und Zulassungsverfahren für Windenergieanlagen auf einer konkreten Fläche.	Fungiert primär als passives Prüfinstrument, das auf Antrag des Vorhabenträgers reagiert.	Fungiert primär als passives Prüfunstrument, das auf Antrag des Vorhabenträgers reagiert.
Prüfungstiefe				
nzeichnet durch größere Untersuchungsbreite, d.h. größere Zahl an Alternativen, und geringere uchungstiefe (keine Detailanalysen) sichtigt raumbezogene, nationale und globale kungen sowie sekundäre, kumulative und etische Auswirkungen im Sinne einer tbetrachtung.	Gekennzeichnet durch größere Untersuchungsbreite, d.h. größere Zahl an Alternativen, und geringere Untersuchungstiefe (keine Detailanalysen) Berücksichtigt lokale, nationale und globale Auswirkungen sowie sekundäre, kumulative und synergetische Auswirkungen im Sinne einer Gesamtbetrachtung.	Gekennzeichnet durch einen kleinräumigeren Untersuchungsraum, größere Untersuchungstiefe (detaillierte Analysen). Die Eignungsfeststellung kann Vorgaben für das spätere Vorhaben beinhalten, insbesondere zu Art und Umfang der Bebauung der Fläche und ihrer Lage auf der Fläche.	Gekennzeichnet durch geringere Untersuchungsbreite (begrenzte Zahl an Alternativen) und größere Untersuchungstiefe (detaillierte Analysen). Beurteilt die Umweltverträglichkeit des Vorhabens und formuliert dazu Auflagen. Berücksichtigt primär lokale Auswirkungen im Nahbereich des Vorhabens.	Gekennzeichnet durch geringere Untersuchungsbreite (begrenzte Zahl an Alternativen) und größere Untersuchungstiefe (detaillierte Analysen). Berücksichtigt primär lokale Auswirkungen im Nahbereich des Vorhabens.
Schwerpunkt der Prüfung				
ative Effekte tplanbetrachtung gische und großräumige Alternativen he grenzüberschreitende Auswirkungen	**Kumulative Effekte** Gesamtplanbetrachtung Strategische, technische und räumliche Alternativen Mögliche grenzüberschreitende Auswirkungen	**Lokale Auswirkungen** bezogen auf die Fläche und deren Lage.	Anlagen-, errichtungs- und betriebsbedingte Umweltauswirkungen Anlagenrückbau Prüfung bezogen auf das konkrete Anlagendesign. Eingriffs-, Ausgleichs- und Ersatzmaßnahmen.	Anlagen-, errichtungs- und betriebsbedingte Umweltauswirkungen Prüfung bezogen auf das konkrete Anlagendesign. Eingriffs-, Ausgleichs- und Ersatzmaßnahmen.
Zulassungsverfahren (Planfeststellung bzw. Plangenehmigung) für WEA **UVP**				
Prüfungsgegenstand				
g der Umweltverträglichkeit auf Antrag für ie Errichtung und den Betrieb von Windenergieanlagen uf der im FEP festgelegten und voruntersuchten Fläche lach den Festlegungen des FEP und Vorgaben der Voruntersuchung.				

I assessments in the planning and approval

Prüfung Umweltauswirkungen
ert (ermittelt, beschreibt und bewertet) die Umweltauswirkungen des konkreten Vorhabens (Windenergieanlagen, ggf. Plattformen und rne Verkabelung). 24 UVPG erarbeitet die zuständige Behörde eine zusammenfassende Darstellung der Umweltauswirkungen des Vorhabens, der Merkmale des Vorhabens und des Standorts, mit denen **erhebliche nachteilige Umweltauswirkungen** ausgeschlossen, vermindert oder ausgeglichen werden sollen, der Maßnahmen, mit denen erhebliche nachteilige Umweltauswirkungen ausgeschlossen, vermindert oder ausgeglichen werden sollen, sowie der Ersatzmaßnahmen bei Eingriffen in Natur und Landschaft (Anmerkung: Ausnahme nach § 56 Abs. 3 BNatSchG)
Zielrichtung
elt die Fragen nach der konkreten Ausgestaltung („Wie“) eines Vorhabens (technische Ausstattung, Bauausführung). t primär als passives Prüfinstrument, das auf Antrag des Ausschreibungsgewinners/Vorhabenträgers reagiert.
Prüfungstiefe
zeichnet durch geringere Untersuchungsbreite, d.h. eine begrenzte Zahl an Alternativen, und größere Untersuchungstiefe (detaillierte n). t die Umweltverträglichkeit des Vorhabens auf der voruntersuchten Fläche und formuliert dazu Auflagen. sichtigt überwiegend lokale Auswirkungen im Nahbereich des Vorhabens.
Schwerpunkt der Prüfung
nwerpunkt der Prüfung bilden: richtungs- und betriebsbedingte Umweltauswirkungen üfung bezogen auf das konkrete Anlagendesign nlagenrückbau.

process.

1.4 Presentation and consideration of environmental protection objectives

The establishment of the Site Development Plan and implementation of the SEA take into account the environmental protection objectives. These provide information on what state of the environment is being sought in the future (environmental quality targets). The environmental protection objectives can be seen in synopsis from the international, common and national conventions and regulations that deal with protection of the marine environment and on the basis of which the Federal Republic of Germany has committed itself to certain principles and objectives.

1.4.1 International conventions on the protection of the marine environment

The Federal Republic of Germany is a party to all relevant international conventions on protection of the marine environment.

1.4.1.1 Conventions in force throughout the world that serve to protect the marine environment in whole or in part

- Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter from 29 December 1972 (London Convention) and Protocol, 1996 (London Protocol)

The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter of 29 December 1972 [10] includes the dumping of waste and other material from ships, aircraft and offshore platforms. While the London Convention of 1972 only provides for bans on the import of certain substances (black list), the 1996 [11] Protocol provides for a general ban on imports. Exemptions from this ban are only permitted for certain categories of waste such as dredged material and inert, inorganic geological substances. These specifications are incorporated at the level of the Site Development Plan within the framework of the planning principles and presented in further detail.

- International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL 73/78)

The 1973 Convention for the Prevention of Pollution from Ships [12], developed under the auspices of the International Maritime Organization, provides the legal basis for environmental protection in maritime shipping. It is aimed at shipowners in particular so as to prevent operational discharges into the sea. The regulations on the discharge of sewage and garbage from ships (Annexes IV and V) are particularly relevant. Annex VI provides for the possibility of designating sulphur emission - control areas. According to Art. 2 subsection 4 of MARPOL, the Convention also applies to offshore platforms. The planning principles include this requirement and provide details on emission reduction, including with regard to waste.

- United Nations Convention on the Law of the Sea dated 1982

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[10] Notice concerning the entry into force of the Convention for the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, of 21 December 1977, Federal Law Gazette II 1977, p. 1492.

[11] Notice concerning the entry into force of the 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, of 9 December 2010, Federal Law Gazette II No. 35.

[12] International Convention for the Prevention of Pollution from Ships, 1973, promulgated by the Act relating to the International Convention for the Prevention of Pollution from Ships, 1973 and the Protocol of 1978 to that Convention of 23 December 1981, Federal Law Gazette 1982 II, p. 2.

Art. 208 of the United Nations Convention on the Law of the Sea of 10 December 1982 (UNCLOS) must be taken into account for the construction of installations for the offshore extraction and production of energy. This obliges coastal states to adopt and enforce legislation to prevent and reduce pollution caused by activities on the seabed or by artificial islands, installations and structures. Otherwise, the Contracting States are generally obliged to protect the marine environment according to their capabilities (see Art. 194 subsection 1 of UNCLOS). Other states and their environment must not be harmed by pollution. For the use of technologies, it is stipulated that all necessary measures must be implemented in order to prevent and reduce resulting marine pollution (Art. 196 of UNCLOS). The purpose of the SEA is to identify, describe and assess the likely significant environmental impacts. Specifications are examined with regard to endangerment of the marine environment and conflicts of use. Measures for the prevention and reduction of impacts are prepared, and standardised technical and planning principles are defined which also serve to protect against pollution.

1.4.1.2 Regional conventions on the protection of the marine environment

- Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992 (Helsinki Convention)

The Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention)[13] covers all anthropogenic sources of pollution. This requires the use of the best environmental practice and available technology (art. 3 subsection 3 Helsinki Convention). However, the Convention is not limited to regulating pollution, it also requires contracting parties to protect ecosystems and habitats. The implications of the rules outlined in the Site Development Plan are examined with regard to the nature conservation areas. The standardised technology and planning principles define requirements for the reduction of emissions from the operation of wind farms, platforms and cables.

- UNECE Convention on Environmental Impact Assessment (EIA) in a Transboundary Context (Espoo [14] Convention)

The United Nations Economic Commission for Europe (UNECE) Convention requires the contracting parties to carry out an EIA and notify interested parties of planned projects that may have significant adverse environmental effects. The notification includes information on the planned project, including information on its transboundary environmental impacts, and indicates the nature of the possible decision. The party within whose jurisdiction a project is planned ensures that EIA documentation is prepared as part of the EIA process and submits it to the party concerned. The EIA documentation forms the basis for consultations with the party concerned on, among other things, the possible transboundary environmental impacts of the project and how to mitigate and avoid them. The contracting parties ensure that the public affected in the country concerned is informed about the project and given the opportunity to submit comments. The neighbouring countries were informed within the framework of Site

[13] Law on the Convention on the Protection of the Marine Environment of the Baltic Sea Area from 9 April 1992, Federal Law Gazette II 1994 p. 1397.

[14] Convention of 25 2. 1991 on Environmental Impact Assessment in a Transboundary Context, implemented by the Espoo Contracts Act of 7 6. 2002, BGBI. 2002 II, p. 1406 ff. and the Second Espoo Contracts Act of 17 3. 2006, BGBI. 2006 II, p. 224 ff.

Development Plan establishment and given the opportunity to comment.

- UNECE Protocol on Strategic Environmental Assessment (SEA Protocol)

The SEA Protocol is an additional protocol to the Espoo Convention (see above). The Protocol on Strategic Environmental Assessment (SEA Protocol) of the UNECE requires the parties to take full account of environmental concerns when drafting plans and programmes.

The objectives of the Protocol include integration of environmental aspects (including health aspects) into the preparation of plans and programmes, voluntary integration of environmental aspects (including health aspects) into policies and legislation, creation of a clear framework for an SEA procedure, and ensuring public participation in SEA procedures.

1.4.1.3 Agreements specific to factors

- Convention on the Conservation of European Wildlife and Natural Habitats, 1979 (Bern Convention)

The Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention)[15] of 1979 regulates the protection of species by means of restrictions on removal and use and the obligation to protect their habitats. Annex II on strictly protected fauna species also protects porpoises, divers and little gulls, for example. The contents also find their way into the environmental impact assessment through species protection law.

- Convention on the Conservation of Migratory Species of Wild Animals, 1979 (Bonn Convention)

The 1979 Convention on the Conservation of Migratory Species of Wild Animals[16] requires Contracting States to take measures to protect wild migratory species that cross boundaries and ensure their sustainable use. What are known as the range states, in which the threatened species are widespread, must preserve their habitats if they are important in order to protect the species from the risk of extinction (Art. 3 subsection 4 a) of the Bonn Convention). Where practicable, they must also prevent or reduce adverse impacts of activities or obstacles which seriously impede, eliminate, compensate for or minimise the migration of the species (Art. 3 subsection 4 b) of the Bonn Convention) and influences which endanger the species. The prerequisites are assessed through wildlife conservation and territorial protection law.

Within the framework of the Bonn Convention, regional agreements for the conservation of the species listed in Annex II were concluded in accordance with Art. 4 no. 3 of the Bonn Convention:

- Agreement on the Conservation of African-Eurasian Migratory Waterbirds, 1995 (AEWA)

The 1995 Agreement on the Conservation of African-Eurasian Migratory Waterbirds[17] is particularly important in view of the importance of the Baltic Sea for migratory birds listed in the

[15] Law relating to the Convention of 19 September 1979 on the Conservation of European Wildlife and Natural Habitats, of 17 July 1984, Federal Law Gazette II 1984 p. 618, last amended by Article 416 of the Ordinance of 31 August 2015 (Federal Law Gazette I p. 1474).

[16] Act on the Agreement of 23 June 1979 on the conservation of migratory species of wild animals of 29 June 1984 (Federal Law Gazette 1984 II p. 569), last amended by Article 417 of the Ordinance of 31 August 2015 (Federal Law Gazette I p. 1474).

[17] Act on the Agreement of 16 June 1995 on the Conservation of African-Eurasian Migratory Waterbirds of 18 September 1998 (Federal Law Gazette 1998 II p. 2498), last amended by Article 29 of the Ordinance of 31 August 2015 (Federal Law Gazette I p. 1474).

Agreement. Migratory birds must be kept in a favourable conservation status or restored to a favourable conservation status on their migratory routes. The environmental report examines the impact of the Site Development Plan specifications on migratory bird movements in the EEZ (see chapters 4.7 and 5.2).

- Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas, 1991 (ASCOBANS)

The 1991 Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas[18] provides for the protection of toothed whales other than sperm whales, specifically in the North Sea and Baltic Sea. In particular, a conservation plan was drafted in order to reduce the bycatch rate. The environmental report examines the effects of the specifications on mammals, and the standardised technical principles prescribe noise reduction and prevention measures, coordination of pile driving work, etc. for the protection of small cetaceans (see chapters 4.5 and 5.1). The actual implementation of these measures must be assessed in greater detail and regulated by the approval or planning approval authority based on the project-specific requirements, taking into account the special features of the relevant specific project area at approval level.

- Agreement on the Conservation of Populations of European Bats, 1991 (EUROBATS)

The 1991 Agreement on the Conservation of Populations of European Bats (EUROBATS)[19] aims to ensure the protection of all European bat species by means of appropriate measures. The agreement is open not only to European states, but also to all range states that are part of the distribution range of at least one European bat population. As the most important instruments, the agreement provides for regulations on the removal of animals, the designation of important conservation areas and the promotion of research, monitoring and public relations work. Moreover, bats are a specially and strictly protected species according to section 7 subsection 2 no. 13 and 14 of the Federal Nature Conservation Act. They are a subject of the species conservation assessment and are also protected under the Habitats Directive. Please see chapters 5 and 6.

- Convention on Biological Diversity, 1993

The Convention on Biological Diversity[20] aims to conserve biodiversity and to ensure fair and equitable sharing of the benefits arising from the utilisation of genetic resources. Moreover, sustainable use of natural resources is also supported as an objective for future generations. According to Art. 4b, the Convention also applies to procedures and activities outside coastal waters in the EEZ. Biodiversity is a protected asset within the framework of the SEA, which is why significant environmental impacts will be assessed in relation to this protected asset as well.

1.4.2 Environmental and nature conservation requirements at EU level

The material scope of application of the TFEU[21] and thus in principle also that of secondary law

[18] Act on the Convention of 31 March 1992 on the Conservation of Small Cetaceans of the Baltic and North Seas of 21 July 1993 (Federal Law Gazette 1993 II p. 1113), last amended by Article 419 of the Ordinance of 31 August 2015 (Federal Law Gazette I p. 1474).

[19] Act on the Agreement of 4 December 1991 on the conservation of bats in Europe, Federal Law Gazette II 1993 p. 1106.

[20] Act on the Convention of 5 June 1992 on Biological Diversity, of 30 August 1993, Federal Law Gazette II no. 72, p. 1741.

[21] Treaty on the Functioning of the European Union, OJ EC no. C 115 of 9 May 2008, p. 47.

is extended if the Member States experience an increase in rights in an area outside their territory which they have transferred to the EU (ECJ, Commission/United Kingdom, 2005). In the field of protection of the marine environment, nature conservation or water protection, the applicability of the legal EU requirements is also valid for the EEZ.

The relevant EU legislation is to be taken into account:

- Council Directive 337/85/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment (Environmental Impact Assessment Directive, EIA Directive).

Council Directive 337/85/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment [22] (codified by Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment) [23] has been transposed into national law by the Environmental Impact - Assessment Act. As the SEA – which is also regulated in this Act – refers in many regulations to the standards for environmental impact assessment, the EIA Directive also has an indirect effect on the preparation of plans subject to SEA.

- Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (Habitats Directive)[24]

In designated FFH areas, an FFH impact assessment in accordance with Art. 6 subsection 3 of the Habitats Directive is required if installations are to be constructed. If there are compelling reasons in respect of public interest, construction may be justified even in the case of incompatibility. The FFH areas in the Baltic Sea have now been designated as conservation areas according to the national conservation area categories. The impact assessment is thus dependent on the protective purposes in the conservation areas.

- Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for community action in the field of water policy (Water Framework Directive, WFD).

Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for community action in the field of water policy [25] (Water Framework Directive, WFD) aims to achieve good ecological status for surface waters. Monitoring, evaluation, objectives and implementation of the measures are linked as steps in this regard. It also applies to transitional and coastal waters, but not to the EEZ. Accordingly, the provisions of the Marine Strategy Framework Directive are primarily relevant for the preparation of the environmental report.

- Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the

[22] Council Directive of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment, OJ 175 p. 40.

[23] Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment, of 28 November 2011, OJ 26/11.

[24] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora, OJ L 206, of 22 July 1992.

[25] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for community action in the field of water policy, OJ L 327, of 22 December 2000.

environment (Strategic Environmental Assessment Directive, SEA Directive)

Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment [26] (Strategic Environmental Assessment Directive, SEA Directive) was transposed into national law in the Environmental Impact Assessment Act. In particular, it contains provisions on the applicability to plans and programmes, on the procedural steps in the assessment of environmental impacts on plans and programmes, and on the national and transboundary participation of public authorities and the public. Its requirements are taken into account in the preparation of the SEA for the Site Development Plan and the preparation of the environmental report. The environmental report contains the information required pursuant to Article 5 in conjunction with Annex I.

- Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive, MSFD)

Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy [27] (Marine Strategy Framework Directive, MSFD) as an environmental pillar of an integrated European maritime policy aims "to achieve or maintain good environmental status in the marine environment by the year 2020 at the latest" (Art. 1 subsection 1 MSFD). The focus is on preserving biodiversity and maintaining or creating diverse and dynamic oceans and seas that are clean, healthy and productive (see recital 3 to the MSFD). As a result, a balance should be achieved between anthropogenic uses and ecological equilibrium.

The environmental objectives of the MSFD have been developed using an ecosystem approach to human governance and the precautionary and "polluter pays" principles:

- Seas unaffected by anthropogenic eutrophication
- Seas unpolluted by harmful substances
- Seas without adverse impacts on marine species and habitats due to the effects of human activities
- Seas with sustainably and carefully used resources
- Seas unpolluted by waste
- Seas unaffected by anthropogenic energy inputs
- Seas with natural hydromorphological characteristics (see BMU 2012).

The purpose of the environmental report is to systematically identify, describe and assess the impacts of the specifications on the marine environment. In particular, the impacts on marine species and habitats are assessed and standardised technical and planning principles are established in order to reduce environmental impacts, including requirements for waste management and use of resources, and with regard to pollutants.

- Directive 2009/147/EC of the European Parliament and of the Council on the conservation of wild birds (Wild Birds Directive)

[26] Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment, OJ L 197, of 21 July 2001.

[27] Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy, OJ L 164, of 25 June 2008.

Council Directive 2009/147/EC on the conservation of wild birds (Birds Directive) [28] aims to ensure the long-term conservation of all naturally occurring bird species, including migratory bird species, in EU territories and to regulate not only the protection but also the management and use of birds. All European bird species within the meaning of Article 1 of Directive 2009/147/EC are protected under section 7 subsection 2 no. 13 b) bb) of the Act on Nature Conservation and Landscape Management. The requirements of the Directive are examined within the framework of the assessment under species protection law.

- Rules for sustainable fishing under the Common Fisheries Policy

The EU has exclusive competence in the field of fisheries policy (see Article 3 subsection 1d of the Treaty on the Functioning of the European Union). The regulations include, for example, catch quotas based on maximum sustainable yield, multi-annual management plans, a landing obligation for bycatches, and support for aquaculture facilities. The use of the EEZ for fishing purposes should be assessed as a matter of importance in the specifications of the Site Development Plan.

1.4.3 Environmental and nature conservation requirements at national level

There are various legal provisions at a national level, too, and their specifications must be taken into account in the environmental report.

- Act for regulating water resources (WHG)

The Water Resources Management Act (WHG) [29] transposes the Marine Strategy Framework Directive (MSFD) into national law in sections 45a to 45l. Section 45a WHG implements the objective of ensuring good status of marine waters by 2020. Deterioration of the condition should be prevented, and human inputs should be avoided or reduced. However, regulations on uses such as authorisation rights are not linked to this. Section 45a ff. WHG implements the requirements of the MSFD. The purpose of the environmental report is to systematically identify, describe and assess the impacts of the specifications on the marine environment. This should also ensure that there is no deterioration of conditions as a result of specifications.

- Act concerning nature conservation and landscape management (Federal Nature Conservation Act - BNatSchG)

According to section 56 [30]subsection 1 of the Act concerning nature conservation and landscape management (Federal Nature Conservation Act, BNatSchG), the Federal Nature Conservation Act is also applicable in the EEZ with the exception of landscape planning requirements. According to section 1 of the Federal Nature Conservation Act, the objectives of the Federal Nature Conservation Act include biodiversity, the efficiency and functionality of the ecosystem and the diversity, uniqueness, beauty and recreational value of nature and the landscape. Sections 56 ff. of the Federal Nature Conservation Act contain requirements for marine nature conservation. With regard to the environmental report as part of the preparation

[28] Directive 2009/147/EC of the European Parliament and of the Council on the conservation of wild birds (Birds Directive) of 30 November 2009, OJ 20/7 of 26 January 2020.

[29] Water Resources Act of 31 July 2009 (Federal Law Gazette I p. 2585), as last amended by Article 2 of the Act of 4 December 2018, Federal Law Gazette I p. 2254).

[30] Act concerning nature conservation and landscape management of 29 July 2009 (Federal Law Gazette I p. 2542), as last amended by Article 8 of the Act of 13 May 2019 (Federal Law Gazette I p. 706).

of the Site Development Plan, it contains requirements on the conservation of species and natural habitats as well as the intervention regulation, which requires certain assessments to be reflected in the environmental report. This concerns the protection of legally protected biotopes pursuant to section 30 of the Federal Nature Conservation Act, the destruction or other significant impairment of which is prohibited. Furthermore, an impact assessment in accordance with section 34 subsection 2 of the Federal Nature Conservation Act must be carried out for plans in conservation areas or for effects on the protective purpose of conservation areas. With regard to species protection, section 44 subsection 1 of the Federal Nature Conservation Act prohibits the injuring or killing of wild animals of specially protected species or significant disturbance of wild animals of strictly protected species and of European bird species during reproduction, rearing, moulting, wintering and migration periods.

Within the framework of the specifications, the sites of the conservation areas are avoided as far as possible when selecting the routes. In cases where this is not possible, an impact assessment is carried out as part of the environmental assessment (see chapter 6) in order to verify whether these areas can be significantly affected in the elements relevant for their protective purposes. Reference is made to the protective purposes of the ordinances in the impact assessment according to section 34 subsection 2 of the Federal Nature Conservation Act. Nature reserves are excluded with regard to the specification of areas and sites in these areas for wind energy utilisation. A species protection assessment was performed for specially and strictly protected species, and significant impairments of legally protected biotopes were also investigated. The specifications were then reviewed to determine whether there was any danger to the marine environment or whether conflicts of use were used as a criterion for the selection. As a result, areas and sites in the former Cluster 5 of the Spatial Offshore Grid Plan for the North Sea were initially assessed or not included. The planning principles include the exclusionary effect of areas and sites in conservation areas, as well as requirements concerning minimum distances to conservation areas and the dismantling of installations, noise reduction, emission reduction, bundling of submarine cable systems, careful cable laying procedures, etc.

- Act concerning the environmental impact assessment (UVPG)

The Environmental Impact Assessment Act (UVPG) provides for the implementation of an SEA for certain plans or programmes. Annex 5.1 of the Environmental Impact Assessment Act lists the Site Development Plan, so section 35 subsection 1 no. 1 of the Environmental Impact Assessment Act generally requires an SEA to be performed. Section 37 of the Environmental Impact Assessment Act provides for exemptions from the SEA requirement where plans pursuant to section 35 subsection 1 of the Environmental Impact Assessment Act are amended only slightly or provide for the use of small areas at a local level. An SEA is only performed if a preliminary assessment of the case in question within the meaning of section 35 subsection 4 of the Environmental Impact Assessment Act shows that the plan is likely to have significant environmental impacts. The requirements of the third and fifth parts of the Environmental Impact Assessment Act will be taken into account accordingly. Within this framework, this environmental report will be prepared and national and transboundary public participation will take place.

- Act concerning the development and promotion of offshore wind energy (Offshore Wind Energy Act - WindSeeG)

The Offshore Wind Energy Act (WindSeeG), sections 4 ff., contains the legal basis for compiling and updating the site development plan. Section 5 subsection 3 sentence 1 of the Offshore Wind Energy Act stipulates that specifications are inadmissible if they conflict with overriding public or private interests. In the following list of inadmissible specifications, the hazard to the marine environment is listed as a presumptive example (see section 5 subsection 3 sentence 1 no. 2 of the Offshore Wind Energy Act). The individual specifications of the Site Development Plan must then be assessed with regard to endangerment of the marine environment. Moreover, section 5 subsection 4 sentence 2 of the Offshore Wind Energy Act contains criteria for specifying the sites and the chronological order of their invitations to tender. The legally defined criteria also include conflicts of use for a site which, like the other criteria, are relevant to the issue of whether, where and when sites are specified and tenders are invited.

- EEZ protected area ordinances

In accordance with section 57 of the Federal Nature Conservation Act, the existing nature conservation and FFH areas in the German EEZ were included in the national territory categories and declared nature conservation areas in accordance with the ordinances of 22 September 2017. They were partially regrouped in this context. The Ordinance on the Establishment of the Nature Conservation Area "Pomeranian Bight – Rönnebank" (NSGPBRV)31, the Ordinance on the Establishment of the Nature Conservation Area "Fehmarn Belt" (NSGFmbV)[32] and the Ordinance on the Establishment of the Nature Conservation Area "Kadetrinne" (NSGKdrV)[33] created the "Pomeranian Bight – Rönnebank", "Fehmarn Belt" and "Kadetrinne" nature conservation areas. This does not give rise to any differences in terms of spatial dimensions. On isolated occasions, some species (the great skua (*Stercorarius skua*) and the pomarine skua (*Stercorarius pomarinus*)) were placed under protection for the first time.

Within the framework of the specifications, the sites of the conservation areas are avoided as far as possible when selecting the routes. In cases where this is not possible, an impact assessment is carried out as part of the environmental assessment (see chapter 6) in order to verify whether these areas can be significantly affected in the elements relevant for their protective purposes. Reference is made to the protective purposes of the ordinances in the impact assessment according to section 34 subsection 2 of the Federal Nature Conservation Act. Nature reserves are excluded with regard to the specification of areas and sites in these areas for wind energy utilisation. The specifications were then reviewed to determine whether there was any danger to the marine environment or whether conflicts of use were used as a criterion for the selection. The planning principles include the exclusion impact of areas and sites in conservation areas, as well as requirements concerning minimum distances to conservation areas and the dismantling of installations, noise reduction, emission reduction, bundling of submarine cable systems, careful cable laying procedures, etc. Reference is also made to Chapter 4.4 of the Site Development Plan.

1.4.4 The Federal Government's energy and climate conservation aims

[31] Ordinance on the establishment of the conservation area "Pomeranian Bight – Rönnebank" of 22 September 2017, Federal Law Gazette I p. 3415.

[32] Ordinance on the establishment of the conservation area "Fehmarn Belt" of 22 September 2017, Federal Law Gazette I p. 3405.

[33] Ordinance on the establishment of the conservation area "Kadetrinne" of 22 September 2017, Federal Law Gazette I p. 3410.

According to the strategy of the Federal Government for the expansion of offshore wind energy utilisation prepared in 2002, offshore wind energy was already of special significance. The proportion of wind energy provided in total power consumption is set to grow to at least 25% within the next three decades. According to the energy concept of the Federal Government dated 28 September 2010, the proportion of renewable energy of the total power consumption is set to increase to 35% by 2020 and to 80% by 2050.

The transition to the age of renewable energies has gained additional significance in the wake of the energy transition decided upon in 2011. On 6 June 2011, the Federal Government decided on an energy package that supplemented the measures of the energy concept and had the aim of accelerating its implementation. Since 2002, the aim has been to install a capacity of a total of 25 GW in the North Sea and the Baltic Sea by 2030.

In the wake of the latest reform of the Renewable Energy Sources Act in 2016, section 1 subsection 2 of the Renewable Energy Sources Act 2017 states that the objective is to increase the proportion of electricity generated from renewable energies in gross electricity consumption to

- 40 to 45% by 2025,
- 55 to 60% by 2035, and
- at least 80% by 2050.

This objective is also intended to increase the proportion of renewable energy of the entire gross final consumption of energy to at least 18% by 2020. The aim is to provide a steady, cost-efficient and grid-compatible expansion.

In section 4 No. 2 of the Renewable Energy Sources Act, the expansion trajectory for offshore wind energy is regulated by increasing the installed offshore wind turbine capacity to 6,500 MW by 2020 and 15,000 MW by 2030.

With the Federal Government's Integrated Energy and Climate Programme, the climate protection targets were adopted in 2007 and confirmed in the coalition agreement of 2013. The Federal Government's Climate Protection Plan 2050 takes up the objectives and sets them out with targets and measures in individual sectors. The aim is to reduce emissions to at least 40% below 1990 levels by 2020, at least 55% by 2030 and 80 to 95% by 2050. By 2050, Germany should achieve a high level of greenhouse gas neutrality, i.e. a balance between greenhouse gases emitted and the binding of these gases by means of sinks.

The Federal Government's climate policy objective of achieving an installed capacity of 15,000 MW by 2030 by means of offshore wind energy forms the planning horizon for specification of the plan. As an increase of the expansion targets seems possible, further scenarios are presented in the annex to the Site Development Plan on an informational basis. The scenarios are not presented separately in the environmental report.

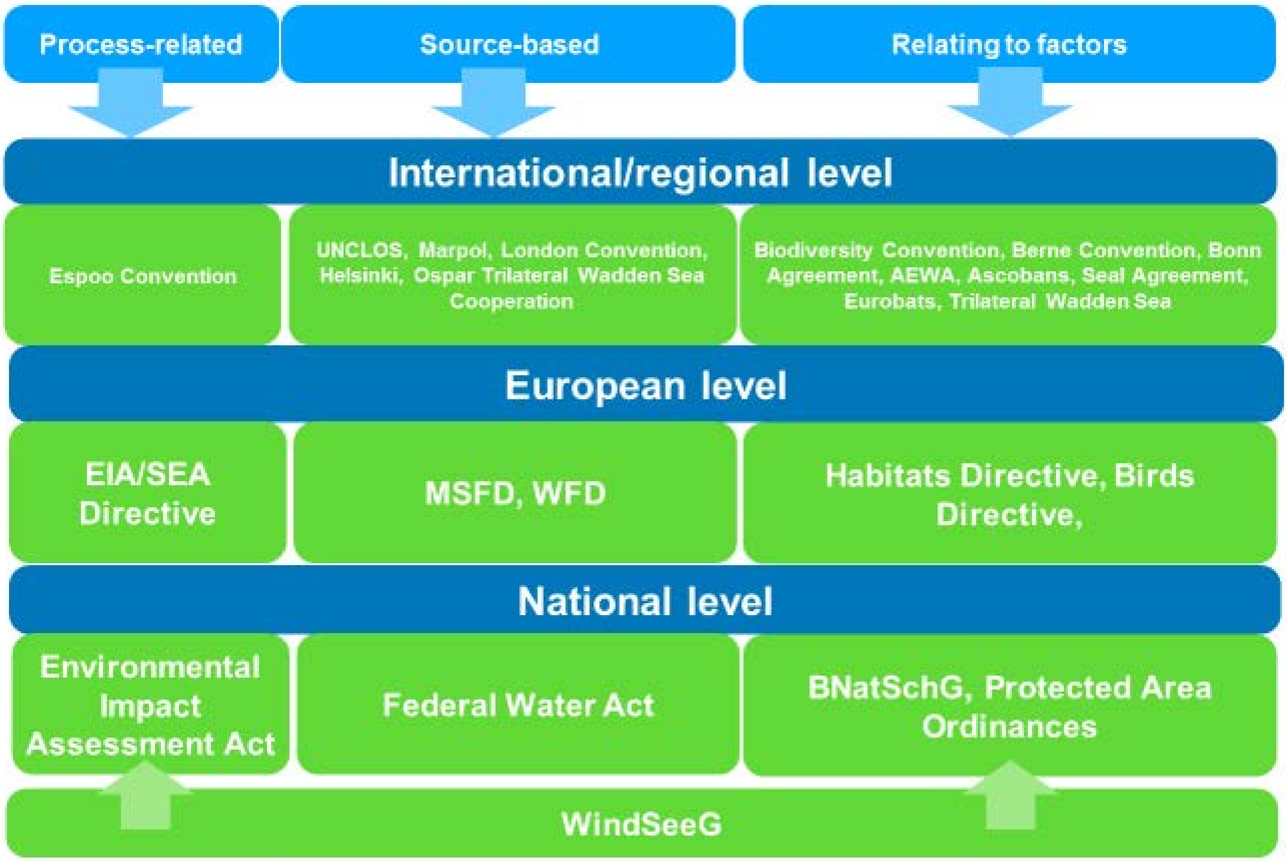

Figure 6: Overview of the standards of the relevant legal acts for the SEA.

1.5 Strategic Environmental Assessment methodology

1.5.1 Introduction

When carrying out the SEA, various approaches to the planning status can be considered within the framework of the methodology. This environmental report builds on the methodology of the SEA of the Spatial Offshore Grid Plan, which has already been used as a basis, and develops it further with a view to the additional rules defined in the Site Development Plan that go beyond the Spatial Offshore Grid Plan.

The methodology is based primarily on the rules of the plan that are to be assessed. Within the framework of this SEA, whether the rules are likely to have significant effects on the factors in question is identified, described and evaluated for the individual rules. In accordance with section 40 subsection 3 of the Environmental Impact Assessment Act, in the environmental report the competent authority provisionally assesses the environmental effects of the rules with regard to effective environmental precautions in accordance with applicable laws. According to the special legal standard of section 5 subsection 3 WindSeeG, the rules must not endanger the marine environment.

The subject matter of the environmental report is compliant with the provisions of the Site Development Plan as set out in section 5 subsection 1 of the Offshore Wind Energy Act (see 1.2). However, it is not so much the actual time specifications that are significant here as the time sequence of the invitation to tender or the calendar years for commissioning, as this has no further environmental impacts with regard to the spatial specifications. Although some planning and technical principles serve to mitigate environmental effects, they can also lead to effects, making a review necessary.

The following specifications are each examined with regard to their anticipated significant environmental effects relating to **protected assets**:

- Areas and sites for offshore wind energy, including rule of the expected generation capacity
- Routes and corridors, including gates
- Locations for platforms (converter and collector platforms and transformer platforms)
- Relevant planning and technical principles

1.5.2 Area of investigation

This description and assessment of the state of the environment relates primarily to the Baltic Sea EEZ, for which the Site Development Plan essentially defines rules. The SEA area of investigation covers the German EEZ of the Baltic Sea. As no provisions are made in the Site Development Plan for the western part of the Baltic Sea EEZ up to the "Fehmarn Belt" nature conservation area, this part of the EEZ is not considered in detail in the SEA (see Figure 7).

In the adjacent coastal waters, areas and a test field will be designated via an administrative agreement with the State of Mecklenburg-Western Pomerania. These rules are also part of the area of investigation and are being checked against the rules in the EEZ for their cumulative effects. The adjacent areas of the neighbouring states are not directly covered by this plan, but they will be considered in the cross-border and cumulative perspective of this SEA (see sections 4.12 and 4.13).

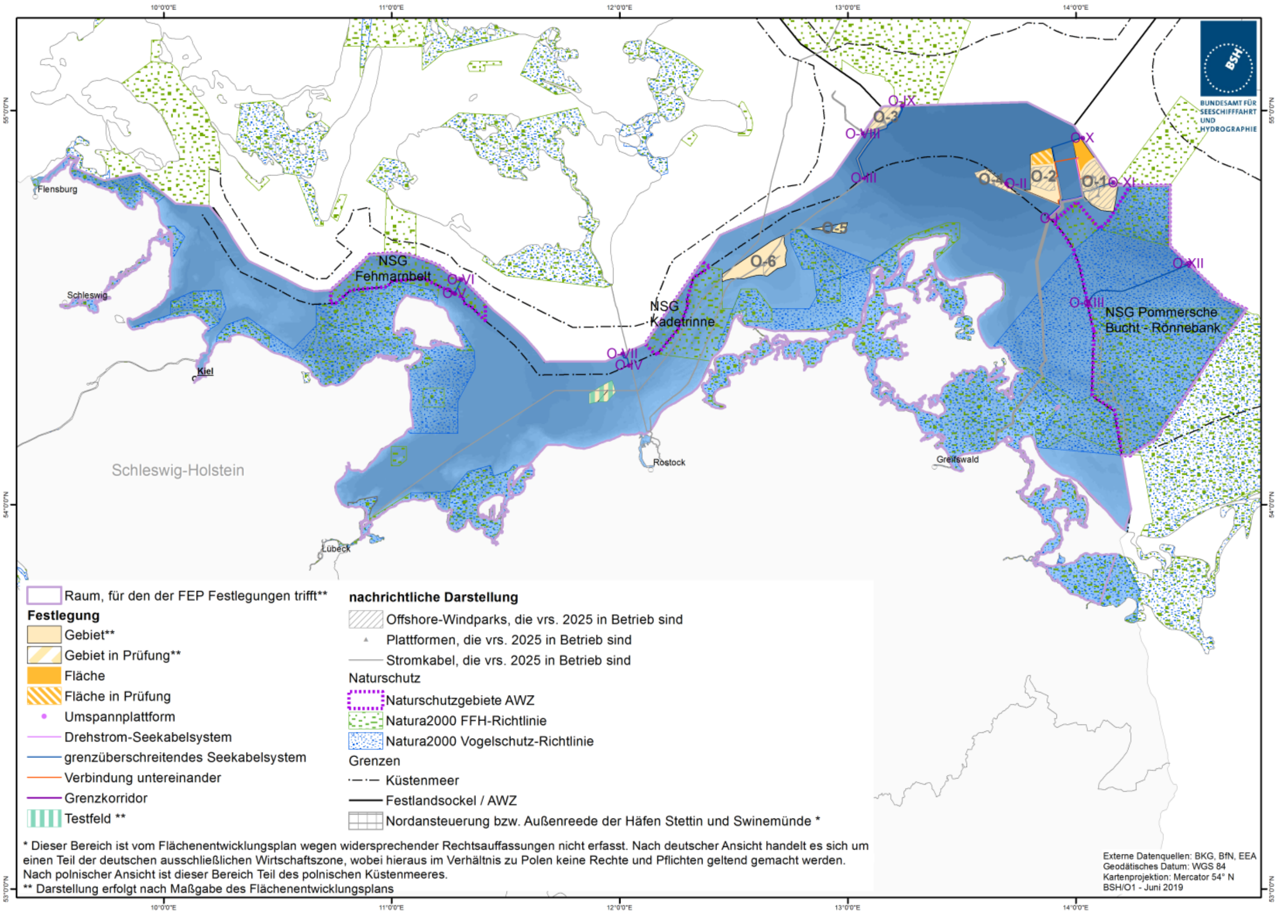

Figure 7: Representation of the investigation area of the SEA for the Baltic Sea for the site development plan.

1.5.3 Carrying out the environmental assessment

This description and assessment of the state of the environment relates to part of the Baltic Sea EEZ, for which the Site Development Plan essentially defines rules. An administrative agreement with the State of Mecklenburg-Western Pomerania also covers the areas of the coastal waters with regard to the cumulative effects of rules on the factors. Otherwise, for coastal waters, reference is made to the assessment of the environmental effects and presentations in the environmental report as part of the preparation of the Mecklenburg-Western Pomerania regional development programme for 2016.[34]

The assessment of the likely significant environmental effects of the implementation of the Site Development Plan includes secondary, cumulative, synergistic, short-, medium- and long-term, permanent and temporary, positive and negative effects related to the factors.

Secondary or indirect effects are those that are not immediate and therefore may only become effective after some time and/or at other locations (WOLFGANG & APPOLD 2007,

[34] Ministry of Energy, Infrastructure and Regional Development Mecklenburg-Western Pomerania, Environmental Report on the Mecklenburg-Western Pomerania regional development programme for 2016, July 2016.

SCHOMERUS et al. 2006). Occasionally, there is also reference to consequences or interrelationships (see chapter 4.11).

Possible effects of the implementation of the plan are described and evaluated in relation to the protected asset. There is no common definition of "significance" as this involves "individually identified significance" that cannot be considered independently of the "specific characteristics of plans or programmes" (SOMMER 2005, 25 ff.). In general, significant effects can be defined as effects that are serious and significant in the context being considered.

According to the criteria in Annex 6 of the Environmental Impact Assessment Act that are significant to the assessment of the likely significant environmental effects, the significance is determined by

- the probability, duration, frequency and reversibility of the effects;
- the cumulative nature of the effects;
- the transboundary nature of the effects;
- the risks to human health or the environment (e.g. due to accidents);
- the magnitude and spatial extent of the effects (geographical area and size of the population likely to be affected);
- the value and vulnerability of the area likely to be affected due to special natural characteristics or cultural heritage, exceeded environmental quality standards or limit values, as well as intensive land-use;
- the effects on areas or landscapes which have a recognised national, Community or international protection status".

The characteristics of plans and programmes, having regard, in particular, to

- the degree to which the plan or programme sets a framework for projects and other activities, either with regard to the location, nature, size and operating conditions or by allocating resources;
- the degree to which the plan or programme influences other plans and programmes including those in a hierarchy;
- the relevance of the plan or programme for the integration of environmental considerations in particular with a view to promoting sustainable development;
- environmental problems relevant to the plan or programme;
- the relevance of the plan or programme for the implementation of Community legislation on the environment (e.g. plans and programmes linked to waste-management or water protection)" (Annex II to the Strategic Environmental Assessment Directive).

Specialist law provides further specifications as to when an effect reaches the significance threshold. Threshold values were also compiled sub-legally so as to be able to make a distinction.

The potential environmental effects are described and assessed in relation to the factors separately for areas and sites, platforms and submarine cable systems, taking into account the status assessment (chapter 2). Furthermore, where necessary, a differentiation is made according to different technical designs. The description and assessment of the likely significant effects of the implementation of the Site Development Plan on the marine environment also refer to the factors described. All plan contents that may potentially have significant environmental effects are examined.

The effects of construction and dismantling, as well as system-related and operational factors, are taken into account. Moreover, effects that may arise in the course of maintenance and repair work are taken into account. This is followed by a description of possible interrelationships and consideration of possible cumulative effects and potential transboundary impacts.

The following factors are considered with regard to assessment of the state of the environment:

- Area
- Ground
- Water
- Plankton
- Biotopes
- Benthos
- Fish
- Marine mammals
- Avifauna
- Bats
- Biodiversity
- Air
- Climate
- Scenery
- Cultural heritage and other material assets
- Human beings, in particular human health
- Interrelationships between factors

In general, the following methodological approaches are used in the environmental assessment:

- Qualitative descriptions and evaluations
- Quantitative descriptions and evaluations
- Evaluation of studies and technical literature
- Visualisations
- Worst-case assumptions
- Trend estimates (e.g. on the state of the art of systems)
- Assessments by experts / the specialist community.

The effects of the Site Development Plan rules are assessed on the basis of the description and assessment of the condition and the function and significance of the individual areas, sites and routes for the individual factors on the one hand, and the effects originating from these rules and the resulting potential effects on the other. A forecast of the project-related effects in the case of implementation of the Site Development Plan is compiled as a function of the criteria of intensity, scope and duration of the effects (see Figure 8).

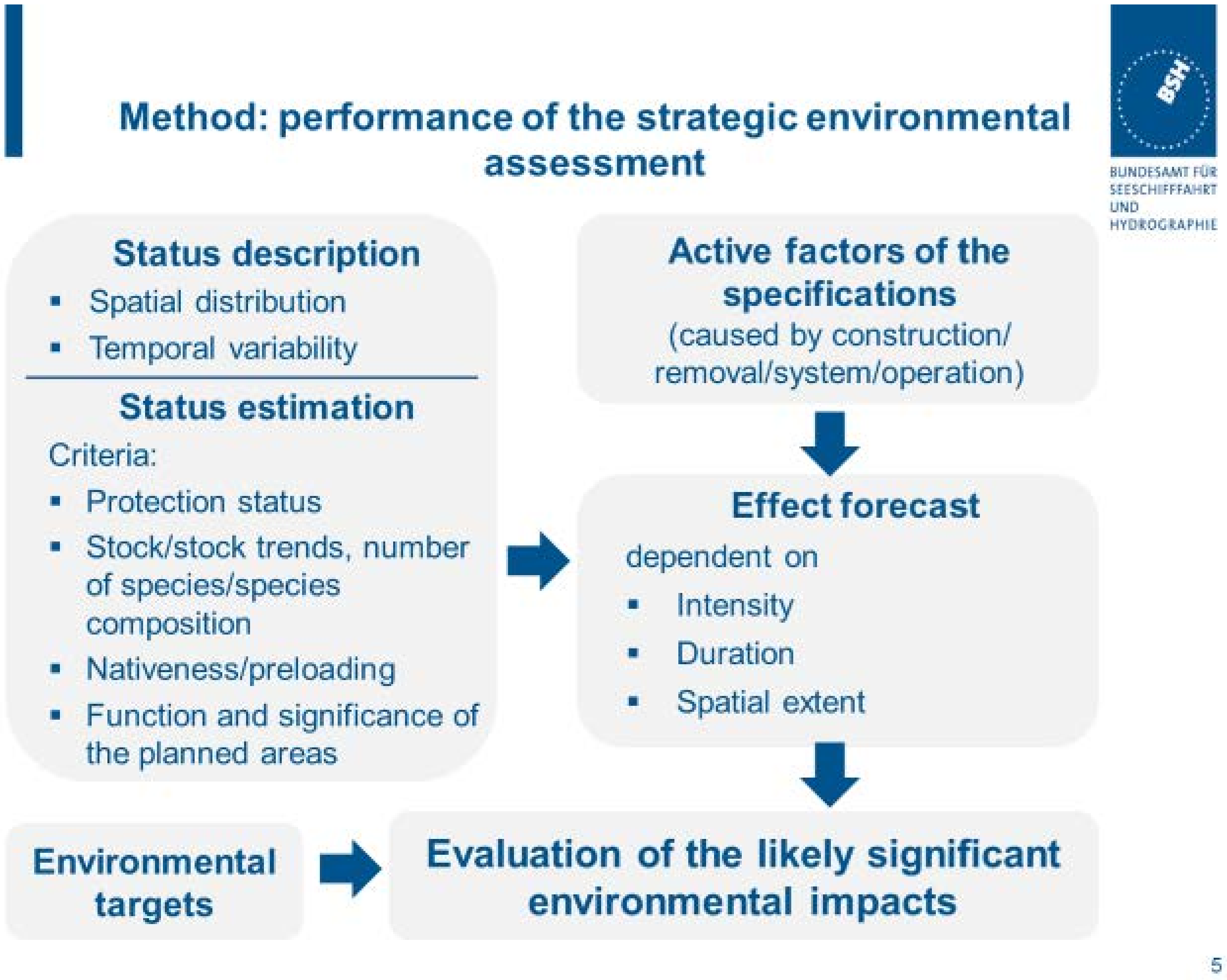

Figure 8: General methodology for assessing the likely significant environmental effects.

Please see chapter 1.4 with regard to the consideration of environmental protection objectives in the assessment of the likely significant environmental effects of the implementation of the Site Development Plan.

1.5.4 Criteria for status description and assessment

The status assessment of the individual factors in chapter 2 is based on various criteria. For the factors area/soil, benthos and fish, the assessment is based on the aspects of rarity and vulnerability, diversity and singularity, as well as naturalness. The description and assessment of the factors Marine mammals, Seabirds and resting birds, and Migratory birds are based on the aspects for the assessment of the condition of the factors Surface/ Soil, Benthos and Fish. As these are highly mobile species, it is not expedient to adopt a similar approach to these factors. The criteria of protection status, assessment of the occurrence, assessment of territorial units and initial loads, are therefore applied for seabirds, resting birds and marine mammals. The aspects of assessment of the occurrence and large-scale significance of the area for bird migration are considered as well as rarity, vulnerability and naturalness.

The criteria that were used for assessing the condition of the protected asset in question are listed below. This overview deals with the protected assets in focus in the environmental assessment.

Area/Soil

Aspect: Rareness and vulnerability
Criterion: The portion of the sediments on the seabed and distribution of the morphological form inventory.
Aspect: Diversity and uniqueness
Criterion: Heterogeneity of the sediments on the seabed and development of the morphological form inventory.
Aspect: Naturalness
Criterion: Extent of initial anthropogenic contamination of sediments on the seabed and of the morphological form inventory.

Benthos

Aspect: Rareness and vulnerability
Criterion: Number of rare or endangered species based on the Red List species identified (Red List by RACHOR et al. 2013).
Aspect: Diversity and uniqueness
Criterion: Number of species and composition of communities of species. The extent to which species or biocoenoses characteristic of the habitat occur and how regularly they occur is assessed.
Aspect: Naturalness
For this criterion, the intensity of fishing activities – which is the most effective disturbance variable – will be used as a benchmark for assessment. The appropriate measurement and detection methods for other disturbance variables, such as eutrophication, shipping or pollutants, are currently unavailable for inclusion in the assessment.

Biotopes

Aspect: Rareness and vulnerability
Criterion: National protection status and threat to biotopes according to the Red List of Threatened Habitat Types in Germany (FINCK et al. 2017).
Aspect: Naturalness
Criterion: Threat from anthropogenic influences.

Fish

Aspect: Rareness and vulnerability
Criterion: Proportion of species that are considered endangered according to the current Red List of marine fish (THIEL et al. 2013) and for which diadromous species are on the Red List of freshwater fish (FREYHOF 2009) and have been assigned to Red List categories.
Aspect: Diversity and uniqueness
Criterion: The diversity of a fish community can be described by the number of species (α-diversity, 'species richness'). The species composition can be used to assess the uniqueness of a fish community, i.e. how regularly species typical to the habitat occur. Diversity and uniqueness are compared and evaluated between the entire Baltic Sea and the German EEZ, as well as between the EEZ and the individual territories.
Aspect: Naturalness
Criterion: The naturalness of a fish community is defined as the absence of anthropogenic influences. The removal of target species and bycatch, as well as the degradation of the seabed in the case of ground-breaking fishing methods, make fisheries the most effective disturbance of the fish community. It is therefore used as a measure of the naturalness of the fish communities in the North Sea and Baltic Sea. The stocks are not assessed on a smaller spatial scale such as the German Bight.

Marine mammals

Aspect: Protection status
Criterion: Status according to Annex II and Annex IV of the Habitats Directive and the following international protection agreements: Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention, CMS), ASCOBANS (Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas), Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention)
Aspect: Assessment of the occurrence
Criteria: Stock, stock changes/trends based on large-scale surveys, distribution patterns and density distributions
Aspect: Assessment of spatial units
Criteria: Function and significance of the German EEZ and the territories for marine mammals as migration areas, feeding grounds or breeding grounds as defined in the Site Development Plan
Aspect: Initial contamination
Criterion: Hazards due to anthropogenic influences and climate change.

Seabirds and resting birds

Aspect: Protection status
Criterion: Status according to Annex I of the Birds Directive, European Red List by BirdLife International
Aspect: Assessment of the occurrence
Criteria: German Baltic Sea stock and German EEZ stock, large-scale distribution patterns, abundances, variability
Aspect: Assessment of spatial units
Criteria: Function of the territories for relevant breeding birds, migratory birds, as resting areas as defined in the Site Development Plan, location of protected areas
Aspect: Initial contamination
Criterion: Hazards due to anthropogenic influences and climate change.

Migratory birds

Aspect: large-scale significance of the area for bird migration
Criterion: Guidelines and concentration ranges
Aspect: Assessment of the occurrence
Criterion: Migration movements and their intensity
Aspect: Rareness and vulnerability
Criterion: Number of species and endangered status of the species involved according to Annex I of the Birds Directive, Bern Convention of 1979 on the Conservation of European Wildlife and Natural Habitats, Bonn Convention of 1979 on the Conservation of Migratory Species of Wild Animals, AEWA (African-Eurasian Waterbird Agreement) and SPEC (Species of European Conservation Concern).
Aspect: Naturalness
Criterion: Initial contamination/hazards due to anthropogenic influences and climate change.

1.5.5 Specific assumptions for assessment of likely significant environmental effects

The likely significant effects of the implementation of the Site Development Plan on the marine environment are described and assessed in relation to factors, based on the status assessment as described above, separately for areas and sites, platforms and submarine cable systems. The table below lists the potential environmental impacts, based on the main drivers, which form the basis for the assessment of the expected significant environmental impacts. The impacts are differentiated according to whether they are due to construction, demolition or operation or are caused by the turbine itself.

Table 1: Project-related effects of implementation of the Site Development Plan.

Factor	Effect	Potential effect	Construction/ dismantling	System	Operation
Areas/sites and platform locations					
Ground	Introduction of hard substrate (foundations)	Change of habitats		X	
	Permanent area use	Change of habitats		X	
	Scouring/sediment shift	Change of habitats		X	
Benthos	Formation of turbidity plumes	Impairment of benthic species	X		
	Re-suspension of sediment and sedimentation	Impairment of or damage to benthic species or communities	X		
	Introduction of hard substrate	Habitat changes, habitat loss		X	
Fish	Sediment turbulence and turbidity plumes	Physiological effects and deterrence	X		
	Noise emissions during pile driving	Aversive conditioning	X		
	Area use	Local habitat loss		X	
	Introduction of hard substrate	Attraction, increase in biodiversity		X	

Factor	Effect	Potential effect	Construction/ dismantling	System	Operation
Seabirds and resting birds	Visual disturbances due to construction work	Local deterrence and barrier effects	X		
	Obstacles in airspace	Deterrence ⇨ Habitat loss, bird strike		X	
	Light emissions	Attraction	X		X
Migratory birds	Obstacles in airspace	Bird strike Barrier effect		X	
	Light emissions	Attraction ⇨ Bird strike	X		X
Marine mammals	Noise emissions during pile driving	Hazard if no prevention and mitigation measures are implemented	X		
Routes for submarine cable systems					
Ground	Introduction of hard substrate (rockfill)	Change of habitats		X	
Benthos	Heat emissions	Impairment/displacement of species that thrive in cold water			X
	Magnetic fields	Impairment of benthic species			X
	Turbidity plumes	Impairment of benthic species	X		
	Introduction of hard substrate (rockfills)	Habitat change, local habitat loss		X	
Fish	Turbidity plumes	Physiological effects and deterrence	X		
	Magnetic fields	Impairment of the orientation behaviour of individual migratory species			X

Cumulative effects and interrelationships between factors are also assessed in addition to the effects on the individual factors.

Interdependency

In general, effects on a factor lead to various consequences and interrelationships between the factors. The essential interdependence of the biotic factors results from the food chains. Interrelationships can only be described very inaccurately due to the variability of the habitat and the complexity of the food web and material cycles.

Cumulative assessment

According to Art. 5 subsection 1 of the SEA Directive, the environmental report also covers assessment of cumulative effects. Cumulative effects arise from the interaction of various independent individual effects that either add up through their interaction (cumulative effects) or reinforce each other and hence generate more than the sum of their individual effects (synergistic effects) (e.g. SCHOMERUS et al. 2006). Cumulative and synergistic effects can be caused by both temporal and spatial coincidence of impacts (cf. chapter 4.12). The effects of the construction phase are mainly of a short-term and transient nature, while installation-related and operational effects may be permanent.

To assess the cumulative effects, it is necessary to assess the extent to which a significant adverse effect can be attributed to the combined rules of the plan. Assessment of the sites is carried out at the level of this sectoral plan based on the current state of knowledge in accordance with Art. 5 subsection 2 SEA Directive.

In detail, the following procedure was carried out for the analysis and assessment of the respective rules:

Areas and sites, including the expected generation capacity:

Regarding the areas, a total of 13 areas is assumed in a worst-case scenario, regardless of the concrete rule in the plan and the probability of implementation. According to section 5 subsection 1 no. 5 of the Offshore Wind Energy Act, the expected generation capacity of offshore wind turbines must be specified in the Site Development Plan for the areas or specifically for the sites. Chapter 4.7 of the Site Development Plan describes how the expected generation capacity per site is determined and specified. Essentially, the sites within the areas are assigned to two categories on the basis of criteria such as area geometry, wind conditions, state of the art of offshore wind turbines and grid connection capacity within the framework of the legal requirements. Based on these parameters and assumptions, the power density to be applied is determined in megawatts/km² per site. For details, reference is made to chapter 4.7 of the Site Development Plan (determination of the expected generation capacity).

To support the plausibility check of the methodology for determining the expected generation capacity on the respective sites, model-based wind farm planning will be simulated with – among other things – wind turbines that may be available in the future. Although one or more layouts for offshore wind farm plans are not used as a basis for determining the expected generation capacity to be installed, certain parameters such as number of turbines, hub height [m], height of the lower rotor tip [m], rotor diameter [m], swept area of the rotor [m²], total height [m] of the turbines, diameter of foundation types [m], site of a foundation [m²] and diameter of the scour protection [m] are assumed for consideration in this SEA with regard to the factors. To illustrate the range of possible developments, the assessment is essentially based on two scenarios. Many small turbines are assumed in the first scenario, and in the second a small number of large turbines are assumed. Because of the resulting range covered, a description and evaluation of the current state of planning that are as comprehensive as possible in relation to the factors become possible.

The SEA takes particular account of the following:

- Turbines that are already in operation (as reference and initial load)
- Transfer of the average parameters of the systems already in operation to the sites to be planned in the central model

- Assumption that existing projects will be implemented within the scope of the transitional phase on the basis of an effective approval (worst-case scenario)
- Forecast of certain technical developments.

The following tables provide an overview of the parameters used. It should be noted here that some of these are merely estimated assumptions, as project-specific parameters are not or cannot be assessed at SEA level.

With regard to the information on hub height, it should be noted that point no. 3.5.1 (8) in the Baltic Sea spatial development plan provides for a 125 m height limit for wind turbines within sight of the coast and islands. Accordingly, this requirement was applied in scenario 1. As sections 19, 6 of the Federal Regional Planning Act basically provide for the possibility of a target deviation procedure for deviation from spatial development targets and the height limit is of no relevance to non-visible installations, a hub height of 175 m was used for scenario 2.

Table 2: Parameters for the consideration of areas and sites

	Scenario 1	Scenario 2
Capacity per turbine [MW]	9	15
Hub height [m]	Approx. 125	Approx. 175
Height of the lower rotor tip [m]	Approx. 26	Approx. 50
Rotor diameter [m]	Approx. 200	Approx. 250
Swept area of the rotor [m²]	Approx. 30.800	Approx. 49.100
Total height [m]	Approx. 225	Approx. 300
Diameter of foundation [m]*	Approx. 8.5	Approx. 12
Site foundation excl. Scour protection [m²]	Approx. 57	Approx. 113
Diameter of scour protection [m]	Approx. 43	Approx. 60
Site foundation incl. Scour protection [m²]	Approx. 1.420	Approx. 2.830

* Calculation of area use is based on the assumption of a monopile foundation. However, it is assumed that monopiles and jackets together use approximately the same area on the seabed.

Locations for platforms

A similar approach is followed when assessing the locations for platforms. Here, too, certain parameters such as the number of platforms, the length of the farm's internal cabling [km], the diameter of one or more foundations [m] and the site for foundations (including scour protection) [m²] are used as a basis.

Table 3: Parameters for the consideration of grid connections and platforms

Grid connection Transformer/residential platforms*	
Anticipated capacity in a site [MW]	Approx. 300
Length of farm's internal cabling [km]	Approx. 36
Number of transformer platforms	1
Number of residential platforms	0
Diameter of foundation [m]**	Approx. 10
Site foundation excl. Scour protection [m^2]	Approx. 80
Diameter of scour protection [m]	Approx. 50
Site foundation incl. scour protection [m]	Approx. 2000

* The data for transformer platforms refers to the number of transformer platforms per area (for completions from 2026 only). Only the length of the farm's internal cabling depends on the expected generation capacity to be installed for the site in question and was determined on the basis of existing plans.

** For the diameter of the foundation, the type of foundation is not decisive in this case. It is assumed that monopiles and jackets together use approximately the same area on the seabed.

Routes and route corridors for submarine cable systems

The rule of routes and route corridors for submarine cable systems (connecting pipelines, interconnectors and cross-connections between converter/transformer platforms) is based on certain cable trench widths [m] and the number and site of intersections [m^2] and converter platforms [m^2]. The environmental effects of construction, operation and repair are considered in particular.

Table 4: Parameters for the consideration of submarine cable systems

Submarine cabling systems	
Cable trench width [m]	Approx. 1
Number of intersections	Approx. 24
Site of intersections [m^2]	Approx. 900
Number of converter platforms	0
Site of converter platforms [m^2]	0

Relevant planning and technical principles

The required space requirements can be minimised and the potential environmental impact can be reduced by regulating planning and technical principles in the Site Development Plan. The vast majority of the planning principles serve to avoid or reduce environmental impacts and are unlikely to lead to significant impacts. This applies, for example, to the overall time coordination of construction and cable laying work, noise reduction, minimisation of scour protection measures, consideration of official standards, specifications and concepts, emission reduction, observance and consideration of conservation areas and legally protected biotopes, careful cable laying procedures, covering, reduction of sediment warming and economical area use.

The Site Development Plan also includes some planning principles that are not related to the mitigation of environmental effects. As these are based on spatial planning objectives, they are binding and must be observed. This concerns impairment of the safety and ease of traffic, implementing the objective of spatial planning 3.5.1 (2). This states that the construction and operation of power generation systems in priority areas for wind energy must not effect traffic safety. The planning principle of shipping crossing priority and reserved areas by the shortest possible route also implements a spatial planning objective for the Site Development Plan (see spatial development plan 3.3.1 (2), according to which the priority areas defined for shipping are to be crossed by submarine cables by the shortest possible route in order to derive the energy generated in the EEZ). The remaining planning principles relating to distance and area requirements are used for the stability of the systems, the safety of the laying, a sufficient safe distance in the event of repairs and exclusion of mutual thermal influence of the submarine cable systems. When selecting the specific distances or site requirements, as little use of the site as possible was taken into consideration, and will be examined under the protected assets Soil/area and Avifauna.

With regard to the technical principles for connecting offshore wind farms in the Baltic Sea to the grid for the EEZ area, a connection concept based on three-phase current technology with a transmission voltage of +/- 220 kV is used in the same way as the previous grid connections when the transformer platform is used by the transmission grid operator. This was already determined in the context of the Baltic Sea Spatial Offshore Grid Plan (BFO) and, accordingly, was also the subject of the assessments in the environmental reports for the Baltic Sea BFO.

1.5.6 Fundamentals of the assessment of alternatives

According to Art. 5 subsection 1 sentence 1 of the SEA Directive in conjunction with the criteria in Annex I of the SEA Directive and section 40 subsection 2 no. 8 of the Environmental Impact Assessment Act, the environmental report contains a brief description of the reasons for choosing the reasonable alternatives assessed. Conceptual/strategic design, spatial and technical alternatives play a part at the planning level. The prerequisite is always that these are reasonable or can be seriously considered.

Assessment of alternatives does not explicitly require the development and assessment of particularly eco-friendly alternatives. Rather, the "reasonable" alternatives in the above sense should be presented in a comparative manner with regard to their environmental effects so that consideration of environmental concerns becomes transparent when deciding on the alternative to be pursued (BALLA 2009). At the same time, the effort required to identify and assess the alternatives under consideration must be reasonable. This means that the greater the expected environmental effects and hence the need for planning conflict resolution, the more likely it is that comprehensive or detailed investigations will be required.

In principle, it should be noted that preliminary examination of possible and conceivable alternatives is already inherent in all rules in the form of standardised technical and planning principles. As can be seen from the justification of the individual planning principles, in particular those relating to the environment – such as, for example, routing that is as bundled as possible and implementation that is as free from crossings as possible – the principle in question is already based on consideration of possible public concerns and legal positions, so that a "preliminary assessment" of possible alternatives has already been carried out. In detail, this environmental report examines spatial and technical alternatives in addition to the zero alternative.

1.6 Data sources and indications of difficulties in compiling the documents

A description and assessment of the state of the environment in the investigation area form the basis for the SEA. All factors must be included. The data source forms the basis for the assessment of the likely significant environmental effects, assessment of natural habitat and wildlife conservation regulations and the alternative assessment.

According to section 39 subsection 2 sentence 2 of the Environmental Impact Assessment Act, the environmental report contains the information that can be obtained with reasonable effort, taking into account the current state of knowledge and public statements known to the authority, generally accepted assessment methods, content and level of detail of the plan and its position in the decision-making process.

According to section 40 subsection 4 of the Environmental Impact Assessment Act, information available to the competent authority from other procedures or activities may be included in the environmental report if it is suitable for the intended purpose and sufficiently up-to-date.

This environmental report is based on the environmental assessments performed within the framework of the preparation and update of the Spatial Offshore Grid Plans for the North Sea and Baltic Sea EEZs. This environmental report is intended as an updated overall document.

This environmental report describes and assesses the current state of the environment and presents the likely development if the plan is not implemented. The likely significant environmental effects resulting from the implementation of the plan are also forecast and assessed. The assessment of possible impacts is based on a detailed description and assessment of the environmental status (chap.2).

The current state of the environment and the expected development if the plan is not implemented (chap.3) have been described and assessed with regard to the following factors:

- Area/ Soil
- Water
- Plankton
- Biotopes
- Benthos
- Fish
- Marine mammals
- Avifauna
- Bats
- Biodiversity
- Air
- Climate
- Scenery
- Cultural heritage and other material assets

- Human beings, in particular human health
- Interrelationships between factors

1.6.1 Overview of data source

The data and knowledge situations have improved considerably in recent years, in particular due to extensive data surveys in the context of environmental impact studies, and construction and operation monitoring for offshore wind farm projects and accompanying ecological research.

In general, the following data sources were used for the environmental report:

- Data from the operation of offshore wind farms
- Data from approval procedures for offshore wind farms
- Studies
- Findings and results from research projects and accompanying ecological research
- Comments from the competent authorities
- Comments from the (specialist) community
- Literature

As the data source may vary depending on the factor, the data foundation is dealt with at the beginning of chapter 2 in each case.

1.6.2 Indications of difficulties in compiling the documents

According to section 40 subsection 2 no. 7 of the Environmental Impact Assessment Act, indications of difficulties arising when compiling the data, such as technical gaps or lack of knowledge, are to be presented. The description and evaluation of the individual factors (chapter 4) make it clear that there are still gaps in knowledge in places. Information gaps exist in particular with regard to the following points:

- Long-term effects from the operation of offshore wind farms and associated systems, such as converter platforms
- Data for assessment of the state of the environment of the various factors in the area of the outer EEZ.

1.6.2.1 Soil/Area and biotopes

- There has been no extensive, detailed mapping to date of sediment distribution in the EEZ outside the nature conservation areas: the description and evaluation of environmental effects with regard to the soil as a factor are based primarily on the evaluation of selective data collection. In particular, there is no comprehensive sediment description for the detailed distribution of coarse sand/fine gravel sites and residual sediments in the form of gravel, stones and rocks.

  Detailed and extensive mapping of marine biotopes in the EEZ is currently being developed as part of R&D projects ongoing at the Federal Agency for Nature Conservation, with spatial emphasis on nature conservation areas. There is no detailed mapping to date of the biotopes, including the legally protected biotopes according to section 30 of the Federal Nature Conservation Act, in the EEZ outside the nature conservation areas.
- Please see planning principle 4.4.4.8 for assessment of compliance with measures regarding temperature increases in the sediment.

1.6.2.2 Benthos

- It is not possible to predict reliably the anticipated effects of the introduction of hard substrate on the development of benthic communities.

1.6.2.3 Fish

- There is a lack of more detailed information on pelagic fish.
- Information on the reaction of fish to noise emissions is available only to a very limited extent.
- The likely effects of habitat change on the development of fish fauna due to the introduction of hard substrate are still largely unknown.

1.6.2.4 Seabirds and resting birds

- The species-specific risk of seabirds colliding with offshore wind turbines can only be partially predicted and is currently being recorded with the investigations according to StUK4 in the operating phase, but also in ongoing research projects. In particular, suitable technology for recording effects is being developed.
- Behavioural changes and Habituation effects among disturbance-sensitive species in the German EEZ have only been investigated since the commissioning of the first large, commercial wind farms, including the converter platforms. Operational monitoring is still ongoing.
- There is still insufficient knowledge of the effects of disturbances or habitat loss at species population level, and these will only be investigated on the basis of the data currently being collected.

1.6.2.5 Migratory birds

- There is currently a lack of sufficient knowledge of the effects of offshore construction in some areas. Knowledge from coastal waters and on land is only transferable to a very limited extent due to the different conditions.
- The species-specific risk of migratory birds colliding with offshore wind turbines is largely unknown.
- Possible barrier impacts of offshore wind turbines on species-specific sea migration routes are largely unexplored.
- Whether the intensity of broad front migration of songbirds decreases according to the distance from the coast is not clear for the bulk of songbirds that migrate at night.

1.6.2.6 Marine mammals

The data availability can currently be described as very good: the data is systematically quality-assured and used for studies, so the current state of knowledge on the occurrence of marine mammals in German waters can also be classified as good.

The most comprehensive data source is provided by data from environmental impact studies and the monitoring of offshore wind farms. Data is collected regularly as part of the monitoring of nature conservation areas on behalf of the Federal Agency for Nature Conservation. Finally, research projects provide data on specific issues. SCANS observations are providing information for the entire distribution area of harbour porpoise so as to allow the abundance of the entire population of harbour porpoise to be assessed.

1.6.2.7 Bats

- There is a lack of knowledge about the quality and quantity of migratory bat populations across the Baltic Sea.
- There is currently a lack of sufficient knowledge of the effects of offshore construction. Knowledge from coastal waters and on land is only transferable to a very limited extent due to the different conditions.

- The species-specific risk of bats colliding with offshore wind turbines is largely unknown.

1.6.2.8 Summary

In principle, forecasts on the development of the living marine environment after implementation of the Site Development Plan are subject to specific uncertainties. Long-term data series or analytical methods are often lacking, e.g. for intersection of extensive information on biotic and abiotic factors so as to provide a better understanding of complex interrelationships in the marine ecosystem.

In particular, there is a lack of extensive, detailed sediment and biotope mapping outside the nature conservation areas of the EEZ. As a result, there is no scientific basis to permit assessment of the effects of the possible use of strictly protected biotope structures. Research and university institutions, and an environmental consultancy, are currently carrying out sediment and biotope mapping with spatial emphasis in the nature conservation areas on behalf of the Federal Agency for Nature Conservation and in cooperation with the Federal Maritime and Hydrographic Agency.

Furthermore, there are no scientific assessment criteria for some factors, both with regard to the assessment of their status and with regard to the effects of anthropogenic activities on the development of the living marine environment, to allow cumulative effects to be considered in both temporal and spatial terms.

Various R&D studies on assessment approaches, including for underwater noise, are currently being developed on behalf of the Federal Maritime and Hydrographic Agency. These projects are being used for continuous refinement of a consistent, quality-assured basis of information on the marine environment for assessment of possible effects of offshore installations.

Overall, the following recommendations can be made for the development of criteria for assessment of effects and the status of protected biological assets:

- Consolidation of results and evaluation of all existing data relating to factors,
- Intersection of biological data with information from marine physics, marine chemistry, marine geology and marine meteorology,
- Review of methods, in particular with regard to possible cumulative or transboundary impacts, for developing assessment criteria with regard to the condition of the living marine environment,
- Evaluation of effect monitoring so as to be able to record possible effects on factors.

2 Description and assessment of state of the environment

2.1 Introduction

According to § 40 subsection 2 no. 3 of the Environmental Impact Assessment Act, the environmental report includes a description of the characteristics of the environment and the current state of the environment in the SEA investigation area. The description of the current state of the environment is necessary in order to predict its change when the plan or programme is implemented. The protected assets listed in § 2 subsection 1 sentence 2 nos. 1 to 4 and their interactions are the subject of the stock survey. The information is presented in a problem-oriented fashion. Priority will therefore be given to potential initial loads, environmental elements that are particularly worthy of protection, and the factors on which the implementation of the plan will have a greater impact. In spatial terms, the description of the environment is based on the relevant environmental effects of the plan. Depending on the type of impact and the factor in question, these will have differing extents and may go beyond the limits of the plan (LANDMANN & ROHMER 2018).

2.2 Soil/Area

2.2.1 Protected asset Land

One objective of the specifications defined in the Site Development Plan is the spatially ordered and space-saving expansion of offshore wind turbines and the offshore connecting cables required for this purpose. Therefore, one aspect of this objective is the arrangement of the wind turbines within a site in a way that saves as much space as possible (see chapter 4.4.2 of the Site Development Plan). As no specific locations are planned for installations within the framework of the Site Development Plan, this is done by determining the expected generation capacity (chapter 4.7 of the Site Development Plan).

The protected assets Land and Soil are considered jointly below. The protected asset Land is dealt with in more detail where it makes sense or is necessary to do so.

2.2.2 Data availability

The description of the surface sediments in the Baltic Sea is based not only on the data and reports of the subsoil investigations from the Federal Maritime and Hydrographic Agency's methods and own investigations but also on the map of sediment distribution in the western Baltic Sea (FEDERAL MARITIME AND HYDROGRAPHIC AGENCY/LEIBNIZ INSTITUTE FOR BALTIC SEA RESEARCH, 2012). To date, however, the Baltic Sea does not have any extensive sediment and biotope mapping of the EEZ. The description and assessment of the environmental impacts with regard to the factor Soil are based primarily on the evaluation of selective data surveys (e.g. the map of sediment distribution in the western Baltic Sea, Federal Maritime and Hydrographic Agency/Leibniz Institute for Baltic Sea Research (2012).

The descriptions of the structure of the near-surface subsoil are essentially based on the geophysical and geotechnical data and reports of the subsoil investigations from the literature.

The data and information used to describe the distribution of pollutants in the sediment, suspended matter and turbidity, as well as nutrient and pollutant distribution, are collected during the Federal Maritime and Hydrographic Agency's annual monitoring cruises.

2.2.3 Geomorphology

The three areas O-1, O-2 and O-3 designated in the German EEZ of the Baltic Sea are located in the area of the Arkona Sea. The Arkona Sea of the German EEZ comprises the Arkona Basin, the south-eastern extensions of the Kriegers Flak shoal, the Adlergrund as the south-western extension of the Rønnebank and parts of the Pomeranian Bight and the Oder Bank. In the west of the Arkona Sea, the 40 m depth line forms the boundary to the Falster-Rügen Plate to the west of the Arkona Basin.

The Arkona Basin has a very balanced morphology and reaches water depths of up to 50 m in the German EEZ. In the north-west of the Arkona Basin, the extensions of the Kriegers Flak shoal extend into the area of the German EEZ. Here the water depths range from 21 m in the shoal area to 40 m in the direction of the Arkona Basin.

The Arkona Basin is bordered in the south-east by the Adlergrund. The Adlergrund is the south-western extension of the Rønnebank, which runs from the Danish island of Bornholm in a south-westerly direction. The water depths in the area of the Adlergrund range between 6 m in the upper reaches of the shoal and 30 m in the direction of the Arkona Basin.

The Pomeranian Bight with the Oder Bank forms the southern boundary of the Arkona Basin and the Adlergrund. The water depths in this area range between 6 m in the upper parts of the Oder Bank and 30 m in the area of the northern Pomeranian Bight. According to KRAMARSKA (1998), the actual Oder Bank is demarcated by the 10 m-depth line.

2.2.4 Sediment distribution on the seabed

The surface sediments in the area of the EEZ of the Arkona Basin consist almost exclusively of fine silt with different classifications. In the transition to the shoals of Kriegers Flak and Adlergrund and to the Pomeranian Bight, the surface sediments increasingly change into fine and medium sands. Area O-2 is located in the south-east Arkona Basin.

In contrast to the Arkona Basin, the shoals of Kriegers Flak and Adlergrund have a strongly structured morphology and a very heterogeneous lithological composition of the surface sediments. In the higher areas of the Kriegers Flak shoal, the seabed surface consists mainly of residual sediments, boulder clay, gravel and medium to coarse sands. Especially in the northern part of the Kriegers Flak shoal (area O-3), many stones and boulders can also be found, some of which form wall-like structures. In the direction of the Arkona Basin, the coarse sands change into medium and fine sands and with increasing depth into silt and clays.

The area of the Adlergrund to the southeast of the Arkona Basin (area O-2) also exhibits a very heterogeneous sediment distribution. The surface sediments consist mainly of residual sediments and differently sorted gravel and sands. Here, too, extensive stone and boulder fields as well as till and residual sediments can be found. In the direction of the Arkona Basin, the sediments change into fine sands, silt and clays. Stones can also be found in the deeper areas in the direction of the Arkona Basin.

South of the Arkona Basin or the Adlergrund, the sands of the Pomeranian Bight or the Oder Bank join the German EEZ of the Baltic Sea. They consist almost exclusively of well-sorted fine sands.

2.2.5 Geological structure of the near-surface subsoil

The near-surface subsoil of the Arkona Basin consists of 2 to 4 m thick, very soft to mushy marine silt, which can be sandier towards the edge of the basin (LEMKE 1998). Depending on the formation of the relief of the underlying sediments, this mushy silt can reach a thickness of more than 10 m locally. The thickest layers occur in the centre of the southern Arkona Basin between area O-3 in the north-west and areas O-2 and O-4 in the south-east (Figure 9).

In the southern Arkona Basin, the marine silt is deposited by a succession of post-glacial, silty clays and silt up to 5 m thick, some with a firm consistency. They may contain fine sands in isolated cases. At the edges of this succession, humic parts such as gyttjenlagen or peat lenses may occur. Late-glacial clays, silt and sporadic fine sands of varying consistency follow in the layers of post-glacial clays and silt. The largest thicknesses of up to 15 m are reached in the south-eastern Arkona Basin.

In the transition area to the Adlergrund (area O-1) there is a layer a few meters thick consisting of clay-silt fine and medium sands of varying thickness. In the near-surface subsoil, the sands are mainly followed by till with an inhomogeneous lithological composition of clays, silt and sands of varying consistency. Rock deposits of varying density and size are to be expected in the area of the till.

The Adlergrund itself has a rather thin layer of sand on the seabed surface, the thickness of which decreases from north-west to south-east and east. This sand layer is missing in large parts, particularly in the higher areas of the Adlergrund. But also in the other areas, it is frequently broken through by the underlying till. Under the sand bed is the till with a very heterogeneous lithological composition consisting of clays, silt, sands and scattered gravel. The till usually has a stiff consistency and can reach thicknesses of 20 m and more. Hydroacoustic recordings in the course of subsoil investigations also indicated numerous stones in the till.

The near-surface subsoil of Kriegers Flak is comprised of solid till, in some places more than 25 m thick, also with a very inhomogeneous lithological composition. The till is characterised by many stones and boulders, which are found both on the surface and in the subsoil, and which form a wall in the north of area O-3. In the direction of the Arkona Basin, the surface of the till is submerged and covered by soft clays and silt up to 4 m thick as well as sands.

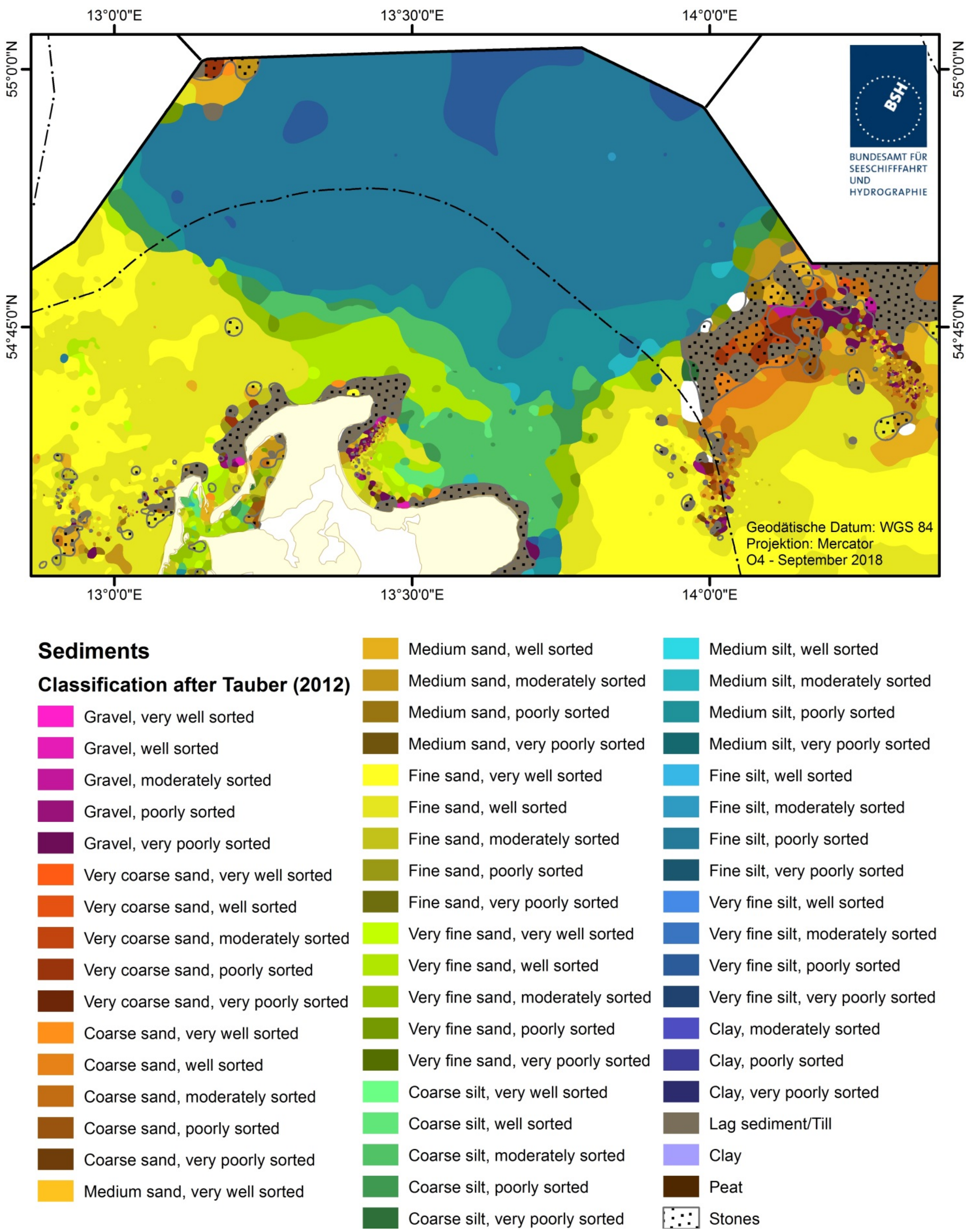

Figure 9: Distribution of surface sediments in the area of cross-cluster connections. The classification was based on TAUBER (2012)

2.2.6 Distribution of pollutants in the sediment

2.2.6.1 Metals

In the western Baltic Sea (Mecklenburg Bight to the Arkona Basin), no trend in the metal content of surface sediments has been identified to date due to the limited period of the available measurement series. The main concentrations of pollutants are located in the Lübeck Bight and the western Arkona Basin. The quality of the sediment in this area is expected to normalise in the long term as the contaminated site in Lübeck Bight is covered and the contaminated material is prevented from resuspension (being whirled up again). Elevated levels of mercury and lead have been measured in the western Arkona Basin for many years. The causes of this anomaly are not known to date. An increase of the element content in the surface sediment is usually observed in the direction of the coast. This applies in particular to mercury and cadmium, but also to zinc and copper. The lead content measured in the EEZ, on the other hand, is fairly comparable with the values observed near the coast, and in some cases even higher.

2.2.6.2 Organic substances

It is extremely difficult to provide a comprehensive overview of the sediment contamination because, first, data related to the open sea is quite incomplete and, secondly, data from coastal areas is highly heterogeneous. A regional analysis is made more difficult by the fact that the published data usually does not relate to the TOC content (TOC = total organic carbon) or to grain size standardisation. The concentrations in the EEZ are consistently lower than in the coastal areas, where local concentrations of pollutants often occur. Further regional assessments need to take into account sediment parameters (TOC, grain size distribution). The distribution in the EEZ is relatively homogeneous with comparable TOC contents of the sediments, while the concentration is always very low at stations with a low fine grain content and low TOC values (sandy sediments). Compared to the North Sea (German Bight), concentrations in the EEZ of the Baltic Sea are on average significantly higher; this is most likely due to the higher TOC and silt contents of the Baltic Sea sediments. No longer-term data is yet available for EEZ sediments, so that no conclusions can be drawn about temporal trends.

2.2.6.3 Radioactive substances (radionuclides)

Compared to other marine areas, the surface sediments in the Baltic Sea show significantly higher specific activities than e.g. those in the North Sea. In most cases, this statement also applies to natural radionuclides. On the one hand, this effect can be attributed to the fact that the grain size of the more silty and thus fine-grained sediments of the Baltic Sea is smaller, on the other hand, this is also due to the fact that the lower turbulence in the water of the Baltic Sea leads to sedimentation of the finer particles. The radioactive contamination of the Baltic Sea is caused by the fallout from the Chernobyl accident in 1986. The larger area deposition of the Chernobyl contaminants discharged into the area of the western Baltic Sea compared to the North Sea is also reflected in the higher level of activities. The development shows that the inventory in the sediments increased steadily in the first few years after the Chernobyl accident. For about 10 years now, stagnation has been evident, which can be explained by a quasi-equilibrium between radioactive decay (half-life of Cs-137: 30 years) and further deposition. Although the radioactive contamination of the Baltic Sea by man-made radionuclides is higher than in the North Sea, it does not pose a threat to humans and nature according to the current state of knowledge.

2.2.6.4 Inherited waste

Possible inherited waste in the EEZ of the Baltic Sea are old munitions dumpsites. A federal-state working group published a basic report on ammunition pollution in German marine waters in 2011, and this is updated annually. According to official estimates, 1.6 million tonnes of old ammunition and a wide variety of explosive ordnances are deposited on the beds of the North Sea and Baltic Sea. A significant proportion of these remnants of munitions date back to the Second World War. Even after the end of the war, large quantities of ammunition were dumped in the North Sea and Baltic Sea for the purposes of disarming Germany. According to current knowledge, explosive ordnance contamination in the German Baltic Sea is estimated at levels of up to 0.3 million tonnes. Overall, there is insufficient data to refer to, so it is necessary to assume that explosive ordnances are also to be expected in the area of the German EEZ (e.g. remnants of mine barrages and combat operations). The locations of the known munitions dumping areas can be found in the official nautical charts and the report from 2011 (with additional information on areas suspected of being contaminated with munitions). The reports by the federal-state working group are available from www.munition-im-meer.de.

2.2.7 Status estimation

2.2.7.1 Natural factors

Climate change and sea level rise: the Baltic Sea region has experienced a dramatic change in climate over the last 11,800 years, linked to a profound change in land-sea distribution due to the global sea level rise of 130 metres. For around 2,000 years, the sea level of the Baltic Sea has adjusted to today's level and is subject to short-term meteorological changes. Storms cause the biggest changes to the seabed. All sediment dynamic processes can be traced back to meteorological and climatic processes, which are essentially controlled by the weather in the North Atlantic.

2.2.7.2 Anthropogenic factors

Eutrophication: as a result of the anthropogenic inflow of nitrogen and phosphorus via rivers, the atmosphere and diffuse sources, increased primary production leads to increased sedimentation of organic matter in the Baltic Sea basins. Microbial degradation usually results in oxygen deficiency situations, which lead to the formation of gyttja, which has a much softer consistency than silt deposits.

Fishing: Since the end of World War I, commercial fishing in the Baltic Sea has almost exclusively involved the use of bottom trawls with trawl boards. Beam trawling is not carried out in this marine area (RUMOHR 2003). Only sporadic observations of fishing activities are available for the area under review. LEMKE (1998) describes many fishing activities in the silty area of the Arkona Basin. Traces of trawl boards are limited to an area south-west of the Oder Bank in the area of the Pomeranian Bight (SCHULZ-OHLBERG et al. 2002). The penetration depths in silt can reach up to 23 cm (WERNER et al. 1990), in silty fine sands up to 15 cm (ARNTZ & WEBER 1970) and in sands up to 5 cm (KROST et al. 1990). Much smaller traces are left behind by the roller and ball gear, which can be 2 to 5 cm deep according to diver observations (KROST et al. 1990).

Submarine cables (telecommunications, energy transmission): in the course of natural sediment dynamics, submarine cables laid on sandy seabeds are buried by themselves in less than one year, with no visible traces of installation (ANDRULEWICZ et al. 2003). No information is currently available on the depth of this self-burial process. However, it can be assumed that it ranges between 10 and 30 cm. Which laying methods are chosen depends essentially on the composition of the subsoil. If sediments are present that can be "pre-trenched", the sediment is resuspended (whirled up) during the pre-trenching process and settles again mainly in the immediate vicinity. The sediment dynamic processes generally lead to complete levelling of the traces left behind after laying, especially after periods of bad weather. In areas with soft to mushy silt, submarine cables can sink into the seabed due to their specific dead weight, where the formation of turbidity plumes is minimal. In areas with compact, non-pre-trenchable sediments (e.g. till), cable trenches must be ploughed where the cables can be laid. In the case of extremely compact sediments or dense rock occurrences, cables are generally laid on the seabed and protected by rock fill.

Anthropogenic factors impact on the seabed in the form of erosion, mixing, resuspension, material sorting, displacement and compression (compaction). The natural sediment dynamics (sedimentation/erosion/redeposition) and the mass transfer between sediment and seabed water are influenced in this way.

Status estimation

The assessment of the state of the seabed with regard to sedimentology and geomorphology is limited to the territories, and submarine cable routes in the area of the EEZ.

Table 5: Assessment of the state of the protected asset "Soil" with regard to sedimentology and geomorphology in the area considered.

Aspect: Rareness/vulnerability			
Criterion	Category		Estimation
The portion of the sediments on the seabed and distribution of the morphological form inventory.	High	Sediment types and soil forms occur exclusively in the EEZ.	MEDIUM – LOW
	Medium	Sediment types and soil forms are distributed in the south-western Baltic Sea.	
	Low	Sediment types and soil forms can be found throughout the Baltic Sea.	
Aspect: Diversity/uniqueness			
Criterion	Category		Estimation
Heterogeneity of the sediments on the seabed and development of the morphological form inventory.	High	Heterogeneous sediment distribution and pronounced morphological conditions.	MEDIUM
	Medium	Heterogeneous sediment distribution and no pronounced soil forms or homogeneous sediment distribution and pronounced soil forms.	
	Low	Homogeneous sediment distribution and unstructured seabed.	
Aspect: Naturalness			
Criterion	Category		Estimation
Extent of initial anthropogenic contamination of sediments on the seabed and of the morphological form inventory.	High	Almost no change due to anthropogenic activities	MEDIUM
	Medium	Change due to anthropogenic activities with no loss of ecological function	
	Low	Change due to anthropogenic activities with loss of ecological function	

2.3 Water

The Baltic Sea is an intracontinental sea. The Baltic Sea is connected to the Kattegat via the Little Belt, the Great Belt and the Øresund, which creates a connection to the North Sea and thus to the Atlantic via the Skagerrak. Due to the shallow water depths of the straits, there is not much water exchanged with the North Sea. In total, the Baltic Sea covers an area of 415,000 km² with an average depth of 52 m (JENSEN & MÜLLER-NAVARRA 2008). Due to its low salinity, the Baltic Sea is considered a sea with brackish water. Water circulation in the Baltic Sea is characterised by freshwater inflows via rivers and the exchange of water volumes with the North Sea. Due to the morphological conditions in the Baltic Sea a vertical stratification of salinity and temperature may develop, some of which is very pronounced. This stratification cannot be broken up by the water currents driven primarily by wind and the minimal tide (< 10 cm) (JENSEN & MÜLLER-NAVARRA 2008, FENNEL & SEIFERT 2008).

2.3.1 Currents

The circulation of the Baltic Sea is characterised by an exchange of water volumes with the North Sea through the Belts and the Sound. In the near-surface area, brackish Baltic Sea water flows into the North Sea, while at the bottom, heavier North Sea water with higher salinity from the Kattegat pushes into the Baltic Sea. This inflow of salt water is hindered by the Drogden Sill (sill depth 9 m) at the southern exit of the sound and the Darss Sill (sill depth 19 m) east of the Belt Sea. Due to specific weather conditions, salt water inflow occurs sporadically, with water rich in salt and oxygen partly penetrating into the deeper eastern basins of the Baltic Sea.

These inflow events of salt water from the Kattegat into the Baltic Sea, which contribute significantly to the "aeration" of the deeper Baltic Sea basins, are divided into two processes: first, there are the large salt water inflows, which transport large quantities of salt water into the Baltic Sea over a period of at least five days. Large parts of the Arkona Basin are filled with salt water in the process. The second process is medium-intensity inflow events that occur about 3 to 5 times per winter. Here the bottom water flows into the Arkona Basin as a dense bottom current after overflowing the Darss Sill and the Drogden Sill. The denser water flowing into the Arkona Basin over the Drogden Sill flows as a relatively narrow band counterclockwise along the edge of the Arkona Basin. It flows around the Kriegers Flak and continues towards the Darss Sill, where the salt water flowing in over the Darss Sill covers this band. From there the band continues east along the southern edge of the Arkona Basin in the direction of Bornholm Gatt, where it flows into the Bornholm Basin (BURCHARD & LASS 2004, LASS 2003).

Model investigations (BURCHARD et al. 2005) with a simplified numerical model modify this picture: according to these investigations, most of the water flowing in over the Drogden Sill flows clockwise around Kriegers Flak and affects the sector in the German EEZ less than the observations and model results published to date indicate. Measurements carried out with an acoustic Doppler profile current meter positioned on the ground east of Kriegers Flak could support these model results. Since the new model investigations are limited solely to the inflow from the Øresund, there are no new findings regarding the inflow from the Belt Sea (Darss Sill). It can be assumed that this inflow essentially spreads to the east at the southern edge of the Arkona Basin and thus also affects the deeper areas of the Adlergrund.

Currents in the Baltic Sea are primarily caused by the presence of wind (drift current). If a current hits a coast, gradient currents also occur as a result of the accumulation. A third factor is the freshwater outflow of the rivers at about 480 km³/year. If precipitation and evaporation are taken into account, there is a freshwater surplus of 540 km³/year, which corresponds to about 2.5% of the water volume of the Baltic Sea. Tidal currents are insignificant in the Baltic Sea. In the Fehmarn Belt, a net outflow of 8 cm/s is observed on the surface on an annual average and a net inflow of 7 cm/s on the ground (LANGE et al. 1991). Average speeds here are about 30 cm/s on the surface and 16 cm/s on the ground. In the large basins east of the Belts, the near-surface speeds are 10-18 cm/s and 7-13 cm/s near the ground. Table 6 shows characteristic current parameters for the Fehmarn Belt, the Mecklenburg Bight and the Arkona Basin.

Table 6: Characteristic current parameters for selected positions in the western Baltic Sea.

	Fehmarn Belt	**Mecklenburg Bight**	**Arkona Basin**
Water depth [m]	28	26	31
Near-surface:			
Average amount [cm/s]	28.7	17.7	9.6
Maximum amount [cm/s]	117.6	74.8	78.0
Residual current [cm/s]	7.6	1.4	2.3
Direction [°]	347	332	184
Near to the ground:			
Average amount [cm/s]	16.4	12.9	6.0
Maximum amount [cm/s]	92.7	90.7	30.0
Residual current [cm/s]	6.6	2.3	0.4
Direction [°]	114	175	230
Source	LANGE et al. (1991)		Federal Maritime and Hydrographic Agency measurement (2005)

2.3.2 Swell and water level fluctuations

In heavy seas, a distinction is made between the waves generated by the local wind, known as wind sea, and swell. Swells are waves that have left their area of origin. Due to the small size and the extensive fragmentation of the Baltic Sea, a fully developed swell rarely occurs. The swell in the Arkona Sea is only about 4%. The swell has a longer wavelength and a longer period than the wind-sea.

The height of the wind sea is dependent on the wind speed and the time over which the wind acts on the surface of the water (duration), and also on the fetch, i.e. the distance over which the wind acts. The significant or characteristic wave height (Hs), i.e. the mean wave height within the upper third of the wave height distribution, defines the size of the waves.

In the climatological annual cycle (1961-1990), the highest wind speeds occur in the Arkona Sea with about 19 knots in December and then drop continuously to 13 knots until June. The wind speed then rises again steadily until the end of November (Federal Maritime and Hydrographic Agency 1996). The annual average wind speed is 16.2 knots. This annual cycle can be applied to the average wave height of the sea cycle.

It is just under 1.4 m in December, falls to approx. 1.15 m by the end of January and maintains this value until mid-March. The value then drops steadily to 0.7 m by the end of May. Starting in June, the wave height increases continuously until December.

Water level fluctuations caused by tides are minimal in the Baltic Sea. The spring tidal range of the half-day tide lies under 10 cm in the area of the German EEZ. Due to its small size, the Baltic Sea reacts very quickly to meteorological conditions (BAERENS & HUPFER 1999).

Extreme high or low water levels are primarily caused by the wind. Water levels of more than 100 cm above or below mean sea level are called storm surge or low tide. In the long-term average, these extreme water levels lie about 110 to 128 cm above, or 115 to 130 cm below mean sea level. Individual events can be well above these values. In addition to storm surges and low tides, natural variations of the Baltic Sea basins (Seiches) cause water level oscillations of up to one metre.

For the 20th century, the annual maximum water levels of the Baltic Sea and the annual variability show a statistically significant positive trend with a significant increase in the 1960s and 1970s. Sea level oscillations with periods greater than one year are also correlated with the oscillations of the North Atlantic Oscillation Index (NAO).

Long-term factors influencing the mean sea level of the Baltic Sea are the isostatic land rise in the area of the Gulf of Bothnia (9 mm/a) and the eustatic sea level rise of 1-2 mm/a (MEIER et al. 2004). Estimates for global sea-level rise are between 0.09 and 0.88 m by 2100, provided that the West Antarctic ice mass remains stable. If it melts, the global sea level will rise by as much as 6 m.

2.3.3 Surface temperature and temperature stratification

Figure 10 provides, based on the data of JANSSEN et al. (1999), an area-wide distribution of the monthly average surface temperatures. The lowest temperatures occur in February on climatological average. The data set of JANSSEN et al. (1999) includes all available temperature measurements from the years 1900 to 1996. The summer warming starts in April and reaches its maximum in August. The cooling phase begins in September.

Between May and June strong thermal stratification builds up, reaching its maximum in August with temperature differences of up to 12 °C between surface and ground. Over the course of September, the thermal stratification quickly diminishes, and in October, the western Baltic Sea is largely homothermal in a vertical direction. Depending on the meteorological constraints, significant deviations from the long-term average may occur in individual years.

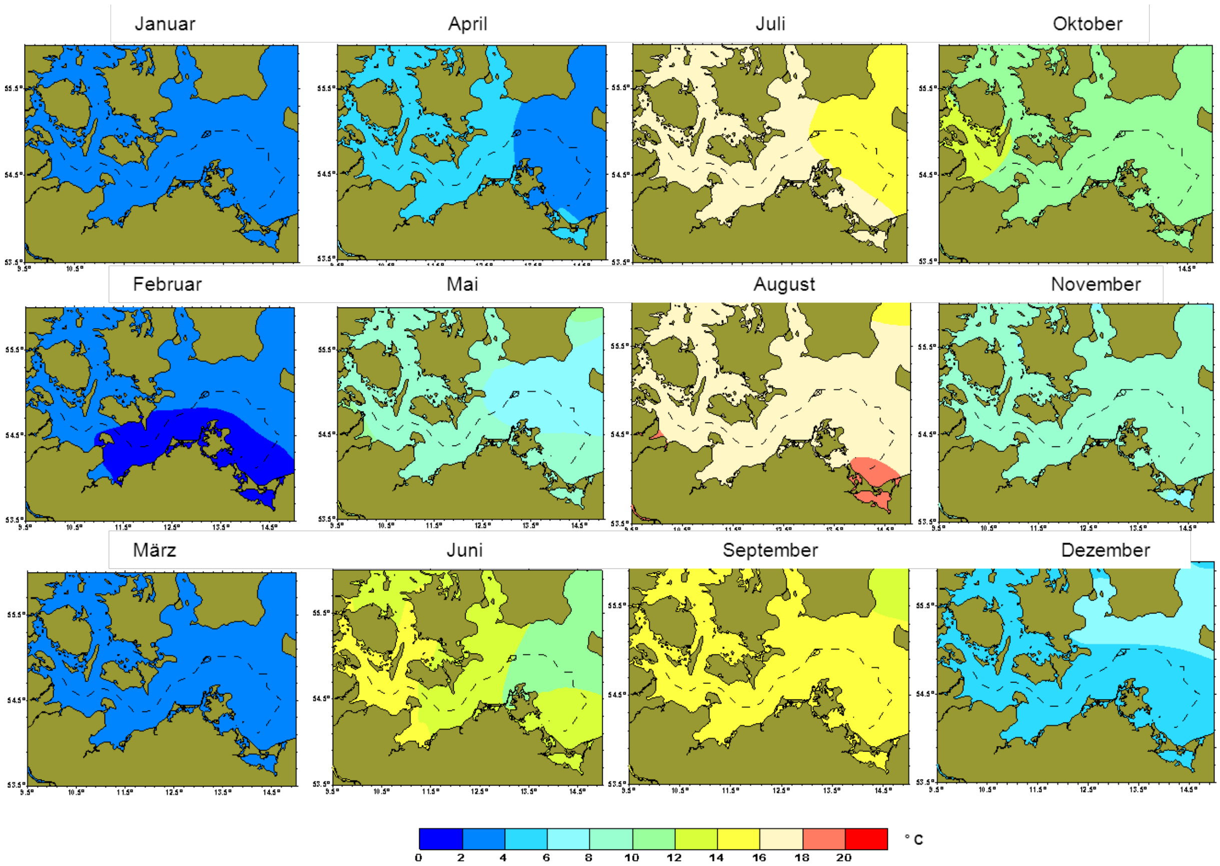

Figure 10: Climatological monthly average of the surface temperature (1900 – 1996) according to JANSSEN et al. (1999).

2.3.4 Surface salinity and salinity stratification

The salinity in the western Baltic Sea generally decreases from west to east, with the horizontal gradients being particularly pronounced in the Belts and Sound. Figure 11 shows the average annual cycle of the salinity of the surface layer according to JANSSEN et al. (1999). On a long-term average, the near-surface salinity in the Belt Sea can vary between 10 and 20 over the course of the year, while values between 6 and 8 have been observed in the eastern Arkona Sea. The 10 isohaline is highlighted to illustrate the boundary between the brackish Baltic Sea water with its low salinity and the water with higher salinity, which flows through the Belts and the Sound from the west from the Kattegat into the western Baltic Sea. Due to the higher density of the water with the higher salinity, this inflow takes place primarily at the bottom and is layered under the lighter surface water. The 10-isohaline reaches its most westerly position in the summer months and its most easterly position in December, when strong winter storms from the west push water from the Skagerrak and Kattegat into the western Baltic Sea.

For the salinity, the stratification is represented by the difference between soil and surface salinity in Figure 12. Large parts of the Belt Sea and the deep basins are haline-stratified year-round (water stratification caused by different salinities), while flat areas such as the Pomeranian Bight are vertically homohaline year-round or have only a very weak stratification. The haline stratification in the Belt Sea and the deep basins intensifies in spring and in summer reaches differences between surface and bottom salinity of more than 10.

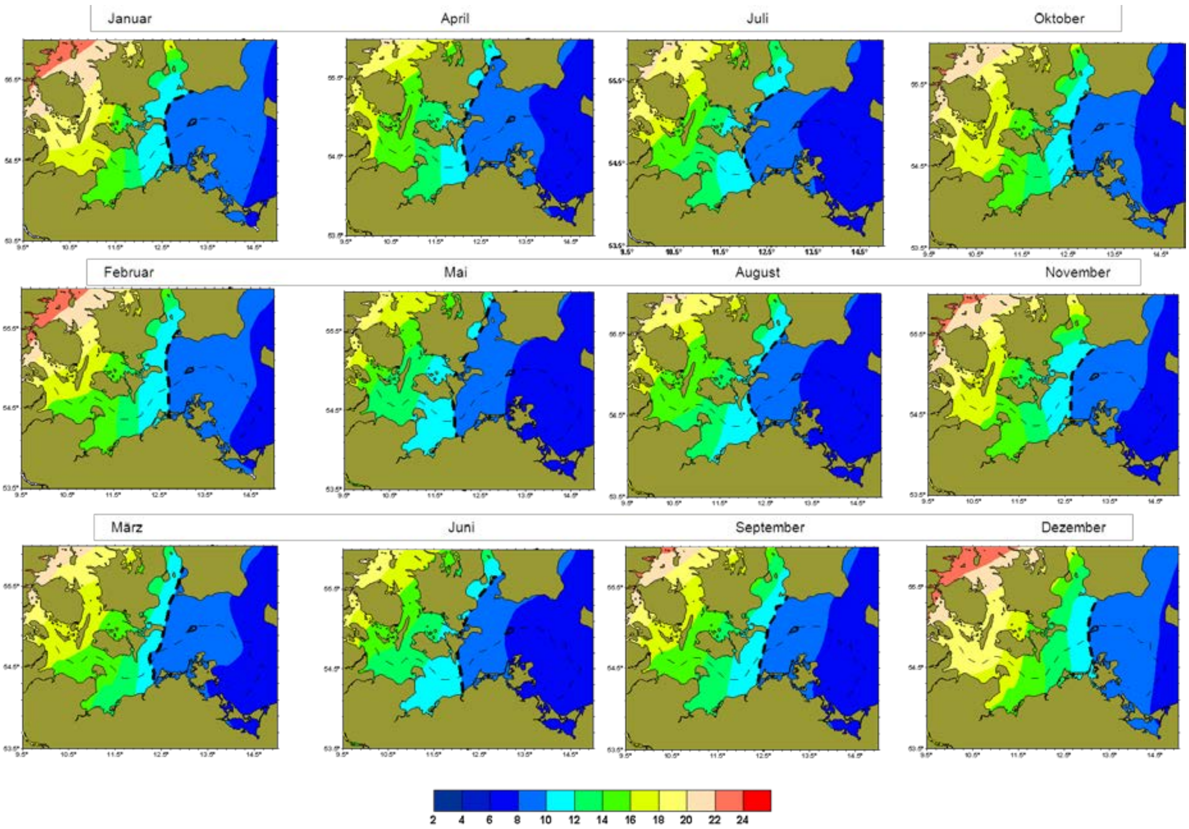

Figure 11: Climatological monthly average of the surface salinity (1900 – 1996) according to JANSSEN et al. (1999).

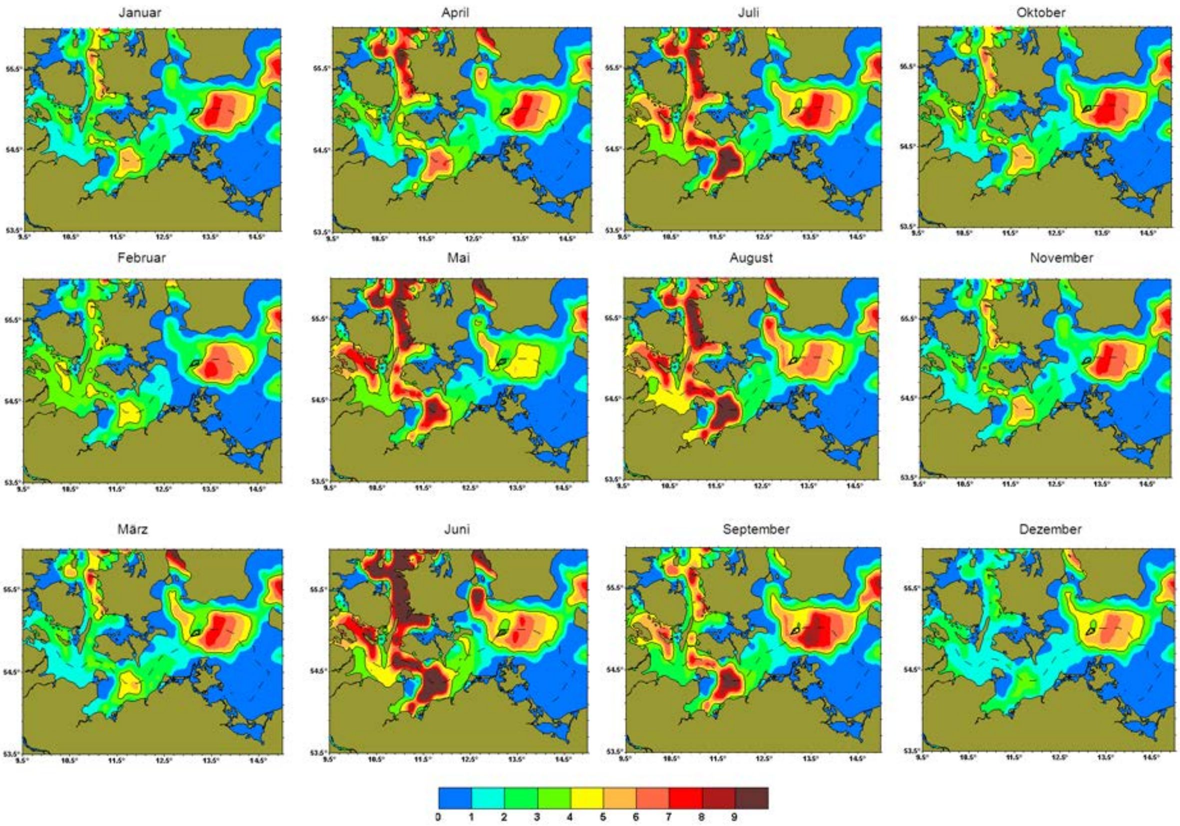

Figure 12: Salinity stratification in the western Baltic Sea according to JANSSEN et al. (1999).

2.3.5 Ice conditions

Ice does not form regularly in the Baltic Sea south of 56° N in winter. The type and stability of the general weather conditions prevailing over Europe are responsible for the large spatial and temporal fluctuations in ice cover. The ice can pass through four characteristic stages of development, determined by the severity of winter, regional oceanographic conditions, coastal morphology and sea depth. They are reflected in Figure 13 by the frequency distribution of ice occurrence.

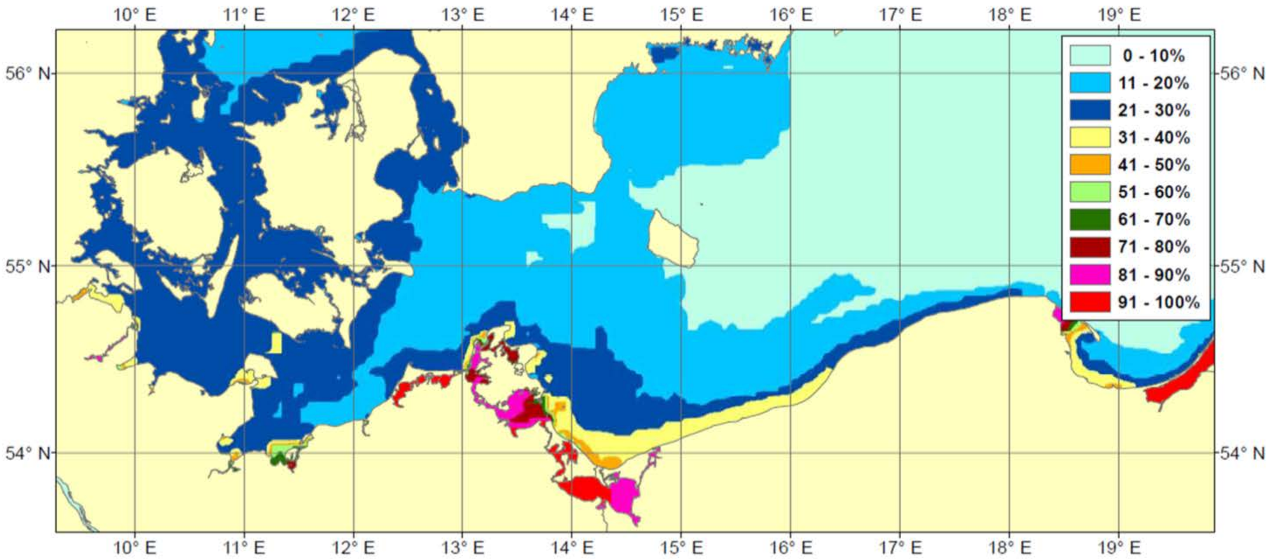

Figure 13: Frequency of ice occurrence in the Baltic Sea south of 56° N over a 50-year period 1961-2010 (Federal Maritime and Hydrographic Agency 2012).

In winters with moderate ice, only the shallow bays freeze completely, which have no significant water exchange with the warmer open sea due to their relatively closed position towards the sea. To a lesser extent, ice also forms on the outer coasts, especially off the east coast of Rügen and off Usedom.

In winters with lots of ice, the surface layers of the Kiel and Mecklenburg Bights and the Fehmarn Belt are cooled to such an extent that ice forms on the open sea. It grows into grey ice (ice thickness 10-15 cm). The degree of coverage is usually less than 6/10 of the water surface over a large area. East of the Darss Sill, ice occurs only in a narrow strip outside the Baltic Sea coasts, whose coverage predominantly amounts to less than 6/10.

In winters with very large amounts of ice, the Baltic Sea west of Bornholm freezes completely, and off the Baltic and Swedish coasts, a wide strip of dense to very dense drift ice (more than 7/10 coverage) occurs. It consists mainly of white ice with a thickness of 30-70 cm.

In the very rare winters with extreme ice, the marine area between Bornholm and the Baltic coast also uses up the considerable heat reserve of the water due to its great depth, so that a closed ice cover can also form there. This very rare ice condition was reached in the last century in the winters 1939/40, 1941/42 and 1946/47.

In the 50-year period 1961-2010 ice occurred in the Baltic Sea south of 56° N with a frequency of 80 to 100% in shallow and sheltered bays, 20 to 50% on the outer coasts and 5 to 30% in the marine area.

2.3.6 Suspended matter and turbidity

The term "suspended matter" refers to all particles with a diameter >0.4 µm that are suspended in seawater. Suspended matter consists of mineral and/or organic material. The organic portion is heavily dependent on the season, the highest values occur during the plankton blooms in early summer. In stormy weather conditions resulting in high waves, the suspended matter content in the entire water column rises sharply due to the whirling-up of silty-sandy bottom sediments. The greatest effect here is exerted by the wind-sea and, in deeper water, swell in particular. In the shallow water areas of the Baltic Sea, the sandy sediment is often covered by a layer of flocculent material (fluff), which can be resuspended very easily and has a high portion of organic material (EMEIS et al. 2000).

The available data for in-situ measurements is very inhomogeneous for the German EEZ of the Baltic Sea and insufficient for reaching statistically sound conclusions. For an initial estimate of the near-surface distribution of suspended matter, the monthly means of the near-surface Suspended Particulate Matter (SPM) from the MERIS[35] data of the ENVISAT satellite of the European Space Agency (ESA) for 2004 are presented in Figure 14.

The highest concentrations are recorded in the Oderhaff and the Bodden. In spring, large amounts of fresh water runoff (snow melt) increasingly introduce suspended matter into the Pomeranian Bight. Since eastern winds dominate in spring, the suspended matter is mainly transported along the coast into the Arkona Sea (SIEGEL et al. 1999). The sedimentation rate in the Arkona Basin was estimated by EMEIS et al. (2000) to approx. 600 g pro m^2 per year. Between the southern tip of Falster, the Gedser Odde, and the south-eastern coast of Lolland, an increased concentration of suspended matter is visible above the Röd-Sand all year round. It is mainly formed as a result of cliff erosion caused by currents.

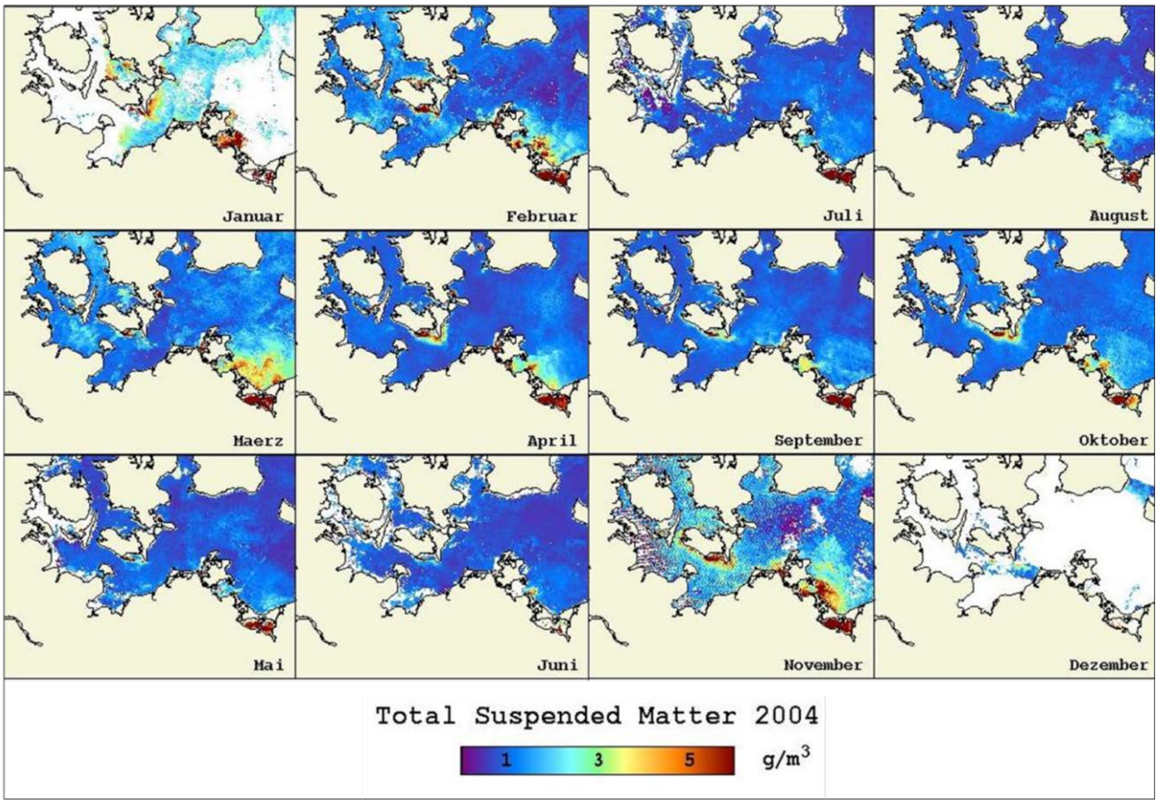

Figure 14: Monthly means of the near-surface total suspended particulate matter from the MERIS data of the ENVISAT satellite for 2004.

2.3.7 Status assessment with regard to nutrient and pollutant distribution

Overall, the Baltic Sea area is a sensitive ecosystem because nutrients and pollutants remain in this area for long periods of time due

[35] Remote sensing method "Medium Resolution Imaging Spectrometer"

to the limited amount of water exchanged through the Belt Sea. Key problems continue to result from excessive nutrients and the resulting eutrophication phenomena. The levels of nutrients and pollutants are naturally higher at the estuaries and coasts and decrease towards the open sea.

2.3.7.1 Nutrients

Nutrient salts such as phosphate and inorganic nitrogen compounds (nitrate, nitrite, ammonium), as well as silicate, are of fundamental importance for marine life. These substances are vital to the formation of phytoplankton (microscopic unicellular algae that float in the sea): the entire marine food chain is based on the biomass production of phytoplankton. These trace substances promote growth, so they are referred to as nutrients. An excess of these nutrients – which did actually occur in the 1970s and 1980s due to extremely high nutrient inputs from industry, transport and agriculture – leads to strong accumulation of nutrients in seawater and results in overfertilisation (eutrophication). This continues in the coastal regions even today. As a result, there may be an increased occurrence of algal blooms (particularly cynobacteria blooms in the Baltic Sea), reduced visibility depths, shifts in the species range and oxygen deficiency situations near the ground.

To monitor the nutrients and oxygen content, the Leibniz Institute for Baltic Sea Research carries out several monitoring trips per year on behalf of the Federal Maritime and Hydrographic Agency. In the Baltic Sea, a typical annual cycle of nutrients can be observed similar to that in the North Sea, with high nutrient concentrations in winter followed by a sharp decrease in concentrations in spring with the onset of biological activity.

From a spatial point of view, the nutrient concentrations in the inner coastal waters are generally two to three times higher than on the outer coast in the offshore open sea; although these differences are more pronounced for nitrate concentrations than for phosphate concentrations. Particularly in the shallow areas of the Baltic Sea, varying stratifications of temperature and salinity lead to highly variable nutrient distributions. Furthermore, exchange processes between water and sediment – especially the re-dissolution of phosphorus – play an important role for the concentrations in the water column in these shallower areas.

The occurrence of areas with oxygen deficiency in the Baltic Sea is a natural phenomenon due to the low water exchange with the North Sea and the permanent stratification of the water body. However, eutrophication and the associated increased degradation of organic material increase the frequency, intensity and spatial extent of areas of oxygen deficiency. Since the re-dissolution of phosphorus from the sediment occurs in particular when oxygen is deficient, eutrophication is further intensified.

Even though the levels of phosphorus and nitrogen compounds in German tributaries to the Baltic Sea have been declining since the 1990s, the eutrophication problems in the Baltic Sea are only declining very slowly due to this internal fertilisation. The subsequent assessment pursuant to the EU MSFD therefore concludes that 100% of the German Baltic Sea is still eutrophic (Federal Ministry for the Environment, Nature Conservation, Construction and Nuclear Safety 2018). The assessment is based on the HELCOM Eutrophication Assessment Tool HEAT 3.0, which classifies the entire Baltic Sea as eutrophicated – with the exception of smaller areas in the northern Baltic Sea and the Kattegat (HELCOM 2017).

2.3.7.2 Oxygen

The deeper areas of the western Baltic Sea are characterised by oxygen deficiency in summer. The intensity of oxygen depletion depends on meteorological (temperature, wind) and hydrographic (stratification) factors as well as on the level of nutrient inputs from the catchment area. The year 2002 was an extreme situation with extreme oxygen depletion, especially off the Danish and Schleswig-Holstein coasts. Hydrogen sulphide had a widespread occurrence with its negative consequences for the soil fauna. In the deep basins of the central Baltic Sea, the frequency and intensity of salt water inflow from the North Sea, which is necessary for water renewal and oxygen supply, has been significantly reduced since the mid-1970s. In the last 30 years, significant inflow events were recorded only in 1983, 1993 and 2003. Between the events, there were long periods of stagnation with considerable concentrations of hydrogen sulphide in the deep water.

Due to the limited water exchange with the North Sea, the soil morphology and the permanent haline stratification, stagnation periods occur regularly in the deep waters of the central Baltic Sea. Salinity and oxygen concentrations are in decline and considerable amounts of hydrogen sulphide develop. The deep water can only be renewed by salt water inflows that transport water with high salt and oxygen contents into the deep basins.

2.3.7.3 Metals

The metals cadmium, mercury, lead and zinc show a typical spatial distribution with a decreasing gradient from west to east in the surface water of the EEZ (see FEDERAL MINISTRY FOR THE ENVIRONMENT, NATURE CONSERVATION, CONSTRUCTION AND NUCLEAR SAFETY, 2012b). Copper, by contrast, shows no clear concentration gradient. The medians of zinc concentrations (1999 to 2004) are clearly above the background reference value and those of copper concentrations are slightly above the background reference value at all stations of the EEZ far from the coast (FEDERAL ENVIRONMENT AGENCY 2004). The elements lead and cadmium show concentrations in the western part of the EEZ whose median is above the reference value and in the eastern part close to or below the reference value. The cadmium concentrations in water are very low overall. In the western part of the EEZ, for example, their median is close to the reference value, and well below it in the eastern part. According to the current state of knowledge, the metal concentrations in seawater mentioned above do not pose an immediate threat to the marine ecosystem.

2.3.7.4 Organic pollutants

The more polar compounds such as the HCH isomers and the modern pesticides (triazines, phenylureas and phenoxyacetic acids) are present in water in significantly higher concentrations than the more lipophilic, "traditional" pollutants such as HCB, DDT, PCB and PAH. The lipophilic chlorinated hydrocarbons (HCB, DDT and PCB) are found in water only in very low concentrations (mostly < 10 pg/L). The pollution is generally higher in coastal areas than in the open Baltic Sea. Temporal trends cannot be seen due to the high variability and limited data availability.

The level of petroleum hydrocarbons in the Baltic Sea water is low. The identification of the individual components shows that the aliphatic hydrocarbons originate mainly from biogenic sources. The concentrations of PAHs are also relatively low and do not exhibit any particular spatial distribution. The concentrations of more highly condensed PAHs (4-6 ring aromatics) increase near the coast, which is largely due to a higher content of suspended particulate matter. Due to the high variability, no temporal trends can be seen for any of the different hydrocarbon classes, whereas there are seasonal differences with highest values observed in winter (PAH). The exposure to toxic relevant PAHs is two to three orders of magnitude lower than the concentrations at which the first signs of carcinogenic effects were observed in animal experiments (VARANASI 1989).

Most pollutant concentrations in Baltic Sea water are in areas similar to those in the German Bight. Slightly higher concentrations have been found in the Baltic Sea in the DDT group. The values for γ-HCH are also slightly higher. The concentrations of α-HCH are about three times as high as in the North Sea, while those of β-HCH are at least ten times as high. In contrast to the southern North Sea, the spatial distribution in the western and central Baltic Sea is characterised by a lack of larger input sources. Only small gradients or no gradients are found for this reason. Long-term trends have only been found for HCH isomers. Both in the short term and in the long term, very significant decreases in concentrations can be seen here.

The quite low concentrations of pollutants currently observed in the sea mean that great attention must be paid in all activities to prevent new inputs into the sea, as this would inevitably lead to a deterioration of the environment. This also needs to be seen in the context of the strategies of the Marine Conventions, which stipulate that concentrations of hazardous anthropogenic pollutants are to be reduced to almost zero by 2020.

2.3.7.5 Radioactive substances (radionuclides)

The Chernobyl accident and the subsequent fallout have significantly changed the inventory of man-made radionuclides, in particular Cs-134 and Cs-137, with large deposits recorded in the Gulf of Bothnia and the Gulf of Finland. In the following years, these high levels of contamination with surface water also penetrated the western Baltic Sea. The contamination of the Baltic Sea by radioactive substances has decreased in recent years. Due to the very low average water exchange of the Baltic Sea with the North Sea through the Danish straits over many years, the contaminants discharged by Chernobyl remains in the water of the Baltic Sea over a longer period of time. Concentrations of Cs-137 continue to increase slightly to the east – in the direction of the main concentration of the Chernobyl fallout. Concentrations of Cs-137 are still higher than before the Chernobyl accident in April 1986. This nuclide makes the largest contribution of man-made radionuclides for a possible dose from the exposure pathway "seafood consumption". However, there is no reason to fear a significant dose from this source or when spending time on the sea or beach.

2.4 Plankton

All organisms that float in water are termed 'plankton'. These mostly very tiny organisms are a fundamental component of the marine ecosystem. Plankton include plant organisms (phytoplankton), tiny animals and developmental stages of the life cycle of marine animals, such as eggs and larvae of fish and benthic organisms (zooplankton), as well as bacteria (bacterioplankton) and fungi.

2.4.1 Data availability and monitoring programmes

Phyto- and zooplankton have been regularly studied in the Baltic Sea under the Helsinki Convention (HELCOM) since 1979. Under the scope of the COMBINE Monitoring Programme of HELCOM, the countries bordering the Baltic Sea carried out investigations of both phyto- and zooplankton in a large-scale station network in the Baltic Sea. This data is now freely available via ICES. In addition, coastal waters are tested for plankton as part of the national marine monitoring for the Baltic Sea.

In the western Baltic Sea, the Leibniz Institute for Baltic Sea Research is investigating plankton samples from stations in coastal waters and in the German EEZ as part of its national monitoring programme. Since 1979, the German EEZ of the Baltic Sea has been covered by a total of 5 stations: one in the Mecklenburg Bight, one on the Darss Sill, two in the Arkona Sea and one on the Oder Bank. The Leibniz Institute for Baltic Sea Research takes two samples (outward and return voyages) per station each year on a total of five ship trips. In addition, the number of samples per station is adapted to the prevailing water stratifications (thermocline and halocline) so that conclusions can be drawn about the vertical distribution of the plankton. Vertical samples are particularly relevant for recording zooplankton, as it occurs in different communities in the vertical distribution of the water column.

A total of 65 samples were taken in 2015. The monitoring trips took place in February, March, April/May, July and October/November. However, there are no continuous samples of the plankton. Due to the lack of continuous sampling, the picture of the occurrence of plankton communities is incomplete. In particular, long-term changes in the plankton and their causes cannot be accurately tracked.

2.4.2 Spatial distribution and temporal variability of phytoplankton

Phytoplankton are the lowest living component in marine food chains, and include tiny organisms usually up to 200 µm in size and taxonomically classified as belonging to the plant kingdom. These are microalgae, usually consisting of a single cell or capable of forming chains or colonies from several cells. Phytoplankton organisms mainly feed autotrophically, i.e. photosynthesis allows them to use the inorganic nutrients dissolved in the water for the synthesis of organic molecules for growth. Phytoplankton also include microorganisms that can feed heterotrophically, i.e. on other microorganisms. There are also mixotrophic organisms that can feed autotrophically or heterotrophically, depending on the situation. Many microalgae, for example, are capable of changing their diet over the course of their life cycle. Bacteria and fungi also form separate phylogenetic (evolutionary) groups. When considering phytoplankton, bacteria, fungi and organisms that are closer to the animal kingdom due to their physiological properties are also taken into account. The term 'phytoplankton' is used in this extended sense in this report.

Around 800 different phytoplankton species occur in the Baltic Sea (WASMUND 2012). The following important taxonomic groups belong to the phytoplankton of the western Baltic Sea:

- Diatoms (Bacillariophyta*),*
- Dinoflagellates (Dinophyceae),
- Microalgae or microflagellates of different taxonomic groups, and
- Blue-green algae (cyanobacteria). These dominate freshwater and brackish water areas. This group can become very abundant in waters with low salinity, such as the Baltic Sea.

Phytoplankton serve as a food source for organisms that specialise in filtering water for their food. The most important primary consumers of phytoplankton are zooplanktonic organisms such as copepods (Copepoda) and water fleas (Cladocera).

The special nature of the Baltic Sea as a semi-enclosed secondary sea also results in special ecological properties and shapes the occurrence of biological communities. Overall, the Baltic Sea is characterised by limited biodiversity. The brackish water of the Baltic Sea has decreasing salinity from 20 PSU in the west to 1 PSU in the east. The water masses of the Baltic Sea also exhibit very strong stratification. The species range consists of marine species as well as freshwater species. The special conditions of the Baltic Sea also make the marine food chains of the Baltic Sea very sensitive to changes.

The occurrence of phytoplankton depends primarily on the physical processes in the water column. Hydrographic conditions – in particular temperature, salinity, light, current, wind, turbidity, topography and exchange processes – influence the occurrence and biodiversity of phytoplankton. The direct dependence of phytoplankton on light for photosynthesis limits its occurrence in the euphotic zone of the pelagic. The depth of the euphotic zone depends on the clarity or the turbidity of the water body. The turbidity of the Baltic Sea varies considerably between the different regions. Over the past 25 years, turbidity has increased drastically in many regions of the Baltic Sea. The increase in turbidity has promoted the growth of blue-green algae and often leads to excessive blue-green algae blooms in summer. However, in 2015 the blue-green algae bloom in the entire Baltic Sea remained below the level observed in recent years. This is due to the lower Sea Surface Temperature (SST) in the summer months compared to the previous year.

In addition to the physical processes, the concentration of nutrients suspended in the water determines the abundance and biomass development of the phytoplankton. Various natural and anthropogenic factors also influence the distribution and abundance of plankton. In the North and Baltic Seas, for example, the Northeast Atlantic Oscillation (NAO) is crucial for the natural succession of plankton. River inputs also affect plankton development - both through freshwater outflows and nutrient and pollutant concentrations. Some plankton species and developmental or resting stages also use the sediment as a habitat. However, the actual habitat of the plankton is formed by the water masses. A spatial delimitation of habitat types is therefore only possible to a very limited extent for plankton, unlike e.g. for benthos. The hydrographic properties of water masses are more important for the associations of plankton species.

Seasonal phytoplankton growth in the Baltic Sea displays fixed patterns. Salinity, water depth and water retention time determine the occurrence and development of phytoplankton (THAMM et al. 2004). Shallow coastal waters warm up more quickly in spring and encourage the growth of phytoplankton. Nutrient inputs via the rivers also promote growth.

Spring blooms are usually dominated by diatom species. Spring algae blooms are triggered by the accumulation of nutrients in the previous winter months, the increase in light intensity and the associated warming of the water.

The spring bloom in the Mecklenburg Bight in 2015 was not dominated by diatom species as was usually the case. Dinoflagellates, dictyochophyceae and prymnesiophyceae were more dominant. However, the Mecklenburg Bight is a very diverse system, meaning that these shifts could also be due to inaccurate measurements. Bloom development in the Arkona Sea started with *Mesodinium rubrum*. In mid-March the bloom was dominated by diatoms (WASMUND et al. 2016a). The boundary between different bloom formations usually lies between the western and central Baltic Sea at the Darss Sill. In 2015 this boundary ran along the eastern Mecklenburg Bight. The spring bloom grew until mid-March 2015 and last disappeared in mid-April, where nitrate was the limiting nutrient factor this year (WASMUND et al. 2016a).

From year to year, different diatom species such as *Thalassiosira levanderi, Skeletonema costatum, Thalassiosira baltica, Dictyocha speculum* and *Chaetoceros* sp. are responsible for the spring algae bloom. Diatomic blossoms usually end abruptly in May. Dinoflagellates increase at the same time. In particular, dinoflagellates are also found in high concentrations in deeper areas (15 m). Flagellates probably use nutrients from deeper water layers or low concentrations of regenerated nutrients. *Gymnodinium* sp. and *Peridiniella* sp. belong to the most frequently occurring taxa of dinoflagellates (WASMUND et al. 2005). In the summer months of July and August, blue-green algae occur in high concentrations and often cause extensive blooms. Blue-green algae blooms are encouraged by salinity values between 3.8 and 11.5 PSU, temperatures around 16°C, radiation of more than 120 W/m^2 (daily mean values) and wind speeds of less than 6 m/s. The development of blue-green algae blooms ends with deterioration of the weather conditions (low solar radiation or strong winds) (WASMUND 1997). In autumn diatom blooms grow again, but they are very weak compared to spring blooms (WASMUND et al. 2005). In the last 30 years, the group of diatoms has experienced a continuous change in species composition in summer and autumn blooms. For example, the species of the diatom genera Skeletonema and Chaetoceros are gradually replaced by *Ceratulina pelagica*, *Dactyliosolen fragilissimus*, *Proboscia alata*, *Pseudo-nitzschia* spp. (WASMUND et al. 2016a).

Eutrophication poses a major threat to the marine ecosystem of the Baltic Sea. The concentration of chlorophyll$_a$ in water, as a metric for the biomass of phytoplankton, provides information on the degree of eutrophication. In the Arkona Sea the concentration of chlorophyll$_a$ in the water is much lower than in the Finnish Bight or in the northern Baltic Sea (HELCOM 2004). In the period 1993 to 1997 the average primary production in the Arkona Sea varied between 37 mg C*m^{-2} per day in January to February and 941 mg C*m^{-2} per day in the months June to September (WASMUND et al. 2000).

Leibniz Institute for Baltic Sea Research series of measurements from 1979 to approx. 1995 show a significant increase in chlorophyll$_a$ concentration during this period. Since then, measured values have been recorded at an almost constantly high level or slightly decreasing values (WASMUND et al. 2016a). The high nutrient concentrations (mainly nitrate, phosphate) that were introduced in the 1970s had a particular effect on the increase of the spring blooms, with the summer and autumn blooms achieving largely the same characteristics. The Mecklenburg Bight is an exception where spring blooms have been continuously decreasing since the start of measurements in 1979 (WASMUND et al. 2016b).

2.4.3 Spatial distribution and temporal variability of zooplankton

The zooplankton contains all marine animals floating or migrating in the water column. In the marine ecosystem, zooplankton plays a central role as the lowest secondary producer within the marine food chain as a food source for carnivorous zooplankton species, fish, marine mammals and seabirds. The zooplankton also has a special significance as a primary consumer (grazer) of phytoplankton. Grazing can stop the algal bloom and regulate the degradation processes of the microbial cycle by consuming the cells.

In the Baltic Sea, the sequence of zooplankton occurs in a distinct seasonal pattern. Maximum abundances generally occur during the summer months. The succession of zooplankton is of critical significance to secondary consumers in marine food chains. Predator-prey ratios or trophic relationships between groups or species regulate the balance of the marine ecosystem. Temporal or spatial offset of the occurrence of succession and abundance of species leads to interruption of food chains. Temporal offset in particular – or trophic mismatch, as it is also known – results in food shortages at various stages of organism development and impacts on the population level.

The zooplankton is divided into two large groups based on the life strategies of the organisms:

- *Holozooplankton:* the entire life cycle of organisms takes place exclusively in the water column. The most well-known *holoplanktonic* groups important for the Baltic Sea are crustaceans such as *Copepoda* (copepods) and *Cladocera* (water fleas).
- *Merozooplankton:* only certain stages of the organisms' life cycle, mostly early stages such as eggs and larvae, are planktonic. The adult individuals then switch to benthic habitats or join the nekton. These include early life stages of bristle worms, mussels, snails, crabs and fish. Pelagic fish eggs and fish larvae are abundant in meroplankton during the reproduction period.

Merozooplankton was particularly abundant in the Kiel Bight in 2015, but fell to below-average abundances in the Arkona Basin and the Mecklenburg Bight. Larvae of polychaetes and mussels were among the main representatives (WASMUND et al. 2016a).

The genera belonging to the holozooplankton *Acartia* and *Oithona* were the main representatives among the copepods in 2015 with *Acartia bifilosa* being the most common species (WASMUND et al. 2016a).

As already mentioned above, marine invertebrates have various developmental stages that occur in plankton (e.g. larvae). The distribution of larvae largely determines the occurrence and population development of both nectonic and benthic species. The transport, distribution and successful colonisation of larvae are of particular importance for the spatial distribution of species and the development of their populations. The distribution of larvae is determined by both the movements of the water masses themselves and the endogenous or species-specific characteristics of the zooplankton. Environmental factors that can influence the distribution, metamorphosis and colonisation of larvae include sediment type and structure, meteorological conditions (especially wind), light, temperature and salinity.

Two transport mechanisms influence the distribution of the larvae and their colonisation in the final habitat: horizontal advection of the larvae with the prevailing current direction and diffusion through small and mesoscale turbulence, i.e. mixing processes in the water body. Field investigations have shown that larvae can form colonies in both local and far away areas. The distribution of larvae from coastal waters is usually regulated by frontal zones between coastal waters and the open sea. However, the larvae have a limited ability to migrate vertically within the water column to areas that allow the boundary layer to be crossed, for example areas with increased turbulence. The organisms develop species-specific strategies for the distribution of larvae and successful colonisation. These strategies, which ultimately ensure the survival of the species, range from adjustment of the reproduction time, depth and area to vertical movements of the larvae and active crossing of boundary layers. The larval competence or maintaining the ability to induce metamorphosis until beneficial conditions emerge regulates the colonisation success of individuals of all species in the species-specific habitat (GRAHAM & SEBENS 1996).

It is difficult to characterise habitat types due to the occurrence of zooplankton. As already explained for phytoplankton, water masses actually form the habitat of zooplankton. A characterisation of water masses and the related zooplankton associations is therefore useful for this purpose. To differentiate between water masses, it is not the species range of the zooplankton populations that is important, but rather the proportion of the respective species, in particular the key species, in the composition of the associations.

A shift in vertical distribution occurs in Baltic Sea biocoenoses due to variability in salinity. This phenomenon was called submergence by REMANE (1955). Animals of the marine eulittoral and the supralittoral can withstand greater fluctuations in salinity than animals of the sublittoral or sea depth. They can therefore penetrate further into brackish water than marine depths. Only very few species can penetrate into the depths, namely those that can eat carnivorous food. However, the phenomenon of brackish water submergence is not a special feature of the Baltic Sea, but is typical for brackish waters (REMMERT 1968). For example, the species *Oithona similis* occurs in the Kiel Bight in concentrations of several thousand individuals per m^3 in the near-surface area. In contrast, this species lives east of the faunistic border of the Darss Sill in salty deep water. The samples taken from the station in the Arkona Sea in 2003 after the salt water inflow showed that with increasing water depth the abundance of this species increased from 2,400 females per

m^3 in the upper 5 m to 31,500 females per m^3 between 18 and 22 m water depth (WASMUND et al. 2004).

An average of 22 zooplankton taxa per year occur in the Baltic Sea (WASMUND et al. 2005). However, only 12 taxa were found year-round between 1999 and 2002 (POSTEL 2005). In general, species range, abundance and dominance conditions depend on the prevailing hydrographic and meteorological conditions and the development of phytoplankton: salt water inflows from the North Sea supply the ecosystem of the Baltic Sea with marine species such as the *Paracalanus parvus* and *Euphysa aurata*. The *Sagitta elegans* occurs after the autumn and winter storms.

During long periods of stagnation, however, the brackish water copepod species *Limnocalanus macrurus* frequently occurs in the southern Baltic Sea (POSTEL 2005). Mild winters, but also warm summers also affect the occurrence and abundance. Heat-loving species such as the copepods *Acartia tonsa* and *Eurytemora affinis* occur more frequently in particularly warm summer months. The occurrence of merozooplankton is determined by the oxygen conditions on the seabed and the reproduction cycles of benthic organisms.

In 2015, significantly more zooplankton taxa were detected at 9 stations of the Leibniz Institute for Baltic Sea Research from the western Baltic Sea to the western Gotland Basin than in previous years. For example, 61 taxa were registered in 2015, 45 taxa in 2014 and 52 taxa in 2013. This increase in species can be attributed to a large inflow of salt water from the North Sea in the previous year (WASMUND et al. 2016). A comparably large salt water inflow prior to that last took place in 1880 (Mohrholz et al., 2015, Nausch et al., 2016). Among the most numerous new species to occur were the *Acartia clausi*, *Calanus spp*., *Centropages typicus*, *Corycaeus spp*., *Longipedia spp*., *Oithona atlantica* and *Oncaea spp*. (WASMUND et al. 2016a).

High abundances of Cladocera (water fleas) are usually found in the waters of Mecklenburg Bight and the Arkona Basin. In 2015, no occurrence of Cladocera was found, contrary to its usual distribution (WASMUND et al. 2016a). Zooplankton development in the Mecklenburg Bight and the Arkona Basin in 2015 was characterised by early growth compared to previous years. This led to an early peak of the population in spring (March), which is usually only reached in summer/autumn. Overall, zooplankton abundances have been declining in comparison since 2000. This trend continued in 2015. With 130 x 10^3 individuals per m^3, the total zooplankton abundance was at its lowest level since 1995 (WASMUND et al. 2016a).

2.4.4 Status assessment of plankton

On the basis of the findings presented, it becomes clear that only very limited conclusions can be drawn about the state of the plankton and the resulting effects on the marine food chains. Firstly, there is a lack of consistently implemented monitoring programmes and long-term series to identify and differentiate natural processes and anthropogenic changes in the development of plankton. Secondly, the influence of physical processes and hydrodynamics on plankton is very distinct: for example, it is only possible to a limited extent to distinguish between the effects of eutrophication and natural processes on the basis of phytoplankton data (ICES 2004).

The entire ecosystem of the Baltic Sea has experienced changes in recent years. Anthropogenic influences and climate change, in addition to natural variability, govern these changes. Since the beginning of the 1980s, slow changes have been observed in the entire ecosystem of the Baltic Sea, and sudden changes in 1987/1988. The changes in the plankton are also related to these observations.

Phytoplankton

The analysis of the phytoplankton data shows changes in the species range, abundance or biomass. An increase in phytoplankton biomass can be seen. For many years, the Leibniz Institute for Baltic Sea Research has observed a decrease in diatoms in the spring bloom in favour of dinoflagellates (WASMUND et al. 2000). In recent years, an increased occurrence of algal blooms, an aperiodic and unpredictable occurrence of toxic algal blooms and the introduction of non-native species have also been observed. However, it remains unclear to what extent eutrophication, climate change or simply natural variability contribute to the changes in phytoplankton (EDWARDS & RICHARDSON 2004). The variability of the hydrographic parameters regulates and, if necessary, limits the biological events.

There are, however, pronounced seasonal effects of nutrient concentrations and subsequent reactions of phytoplankton on nutrient supply. Especially in the summer months, the supply of nutrients is much more important for phytoplankton growth than the accumulation of nutrients in winter, which can only stimulate spring growth. The spatial variability in the intake and use of nutrients between the phytoplankton in coastal waters and the phytoplankton in the offshore area additionally complicates, e.g. the evaluation of eutrophication effects on plankton development (PAINTING et al. 2005). Findings from large-scale investigations and research projects (HELCOM, Leibniz Institute for Baltic Sea Research) have documented the high variability of phytoplankton occurrences in the Baltic Sea.

Phytoplankton growth also developed parallel to the increase in nutrient inputs: from the beginning of chlorophyll measurements (1979) until the mid-1990s, the concentration of $chlorophyll_a$ increased significantly, i.e. the mass of microalgae gradually increased per year. Since then the values have stagnated or even decreased. Overall, however, phytoplankton abundance in the Baltic Sea is still at a very high level. An excessive supply of nutrients, however, causes changes in the structure and functionality of the ecosystem.

The following direct effects are described for phytoplankton with regard to eutrophication (HELCOM 2006): increase in primary production and biomass, change in species range, increase in the occurrence of algal blooms, increase in turbidity and reduction of light penetration depth in the water and increase in sedimentation of organic matter.

The Leibniz Institute for Baltic Sea Research annually compiles extensive lists of diatoms and dinoflagellates for the Baltic Sea. For many years, it has been observed how the number of diatoms in the spring blooms decreases in favour of dinoflagellates (WASMUND et al. 2000). ALHEIT et al. (2005) analysed the existing long-term data of the Helgoland roadstead and the Baltic Sea station "K2 Bornholm" for changes. It was found that the ecosystems of the North Sea and the Baltic Sea have experienced simultaneous changes with different consequences for the marine food chains since 1987. This is all the more important when the completely different hydrographic conditions of the North Sea and the Baltic Sea are taken into account. These changes affect all levels of the food chains, from phytoplankton to upper secondary consumers. For both ecosystems, the changes correlated with the change in the NAO.

Under certain conditions, phytoplankton can pose a threat to the marine environment. In particular, toxic algal blooms (e.g. blue-green algal blooms) pose a major threat to secondary consumers in the marine ecosystem and to humans. Toxic and potentially toxic species have been regularly found in the Baltic Sea in recent years, sometimes in high abundance. The extreme proliferation and algal bloom of the toxic species *Chrysochromulina polylepis* from May to June 1988 led to the mass death of fish and bottom-dwelling species along the Norwegian coast in the Skagerrak (GJOSAETER et al. 2000). In 2015, the cyanobacteria bloom was smaller compared to the previous years in terms of its distribution and density (ÖBERG 2016).

Avoidance responses to toxic algal blooms in coastal waters have been documented in seabirds (KVITEK & BRETZ 2005). Similar avoidance responses are less common in fish-eating, deep-sea birds, so that they often fall victim to algal toxins that have accumulated in fish (SHUMWAY et al. 2003).

Zooplankton

Zooplankton is also affected by natural and anthropogenic changes. For the zooplankton in the western Baltic Sea, a gradual change has been observed in recent years. The species composition and dominance conditions within the zooplankton groups, for example, have changed. The number of non-native species has increased. Many non-native species have already become established. Many species typical of the area have declined, including those that are part of the natural food resources of the marine ecosystem. Evaluations of data from monitoring trips conducted by the Leibniz Institute for Baltic Sea Research have shown that the abundance of some zooplankton taxa has decreased in recent years, e.g. the maximum abundance of *Pseudocalanus spp.*, an important food resource for herring in the Baltic Sea (HELCOM 2004). Clear shifts in the species range are also evident (POSTEL 2005).

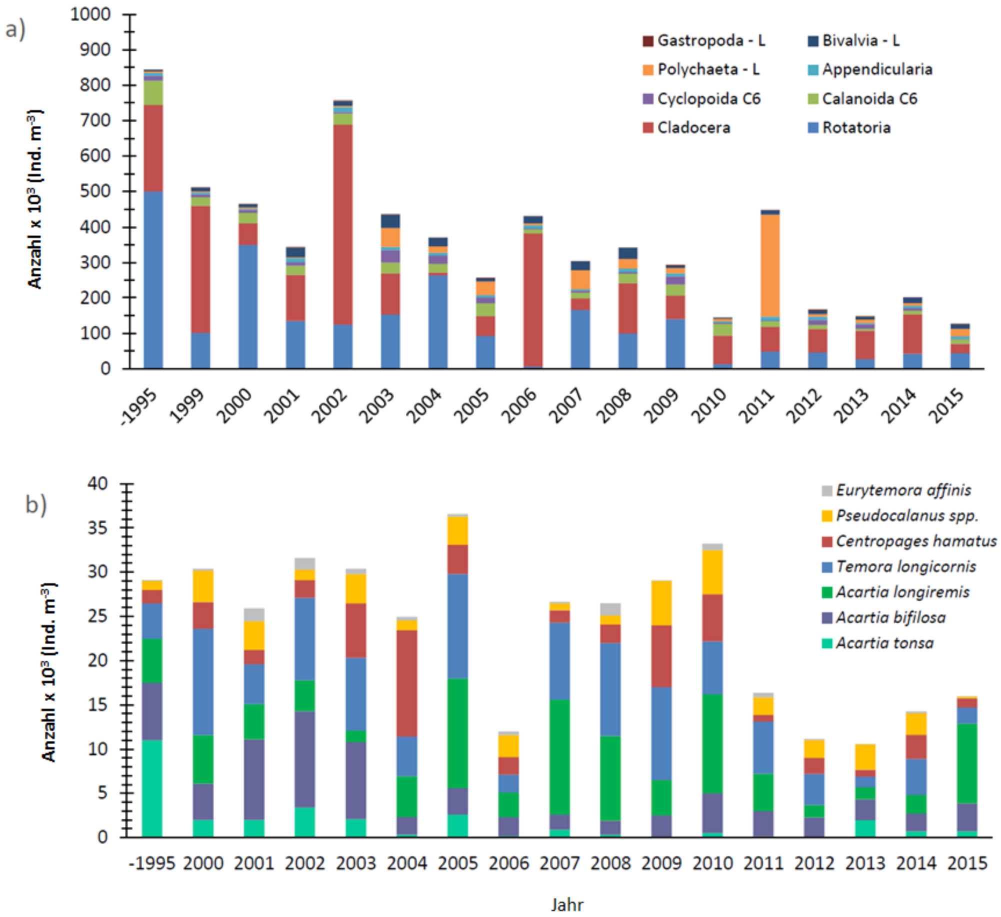

Figure 15: Development in the maximal abundance of a) five holoplanktonic taxa (Rotatoria, Cladocera, Cyclopoida, Calanoida, and Copelata) and three meroplanktonic taxa (Polychaeta, Bivalvia, Gastropoda) and b) of seven calanoid copepod species in the years 1995 to 2015 (WASMUND et al. 2016a).

Results of the Leibniz Institute for Baltic Sea Research status report show a general decrease in the overall abundance of holozooplankton from 1995 to 2015 (Figure 15a). With the exception of the years 2002 and 1995 with relatively high concentrations, the sum of the maxima of all taxa analysed shrank between 1995 and 2015 from 850 x 10^3 to 130 x 10^3 ind. per m³. In 2011, however, the sum of the respective maximum concentrations doubled compared to the previous year due to a significant increase in polychaete larvae and a moderate increase in rotatoria. The unusually high concentration of polychaete larvae is due to the synchronous release of the larvae, which must have coincided with the sampling date in March. The low abundances in 2015 can be attributed to a sharp decrease in *Cladocera* and *Calanoida* compared to the previous years (Figure 15a). If individual calanoid copepods are analysed, the occurrence of the species *Pseudocalanus spp*., *Temora longicornis* and *Centropages hamatus* tends to decrease. No clear trend can be identified for *Acartia spp.* (Figure 15b).

Changes were also observed in the zooplankton of the North Sea. These changes are also relevant for the Baltic Sea due to the exchange between the ecosystems of the North Sea and the Baltic Sea. The abundance of *scyphomedusae* (jellyfish) decreased as water temperatures increased (LYNAM et al. 2004). Jellyfish feed primarily on fish larvae and may contribute to the decimation of fish stocks.

The authors therefore discuss the positive effects of climate change on the recovery of fish stocks – in this case through a decrease in predator species. Nevertheless, the possibility of the simultaneous impact of other factors, such as eutrophication and fishing activity, cannot be excluded.

Increasingly, non-local species are also affecting succession. These are mainly introduced by shipping (ballast water) and mussel aquaculture. The possibility of changes in species composition and possible shifts in species due to the spread of non-native plankton species cannot be ruled out. Indirect impacts of non-native species on the marine food chain cannot be excluded either. Overall, it can be assumed that the natural processes in plankton are endangered by the introduction of non-native species. Many non-native zooplankton species have already become established. The crustacean species *Acartia tonsa*, *Ameira divagans* and *Cercopagis pengoi* were introduced into the Baltic Sea by ballast water from ships. The introduction of the large warty comb jelly *Mnemiopsis leydei* has recently been a cause for concern. If the large warty comb jelly were to establish itself in the Baltic Sea and reproduce excessively due to warming, this would pose a threat to fish stocks. The large warty comb jelly feeds on larger zooplankton and especially also on fish larvae. However, there was no indication of this in 2011 (WASMUND et al. 2012). Larger numbers of large warty comb jellies have not been found recently (WASMUND et al. 2016a).

Since phytoplankton is transported and distributed by currents, phytoplankton species from the Atlantic also flow into the Baltic Sea with the water masses and affect natural succession (REID et al. 1990). Among the phytoplankton, the *Prorocentrum minimum* was identified as the most important migratory species, which probably entered the Baltic Sea naturally, spread extensively from the west since 1981 and formed strong blooms especially in the 1990s. In the meantime *Prorocentrum minimum* (today called *Prorocentrum cordatum*) has become established in the Baltic Sea and occasionally develops dominant stocks (WASMUND et al. 2016a).

Impacts of climate change

Climate change and its consequences for the marine ecosystem have been of increasing concern to scientists in recent years.

BEAUGRAND (2004) analysed and summarised previous findings on phenology, causes, mechanisms and consequences of changes in the marine ecosystems of the north-east Atlantic and the North Sea. Taking into account the data from the period 1960 to 1999, the statistical analyses have shown a clear change or increase in the phytoplankton biomass after 1985. The increase in phytoplankton biomass was particularly pronounced in 1988. In terms of time, the increase in biomass correlates with the strongly pronounced climatic and hydrographic changes between 1987 and 1988. BEAUGRAND (2004) assumes that changes in the marine ecosystem caused by changes in hydrographic and meteorological conditions, especially after 1987, strongly correlated with NAO development and a shift in biogeographical boundaries since the early 1980s could occur as a result of reorganisation of the biological structure of the ecosystem in the north-east Atlantic.

According to HAYS et al. (2005), climate change has in particular affected the range limits of species and groups in the marine ecosystem. Zooplankton associations of warmwater species in the North-East Atlantic, for example, have shifted their distribution almost 1,000 km to the north. In contrast, the areas of coldwater associations have decreased in size. Moreover, climate change has an impact on the seasonal occurrence of abundance maxima of different groups. Delayed population development can impact on the entire marine food chain. EDWARDS and RICHARDSON (2004) even suspect a particular threat to temperate marine ecosystems through change or temporal offset in the development of different groups. The threat arises from the direct dependence of the reproductive success of secondary consumers on plankton (fish, marine mammals, sea birds). Evaluations of long-term data for the period 1958 to 2002 for 66 marine taxa have confirmed that marine planktonic associations react to climate change. However, the reactions are very different with regard to association or group and seasonality.

BEAUGRAND & REID (2003) analysed long-term changes in three different trophic levels of the marine food chains (phytoplankton, zooplankton and fish) associated with climate change. It was shown that changes occurred at different times in all three pelagic levels. A decrease of euphasiaceae (krill) was first observed in 1982. An increase in the abundance of the small copepods followed in 1984. In 1986 there was an increase in the phytoplankton biomass and a decrease in the large copepod *Calanus finmarchicus*. A drop in salmon stocks followed in 1988. These changes ushered in a new phase of the structure of the marine ecosystem in the north-east Atlantic and adjacent seas in 1986 that continues to this day. The increase in temperature appears to play a major role in this change.

Studies by SOMMER et al. (2007) also show that climate change can affect several trophic levels. In this case, with temperature increases of 2 - 6°C, higher mortality rates of Nauplius larvae, a developmental stage of copepods, were observed. Naupilus larvae are an important organism in the trophic network as they are the main food source of many fish larvae.

According to HELCOM, surface water temperatures can be expected to rise by 2°C in the southern Baltic Sea and by 4°C in the northern Baltic Sea by the end of the next century (HELCOM 2013a). In addition, a drastic decline in ice cover is expected in winter. The already increased amounts of precipitation can increase more sharply on average and partially reduce the salinity. The expected temperature increase could lead to changes in the species composition of zooplankton (HELCOM 2013a).

Another consequence of the rise in temperature could be a change in the scale of phytoplankton distribution. SOMMER et al. (2007), for example, already found lower abundances of larger phytoplankton organisms at a temperature increase of 2°C.

Changes in the seasonal progression of phytoplankton growth can also lead to trophic mismatch (delayed occurrence of groups that are interdependent in their food resources) within marine food chains: delayed diatom growth can affect the growth of primary consumers. Small copepods can suffer from a lack of food due to the absence of diatoms during the growth phase. Copepods are in turn an important component as a food source for fish larvae. Fish larvae would starve to death as a result of lower growth of copepods. Trophic mismatch has often been observed in different areas in recent years.

Plankton organisms respond to adverse situations with species-specific protection and defence mechanisms. Diapause and spore formation are among the most well-known of these survival mechanisms (PANOV et al. 2004). Diatoms and dinoflagellates are able to develop resting cysts, which then spend the winter in the sediment or wait for favourable growth conditions.

2.5 Biotopes

According to VON NORDHEIM & MERCK (1995), a marine biotope is a characteristic, typified marine habitat. With its ecological conditions, a marine biotope type offers largely consistent conditions for marine communities that are different from those of other types. Typing includes abiotic (e.g. moisture, nutrient content) and biotic characteristics (occurrence of certain vegetation types and structures, plant communities, animal species).

The majority of Central European types are also characterised in their specific form by the prevailing anthropogenic uses (agriculture, transport, etc.) and impairments (pollutants, eutrophication, leisure use, etc.).

The current biotope classification of the Baltic Sea has been published by the Federal Agency for Nature Conservation (BfN) in the Red List of Threatened Habitat Types in Germany (FINCK et al. 2017).

2.5.1 Data availability

Under the Federal Agency for Nature Conservation's R&D project "Marine Landschaftstypen der Nord- und Ostsee" (Marine landscape types of the North Sea and Baltic Sea), a spatial distribution pattern of the ecologically most important sediment classes and partly also of higher biotope type classes was created (see Figure 16, SCHUCHARDT et al. 2010). However, areas of marine biotopes that cannot be sufficiently scientifically defined can be represented on this basis. A modelled area-wide distribution of marine biotopes of the German Baltic Sea according to the HELCOM "Underwater Biotopes and Habitat Classification System" (HELCOM HUB) was developed by SCHIELE et al. (2015). To this end, modelled distributions of less mobile macrozoobenthos species were mixed with abiotic data (e.g. grain size, salinity, temperature, water depth, etc.). The occurrences of reefs and sandbanks reported by the Federal Agency for Nature Conservation can also be used. Other important findings are the findings on biotope occurrences, which were determined as part of approval procedures for grid connections and wind farms. With regard to the designated site O-1.3, the results of the biotope protection assessment carried out as part of the two-year baseline studies from 2011-2013 can be used (INSTITUTE FOR APPLIED ECOSYSTEM RESEARCH 2015, INSTITUTE FOR APPLIED ECOSYSTEM RESEARCH 2016).

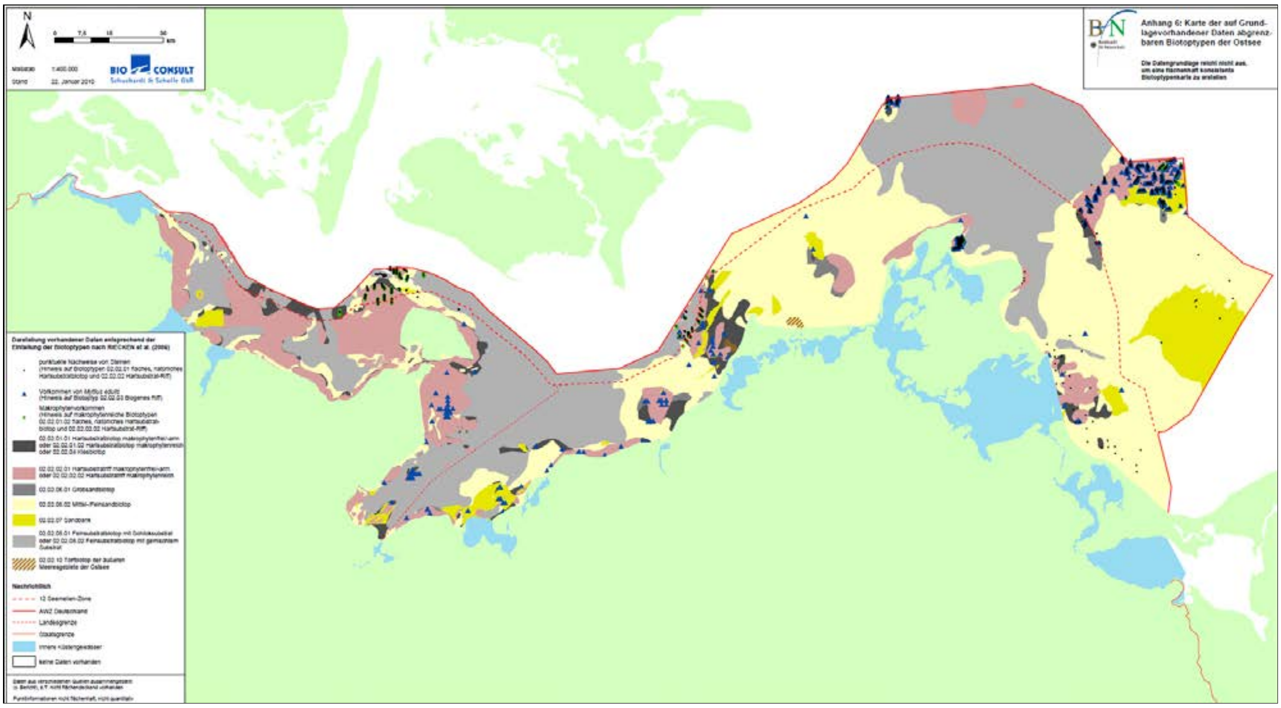

Figure 16: Map of the biotopes of the German Baltic Sea that can be delimited on the basis of existing data (according to SCHUCHARDT et al. 2010).

2.5.2 Biotopes in the German Baltic Sea

A current representation of the distribution of marine biotopes in the German Baltic Sea according to the HELCOM "Underwater Biotope and Habitat Classification System" (HELCOM HUB) is presented in Figure 17. The analysis showed a total of 68 identified HELCOM HUB biotopes for the German Baltic Sea region. According to SCHIELE et al. (2015), almost 60% of the German Baltic Sea area is covered by the following predominant HUB biotopes:

- Photic/aphotic sand with dominant colonisation by the bivalve species *Cerastoderma glaucum*, *Macoma balthica* and *Mya arenaria* (31.2%, code AA/AB.J3L9)
- Aphotic silty sediment with dominant colonisation by the Baltic clam *Macoma balthica* (12.1%, code AB.H3L1)
- Photic/aphotic silty sediment with dominant colonisation by the ocean quahog *Arctica islandica* (9.6%, code AA/AB.H3L3)
- Photic/aphotic sand with dominant colonisation by the ocean quahog *Arctica islandica* (6.3%, code AA/AB.J3L3)

In the aphotic zone of deep Baltic Sea waters, only a few salt water inflows in recent decades have resulted in prolonged periods of oxygen deficiency near the seabed. This has had a negative impact on the stocks of ocean quahogs in the deep Baltic Sea basins. For this reason, the two HUB biotopes characterised by colonisation with the ocean quahog in their aphotic variants are listed as endangered biotopes in the HELCOM Red List (HELCOM 2013c).

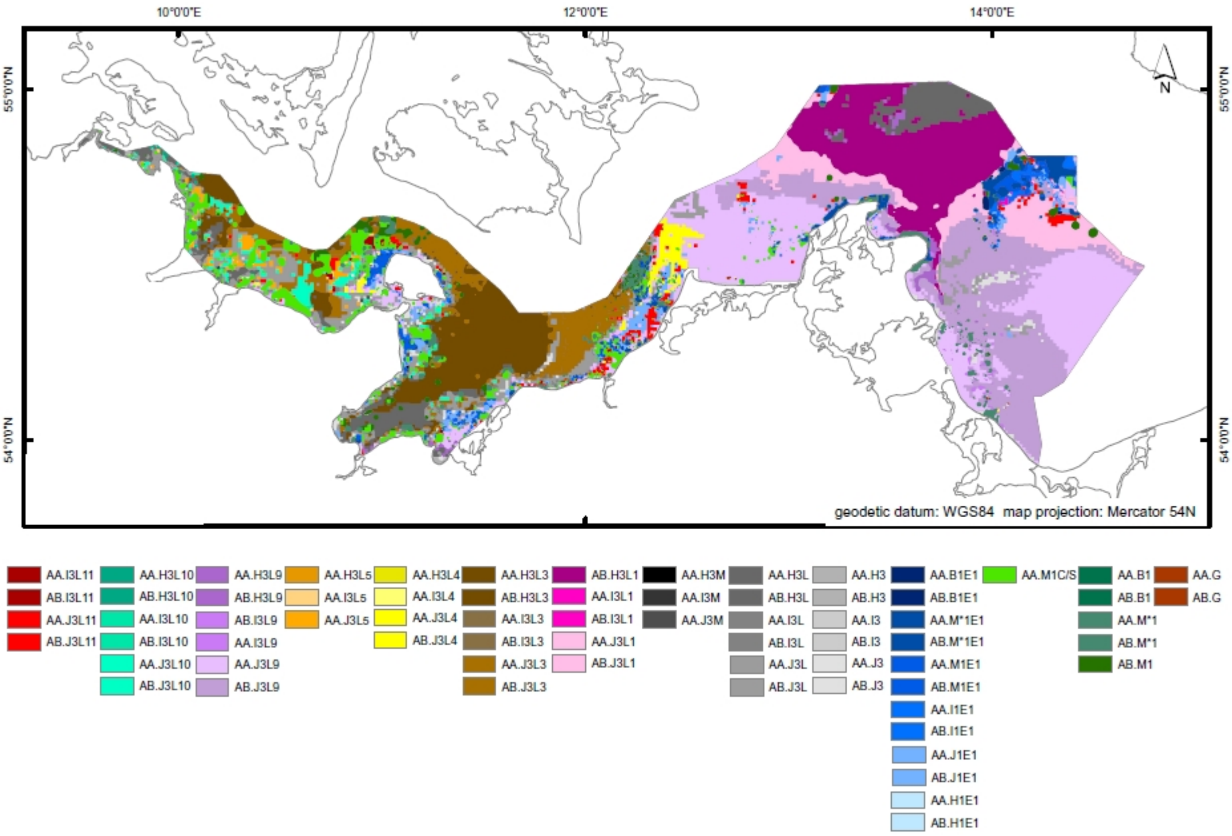

Figure 17: Biotope map of the German Baltic Sea according to SCHIELE et al. (2015). HELCOM HUB codes explained in HELCOM (2013b).

2.5.3 Legally protected marine biotopes according to section 30 of the Federal Nature Conservation Act and FFH habitat types

A number of marine biotopes are subject to direct federal protection pursuant to section 30 of the Federal Nature Conservation Act. Section 30 subsection 2 of the Federal Nature Conservation Act essentially prohibits acts that may cause destruction or other significant impairment of the listed biotopes. No designation of protected areas is required for this purpose. This protection was extended to the EEZ with the 2010 amendment of the Federal Nature Conservation Act. In addition to the marine habitat types listed in Annex I of the Habitats Directive, reefs and sandbanks, the two biotopes "seagrass meadows and other marine macrophyte populations" and "species-rich gravel, coarse sand and shell layers in the marine and coastal areas" in the Baltic Sea EEZ area enjoy legal protection status pursuant to section 30 subsection 2 sentence 1 no. 6 of the Federal Nature Conservation Act. The biotope type "Silty bottoms with burrowing megafauna", which is also protected, does not occur in the German Baltic Sea.

2.5.3.1 Reefs

Habitat type 1170 (reefs) according to the Habitats Directive and at the same time according to section 30 of the Federal Nature Conservation Act protected biotope type is defined as follows: "Reefs can be either biogenic concretions or of geogenic origin. They are hard compact substrata on solid and soft bottoms, which arise from the sea floor in the sublittoral and littoral zone. Reefs may support a zonation of benthic communities of algae and animal species as well as concretions and corallogenic concretions" (DOC.HAB. 06-09/03). The "hard substrate" comprises rocks (including soft rocks such as chalk cliffs), boulders and cobbles. "BfN-Kartieranleitung für "Riffe" in der deutschen ausschließlichen Wirtschaftszone (AWZ)" [The Federal Agency for Nature Conservation's Mapping Guide for "Reefs" in the German Exclusive Economic Zone (EEZ)] was published on 9 July 2018 and has not yet been used in the projects.

In the EEZ of the Baltic Sea, reefs and reef-like structures occur predominantly as boulder fields on moraine ridges. They were mainly found in the area of the Adlergrund, the Rönnebank, the Kadetrinne and the Fehmarn Belt. Here there are distinct blue mussel beds with their accompanying species, which have comparatively high species numbers for the Baltic Sea. Also of great importance here is the vegetation with large algae, especially laminaria (brown algae), red algae or sea lace. According to the Federal Agency for Nature Conservation, reefs with an area of approx. 460 km^2 were identified in the German Baltic Sea EEZ. A large part of these areas (270 km^2) were now placed under protection as a nature conservation area by the ordinance of 22 September 2017 on the designation of the nature conservation area "Pomeranian Bight – Rönnebank", the ordinance of 22 September 2017 on the designation of the nature conservation area "Kadetrinne" and the ordinance of 22 September 2017 on the designation of the nature conservation area "Fehmarn Belt". With these legal ordinances, the existing nature conservation and FFH areas were declared nature conservation areas and partially regrouped within this framework. As part of the approval procedure for the "cables 1 to 6/cross-connection" grid connection, further reef suspected sites in area O-1 (1.5.2) were identified in addition to the reef occurrences reported by the Federal Agency for Nature Conservation. The Federal Agency for Nature Conservation's mapping instructions are to be used to record the biotope "reefs" in the German EEZ (Federal Agency for Nature Conservation 2018).

2.5.3.2 Sandbanks

Habitat type 1110 according to the Habitats Directive, refers to "Sandbanks which are slightly covered by sea water all the time" (DOC.HAB. 06-09/03) and is defined as follows: "Sandbanks are elevated, elongated, rounded or irregular topographic features, permanently submerged and predominantly surrounded by deeper water. They consist mainly of sandy sediments, but larger grain sizes, including boulders and cobbles, or smaller grain sizes including silt may also be present on a sandbank. Banks where sandy sediments occur in a layer over hard substrata are classed as sandbanks if the associated biota are dependent on the sand rather than on the underlying hard substrata". Sandbanks are also protected biotopes pursuant to section 30 of the Federal Nature Conservation Act.

Several sandbanks of high conservation value were identified in the German Baltic Sea EEZ. "Sandbanks" in the definition of FFH habitat types occur in the German EEZ east of the Darss Sill at the edge of the Arkona Basin and in the Pomeranian Bight. They are covered with residual sediments (boulders, debris, coarse sand, medium sand) and are colonised accordingly by sandy soil communities or covered with large algae on hard substrata in the euphotic area. The total area is approx. 570 km^2, where the Oder Bank is a particularly large sandbank.

For these reasons, the sandbanks identified were protected by the FFH area notifications "Fehmarn Belt" (DE 1332-301), "Adlergrund" (DE 1251-301) and "Pomeranian Bight with Oder Bank" (DE 1652-301) in the EEZ of the Baltic Sea.

The epifauna on the sandy soils has few species and consists mainly of blue mussels, which are covered with growth species and are home to substrate species such as small crustaceans. Most of the species are found in the sand (infauna). Molluscs and polychaetes dominate. The number of species on the Adlergrund and Kriegers Flak is about 110, while only 21 species have been recorded on the Oder Bank. The decline in species compared to the Belt Sea is due to the low salinity.

The low number of species on the Oder Bank is a result of the homogeneity of the habitat, which consists of flat substrata with little structure and fine sand cover. Under the extreme living conditions (exposed sandy soils, low salinity), adapted sandy soil species such as *Pygospio elegans*, the crustaceans *Bathyporeia pilosa* and *Crangon crangon* and the bivalves *Mya arenaria, Macoma balthica* and *Cerastoderma lamarcki* dominate. They often reach very high individual densities and are distributed quite homogeneously throughout the entire area. Three species, *Bathyporeia pilosa, Mya arenaria* and *Hydrobia ulvae,* together represent over 70% of the total number of individuals.

No mapping instructions currently exist for the biotope "sandbanks which are slightly covered by sea water all the time".

2.5.3.3 Seagrass beds and other marine macrophyte stocks

The biotope "seagrass meadows and other marine macrophyte populations" describes a habitat characterised by submerged flowering plants and/or large algae exposed to light. According to the current state of knowledge, it only occurs in association with reefs in the area of the EEZ of the Baltic Sea. In the coastal area, however, extensive "marine macrophyte populations" also occur beyond reefs. Different biotopes characterised by marine macrophyte populations are included in the OSPAR and HELCOM lists of declining and/or endangered biotopes (FEDERAL AGENCY FOR NATURE CONSERVATION 2012a). There are currently no mapping instructions for the biotope "seagrass meadows and other marine macrophyte populations". According to the current state of knowledge, no concrete areas can be identified for this biotope.

2.5.3.4 Species-rich gravel, coarse sand and shell layers in marine and coastal areas

This legally protected biotope includes species-rich sublittoral pure or mixed occurrences of gravel, coarse sand or shell sediments from the seabed which are colonised by a specific endofauna (including interstitial fauna) and macrozoobenthos community.

The biotope in the North Sea and Baltic Sea may be associated with the occurrence of rocks or mixed substrates and the occurrence of mussel beds, or may occur in spatial proximity to "sandbank" and "reef" habitat types. Reefs and species-rich gravel, coarse sand and shell layers occur regularly together. In the sublittoral of the Baltic Sea, the biotope is characterised by the polychaetes *Ophelia* spp. and *Travisia forbesii*. *Branchiostoma lanceolatum* also occurs in shell layers in the western Baltic Sea. The richness of species and the high proportion of specialised species in these sediment types results from the occurrence of relatively stable spaces between the sediment particles with high pore water content and relatively high oxygen content.

The colonisation of species-rich gravel, coarse sand and shell layers is spatially very heterogeneous. Gravel and coarse sand biotopes occur in the outer coastal waters of the Baltic Sea, predominantly at a depth of 5-15 m, including in submarine sills and together with reefs. The Adlergrund is one example. Its sediment also contains coarse sand and gravel in some areas. Pure shell biotopes are generally rare.

Based on the comprehensive mapping of HELCOM HUB biotopes in the German Baltic Sea compiled by SCHIELE et al. (2015), it is possible to draw certain conclusions about possible occurrences of "species-rich gravel, coarse sand and shell layers". Since the distributions of the respective character species *Ophelia* spp. and *Travisia forbesii* on which the study is based are, however, based on presence/absence modelling, the mapping instructions "species-rich gravel, coarse sand and shell layers in marine and coastal areas" (FEDERAL AGENCY FOR NATURE CONSERVATION, 2012b) must also be used to record this biotope.

2.5.4 Status estimation

The population assessment of the biotopes occurring in the German sea area is published based on the national protection status and the vulnerability of these biotopes according to the Red List of Threatened Habitat Types in Germany (FINCK et al. 2017). The aforementioned legally protected biotopes are fundamentally of great importance in this regard. In the Baltic Sea, these biotopes are primarily endangered by current or past nutrient and pollutant inputs (e.g. sewage discharges, oil pollution, dumping, waste and debris deposits), due to bottom contact fishing methods and, where applicable, due to the effects of construction activities. As bottom contact fishing methods are largely excluded at wind farms, a certain degree of recovery of the biotopes occurring there can be expected in the area of the territories.

2.5.4.1 Importance of areas and sites for biotopes

Area O-1

Occurrences of the "reef" biotope are known in area O-1. Particularly in the south-east of the area, there are rock fields with extensive blue mussel beds that extend from Adlergrund into the area. Mainly blue mussel beds, gravel and stone beds and till were identified. The stone cover in the south-eastern area is >10% In the south-western part of area O-1 the stone cover is <10% lower. The Federal Agency for Nature Conservation estimates that this section of reef area No 33 designated by the Federal Agency for Nature Conservation takes up 26% of the reef.

In the vicinity of the designated site O-1.3, most of the site is characterised by the biotope "Baltic Sea sublittoral silt seabed with Baltic clams (*Macoma balthica*) (code 05.02.11.02.03.02)" (INSTITUTE FOR APPLIED ECOSYSTEM RESEARCH 2015). According to the Red List (FINCK et al. 2017), there is currently no evidence of any risk for this biotope type. In the eastern part of site O-1.3, two areas with a slightly higher portion of medium sands were identified. The biotope "sublittoral mixed substrate of the Baltic Sea with sporadic epibenthos, grazers or without epibenthic macroflora or fauna (code 05.02.06.02)", which occurs in these areas, is also currently not endangered according to the Red List. In the north-eastern part of site O-1.3, a residual sedimentary area with coarser sediments and occurrence of covered stones was found. The area occurring here is a suspected area of the legally protected biotope type "reefs". Verification of this suspected site by means of mapping instructions of the Federal Agency for Nature Conservation is still pending.

Area O-2

Area O-2 has a low overall structural diversity. According to the Red List (FINCK et al. 2017), the biotope "Baltic Sea sublittoral silt seabed" (code 05.02.11), which occurs in the entire area O-2, is currently not at risk. Occurrence of legally protected biotopes is not to be expected in this area.

Area O-3

In area O-3, there are stone and debris fields beds with extensive blue mussel beds in the northern shallow area. The wall-like boulders found there are to be classified as the biotope "reef". Verification by means of mapping instructions of the Federal Agency for Nature Conservation is still pending.

2.6 Benthos

Benthos are all communities at the bottom of water bodies that are bound to substrate surfaces or live in soft substrates. Benthic organisms are an important component in the Baltic Sea ecosystem. They are the main food source for many fish species and play a crucial role in the conversion and remineralisation of sedimented organic matter (KRÖNCKE 1995). According to RACHOR (1990), the benthos includes microorganisms such as bacteria and fungi, protozoa and plants as well as multicellular organisms, large algae, living organisms and even demersal fish. Zoobenthos are defined as those animals that are predominantly in or on the ground. These organisms largely limit their activities to the boundary area between the free water and the uppermost soil layer (which is usually only a few decimetres vertically).

With what are known as holobenthic species, all life phases take place within this ground-level community. However, the majority of animals are merobenthic, i.e. only certain phases of their life cycles are linked to this ecosystem (TARDENT 1993).

These usually spread via planktonic larvae. In older stages, however, they are less capable of changing their location. Overall, most representatives of the benthos are characterised by a lack of or limited mobility compared to plankton and nekton. As a result, seabed fauna are generally hardly capable of avoiding natural and anthropogenic changes and pollution due to their relative local stability, and so in many cases these are an indicator of changed environmental conditions (RACHOR 1990).

The German part of the Baltic Sea is characterised by a relief-like seabed and a very heterogeneous surface structure. The bottom of the Baltic Sea has coarse sand, debris and stones in parts, but consists of large areas of sandy or silty sediments, so that the animals can also penetrate into the soil. Besides the epifauna living on the surface of the seabed, typical infauna living in the seabed (syn. endofauna) have also developed. Small animals less than 1 mm in size (microfauna and meiofauna) make up the majority of these inhabitants of the seabed. Better known, however, are the larger animals, macrofauna, and above all the more stationary forms such as annelids, molluscs and snails, echinoderms and various crustaceans (RACHOR 1990). Therefore, for practical reasons, the macrozoobenthos (animals > 1 mm) are examined internationally as representatives of the entire zoobenthos (ARMONIES & ASMUS 2002).

2.6.1 Data availability

The flora and fauna living at the bottom of the Baltic Sea already sparked the interest of nature researchers in the middle of the 19th century, when they started to collect and catalogue them (MÖBIUS, 1873). In the 20th century, the macrozoobenthos of the Kiel and Mecklenburg Bights were investigated in detail (HAGMEIER 1930; KÜHLMORGEN-HILLE 1963, 1965, SCHULZ 1968, 1969a, 1969b, ARNTZ 1970, 1971, 1978, ARNTZ et al. 1976; GOSSELCK & GEORGI 1984, WEIGELT 1985, ARNTZ & RUMOHR 1986, GOSSELCK et al. 1987, BREY 1984, RUMOHR 1995, GOSSELCK 1992, ZETTLER et al. 2000). More current data is provided in particular by the long-standing biological monitoring conducted by the Leibniz Institute for Baltic Sea Research and benthic investigations, which have been carried out since 2002 as part of approval procedures for offshore wind farm projects. Research projects such as the benthological work on the ecological assessment of areas suitable for wind energy of ZETTLER et al. (2003) or BeoFINO as well as the monitoring of benthic communities in nature conservation areas also provide important information. With regard to the designated site O-1.3, the results of the two-year baseline studies from 2011-2013 can be used (INSTITUTE FOR APPLIED ECOSYSTEM RESEARCH 2013, INSTITUTE FOR APPLIED ECOSYSTEM RESEARCH 2016).

2.6.2 Spatial distribution and temporal variability

The spatial and temporal variability of zoobenthos is largely controlled by oceanographic and climatic factors, as well as anthropogenic influences. Winter temperatures are an important climatic factor that cause high mortality in some species (BEUKEMA 1992, ARMONIES et al. 2001) as well as wind-induced currents. Currents are responsible for the distribution of planktonic larvae and redistribution of demersal stages due to current-induced sediment rearrangements (ARMONIES 1999, 2000). Among the anthropogenic impacts, besides nutrient and pollutant discharges, disturbance of the surface of the seabed by fishing is of particular importance (RACHOR et al. 1998).

Salinity is the determining factor for the occurrence and distribution of benthic species in the Baltic Sea. Aperiodic salt water inflows temporarily increase the salinity in deeper areas (> 40 m) to over 15 PSU, while surface water rarely exceeds salinity of 10 PSU. The zoobenthos of the Baltic Sea comprise a multitude of systematic groups and demonstrate a wide variety of behaviours. All in all, this fauna has been studied fairly extensively and therefore permits comparisons with conditions a few decades ago.

Natural spatial classification of the German Baltic Sea EEZ: Benthos

The following proposal for a natural spatial classification of the German Baltic Sea EEZ in respect of benthological aspects differs from the classification according to sedimentological criteria. The main structuring factor for the composition of macrozoobenthos is the salinity. The occurrence of macrozoobenthos species in the Baltic Sea also depends on hydrographic conditions and water depth. The natural spatial classification is based on the Federal Agency for Nature Conservation's nature conservation planning contribution to spatial planning (FEDERAL AGENCY FOR NATURE CONSERVATION 2006). Accordingly, five natural spatial units can be differentiated from west to east: the Kiel Bight (A) and the Mecklenburg Bight (B), which still have a more marine character, the transition area of the Darss Sill (C), followed by the Arkona Basin (D) and the Pomeranian Bight (E) (Table 7; Figure 18).

The German part of the Baltic Sea lies in the transitional area between the Belt Sea, which mainly has a marine character, and the central Baltic Sea, which is dominated by brackish water. The Darss Sill forms a distinctive ecological boundary between the two different water bodies.

Table 7: Natural spatial structure of the German Baltic Sea EEZ (according to the FEDERAL AGENCY FOR NATURE CONSERVATION 2006).

Designation	Abbreviation Figure 18	Hydrography	Water depth	Sediment	Benthos
Belt Sea EEZ and Kiel Bight	**A**	Thermohaline stratification with ∅ salinity > 20, frequent oxygen deficiency in water layers near the bottom; ice formation rare	from 15 m to 30 m	Fine sand, occasionally also silt and clay, stones, residual sediment, heterogeneous sediment distribution	Marine species dominate, partly species-rich endofauna communities as well as very species-rich phytal communities
Mecklenburg Bight EEZ	**B**	Relatively low flow velocities; thermohaline stratification with regular oxygen deficiency, ∅ salinity > 7 < 20; occasional ice formation	from 20 m to 30 m	Silt, clay in the central area, residual sediment surfaces in the peripheral areas	Marine species dominate, partly species-rich endofauna communities as well as very species-rich phytal communities
Darss Sill	**C**	Water exchange between central and western Baltic Sea through the Kadetrinne	from 18 m to 25 m; sill between the Belt Sea/Mecklenburg Bight and the Arkona Basin; the Kadetrinne, which is up to 25 m deep, is embedded	Medium and coarse sand, gravel, residual sediment areas and boulder fields (reef)	Transition area, decrease in marine species *(Macoma balthica*; at lower depths from -20 m also *Abra alba*, Arctica islandica - populations and phytal communities in the Kadetrinne)
Arkona Basin EEZ	**D**	Relatively low current velocities; thermohaline stratification with frequent oxygen deficiency; ice formation possible in winter, salinity > 7	from 20 m to 47 m	Silt, clay	Species-poor brackish water community of the central Baltic Sea with stenothermic cold water relicts in a unique combination with freshwater species
Pomeranian Bight (with Adlergrund and Oder Bank)	**E**	Relatively low current velocities; ice formation possible in winter: (Adlergrund: rarely freezes over; Oder Bank: frequently freezes over in winter), salinity > 7	shallow bottom from 6 m to 30 m	Medium and coarse sand, gravel, debris, large-area homogeneous sands in the central areas	Species-poor brackish water communities in unique combination with freshwater species *(Macoma balthica*; *Mya arenaria, Theodoxus fluviatilis*)

The Kadetrinne serves as a link between them. More than 70% of the water exchange of the entire Baltic Sea takes place via the Fehmarn Belt and through the Kadetrinne.

The bottom water in the Belt Sea is exchanged several times a year, while "salt water inflows" into the Baltic Sea are rare. The salinity is subject to strong horizontal and vertical fluctuations. The stratification in the Belt Sea is unstable (stagnation phases), while there is a stable stratified water body in the central Baltic Sea.

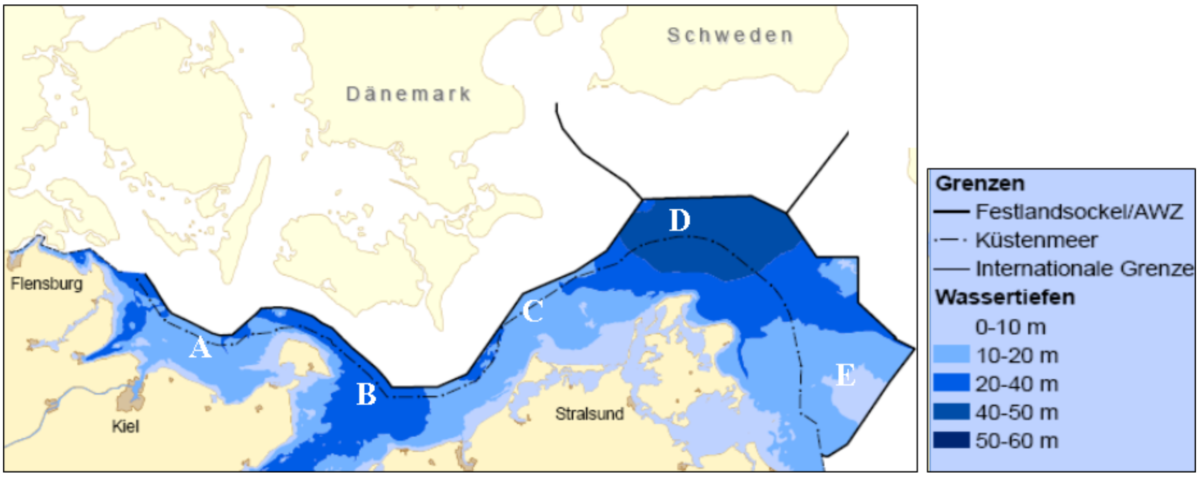

Figure 18: Natural spatial structure of the German EEZ of the Baltic Sea (according to the FEDERAL AGENCY FOR NATURE CONSERVATION 2006).

2.6.2.1 The macro-zoobenthos of the German Baltic Sea

Overall, the Baltic Sea is poor in species compared to the North Sea. The demersal invertebrates of the Baltic Sea consist primarily of migratory marine species from the North Sea, brackish water species and ice age relicts (GOSSELCK et al. 1996). Marine-euryhaline species make up the majority of the species which, depending on their tolerance to decreasing salinity, penetrate the Baltic Sea to varying degrees. Many marine species do not enter the areas east of the Darss Sill, or only after extreme events. The marine species thus decrease from the Belt Sea in the direction of the central and eastern Baltic Sea in favour of brackish water and limnic species and reach their eastern distribution limit in the area of the Arkona Basin. Since marine-euryhaline species are not replaced to the same extent by freshwater species, the number of species is decreasing.

The decline in the number of species as a result of the decreasing salinity from west to east is illustrated by the data analysis of the long-term monitoring at 8 monitoring stations in the western Baltic Sea shown in Figure 19 (WASMUND et al. 2017). As a result both 2016 and the long-term trend show a clear decrease in the number of species from the Kiel Bight (83 species) to the central Mecklenburg Bight (12-16 species). In the area of the Fehmarn Belt, the number of species recorded in 2016 was significantly lower than the long-term trend. An increased species diversity of up to 62 species can be seen in the area of the southern Mecklenburg Bight and the Darss Sill. East of the Darss Sill to the Pomeranian Bight smaller numbers of species (18-28) and the lowest numbers of species in the long-term trend are again recorded (WASMUND et al. 2017).

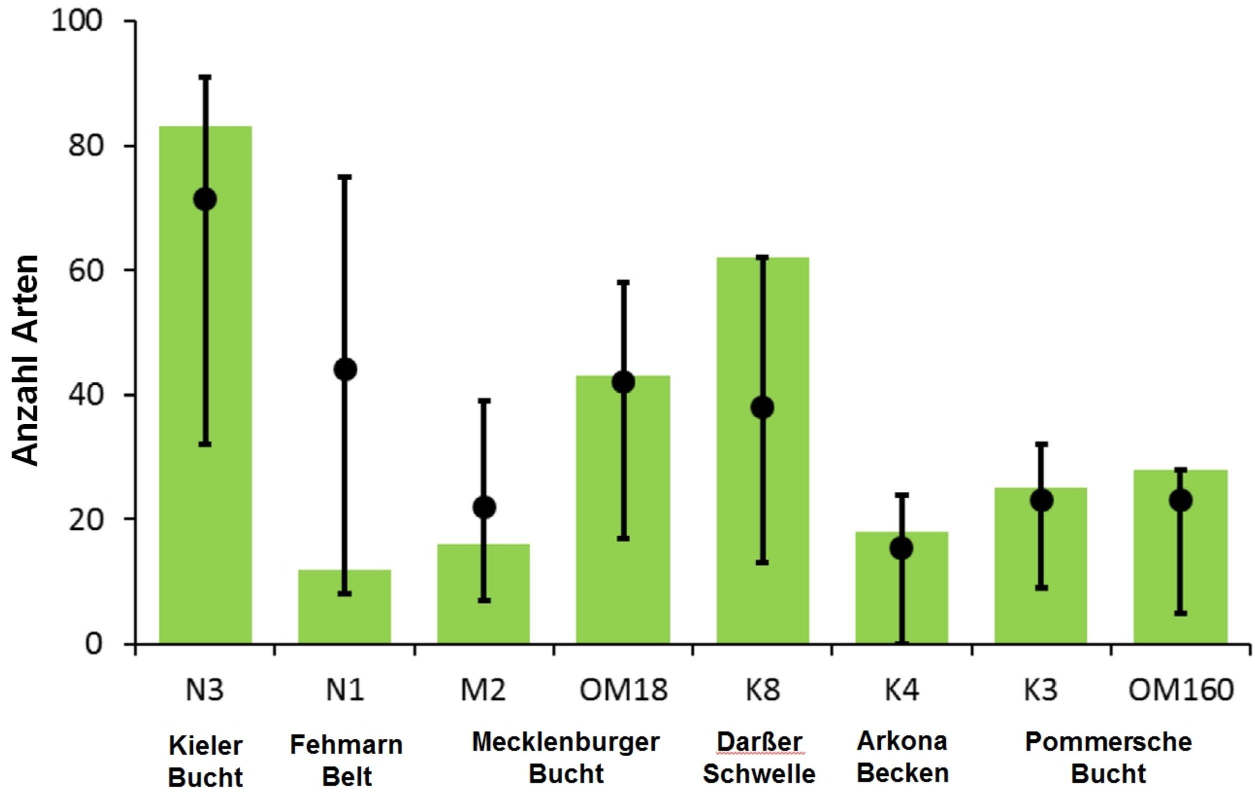

Figure 19: Number of species of macrozoobenthic species at 8 monitoring stations in November 2016 (green bars). Black dots and error bars show median, minimum and maximum species numbers between 1991 and 2016 (changed according to WASMUND et al. 2017).

There is a close correlation between the species numbers of macrozoobenthos and the salt concentration on the one hand and the sediment conditions on the other (REMANE 1934; ZETTLER et al. 2014). Both higher mean salinity and hard substrate or fine substrate habitats (including silty areas) have been found to be particularly abundant in macrozoobenthos species.

When considering the detailed results for the Fehmarn Belt station, it becomes evident that the benthic communities are subject to strong fluctuations from year to year both with regard to their individual densities and their species composition (Figure 20). The relatively species-poor molluscs are found in the highest abundances, most commonly *Macoma baltica* (Baltic clam) and *Mytilus edulis* (blue mussel). Crustaceans and polychaetes are less stable in their densities.

The polychaetes have shown the highest numbers of species over the years. This is due to their high adaptability to changing environmental conditions (e.g. lower salt concentrations or low oxygen concentrations).

Abundance fluctuations of other species can be explained by the considerable annual fluctuations of the salt water inflow from the North Sea. A strong salt water influx can lead to a significant increase in the number of individuals among the macrozoobenthos species within a few weeks. Frequent oxygen deficiency events have reduced species diversity and population density in recent decades. However, following a salt water inflow in 2014, euhaline species such as the bivalves *Abra alba* and *Corbula gibba*, the polychaetes *Nephtys ciliata* and *Nephtys hombergii* and the brittle star *Ophiura albida* were found in the central Arkona Basin in the year following a long absence or for the first time (WASMUND et al. 2016a).

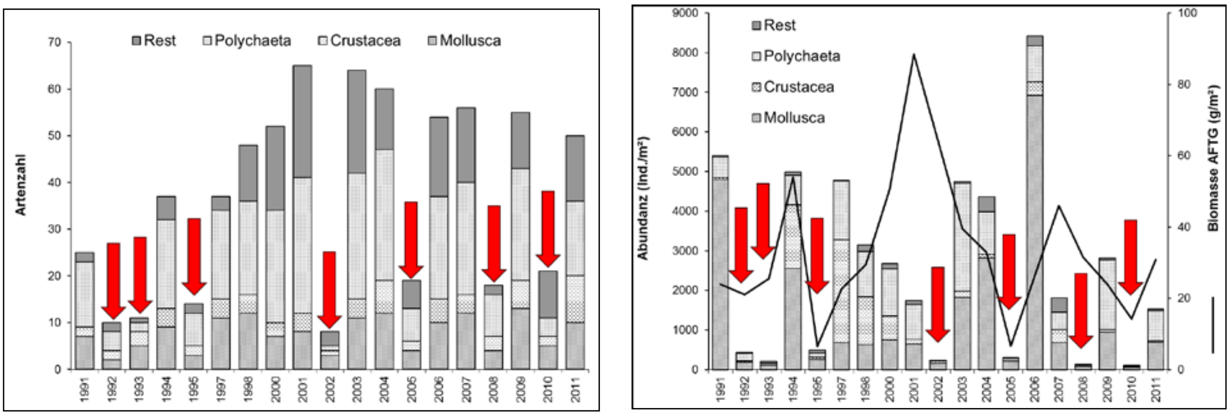

Figure 20: Development of species numbers, abundance and biomass of macrozoobenthos at the Fehmarn Belt station from 1991 to 2011. The arrows indicate summer oxygen deficiency events in water bodies near the bottom (from WASMUND et al. 2012).

A total of 383 benthic species are listed for the German marine and coastal area of the Baltic Sea of GOSSELCK et al. (1996). In comparison, a total of 2,035 macrozoobenthos species can be found in the entire Baltic Sea, distributed among 1,423 marine species and 612 freshwater and brackish water species (ZETTLER et al. 2014). A total of 51 of these species are classified as neozoa.

WASMUND et al. (2017) report that between 1991 and 2016 a total of 260 taxa were detected at eight stations in the Baltic Sea (Kiel Bight to the Pomeranian Bight). Of these, however, around a third appears only occasionally. In the 1980s, 150 regularly occurring macrozoobenthos species were recorded in the Kiel Bight (BREY 1984; WEIGELT 1985). In the course of the long-term monitoring of the outer coasts of Mecklenburg Western Pomerania (INSTITUTE FOR APPLIED ECOSYSTEM RESEARCH 2005b), about 140 taxa were identified in the Mecklenburg Bight. The high percentage of marine "guest species" that are introduced into the Mecklenburg Bight during salt water inflows is noteworthy. ZETTLER et al. (2000) found more than 240 species of macrozoobenthos in the Mecklenburg Bight. The dominant systematic main groups were the polychaeta (71 taxa), crustacea (57 taxa) and mollusca (50 taxa). This high level of species diversity can be attributed to the fact that all benthic habitats were included, as well as to the fact that a large number of migratory marine species were found in the Benthal of the Mecklenburg Bight at the time of the study in 1999 due to the favourable hydrographic conditions.

According to literature research as part of an R&D project (ZETTLER et al. 2003), 126 taxa were found in the Arkona Sea. It should be noted that in the case of more than 80 species, they are rare or individual specimens. Dominant species are the bivalves *Macoma balthica* and *Mytilus edulis* and the polychaetes *Pygospio elegans* and *Scoloplos armiger*.

The occurrence of macrozoobenthos in the Baltic Sea depends not only on the salinity but also on the hydrographic conditions and water depth. Deeper areas (40 m) with muddy substrata below the halocline are considered to be very species-poor. For example, ZETTLER et al. (2000) found the greatest species diversity in the Mecklenburg Bight with 140 taxa at water depths of between 10 and 20 m. The lowest species diversity of about 70 taxa was found in the depth zone of 25 - 30 m, which represented the deepest part of the study area.

The stratified waters have a special status. The increased salinity in the water body near the bottom and the temporary oxygen deficiency result in different colonisation patterns of the benthos. With the salt water from the North Sea/Kattegat area, larvae of marine invertebrates enter the Baltic Sea, so that marine faunal elements colonise the mixohaline waters at least temporarily. On the other hand, the oxygen deficiency that occurs can cause the benthic communities to collapse (KÖLMEL 1979, WEIGELT 1987, GOSSELCK et al. 1987).

A special characteristic of this region is the brackish water submergence of some species. Water rich in salt is deposited in the basins and depressions and provides a habitat for species that can also be found in shallower water depths in the completely marine area. In the process, they may also in some circumstances shift to substrata that do not correspond to their preferred habitat in the completely marine area. Submergence areas can change as a result of the constant exchange processes between the North Sea and the Baltic Sea, meaning that this area is not fixed. Among the species of macrozoobenthos that, according to TISCHLER (1993), can serve as examples of "brackish water submergence" in the Baltic Sea are *Mytilus edulis* (blue mussel), *Macoma baltica* (Baltic clam), *Hydrobia ulvae* (Laver spire shell) and the worms *Pygospio elegans* and *Scoloplos armiger*.

2.6.2.2 Benthic communities

According to RUMOHR (1996), the zoobenthos community in the shallow waters of the western Baltic Sea is mainly dominated by the *Macoma balthica* (Baltic clam) community. While the lower distribution limit of the community in the North Sea is 10 to 15 m deep, it is mainly in the central part of the Baltic Sea, which is low in salt, that it extends to the range between 75 and 100 m due to the higher salt concentrations at this depth (TISCHLER 1993). In the western Baltic Sea, the species of the *Macoma balthica* community can also be found in shallower areas of coastal waters. The "real" deep water communities of the western Baltic Sea are dominated by the *Abra alba* or *Arctica islandica* communities. A clear distinction between shallow and deep-water benthic communities is also demonstrated by GLOCKZIN & ZETTLER (2008).

According to KOCK (2001), the fauna of the deeper Fehmarn Belt (19-28 m) can be considered as a depleted *Abra alba* community as defined by PETERSEN (1918) and THORSON (1957). This community occurs on mixed to silty bottoms with organic matter at depths of 5 to 30 m. The expected character species are the bivalves *Abra alba, Phaxas pellucidus, Aloides gibba* and *Nucula* sp., the polychaetes *Pectinaria koreni* and *Nephtys* sp. and the sea urchin *Echinocardium* sp.

In the Mecklenburg Bight, the delimitation of communities according to ZETTLER et al. (2000) is directly linked to depth zoning (salt, temperature, sediments). Three are three distinct main communities: the first group can be described as *Mya-arenaria-Pygospio-elegans* coenosis of shallow sandy areas at water depths below 15 m. Here, in addition to the soft-shell clams and the spionidae *Pygospio elegans*, there are also a lot of *Hydrobia ulvae, Mytilus edulis, Macoma balthica* and *Scoloplos armiger*. The second group is the community of the sandy muds and muds at water depths over 15 m. The main species are *Arctica islandica* and *Abra alba*. Other important taxa include *Diastylis rathkei, Euchone papillosa* and *Terebellides stroemi*. This *Abra-alba-Arctica-islandica* coenosis is found in Mecklenburg Bight at depths between 15 and 29.6 m. After extended oxygen depression, this coenosis can be reduced to *A. islandica* and *Halicryptus spinulosus* (Prena et al. 1997). The third group are species of silty sand at water depths between 12 and 22 m. This transition area from sands to muds has also created a distinct community. This community can be called a *Mysella-bidentata-Astarte-borealis* coenosis. This area is dominated primarily by five bivalve species. In addition to *Mysella bidentata* and *Astarte borealis*, there are regular occurrences of *Corbula gibba, Parvicardium ovale* and *A. elliptica*. This zone is also the main area of occurrence of *Asterias rubens*.

The exposed crests with their moving coarser sands are a special habitat. Various specialists such as bristle worm species or the amphipod *Bathyporeia sarsi* live here. Low-silt fine sands dominate, which are colonised by a typical, species-poor community with a high degree of stability. Dominant species in these areas are the Baltic clam, soft-shell clam, lagoon cockle, blue mussel and the Laver spire shell in the group of the molluscs and the ragworm, *Pygospio elegans*, *Marenzelleria neglecta* and *Heterochaeta costata* from the group of the ringed worms (polychaeta and oligochaeta). Special communities can also be found on the boulder and debris layers. The epifauna community that lives in hard substrata is dominated by blue mussels (*Mytilus edulis*) and bay barnacles (*B. improvisus*). This community as well as the phytal coenosis is accompanied above all by sessile colony builders (bryozoans, cnidarians) and vagile isopods and amphipods (Sordyl et al. 2010).

An up-to-date and comprehensive description of benthic communities for the entire Baltic Sea is provided by Gogina et al. (2016). This study identified 10 benthic communities based on abundances and 17 communities based on biomass. In the area of the Mecklenburg Bight and shallow sandy sediments, there is a community characterised by high abundances of gastropods of the Hydrobiidae genus, the polychaete *Pygospio elegans* and the lagoon cockle *Cerastoderma glaucum*. In addition, in deeper areas of the Mecklenburg Bight, there is a community characterised by the occurrence of the Cumacea crustacean *Diastylis rathkei*, the bivalves *Corbula gibba, Arctica islandica, Abra alba* and the polychaetes *Dipolydora quadrilobata and Aricidea suecica*. The amphipod *Pontoporeia femorata* and the polychaete *Bylgides sarsi* are frequently found in the area of the Arkona Basin. This community is closely linked to the oxygen conditions in the deep basins. When oxygen concentrations increase after longer periods of oxygen deficiency, the *Bylgides sarsi* often recolonises the sediments as one of the first species Gogina et al. (2016).

Area O-1

Three communities (A, B and C) were identified in area O-1. Community A is mainly distributed above the halocline, also locally in the area of hard substrata below the halocline. The community is dominated by the blue mussel and elements of its typical accompanying fauna (e.g. *Gammarus spp*., *Microdeutopus gryllotalpa*, *Jaera albifrons*), but also by *Saduria entomon*. Community B is limited in distribution to the sandy areas above the halocline. It is dominated by oligochaeta, *Pygospio elegans* and *Hydrobia ulvae*, also locally by *Marenzelleria neglecta* and *Travisia forbesii.* Community C is the community of the muddy soft layers below the halocline. Characteristic species include *Scoloplos armiger, Halicryptus spinulosus, Pontoporeia femorata, Diastylis rathkei, Ampharete* spp. and *Terebellides stroemi*.

Site O-1.3

In site O-1.3, the epifauna species *Mytilus edulis* (blue mussel) and *Crangon crangon* (brown shrimp) were found in the baseline survey 2011-2012. The infauna was represented by a total of 40 species and 13 supra-specific taxa. The polychaeta were the most species-rich large group followed by the mollusca and crustacea. The Baltic clam *Macoma balthica* and the ringed worm *Scoloplos armiger* dominated the community in terms of total abundance. Other dominant species were the crustacean *Diastylis rathkei* and the amphipod *Pontoporeia femorata*. In terms of biomass, *Macoma balthica* mainly dominated.

Area O-2

The *Macoma balthica* community, which is widespread in large parts of the Baltic Sea, is present throughout area O-2. The three main species measured in terms of total individual number are the Baltic clam, the ringed worm *Scoloplos armiger* and the Cumacea crustacean *Diastylis rathkei*. The predominant benthic species consist mainly of species that regenerate quickly after disturbances.

Area O-3

Two communities can be identified in area O-3 in the Arkona Sea. The first community populates shallow areas (up to 30 m water depth). Typical representatives of the community here are the polychaete *Travisia forbesii*, the bivalve *Mya arenaria*, the snail *Hydrobia ulvae* and the amphipod *Bathyporeia pilosa*. Due to their feeding habits, all four are typical for light to medium exposed areas of coastal waters and are rarely found below a water depth of 20 m. The areas in the central and northern parts of area O-3 can be assigned to this community. The second community inhabits deeper areas (30 to 40 m) and includes cold-water species such as the bivalve *Astarte borealis*, the glacial relict amphipods *Monoporeia affinis* and *Pontoporeia femorata*, the relict isopod *Saduria entomon* and the polychaete *Terebellides stroemi*.

2.6.2.3 Red List species

According to the current state of knowledge, a possible occurrence of at least 30 Red List species is to be expected in the area of the German EEZ according to RACHOR et al. (2013) and HELCOM (2013b) (see Table 8).

The main threats are caused by the destruction of habitats by direct anthropogenic influences and the effects of eutrophication such as oxygen deficiency and increasing siltation of sandy soils. For coldstenothermic species, climate-induced warming of the Baltic Sea will be a major threat in the future (SORDYL et al. 2010).

The macrozoobenthos surveys carried out as part of HELCOM monitoring at eight stations in the western Baltic Sea (WASMUND et al. 2017) in November 2016 identified a total of 23 species on the Red List for the North Sea and the Baltic Sea (RACHOR et al. 2013). Two of these species are listed as threatened with extinction (category 1), among them the chalky mollusc (*Macoma calcarea*), which, as in previous years, was found in low abundance in the Kiel Bight area. The anthozoe *Halcampa duodecimcirrata*, also classified as threatened with extinction, was found in small numbers in the southern Mecklenburg Bight, but outside the German EEZ. Among the species classified as critically endangered (category 2) according to RACHOR et al. (2013), the common whelk (*Buccinum undatum*) occurred in the area of the Kiel Bight. The polychaete *Euchone papillosa*, also categorised as critically endangered, was found in the Mecklenburg Bight. In the case of the species classified as endangered (category 3), the Astarte bivalve (*Astarte montagui*) was only found in the area of the Kiel Bight, while the ocean quahog (*Arctica islandica*) was found at several stations in the western Baltic Sea and in the Arkona Basin.

In the HELCOM Red List for the entire Baltic Sea (HELCOM 2013b), which was developed according to global criteria established by the International Union for Conservation of Nature (IUCN), according to RACHOR et al. (2013) fewer species are listed as endangered due to different assessment criteria compared to the national Red List (Table 8).

Due to the different assessment standards of the two Red Lists, the endangered classifications also differ.

Most of the species listed as critically endangered (category EN) or endangered (category VU) on the HELCOM list occur outside the German EEZ in the Kattegat, or are restricted to shallow coastal waters or beaches. The three bivalve species *Macoma calcarea*, *Modiolus modiolus* and *Nucula nucleus* are listed as endangered (category VU) in HELCOM (2013b) of the species potentially occurring in the German EEZ. Three species occurring in the EEZ are on the Early Warning List (category NT), including the blunt soft-shell clam (*Mya truncata*) and the Iceland moonsnail (*Amauropsis islandica*) and the bobtail trophon (*Boreotrophon truncatus*).

A further 6 species on the Red List were identified in the investigations of the wind farm projects "Viking", "Viking South", "Viking North", "Arkona Basin South East", "Baltic Eagle" and "EnBW Baltic 2" as well as the "cables 1 to 6/cross-connection" grid connection. These include the endangered bryozoan species *Alcyonidium gelatinosum* and the amphipod *Monoporeia affinis*. Another four species are subject to an indeterminate threat. Previous investigations in area O-1 have identified 10 endangered species, seven of them within site O-1.3 (Table 8).

The ocean quahog *Arctica islandica* occurs in the Baltic Sea from the Kiel Bight via Mecklenburg Bight to the northern Arkona Basin. It colonises silt and silty sand and requires a high level of salinity of at least 14 PSU and low temperatures. Since 1960, a decline in the Baltic Sea population has been described, caused by prolonged oxygen deficiency in deep water (SCHULZ 1968). In the depth zones of 20 to 15 m, which are rarely affected by oxygen deficiency, the ocean quahog continues to occur in the Mecklenburg Bight, and also once again in high densities (ZETTLER et al. 2001). It has high potential for recolonisation and, due to oxygen deficiency, is almost always one of the first colonisers of the deserted soils in the deep zones of the Lübeck and Mecklenburg Bight (GOSSELCK et al. 1987). Older individuals are tolerant of temporary oxygen deficiency. The occurrences in the Baltic Sea are the only currently known reproductive populations of this species, which is generally widespread throughout the German marine area.

Table 8: Endangered benthic invertebrate species of the EEZ of the German Baltic Sea and identification (X) in areas O-1 to O-3 and site O-1.3. (RACHOR et al. 2013: 1=threatened with extinction, 2=critically endangered, 3=endangered, G=indeterminate HELCOM, 2013b: VU=vulnerable, NT=near threatened).

Species	Status according to Rachor et al., 2013	Status according to HELCOM, 2013	Area O-1	Site O-1.3	Area O-2	Area O-3
Anthozoa (sea anemones)						
Halcampa duodecimcirrata	1	-				
Bivalvia						
Arctica islandica	3	-	X	X	X	X
Astarte borealis	G	-	X	X		X
Astarte elliptica	G	-	X	X		X
Astarte montagui	3	-				X
Macoma calcarea	1	VU				
Modiolus modiolus	2	VU				
Musculus discors	G	-				
Musculus niger	G	-				
Musculus subpictus	G	-				
Mya truncata	2	NT	X	X		
Gastropoda						
Amauropsis islandica	2	NT				
Aporrhais pespelicani	G	-				
Boreotrophon truncatus	2	NT				
Buccinum undatum	2	-				
Nassarius reticulatus	G	-				
Neptunea antiqua	G	-				
Crustacea						
Monoporeia affinis	3	-	X			X
Saduria entomon	G	-	X	X		X
Oligochaeta						
Clitellio arenarius	G	-				X
Tubificoides pseudogaster	G	-				X
Polychaeta						
Euchone papillosa	2	-				
Fabriciola baltica	G	-	X			X
Nereimyra punctata	G	-				
Scalibregma inflatum	G	-				

Species	Status according to Rachor et al., 2013	Status according to HELCOM, 2013	Area O-1	Site O-1.3	Area O-2	Area O-3
Travisia forbesii	G	-	X			X
Echinodermata						
Echinocyamus pusillus	G	-				
Hydrozoa						
Sertularia cupressina	G	-				
Halitholus yoldiaearcticae	3	-	X	X		
Bryozoa						
Alcyonidium gelatinosum	3	-	X	X		

The Astarte species are represented in the EEZ by three species. The *Astarte borealis* and *Astarte elliptica* were documented in area O-1. As marine species, they colonise the sublittoral sandy-silty to silty-sandy zone between a water depth of approximately 12 to 20 m. *Astarte montagui* was never found with any frequency. It is one of the marine species that temporarily populates the area of the Belt Sea after salt water inflows.

The supposedly always small populations of *Mya truncata* were further decimated by oxygen deficiency. Another influence on the occurrence of *M. truncata* is eutrophication as well as bottom fishing, as the species does not burrow deep into the sediment (HELCOM 2013b). Since 1994, more frequently since 1997, *M. truncata* has been found again at the deep stations (15 to 20 m) of the M-V coastal monitoring programme. The species has so far been found in small numbers in the area of the Kiel Bight as well as part of the investigations of site O-1.3.

Macoma calcarea, the large relative of the Baltic clam, occurred until the 1970s along the salt water zone between a water depth of 15 and 20 m in the Belt Sea, in the northern Arkona Basin and in the Bornholm Basin. Oxygen deficiency led to a decline in the Baltic Sea and Mecklenburg Bight populations. The occurrence of this species is currently limited to the western part of the German EEZ (HELCOM 2013b).

The marine gastropods *Amauropsis islandica* and *Boreotrophon truncatus* are marine species that need cold water and high levels of salinity. Their occurrence is currently limited to the western part of the German EEZ and their populations are mainly threatened by bottom fishing and eutrophication (HELCOM 2013b).

The amphipod *Monoporeia affinis* lives in the cold water zone of the actual Baltic Sea. It is one of the dominant species under favourable hydrographic conditions (ANDERSIN et al. 1978). The species inhabits sandy and silty soils and is dependent on cold water temperatures. It resides in the upper 5 cm of the sediment and is an active bioturbator that influences sediment structure, nutrient flows and oxygen availability in the sediment. Deposited phytoplankton and organic matter of the detritus are considered to be the main food source. *M. affinis*was found in the vicinity of area 3 in the area of the German EEZ.

2.6.2.4 Benthic algae

The biotopes of the Baltic Sea EEZ are primarily populated by benthic invertebrates. The submerged vegetation is represented by large algae (red and brown algae) on hard substrata (debris, boulders) in the area of the crests

(Adlergrund, Kriegers Flak) and trench (Kadetrinne). Seagrass observations (*Zostera marina*) are not available for the area of the EEZ, although it may occur at this water depth.

Macrophyte populations have not yet been detected in area O-1 and site O-1.3.

2.6.3 Status assessment of the factor Benthos

The benthos of the Baltic Sea EEZ is subject to changes due to both natural and anthropogenic influences. Besides natural and weather-related variability (severe winters), demersal fishing, sand and gravel extraction, introduction of alien species and eutrophication of the water body, as well as climate change, are major influencing factors.

2.6.3.1 Importance of areas and sites for benthic communities

The criteria used to assess the benthic communities are those that have already proven their worth in the environmental impact assessments of the offshore wind farm projects in the EEZ.

Criterion: Rareness and vulnerability

The criterion "Rareness and vulnerability" of the population takes into account the number of rare or endangered species. This can be estimated on the basis of the documented Red List species.

According to the currently available studies, the macrozoobenthos of the Baltic Sea EEZ is also considered average due to the identified number of Red List species. A species list for the entire EEZ is not currently available. However, the investigations conducted by KOCK (2001), in the course of which more than 110 different macrozoobenthos species were found in the deep water area of the Fehmarn Belt, provide evidence of species diversity. More than 126 species have been identified so far in the Arkona Sea according to ZETTLER et al. (2003).

A total of 383 benthic species are listed for the German marine and coastal area of the Baltic Sea of GOSSELCK et al. (1996). WASMUND et al. (2016) report that between 1991 and 2015 a total of 251 macrobenthos taxa were detected at eight stations in the Baltic Sea (Kiel Bight and Mecklenburg Bight, Arkona Sea). The 29 Red List species detected in the area of the German EEZ thus correspond to approx. 8-12% of the total population. This does not include species on the Early Warning List or species with deficient data.

Criterion: Diversity and uniqueness

This criterion refers to the species number and the composition of the species communities. The extent to which species or biocoenoses characteristic of the habitat occur and how regularly they occur is assessed.

The species inventory of the Baltic Sea EEZ is to be considered average, with about 200 species of macro-zoobenthos. The benthic communities also do not exhibit any special features for the most part. For higher salinity levels, such as those found in the lower horizons (from approx. 20 m) in the German Belt Sea, the conditions for a relatively species-rich *Abra-alba* coenosis exist. The white furrow shell (*Abra alba*), from which the coenosis takes its name, is accompanied by the basket shell (*Corbula gibba*), the ocean quahog (*Arctica islandica*), the trumpet worm (*Lagis koreni*), the bristle worm *Nephtys* spec., the crustacean *Diastylis rathkei* or the brittle star (*Ophiura albida*). There is also a number of other marine euryhaline bristle worms, crustaceans and bivalves. In the actual Baltic Sea, the *Macoma balthica* coenosis dominates in the shallower areas with a salinity-related decrease in species.

Criterion: Naturalness

For the Naturalness criterion, the intensity of fishing activities – which is the most significant disturbance variable – will be used as a benchmark for assessment. The appropriate measurement and detection methods for other disturbance variables are currently unavailable for inclusion in the assessment.

The benthos of the Baltic Sea has already been affected by various anthropogenic disturbance factors and diverges from its original state. Therefore, neither the species composition nor the biomass of zoobenthos today corresponds to the state that would be anticipated without human utilisation. Particularly noteworthy is the disturbance of the seabed surface by intensive fishing activities, which poses a high risk potential for the epibenthos and causes a shift from long-lived species (bivalves) to short-lived, rapidly reproducing species. Eutrophication and shipping are other important drivers. The most important effects of eutrophication on the ecosystem of the Baltic Sea were the increase in primary production of plankton, the increase in benthic biomass (CEDERWALL and ELMGREN, 1980) and the increase in oxygen deficiency events. Increasing oxygen consumption due to eutrophication processes and lower water exchange due to climate fluctuations or changes are seen as causes of frequent and extreme oxygen deficiency situations in the Baltic Sea (HELCOM 2009). Threats to the benthos can also originate from the warfare agents dumped in the Baltic Sea.

In addition to the above assessment criteria, the Baltic Sea succession model of RUMOHR (1996) can be used to describe the situation of benthic communities in the Baltic Sea. The application of this model shows that the benthological state of the Baltic Sea deteriorated by at least one level between 1932 and 1989. The special hydrographic and morphological characteristics of the Baltic Sea as well as natural events (salt water inflows, oxygen deficiency) and anthropogenic influences (eutrophication, pollutant inputs) suggest a succession of typical benthic states. RUMOHR (1996) distinguishes a sequence of typical states and defines a total of five different stages which begin with a stable (climax) community dominated by long-lived bivalves or echinoderms (stage 1, hardly found today) and change with increasing eutrophication into a community dominated by bivalves and long-lived polychaetes and subjected to strong fluctuations with increased biomass (stage 2). Further deterioration of the conditions leads to a short-lived, low-biomass small polychaete community with strong fluctuations in population parameters and occasional extinction due to oxygen deficiency (stage 3). If oxygen levels drop even further, the entire fauna living in the soil (infauna) dies and only an occasional mobile epifauna can be found. Stage 5 features sediment that is animal-free (azoic) over the long term with laminated fine stratification.

Since the end of the 1980s, the western Arkona Basin, like the eastern basins, has been one of the areas of the Baltic Sea at acute risk from temporary oxygen deficiency situations, as a comparison of the state of the marine environment between data from HAGMEIER from 1932 (stage 1-2) and 1989 (stage 3-4) shows (RUMOHR, 1996). After previous oxygen deficiency situations, however, it was also shown that the benthos has an enormous potential for regeneration (see WASMUND et al. 2012). The current state of the benthos, as shown by data from environmental impact studies (EIS) and R&D projects, can be classified as stage 2-3 of the Baltic Sea succession model according to RUMOHR (1996). However, the individual steps in this succession model can also be reversed if conditions change as a result of environmental improvements.

Area O-1

A total of 69 macrozoobenthos species were identified in preparatory investigations conducted by ZETTLER et al. (2003) for the designation of the special "Western Adlergrund" area (area O-1). Total densities between 750 and 31,250 individuals/m² were recorded, whereby the abundances were significantly influenced by the occurrence of the blue mussel (*Mytilus edulis*). Accordingly, the biomass mainly correlates with their occurrence. In total, ZETTLER et al. (2003) found six species, which are considered glacial relicts (*Halitholus yoldiaearcticae*, *Astarte borealis, A. elliptica, Monoporeia affinis, Pontoporeia femorata and Saduria entomon*). These species, like *Arctica islandica*, depend on cold and relatively salty water and are therefore largely restricted to the deeper parts of the area. From a macrozoobenthic perspective, the areas with *Astarte borealis* are particularly valuable for the region. Strong aperiodic salt water inflows can wash marine species as far as the eastern Arkona Basin and thus contribute to species diversity. Bivalve cenoses of *Mytilus edulis* and *Macoma baltica* were detected in the southern half.

The investigations of benthos in area 1 carried out as part of the baseline survey (MARILIM 2016) only partially confirmed the findings of ZETTLER et al. (2003). The identified species were assigned to the *Macoma balthica* community which is widely distributed in the western and central Baltic Sea. In area O-1, the species *Macoma balthica, Scoloplos armiger* and *Pygospio elegans* were most common, with biomass dominated by the Baltic clam (*Macoma balthica*). By contrast, the three main species *Mytilus edulis*, *Pygospio elegans* and *Macoma balthica* were most common in the southern part of area O-1. The biomass in this area was constantly dominated by bivalves (*Mytilus edulis* and *Macoma balthica*).

The benthos community in area O-1 is considered to be of high value due to the abundance of species, the rare relict species and the Red List species. This means that the area has a relatively high proportion of endangered species. From a macrozoobenthic perspective, particularly valuable are the rock fields with their extensive blue mussel beds, which, with their very high numbers of benthic species for the region, extend from Adlergrund into area O-1 in the southeast. Primarily blue mussel beds, gravel and stone beds as well as till were identified.

Site O-1.3

Also the benthos in site O-1.3 can be assigned to the *Macoma balthica* community, also with a pronounced dominance of the species *Macoma balthica* and *Scoloplos armiger*. In the investigations in area O-1, a total of 10 endangered Red List species according to RACHOR et al. (2013) have been identified to date, seven of which occurred within site O-1.3 (see Table 8).

Of the endangered species, the occurrence of the ocean quahog *Arctica islandica* ranged from frequent to widespread in site O-1.3. The bivalve *Astarte borealis* was widespread in spring 2012.

Within site O-1.3, the benthos has medium importance overall with regard to the criteria of rareness and vulnerability as a result of the in part continuous detection of Red List species. The residual sediment area in the eastern part with scattered stones overgrown with macrozoobenthos is to be considered as a reef suspected area of higher value.

The 47 species and 16 other supra-specific taxa found in site O-1.3 are characteristic of the *Macoma balthica* coenosis widespread in the Baltic Sea, which is characterised by a decrease in species due to salinity. Due to the community typical for this habitat, the benthos is of medium importance in terms of diversity and uniqueness.

No high contamination of the benthic community could be detected in the area of site O-1.3. Overall, the naturalness of the benthic community in this area can therefore be classified as medium.

According to the current state of knowledge, the overall assessment of the benthic community in site O-1.3 is of medium importance overall.

Area O-2

The results of the environmental assessments of the offshore wind farms "Baltic Eagle" and "Ostseeschatz" will be used to assess the benthos in area O-2. The *Macoma balthica* community, which is widespread in large parts of the Baltic Sea, is present throughout the area. In addition to the Baltic clam, which gives the community its name, various other bivalves, polychaetes, crustaceans and gastropods dominate the benthic community. The three main species measured in terms of total individual number are the Baltic clam, the ringed worm *Scoloplos armiger* and the Cumacea crustacean *Diastylis rathkei*. Apart from the bivalves, they are mainly fast-growing, short-lived "opportunists", known for their rapid sexual maturity, high numbers of offspring and short life cycles. These are key characteristics to withstand the highly variable environmental factors of the habitat.

A total of 42 macrozoobenthos species were identified in the "Baltic Eagle" and "Ostseeschatz" project areas. The average individual density in the "Ostseeschatz" project area was 643 ind./m². Individual species often dominate. The epifauna is dominated by species that can live as scavengers or predators on silty substrata, such as the polychaetes *Nephtys ciliata* and *Bylgides sarsi*. According to the Red List (Rachor et al., 2013), only the ocean quahog (*Arctica islandica*) is classified as endangered (see Table 8).

Overall, area O-2 has a low structural diversity. The predominant benthic species consist mainly of species that regenerate quickly. The pronounced ability to recover quickly after disturbances is characteristic of the benthic fauna (RUMOHR 1995). The area is therefore of minor importance for both the infauna and the epifauna.

Area O-3

The description of area O-3 is based on the results of the preparatory investigations for the designation of the special "Kriegers Flak" area and the results of the benthic investigations under the scope of the environmental impact study and the monitoring during construction for the wind farm "EnBW Baltic 2".

A total of 77 macrozoobenthos species were found as part of the investigations conducted by ZETTLER et al. (2003). Total densities between 386 and 8875 ind./m² were recorded, whereby the abundances were significantly influenced by the presence or absence of the Baltic clam (*Macoma balthica*) and the polychaete *Pygospio elegans*. The biomass was mainly dependent on the larger bivalve species (*Macoma balthica*, *Mya arenaria* and *Mytilus edulis*). The polychaete *Terebellides stroemi* was regularly recorded in relatively high abundances at the mud stations at water depths above 35 m. Of the species identified, seven are to be regarded as what are known as glacial relicts (including *Astarte borealis*, *Monoporeia affinis* and *Pontoporeia femorata)*. These species and the *Arctica islandica* depend on cold and relatively salty water and are therefore mostly restricted to the deeper parts of the area. From a macrozoobenthic perspective, these areas are particularly valuable for the Kriegers Flak region.

With the exception of a few findings of rare species, the results of the investigations under the scope of the environmental impact study on the current population of the benthic communities are consistent with the results of the investigations under the scope of the R&D project commissioned by the Federal Agency for Nature Conservation (ZETTLER et al. 2003). A total of 83 macrozoobenthos taxa were detected in the study area of the "EnBW Baltic 2" wind farm as part of the environmental impact study. The investigations carried out as part of the monitoring during construction (INSTITUTE FOR APPLIED ECOSYSTEM RESEARCH 2015a) also showed a total of 60 species and 20 supra-specific taxa. The most common species were the Baltic clam (*Macoma balthica*) and the blue mussel, the Laver spire shell (*Hydrobia ulvae*), the polychaetes *Pygospio elegans* and *Scoloplos armiger* and the Cumacea species *Diastylis rathkei*.

A total of 10 endangered Red List species according to RACHOR et al. (2013) were detected in area O-3 between 2002 and 2014 (see Table 8).

The benthic community in area O-3 is considered to be of high value due to the abundance of species, the rare relict species and the number of Red List species. This follows on the one hand from the fact that a total of 83 species were found in the study area of the "EnBW Baltic 2" wind farm, 10 of which were on the Red List. The southern and to some extent north-eastern parts of the area are of particular importance, as they are home to cold water species that are rare in the Baltic Sea (e.g. *Astarte borealis, Monoporeia affinis*). From a macrozoobenthic perspective, according to ZETTLER et al. (2003), the rock and debris layers in the northern shallow area with the extensive blue mussel beds are particularly valuable.

Connecting route of areas O-1 and O-2

In the course of the benthic investigations for the grid connection of the offshore wind farm "Arkona Basin Southeast", a total of 36 macrozoobenthos species were detected by means of grab sampling. The most species-rich groups were the polychaetes and crustaceans. The individual density was on average 3,396 ind. per m². A total of 61 species were identified during the route investigations carried out in 2012 for the planned grid connections for area O-1.

The soft substrate coenosis found along the route outside area O-1 is relatively species-poor. The individual densities and total biomass found are also relatively low. Soft substrata-dwelling species dominate such as *Halicryptus spinulosus, Macoma balthica, Terrebellides stroemi, Diastylis rathkei* and *Pontoporeia femorata*. Particularly in summer, aperiodic oxygen deficiency events can occur in the muddy sediments and lead to large-scale extinction of the benthic fauna. Overall, the importance of the route for the macrozoobenthos can be classified as low to medium. The transect investigations inside area O-1 show a clearly species-richer benthic coenosis with higher individual densities. The blue mussel dominates the hard substrata coenosis here.

More recent investigations of the benthic communities were carried out as part of the approval procedure "cables 1 to 6/cross-connection" grid connection in areas 1 and 2 (50 HERTZ 2014), the routes of which largely coincide with the routes of the connections. A total of 42 taxa were found along the planned cable routes, with polychaetes (14 species), crustaceans (12 species) and molluscs (5 species) being the most species-rich taxonomic groups. Two of the species found are classified with an indeterminate threat (RL category G) in the Red List according to RACHOR et al. (2013) due to their population situation or development. These are the bivalve *Astarte borealis* and the isopod crustacean *Saduria entomon*. At least locally, the endangered, long-lived bivalve *Arctica islandica* (RL category 3) may also occur, even if it was not detected in the above investigations. The occurrence of typical reef species or reef communities can be expected within the rock fields occurring in the area. The benthic community is therefore to be classified as "regionally important", especially in the area O-1.

2.7 Fish

As the most species-rich of all vertebrate groups alive today, fish are equally important as both predators and prey in marine ecosystems. Demersal fish feed predominantly on invertebrates living in and on the seabed, while pelagic fish species almost exclusively eat zooplankton or other fish. In this way, biomass produced in and on the seabed as well as in open water, and the energy bound up in it is also available to seabirds and marine mammals.

Fishing and climate change are the most important influences on fish populations (HOLLOWED et al. 2013, HEESSEN et al. 2015). These factors interact and can hardly be distinguished in terms of their relative effect on the population dynamics of fish (DAAN et al. 1990, VAN BEUSEKOM et al. 2018). Hydrographic conditions and the influences of various human activities also have a part to play. Thus the dominance conditions within a fish species community can follow long-term, periodic climate fluctuations (PERRY et al. 2005, BEAUGRAND 2009, GRÖGER et al. 2010, HISLOP et al. 2015). However, these cannot be explained without taking fishing into account (FAUCHALD 2010).

Weakening of the synchronicity between temperature-controlled zooplankton development and day length-controlled phytoplankton development is another mechanism by which increased temperatures due to climatic changes can influence the population dynamics of fish. This "mismatch" (CUSHING 1990, BEAUGRAND et al. 2003) may reduce the density of zooplankton found by fish larvae if they are dependent on external nutrition after consuming their yolk sacs. The survival rates of early life stages have a disproportionate effect on population dynamics across species (HOUDE 1987, 2008). This variability can propagate to the predators at the top of the food chain (DURANT et al. 2007, DÄNHARDT & BECKER 2011), which also includes fishing. Climate change could indirectly impact marine fish communities, as humans react to climate change by installing offshore wind farms (EEA 2015). On the one hand, this would create large areas where fishing is excluded and, on the other hand, artificial hard substrates would be introduced on a large scale, creating habitats for species that would not otherwise occur in the areas in question (EHRICH ET AL. 2007). These mechanisms are generally also effective in the Baltic Sea, whose hydrographic dependence on wind-driven influx of salty and oxygen-rich North Sea water is the decisive factor for fish populations (MÖLLMANN ET AL. 2009). Oxygen deficiency thus occurs repeatedly in the deep basins. A stable stratification of the water body with oxygen depletion below the thermocline can severely impair the reproductive success of fish whose eggs are suspended in these layers (e.g. Baltic cod; NISSLING ET AL. 1994). That said, climate change and fishing are not the only factors that can control fish populations. ÖSTERBLOM ET AL. (2007) explain the development of fish populations in the Baltic Sea between 1900 and 1980 largely by the decline in the seal population and the strong eutrophication.

The way the adult animals live in the water body can be used for an initial classification of the fish fauna. The bottom-dwelling species (demersal) can be distinguished from those that live in open water (pelagic). Mixed forms of both – benthopelagic species – are also widespread. However, this separation is not strict: demersal fish ascend into the water column, while pelagic fish occasionally stay near the seabed. At 53%, demersal fish account for the largest share ahead of benthopelagic (27%) and pelagic (17%) species. Only approximately 3% cannot be assigned to any of the three types due to close habitat affinity (WWW.FISHBASE.ORG). The individual life stages of species often differ more widely from one another in terms of form and behaviour than the same stages of different species: the pelagic Atlantic herring *Clupea harengus* lays its eggs in thick mats on sandy-gravelly seabed or sticks them to suitable substrates such as algae or rocks (DICKEY-COLLAS et al. 2015), all flatfishes have pelagic larvae, which metamorphose into the characteristic body shape for life on the seabed (VELASCO et al. 2015), and benthopelagic fish such as cod produce pelagic eggs and larvae (HISLOP et al. 2015).

Fish can be assigned to functional guilds based on diet, reproduction or habitat use. Unlike taxonomic classification, these make it easier to describe the functions of fish in the ecosystem (ELLIOTT et al. 2007). This concept is described extensively for estuarine fish species (ELLIOTT et al. 2007, FRANCO et al. 2008, POTTER et al. 2015), but it has not been used widely for marine fish to date.

More than 5,300 fishing vessels from nine nations operate in the Baltic Sea with an annual catch of almost 700,000 tonnes spanning all species and populations (ICES 2017a). A total of 4,100 small coastal fishing vessels stand in contrast to only 1,200 units fishing in the open Baltic Sea. However, there are significant differences between the nations involved. While 95% of the Swedish fleet operates offshore, smaller coastal fishing vessels account for 80% of the German Baltic Sea fleet (ICES 2017a). The main target species Atlantic cod *Gadus morhua*, herring and European sprat *Sprattus sprattus* account for about 95% of the total catch. Other fish species with less economic importance are the Atlantic salmon *Salmo salar*, European plaice *Pleuronectes platessa*, common dab *Limanda limanda*, turbot and brill *Scophthalmus rhombus and S. maximus*, European flounder *Platichthys flesus*, zander *Sander lucioperca*, northern pike *Esox lucius*, common perch *Perca fluviatilis*, maraene *Coregonus maraena*, various whitefish, eel *Anguilla anguilla* and brown trout *Salmo trutta*. Pelagic fishing for herring and sprat is the most widespread form of fishing in the Baltic Sea and has by far the largest number of landings.

Demersal fishing targets Atlantic cod and flatfish and is concentrated in the south and west. The role of recreational fishermen in the Baltic Sea, who land more than half of the annual fish biomass removed in Germany, has also long been underestimated (HYDER et al. 2017).

2.7.1 Data availability

As data is almost only available from demersal fishing, but not from sampling in the pelagic zone, the following assessment can only take place for demersal fish. No reliable estimates are possible for pelagic fish. The basis for the assessment of the state of the factor (demersal) fish are

- the findings from environmental impact studies and cluster studies to compile current species lists (Area 1: cluster west of the Adlergrund spring 2014, Area 2: Baltic Eagle autumn 2012, Area 3: EnBW Baltic 2 autumn 2014).
- the International Council for the Exploration of the Sea (ICES) Database of Trawl Surveys (DATRAS) (accessed on 12 marts 2018). Only the standard areas and grid squares covering the German Baltic Sea EEZ were considered. These are the standard roundfish areas 22 and 24, with wind farm areas O-1, O-2 and O-3 all located in standard roundfish area 24. The catch data from the fourth quarter of 2017 and the first quarter of 2018 was merged.

EHRICH et al. (2006) and KLOPPMANN et al. (2003) were consulted for a historical reference. HEESSEN et al. (2015) was used for classification in the context covering the Baltic Sea as a whole. The online portal "Fischbestände online" [Fish populations online] (BARZ & ZIMMERMANN 2018) was used for the current assessment (2017/2018) of the fished populations. This summarises ICES' scientific population assessment.

2.7.2 Spatial distribution and temporal variability

The spatial and temporal distribution of fish is determined first and foremost by their life cycles and the migration associated with the various stages of development (HARDEN-JONES 1968, WOOTTON 2012, KING 2013). The framework for this is defined by many different factors that are effective on a variety of spatial and temporal scales. Hydrographic and general climatic factors such as swell and, above all, wind-induced currents that control the inflow of cold, oxygen-rich salt water from the North Sea, which has a major impact on the living conditions of fish in the Baltic Sea. Water temperature and other hydrophysical and hydrochemical parameters, as well as food availability, intraspecies and interspecies competition and predation – of which fishing forms a part – operate on a medium (regional) to small (local) space-time scale. Another decisive factor for the distribution of fish in time and space is habitat, which in a broader sense means not only physical structures but also hydrographic phenomena such as fronts (MUNK et al. 2009) and upwelling regions (GUTIERREZ et al. 2007), where prey aggregates and can thus set whole trophic cascades in motion and maintain them. Diverse human activities and influences are other factors that structure the distribution of fish. These range from nutrient and pollutant discharges to the obstruction of migration routes for migratory species and fishing, to marine structures that fish use as spawning substrates (sheet piling for herring spawn) or food sources (fouling on artificial structures), or even as retreats where fishing is excluded to date (offshore wind farms) (EEA 2015).

2.7.2.1 Fish fauna in the German EEZ

The special hydrography and the decreasing salinity from west to east are also reflected in the fish fauna of the Baltic Sea. Where marine species predominate in the North Sea, freshwater fish make up a large part of the fish species community. As of November 2015, the fish database Fishbase (WWW.FISHBASE.ORG) list 160 species that have been detected in the entire Baltic Sea to date. THIEL et al. (1996) estimate the number of Baltic fish species at 144, consisting of 97 marine fish species, 7 migratory and 40 freshwater fish species. In their comprehensive overview, WINKLER & SCHRÖDER (2003) list 151 species for the entire German Baltic Sea coast. The reference area includes the Baltic Sea coasts of Schleswig-Holstein and Mecklenburg-Western Pomerania, bordered on the outside by the middle line defined with the neighbouring countries (according to the definition of FRICKE et al. 1996). The documentation contains all species for which scientifically verified proof is available from the German Baltic Sea region. If all individual findings ever recorded in the Baltic Sea are included, the list of Baltic Sea fish consists of 176 species (WINKLER et al. 2000). According to Möbius, MÖBIUS & HEINCKE (1883) the species are divided into four categories according to the type of use of the area as habitat:

- Marine stationary fish that migrate, but are always found in the area and reproduce there,
- Marine migratory and accidental migrants that migrate regularly, sporadically or extremely rarely from the North Sea, but do not reproduce in the Baltic Sea,
- Diadromic migratory fish that reproduce in freshwater and mature in the sea or vice versa,
- Freshwater fish with stationary occurrences or migratory fish that reproduce in brackish or pure freshwater.

According to MOYLE & CECH (2000) , diadromic migratory species can be divided into

- anadromous species such as salmon, twait shad *Alosa fallax* and European river lamprey *Lampetra fluviatilis* that spawn in freshwater and mature in estuaries or the sea.
- semi-anadromous species such as the vimba bream *Vimba vimba*, ziege *Pelecus cultratus*, maraene *Coregonus maraena* or European smelt *Osmerus eperlanus* that spawn in the upper estuary/low salinity brackish water or freshwater, and
- catadromous species such as eel or flounder, which spawn in the sea and mature in brackish or freshwater.

While guest species usually occur regularly in the area during their food migrations, accidental migrants seem almost impossible to predict and are mostly due to unusual hydrographic and meteorological phenomena. In the Baltic Sea, almost half of all species in the area are stationary fish, 18% can be classified as regular guests, 29% are accidental migrants and 8% have been introduced into the Baltic Sea, mostly temporarily through intentional or unintentional restocking measures.

The total number of species has almost doubled compared to the 16th century, mainly due to the occurrence of marine species, with the ratio between marine and diadromous and freshwater species still at 2:1: According to WINKLER & SCHRÖDER (2003), 2/3 of the fish community are marine species, 12% diadromous migrants and 21% freshwater fish. Of the 151 species occurring in the Baltic Sea, 44 are considered to be very rare, 36 rare, 33 regular, 24 frequent, and 13 occur very frequent in the German Baltic Sea. About 46% of the fish species (70 of 151) occur regularly to very frequently and about 54% rarely to very rarely in the German Baltic Sea (WINKLER & SCHRÖDER 2003).

The current Red List (THIEL et al. 2013) limits its risk assessment to the established species, as many marine fish species and lampreys carry out extensive migrations between feeding, spawning and nursery areas, which are sometimes far apart, in the course of their development. A species is therefore considered established not only if it reproduces regularly in the assessment area, but also if at least one of its developmental stages (juvenile, subadult, adult) regularly visits a partial habitat in the area or if it only occurs here as a regular migratory guest (Thiel et al. 2013). A total of 90 species established according to these criteria can be found in the Baltic Sea assessment area. Of these, 47 species (52.8%) are rare to extremely rare, 40 species (45%) are moderately common to very common. Very common fish include the marine fish species herring, sprat, Atlantic cod, lesser sand eel *Ammodytes marinus* and great sand eel *Hyperoplus lanceolatus*, sand and common goby *Pomatoschistus minutus* and *P. microps*, the flat fish common dab and flounder and the three-spined stickleback *Gasterosteus aculeatus* that occurs in the marine habitat and in freshwater. Baltic herring is classified as a subspecies (*Clupea harengus membras*) and Baltic cod is also classified taxonomically as a subspecies (*Gadus morhua calaris*). The environmental conditions in the Baltic Sea, which differ from those in the North Sea, are manifested, among other things, in changed growth characteristics and body proportions of the local forms. In the eastern Baltic Sea, the herring stays, e.g. much smaller and becomes sexually mature with a smaller body size. The very common species also include smelt, perch and zander. It is common to find salmon and sea trout, the freshwater fish ide *Leuciscus idus*, common bream *Abramis brama* and white bream *Blicca bjoerkna* and the marine species whiting *Merlangius merlangus*, garfish *Belone belone*, lumpsucker *Cyclopterus lumpus* and plaice. The occurrence of the many carp-like species (Cyprinidae) is limited to the peripheral waters of the Baltic Sea such as the Oder estuary. Salmon listed in Annex II of the Habitats Directive as an animal species of Community interest for which special protected areas are to be established for their conservation, sea trout and maraene are supported by fisheries support measures. The population of the latter species appears to have increased significantly in recent years as a result of extensive support measures.

The sea lamprey *Petromyzon marinus* and river lamprey, both anadromous migrants, are found rarely to regularly in the German Baltic Sea areas. The very rare fish species include all sharks and rays, which are without exception accidental migrants, and are found only at the transition between Kattegatt and the Belt and Sund Sea. The anadromous migratory fish, relatives of the herring, the twait and allis shad (*Alosa alosa*), both called salmon in Annex II of the Habitats Directive, are rarely or very rarely observed in the Baltic Sea. Since 1990, only two individual specimens of the allis shad have been recorded in German Baltic Sea waters (Thiel & Winkler 2007), and also historical specimens of the allis shad are extremely rare, spatially and temporally very variable and not always unambiguous (Winkler et al. 2002). The twait, closely related to the allis shad, however, is still established in the southern Baltic Sea (Thiel & Winkler 2007). After hardly any evidence was found between 1960 and 1989 (Winkler 1991), observations in the southern Baltic Sea have increased again since the mid-1990s, mainly in the areas north-east of Rügen, from the Pomeranian Bight and from the Oder estuary. This development corresponds to development in Poland (Repečka 2003), Lithuania (Skóra 2003) and Russia (Maksimov 2004). Causes for the decline in twait populations in the southern Baltic Sea are considered to be increasing water pollution in coastal waters, the construction of barriers to migration (e.g. Repečka 1999) and possibly climate factors (e.g. Thiel et al. 2007).

Fish communities typical for the habitat

The fish communities typical of the Baltic Sea habitat are represented by pelagic, benthic (demersal) and littoral species (Nellen & Thiel 1995). The boundaries are fluid and there are exchanges, e.g. when pelagic fish such as herring visit their spawning grounds on the coast.

In addition to spawning grounds, there are also feeding grounds for many fish species on the coast. The pelagic fish community is dominated by herring, which occurs throughout the Baltic Sea. Sprat, salmon and sea trout are other characteristic representatives. The most important representatives of the benthic fish community in economic terms are cod, flounder and plaice. In addition to the commercial species mentioned above, various small fish species (e.g. gobies) are important links within the fish communities of the Baltic Sea. This includes the round goby *Neogobius melanostomus*, one of the most common invasive fish species in the world. Round goby originating from the Black Sea have spread in the Baltic Sea since 1990 from Gdansk Bight to the west (SAPOTA & SKORA 2005) and into Estonian and Latvian coastal waters (OJAVEER et al. 2006). It was first detected in Germany in 1998 (WINKLER 2006). In the meantime, the up to 20-cm-long goby has become established in the food web up to the level of birds (KARLSON et al. 2007, ALMQVIST et al. 2010). The littoral fish community consists almost exclusively of juvenile individuals of pelagic species. The littoral of the Baltic Sea, the Bodden and lagoon, is characterised by dense vegetation with algae and seaweed as well as an abundance of food, which explains its function as a nursery area for economically important species and as a habitat for small fish.

Typical regional communities

The distribution of Baltic Sea fish is largely determined by their tolerance or preference for abiotic factors such as salinity, temperature and oxygen content. The more sensitive development stages in particular play a crucial role here. Freshwater fish in the brackish Baltic Sea reach their physiological limits just as much as marine fish from the North Sea, and the distribution of fish species reflects the salinity gradient, which decreases from east to north (RHEINHEIMER 1996). Along the same gradient, both the number of species and the species-specific abundance decrease, which can be largely explained by the fact that marine fish avoid areas with low salinity. For example, marine fish are mainly found in the Kattegat and in the western Baltic Sea (NELLEN & THIEL 1995), while freshwater fish are represented with the most species in the coastal waters of the central Baltic Sea. REMANE (1958) reports 120 species of marine fish in the North Sea, only 70 in the Kiel and Mecklenburg Bight, 40 to 50 in the southern and central Baltic Sea and only 20 in the Aland Sea, the Gulf of Finland and the Bothnian Sea. In addition to salinity, water temperature also seems to be a factor that affects the structure of the fish community. The fish fauna of the North Sea consists of species whose main distribution is either in the north (Norway, Iceland) or in the south (English Channel, Bay of Biscay). In the western Baltic Sea, with few exceptions, all common marine fish are mainly adapted to cold water, e.g. cod, whiting, plaice and dab. In contrast, fish species with more southern distribution are rare guests in the western Baltic Sea, including the Atlantic mackerel *Scomber scombrus*, Atlantic horse mackerel *Trachurus trachurus*, haddock *Melanogrammus aeglefinus*, tub gurnard *Chelidonichthys lucernus*, European anchovy *Engraulis encrasicolus* and thicklip grey mullet *Chelon labrosus*. Some representatives of the "southern type" (NELLEN & THIEL 1995) can be found among the stationary fish of the western Baltic Sea with turbot, garfish, sprat, black goby *Gobius niger*. The occurrence of freshwater fish in the Baltic Sea is limited to river estuaries, Bodden and lagoon waters (THIEL et al. 1996).

The salinity plays a decisive role in the species composition of the fish fauna. The EEZ can therefore be divided into a western and eastern unit of natural space, the boundary of which is represented by the Darss Sill. While little is known about the fish stocks of the whole EEZ except for the main commercial fish species, the data availability for the eastern EEZ is more extensive. In addition to the investigations conducted by EHRICH et al. (2006) and KLOPPMANN et al. (2003), other investigations carried out by THIEL & WINKLER (2007) from the former FFH areas and current environmental impact studies (EIS) for the wind farms planned in the EEZ are available. A total of 43 fish species were found in these investigations for the offshore wind farm projects "EnBW Baltic 2", "Arkona Basin Southeast", "Viking" "Baltic Eagle" and "Ostseeschatz", most of them in the area of Kriegers Flak. EHRICH et al. (2006) and KLOPPMANN et al. (2003) found a total of 42 fish species in the Arkona Sea between 1990 and 2001, including 12 species that were not caught during the EIS. In addition to the species detected in the EIS, the following were also found: common whitefish *Coregonus lavaretus*, European bullhead *Cottus gobio*, grey gurnard *Eutrigla gurnardus*, river lamprey, European hake *Merluccius merluccius*, rainbow trout *Oncorhynuchus mykiss*, perch, pollock, common roach *Rutilus rutilus*, salmon, sea trout and the sea stickleback *Spinachia spinachia* (EHRICH et al. 2006, KLOPPMANN et al. 2003). In addition, THIEL & WINKLER (2007) reported in the context of the R & D project "Recording of FFH Annex II fish species in the German EEZ of the North Sea and Baltic Sea (ANFIOS) finding the maraene *Coregonus maraena*, longspined bullhead *Taurulus bubalis*, goldsinny wrasse *Ctenolabrus ruperstris*, Eurasian ruffe *Gymnocephalus cernuus*, burbot *Lota lota*, round goy, common goby and ninespine stickleback *Pungitius pungitius.* MIESKE (2003, 2006) reports catching greater sand eel *Hyperoplus immaculatus*, indicating 64 species in the Baltic Sea in the recent past.

2.7.2.2 Red List species in the German EEZ

The threat to the 89 fish and lamprey species established in the Baltic Sea was assessed within the scope of the Red List based on the current population situation and long-term and short-term population trend (THIEL et al. 2013). Accordingly, 9% (8 species) of the marine fish and lampreys established in the Baltic Sea are classified as extinct or endangered according to the Red List status. Taking into account the extremely rare species, the proportion of Red List species increases to 16.9% (15 species). A total of 4 species with Red List status in the Baltic Sea were detected in the eastern EEZ (FREYHOF 2009; THIEL ET AL. 2013). The river lamprey is threatened with extinction (1) (FREYHOF 2009). The European eel is critically endangered in the Baltic Sea (2), twait and salmon are endangered (3) (THIEL et al. 2013).
Three of the Red List species are listed in Annex II of the Habitats Directive, namely the twait, the river lamprey and the salmon, which only has FFH status in freshwater. The sturgeon *Acipenser oxyrhinchus* is classified as extinct in the Baltic Sea (FREYHOF 2009). According to genetic and morphometric studies, the "Baltic" or "Baltic Sea sturgeon" is not, as previously assumed, the Atlantic sturgeon *Acipenser sturio*, but a descendant of the *A. oxyrhinchus* (LUDWIG et al. 2002). *A. sturio* was last caught in 1952 off Rügen. In the context of the project to reintroduce the Baltic Sea sturgeon *Acipenser oxyrinchus*, since 2007/2008, several thousand juvenile fish, some with transmitters, have been released into the Oder. No natural reproduction has taken place so far and all reported sturgeon catches can be traced back to these stocking measures (GESSNER et al. 2000).

2.7.3 Status assessment of the factor Fish

The assessment of the state of the demersal fish community of the German Baltic Sea EEZ is based on i) the rareness and vulnerability, ii) the diversity and uniqueness and iii) the naturalness. These three criteria are defined below and are applied separately for areas 1, 2 and 3.

Rareness and vulnerability

The rarity and vulnerability of the fish community is assessed based on the proportion of species that are considered endangered according to the current Red List of Marine Fishes (THIEL et al.

2013) and for the diadromous species of the Red List of Freshwater Fishes (FREYHOF 2009) and have been assigned to one of the following Red List categories: extinct or disappeared (0), threatened with extinction (1), critically endangered (2), endangered (3), indeterminate (G), extremely rare (R), Early Warning List (V), data deficient (D) or of least concern (*) (THIEL et al. 2013). Particular attention must be paid to the threat to species listed in Annex II of the Habitats Directive. Europe-wide protection efforts are being focused on these, and they require special protection measures, e.g. their habitats.

In the Baltic Sea territories in which **areas 1, 2 and 3** are located, a total of 45 fish species were identified during the environmental impact assessments in the above period (2.8.1) and within the framework of fish monitoring for population assessment. According to THIEL et al. (2013) and FREYHOF (2009), no species is considered extinct or disappeared (0) or threatened with extinction (1). Three critically endangered species (2) - eel, haddock and sea stickleback - were identified (6.7%). The greater weever *Trachinus draco* and the poor cod *Trisopterus minutus* are considered endangered (3) (2 species, 4.4%). Indeterminate threats (G) were not found for any of the species occurring. The pollock is regarded as extremely rare (R, 1 species, 2.2%), turbot, mackerel and common **Table 9**).

sole *Solea solea* are on the Early Warning List (V; 3 species, 6.7%). For lesser sand eels *Ammodytes tobianus*, *Hyperoplus immaculatus* and *H. lanceolatus* as well as for hake and the longspined bullhead (5 species, 11.1%), the available data is considered deficient (D). The vast majority of species (31, 68.9%) is classified as of least concern (*).

In the sea areas where **area 1** is located, a total of 38 species were identified during the environmental impact assessments and within the scope of fish monitoring for population assessment purposes. According to FREYHOF (2009) and THIEL et al. (2013), none of these species is considered to be extinct or disappeared (0), threatened with extinction or considered to be endangered to an indeterminate extent (G). Three critically endangered species (2), eel, haddock and sea stickleback, were identified (7.9%), the greater weever is endangered (3, 1 species, 2.6%). The pollock is extremely rare (R, 1 species, 2.6%), turbot, mackerel and sole are on the Early Warning List (V; 3 species, 7.9%). For the great sand eel and the greater sand eel, the available data does not allow an assessment (D, 3 species, 7.9%). The remaining 27 species (71.1%) are considered to be of least concern (*) (.

Table 9: Relative percentages of Red List categories among fish species detected in areas 1, 2 and 3. Extinct or disappeared (0), threatened with extinction (1), critically endangered (2), endangered (3), indeterminate (G), extremely rare (R), Early Warning List (V), data deficient (D) or least concern (*) (THIEL et al. 2013). (EIS data for areas 1, 2 and 3 and data from 2017/2018 from the ICES DATRAS database, see 2.8.1). The relative percentages of the assessment categories in the Baltic Sea Red List (THIEL et al. 2013) are shown by way of comparison.

	Red List category								
AREA	**0**	**1**	**2**	**3**	**G**	**R**	**V**	**D**	*****
1	0.0	0.0	7.9	2.6	0.0	2.6	7.9	7.9	71.1
2	0.0	0.0	7.1	2.4	0.0	2.4	7.1	9.5	71.4
3	0.0	0.0	7.5	5.0	0.0	2.5	7.5	5.0	72.5
Red List	**1.1**	**2.1**	**1.1**	**3.2**	**1.1**	**7.4**	**1.1**	**19.1**	**63.8**

In the sea areas where **area 2** is located, a total of 42 species were identified during the environmental impact assessments and within the scope of fish monitoring for population assessment purposes. According to FREYHOF (2009) and THIEL et al. (2013), none of these species is considered to be extinct or disappeared (0), threatened with extinction or considered to be endangered to an indeterminate extent (G). Three critically endangered species (2), eel, haddock and sea stickleback, were identified (7.1%), the greater weever is endangered (3, 1 species, 2.4%). The pollock is extremely rare (R, 1 species, 2.4%), turbot, mackerel and sole are on the Early Warning List (V; 3 species, 7.1%). For the sand eels and for the hake, the available data does not allow an assessment (D, 4 species, 9.5%). The remaining 30 species (71.4%) are considered to be of least concern (*) (Table 9).

In the sea areas where **area 3** is located, a total of 40 species were identified during the environmental impact assessments and within the scope of fish monitoring for population assessment purposes. According to FREYHOF (2009) and THIEL et al. (2013), none of these species is considered to be extinct or disappeared (0), threatened with extinction or considered to be endangered to an indeterminate extent (G).

Three critically endangered species (2) were identified: eel, haddock and sea bream (7.5). The greater weever and the poor cod are considered endangered (3) (2 species, 5.0%). The pollock is considered extremely rare (R, 1 species, 2.5%), turbot, mackerel and sole are on the Early Warning List (V; 3 species, 7.5%).

For the great sand eel and the greater sand eel, the available data does not allow an assessment (D, 2 species 5.0%). The remaining 29 species (72.5%) are considered to be of least concern (*) (Table 9).

In the Red Lists of Marine Fish for the Baltic Sea (THIEL et al. 2013) and Freshwater Fishes (FREYHOF 2009), a total of 16.0% of the species assessed were assigned to a threat category (0, 1, 2, 3, G or R), 1.1% were on the Early Warning List, and 19.1% could not be assessed due to a lack of data. A total of 63.8% of species are considered to be of least concern (FREYHOF

2009, THIEL et al. 2013) (Table 9). By way of comparison, significantly fewer species with a threat status were found in three Baltic Sea areas (1: 13.1%, 2: 11.9%, 3: 15.0%), while considerably more species deemed to be of least concern were always found than were named in the Red Lists (1: 71.1%, 2: 71.4%, 3: 72.5%).

Extinct or disappeared species (category 0) were not identified in any of the areas, as expected. The significance of the areas is below average for endangered species (1), while critically endangered species (2) were relatively more frequent in all areas than in the Red Lists. This also applied to endangered species (3) in area 3. The areas are of above-average importance for these species. Endangered species accounted for a smaller percentage in areas 1 and 2 (Table 9). Species in category G (indeterminate) and extremely rare species were found in all three areas in lower proportions than on the Red Lists, while the proportion of species on the Early Warning List was higher. The proportion of species that could not be evaluated due to deficient data (D) was half (area 2) to almost three quarters (area 3) below the proportion on the Red Lists. Relatively more species of least concern (*) were found in all areas, which are therefore of above-average importance for species in this category (Table 9).

FFH species were not identified either during the environmental impact studies or in the fishing management surveys. Against this background, the overall assessment of the Spatial Offshore Grid Plan 2016/2017 (Federal Maritime and Hydrographic Agency 2017) is that the fish fauna of the areas under consideration is to be regarded as average in terms of the criteria of rarity and vulnerability.

Diversity and uniqueness

The diversity of a fish community can be described by the number of species (α-diversity, 'species richness'). The species composition can be used to assess the uniqueness of a fish community, i.e. how regularly species typical to the habitat occur. Diversity and uniqueness are compared below and evaluated between the entire Baltic Sea and the German EEZ, as well as between the EEZ and the individual territories.

If all documented species are included, there are 176 species in the Baltic Sea (WINKLER et al. 2000). According to the fish database Fishbase (WWW.FISHBASE.ORG), as of November 2015, 160 fish species have been identified in the entire Baltic Sea, and WINKLER & SCHRÖDER (2003) list 151 species for the entire German Baltic Sea coast species for which scientifically verified proof is available from the German Baltic Sea region. THIEL ET AL. (1996) estimate the number of Baltic fish species at 144, including 97 marine fish species, 7 migratory and 40 freshwater fish species. Most of them by far are rare individual specimens, and only just over half of them reproduce regularly in the German Exclusive Economic Zone (EEZ) or are found as larvae, juveniles or adult specimens. According to these criteria, only 89 species are considered established in the Baltic Sea (THIEL et al. 2013). The Baltic International Trawl Surveys (BITS) identified 69 fish species in the entire North Sea between 2014 and 2018. In the German EEZ, represented here by the cluster-related fish data from environmental impact studies (see 2.8.1) and the DATRAS database of ICES (BITS data 2017 & 2018), a total of 45 species were identified (Figure 21). The number of species in the individual areas was very close together between 38 and 42 (see "Rareness and vulnerability"). Most species were caught in the fishing management surveys, but species not included in the BITS survey were found in the environmental impact studies. These were the lesser sand eel, anchovy, three-spined stickleback, common seasnail *Liparis liparis*, hake, sand goby, longspined bullhead and whiting-pout. Most species were found in area 2, followed by areas 3 and 1 (Figure 21).

All demersal flatfish and roundfish species typical for the Baltic Sea have been found in all areas. All flatfish species (American plaice *Hippoglossoides platessoides*, dab, flounder, plaice, turbot, brill and sole) were present in all areas analysed (Figure 21).

Although the bottom trawls used are unsuitable for pelagic fish, the species typical of the pelagic part of the fish community were found in all clusters with the lesser sand eel, herring, great and greater sand eel, smelt, mackerel, sprat and Atlantic horse mackerel (Figure 21).

Of the 45 species detected in the German EEZ during the period under analysis, 37 species were found in all areas, one species (sand goby) was found in two areas, and 7 species were detected in one area each (Figure 21). A spatial structure of the occurrence of different species e.g. according to their preferred habitat or salinity was not found: freshwater fish such as perch and zander and coastal species such as flounder and smelt were present in all three areas, while marine species such as anchovy and hake were caught in only one area (Figure 21). It is possible that the environmental gradients in the area in question are not sufficiently pronounced to provide a measurable structure for the occurrence of species. The composition of fish species only differs between areas in terms of individual, rare species, while there are great similarities in the case of the more characteristic, more abundant species (Figure 21).

Between 1977 and 2005, EHRICH et al. (2006) found 58 fish species in the Baltic Sea. Compared with these reports and the data from the Baltic Sea as a whole, the diversity in all areas can be regarded as average in line with the assessment of the Spatial Offshore Grid Plan 2016/2017 (Federal Maritime and Hydrographic Agency 2017). The typical and characteristic species of both the pelagic and demersal components of the fish communities considered were also present in all areas (see above). The characteristics of the fish communities found are thus also deemed to be average.

Artname	Deutscher Trivialname	OS1	OS2	OS3
Agonus cataphractus	Steinpicker	x	x	x
Ammodytes tobianus	Tobiasfisch		x	
Anguilla anguilla	Europäischer Aal	x	x	x
Aphia minuta	Glasgrundel	x	x	x
Clupea harengus	Hering	x	x	x
Cyclopterus lumpus	Seehase	x	x	x
Enchelyopus cimbrius	Vierbärtelige Seequappe	x	x	x
Engraulis encrasicolus	Sardelle		x	
Eutrigla gurnardus	Grauer Knurrhahn	x	x	x
Gadus morhua	Kabeljau	x	x	x
Gasterosteus aculeatus	Dreistachliger Stichling			x
Gobius niger	Schwarzgrundel	x	x	x
Hippoglossoides platessoides	Doggerscharbe	x	x	x
Hyperoplus immaculatus	Ungefleckter großer Sandaal	x	x	x
Hyperoplus lanceolatus	Gefleckter großer Sandaal	x	x	x
Limanda limanda	Kliesche	x	x	x
Liparis liparis	Großer Scheibenbauch		x	
Melanogrammus aeglefinus	Schellfisch	x	x	x
Merlangius merlangus	Wittling	x	x	x
Merluccius merluccius	Seehecht		x	
Mullus surmuletus	Streifenbarbe	x	x	x
Myoxocephalus scorpius	Seeskorpion	x	x	x
Neogobius melanostomus	Schwarzmundgrundel	x	x	x
Osmerus eperlanus	Stint	x	x	x
Perca fluviatilis	Flussbarsch	x	x	x
Platichthys flesus	Flunder	x	x	x
Pleuronectes platessa	Scholle	x	x	x
Pollachius pollachius	Pollack	x	x	x
Pollachius virens	Seelachs	x	x	x
Pomatoschistus minutus	Sandgrundel		x	x
Sander lucioperca	Zander	x	x	x
Scomber scombrus	Makrele	x	x	x
Scophthalmus maximus	Steinbutt	x	x	x
Scophthalmus rhombus	Glattbutt	x	x	x
Solea solea	Seezunge	x	x	x
Spinachia spinachia	Seestichling	x	x	x
Sprattus sprattus	Sprotte	x	x	x
Syngnathus rostellatus	Kleine Seenadel	x	x	x
Syngnathus typhle	Grasnadel	x	x	x
Taurulus bubalis	Seebull	x		
Trachinus draco	Großes Petermännchen	x	x	x
Trachurus trachurus	Holzmakrele (=Stöcker)	x	x	x
Trisopterus esmarkii	Stintdorsch	x	x	x
Trisopterus minutus	Franzosendorsch			x
Zoarces viviparus	Aalmutter	x	x	x
	Anzahl Arten	38	42	40

Figure 21: Total species list for fish in the German Baltic Sea EEZ and species identified in clusters 1, 2 and 3 (EIS data from 2014 onwards, and data from 2017/2018 from the ICES DATRAS database, see 2.8.1).

Naturalness

The naturalness of a fish community is defined as the absence of anthropogenic influences, of which fishing has the greatest impact. Certainly, fish are also subject to other direct or indirect human influences, such as eutrophication, shipping, pollutants and sand and gravel extraction. However, these effects cannot be measured reliably as yet. In principle, the relative effects of the individual anthropogenic factors on the fish community and their interactions with natural biotic (predators, prey, competitors, reproduction) and abiotic (hydrography, meteorology, sediment dynamics) influencing variables of the German EEZ cannot be separated clearly. However, the removal of target species and bycatch, as well as the degradation of the seabed in the case of ground-breaking fishing methods, make fisheries the most effective disturbance of the fish community. It is therefore used as a measure of the naturalness of the fish communities in the Baltic Sea. The stocks are not assessed on a smaller spatial scale such as of the German EEZ is not carried out as part of fishing management, so that the following evaluation of this criterion cannot be carried out at cluster level either, but only for the entire Baltic Sea. Of the 89 species considered established in the Baltic Sea (THIEL et al. 2013, 17 stocks of 9 species are commercially fished (ICES 2017a). The assessment of naturalness is based on "Fisheries overview – Baltic Sea Ecoregion" of the International Council for the Exploration of the Sea (ICES 2017a).

Fishing impacts on the ecosystem in two primary ways: disturbance or destruction of benthic habitats by bottom contact nets, and removal of target species and bycatch species. The latter often includes protected, endangered or threatened species, including reptiles, birds and mammals in addition to fish (ICES 2017b). More than 5,300 fishing vessels from nine nations operate in the Baltic Sea with an annual catch of almost 700,000 tonnes spanning all species and populations (ICES 2017a). A total of 4,100 small coastal fishing vessels stand in contrast to only 1,200 units fishing in the open Baltic Sea. However, there are significant differences between the nations involved.

The intensity of bottom trawling is concentrated in the southern Baltic Sea, but outside coastal waters the fleet mainly uses pelagic trawls. In coastal fishing, bottom-set gillnets (ICES 2017a) predominate.

The German fleet comprises more than 700 fishing vessels, of which only 60 operate in areas remote from the coast. 650 smaller units are engaged exclusively in bottom-set gillnet fishing in the coastal waters. The number of people fishing on the German Baltic coast alone is estimated at 161,000, who catch cod, herring, sea trout, whiting and flatfish either from the shore or from boats within 5 nautical miles.

Commercial fishing and the size of spawning stocks are assessed against the Maximum Sustainable Yield (MSY), taking into account the precautionary approach. A total of 17 populations were taken into consideration in terms of fishing intensity, of which 14 were scientifically assessed and only 3 were not.

Of the 17 populations evaluated, 7 are managed sustainably or overused (Figure 2.8.5; ICES 2017a). Ten of the 17 populations were assessed for their reproductive capacity (spawning stock biomass). Six of these have full reproductive capacity (Figure 22; ICES 2017a). The share of biomass in the total catch of the Baltic Sea (687,000 t in 2017) of populations managed with excessive fishing intensity outweighs by far the share of sustainably caught and unevaluated populations (>90%,Figure 22). Still, fish from populations account for the predominant biomass share of the catch (>90%), whose reproductive capacity is above the defined reference values. The biomass from evaluated populations and those with a reproductive potential below the reference level is less than 10% overall (Figure 22).

Overall, catch yields were at their peak in the mid-1970s and 1990s, which can be explained by corresponding population sizes of Atlantic cod *Gadus morhua* and Atlantic herring *Clupea harengus*. Half of the fish populations in the Baltic Sea monitored by reference values are managed with an intensity at or below sustainable long-term yield (F_{MSY}), while the other half are overfished. This is also reflected in the fact that the vast majority of biomass in the catch comes from these populations (Figure 22). While pelagic trawls and passive fishing devices are the predominant fishing methods in the Baltic Sea, bottom trawling is concentrated in the southern Baltic Sea and thus also disrupts the seabed. In bottom-set gillnet fishing, high by-catch rates of diving seabirds (auks and sea ducks) and, to a lesser extent, harbour porpoises can sometimes occur.

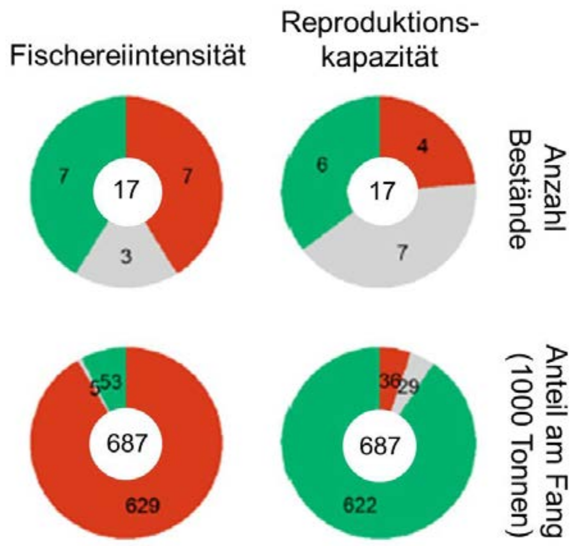

Figure 22: Summary of the status of fish populations in the Baltic Sea, 2017. Left: The fishing intensity indicates the number of populations (above) and the biomass percentage of the catch (below; in 1000 tonnes) below (green) or above the reference value (FMSY, fishing mortality consistent with achieving maximum sustainable yield). Right: Reproductive capacity is the number of populations (above) and the biomass percentage of the catch (below) above (green) or below (red) the reference value (spawning stock biomass, MSY Btrigger). Grey indicates the number or biomass percentage of the catch among populations for which no reference points are defined and for which it is therefore not possible to estimate the population. A total of 17 populations were taken into consideration, which jointly provided 687,000 tonnes of catch. Amended according to ICES (2017a).

In the overview of key fishing figures (ICES 2017a) and the ecosystem effects of bottom contact fishing (Watling & Norse 1998, Hiddink et al. 2006) and bottom-set gillnet fishing, the naturalness of the fish fauna is classified as average as in the Spatial Offshore Grid Plan 2016/2017 (Federal Maritime and Hydrographic Agency 2017).

2.7.3.1 Importance of areas and sites for fish

The primary criterion for the importance of the areas and sites for fish is the relationship to the life cycle, within which various stations are linked with stage-specific habitat requirements via more or less extensive migrations in the interim. Information on the reproductive status was not collected in any of the datasets used, so the significance of the areas and sites for fish can only be described in general terms. Moreover, the fact that the catch data used was collected using methods that do not allow habitat references to be derived impedes precise assessment of the area. The overview of the species records by area did not show any particular significance of a specific area for the constant, frequent character species. There is no apparent trend that species with special ways of life may prefer certain areas (Figure **21**), but this may be due to the fact that the area in question is too small and too homogeneous to reflect environmental gradients in species composition. The fish also cross the wind farm areas on the regular migrations between the spawning grounds and nursery areas near the coast and the deeper areas which characterise the life cycle of most species. They are therefore important as transit areas, at least for marine species. Freshwater species are concentrated on the coast and near the estuaries, which is due to the absence of many freshwater species that are typical and characteristic of the Baltic Sea (THIEL et al. 2013) in the data evaluated here. The importance of wind farm areas for these species is low. However, the relatively higher proportion of critically endangered fish species in all three areas indicates a higher importance of these areas for these species (eel, haddock and sea stickleback).

2.8 Marine mammals

Three marine mammal species are found regularly in the German Baltic Sea EEZ: the harbour porpoise (*Phocoena phocoena*), the grey seal (*Halichoerus grypus*) and the harbour seal (*Phoca vitulina*). All three types are characterised by high levels of mobility. Migration, especially for the purpose of searching for food, is not limited to the EEZ, but also includes coastal waters and large transboundary areas of the Baltic Sea. Resting and breeding grounds for the two seal species are found on islands and sandbanks in the area around coastal waters. They undertake extensive migrations in the open sea from their resting grounds in order to hunt for food. Due to their high mobility and the use of very extensive areas, it is necessary to consider their occurrence not only in the German EEZ, but in the whole area of the western Baltic Sea.

Marine mammals are among the top consumers in the marine food chain. They are therefore dependent on the lower components of the marine food chain: their direct food organisms (fish and zooplankton) on the one hand, and – indirectly – phytoplankton on the other. As consumers at the top of the marine food chain, marine mammals simultaneously influence the occurrence of food organisms as well.

2.8.1 Data availability

Due to a large number of study programmes, particularly in German waters, data availability has improved significantly in recent years compared to previous years and can now be rated as good. However, there is no continuous study or monitoring programme for marine mammals in the EEZ and in the coastal waters. Data is available at different spatial levels:

- for the entire area of northern European waters by observations under SCANS I, II and III [36] in 1994, 2005 and 2016 as well as the so-called Mini-SCANS of 2012 (SCANS, however, only covers the western Baltic Sea up to the German part of the Pomeranian Bight),
- Research projects in the German EEZ and in the coastal waters, such as MINOS[37] and MINOSplus surveys in the years 2002 to 2006,
- Investigations under the scope of approval and planning permission procedures for offshore wind farms as well as planning permission procedures for pipelines,
- Monitoring of the Natura2000 sites / acoustic monitoring by the German Oceanographic Museum,
- The EU research project SAMBAH[38].

SAMBAH (Static Acoustic Monitoring of the Baltic Sea Harbour Porpoise)is an international monitoring project which aims to promote conservation of the Baltic Sea harbour porpoise with scientific data. Between May 2011 and May 2013, 300 click detectors were deployed in the central Baltic Sea to determine the density, frequency and distribution of the harbour porpoise population.

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[36] Small Cetacean Abundance in the North Sea and Adjacent Waters

[37] Marine warm-blooded animals in the North and Baltic Seas: Foundations for assessment of offshore wind farms (project funded by the Federal Ministry for the Environment, Nature Conservation, Construction and Nuclear Safety)

[38] Static Acoustic Monitoring of the Baltic Sea Harbour Porpoise

2.8.2 Spatial distribution and temporal variability

The high mobility of marine mammals, depending on particular conditions in the marine environment, leads to high spatial and temporal variability in the occurrence of marine mammals. Both the distribution and the abundance of the animals vary throughout the seasons. A good data basis is necessary in order to draw conclusions about seasonal distribution patterns and the use of different subareas. To be able to recognise effects of intra- and interannual variability, large-scale long-term studies are necessary in particular.

Harbour porpoises occur all year round in the German Baltic Sea EEZ, but concentrations in their occurrence and spatial distribution are apparent depending on the season (GILLES et al. 2008, 2009). However, seasonal distribution patterns are weaker than in the North Sea.

2.8.2.1 Harbour porpoise

The harbour porpoise is a common species of whale in the temperate waters of the North Atlantic and North Pacific, as well as in some intracontinental seas such as the Baltic Sea. Due to its hunting and diving behaviour, the distribution of the harbour porpoise is limited to continental shelf seas (READ 1999). The harbour porpoise is the only regular species of porpoise in the Baltic Sea.

Studies indicate that three separate harbour porpoise populations are found in the waters between the North Sea and the Baltic Sea: a) the North Sea and Skagerrak populations, b) the Belt Sea population (Kattegat, Belt Sea, the Sound and western Baltic Sea), and c) the separate population of the central Baltic Sea (TEILMANN et al. 2011). The existence of a separate population in the eastern Baltic Sea with a population of a few hundred individuals is indicated by the results of morphometric and genetic investigations and the results of the SAMBAH research project (e.g. GALATIUS et al. 2012).

Harbour porpoises migrate in search of abundant food sources and temporarily concentrate in areas of qualitatively and/or quantitatively high food availability (REIJNDERS 1992, EVANS 1990). Fish, mainly herring and cod-related species, are the preferred food of the harbour porpoise. Harbour porpoises mainly hunt schools of fish (READ 1999). Pelagic and semipelagic fish species dominate the food spectrum. Rearing areas are mainly coastal areas with water depths below 20 m, e.g. in the Belt Sea and on the coasts of Mecklenburg-Western Pomerania (KINZE 1990, SCHULZE 1996).

Occurrence of harbour porpoise in the German Baltic Sea

For the entire Kattegat, Belt Sea, the Sound and western Baltic Sea area, there was a significant decline in stock numbers between 1994 and 2005. While 27,800 animals (95% confidence interval = 11,946-64,549) were recorded in this area under SCANS I in 1994, only 10,900 animals (CI = 5,840-20,214) were detected in the area in 2005 (TEILMANN et al. 2011). However, the difference is not significant due to the large range of 95% confidence intervals (ASCOBANS 2012). The area east of the Darss Sill is not covered by the SCANS survey.

SCHEIDAT et al. (2008) showed that the population density in the southwestern Baltic Sea is subject to both seasonal and spatial fluctuations. The highest densities occur in the area of the Kiel Bight. The abundance of harbour porpoises recorded varied between 457 individuals in March 2003 (CI: 0-1,632) and the highest estimates in May 2005 with 4,610 animals (CI: 2,259-9,098). The most recent population estimates for the Kiel Bight (including Danish waters to the island of Funen) in 2010 and 2011 show low densities of less than 0.4 individuals per km² (GILLES et al. 2011).

For the area east of the Darss and Limhamn Sill to Øland and the outer Gdansk Bight, only 599 animals were recorded in 1995 (HIBY & LOVELL 1995). These values reflect a clear decrease in population density along a gradient from the Kattegat to Polish waters (KOSCHINSKI 2002).

An analysis of data from aerial surveys, random sightings and strandings has shown that the density of harbour porpoises in the Baltic Sea decreases from west to east (SIEBERT et al. 2006). This is confirmed by a gradient in the echolocation activity of harbour porpoises (GILLESPIE et al. 2003, VERFUSS et al. 2004). Through the use of stationary click detectors (PODs), porpoises were detected in Fehmarn almost every day. In the investigation period 2008 to 2010, 90 to 100% porpoise-positive days (PPD) were recorded around Fehmarn and in the Mecklenburg Bight. The results from the Adlergrund and Oder Bank showed significantly lower overall harbour porpoise numbers than in the western study areas with a maximum of 21% porpoise-positive days in February 2010 (see Fig.14; GALLUS et al. 2010).

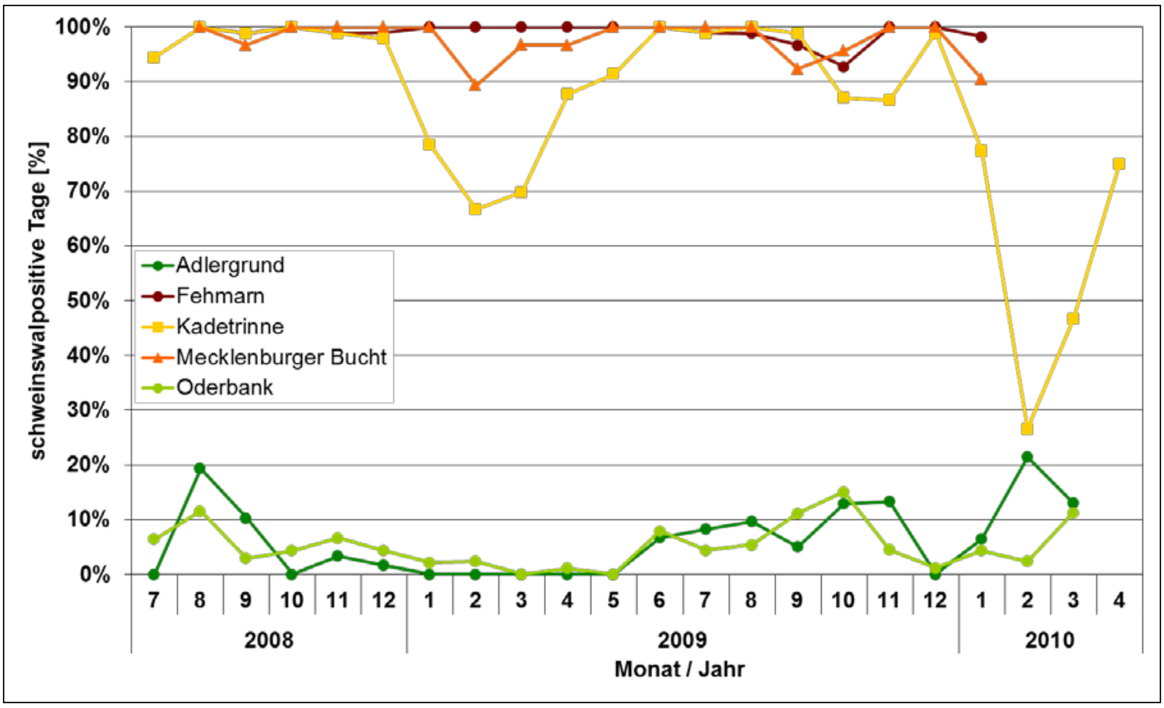

Figure 23: Percentage of porpoise-positive days in the total number of all recording days for the study areas Fehmarn (3 stations), the Mecklenburg Bight (1 station), Kadetrinne (3 stations), Adlergrund (2 stations) and Oder Bank (3 stations). Fehmarn, Kadetrinne and Mecklenburg Bight were evaluated with *Cet All* automatically, while the Oder Bank and Adlergrund were verified visually. The values for 2010 on the Adlergrund are only to be seen as a trend, because at this time only one station provided usable data and only 6 days were observed in March (source: GALLUS et al. 2010).

For the large-scale investigations in the MINOS and MINOSplus projects, the German EEZ of the Baltic Sea was divided into three sub-areas (SCHEIDAT et al. 2004, GILLES et al. 2007, GILLES et al. 2008). Area E (Kiel Bight) covers the western part of the EEZ and the coastal waters, area F (Mecklenburg Bight) the area up to the Darss Sill and area G (Rügen) the eastern part of the German EEZ and the coastal waters. Mapping covered a total of 24,360 km over the entire investigation period. However, only a total of 335 harbour porpoises were sighted. In the investigation period 2002 to 2006, the density of harbour porpoises in the areas ranged from 0.06 ind./km² in spring 2005, over 0.08 ind./km² in June 2003, to 0.13 ind./km² in June 2005. The population was estimated at 1,300 (200 to 3,800) harbour porpoises in spring, 1,700 (700 to 3,700) in summer and 2,800 (1,200 to 5,900) in autumn.

In the winter months from December to February, weather conditions restricted mapping work, so that no calculations can be made. Most of the harbour porpoises were seen around the island of Fehmarn and on the Oder Bank in spring. The highest densities were found in the Kiel Bight in summer. Although an unexpectedly high number of harbour porpoises were sighted on the Oder Bank in July 2002 (84), none were found in the subsequent years. The possibility can therefore not be ruled out that this was a temporary migration of animals from the western Baltic Sea in search of food. Many harbour porpoises were sighted in the western area in autumn, albeit fewer than in summer. With the exception of a single sighting on the Adlergrund, no harbour porpoises were sighted east of the Darss peninsula. The density gradient running from west to east remained over the entire period and was particularly pronounced in autumn (GILLES et al. 2007).

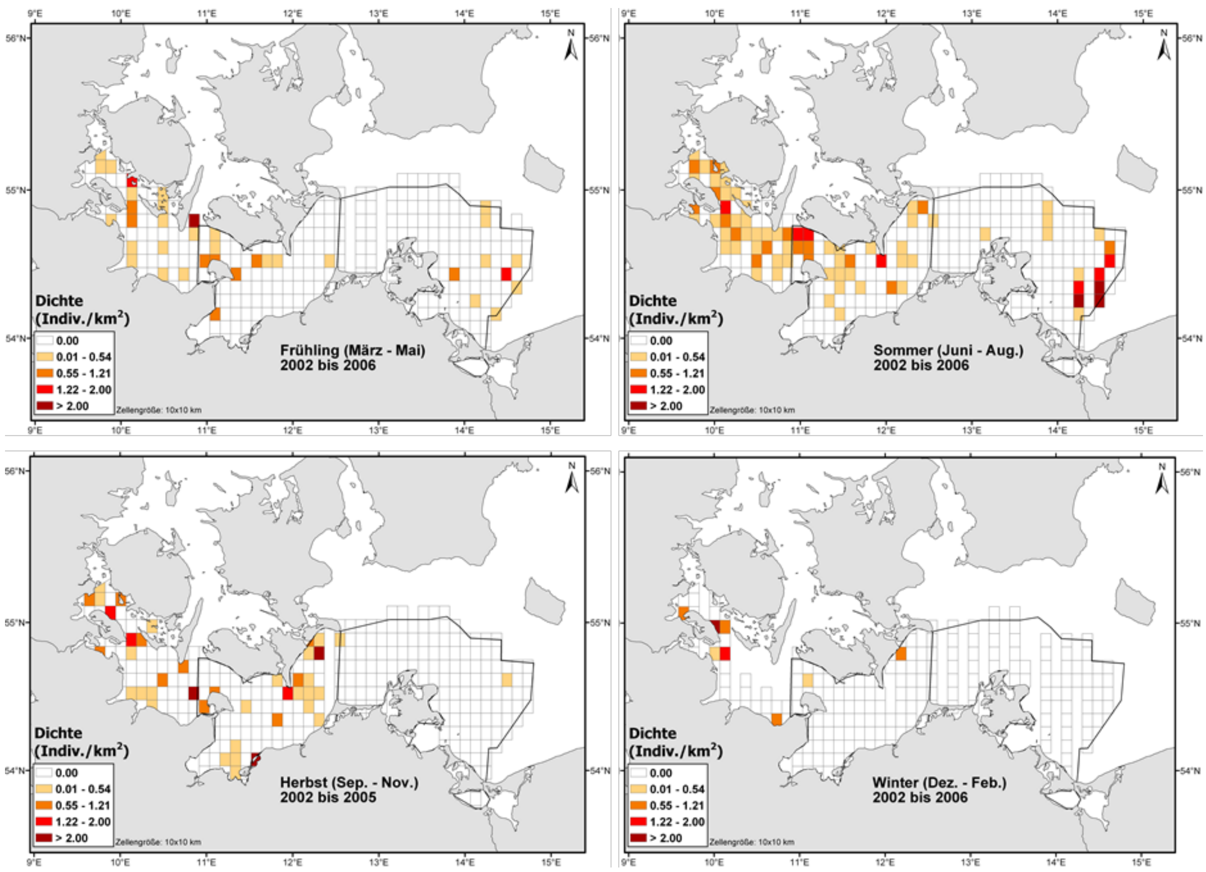

Figure 24: Seasonal distribution pattern of harbour porpoises in the south-western Baltic Sea (2002-2006). The raster maps have been adjusted for complexity. Shown is the mean density of harbour porpoises per grid cell (10x10km) in a) spring (March-May), b) summer (June-August), c) autumn (September-November) and d) winter (December-February, source: GILLES et al. 2007, p.126f.).

Occurrence in conservation areas

Based on the results of the MINOS and EMSON [39] studies, five areas of particular importance for harbour porpoises were defined in the German Baltic Sea EEZ. These are the FFH areas Fehmarn Belt, Kadetrinne, Adlergrund, Western Rönnebank and Pomeranian Bight with Oder Bank. In systematic aerial surveys, harbour porpoises were only sighted on the Adlergrund and Pomeranian Bight in May 2002 (GILLES et al. 2004). The abundance for the Adlergrund estimated from the sightings is 33 harbour porpoises.

An abundance calculation for Pomeranian Bight can only be made with a very large margin of error. Due to the methodology, it will produce excessive values. The observation of 84 harbour porpoises on the Oder Bank in July 2002 has remained a one-off. Despite considerable mapping efforts, no harbour porpoises were sighted here in the subsequent years. Echolocation sounds were regularly recorded around the island of Fehmarn and in the Kadetrinne (VERFUSS et al. 2004). The Kadetrinne is regularly frequented by harbour porpoises, especially on migrations. The importance of the area for the harbour porpoise is also still unclear. Between 1996 and 2002, 36% of the harbour porpoises stranded in the Kiel Bight to Fehmarn were calves. This is a indication that the area is very important for reproduction (SCHEIDAT et al. 2004).

The winter recordings of high echolocation frequencies at some stations near Fehmarn (VERFUSS et al. 2004) suggest that the area is also used as wintering grounds. Overall, the data analysed suggest a strongly seasonal occurrence with maximum abundance in summer.

The 2017 ordinances conferred the status of nature conservation areas on FFH areas in the German EEZ of the Baltic Sea:

- Ordinance on the establishment of the conservation area "Fehmarn Belt" (NSGFmbV), Federal Law Gazette I, I p. 3405 of 22 September 2017,

[39] Recording of marine mammals and seabirds in the German North Sea and Baltic Sea EEZs

- Ordinance on the establishment of the conservation area "Kadetrinne" (NSGKdrV), Federal Law Gazette I, I p. 3410 of 22 September 2017,
- Ordinance on the establishment of the conservation area "Pomeranian Bight – Oderbank" (NSGPBRV), Federal Law Gazette I, I p. 3415 of 22 September 2017.

Occurrences in areas O-1 and O-2

Areas O-1 and O-2 are assigned to the harbour porpoise habitat based on sightings in an indirect environment during the MINOS and EIS investigations, monitoring of the offshore projects "Vikings" and "Arkona Basin Southeast" and on the results of the acoustic recording of harbour porpoise activity from the area of the Adlergrund.

All previous results from investigations in the two areas as well as from the indirect environment can be summarised as follows:

- The areas are used irregularly by harbour porpoises as a transit area, as a stopover and as a feeding ground.
- The occurrence of harbour porpoises in these areas is low compared with that east of the Darss Sill and in particular around the island of Fehmarn, the Kiel Bight, the Belt Sea and the Kattegat.
- Temporary use, as seen in July 2002, is possible for areas such as the Oder Bank - possibly due to an increase in food supply.
- It has not been clearly proven that the areas are used as rearing grounds.
- These areas are of medium to high seasonal importance for harbour porpoises.
- The high significance of the areas results from the possible use by individuals of the separate and highly endangered Baltic Sea population of the harbour porpoise in the winter months.
- These areas are of little to medium importance for grey seals and harbour seals.

Threats to harbour porpoises in the sites of areas O-1 and O-2 may be caused by the construction of wind turbines and transformers, in particular noise immissions during the installation of foundations, if no avoidance or minimisation measures are taken.

Occurrence in area O-3

Area O-3 is assigned to the porpoise habitat based on sightings in an indirect environment during the MINOS and EIS investigations, monitoring of the offshore project "EnBW Baltic 2" and on the results of the acoustic recording of harbour porpoise activity in the context of research projects and monitoring of Federal Agency for Nature Conservation.

All previous results from investigations in area O-3 as well as from the indirect environment can be summarised as follows:

- The area is used irregularly by harbour porpoises as a transit area.
- The occurrence of harbour porpoises in this area is low compared with that east of the Darss Sill and in particular around the island of Fehmarn, the Kiel Bight, the Belt Sea and the Kattegat.
- It has not been proven that the area is currently used as a rearing ground.
- This area is of medium importance for harbour porpoises.
- This area is of little importance to grey seals and harbour seals.

Threats to harbour porpoises in area O-3 may be caused by the construction of transformers, in particular noise immissions during the installation of foundations, if no avoidance or minimisation measures are taken.

2.8.2.2 Seals and grey seals

The harbour seal is the most common seal species in the North Atlantic and is found throughout the North Sea and Kattegat. In the Baltic Sea, the regular distribution area is limited to the Øresund and areas around the Danish islands of Falster, Lolland and Møn. The south-eastern distribution boundary is reached in Scania (Sweden) (HARDER 1996, TEILMANN & HEIDE-JØRGENSEN 2001, SCHWARZ et al. 2003). There are currently no harbour seal colonies on the German coasts (HELCOM 2005). Every year about 5 to 10 harbour seals are detected in Mecklenburg-Western Pomerania. The findings are distributed over the entire coastal region, concentrated on the western Rügen Bodden and Wismar Bight (HARDER & SCHULZE 2001). Young harbour seals are rarely born here.

Suitable undisturbed resting grounds are of crucial importance for the occurrence of harbour seals. Due to the significantly lower diving depth observed in telemetric surveys - in comparison to grey seals - and the significantly shorter distances covered (DIETZ et al. 2003), harbour seals in the southern Baltic Sea probably use shallow water areas close to the coast as hunting grounds. Potential feeding habitats can therefore be found in German waters along the Bodden coast of Mecklenburg-Western Pomerania, especially within a radius of up to 60 km around the resting places. Telemetric surveys show that adult harbour seals in particular rarely move more than 50 km away from their traditional resting grounds (TOLLIT et al. 1998).

On the basis of regular aerial surveys in 2002 and 2003 at the resting places off the Danish and Swedish coasts closest to the German EEZ, the authors calculate a total population of 655 harbour seals in the southern Baltic Sea for 2003, taking into account a correction factor for harbour seals in the water (TEILMANN et al. 2004).

Also for the occurrence of grey seals, suitable, undisturbed breeding and resting sites are of crucial importance. Potential resting sites include sandbanks and unused sections of beach (e.g. in the core zone of the Western Pomerania Lagoon Area National Park). There are currently no colonies of grey seals on the German coast of the Baltic Sea. The resting grounds closest to the German EEZ are at Rødsand off the Danish island of Falster, in Øresund and Måkläppen near Falsterbo in southern Sweden (TEILMANN & HEIDE-JØRGENSEN 2001, SCHWARZ et al. 2003). In the German EEZ, habitats east of the Darss are mainly used to search for food, while areas further west probably play only a minor role (SCHWARZ et al. 2003).

Grey seal surveys in the Baltic Sea between May and June 2004 during the moulting season yielded a total of 17,640 seals (KARLSSON & HELANDER 2005). A total population of approx. 21,000 seals is inferred on this basis.

The distribution of Baltic grey seals probably depends on ice cover in addition to other factors. The hunting grounds for grey seals are both coastal and remote shallow water areas as well as undersea slopes and reefs (SCHWARZ et al. 2003). Potential hunting grounds can therefore be found in the EEZ, for example in the area of the Kadetrinne, the Adlergrund or the Oder Bank. However, according to the current state of knowledge, no prediction can be made about the use of these possible habitats, as both the food composition and the preferences for the selection of feeding habitats can vary greatly over the course of one year and over several years (SCHWARZ et al. 2003).

In addition to relatively small-scale movements of less than 10 km, which led back to the same resting place, migrations to feeding grounds, some of which are more than 100 km away, and migrations to other colonies which can be quite far have been described. DIETZ et al. (2003) identified the "95% Kernel Home Range" from the positions of the grey seals transmittered at Rødsand. This representation indicates the area in which a seal can be sighted at any time with a probability of 95%. For four of the six seals, the "Kernel Home Range" includes parts of the German EEZ.

Neither harbour seals nor grey seals were sighted on the Baltic Sea harbour porpoise aerial surveys (GILLES et al. 2004), meaning that it is impossible to draw any conclusions about how the areas are used. The telemetric surveys from the southern Baltic Sea (DIETZ et al. 2003) and observations in the area of Wismar Bight (HARDER & SCHULZE 1997) suggest an occasional use of the Fehmarn Belt as a feeding habitat for harbour seals. The telemetric study from the southern Baltic Sea (DIETZ et al. 2003) and individual observations as well as finds of dead seals (HARDER et al. 1995) suggest the use of the Kadetrinne, the Adlergrund or the Oder Bank as a migration corridor or feeding habitat for grey seals. According to a current population survey conducted by the Federal Agency for Nature Conservation, around 50 to 60 grey seals live in the waters around Rügen – 30 of them in the Greifswald Bodden alone.

2.8.3 Status assessment of the factor Marine mammals

The number of harbour porpoises in the Baltic Sea has declined over the last few centuries. The situation of the harbour porpoise in the Baltic Sea has deteriorated due to the commercial fishing of seals in the past, but also due to extreme winters with extreme ice formation, and has ultimately been exacerbated by by-catch, pollution, noise and limited food supply (ASCOBANS 2003). The separate population of the eastern Baltic Sea is also particularly threatened by the small number of individuals, the geographical restriction and the lack of gene exchange and is therefore considered to be threatened with extinction (ASCOBANS 2010).

2.8.3.1 Importance of areas and sites for marine mammals

Reliable estimates of the occurrence of harbour porpoises in the German waters of the North and Baltic Seas were made on the basis of large-scale aerial surveys and acoustic recordings with click detectors, in particular in the context of research projects such as MINOS and MINOSplus as well as in the context of the monitoring of the Natura2000 sites by the German Oceanographic Museum on behalf of the Federal Agency for Nature Conservation. A density gradient from west to east was determined in the Baltic Sea in the process. This gradient is already present in summer and increases in autumn. According to the current state of knowledge, the western area is most frequently used by harbour porpoises. The eastern part of the German Baltic Sea is not used as much by harbour porpoises. The one-off sighting of a larger group of seals on the Oder Bank indicates temporary migration rather than regular use of the area (BENKE et al. 2014). However, it is conceivable that the stock could increase through appropriate measures (ASCOBANS 2003/ 2010) and that the eastern area could then also be used more by harbour porpoises. Overall, the data analysed suggest a strongly seasonal occurrence with maximum abundance in summer.

Current findings of the research project SAMBAH involving the Baltic Sea riparian states have shown that three populations of harbour porpoises occur in the Baltic Sea: a) the North Sea population in Skagerrak, b) the Belt Sea population in the western Baltic Sea - Kattegat, Belt Sea, Sound - up to the area north of Rügen and c) the Baltic Sea population from the area north of Rügen and in the central Baltic Sea. The abundance of the Baltic Sea population was estimated on the basis of acoustic data at 447 individuals (95% confidence interval, 90 - 997) (SAMBAH 2014 and 2016).

The Baltic Sea population was classified as critically endangered by IUCN and HELCOM due to the very small number of individuals and the spatially limited genetic exchange (HELCOM - Red List Species, 2013).

Importance of areas O-1 and O-2

Areas O-1 and O-2, like the entire western Baltic Sea, are part of the harbour porpoise habitat.

The Federal Maritime and Hydrographic Agency has a solid data basis available to assess the importance of the areas in the German EEZ.

Areas O-1 and O-2 are mainly assigned to the habitat of harbour porpoises of the critically endangered Baltic Sea population according to the current state of knowledge. However, the area is used irregularly by harbour porpoises as a transit area, as a stopover and as a feeding ground. The occurrence of harbour porpoises in these areas is low compared with that west of the Darss Sill and in particular around the island of Fehmarn, the Kiel Bight, the Belt Sea and the Kattegat. Temporary use, as seen in July 2002, is possible for areas such as the Oder Bank - possibly due to an increase in food supply. It has not been clearly proven that the areas are used as a rearing ground. For harbour porpoises, these areas have a medium to seasonal importance in the winter months. The significance of areas O-1 and O-2 results from the possible use by individuals of the separate and highly endangered Baltic Sea population of the harbour porpoise. Research results have shown that especially during the winter months individuals of the critically endangered harbour porpoise population of the central Baltic Sea migrate to German waters and also use the planning area. These areas are of little importance to grey seals and harbour seals. Harbour seals and grey seals cross the areas sporadically during their migrations.

Since 2003, data for the surroundings of areas O-1 and O-2 has been collected in the context of various research projects, such as MINOS and from the acoustic monitoring of the harbour porpoise in the German Baltic Sea by the German Oceanographic Museum on behalf of the Federal Agency for Nature Conservation. The data from the long-term monitoring of the German Oceanographic Museum shows that mainly harbour porpoises of the Belt Sea population occur in the German waters of the Baltic Sea. The occurrence rates of the harbour porpoise west of the Darss Sill are much higher than east of it (Gallus A., K. Krügel und H. Benke, 2015. Acoustic monitoring of harbour porpoises in the Baltic Sea, Part B *in* Monitoring of marine mammals 2014 in the German North Sea and Baltic Sea on behalf of the Federal Agency for Nature Conservation).

The boundary of the population of the harbour porpoise in the central Baltic Sea classified as endangered is 13°30' East, taking into account the results of acoustic, morphological, genetic and satellite-based surveys carried out at Rügen level (SVEEGARD et al. 2015).

The findings of the multi-year project SAMBAH have also shown that in the winter months up to April the seals in the population of the central Baltic Sea are widely distributed and occur close to the coast. In summer, on the other hand, there is a clearly defined boundary east of Bornholm (SAMBAH 2015).

Current findings for areas O-1 and O-2 are also provided by the investigations as part of monitoring for the existing pipeline "Nord Stream". The occurrence of marine mammals was investigated from June 2010 until the end of 2013. As part of the environmental impact study for the "Nord Stream 2" pipeline, further investigations were carried out between September 2015 and August 2016 (Nord Stream 2, 2017. Environmental impact study (EIS) for the area from the maritime border of the German Exclusive Economic Zone (EEZ) to the landing. Here, too, the focus of the investigations was on the acoustic recording of the harbour porpoise using C-PODs.

The visual survey by means of observers or digital technology is not a suitable detection method in this area of the western Baltic Sea due to the relatively low occurrence. No marine mammals were observed during the ship-based survey for the "Nord Stream" pipeline between June 2010 and the end of 2013. A harbour porpoise was sighted from a ship in the period 2015 to 2016. No marine mammals have been detected in a total of four digital aerial surveys.

The ongoing monitoring of the "Western Adlergrund" cluster for the offshore wind farms "Viking" and "Arkona Basin Southeast" provides more current information on the occurrence of marine mammals in areas O-1 and O-2.

Ten video-assisted aerial surveys were conducted from March 2015 up to and including February 2016, with a total of 8 harbour porpoises, two harbour seals and an unidentified seal sighted in the 2,620 km^2 study area. A single grey seal was sighted in 12 ship-based surveys carried out during the same period, one per month. To determine the continuous use of the area by harbour porpoises, data from the acoustic recording using C-PODs were evaluated at two measuring stations further north of the planned pipeline.

The data from the acoustic recording using C-PODs shows that the area of the German EEZ north of the planned pipeline is used by harbour porpoises to a limited extent in the period from June to October. At the nearest measuring station approx. 18 km away in area I of the "Pomeranian Bight – Rönnebank" nature conservation area, a total of 17.8% detection-positive days were recorded, i.e. harbour porpoises were present in the area on 65 out of 365 days (MIELKE L., A. SCHUBERT, C. HÖSCHLE AND M. BRANDT, 2017. Environmental monitoring in the "Western Austerngrund" cluster, expert opinion on marine mammals, 2nd investigation year, March 2015 to February 2016).

The use of the area by harbour porpoises is low compared to the use west of the Darss Sill. For this reason, the percentage of days on which harbour porpoise clicks were recorded within a month (PPT/month) is used to assess habitat use.

The use of the area by harbour porpoises shows a high degree of interannual variability. In 2013, the highest occurrence was recorded with an occurrence rate of 40% of the days of a month (PPT/month). In 2011, however, the use of the area by harbour porpoises was lower with a maximum occurrence of up to 25% of the days in a month (PPT/month).

There are also distinct seasonal patterns in the use of the area to the east of Sassnitz and the Oder Bank by harbour porpoises.

The occurrence rates of harbour porpoises begin to rise slowly from June onwards. The highest occurrence rates were always observed in late summer and autumn. The area is used only sporadically by harbour porpoises in the winter months and spring.

The highest occurrence rates have always been observed in the northern part of the area along the slopes of the Arkona Basin.

Very low occurrence rates were observed in the southern part of the area in shallower areas of the Pomeranian Bight. A seasonal pattern was not discernible in this area.

Based on all previous findings, the area around the cable route can be assigned to the habitat of harbour porpoises.

- Areas O-1 and O-2 are regularly used by harbour porpoises but to a very limited extent.
- The presence of the harbour porpoise in the vicinity of areas O-1 and O-2 is low compared with that west of the Darss Sill.
- It has not been proven that the area is used as a rearing ground according to the current state of knowledge.
- For harbour porpoises, these areas are of little to medium importance.
- These areas are of little importance to grey seals and harbour seals.

Existing pressures on harbour porpoises in the surrounding area include by-catch in bottom-set gillnets, fishing and reduction of food supply, pollution, eutrophication and climate change.

The laying work for the pipeline in the German EEZ of the Baltic Sea and the operation of the pipeline are not expected to have any effects on marine mammals.

According to the current state of knowledge, the three areas are used by harbour porpoises as transit areas. There is currently no evidence that these areas have special functions as feeding grounds or rearing areas for harbour porpoises. Harbour seals and grey seals use the areas only sporadically as transit areas. The findings from the monitoring of the Natura 2000 sites and research results currently indicate a medium to high seasonal importance of areas O-1 and O-2 for harbour porpoises. The seasonally high importance of the area arises from the possible use by individuals of the separate and critically endangered Baltic Sea population of harbour porpoise in the winter months. For harbour seals and grey seals, the areas have a low to at most medium importance.

Importance of area O-3

Area O-3 is of medium importance for marine mammals. The use of the area by harbour porpoises varies depending on the season. The occurrence of harbour porpoises in this area is average to very low compared to that in the Kiel Bight, the Belt Sea and the Kattegat. The area has no particular function as a rearing ground for harbour porpoises. For grey seals and harbour seals, it is of little importance due to the distance to the nearest resting grounds.

Current data from the investigations for the wind farm project "EnBW Baltic 2" is available (BioConsultSH, 2018. expert opinion 2nd year of operational monitoring).

- The area is used irregularly and to a very limited extent by harbour porpoises.
- The occurrence of harbour porpoise in area O-3 is low compared with that in the Kadetrinne.
- It has not been proven that the area is used as a rearing ground according to the current state of knowledge.
- This area is of low importance for harbour porpoises.
- For grey seals and harbour seals, this area lies on the edge of the distribution area of the respective species and is of minor importance.

2.8.3.2 Protection status

Harbour porpoises are protected pursuant to several international conservation agreements. Harbour porpoises fall under the protection mandate of the European Habitats Directive, under which special areas are designated for the protection of the species. Harbour porpoises are listed in both Annex II and Annex IV of the Habitats Directive. As an Annex IV species, harbour porpoises enjoy general strict wildlife conservation status in accordance with Arts. 12 and 16 of the Habitats Directive.

The harbour porpoise is also listed in Annex II to the Convention on the Conservation of Migratory Species of Wild Animals (the Bonn Convention, CMS). The Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) was also concluded under the auspices of CMS. In 2002, ASCOBANS adopted a special conservation plan for Baltic porpoises, known as the Jastarnia Plan, after it was established that porpoise populations in the Baltic Sea were independent and particularly threatened. The aim of the Jastarnia Plan, revised in 2009, is to restore a population size to 80% of the biotope capacity of the Baltic Sea ecosystem (ASCOBANS 2010).

There is also the Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention), and the harbour porpoise is also listed in Annex II to this.

In the IUCN list of threatened species, the harbour porpoise population of the central Baltic Sea is considered critically endangered (Cetacean update of the 2008 IUCN Red List of Threatened Species). In Germany the harbour porpoise is also included in the Red List of Threatened Animals (HAUPT et al. 2009). They are classified as belonging to threat category 2 (critically endangered).

The grey seal and harbour seal are also listed in Annex II of the Habitats Directive. The Red List also classified the grey seal in threat category 2, while the harbour seal was classified as of least concern.

2.8.3.3 Hazards

The harbour porpoise population in the Baltic Sea is threatened by a variety of anthropogenic activities, changes to the marine ecosystem and climate change. Prior impacts on marine mammals result from fishing, underwater noise immissions and pollution. The greatest threat to harbour porpoise populations in the Baltic Sea comes from unwanted by-catch in bottom-set gillnets (ASCOBANS 2010). By-catch in the

Baltic Sea is much higher than in the North Sea. In particular, the separate Baltic Sea population is severely threatened even when by-catch rates are low.

The International Whaling Commission (IWC) has agreed that the rate of by-catch mortality should not exceed 1% of the estimated stock (IWC, 2000). In the case of higher by-catch rates, the protection target is at risk, i.e. a recovery of the populations to 80% of the carrying capacity of the habitat (ASCOBANS 2010).

From individual reports on by-catches in the Baltic Sea (KASCHNER 2001), it can be assumed that by-catch is mainly caused by bottom-set gillnet fishing for turbot, cod, plaice and lumpfish and driftnet fishing for salmon. However, by-catch rates cannot be determined as information for the Baltic Sea is limited (KASCHNER 2001, 2003). In Poland, about 5 by-catches per year are reported, in Sweden in the early 1990s also 5 (SGFEN 2001). A questionnaire-based estimate assumes 57 by-catches per year (21 in recreational fishing, 36 in commercial fishing) for German fishing in the western Baltic Sea (RUBSCH & KOCK 2004).

25 by-catches (1 in recreational fishing, 24 in commercial fishing) are indicated for the area east of the Darss Sill. This is much higher than the official figures reported by fishermen and exceeds the by-catch rates tolerated by IWC and ASCOBANS (IWC 2000).

Underwater noise from anthropogenic sources can in extreme cases lead to physical damage, but can also disrupt communication or lead to changes in behaviour - e.g. disrupt social and predatory behaviour or trigger flight responses. Current anthropogenic applications in the EEZ resulting in high noise pollution include seismic surveys, sand and gravel extraction and military uses, as well as shipping. Marine mammals may be endangered during the construction of wind turbines and transformer platforms, in particular due to noise emissions during the installation of foundations if no measures are taken to reduce noise. There is currently a lack of experience on possible effects of water stratification under certain hydrographic conditions on the dispersion of pile-driving noise in the Baltic Sea and related effects on marine mammals. In general, noise propagation in the Baltic Sea is considered to be particularly difficult to describe and thus to predict (THIELE 2005).

Besides pollution caused by the discharge of organic and inorganic contaminants, the population is also at risk from diseases (of bacterial or viral origin), eutrophication and climate change (impact on the marine food chains). It is likely that at present, due to climate change, harbour porpoises will migrate to the southern North Sea (CAMPHUYSEN 2005, ABT 2005). The extent to which this has an indirect impact on the harbour porpoise population in the Baltic Sea is still unknown.

2.9 Seabirds and resting birds

According to "Qualitätsstandards für den Gebrauch vogelkundlicher Daten in raumbedeutsamen Planungen" [Quality standards for the use of ornithological data in spatially significant planning operations] (Deutsche Ornithologen-Gesellschaft 1995), resting birds are "birds that usually remain in an area outside the breeding territory for a longer period of time, e.g. for moulting, feeding, resting, overwintering". Visiting species are defined as birds "that regularly seek food in the area studied and do not breed there, but that breed or may breed in the wider region".

Seabirds are bird species that are mainly bound to the sea with their way of life and only come onto land for brief periods when brooding their eggs. These include northern fulmars, gannets and auks (guillemots, razorbills), for example. The distribution of terns and seagulls, on the other hand, is more coastal than for seabirds in general.

2.9.1 Data availability

A good data basis is necessary in order to draw conclusions about seasonal distribution patterns and the use of different subareas. In particular, large-scale long-term studies are required for this in order to identify correlations in distribution patterns and effects of intraannual and interannual variability.

The findings on the spatial and temporal variability of the occurrence of seabirds in the western Baltic Sea are based on a number of research and monitoring activities. However, most of the data describes the occurrence of water birds, in particular sea ducks, in coastal areas and in the Pomeranian Bight.

For the area of the EEZ, the information basis has improved in recent years, in particular through data from environmental impact studies (EIS) for planning permission procedures for offshore wind farms and the subsequent mandatory investigations during the construction and operation phases. In addition, findings from various research projects contribute to a better understanding of seabird abundance. In the period 2001-2004, ERASNO and EMSON R&D projects carried out investigations to designate bird sanctuaries in the EEZ. In the context of the MINOS and MINOSplus projects, ship-based and aerial surveys were carried out throughout the German Baltic Sea between 2002 and 2006 (DIEDERICHS et al. 2002, GARTHE et al. 2004). In a study based on the results of various research projects and literature sources, GARTHE et al. (2003) summarise the findings on the occurrence in winter, threat level and protection of sea and water birds in the German Baltic Sea. SONNTAG et al. (2006) analysed for the first time the distribution and frequency of sea and water birds over the course of a year and mainly for the offshore area on the basis of systematically conducted ship-based surveys in the period 2000-2005. In addition, the seabird monitoring of the Natura 2000 sites commissioned by the Federal Agency for Nature Conservation in recent years contributes other essential information on resting populations and overwintering of certain species in the Baltic Sea (MARKONES & GARTHE 2011, MARKONES et al. 2013, MARKONES et al. 2014, MARKONES et al. 2015).

2.9.2 Spatial distribution and temporal variability

Seabirds have the highest mobility among the higher consumers of marine food chains. They are therefore able to search large areas during their hunt for food, or to track species-specific prey organisms such as fish over long distances. The high level of mobility – depending on specific conditions in the marine environment – leads to a high spatial and temporal variability of the occurrence of seabirds. The distribution and abundance of birds vary throughout the seasons, as well as interannually.

The distribution of seabirds in the Baltic Sea is determined in particular by the availability of food, hydrographic conditions, water depth and sediment conditions. The occurrence is also influenced by severe natural events (e.g. icy winters) and anthropogenic factors such as nutrient and pollutant inputs, shipping and fishing. In general, open, largely shallow areas with water depths of up to 20 m and an abundant food supply offer ideal conditions for seabirds to rest and spend the winter. In addition, the importance of resting areas increases when stocks continue to shift westwards in winter due to ice formation or ice cover in the eastern Baltic Sea (VAITKUS 1999).

Several million birds spend the winter on the Baltic Sea every year. It is one of the most important areas for sea and water birds in the Palearctic. A number of studies also show the great importance of the German Baltic Sea for sea and water birds – not only nationally, but also internationally (DURINCK et al. 1994, GARTHE et al. 2003, SONNTAG et al. 2006, SKOV et al. 2011). In particular, the "Pomeranian Bight

– Rönnebank" nature conservation area, which has been part of the Natura2000 European network of protected areas since 2007 and was established by ordinance of 22 September 2017, should be mentioned here with its important resting and feeding grounds Adlergrund and Oder Bank.

2.9.2.1 Abundance of seabirds and resting birds in German waters in the Baltic Sea

The western Baltic Sea is very important for many sea and water birds as a resting and wintering habitat. 38 seabird and resting bird species occur regularly in the German Baltic Sea (SONNTAG et al. 2006). The following Table 10 include population estimates for the main seabird species in the EEZ and throughout the German Baltic Sea in winter.

Table 10: Winter populations of the most important resting bird species in the German Baltic Sea and the EEZ according to MENDEL et al. (2008).

English name (*scientific name*)	**Population German Baltic Sea**	**Population German Exclusive economic zone**
Long-tailed duck *(Clangula hyemalis)*	315.000	150.000
Common scoter *(Melanitta nigra)*	230.000	57.000
Velvet scoter *(Melanitta fusca)*	38.000	37.000
Common eider *(Somateria mollisima)*	190.000	9.000
Red-breasted merganser *(Mergus serrator)*	10.500	0
Great crested grebe (*Podiceps cristatus*)	8.500	< 50
Red-necked grebe *(Podiceps grisegena)*	750	210
Horned grebe (thin-billed) (*Podiceps auritus*)	1.000	700
Red-throated diver (*Gavia stellata*)	3.200	550
Black-throated diver (*Gavia arctica*)	2.400	550
Cormorant (*Phalacrocorax carbo*)	10.500	< 50

English name (*scientific name*)	Population German Baltic Sea	Population German Exclusive economic zone
Razorbill (*Alca torda)*	3.600	310
Guillemot (*Uria aalge*)	1.500	950
Black guillemot (*Cepphus grylle*)	700	310
Little gull (*Hydrocoloeus minutus*)	220	90
Black-headed gull (*Larus ridibundus)*	15.000	0
Common gull (*Larus canus*)	11.500	1.100
Great black-backed gull (*Larus marinus*)	7.000	800
European herring gull (*Larus argentatus*)	70.000	4.200

2.9.2.2 Common species and species of special importance for the nature conservation area "Pomeranian Bight – Rönnebank"

Long-term observations and systematic counts provide information on recurring seasonal distribution patterns of the most common species in German Baltic Sea waters. Overall, the analyses by MENDEL et al. (2008) and SONNTAG et al. (2006) confirmed and clarified the high species-specific spatial and temporal variability of the incidence of seabirds and resting birds in German waters of the Baltic Sea. Numerous current investigations can be drawn on to underline the topicality of these descriptions.

Sea ducks prefer coastal areas with low water depths and offshore shallows such as Adlergrund and Oder Bank. Great Crested Grebes and Red-breasted Mergansers keep almost exclusively to coastal waters; grebes (podicipediformes), by contrast, prefer shallows further away from the coast. Common guillemots and razorbills stay predominantly in deeper offshore waters. Terns are found only occasionally in the offshore area during migration periods. The latter almost exclusively use lagoons and inland lakes to search for food (SONNTAG et al. 2006, MENDEL et al. 2008)

<u>Red-throated diver (*Gavia stellata*) and black-throated diver (*Gavia arctica*)</u>

Divers are found in the Baltic Sea as winter visitors or passage migrants (MENDEL et al. 2008). Red-throated divers use the coastal waters and the German EEZ in the spring and winter, whilst black-throated divers are seen in greater numbers in the autumn and winter, only in small numbers in the spring and sporadically also in the summer. Both species prefer an area east of the island of Rügen and the Pomeranian Bight as far as the Oder Bank (see

Figure 25 and

Figure 26) (SONNTAG et al. 2006).

Red-throated divers roost predominantly in waters of the Baltic Sea which are less than 20 m deep (DURINCK et al. 1994). The main resting populations are in the sea area around Rügen, in the area of the Oder Bank and in the Mecklenburg Bight. In the spring, distribution is concentrated in the Pomeranian Bight, especially the coastal waters off Rügen. Distribution of black-throated divers is concentrated in the eastern section of the German Baltic Sea. In the winter, they are widespread throughout the Pomeranian Bight. Here, the highest densities can generally be recorded in the coastal region of Rügen and in the Adlergrund and Oder Bank areas (MENDEL et al. 2008). Towards spring, prevalence shifts predominantly to the areas of the Pomeranian Bight further away from the coast. Later studies carried out as part of the BfN seabird monitoring-programme in the German Baltic Sea confirm this distribution pattern (MARKONES et al. 2014).

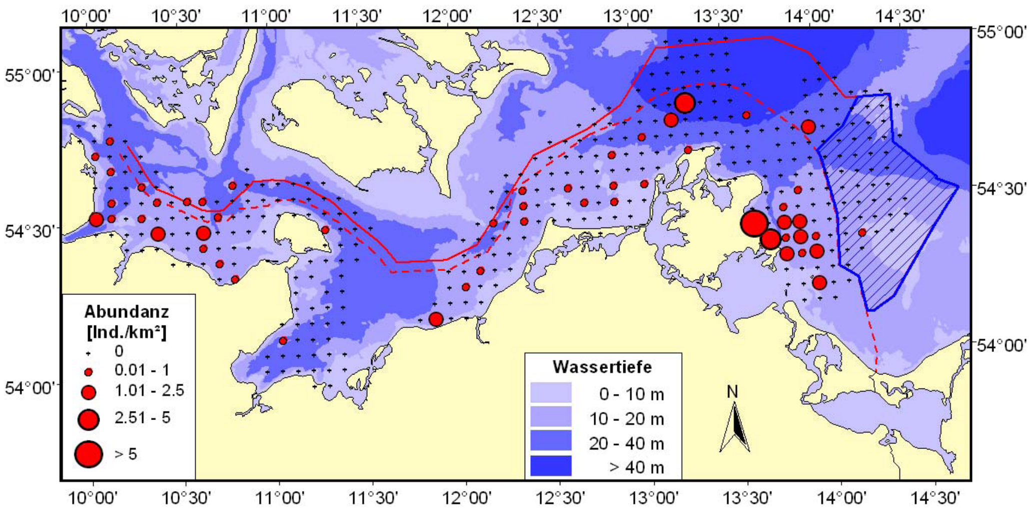

Figure 25: Distribution of divers (*Gavia stellata/G. arctica*) throughout the German Baltic Sea in January/February 2009 (aerial-based survey; MARKONES & GARTHE 2009).

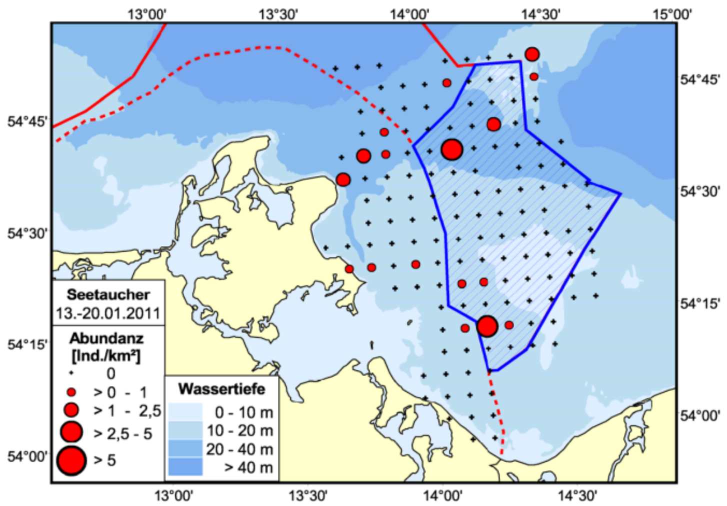

Figure 26: Incidence of divers (*Gavia stellata/ G. arctica)* in the German Baltic Sea in the course of a ship-based survey conducted between the 13th and 20th January 2011 (MARKONES & GARTHE 2011).

Horned grebe (*Podiceps auritus*)

In the German Baltic Sea, horned grebes predominantly occur in the Pomeranian Bight. This is the most important overwintering area in NW European waters (DURINCK et al. 1994). The focal distribution point of the approx. 1,000 horned grebes (German winter population) is around Oder Bank. In particular, waters less than 10 m deep are used. Horned grebes migrate to the shallow waters in the autumn and spend the winter there (SONNTAG et al. 2006). Horned grebes are concentrated in the Oder Bank area in the spring too, though they also stay in the coastal area off Usedom. Investigations of wind farm projects in the EEZ revealed only very isolated sightings of horned grebes (BIOCONSULT SH GmbH & Co.KG 2016, OECOS GMBH 2015).

Little gull (*Larus minutus*)

In the spring and summer, little gulls only occur in very small numbers in offshore areas. They predominantly occur in inshore coastal waters. Little gulls mainly migrate along the coastline. During autumn migration, they occur in large numbers in the Pomeranian Bight. Little gulls then prefer to use coastal areas for foraging and roosting (SONNTAG et al. 2006).

Long-tailed duck (*Clangula hyemalis*)

The long-tailed duck is the most common species of duck in the Baltic Sea. However according to a study by SKOV et al. (2011) its winter resting population decreased by 65.3% between 1992 and 2009. One of the most important winter resting areas is the Pomeranian Bight in the southern Baltic Sea. As with the Baltic Sea overall, here too an 82% decrease in the incidence of long-tailed ducks was recorded in the period up to 2010 (BELLEBAUM et al. 2014). An analysis of other resting habitats suggests a shift further north (SKOV et al. 2011). Nevertheless, it is generally assumed that the Pomeranian Bight can continue to accommodate sizable occurrences (BELLEBAUM et al. 2014). The long-tailed duck has further extensive main resting habitats for the winter and spring located to the east of Rügen and to the north of Usedom (see Figure 27) (GARTHE et al. 2003, Garthe et al. 2004). Intense migration to the German Baltic Sea areas takes place from the end of October. By contrast, only a few long-tailed ducks can be seen in the German Baltic Sea in the summer months. In all seasons, the species is noticeably absent from the offshore EEZ area to the north and northeast of Rügen. As with other duck species in the Baltic Sea, the long-tailed duck prefers shallow coastal waters or offshore shallows with sea depths of less than 20 m (SONNTAG et al. 2006, MARKONES & GARTHE 2009). More recent investigations confirm widespread incidence of long-tailed ducks in the winter, with focal points at the Adlergrund and Oder Bank, among others (MARKONES et al. 2014, BIOCONSULT SH & Co.KG 2016).

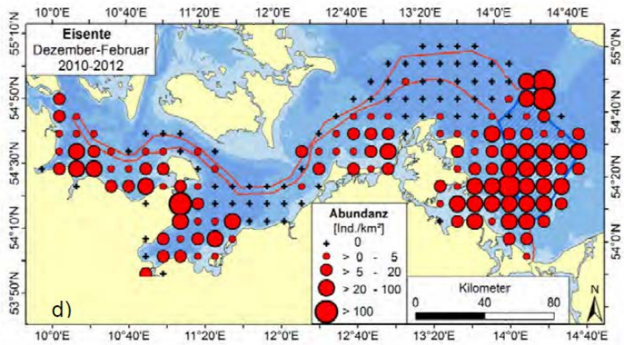

Figure 27: Mean winter incidence of long-tailed ducks (*Clangula hyemalis*) in the German Baltic Sea for the period 2010 to 2012 (aerial and ship-based surveys, MARKONES et al. 2015).

Velvet scoter (*Melanitta fusca*)

The velvet scoter overwinters in the northern Kattegat, the Gulf of Riga and most notably the Pomeranian Bight. In the Pomeranian Bight, the focal distribution point for velvet scoters in winter and spring is the area between Oder Bank and Adlergrund (GARTHE et al. 2003, GARTHE et al. 2004). In ice-free winter months, the velvet scoter uses primarily the central Oder Bank areas; when there is ice cover, its incidence appears to be confined to immediately adjacent ice-free areas in the northern Oder Bank area (MARKONES et al. 2013, MARKONES et al. 2014).

Common scoter (*Melanitta nigra*)

The Oder Bank in the Pomeranian Bight is one of the most important resting areas for the common scoter in the whole of the Baltic Sea (DURINCK et al. 1994, GARTHE et al. 2003). Other resting areas include the shallows of the Kiel Bight and the area north of the Darß-Zingst peninsula (see Figure 28). According to GARTHE et al. (2003, 2004) and SONNTAG et al. (2006), common scoters occur all year round in the German Baltic Sea. The Pomeranian Bight plays a key role as a resting and moulting habitat for the common scoter. On just one single survey day in the summer of 2012, around 2000 common scoters were spotted in the process of moulting in the northwest area of Oder Bank (MARKONES et al. 2013).

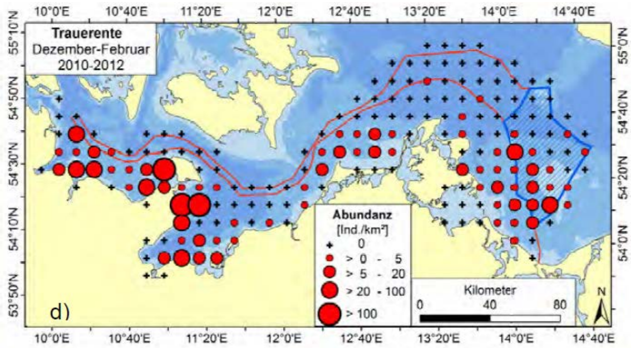

Figure 28: Mean winter incidence of the common scoter (*Melanitta nigra*) in the German Baltic Sea for the period 2010 to 2012 (aerial and ship-based surveys, MARKONES et al. 2015).

Common eider (*Somateria mollissima*)

The common eider occurs very frequently in the winter season and in high densities in areas west of the Darss Sill. The common eider is only found occasionally in the area to the east of the Darss Sill. Only in winter do they occur in small numbers in the Bay of Greifswald and in the coastal waters off the Pomeranian Bight. In the summer, only a few common eiders remain in the western Baltic Sea (SONNTAG et al. 2006).

Guillemot (*Uria aalge*)

DURINCK et al. (1994) estimate the winter resting population of common guillemot in the Baltic Sea to be approx. 85,000 individuals. They only occur occasionally in the spring, summer and winter. The highest numbers of common guillemot occur in the winter. It is believed that common guillemots are less sensitive to severe winter conditions.

Common guillemots spend the winter in the Baltic Sea, close to their breeding colonies. Their focal distribution points are the offshore areas of the Pomeranian Bight, in particular in the deep waters between Oder Bank and Adlergrund and to the northwest of Adlergrund (see Figure 29) (MENDEL et al. 2006). According to GARTHE et al. (2003, 2004), common guillemot occur in low to medium densities in the area northeast of Rügen.

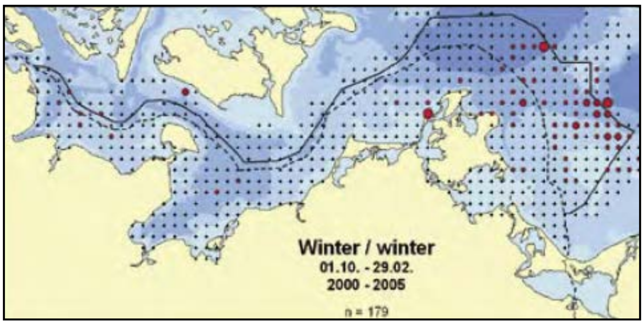

Figure 29: Distribution of common guillemot in the German Baltic Sea (winter 2000-2005; SONNTAG et al. 2006).

Razorbill (*Alca torda*)

The winter resting area of razorbills is located in the deeper waters of the central Baltic Sea. In the winter months, razorbills occur predominantly in the German Baltic Sea. They occur in low and medium densities in large parts of the coastal and offshore areas of the Pomeranian Bight (MENDEL et al. 2008).

Black guillemot (*Cepphus grylle*)

DURINCK et al. (1994) estimate the winter resting population of black guillemot in the Baltic Sea to be approx. 28,560 individuals. The preferred winter resting areas of the black guillemot include shallower areas and reefs. Between autumn and spring, black guillemots stay predominantly around the Adlergrund (see Figure 30). According to GARTHE et al. (2003) this incidence should be categorised as internationally significant, despite the relatively low densities (MENDEL et al. 2008).

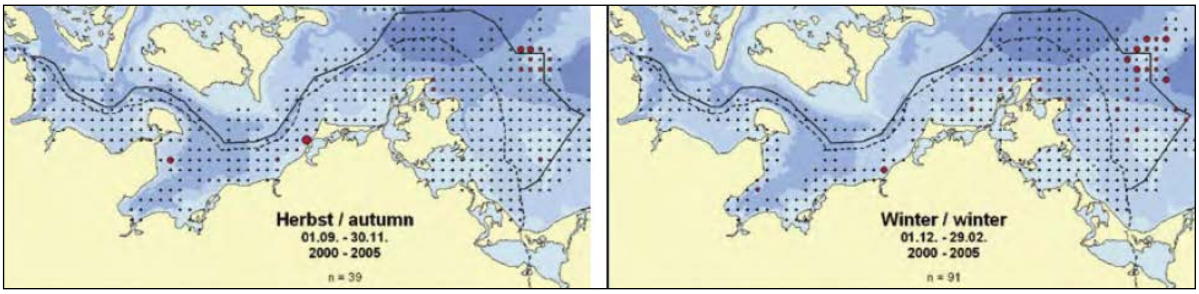

Figure 30: Distribution of black guillemots in the western Baltic Sea in autumn (left) and winter (right) for the period 2000 to 2005 from SONNTAG et al. 2006.

Red-necked grebe (*Podiceps grisegna*)

Red-necked grebes predominantly occur in the German Baltic Sea in the area of the Pomeranian Bight (see Figure 31). As with divers, these are mainly winter visitors or passage migrants. The resting populations reach their peak here in winter and decrease again in the spring (MENDEL et al. 2008).

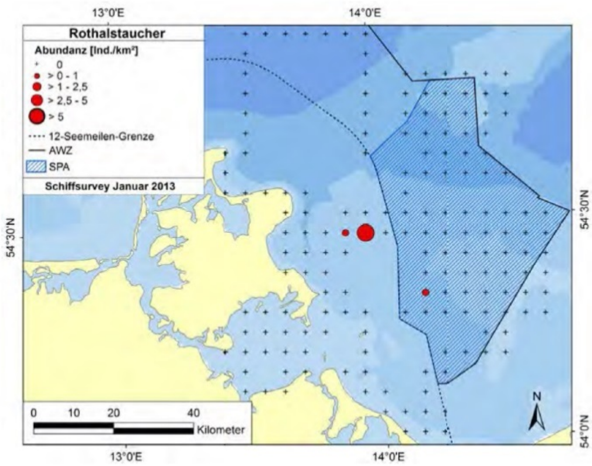

Figure 31: Distribution of red-necked grebes (*Podiceps grisegena)* in the Pomeranian Bight, Baltic Sea in January 2013 (MARKONES et al. 2014).

Yellow-billed diver (*Gavia adamsii*)

Yellow-billed divers occur in the Baltic Sea as passage migrants during the migration periods and use the western Baltic Sea as a winter resting ground. Incidence in winter is low and confined to the areas of the Pomeranian Bight further away from the coast (BELLEBAUM et al. 2010).

Common gull (*Larus canus*)

The common gull occurs in much lower densities in the Baltic Sea than in the North Sea. This is also related to the fact that during the entire breeding season, their food is terrestrial in origin (KUBETZKI et al. 1999). In the summer, therefore, common gulls only appear sporadically in the German Baltic Sea. The populations reach their peak in the winter and spring. During this period, the common gull is mainly seen in the coastal and offshore areas of the Pomeranian Bight (SONNTAG et al. 2006).

Other gulls of the Larus genus

The most frequently occurring species of gull in the Baltic Sea is the European herring gull (*Larus argentatus*), which can be seen all year round. In the winter and spring, European herring gulls occur in high concentrations in both coastal waters and in the EEZ. In particular, they can be found in the Kiel and Mecklenburg Bights, around Fehmarn and to the northwest of Rügen. Particularly high concentrations occur where there are fishing activities (SONNTAG et al. 2006). The European herring gull is not thought to be a naturally occurring breeding bird of the western Baltic Sea.

It was the establishment of motorised trawl fishing back in the 1930s that led to the influx and an increase in the population (VAUK & PRÜTER 1987).

Great black-backed gulls *(Larus marinus)* stay in the western Baltic Sea all-year round. However, during the breeding season from April to July, their numbers are low. The winter population is possibly dependent on the ice conditions in the Baltic Sea. However, the great black-backed gull is seen in greater numbers during the autumnal migration period and in the winter months. Like the European herring gull, this species is often concentrated near to fishing vessels (SONNTAG et al. 2006).

The *lesser black-backed gull (Larus fuscus)* occurs only sporadically in the Baltic Sea during the summer, and occasionally also in connection with fishing activities (MENDEL et al. 2008).

2.9.2.3 Occurrence of seabirds and resting birds in the areas

Area O-1

Surveys carried out so far on wind farm projects in area O-1 have revealed average incidence of seabirds.

The extensive resting habitats of the Pomeranian Bight and Adlergrund (and their northern and northwestern peripheral areas) only extend as far as the southern and southeastern part of area O-1. According to GARTHE et al. (2003), for the seabird species listed in Annex I of the Wild Birds Directive as requiring special conservation measures, the sub-region is not considered to be one of their important resting habitats or one of their preferred long-stay habitats in the Baltic Sea. Current surveys in area O-1 show only a low incidence of divers south of area O-1 (BIOCONSULT SH & CO.KG 2017a). Horned grebes have so far only been sighted on very rare occasions in this area. Little gulls occur sporadically in spring as passage migrants (BIOCONSULT SH & CO.KG 2016).

Even during the winter of 2010, when there was significant ice formation in coastal waters and the Oder Bank area, neither seabirds nor resting birds used the ice-free part of area O-1 as a refuge (SONNTAG et al. 2010). Similar observations were also made in the winter of 2011 when the Pomeranian Bight was covered in ice (MARKONES et al. 2013). This is due to the area's particular location in the transitional area between the deeper waters of the Arkona Basin and the shallower areas of the Pomeranian Bight and the Adlergrund. As a result, diving sea ducks only occur in area O-1 in average numbers. In current surveys, Long-tailed Ducks have been sighted in high and very high densities to the east and south of area O-1, whilst only a few individuals have been seen in the area itself. Velvet scoters and common scoters were predominantly observed to the south of area O-1 during migration periods (BIOCONSULT SH & CO.KG 2016, BIOCONSULT SH & CO.KG 2017a).

Though common guillemots and razorbills occur extensively in area O-1, their focal point is in the south. For the two species of auk, this sub-region belongs to the southern peripheral area of their main winter resting area in the Baltic Sea. Black guillemots are only seen sporadically to the east of this area. During migration periods, European herring gulls are one of the most common species observed around area O-1 and are also widespread in winter. By contrast, great black-backed gulls and common gulls occur only in low densities during these periods although in part over a wide area (BIOCONSULT SH & CO.KG 2016, BIOCONSULT SH & CO.KG 2017a).

Area O-2

The seabird population in area O-2 consists primarily of ocean-going species such as common guillemot as passage migrants and gulls. In the German Baltic Sea, divers are concentrated in a location far to the south of area O-2, southeast of Rügen. All findings so far indicate that for the seabird and resting bird species occurring all around area O-2, this area of the German Baltic Sea functions as a transit area rather than as a resting or feeding area (OECOS GMBH 2015, BIOCONSULT SH & CO.KG 2016, BIOCONSULT SH & CO.KG 2017a).

Area O-3

A comparison of data for area O-3 with data from the Pomeranian Bight reveals a below-average incidence of seabirds in this area (GARTHE et al. 2003). In area O-3, the seabird population generally consists of species using the area as a transit area.

According to GARTHE et al. 2003, for the divers listed in Annex I of the Wild Birds Directive as requiring special conservation measures (namely the red-throated diver and black-throated diver) and for the horned grebe, area O-3 is not one of the preferred long-stay habitats in the Baltic Sea. The same applies to little gulls. Furthermore, more recent surveys have revealed only isolated sightings of these species in this area (IFAÖ 2016).

Sea ducks which dive for food, such as long-tailed ducks, velvet scoters and common scoters, occur in this area of the EEZ mainly as passage migrants in the spring but also to a lesser extent as resting birds in the winter. However, their distribution area during this time extends to the "Kriegers Flak" shallows in the northwest of area O-3 (IFAÖ 2016, IFAÖ 2017a).

European herring gulls and great black-backed gulls are amongst the most common species found in area O-3 and its surrounding area. Common gulls occur in deeper waters during the winter. In current surveys, razorbills have been observed in the area around area O-3 in greater numbers than common guillemots. For both species, however, this area has no special significance as a resting habitat. Black guillemots are sighted only very occasionally (IFAÖ 2016, IFAÖ 2017a).

2.9.3 Status assessment of seabirds and resting birds

The great deal of work that has gone into mapping over the last few years and the latest information available permit good assessment of the importance and condition of the areas considered here as habitats for seabirds.

2.9.3.1 Importance of areas and sites for seabirds and resting birds

Area O-1

All findings so far indicate that area O-1 is of medium significance for seabirds. It only abuts the edges of the extensive resting habitats of the Pomeranian Bight and the Adlergrund to the south and southeast. On the whole, the area has an average incidence of seabirds and similarly only an average incidence of endangered species and species requiring special conservation measures. It is not one of the main resting, feeding or overwintering habitats of species listed in Annex I of the Wild Birds Directive or of species of the "Pomeranian Bight – Rönnebank" nature conservation area that require special conservation measures.

Area O-1 has medium significance as a feeding and resting habitat for ocean-going birds and ship followers. It is not significant for breeding birds, due to its distance from the coast. Because of the depth of the water (more than 20

m) and the nature of the seabed, it is not an important feeding ground for diving sea ducks. The latter use the area in spring and autumn as a transit area. European herring gulls occur frequently in the area, whilst great black-backed and common gulls occur in comparatively smaller densities. Divers use the sub-region exclusively as a transit area. Area O-1 abuts the extreme outer edges of the winter resting habitats of razorbills and common guillemots. Black guillemots are very seldomly spotted. As a minimum, the effects of the existing burdens of fishing and shipping on seabirds are of average intensity.

Area O-2

All findings so far indicate that area O-2 is of low significance for seabirds. The area has a low incidence of endangered species and species requiring special conservation measures. It is not one of the main resting, feeding or overwintering habitats of species listed in Annex I of the Wild Birds Directive, or of species of the "Pomeranian Bight – Rönnebank" conservation area that require special conservation measures. As a minimum, the effects of the existing burdens of fishing and shipping on seabirds are of average intensity.

Area O-3

According to current knowledge, area O-3 is of low significance as a feeding and resting habitat for seabirds. On the whole, the area has a low incidence of seabirds. It is not one of the main resting, feeding or overwintering habitats of species listed in Annex I of the Wild Birds Directive or of species of the "Pomeranian Bight – Rönnebank" nature conservation area that require special conservation measures. The incidence of these species is very low. The area is insignificant for breeding birds, due to its distance from the coast. Due to the depth of the water and the nature of the seabed, the area is not significant as a feeding ground for diving sea ducks. As a minimum, the effects of the existing burdens of fishing and shipping on seabirds are of average intensity.

2.9.3.2 Protection status

The German EEZ of the Baltic Sea is host to significant populations of long-tailed duck, common scoter, velvet scoter and black guillemot. Red-throated and black-throated divers, horned grebes and little gulls are subject to special protection. The remaining species are migratory birds whose protection is also to be ensured under Article 4 (2) of the Wild Birds Directive.

Within the EEZ, the nature conservation area "Pomeranian Bight – Rönnebank" was established by the ordinance of 22 September 2017, its area IV having already been under protection as the "Pomeranian Bight Special Protection Area" since 2005. The conservation area is host to significant populations of important species of resting birds, most especially sea ducks (long-tailed duck, common scoter, velvet scoter).

The following Table 11 lists the species and their currently allocated threat categories in the European Red List (Europe and EU27) and the HELCOM Red List. Differences in the classifications are due to the fact that different geographical frames of reference were used.

Table 11: List of the most important species of resting birds in the German EEZ in the Baltic Sea and their threat categories as currently allocated in the European Red List and by HELCOM. Categories defined by IUCN (also applies to HELCOM): **LC** = Least Concern; **NT** = Near Threatened; **VU** = Vulnerable; **EN** = Endangered; **CR** = Critically Endangered).

	Annex I of the Birds Directive	**IUCN Red List, Europe[a)]**	**IUCN Red List, EU 27 [a)]**	**HELCOM winter resting population [b)]**
Red-throated diver	X	LC	LC	CR
Black-throated diver	X	LC	LC	CR
Horned grebe	X	NT	VU	NT
Red-necked grebe		LC	LC	EN
Great crested grebe		LC	LC	LC
Little gull	X	NT	LC	NT
European herring gull		NT	VU	
Great black-backed gull		LC	LC	
Common gull		LC	LC	
Long-tailed duck		VU	VU	EN
Velvet scoter		VU	VU	EN
Common scoter		LC	LC	EN
Common eider		VU	EN	EN
Black guillemot		LC	VU	NT
Guillemot		NT	LC	
Razorbill		NT	LC	

[a] BIRDLIFE INTERNATIONAL (2015) European Red List of Birds

[b] HELCOM (2013c)

According to the European Red List, long-tailed ducks, velvet scoters and common eiders are classified as "Vulnerable" due to the negative population trends over the last few years. The drastic reduction in the winter resting population of long-tailed ducks in the Baltic Sea (SKOV et al. 2011) is also clearly reflected in the HELCOM Red List. Here, the long-tailed duck, along with other species of sea duck, is classified as "Endangered". The winter resting populations of red-throated and black-throated divers in the Baltic Sea are classified as "Critically Endangered", even though their populations in Europe as a whole are classified as being of "Least Concern". The populations of little gulls and horned grebe are classified both in Europe as a whole and in the Baltic Sea (winter resting population) as "Near Threatened". Great black-backed gulls and common gulls are generally held to be of "Least Concern". European herring gulls, common guillemots and razorbills are listed as "Near Threatened" on the Red List for the whole of Europe, whilst their winter resting populations in the Baltic Sea have not been assigned any threat status. The opposite is the case for populations of black guillemot.

2.9.3.3 Hazards

The seabird community in the EEZ of the Baltic Sea is not to be regarded as naturally occurring. It is significantly influenced by anthropogenic activities, especially fishing and shipping. Alongside anthropogenic activities, climate change and natural variability also influence the seabird community of the southern Baltic Sea. Seabirds are exposed to various hazards.

- ***Fishing***: Fishing can be expected to have a significant impact on the composition of the seabird community in the EEZ. Fishing can lead to a reduction in the supply of food and may even lead to limits on food. Selective catching of fish species or fish sizes can lead to changes in the food supply for seabirds. Gillnet fishing causes high losses of seabirds in the Baltic Sea all-year round, due to the birds being caught in the nets and subsequently drowning (ERDMANN et al. 2005). Divers, grebes (podicipediformes) and diving ducks in particular fall victim to the gillnets (SCHIRMEISTER 2003, DAGYS & ZYDELIS 2002). According to ZYDELIS et al. (2009), the annual bycatch is around 73,000 for the whole of the Baltic Sea and 20,000 birds for the southern Baltic Sea. Fishing discards provide additional food sources for some species of seabird (CAMPHUYSEN & GARTHE 2000). In particular, many ocean-going bird species such as the European herring gull and great black-backed gull benefit from discards.
- ***Shipping***: Shipping traffic has a significant scare effect on species which are sensitive to disturbance, e. g. divers. Shipping also brings a risk of oil contamination. The rapid development of commercial shipping has led to water birds increasingly avoiding the main traffic routes in the western Baltic Sea (BELLEBAUM et al. 2006). With regard to the German EEZ in the Baltic Sea, this means that the EEZ area west of the DW 17 deep-water route is used very little by seabirds. In the area of the Fehmarn Belt, evidence of avoidance behaviour by seabirds due to shipping has also been observed (SKOV et al. 1998).
- ***Technical structures (e.g. offshore wind turbines)***: Technical structures can have similar effects to shipping on species susceptible to disturbance. This also includes an increase in the volume of shipping traffic due to maintenance journeys, for instance. There is also a risk of collision with such structures.
- ***Hunting***: Virtually all migrating ducks in the Baltic Sea region are affected by hunting. Between 1996 and 2001, 122,500 eider ducks were shot each year in Scandinavia, 92,820 of them in Denmark alone (ASFERG 2002). This equates to 16% of the winter population of 760,000 individuals (DESHOLM et al. 2002).
- ***Climate change***: Changes in water temperature are accompanied amongst other things by changes in water circulation, the distribution of plankton and the composition of fish fauna which form the basis of the seabirds' diet.

The eco-system of the North Sea and Baltic Sea has changed radically, particularly since the end of the 1980s (ALHEIT et al. 2005). However, it is hardly possible to predict the effects on seabirds and resting birds due to uncertainty with regard to the effects of climate change on individual ecosystem components. Since the 1990s, global warming has been affecting the winter resting activities of seabirds and resting birds in the western Baltic Sea: the main populations are moving eastwards and regular seasonal oxygen deficiency is causing a localised permanent decrease in the mussel population (e.g. the old Oder bed in the western Pomeranian Bight).

Additional risks posed to seabirds and resting birds include eutrophication, the accumulation of pollutants in the marine food chains and rubbish floating in the water, e. g. from fishing nets and plastic parts. Epidemics of viral or bacterial origin also pose a threat to resting bird and seabird populations.

2.10 Migratory birds

The term "bird migration" is usually defined as periodic migrations between the breeding ground and a separate staging area outside the breeding period, which normally includes wintering grounds in the case of birds of higher latitudes. In addition to a destination for resting, birds often call at one or more stopover destinations, e. g. to moult or to visit rich feeding grounds. It is possible to tell long-distance and short-distance migrators apart by the distance covered and according to physiological criteria.

2.10.1 Data availability

Systematic studies of bird migration have a long tradition in the Baltic Sea region, commencing back in 1901 at the former Rossitten Bird Observatory on the Curonian Spit. Bird migration has been monitored at Falsterbo on the southern tip of Sweden since 1972; the ringing of migrating birds is also carried out here. Numerous experiments have also been carried out here and have provided detailed findings on various aspects of migration behaviour (e.g. the selection of migratory direction). Staying in Sweden, the southern tip of the island of Öland has been home to the Ottenby ringing station since 1948. Another ringing station is located on the Danish island of Christiansø near to Bornholm (LAUSTEN & LYNGS, 2004). On the island of Greifswalder Oie, east of Rügen, the Verein Jordsand has been running a trapping scheme for registering migrating songbirds since 1995 (VON RÖNN 2001).

The many years of research have resulted in more than 1,000 publications about bird migration in the western Baltic Sea. The ringing stations provide long-term data, some extremely detailed, which allow population trends to be assessed. Most of this data relates to songbird and raptor migration, but there are also visual observations of water birds and waders. These figures describe migration in areas close to the coast.

There is hardly any long-term data on migration activities over open sea. One exception are the records from the Fehmarn Belt lightship, from where over-sea bird migration was systematically observed between 1955 and 1957. Since the 1970s, the over-sea migration behaviour of a number of species has been studied using military radar (Lund University, Sweden). Since 2002, the Institute for Applied Ecosystem Research (IfAÖ) has been studying visible bird migration in the German sector of the Baltic Sea at various locations along the western Baltic Sea coast and at offshore locations (see Figure 32), the studies being part of the approval process for offshore wind farms and research projects for the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). At the same time, bird migration up to an altitude of 1,000 m is being quantified using vertical radar. Further studies have been or are being carried out by other planning agencies (e.g. OECOS 2015, BIOCONSULT SH 2017) as part of offshore wind farm projects.

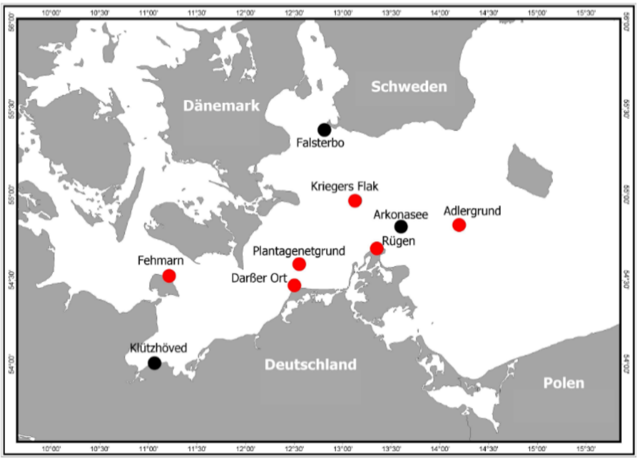

Figure 32: Bird migration observation stations and radar recording points of the Institute for Applied Ecosystem Research in the western Baltic Sea (Falsterbo did not carry out its own observations; from BELLEBAUM et al. 2008).

Alongside data from the ringing stations, various other sources also need to be used for estimating migratory bird populations (national breeding bird monitoring programmes in Scandinavia, BIRDLIFE INTERNATIONAL, 2004a). For migrating songbirds and raptors, the breeding populations in Sweden and Finland are pertinent. For divers and sea ducks, however, it is the populations that migrate across the Baltic Sea from their western Siberian breeding grounds to their western European overwintering areas that are of interest. Estimates of wading bird populations in resting places along the "East Atlantic Flyway" can be used to estimate the extent of migration of this group of birds in the Baltic Sea region. Despite many years of observations, there is still insufficient knowledge of specific issues in the German EEZ region of the Baltic Sea.

2.10.2 Spatial distribution and temporal variability of migratory birds

According to prior information, migratory bird activity can be roughly divided into two phenomena: broad-front migration and migration along migratory routes. It is known that most migratory bird species fly over at least large parts of their migration areas on a broad front. According to prior information provided by KNUST et al. (2003), this also applies to the North Sea and the Baltic Sea. In particular, species that migrate at night – which cannot be guided by geographical structures due to the darkness – migrate across the sea on a broad front. Nevertheless, many species are known to migrate along narrow corridors or flight paths with no obvious leading lines. This applies, e. g. to cranes. From their vast distribution area covering almost the whole of northern Eurasia, cranes migrate along a relatively small number of traditional narrow migration routes to just ten fixed wintering grounds extending from Spain across to North and East Africa and all the way to China. This is what's known as narrow-front migration.

It is known from diurnal migrants in particular that geographical barriers or leading lines, such as estuaries and large expanses of water, influence migration routes. According to PFEIFER (1974), the western Baltic Sea has three main migration routes:

- Southern Sweden – Danish Islands (Seeland, Møn, Falster, Lolland) – Fehmarn (known as the "Vogelfluglinie" (flyway)). This route is especially preferred by diurnal migrating songbirds and thermal soarers such as raptors. They then only need to fly short distances over expanses of water.

- Southern Sweden – Rügen. In addition to cranes and raptors, this route is especially used in spring by songbirds heading north across the Baltic Sea from Darss and Rügen.
- From the Baltic States/Finland/Siberia in a southwesterly/westerly direction, along the narrowing funnel of the western Baltic Sea. Here a distinction is made between two main coastal routes 1) along the Mecklenburg coast and 2) along the southern coast of Sweden and the Danish islands to Fehmarn.

Seasonal migration intensity is closely linked to species-specific or population-specific life cycles (e.g. BERTHOLD 2000). Besides these largely endogenously controlled annual rhythms in migration activity, the specific course of migration activity is determined primarily by weather conditions. Weather factors also influence the altitude and speed at which animals move.

In general, birds wait for favourable weather conditions (e.g. good visibility, tailwind, no precipitation) before migration in order to optimise their efforts in terms of energy. This means that bird migration is concentrated on individual days or nights in autumn or spring. According to the results of an R&D project (KNUST et al. 2003), half of all birds migrate on just 5 to 10% of all days. Furthermore, the intensity of migration is also subject to daily fluctuations. About two-thirds of all bird species migrate predominantly or exclusively at night (HÜPPOP et al. 2009).

2.10.2.1 Bird migration over the western Baltic Sea

Bird migration over the western Baltic Sea is documented all year round by means of various methods (radar and visual observations, acoustic recordings, analysis of ring recoveries), with strong seasonal fluctuations occurring and concentrations in spring and autumn. The Baltic Sea is located on the migratory route of numerous bird species. Every autumn, around 500 million birds (see

Table 12) migrate over the western Baltic Sea from their breeding grounds in the north to their wintering grounds further south (BERTHOLD 2000). In the spring, numbers are significantly lower (200-300 million). The reason for this is the high mortality rates of young birds in their first winter. More than 95% of these birds are small, land-dwelling birds.

To analyse migration rates and migration routes, it is useful to break down the migratory bird population into migration types. Here, a distinction must be made between water birds and land birds and between diurnal and nocturnal migration, due to the different migration conditions. Amongst the diurnal migratory land birds are some optional users of thermals (cranes, larger raptors) who use the thermals over land to gain height, but migrate over water using active flapping flight (BELLEBAUM et al. 2008).

Table 12: Population estimates for migratory birds with different types of flight in the southern Baltic Sea region (data valid only for the autumn season; source: BELLEBAUM et al. 2008; calculated in accordance with HEATH et al. 2000 and SKOV et al. 1998).

Migration type	Species groups	Autumn population
Water birds	Divers, grebes (podicipediformes), pelecaniformes, ducks, geese, mergansers, waders, gulls, terns, auks	10-20 million
Land birds: optional thermal soarers	Raptors	< 0.5 million
	Cranes	60.000
Land birds: Flapping wing flyers	Nocturnal migrants	200-250 million
	Diurnal/nocturnal migrants, solely diurnal migrants	150-200 million

Each year, around 200 species of birds are involved in migration activities in the western Baltic Sea. In addition, there are a further 100 rare species and accidental migrants. Figure 33 is a schematic representation of the general migration systems of the western Baltic Sea, the arrows representing the migration routes, the exact course of which should not be interpreted too narrowly. The largest migration populations of water birds (sea ducks, divers, geese and swans) originate predominantly from Siberia, meaning that their migration path is generally west to east. Sea ducks and divers fly low over the water, usually at heights below 10 m, and frequently close to the coast (e.g. KRÜGER & GARTHE 2001). Waders which, in the spring at least, fly at higher altitudes (on average 2,000 m, GREEN 2005) are relatively infrequently observed in the Baltic Sea. Raptors fly both above the "flyway" and over the open waters of the Baltic Sea. Flight behaviour varies by species and by season. Active flapping wing flyers tend to fly more/also over the sea, whilst thermal soarers such as common buzzards generally use the "flyway".

Cranes migrate over the Baltic Sea predominantly in a north-south direction between the Rügen-Bock region in the "Western Pomerania Lagoon Area" national park and the southern coast of Sweden (ALERSTAM 1990).

For songbirds that migrate during the day, in particular short and medium-distance migrants such as finches and wagtails (BERTHOLD 2000), the "flyway" is important, since for this species group, leading lines play a key role in migration, at the very least assisting low-flying migrants with orientation. However, a large proportion of the migration takes place in tailwind conditions at high altitude, albeit also over the open Baltic Sea and following a north-south direction (ALERSTAM & ULFSTRAND 1972). Due to the limited number of visual cues to assist with orientation, small nocturnal migratory birds, especially medium-distance migrants such as thrushes and robins or long-distance migrants such as reed warblers, adopt broadfront migration (BERTHOLD 2000, ZEHNDER et al. 2001, BRUDERER & LIECHTI 2005). KNUST et al. (2003) were able to determine that the main migratory direction for the autumnal migration at Fehmarn and Rügen in the German Baltic Sea was SW to SSW.

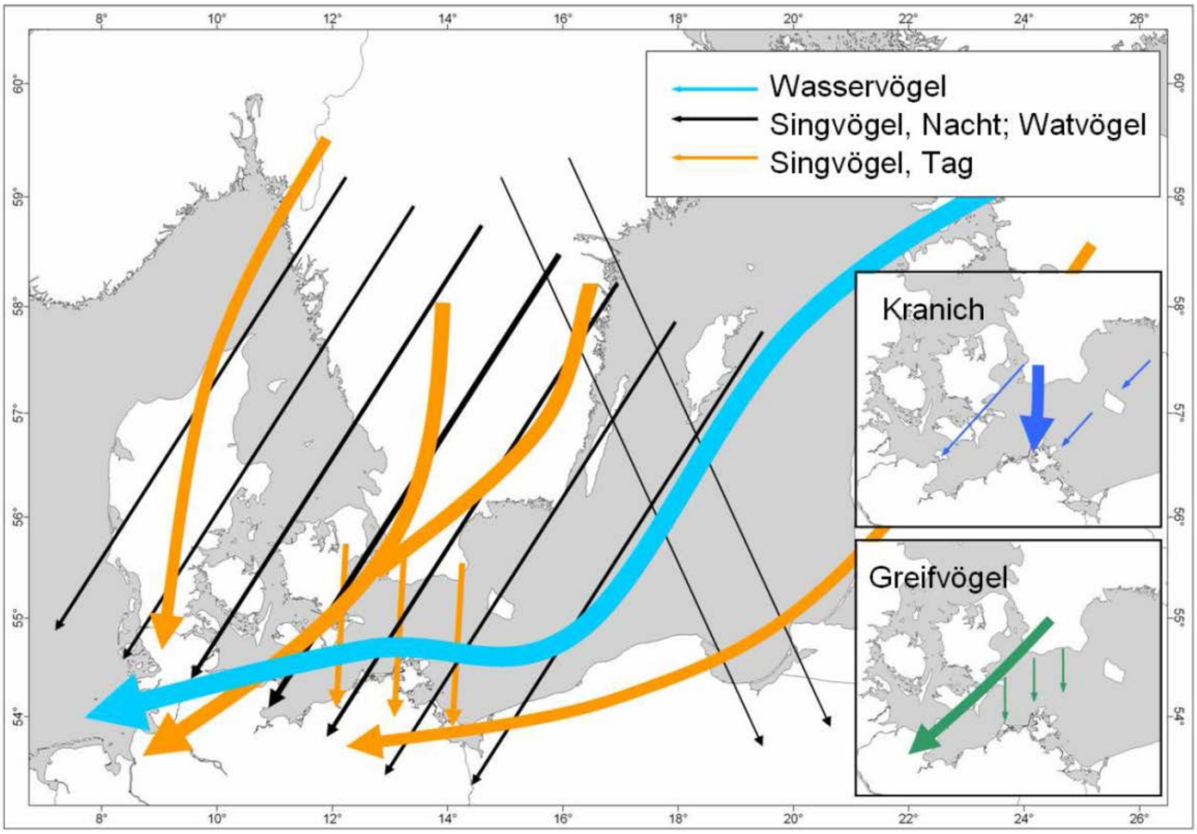

Figure 33: Schematic diagram of the main migration routes in the Baltic Sea region for autumn migration (BELLEBAUM et al. 2008).

Over open water, migration altitude seems to rise in general (BEZZEL & PRINZINGER 1990). Ultimately, flight altitudes during migration depend on various factors (e.g. season, time of day and wind and weather conditions). Nocturnal migrants generally fly at higher altitudes than diurnal migrants. Wind conditions also have a major influence on migration altitude. KRÜGER & GARTHE (2001) were able to establish that divers and sea ducks (eider ducks, common scoters) frequently flew low over the water (at heights less than 1.5 m) when there was a headwind, but that flight altitudes rose when there was a tailwind. This is probably related to the fact that wind strength usually increases with increasing altitude. By adapting flying altitude to the wind conditions, flight speed can be significantly increased and energy consumption substantially reduced (LIECHTI et al. 2000, LIECHTI & BRUDERER 1998).

2.10.2.2 Species composition

Water birds (flapping wing flyers, diurnal/ nocturnal migrants)

The exact migration routes of only a third of the 70 or so species of water bird that regularly migrate through the western Baltic Sea, are known (only diurnal migrants with flying altitudes < 200 m, divers, geese, sea ducks, terns). Many species migrate at night and/or at high altitudes (diving ducks, waders, e.g. GREEN 2005). The flight paths of most species/populations cross the area in an east-west direction, as the birds (e.g. geese, sea ducks, stints, divers; see Figure 33 and Figure 34) move from their Arctic breeding grounds in Western Siberia to their wintering grounds in Western Europe. These birds often navigate along the coastlines. Other species/populations which breed in the Scandinavian wetlands and use freshwater biotopes as habitats (field geese, dabbling ducks, mergansers, wading birds of the tringa genus) migrate in a north-south direction. These species follow old traditional population-specific migration routes. Species that migrate at night possibly also migrate on a broad front (e.g. snipe).

With regard to diurnal migrants, there are three known principal routes through the western Baltic Sea for water birds:

- Along the Swedish coast (main route of most eider ducks, barnacle geese and brent geese),
- Along the German coast (main route of most common scoter and many divers and terns), and
- In a north-south direction (swans, field geese, dabbling ducks, mergansers).

Geese

During autumn migration, the Russian and Baltic populations of barnacle geese (*Branta leucopsis*) and brent geese (*Branta bernicla*) cross the Baltic Sea to reach their wintering grounds along the coasts of Western Europe. In the western Baltic Sea, most of these geese migrate along the southern coast of Sweden. Only a few thousand birds cross the Arkona Sea to follow the German coast.

In the course of the spring migration in the western Baltic Sea, differences between the two species gradually emerge. Barnacle geese fly to a greater extent over the open see or over the southernmost tip of southern Sweden, whilst brent geese tend to fly further inland (GREEN & ALERSTAM 2000). The mean migratory direction of the barnacle goose is northeast, whilst brent geese tend to fly eastwards. In the spring, barnacle geese usually migrate in April, whilst the majority of brent geese pass through at the end of May. The main migration days therefore coincide with periods of tailwinds which are selectively preferred. Both species fly over the German EEZ, predominantly in the Kiel Bight/Fehmarn Belt region. Brent geese fly at higher speeds in spring than in autumn and also migrate in larger groups and at higher altitudes (average in spring: 341 m, autumn 215 m).

It is presumed that other species of geese migrate predominantly at higher altitudes over the Baltic Sea and preferably follow the coast. A 25-year study conducted on the Danish island of Christiansø observed only greater white-fronted geese (Anser albifrons) in significant numbers (LAUSTEN & LYNGS 2004). And in the migration route studies conducted so far by the Institute for Applied Ecosystem Research, it is predominantly greater white-fronted geese that have been observed crossing the Baltic Sea. In May 2003, a conspicuous low-altitude (< 100 m) moult migration of greylag geese (Anser anser) (as well as mute swans (Cygnus olor)) from the Darsser Ort to the Danish Islands was recorded (IFAÖ 2005).

Sea ducks

For sea ducks, the southern and western Baltic Sea represents an important transit area en route to their wintering areas in the North Sea and the northern Kattegat. Though migration occurs predominantly close to the coast (many sea ducks maintain visual contact with land features as they fly), some sea duck migration also occurs over the open sea (IfAÖ 2005).

During the spring, **eider ducks** migrate home along the southern coast of Sweden in a relatively narrow corridor very close to the coast. As they migrate, they make constant use of topographical features (coastline) as reference points: initially, they migrate eastwards from the Kattegat and the Belt Sea area (partly overland), then head northeast, keeping close to the coastline in very concentrated groups (ALERSTAM 1990). In the autumn, they migrate along roughly the same route. Although eider ducks migrate both by day and by night, most migration activity takes place during the day. Radar studies of eider duck migration off the coast of southern Sweden have shown that less than 10% of the entire migration process takes place under cover of darkness (ALERSTAM et al. 1974). Particularly if there is good weather, the bulk of the eider duck migration process can be completed in just a few days (ELLESTRÖM 2002).

The spring migration of the **common scoter** takes place predominantly along the German coast. On their vernal migration, most of the common scoters which have been overwintering in the North Sea appear to fly south as far as the Western Beach of the Darss, then fly around the Darsser Ort and Cape Arkona, keeping relatively close in. In the spring of 2003, around 9% of the biogeographical population (1.6 million individuals, Wetlands International, 2006) was found at Darsser Ort alone (WENDELN & KUBE 2005). However, observations conducted synchronously (with the observations at Darsser Ort itself) out at sea, 20 km north of Darsser Ort, recorded numbers equating to a 35% share (24% in the autumn), meaning that larger numbers of common scoter are to be found offshore. An unknown percentage of the birds migrate at night.

Whilst common scoters occur in very concentrated groups to the north of Cape Arkona on the island of Rügen at moulting and autumn migration time (between 50,000 and 100,000 in July/August alone, NEHLS & ZÖLLICK 1990), the overall numbers at Darsser Ort at this time of year are low (Wendeln & Kube, 2005). It appears that the autumn migration in the area between Darsser Ort and Falsterbo does not take place close to the coast. The birds presumably head out from Cape Arkona towards the Danish island of Møn. In the Fehmarn Belt, hardly any common scoter were observed along the German coast in the spring and autumn of 2005 (IfAÖ 2005). Either the migration occurs in concentrated numbers along the Danish coast or the birds fly at high altitudes on both their inbound and outbound migrations in order to fly over Schleswig-Holstein (see Berndt and Busche, 1991).

Hardly any migration of **velvet scoter** is observed in the German Baltic Sea (GARTHE et al. 2003, WENDELN & KUBE 2005). It appears that there is hardly any movement between the main wintering areas in the Northern Kattegat and the Pomeranian Bight. The same applies to **long-tailed ducks**. Only a few thousand individuals of this species overwinter west of the Darss Sill. However, there is very intensive exchange between the main overwintering areas to the west and east of Rügen.

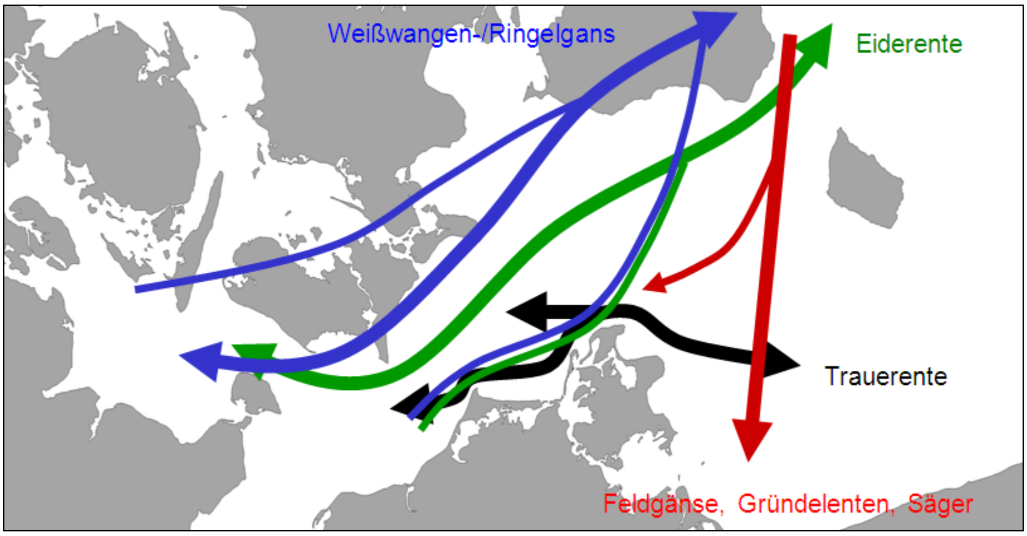

Figure 34: Schematic diagram of selected migration routes of water birds in the western Baltic Sea (IfAÖ compilation based on literature sources and own observations in the Arkona Sea; from Federal Maritime and Hydrographic Agency, 2009).

Field geese, swans, dabbling ducks and mergansers

According to IfAÖ observations, limnetic species of water bird that breed in Scandinavia (swans, dabbling ducks, diving ducks, mergansers) migrate in a north-south direction over the Arkona Sea and are assumed to head predominantly for the Oder estuary (incl. the Bay of Greifswald). Birds that meet the north coast of Rügen then turn westwards and follow the coastline. Observations carried out in southern Sweden suggest that the birds initially migrated along the Swedish Baltic Sea coast (FLYCKT et al. 2003, 2004). At present, however, there is insufficient data to describe the existing north-south migration in detail. It is noticeable that for many of these species, only a few individuals are generally seen each season (the exceptions being meurasian wigeon and red-breasted Merganser, see also LAUSTEN & LYNGS 2004). This suggests that many species of duck are most likely migrating at night and at high altitudes.

Waders from the Siberian Arctic

Adult waders from their Arctic breeding grounds (stints and plovers, etc.) mostly migrate over the Baltic Sea at high altitude to the Wadden Sea, often crossing southern Sweden as well. The juvenile birds, by contrast, migrate in small stages along the coasts, resting frequently in mudflats (KUBE & STRUWE 1994). In the spring, almost all wading birds migrate from the Wadden Sea to Western Siberia at high altitude. Their average flying altitude is around 2,000 m (GREEN 2005). Wading birds always prefer tailwinds when migrating (GREEN 2005). When there is a strong headwind or precipitation, they will occasionally use the western Baltic Sea as an emergency roost or will migrate low over the sea along the Swedish (SW wind in autumn) or German (NW wind in autumn) coasts. By contrast, wading birds are recorded only very seldomly on open sea. Any calls heard are predominantly during the night (IFAÖ 2005).

Cranes/raptors (thermal soarers/flapping wing flyers/diurnal migrants)

Cranes

The common cranes (*Grus grus*) of Northern Europe use various migration routes. Whilst eastern populations (Finland, Baltic States) migrate in a south-southeast direction (to Israel and northwest and east Africa), birds of the sub-population following the west European migration route from Norway, Sweden, Poland and Germany to their wintering grounds in France, Spain and northwest Africa, head southwest. This population is currently estimated at around 150,000 individuals (G. NOWALD pers. comm.).

The Scandinavian birds migrating across the Baltic Sea are of particular interest for the western Baltic Sea. For these cranes, the Rügen-Bock region is the most important resting area on the southern Baltic Sea coast (hosting up to 40,000 resting cranes at any one time).

Scandinavian cranes reach their resting areas in the lagoons of Western Pomerania via two migration routes: from Finland, by flying partly along the southern Baltic Sea coast and from Sweden, by flying non-stop for 1 to 2 hours over the Arkona Basin. An estimated 50,000 to 60,000 individuals take this latter route. The vernal migration from the resting places in Western Pomerania to Sweden is done in the opposite direction, with the birds heading in a northerly direction (ALERSTAM 1990, Figure 35).

Cranes cross the Baltic Sea in an almost direct north-south direction. The flight directions of the cranes studied by the IfAÖ deviated from the direct north-south heading by a good 10°, both on the outward and return migration journey. This could be related to wind drift over the sea which was only partially compensated for. By contrast, wind drift is fully compensated for over land (ALERSTAM 1975). Neither autumn or spring migrations were evenly spread, but instead were characterised by mass migrations occurring over a relatively small number of days. The cranes deliberately used tailwind phases to cross the Baltic Sea. The wind also had a decisive influence on the cranes' flying altitude. The flying altitude was much lower in headwinds than in tailwinds or "neutral" winds (BELLEBAUM et al. 2008).

Due to having a large wing area relative to their weight, cranes belong to the group of birds known as thermal soarers. They alternate between periods of spiralling upwards to higher altitudes in thermal columns with gliding phases. This behaviour enables them to conserve a lot of energy while flying. Using gliding flight to cross the entire 80 km stretch of the Baltic Sea, however, is not possible. From a starting altitude of 1,000 m, cranes can glide for a maximum distance of 16 km (ALERSTAM 1990).

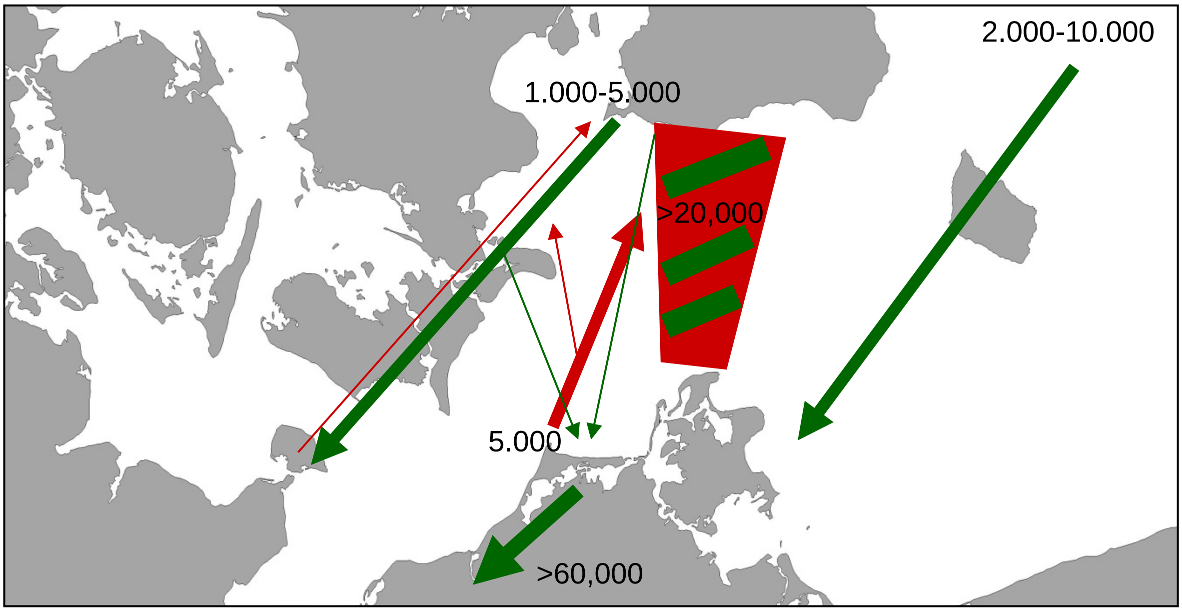

Figure 35: Schematic diagram of crane migration routes in the western Baltic Sea (red = vernal migration, green = autumnal migration; IfAÖ compilation based on observation data from Falsterbo, Bornholm and own observations in the Arkona Sea; from: Federal Maritime and Hydrographic Agency, 2009).

As no updraughts occur over sea areas, they have to cover a large part of the distance using active flapping flight (possibly alternating with gliding phases initially). Consequently, they normally wait for weather conditions with tailwinds (ALERSTAM & BAUER 1973). Flight speed is also heavily dependent on the wind and is on average around 70 km/h (ALERSTAM 1975). In the spring, flying altitudes of 200-700 m were measured over the southern tip of Sweden, after the Baltic Sea had been crossed (KARLSSON & ALERSTAM 1974). The flocks of cranes observed by the Institute for Applied Ecosystem Research used spiralling flight movements to gain height, especially over land. Cranes could also be regularly observed using spirally flight (and gaining significant height as a result) over water, albeit close to land, up to 15 km away from the coast (Wendeln et al., 2008). Based on existing data, the proportion of nocturnal migration was estimated to be around 10% (BELLEBAUM et al. 2008).

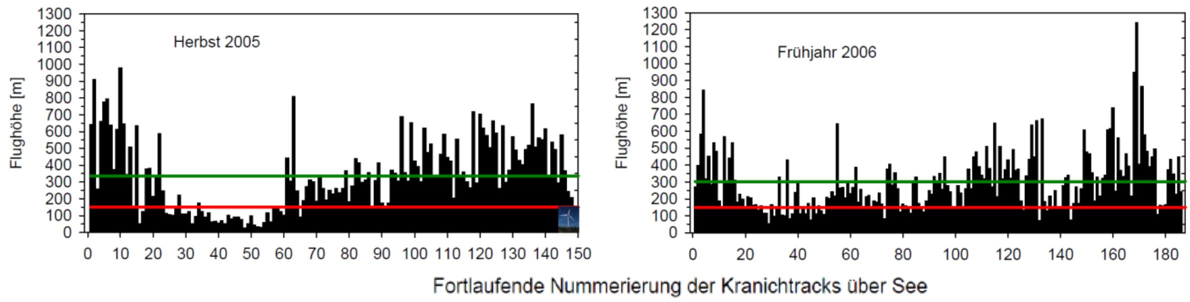

Figure 36: Flight altitudes of flocks of cranes over the sea during autumn and spring migration (green line: mean flight altitude over the entire season; red line: max. wind turbine height, BELLEBAUM et al. 2008).

The results of surveys using target-tracking radar along the coast of Rügen show that flight altitude over the sea can vary greatly. Around a third of the cranes recorded (32% in autumn 2005, 33% in spring 2006) migrated at heights below 200 m (Figure 36). Consequently a significant proportion of crane migration takes place within the same height range as wind turbines.

Raptors

Raptors are frequent thermal soarers. Thermal soaring raptors spiral up to altitudes of several hundred metres over land before commencing their migration. But there are also species which migrate using flapping flight (e.g. sparrowhawks, ospreys, falcons). Whilst the majority of diurnal migratory raptors from Swedish populations follow the "flyway" via Falsterbo during the autumn migration, a number of them cross the Baltic Sea in a north-south direction (to some degree this is species-specific, e.g. rough-legged buzzard). Thus the migratory patterns of sparrowhawks ringed in Falsterbo and Otterby, for example, reveal that the breeding grounds and overwintering areas of these birds are parallel and offset: birds breeding further east may possibly also migrate along a route further to the east and therefore have to fly over larger expanses of water to cross the Baltic Sea. Raptors that primarily follow the "flyway" in autumn migrate in a south-southwesterly direction. Raptors that primarily cross the open sea between the southern coast of Sweden and the Mecklenburg coast migrate in a more southerly direction.

Every autumn, up to 50,000 Scandinavian raptors migrate south via Falsterbo. These birds then cross the Fehmarn Belt. Depending on the prevailing wind direction, the birds cross this sea area on a slightly broader front (KOOP 2005). The migration altitude of the raptors is predominantly above 50 m (IFAÖ 2005).

In the spring migration period, the Fehmarn Belt is less significant for migrating raptors. During this season, it is thought that many birds migrate over Schleswig-Holstein and the Danish islands, passing north of the Fehmarn Belt. However, a not insignificant number also follow the southern Baltic Sea coast and cross the western Baltic Sea from Darsser Ort and Rügen. The population shares of some species at Darsser Ort are considerable (Table 13). In the spring, Darsser Ort became a significant concentration area. The proportion of observed individuals relative to autumn migration in Falsterbo exceeded the 10% mark for almost all species (red kite: approx. 30%, osprey/common buzzard: approx. 20%). Raptor migration was also observed in Rügen during the spring. However, the proportions relative to autumn migration at Falsterbo rarely exceed 10%, and consequently are well below the figures calculated at Darsser Ort (BELLEBAUM et al., 2008).

Table 13: Comparison of raptor autumn migration in Falsterbo in 2002 and 2003 with spring migration in 2003 at Darsser Ort (M-V) and autumn migration in Falsterbo 2007 with spring migration in Rügen 2007 and 2008 (numbers of observed individuals; source: BELLEBAUM et al. 2008).

	Falsterbo autumn 2002	**Falsterbo autumn 2003**	**Darsser Ort spring 2003**	**Falsterbo autumn 2007**	**Rügen spring 2007**	**Rügen spring 2008**
European honey	3.232	3.076	574	2.745	0	30
Red kite	1.148	1.441	390	2.381	308	255
Western marsh	801	969	142	569	44	90
Sparrowhawk	13.478	24.648	1.446	27.193	1.258	1.462
Common	8.607	14.203	1.820	18.872	743	970
Rough-legged	374	153	442	1.165	95	372
Osprey	234	303	57	232	19	33
Common kestrel	385	943	41	725	0	0
Merlin	182	405	17	367	12	25
Eurasian hobby	47	61	24	39	6	12

Sighting observations revealed only a few migrating raptors over the Arkona Sea (IFAÖ, own obs.). It is possible that in spring, raptors migrate predominantly at altitudes higher than the visual range limit of 200 m. Thermal soaring raptors predominantly fly over other marine areas at higher altitudes, e.g. rarely below 400 m when crossing Gibraltar (MEYER et al. 2000). By contrast in the autumn, when there are frequent headwinds, the migration altitudes near the "flyway" are often lower (Falsterbo/Fehmarnbelt).

Land birds (flapping wing flyers)

Land birds (diurnal migrants)

Many species of land bird migrate during the day. In addition to the raptors already described, these include doves and songbirds (Table 14). Included most notably among the diurnal migratory songbird species are short-distance migrants (in particular finches and buntings; but also pipits, wagtails, tits and crows). Of the long-distance migrants, swallows are an exception, being solely diurnal migratory birds. Diurnal migratory land birds are among the most commonly occurring species of breeding bird in Scandinavia. For the western Baltic Sea, Swedish and, in part, also Finnish breeding birds are of particular relevance (see ring recoveries in LAUSTEN & LYNGS 2004).

Table 14: Visible percentage of the autumn migration volume of common Scandinavian diurnal migrants: migration rates at various locations and breeding numbers of Swedish populations and estimate of the percentage of diurnal bird migration that cannot be recorded visually (from BELLEBAUM et al. 2008).

	Common chaffinch and brambling	**Eurasian skylark**	**Meadow pipit**	**Barn swallow**	**Common house martin**
Mean migration rate [ind. per h]					
Falsterbo	1,002.0	4.7	16.5	25.3	12.9
Kriegers Flak	1.1	0.2	0.5	0.7	0.05
Adlergrund	3.8	0.5	1.9	1.6	0.2
Darsser Ort	22.3	4.0	4.1	5.4	0.6
Total number of visible birds					
Falsterbo (mean 1973-2001)[1]	760.758	1.571	8.324	23.279	5.283
Offshore[2]	664.160	136.320	292.800	618.240	29.280
Breeding population in Sweden/migration volume					
Breeding pairs[3]	12.500.000	750.000	750.000	225.000	150.000
Total individuals (autumn)[4]	50.000.000	3.000.000	3.000.000	900.000	600.000
Visible percentage (%)					
Falsterbo	1.52	0.05	0.28	2.59	0.88
Offshore (Møn to Bornholm)	1.29	4.54	9.76	68.69	4.88
Visible percentage, total (%)	2.81	4.60	10.04	71.28	5.76
Non-visible percentage (%) Migration over the Danish islands/ migration at high altitude/nocturnal migration/overwintering in Scandinavia	**97.19**	**95.40**	**89.96**	**28.72**	**94.24**

1 http://www.skov.se/fbo/index_e.html
2 Assumed: broadfront migration of Swedish breeding birds, migration rates at Kriegers Flak used as basis for sea area betw. Møn and Borholm (150 km), max. recording distance on ship
3 Number of breeding pairs acc. to HEATH et al. (2001)
4 Conservative estimate of reproduction rate (= 2 fledged juveniles per pair): Migration volume in autumn = (2 adults + 2 juveniles)*Number of breeding pairs

In the western Baltic Sea, the migration of diurnal migratory land birds follows two basic rules:

- Many diurnal migrants prefer to cross the Baltic Sea around the Danish islands. Some of them fly within visible range (below 50-100 m). Common wood pigeons migrate, for example, over inland Sweden in a broadfront migration pattern; however near to the southern tip of Sweden, around Falsterbo, significant migration concentrations arise. Common wood pigeons are observed in large numbers at Falsterbo and on Fehmarn (KOOP 2005).
- Diurnal migrants avoid crossing the Arkona Sea by day at low altitudes (below 100 m). They either migrate at very high altitudes (e.g. common chaffinch > 1,000 m, IfAÖ own observations) or partly also at night (e.g. Eurasian skylark, common starling, brambling).

In view of the methodological difficulties in recording diurnal migratory land birds over the sea (only possible with target-tracking radar), little is known about the migratory behaviour of these species. All that is known is that a few species cross the Baltic Sea in a broadfront formation (e.g. swallows, wagtails and pipits).

Land birds (nocturnal migrants)

Nocturnal migrants make up more than half of all migratory birds in the western Baltic Sea (long and short-distance migrants). Among the expressly nocturnal migrants are most notably the small insectivorous birds such as typical (sylviid) warblers, leaf warblers, Old World flycatchers, northern wheatears (*Oenanthe oenanthe*) and European robins (*Erithacus rubecula*), as well as thrushes (Table 15).

A number of bird species which migrate during the day (ducks, geese, swans, waders and gulls) can also be observed migrating at night. Often for these species, however, migration predominantly takes place during the day. Radar studies of eider duck migration off the coast of southern Sweden have shown, for example, that no more than 10-20% of the entire migration process takes place under cover of darkness (Alerstam et al., 1974).

Table 15: Population sizes (number of breeding pairs; status in 2000) for the most common nocturnal migratory songbirds in Sweden (T = partly diurnal migrants; acc. to BIRDLIFE INTERNATIONAL, 2004a)

Species	Number of breeding pairs	Species	Number of breeding pairs
Cuckoo	30,000 – 70,000	Lesser whitethroat	150,000 – 400,000
Winter wren	100,000 – 500,000	Common whitethroat	500,000 – 1.000,000
European robin	2.500,000 – 5.000,000	Garden warbler (T)	1.000,000 – 3.000,000
Thrush nightingale	20,000 – 50,000	Blackcap (T)	400,000 – 1.000,000
Common redstart	100,000 – 300,000	Wood warbler	200,000 – 250,000
Northern wheatear	100,000 – 500,000	Common chiffchaff	100,000 – 400,000
Whinchat	200,000 – 400,000	Willow warbler	10.000,000 – 16.000,000
Song thrush	1.500,000 – 3.000,000	Goldcrest	2.000,000 – 4.000,000
Redwing (T)	750,000 – 1.500,000	Spotted flycatcher (T)	500,000 – 1.200,000
Sedge warbler	50,000 – 200,000	Pied flycatcher	1.000,000 – 2.000,000
Marsh warbler	15,000 – 20,000	Red-backed shrike	26,000 – 34,000
Icterine warbler	40,000 – 100,000		

Most nocturnal bird migration over the Baltic Sea occurs on a broad front. The birds of individual sub-populations fly in their (mainly endogenously) defined migratory direction in parallel adjacent sectors, creating migration patterns which spread over a wide area (e.g. BERTHOLD 2000). Evidence of broadfront migration is provided, for example, by the comparisons of trapping figures from the Falsterbo and Ottenby ringing stations located approx. 240 km apart. Virtually identical numbers of goldcrests were trapped at each station every year for more than 20 years. Unusual events, such as when goldcrest migration failed almost completely in 2002, is also reflected at both trapping stations. This can only be explained by the fact that nocturnal migratory birds are migrating southwards on a broad front (GRENMYR 2003).

Studies into species composition during the autumn migration of 2005 on Rügen using vertical radar revealed that songbirds were the most numerous, making up around 90% of the total nocturnal migrant population; waders, by contrast, accounted for just 5%. Large songbirds, such as thrushes, were more numerous than small songbirds (see Figure 37). However, the proportion of small songbirds (e.g. European robin, leaf warblers) relative to large songbirds increased with altitude.

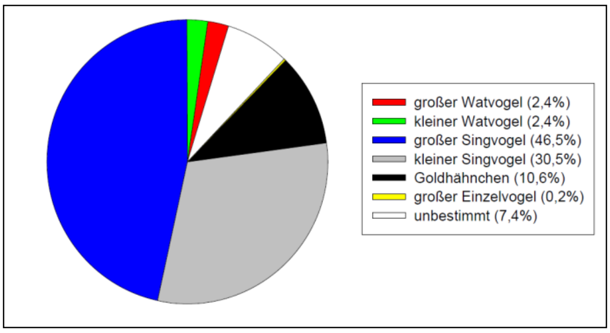

Figure 37: Species composition of nocturnal migration populations on Rügen in autumn 2005 (n=26,612 echoes; from BELLEBAUM et al. 2008).

Many species of nocturnal migrants have the same main migratory direction. In autumn it is approximately south-southwest and in spring north-northwest (see Figure 38). In the autumn of 2005, a study of the migratory directions of nocturnal migrants on Rügen using target-tracking radar (mean over 9 nights; n = 712 measurements) produced a median of 213°; the innate direction was aligned slightly further to the south (median: 207°). In addition, there are species whose wintering grounds lie in a southeasterly direction (e.g. barred warblers, marsh warblers, lesser whitethroats, red-backed shrikes, etc.). Even with nocturnal migrants whose main migratory direction is southwest, substantial movements in a southeasterly direction are observed regularly, particularly in combination with northwesterly winds. The active selection of a migratory direction depending on wind direction is also referred to as "pseudodrift".

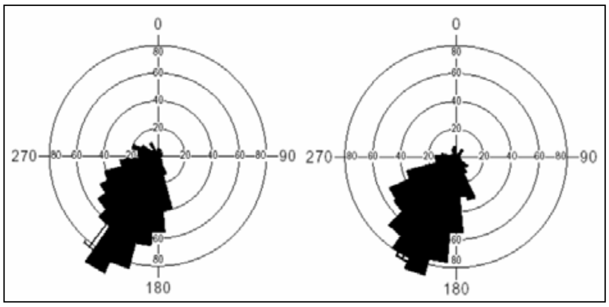

Figure 38: Frequency of migratory directions in nocturnal bird migration (left: direction of flight; right: innate direction/heading) based on measurements using the "Superfledermaus" target-tracking radar conducted on Rügen in autumn 2005 (from BELLEBAUM et al. 2008).

Land birds cross the Baltic Sea throughout the year. However, there are seasonal differences, with high migration intensities from March to May (vernal migration) and in September/October (autumnal migration). Within the main migration periods, migration intensity varies greatly from day to day. These variations are caused by differences in weather conditions, with wind conditions often playing a crucial role (see LIECHTI & BRUDERER 1998; ERNI et al. 2002). Where nocturnal migrating songbirds are concerned, there are fundamental differences in the seasonal migration phenologies of long and short/medium distance migrants. Short and medium-distance migrants (e.g. goldcrests, winter wren, thrushes, European robins) migrate to their breeding grounds earlier (often as early as March/April) and leave them later (between September and November), whilst the breeding season of long-distance migrants (e.g. typical warblers, reed warblers, Old World flycatchers, icterine warblers (hippolais icterina)) is much shorter, i.e. they often do not arrive until May/June and leave the breeding grounds as early as the end of July/beginning of August (e.g. KARLSSON 1992).

Between 2002 and 2006, the migration rates were calculated at various coastal locations and from ships on the Baltic Sea using vertical radar, the objective being to get an impression of the spatial distribution of night-time migration activities.

The highest nocturnal migration intensities were recorded at the land-based locations Darsser Ort and Fehmarn (approx. 1,000 echoes/(h*km) on average in the spring and approx. 500-600 in autumn). The rates recorded on Rügen were about half of these figures; this location did not experience the migration rates of Fehmarn and Darsser Ort on any night. Markedly low migration rates were measured at the offshore locations. Higher migration rates were recorded on a few nights, however (e.g. Kriegers Flak on the 7.10.2003: mean migration rate 1,802/max. hourly figure: 3,513 echoes/(h*km)). The maximum nocturnal migration rates peaked in the spring on Fehmarn, with 5,228 echoes per hour and km in one night (max. hourly figure: 15,278 echoes/(h*km)).

A comparison of the different locations and survey years shows pronounced fluctuations in the nocturnal migration rates at land-based locations where continuous measurements could be carried out (see Figure 39). However, it can be concluded from the data that higher migration rates also occur along the "flyway" at night and that these decrease towards the east. The low migration rates at sea are possibly related to the fact that records were incomplete and the measurement conditions could not be kept sufficiently consistent (BELLEBAUM et al. 2008).

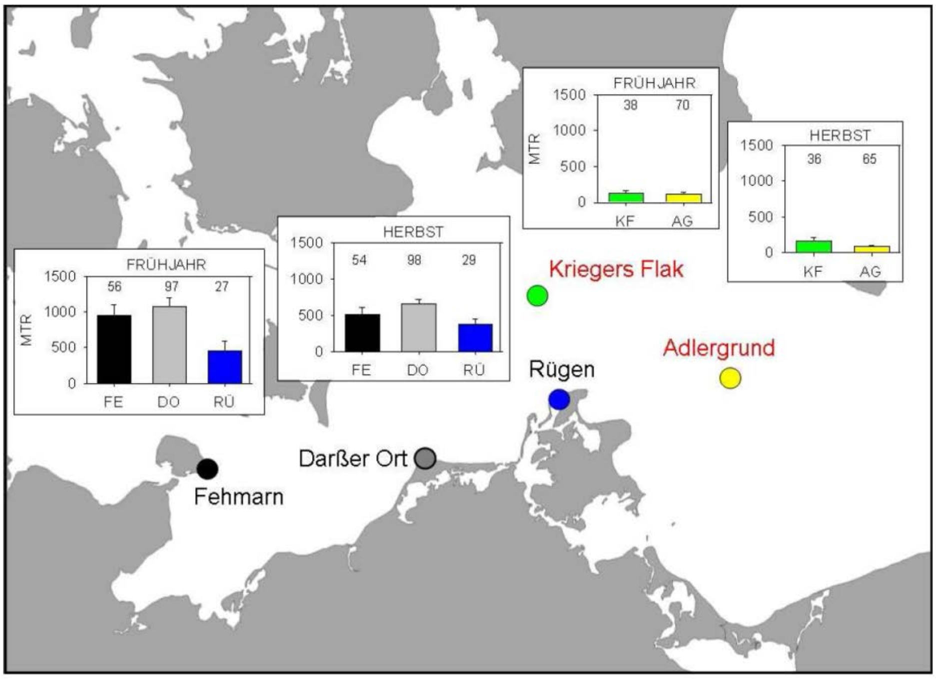

Figure 39: Mean migration rates (MTR = mean traffic rate = birds per kilometre and hour) at various measuring locations in the spring and autumn (from BELLEBAUM et al. 2008).

2.10.3 Status assessment of the factor Migratory birds

The following evaluation criteria were applied to the migratory birds:

- Leading lines and concentration areas: due to the lack of features, the definition of concentration areas and leading lines for bird migration in offshore areas should not be interpreted from a small-scale perspective, but rather an assessment of this criterion must take into account the large-scale progression of bird migration in the western Baltic Sea.
- Migration movements and their intensity.
- Number of species and threat status of the species in question.

According to current knowledge, several million birds migrate over the western Baltic Sea each year. Most notably, the nocturnal migration of land birds between Central Europe and Scandinavia occurs on a broad front. Due to the broadfront migration of these birds, there is no land-sea gradient. In the western Baltic Sea, land-sea gradients are confined to the immediate coastal areas where, due to the leading line effect of the shoreline, localised concentration of migration activity occurs, even at night (in southern Sweden in autumn, in Mecklenburg-Vorpommern in spring).

Concentration areas and leading lines are present for diurnal bird migration in the western Baltic Sea. Thermal soarers and other diurnal migratory land birds, such as common wood pigeon preferably migrate along the "flyway" (islands of Fehmarn, Falster, Møn and Seeland, Falsterbo). East of this main route, these birds migrate in much lower density (e.g. FRANSSON & PETTERSSON 2001).

Below is the status assessment broken down into the main groups of water birds, cranes and raptors and land birds. The species requiring special conservation measures in accordance with Annex I of the Wild Birds Directive and the bird species which are subject to special protection under Art. 4 (2) of the Wild Birds Directive are also reviewed individually.

Water birds

For sea ducks and geese which breed in Northern Europe and Russia (as far as Western Siberia), the western Baltic Sea is an important transit area to their overwintering areas in the North Sea and the Northern Kattegat. As sea ducks are predominantly diurnal migrants that preferably navigate using landmarks, a large proportion of the migration takes place near to the coast. Common scoters, for example, usually maintain visual contact with land-based features as they fly. Radar measurements carried out around Cape Arkona and Hiddensee as part of an R&D project (KNUST et al. 2003) established that migration predominantly occurred parallel to the coast. In addition, a broadfront migration occurs over open waters in the western Baltic Sea (RAUTENBERG 1956; KNUST et al. 2003). According to observations conducted by the IfAÖ, gulls and auks migrate over open sea without keeping to any particular routes.

Divers

Coming under the category of divers are the red-throated diver and black-throated diver, both of whom are subject to protection under Annex I of the Wild Birds Directive. The main migration route for most divers is along the German coast. Results from the EIS monitoring reports indicate that the EEZ has low significance for diver migration (more details can be found in chapter 2.10.3.3).

Sea ducks

Eider ducks, long-tailed ducks, common scoters and velvet scoters are among the commonly occurring species of migratory bird not listed in Annex I of the Wild Birds Directive for which special protection measures need to be taken pursuant to Art. 4 (2) of the Wild Birds Directive.

According to BIRDLIFE INTERNATIONAL (2004b), the populations of sea ducks (with the exception of the velvet scoter) are showing a predominantly positive trend. However, according to more recent estimates by WETLANDS INTERNATIONAL (2012), this only applies to the eider duck, the current biogeographical population of which was said to be 976,000 individuals. The biogeographical populations of the other three duck species have fallen by more than 50 percent in recent years. A figure of 1.6 million is given for the long-tailed duck, 550,000 for the common scoter and 450,000 for the velvet scoter (WETLANDS INTERNATIONAL 2012).

As primarily diurnal migrants, the four species of duck make constant use of topographical features as reference points and consequently migrate increasingly along the coastline. The investigations as part of an R&D project (KNUST et al. 2003) have revealed, however, that the ducks also migrate on a broad front over the Baltic Sea.

According to current knowledge, eider duck migration occurs predominantly on the coast of Sweden. The latest daytime observations conducted between autumn 2013 and autumn 2015 in area O-3 have revealed substantial fluctuations in eider duck sighting rates. The highest number of eider duck sightings (10,832 individuals) occurred in autumn 2013, the lowest (1,823 individuals) in spring 2015 (IFAÖ 2016a and b). In area O-1 in 2014, the total number of eider ducks sighted was 457 (BIOCONSULT 2016). This meant that in one migration period, up to 1.1% of the biogeographical population was sighted in a small area of the EEZ. Despite this high sighting rate, eider duck migration on the Swedish coast is around 40 times higher than in area O-3. On the basis of these results and the observations, that eider ducks make constant use of topographical features (coastline) as reference points, the German EEZ has only medium importance for eider duck migration.

By contrast common scoter migration occurs predominantly on the German coast. It was established that around 9% of the biogeographical population could be found at Darsser Ort in the spring (WENDELN & KUBE 2005), however with a not insignificant proportion being sighted at sea, 20 km north of Darsser Ort, it was concluded that considerable numbers of common scoters also migrate in the EEZ. In area O-1, around 0.33% of the biogeographical population were sighted in 2014 (BIOCONSULT 2016) and in area O-3 around 0.5% (2014) and 0.12% (2015) (IfAÖ 2016a and b). Hardly any migration of velvet scoter is observed in the German Baltic Sea (GARTHE et al. 2003, WENDELN & KUBE 2005). This is also confirmed by the latest observations in the two priority areas. In the priority area "Kriegers Flak" only 105 velvet scoters and in the priority area "Western Adlergrund" 217 velvet scoters were sighted. The same applies to the long-tailed duck in area O-3. Although 6,728 long-tailed ducks (0.4% of the biogeographic population) were sighted in the O-1 area in 2014, the EEZ is only slightly significant for the migration of the two species of duck.

Overall, the German EEZ of the Baltic Sea has average to above-average significance for migrating water birds. This is derived from the fact that there are two main routes along the Swedish and German coasts in the western Baltic for the diurnal migratory water birds and the German EEZ can at the very least be said to lie on the border of the coastal focus of the migration along the Mecklenburg coast (KNUST et al. 2003). Moreover, there are concentration areas in the north-south direction over the known migration routes of the open Baltic Sea (e.g. "flyway", southern Sweden - Rügen). In addition, the western Baltic Sea is crossed, sometimes in high intensities, by several species that require special protection (e.g. barnacle goose, whooper swan, eider duck, common and velvet scoter).

Barnacle goose (Branta leucopsis)

The Russian-Baltic breeding population of the barnacle goose is decisive for the western Baltic Sea because this breeding population crosses the Baltic Sea on the way to its main wintering grounds (the German and Dutch coasts amongst others). The biogeographic population of the barnacle goose is estimated at 770,000 (WETLANDS INTERNATIONAL 2012). Over recent decades, the population has experienced a very strong increase in the number of birds. According to the literature, the main migration is along the Swedish coast in the western Baltic Sea. However, in the spring, migration is increasingly over the open sea (GREEN & ALERSTAM 2000).

The EEZ is primarily overflown in the area Kiel Bight/Fehmarn Belt. However, in the O-3 area (priority area "Kriegers Flak"), 8,190 migrating barnacle geese were identified in 2014 and 2,622 in 2015 within the framework of monitoring of the OWP project "EnBW Baltic 2" (IfAÖ, 2016a and b). These represent about 1.06% and 0.34% of the biogeographic population. Consequently, the area around Kriegers Flak is highly important for the barnacle goose migration. On the other hand, the area O-1 ("Western Adlergrund" area) is of only minor significance because only up to 42 migrating barnacle geese (BioConsult, 2016), that is about 0.01% of the biogeographic population, were detected. In the area O-2, a total of 3,340 barnacle geese were recorded in the period from 2008 to 2012 as part of the bird migration observations for the "Baltic Eagle" offshore wind farm (OECOS 2015). On average, this corresponds to an annual sighting rate of about 850 individuals (= 0.11% of the biogeographic population). Overall, based on the current state of knowledge, the EEZ is of average to high significance for the migration of barnacle geese. The average significance can be justified in that the main focus of the migration generally lies outside the EEZ. A high significance exists in sections, as for example in the Krigers Flak area, where the barnacle geese pass through with a significant intensity (> 1% of the biogeographic population).

Whooper swan (Cygnus cygnus)

According to BAUER & BERTHOLD (1997) whooper swan numbers have been steadily increasing in all European countries with a breeding population for a number of decades. The biogeographic population whose migration route crosses the Baltic Sea is estimated at 59,000 birds (WETLANDS INTERNATIONAL 2012). In the priority area "Western Adlergrund" (area O-1) approximately 0.3% of the biogeographic population was recorded in one year and in the priority area "Kriegers Flak" (area O-3) approximately 0.03% of the biogeographic population was recorded. In area O-2, the sighting rate is about 0.01%. Therefore, the three areas are of only limited significance where the migration of whooper swans is concerned. Overall, the significance of the EEZ for whooper swan migration can at most be estimated as average, because it cannot be ruled out that the whooper swans, which are primarily diurnal migrants, may possibly use the known migratory routes ("flyway") with increased intensity.

Cranes

As a bird species of Appendix I of the Wild Birds Directive, the crane has special protection status. While the European population recorded a significant drop between 1970 and 1990, it has now been recording significantly increasing numbers for many years (Birdlife International, 2004; Prange, 2005). According to WETLANDS INTERNATIONAL (2012) the biogeographic population is 90,000 birds. The cranes from the various North European breeding grounds use different migration routes to their wintering grounds. The Scandinavian birds migrating across the Baltic Sea are of particular interest for the western Baltic Sea.

If the western Baltic Sea and with it the entire German EEZ is considered, it is of above-average importance for the crane migration because inevitably the majority of the biogeographic population flying south must cross the Baltic Sea. However, because the crane is a narrow-front migrant, the migration route crosses the EEZ bundled into individual concentration areas. It is assumed that some 50,000 to 60,000 cranes migrate from southern Sweden over the Arkona Basin. Thus, about 55% alone of the biogeographic population uses this migration route. Nevertheless, it can also occur that as a result of increased winds, more of the crane migration is observed in adjoining areas.

Thus, in autumn 2014 and autumn 2015, very high numbers of 5,028 and 3,517 cranes each were recorded in the area O-3 ("Kriegers Flak") (IFAÖ 2016a and b). Thus, approximately 5.6% and 3.9% respectively of the biogeographic population flew over area O-3. Presumably the cause for this was stronger east winds, so that the cranes drifted into the "EnBW Baltic 2" OWP project area. This is supported by the circumstance that in autumn 2015 cranes were only detected at "EnBW Baltic 2" when north-easterly or easterly winds of force 2 - 5 on the Beaufort scale were detected. In area O-2, the annual sighting rates were between 500 and 700 individuals, with 550 cranes sighted on two days alone in autumn 2008 when there were westerly breezes of force 4 to 5 on the Beaufort scale (OECOS 2015). In the priority area "Western Adlergrund" (area O-1) a total of 546 migrating cranes were recorded in the 2014 autumn migration (BIOCONSULT SH, 2016), which corresponds to about 1.4% of the Western Pomeranian resting population (resting numbers: over 40,000 individuals simultaneously) or 0.6% of the biogeographic population. Here as well, most of these birds probably drifted here from a flight route South Sweden-Rügen to the southeast by north-westerly winds. Moreover, cranes from Finnish (and Baltic) populations are also highly likely to crop up in the Adlergrund area. Thus, for example, on Christiansö and Bornholm on 12/10/2003 migratory movements of 5,490 and 6,300 cranes respectively (flight direction W to SW) were recorded, so that it is possible to conclude that at times large numbers of cranes may also occur in the Adlergrund area.

Based on this migration behaviour, a differentiated consideration is required. Thus, the known main migration routes are without doubt of above-average importance. The adjoining areas of these main migratory routes are of average to above-average importance, presumably dependent on the wind-strength and direction. Away from these areas, the importance is probably low. Based on the determined flying altitudes and flight directions, it is to be assumed that some of the cranes migrating over the Baltic Sea will encounter the planned wind farms. Since cranes generally migrate in favourable weather conditions with a tailwind and good visibility, it can be assumed that they will take evasive action as with land sites. However, there are still no corresponding open sea investigations. Lastly, it is necessary to carry out investigations of the crane migration for individual projects at the project level in order to carry out an assessment of the migration route under consideration.

Raptors

Diurnally migrating raptors of the Swedish populations primarily use the "flyway" originating from Falsterbro and crossing over Fehmarn. However, a part of the population also crosses the Baltic Sea in autumn in the North-South direction. In total, up to 50,000 Scandinavian raptors migrate south via Falsterbo. This includes some Appendix I species (Wild Birds Directive), which migrate across the Baltic Sea is significant numbers. Under consideration here are the European honey buzzard (*Pernis apivorus*), red kite (*Milvus milvus*), western marsh harrier (*Circus aeruginosus*), osprey

(*Pandion haliaetus*) and merlin (*Falco columbarius*).

Overall, the German EEZ of the Baltic Sea is of above-average importance for raptors, especially the Scandinavian populations. However, due to their migratory behaviour, they also exhibit significant local differences, so that a differentiated view is required. Thus, the known main migration routes are without doubt of above-average importance. The adjoining areas of these main migratory routes are of average to above-average importance, presumably dependent on the wind-strength and direction. Away from these areas, the importance is probably low. Lastly, it is necessary to carry out investigations of the raptor migration for individual projects at the project level to enable an assessment of the area under consideration.

Land birds
Where land birds are concerned, a differentiation must be made between diurnal and nocturnal migrants.

Diurnal migrants

The diurnal migrants include most of all pigeons, doves and songbirds. Here, leading lines play an important role. Thus, when crossing the Baltic Sea, they primarily use the Danish islands. A further migration grouping takes place over the "flyway". Therefore these areas have above-average importance. Outside these main migration routes, the migration intensities of diurnal migrants in high-sea areas are comparatively low and therefore are of only low to average importance.

However, it should be borne in mind here that hardly anything is known about migration over the open sea areas of the Baltic. As is known, only a few species (e.g. swallows, wagtails, pipits) fly across the Baltic Sea over a wide front.

Nocturnal migrants

Nocturnal migrants represent more than half of all migratory birds in the western Baltic Sea. Most nocturnal bird migration over the Baltic Sea occurs on a broad front. Due to the very high expected number of birds and the significant proportion of endangered species, the EEZ is of above-average importance for the nocturnal migrants.

2.10.3.1 Anthropogenic influences on bird migration

Migratory birds are subject to a large number of anthropogenic stresses. Anthropogenic factors contribute to the mortality of migratory birds in many ways and can impact on population size and determine relevant migration activity in a complex interaction. On the one hand, this relates to losses of breeding, resting and wintering grounds due to a wide range of human activities as well as long term climate changes. In addition, a large number of birds are killed annually by human influences. In Scandinavia and the Baltic Sea region more than 100 million birds die every year due to deliberate hunting, collisions with anthropogenically created structures, fishing, or oil and chemical pollution. The various factors have a cumulative effect so that the isolated significance of one particular factor is generally difficult to determine.

Analyses of recovered rings of birds ringed in Helgoland show that over the course of the last century anthropogenic causes of death have increased in all species groups, especially building and vehicle bird strikes ("passive cause of death", 14% of all birds found dead in the last two decades, 49% amongst raptors and owls; HÜPPOP & HÜPPOP 2002).

Numerous Scandinavian migratory bird species are listed in Appendix II/1 or II/2 of the Wild Birds Directive and are subject to hunting in at least a part of their annual habitat. Nearly all migrating Anatidae (ducks, swans, geese) are affected by hunting in the Baltic Sea region. Between 1996 and 2001, 122,500 eider ducks were shot each year in Scandinavia, 92,820 of them in Denmark alone (ASFERG 2002). This equates to 16% of the winter population of 760,000 individuals (DESHOLM et al. 2002), to which shootings in the successor states of the Soviet Union must be added, but for which no data is available. Especially in the western Mediterranean, a significant wintering ground for Scandinavian medium distance migratory birds, there is still a statistically inadequately recorded proportion of the hunting (HÜPPOP & HÜPPOP 2002).

In the Western Baltic Sea itself, apart from hunting, there are currently only a few stress-factors impacting Scandinavian migratory birds. Generally these include a risk of collision with ships, bridges, offshore wind turbines and lighthouses for nocturnal migrants.

The results of investigations on lightships and platforms suggest that the risk of collision of nocturnally migrating land birds with offshore wind turbines can be considered to be high. The risk of collision with lighthouses in the Western Baltic Sea has been investigated several times (e.g. HANSEN 1954, BANZHAF 1936). HANSEN (1954) analysed the bird strikes reported at 50 lighthouses in Denmark over a period of 54 years (1887-1939), a total of 96,500 birds. Approximately 50% of all reported bird strike dead birds originated from the 12 Danish lightships, where it should be noted that presumably only a fraction of the collision victims fell on board and a much greater fraction fell in the sea. Obviously therefore, the collision risk for birds over the sea was generally greater than on land. Considering lightships alone, the annual collision rate was at least 100-200 birds. The risk of collision varies widely between species. According to the investigations of HANSEN (1954), five species accounted for approximately 75% of all victims, namely skylark, song thrush, redwing, starling and robin. The bird strike dead birds were almost all night migrants. Only in exceptional cases were diurnal migrants accident victims and in the case of soaring birds effectively never (three birds).

Similar findings are available for the "FINO1" research platform (HÜPPOP et al. 2009) and the "North Sea Research Platform" (MÜLLER 1981). The species in question are characterised by night migration and relatively large populations. It is noticeable that almost 50% of the collisions recorded at "FINO1" took place over just two nights. On both nights, there were southeasterly winds which could have promoted migration over the sea, along with poor visibility, which could have led to a reduction in flight altitude and increased the attraction of the illuminated platform (HÜPPOP et al. 2009). Illuminated bridges over large expanses of water can also represent a danger for nocturnal migrants. Following the completion of the Øresund Bridge in Autumn 2000, the highly illuminated bridge with limited visibility caused mass collisions, resulting in several thousand victims in just a few days. Investigations initiated in the following year as a consequence of this event resulted, with significantly reduced lighting, in 295 dead birds, with robins, song thrushes and goldcrests dominating (BENGTSSON mdl. Mitt.). The investigations also illustrate the danger for songbirds migrating at night over the sea.

Quantitative information on the risk of collision of birds with offshore wind turbines is not currently available (DESHOLM et al. 2005). In the offshore wind farms "Tunø Knob" (Denmark, GUILLEMETTE et al. 1999), "Utgrunden" (Sweden, PETTERSSON 2005) and "Nysted" (Denmark, DESHOLM & KAHLERT 2005), investigations have so far only looked at the risk of collision for eider ducks and geese. The infrared-camera based investigations in the "Nysted" OWP (DESHOLM 2005) do not permit any conclusions to be drawn about the collision risk of small birds due to the method used.

2.10.3.2 Climatic changes

Global warming and climate changes also have measurable effects on bird migration. For example, changes in phenology or changes in migration arrival and departure times, which are species-specific and regionally different (see BAIRLEIN & HÜPPOP 2004; CRICK, 2004, BAIRLEIN & WINKEL 2001).

Also, clear relationships between large-scale climate cycles such as the North Atlantic Oscillation (NAO) and the vernal migration condition of captured songbirds, for example, could be demonstrated (HÜPPOP & HÜPPOP 2003). Climate change can also affect the conditions in breeding, resting and wintering areas and what these partial habitats have to offer.

2.10.3.3 Importance of areas and sites for migratory birds

The evaluation criteria listed in Chapter 2.11.3 are used for the assessment of the importance of areas and sites for migratory birds, taking into account the main groups water birds, cranes, raptors and land birds. The species requiring special conservation measures in accordance with Annex I of the Wild Birds Directive and the bird species which are subject to special protection under Art. 4 (2) of the Wild Birds Directive are also reviewed individually.

Area O-1

Water birds

Overall, area O-1 is of average importance for migrating water birds. This follows from the fact that the area is overflown by several species that are subject to special protection (e.g. barnacle goose, whooper swan, eider duck, common and velvet scoter), but lies outside the main route along the German coast. However, the results of the environmental monitoring in the area O-1 "Western Adlergrund" indicate that the migration of protected waterbird species is of minor importance (BIOCONSULT SH 2016, 2017). Thus, considering Gaviiformes (divers), only 26 birds were sighted in 2014 and only 105 in 2015. The number of eider duck sightings in 2014 totalled 457 while in 2015 it was 2786. Thus, in 2015 about 0.3% of the biogeographic population was sighted in area O-1. Also the sighting rates of the common scoter, velvet scoter and long-tailed duck were below 0.5% of the respective biogeographic population in both years (2014 and 2015) (common scoter 0.33%, velvet scoter 0.05% and long-tailed duck 0.4%). The sighting of 42 migratory barnacle geese (BIOCONSULT 2016) corresponds to approximately 0.01% of the biogeographic population. Where the whooper swan is concerned, it can also be stated that the area is not of great importance for migration because only about 0.3% of the biogeographic population was recorded in one year.

Cranes

In area O-1 the 2014 autumn migration totalled 546 and the 2015 autumn migration 110 recorded migrating cranes (BIOCONSULT SH 2016, 2017). The 546 cranes correspond to about 1.4% of the Western Pomeranian resting population (resting numbers: over 40,000 birds at one time) or 0.6% of the biogeographic population. Most of these birds probably drifted here from a flight route South Sweden-Rügen to the southeast by north-westerly winds. Moreover, cranes from Finnish (and Baltic) populations are also highly likely to crop up in the Adlergrund area. Thus, for example, on Christiansö and Bornholm on 12/10/2003 migratory movements of 5,490 and 6,300 cranes respectively (flight direction W to SW) were recorded, so that it is possible to conclude that at times large numbers of cranes may also occur in the Adlergrund area.

Based on this migration behaviour, a differentiated consideration is required. Thus, the known main migration routes are without doubt of above-average importance. The adjoining areas of these main migratory routes are of average to above-average importance, presumably dependent on the wind-strength and direction. This also applies to the sites of area O-1.

Raptors

Based on the latest investigation results, the area O-1 is only of low importance for raptor migration, because only very low numbers of individual birds were recorded. Thus, of the Appendix I species (Wild Birds Directive) 2 honey buzzards were sighted, 4 western marsh harriers and 1 merlin.

Land birds

Where land birds are concerned, a differentiation must be made between diurnal and nocturnal migrants.

Diurnal migrants

The diurnal migrants include most of all pigeons, doves and songbirds. Here, leading lines play an important role. Thus, when crossing the Baltic Sea, they primarily use the Danish islands. A further migration grouping takes place over the "flyway". Therefore these areas have above-average importance. Outside these main migration routes, the migration intensities of diurnal migrants in high-sea areas are comparatively low and therefore are of only low to average importance.

Nocturnal migrants

Nocturnal migrants represent more than half of all migratory birds in the western Baltic Sea. Most nocturnal bird migration over the Baltic Sea occurs on a broad front. Due to the very high expected number of birds and the significant proportion of endangered species, the sites of area O-1 are of average to above-average importance for the nocturnal migrants.

Area O-2

Water birds

Overall, area O-2 is of average to above-average importance for migrating water birds. This follows from the fact that the area is overflown by several species that are subject to special protection (e.g. barnacle goose, whooper swan, eider duck, common and velvet scoter), but lies outside the main route along the German coast. However, the results from the baseline survey for the planned offshore wind farm "Baltic Eagle" indicate that the migration of some protected waterbird species is of minor importance (OECOS 2012a). Thus, considering Gaviiformes (divers), only 347 birds were sighted in 2011. The number of eider duck sightings in 2011 totalled 140. Thus, in 2011 about 0.01% of the biogeographic population was recorded in the area O-2. Similarly, the sighting rates for velvet scoters and long-tailed ducks in 2011 were, at 0.04% and 0.06% of the biogeographic populations respectively, very low. In contrast, large numbers of the common scoter were identified. Thus in 2011, 8174 birds were counted. Therefore, approximately 1.5% of the biogeographic population migrated through area O-2. Consequently, the area is of above-average importance for migration of the common scoter. The sighting of 2619 migrating barnacle geese (OECOS 2012a) corresponds to a fraction of 0.34% of the biogeographic population and thus the area is of average importance. Where the whooper swan is concerned, it can be stated that the area is not of great importance for migration because only about 30 birds were recorded in one year.

Cranes

In area O-2 the 2008 autumn migration totalled 1231 recorded migrating cranes (BIOCONSULT SH 2012a). The 1231 cranes correspond to about 3.1% of the Western Pomeranian resting population (resting numbers: over 40,000 birds at one time) or 1.37% of the biogeographic population. Most of these birds probably drifted here from a flight route South Sweden-Rügen to the southeast by north-westerly winds. Moreover, cranes from Finnish (and Baltic) populations are also highly likely to crop up in the Adlergrund area. Thus, for example, on Christiansö and Bornholm on 12/10/2003 migratory movements of 5,490 and 6,300 cranes respectively (flight direction W to SW) were recorded, so that it is possible to conclude that at times large numbers of cranes may also occur in the O-2 area.

Based on this migration behaviour, a differentiated consideration is required. Thus, the known main migration routes are without doubt of above-average importance. The adjoining areas of these main migratory routes are of average to above-average importance, presumably dependent on the wind-strength and direction. This also applies to the sites of area O-2.

Raptors

Based on the latest investigation results, the area O-2 is only of low importance for raptor migration, because only very low numbers of individual birds were recorded. Thus, of the Appendix I species (Wild Birds Directive) 1 honey buzzard was sighted, 4 western marsh harriers, 2 ospreys and 4 merlins (OECOS 2012a).

Land birds

Where land birds are concerned, a differentiation must be made between diurnal and nocturnal migrants.

Diurnal migrants

The diurnal migrants include most of all pigeons, doves and songbirds. Here, leading lines play an important role. Thus, when crossing the Baltic Sea, they primarily use the Danish islands. A further migration grouping takes place over the "flyway". Therefore these areas have above-average importance. Outside these main migration routes, the migration intensities of diurnal migrants in high-sea areas are comparatively low and therefore are of only low to average importance.

Nocturnal migrants

Nocturnal migrants represent more than half of all migratory birds in the western Baltic Sea. Most nocturnal bird migration over the Baltic Sea occurs on a broad front. Due to the very high expected number of birds and the significant proportion of endangered species, the sites of area O-2 are of average to above-average importance for the nocturnal migrants.

Area O-3

Water birds

Overall, the area O-3 is of average to above-average importance for migrating water birds. This follows from the fact that the area is overflown by several species that are subject to special protection (e.g. barnacle goose, whooper swan, eider duck, common and velvet scoter), but lies outside the main route along the German coast. However, the results from the construction monitoring for the offshore wind farm "Baltic Eagle 2" indicate that the migration of some protected waterbird species is of minor importance (IFAÖ 2016b). Thus, considering Gaviiformes (divers), only 91 birds were sighted in 2014 and just 18 in 2015. Where the common scoter is concerned, in area O-3 approximately 0.5% (2014) or 0.12% (2015) (IFAÖ 2016b) of the biogeographic population were sighted. The sighting rate for velvet scoters was 105 birds and this was the same for long-tailed ducks. The daytime observations conducted between autumn 2013 and autumn 2015 in area O-3 have revealed substantial fluctuations in eider duck sighting rates. The highest number of eider duck sightings (10,832 individuals) occurred in autumn 2013, the lowest (1,823 individuals) in spring 2015 (IFAÖ 2016b). Thus in one migration period, a maximum of 1.1% of the biogeographic population was sighted in a small area of the EEZ and thus the area O-3 has an above-average importance for eider duck migration. The area O-3 is of comparable importance for barnacle goose migration. Thus within the framework of the monitoring for the OWP project "EnBW Baltic 2", in 2014 8,190 and in 2015 2,622 migrating barnacle geese were identified (IfAÖ 2016a and b). These represent about 1.06% and 0.34% of the biogeographic population. Where the whooper swan is concerned, it can be stated that the area is not of great importance for migration because only about 0.03% of the biogeographic population was recorded in one year.

Cranes

In the area O-3, in autumn 2014 and autumn 2015, very high numbers of 5,028 and 3,517 cranes respectively were recorded (IfAÖ 2016a and b). Thus, approximately 5.6% and 3.9% respectively of the biogeographic population flew over area O-3. Presumably the cause for this was stronger east winds, so that the cranes drifted into the "EnBW Baltic 2" OWP project area. This is supported by the circumstance that in autumn 2015 cranes were only detected at "EnBW Baltic 2" when north-easterly or easterly winds of force 2 - 5 on the Beaufort scale were detected. Based on the migration behaviour, a differentiated consideration is required. Thus, the known main migration routes are without doubt of above-average importance. The adjoining areas of these main migratory routes are of average to above-average importance, presumably dependent on the wind-strength and direction. This also applies to the sites of area O-3.

Raptors

Based on the latest investigation results, the area O-3 is only of low importance for raptor migration, because only very low numbers of individual birds were recorded.

Land birds

Where land birds are concerned, a differentiation must be made between diurnal and nocturnal migrants.

Diurnal migrants

The diurnal migrants include most of all pigeons, doves and songbirds. Here, leading lines play an important role. Thus, when crossing the Baltic Sea, they primarily use the Danish islands. A further migration grouping takes place over the "flyway". Therefore these areas have above-average importance. Outside these main migration routes, the migration intensities of diurnal migrants in high-sea areas are comparatively low and therefore are of only low to average importance.

Nocturnal migrants

Nocturnal migrants represent more than half of all migratory birds in the western Baltic Sea. Most nocturnal bird migration over the Baltic Sea occurs on a broad front. Due to the very high expected number of birds and the significant proportion of endangered species, the sites of area O-3 are of average to above-average importance for the nocturnal migrants.

2.11 Bats and bat migration

Bats are characterised by very high levels of mobility. While bats can cover up to 60 km a day in search of food, nesting or summer resting places and wintering areas are several hundred kilometres apart. Migratory movements of bats in search of abundant food sources and suitable resting places are very frequently observed on land, but mainly aperiodically.

In contrast to irregular migratory movements migratory movements take place periodically or seasonally. The migratory behaviour of bats is very variable, depending on species and sex. Differences in the migration and territorial behaviour also occur within a population of a species. Based on their migratory behaviour, bats are divided into short-distance, medium-distance and long-distance migratory species.

Bats migrate over short and medium distances on their search for places to nest, feed and rest. Corridors along flowing waters and around lakes and shallow coastal waters are known for medium distances (BACH & MEYER-CORDS 2005). Long-distance migrations are still largely unexplored, however. In contrast to bird migration, which has been proven by means of extensive studies, very little is known of the migration of bats at present due to the lack of suitable methods or large-scale special monitoring programmes.

The long-distance migratory species include the common noctule (*Nyctalus noctula*), the Nathusius' pipistrelle (*Pipistrellus nathusii*), the parti-coloured bat (*Verspertilio murinus*) and the lesser noctule Abendsegler (*Nyctalus leisleri*). Migrations over a distance of 1,500 to 2,000 km are recorded regularly for these four species (TRESS et al. 2004, HUTTERER et al. 2005). Long-distance migratory movements are also suspected in the soprano pipistrelle (*Pipistrellus pygmaeus*) and common pipistrelle (*Pipistrellus pipistrellus*) species (BACH & MEYER-CORDS 2005). Some long-distance migratory species can be found in Germany and in countries bordering the Baltic Sea and have occasionally been found on ships in coastal regions in the Baltic Sea.

Common noctule (*Nyctalus noctula*): in coastal regions of southern Sweden, bats have been observed to fly from the land towards the sea during the normal bird migration season. Winter finds of animals ringed in Sweden were also recorded in Germany (AHLEN 1997, AHLEN et al. 2009).

Nathusius's pipistrelle (*Pipistrellus nathusii):* migrating bats are frequently observed in spring and autumn. There is increasing evidence that Nathusius's pipistrelle also hibernates in northern Germany. In coastal regions of southern Sweden, as with the great noctule, bats have been observed flying in the direction of the sea. Also there have been winter finds in Germany of Nathusius's pipistrelle bats ringed in Sweden (AHLEN 1997, AHLEN et al. 2009).

The common pipistrelle (*Pipistrellus pipistrellus*) is, according to BOYE et al. (1999), the most frequently spotted bat species in Germany. It occurs all year round and is very widespread. There is some evidence that these species also undertake long-distance migration, possibly crossing the sea.

The northern bat (*Eptesicus nilssoni*) is a Nordic species with its main range north of 60°N and its southernmost range limit in Germany. Collections of northern bats have been observed in the coastal regions of southern Sweden (AHLEN 1997). The existing observations indicate that the northern bat possibly undertakes long-distance migrations across the sea.

2.11.1 Data availability

Migratory movements of bats across the Baltic Sea are documented based on ringing finds. Nevertheless, the migration directions, migration times and, in particular, possible migration corridors of bats over the Baltic Sea remain largely unknown even today. The data set is therefore insufficient to provide a detailed description of the occurrence and intensity of bat migrations in the offshore area and areas and sites included in the Site Development Plan for wind energy. Therefore in the following, reference is made to the general literature and publications about bats and bat migration across the Baltic Sea in order to reproduce the current state of knowledge.

2.11.2 Migration and migratory movements of bats over the Baltic Sea

Until now there has been little research into the migratory movements of bats across the Baltic Sea. This is mainly due to the lack of suitable measurement methods that would be capable of providing reliable data on bat migration in the sea area. Visual observations, such as from the coast or ships, while they do indeed provide information, are scarcely suitable for fully recording the migratory behaviour of nocturnal and night-migrating bats over the sea. Due to the altitude of the flight movements (e.g. 1,200 m for the great noctule) visual observations for determining the migratory behaviour are only slightly suitable or severely limited. WALTER et al.

(2005) summarised all existing sightings of bats from ships and also from platforms.

A series of observations suggest that bats regularly cross the Baltic Sea during seasonal migrations. The few systematic scientific studies on bat migrations over the Baltic Sea were carried out in Scandinavia. Based on observations of bat concentrations at various coastal towns in southern Sweden (e.g. Falsterbo, Ottenby) by AHLEN (1997) and AHLEN et al. (2009) at least four of the 18 bat species present in Sweden migrate southwards. Observations of individual bats which have left the land flying towards the sea are available for the Nathusius's pipistrelle, common noctule and parti-coloured bat. However, winter finds in Germany for bats ringed in Sweden only exist for the Nathusius's pipistrelle and the common noctule.

Further findings based on ringing finds are provided by studies on the migratory behaviour of the Nathusius's pipistrelle bat from Latvia (PETERSONS 2004). It was found that the bats stopping over in Latvia during the summer months search for wintering roosts in western, central and southern Europe. The ringed bats were recorded at a distance away of up to 1,905 km. The average distance away of all finds was 1,365.5 km for males and 1,216.5 for females. Here, the calculated average migration speed of the Nathusius's pipistrelle was 47.8 km per night. Amongst other locations, ringed bats were found in resting habitats in north and north-east Germany. Ring finds were also reported from the Netherlands and France, with probable migration routes over Germany. Little is known of the flight and migration altitudes of bats. When searching for food (insects) the common noctule mainly flies at 500 m altitude. Based on observations from Falsterbo, the common noctule flies at altitudes up to 1,200 m (AHLEN 1997). The common noctule is also known as a diurnally migrating species (EKÖLF 2003). It is assumed that migratory movements in daylight take place preferentially at altitudes of more than 500 m, in order to avoid hunting by raptors.

However, ringing finds serve only as evidence of stopping points of the marked bats, not, however, the intervening migration routes. Thus far, no suitable methods exist for the precise determination of flyways of individual bats over long distances (HOLLAND & WIKELSKI 2009). Therefore, conclusions about the number of regularly migrating bats are also not possible.

Detection by ultrasonic detectors, so-called bat detectors, delivers good results on the occurrence of bats on land (SKIBA 2003). However, their use offshore is associated with difficulties. Nevertheless, given the low acquisition range of the system, recordings do indeed provide evidence of the presence of bats offshore. These methods are, however, impeded by the presence of high winds, as are frequently present at sea, because they contribute to background noise which makes reliable measurement of bat signals difficult. There is a need for further research in this area.

A good summary of the current state of knowledge is provided by the expert report "Fledermauszug im Bereich der deutschen Ostseeküste (Bat Migration in the Area of the German Baltic Coast - in German)" (SEEBENS et al. 2013). It summarises and discusses the results of various bat surveys performed off the coast of Mecklenburg-Western Pomerania. The surveys included amongst others surveys on the Greifswalder Oie, with recordings made from the platform "Riff Rosenort" and from a ferry. A total of 23 Nathusius's pipistrelle bats and 7 noctules were recorded using real-time/time-stretch detectors on the work platform "Riff Rosenort", about 2 km off the coast, from the middle of May to the middle of June 2012. The evidence suggests cross-migration activities. However, due to the proximity of the site to the coast, hunting flights of both species over the Baltic Sea cannot be excluded (SEEBENS et al. 2013).

In 2011 and 2012 studies on the occurrence of bats were carried out on the island of Greifswalder Oie, which is located about 12 km north of Usedom and 10 km east of Rügen, using automatic detectors, net traps and by checking buildings suitable as roosts. Nine bat species could be identified in the surveys, partially in notable numbers, including common noctule, lesser noctule, common pipistrelle, and Nathusius's pipistrelle. High activity was identified especially in May, and this on just a few days. The evaluation of the automatically recorded bat calls reveals for 2012 a total of 4,788 contacts of the Nathusius's pipistrelle (2011: 3,644 contacts), 2,178 for the common pipistrelle (2011: 1,750 contacts) and 817 contacts for the common noctule (2011: 1,056 contacts). On 6/5/2011 at wind strengths of force 2-3 on the Beaufort scale, 48 Nathusius's pipistrelle and one common noctule were recorded by netting (SEEBENS et al. 2013). The authors conclude from the high activity of the species Nathusius's pipistrelle and common noctule during a few days in the spring that there is clear evidence of migrations in the area of the Greifswald Oie.

Findings relating to the occurrence of offshore bats were obtained using a bioacoustic detection system installed on a ferry. The ferry travels between Rostock and Trelleborg in Sweden. In May 2012, 11 echo-locating calls from bats were recorded offshore during recording in 180 out of a total of 540 migration-relevant night-time hours. Of these, seven contacts were within 20 km distance of the coast of Mecklenburg-Western Pomerania, two more within 20 km distance of the Swedish or Danish coast and two contacts at a distance of more than 20 km from the nearest coast. The recorded calls could be assigned to the common noctule and the Nathusius's pipistrelle bat (SEEBENS et al. 2013).

Despite this evidence, there is currently a lack of concrete findings that would permit quantification of bat migration over the Baltic Sea. This applies accordingly to the types of migrating species, migration corridors, migration altitude, migration direction and concentration areas. Existing findings merely suggest that bats, especially long-distance migratory species, migrate across the Baltic Sea.

On the basis of the results of the above-mentioned expert report, the recording of the bat migration phenomenon was included in the latest standard investigation concept (StUK4) in order to obtain more concrete indications of the importance of the Baltic Sea EEZ as a cross-migration area for bats. The investigations will be carried out in parallel with the nocturnal call recording of migratory birds using bat detectors to record call activity. Within the context of this mandatory bat monitoring of wind farm projects in area O-1, in spring 2014 (May) only four bats (including two Nathusius's pipistrelles) were detected in nine nights of observation. In Autumn (August - October) of the same year, three Nathusius's pipistrelles were recorded in 20 nights. Based on the available data, it has not been possible to deduce any special significance of area O-1 from the available data (BIOCONSULT SH 2015).

In the course of the basic surveys for offshore wind farm projects in the German EEZ of the Baltic Sea, individual sightings of bats were recorded as part of the nocturnal bird migration survey. In the investigations of the offshore wind farm project "Arkona Basin Southeast", one bat was spotted from the ship in both autumn 2003 and 2004. A further bat was spotted in the autumn of 2003 during the surveys relating to the "Viking" offshore wind farm project. During other ship journeys, two individual bats were sighted in the area O-1. In area O-2, three bat calls were recorded on 21/5/2012 using bioacoustic hand-held devices. In the spring of 2011, two Nathusius's pipistrelles were also spotted on board the ship used for bird surveys. In area O-3, one bat of an unidentified species was observed during the basic surveys in both July and September 2003. Some of the sightings even occurred during the day.

In summary, it can be stated for the bat populations of species relevant to the Baltic Sea that the populations and range of migratory species are not fully recorded, primarily due to the high dynamics of the migration. There is a lack of adequate methods and monitoring programmes to be able to record and quantify population trends, migrations and migratory movements across the open sea.

On the basis of the existing findings it can be stated for bat migration across the Baltic Sea: observations and ringing finds indicate that some species such as common noctule, Nathusius's pipistrelle, parti-coloured bat, common pipistrelle and northern bat migrate across the Baltic Sea.

It is assumed that a wide-front migration takes place along prominent landscape features such as shorelines. However, migration directions, altitudes, times and first and foremost possible migration corridors in the Baltic Sea remain largely unknown.

2.11.3 Conservation status of potentially migratory bat species in countries adjacent to the Baltic Sea

Some species, such as the Nathusius' pipistrelle and the common noctule, are listed in Appendix II of the 1979 Convention on the Conservation of Migratory Species of Wild Animals (CMS, the Bonn Convention). Within the framework of the CMS convention, the adoption of the Agreement on the Conservation of Populations of European Bats (EUROBATS) in 1991 and its ratification in 1994 created the framework for a conservation and management plan for the conservation of bats in Europe.

As part of the reporting obligations for EUROBATS, reports are prepared by all the reporting states on the respective regional occurrence, population development and status of bats. Data from the reports to EUROBATS of a few countries bordering the Baltic Sea, e.g. Baltic countries and Scandinavia, provide information about the range of species and occurrence and about possible migration movements over the Baltic Sea.

In Denmark, 17 species of bats have been identified; 14 of them roost in Denmark. Although the populations of the three long-distance migratory species Nathusius's pipistrelle, common noctule and parti-coloured bat are not quantified, there are numerous roosting records. Also, the assumed to be long-distance migratory bats, the common pipistrelle and northern bat are amongst the species roosting in Denmark. The five species mentioned previously are considered "not endangered" in Denmark (The Danish Nature Agency 2015).

The distribution of bats in Sweden was last described in a national report from 2006 within the framework of EUROBATS (Swedish Environmental Protection Agency 2006). There are 18 bat species in Sweden. In recent decades, the populations of five species, including the Nathusius's pipistrelle and northern bat have increased. A population decrease is assumed for three other species, including the migratory parti-coloured bat. Amongst the migratory species in Sweden only Nathusius's pipistrelle is included on the Red List as being potentially endangered. The common noctule was removed from the Red List as long ago as 2000. Overall, Swedish surveys have shown that Nathusius's pipistrelle populations have increased over the last two decades and also that their geographic range has increased up to 60°N. By contrast, the common noctule is only relatively common in southern Sweden and coastal areas. In contrast to the above mentioned species, the parti-coloured bat has a very uneven distribution. This species is occasionally observed during migration periods on the south coast.

There are 13 bat species in Finland (Ministry of the Environment Finland, 2014). The most common is the northern bat. The three migratory species Nathusius's pipistrelle, common noctule and parti-coloured bat occur only in the summer months in southern Finland. Moreover, their populations and population trends are largely unknown. The Nathusius's pipistrelle is classified as "endangered".

There are 15 bat species in Latvia (Ministry of Environmental Protection and Regional Development of the Republic of Latvia 2014). A comparison of the occurrence of bats in Latvia with the occurrence in Estonia and north-western Russia has revealed that at least four species reach the limit of their range in Latvia. Nathusius's pipistrelle, common noctule and parti-coloured bat occur widely during the summer months. Two other species, the common pipistrelle and the lesser noctule are classified as migratory in Latvia based on ring finds. Thus there are five migratory species in Latvia. Nathusius's pipistrelle and common noctule are not assigned any threat status in Latvia. Parti-coloured bat, common pipistrelle and lesser noctule are merely classified as rare.

15 species of bats have been recorded in Lithuania, including the long-distance migratory species Nathusius's pipistrelle, common and lesser noctules, common pipistrelle and parti-coloured bat. The population trend is largely unknown and most are classified as not endangered (The Protected Areas and Landscape Department of the Ministry of the Environment of the Republic of Lithuania 2014).

In total, there are 21 bat species in Poland (Ministry of the Environment Poland 2014). Amongst the migratory species in Poland, the common pipistrelle is classified as endangered. By contrast, the parti-coloured bat is classified as low concern.

A total of 25 species of bat are native to Germany. In the current Red List of Mammals (Meinig et al. 2008), two species were assigned to the category "indeterminate", four species to the category "critically endangered", and three species to the category "threatened with extinction". The common bent-wing bat *(Miniopterus schreibersii) is considered* "extinct or disappeared". Of the species that have been observed more frequently in the sea and coastal areas in Germany to date, the common noctule is on the Early Warning List, the common pipistrelle and the Nathusius' pipistrelle are considered to be "of least concern". The data situation is deficient for assessment of the threat status of the lesser noctule.

2.11.4 Hazards to bats

Anthropogenic hazards to migratory bats are caused in particular by the loss of summer roosts through the cutting down of old trees, the loss of winter roosts caused by the renovation of old buildings, and the use of wood preservatives, the intensification of agriculture and the use of pesticides. According to a report by the BTO (British Trust for Ornithology) on the effects of climate change on migratory species, some of the effects of climate change can be predicted based on recent findings on the abundance, range and habitat preferences of bats. Loss of resting places along migratory routes, decimation of breeding habitats and changes in the food supply are examples of issues to be expected (ROBINSON ET AL. 2005). All species will be indirectly affected by possible effects of climate change on their food organisms, in this case insects. The observed insect mortality will have an increased adverse impact on bats. In particular, a time-mismatch between the development of the bat brood and the availability of its food can have consequences for the breeding success of the bats. In addition, high structures such as buildings, bridges or wind turbines can pose a risk to bats due to a barrier effect and possible collisions (e.g. AHLEN 2002).

2.12 Biodiversity

Biological diversity (or biodiversity for short) comprises the diversity of habitats and communities, the diversity of species and genetic diversity within species (Art. 2 of the Convention on Biological Diversity 1992). Biodiversity is the focus of public attention. Biodiversity is the result of over 3.5 billion years of evolution, a dynamic process of extinction and species development. Of the approximately 1.7 million species described by scientists to date, some 250,000 occur in the sea, and although considerably more species have been described on land to date, the sea is more comprehensive and phylogenetically more developed than the land in terms of its phylogenetic biodiversity. Of the 33 known animal phyla 32 are found in the sea, of which 15 are exclusively marine (VON WESTERNHAGEN & DETHLEFSEN 2003). Recent projections from MORA et al. (2011) indicate that there are approximately 8.7 million species worldwide, of which 2.2 million are marine species.

Marine diversity is beyond direct observation and is therefore difficult to assess. Instruments such as nets, traps, grabs, traps or visual recording methods always have to be used to assess these. However, the use of such devices can only ever provide a fraction of the actual species composition, exactly the species specific to the trap in question. From this it can be deduced that in regions that are inaccessible with the available equipment (e.g. the deep sea), there must still be a large number of species that are still completely unknown. The situation in the Baltic Sea is different because as a relatively shallow inland sea, it is more easily accessible so that even as long ago as the middle of the 19th century, intensive marine research had taken place, which had led to an increase in knowledge about its flora and fauna.

Within the framework of HELCOM monitoring, more than 800 phytoplankton taxa have been recorded in the Baltic Sea (WASMUND et al. 2016a). Some 61 Zooplankton taxa have been recorded (WASMUND et al. 2016a). More than 700 species of macrozoobenthos (GERLACH 2000) are known in Kiel Bight alone. According to WINKLER et al. (2000), the fish fauna of the Baltic Sea currently comprises 176 fish and lamprey species. Only four species of marine mammals are known. There are 38 species of regularly occurring seabirds and resting birds in the German Baltic Sea.

With regard to the current state of biodiversity in the Baltic Sea, there is a wealth of evidence of changes in biodiversity and species patterns in all systematic and trophic levels of the Baltic Sea. Changes in biodiversity are due mainly to human activities, such as fishing and marine pollution, or to climate change.

In this regard, Red Lists of endangered animal and plant species have an important control and warning function as they indicate the state of populations of species and biotopes in a region. According to the Red Lists, more than 17% of the macrozoobenthos species (GOSSELCK et al., 1996) and about 16.9% of the cyclostomata and seafish found permanently in the Baltic Sea (THIEL et al. 2013) are endangered. The marine mammals form a species group of which currently all species are endangered (VON NORDHEIM et al. 2003). Of the 38 regularly occurring seabirds and resting birds, four species are listed in Annex I of the Birds Directive. In general, all wild native bird species are to be preserved and thus protected in accordance with the Birds Directive.

2.13 Air

Shipping generates emissions of nitrogen oxides, sulphur dioxides, carbon dioxide and soot particles. These can have an adverse impact on air quality and be discharged to a great extent into the sea in the form of atmospheric deposition. As, since 2006, the Baltic Sea has been one of the emission monitoring areas according to Annex VI of the MARPOL Convention, the so-called "Sulphur Emission Control Area" (SECA) applies and stricter regulations for emissions from shipping apply to it. Since 01 January 2015, ships navigating in it may only use fuel oil with a maximum sulphur content of 0.10%. According to HELCOM this has led to an 88% reduction in sulphur emissions compared to 2014. Worldwide, the limit is currently 3.50%. According to a decision of the International Maritime Organisation (IMO) taken in 2016, this limit is to be reduced to 0.50% worldwide from 2020 onwards.

Emissions of nitrogen oxides are of particularly relevance to the Baltic Sea as an additional nutrient load. Shipping is one of the largest sources of nitrogen oxide inputs from the air (HELCOM). Accordingly, the IMO decided in 2017 that the Baltic Sea would be declared a "Nitrogen Emission Control Area" (NECA) from 2021 onwards. The reduction of nitrogen oxide input into the Baltic Sea region through the North Sea and Baltic Sea ECA measure is estimated to stand at 22,000 t (European Monitoring and Evaluation Programme (EMEP, 2016)).

2.14 Climate

The German Baltic Sea is located in the temperate climate zone. As an inland sea, it is disconnected from the influence of the Gulf Stream. It does not develop its own maritime climate because it is quite small and the salinity of the Baltic Sea water is relatively low. Therefore, it ices up in parts every winter, sometimes even completely. There is broad consensus among climate scientists that the global climate system is being noticeably influenced by the increasing release of greenhouse gases and pollutants, and the first signs of this are already apparent. According to reports from the Intergovernmental Panel on Climate Change (IPCC 2001, 2007), the increase in the surface temperature of the sea and average global sea level are to be expected as large-scale impacts of climate change on the oceans. Many marine ecosystems are sensitive to climate change. Global warming is also expected to have a significant impact on the Baltic Sea.

2.15 Scenery

The marine landscape is characterised by a wide-area open space structure and largely unaffected by interruptions. Until now, there have only been a few high structures in the German EEZ of the Baltic Sea. These include the "Baltic 2" offshore wind farm located 33 km northwest of Rügen and the "Viking" wind farm, the latter being located about 34 km northeast of Rügen. Other high structures are two measuring masts for measurement and research purposes, the first being measuring mast Arkona Basin, about 35 km northeast of Rügen and the second, the research platform "FINO2" in the Kriegers Flak area, about 39 km northwest of Rügen. However, due to the large distances, these are not visible from land. The construction of more wind farms will in the future further change the overall appearance of the landscape. The necessary navigation and warning lights will also encroach upon the landscape. The extent to which the landscape is impaired by vertical structures is greatly dependent on visibility. The space in which a building becomes visible in the landscape is known as the visual space. This is defined by the visual link between a building and its surroundings, the intensity of an effect decreasing further away (Gassner et al. 2005). Where measuring masts, platforms and offshore wind farms are concerned, which are planned at a distance of at least 30 km from the coastline, there is low impact on the landscape as perceived from land. The platforms and wind farms will scarcely be visible at such a distance, even when visibility is good. This also applies to navigation lights for safety purposes at night.

2.16 Cultural heritage and other material assets

There are indications of possible material assets or cultural heritage insofar as the spatial location of a large number of wrecks is known on the basis of the evaluation of existing hydroacoustic recordings and the BSH wreck database, and recorded in BSH navigation charts. No further information is available on archaeological monuments in the EEZ, such as remains of settlements.

2.17 Human beings, including human health

All in all, the area for which the Site Development Plan defines specifications is of minor importance to the community as a protected asset. In a broader sense, maritime space represents the working environment for people who work on ships. Precise numbers of people who are regularly to be found in the area are not available. The importance as a working environment can be regarded as low. Direct use for recreation and leisure purposes by leisure boats and tourist watercraft is occasional. The initial impact can be designated as low. It is not possible to deduce the special significance of the planning area for human health and well-being.

2.18 Interrelationships between the factors

The components of the marine ecosystem, from bacteria and plankton to marine mammals and birds, influence one another via complex processes. The biological protected assets plankton, benthos, fish, marine mammals and birds, as described individually in chapter 2, are dependent upon one another within the marine food chains.

Phytoplankton serve as a food source for organisms that specialise in filtering water for their food. The most important primary consumers of phytoplankton are zooplanktonic organisms such as copepods and water fleas. Zooplankton play a key role in the marine ecosystem as a primary consumer of phytoplankton on the one hand, and as the lowest secondary producer within the marine food chains on the other. Zooplankton serve as food for secondary consumers in marine food chains, from carnivorous zooplankton species to benthos, fish, marine mammals and seabirds. What are known as predators are among the top components of the marine food chains. Water birds, seabirds and marine mammals are some of the upper predators within the marine food chains. Producers and consumers are interdependent in the food chains and influence one another in many ways. In general, food availability regulates the growth and spread of species. Exhaustion of the producer results in the downfall of the consumer. In turn, consumers control the growth of producers by eating them. A limited food supply acts at the individual level by negatively impacting the condition of individual creatures. At population level, food limitation leads to changes in the abundance and distribution of species. Food competition within a species or between different species has similar effects.

The temporally adjusted succession or sequence of growth between the various components of the marine food chains is of critical importance. For example, the growth of fish larvae is directly dependent on the available plankton biomass. The breeding success of seabirds is also directly related to the availability of suitable food, mostly fish (species, length, biomass, energetic value). The occurrence of succession, offset temporally or spatially, and abundance of species at various trophic levels leads to interruption of food chains. Temporal offset, known as the trophic "mismatch", causes early developmental stages of organisms in particular to be undernourished, or even to starve to death. Interruptions in marine food chains can affect not just individuals, but populations as well. Predator-prey ratios or trophic relationships between size or age groups of a species or between species also regulate the balance of the marine ecosystem. Thus for example, the decline in cod stocks in the Baltic Sea has had a positive effect on the increase in sprat stocks. However, the exceptional increase in sprat stocks was limited by the available food resources (zooplankton). Consequently, the abundant sprats were ultimately undernourished and therefore had a low energy content. The poor nutritional status of the sprats was reflected in the nutritional state of their consumers, the guillemot juveniles. The growth and the chance of survival of the young guillemots was decreased at times due to the reduced food quality (Österblom et al., 2008).

Trophic relationships and interactions between plankton, benthos, fish, marine mammals and seabirds are controlled by various control mechanisms. Such mechanisms work from the lower part of the food chains, starting with the availability of nutrients, oxygen or light and working up to the upper predators. A "bottom-up" control mechanism of this kind can work by increasing or decreasing primary production. Effects from upper predators downwards, via what are known as "top-down" mechanisms, can also control food availability.

The interactions within the components of marine food chains are influenced by abiotic and biotic factors. For example, dynamic hydrographic structures, water stratification and current play a crucial role in food availability (increase in primary production) and use by upper predators. Exceptional events such as storms and ice winters also affect trophic relationships within marine food chains. Biotic factors such as toxic algal blooms, parasite infestation and epidemics also affect the entire food chain.

Anthropogenic activities also have a decisive influence on interactions within the components of the marine ecosystem. Mankind affects the marine food chain both directly by catching marine animals, and indirectly through activities that may affect components of the food chains. Overfishing of fish populations, for example, confronts upper predators, seabirds and marine mammals with food limitations or forces them to develop new food resources. Overfishing can also cause changes at the bottom of the food chains. This can lead extreme jellyfish dispersion when their fish predators are removed by fishing. Moreover, shipping and mariculture are an additional factor that may lead to positive or negative changes in marine food chains through the introduction of non-native species. Discharges of nutrients and pollutants via rivers and the atmosphere also have an impact on marine organisms and may lead to changes in trophic conditions. Natural or anthropogenic effects on one of the components of the marine food chains, e.g. the species composition or plankton biomass, can affect the entire food chain and shift and possibly endanger the balance of the marine ecosystem. Examples of the very complex interactions and control mechanisms within the marine food chains were presented in detail in the description of the individual protected assets.

The complex interactions between the various components resulted ultimately in changes to the entire marine ecosystem of the Baltic Sea, as shown by the example of trophic interactions between guillemot, cod, sprat and zooplankton. Based on the factor-related changes already described in chapter 2, the marine ecosystem of the Baltic Sea can be summarised as follows:

- There are slow changes to the biotic marine environment.
- Rapid changes in the living marine environment have been observed since 1987/88.

The following aspects or Changes can affect the interactions between the various components of the biotic marine environment: changes in species composition (phytoplankton and zooplankton, benthos, fish), introduction and partial establishment of non-native species (phytoplankton and zooplankton, benthos, fish), change in species abundance and dominance ratios (phytoplankton and zooplankton), change in available biomass (phytoplankton), decline in many species typical of the area (plankton, benthos, fish), decline in food resources for upper predators (seabirds).

3 Likely evolution without implementation of the plan

Expansion of offshore wind energy plays a key role in meeting the German government's climate protection and energy policy objectives.

Section 6 WindSeeG gives the Federal Maritime and Hydrographic Agency the task of compiling and updating a Site Development Plan for the EEZ under the conditions set out in section 4 ff. WindSeeG and, if an administrative agreement is concluded, also for coastal waters. The task of the plan, therefore, is to spatially define the areas and sites for wind turbines, the expected generation capacity there and the necessary routes and locations for the entire required grid infrastructure or grid topology in the Baltic Sea EEZ. Furthermore, the plan also develops the temporal component of the expansion by determining the temporal sequence of the calls for tender for the sites for offshore wind turbines and the calendar years of the commissioning of connecting lines.

It is necessary to install offshore wind turbines in order to meet the expansion targets laid down in section 4 no. 2b of the Renewable Energy Sources Act. Even if the Site Development Plan were not to be implemented, further wind farms would still be built and commissioned in accordance with the applicable legal bases. The sectoral plan is used for spatially and temporally ordered, space-saving and efficient expansion of offshore wind energy in order to implement fragmentation by further application outside the areas, and hence to control land usage and thereby ensure minimal conflict in the development of this technology. Therefore, the environmental effects of the Site Development Plan's rules do not go beyond the effects of the zero alternative (non-implementation of the plan), but in fact can be reduced by the Site Development Plan on account of its steering effect.

According to section 17d (1) sentence 1 of the Energy Industry Act, the responsible TSO must ensure the reliable grid connection of offshore wind farms or according to the specifications of the confirmed by the BNetzA O-NEP respectively from 01 January 2019, construct and operate them in accordance with the grid development plan and the Site Development Plan pursuant to section 5 of the Offshore Wind Energy Act.

It is absolutely necessary to lay the current-carrying submarine cable systems up to the grid connection points on land to allow the electricity generated at the offshore wind farms in the Baltic Sea EEZ to be fed into the onshore high voltage grid. The need to connect offshore wind farms to the grid would exist even if the plan were not implemented. This means that even if the plan were not implemented, these uses would still be exercised in accordance with the applicable legal bases.

The TSO, which is obliged to connect the offshore wind farms in the Baltic Sea to the grid, has so far pursued a connection concept based on three-phase current technology. When using the three-phase current technology, offshore wind farms are connected to the grid by combining the electricity generated by the individual wind turbines from one or more wind farms at a transformer platform, and from here it is routed directly ashore via AC Subsea Cable and on to the grid connection point. In contrast to the HVDC concept, this means that no separate converter platform is required for the grid connection itself. However, for discharging a given output, a higher number of cable systems is required when using three-phase technology due to the lower transmission capacity of AC Subsea Cable. Due to the expected low wind farm capacity in the German EEZ of the Baltic Sea for commissioning activities from 2026 compared to the capacity of an HVDC system, a connection by means of a direct current system would probably lead to permanent vacancies. As already explained, these sites are used for submarine cable systems and converter platforms independently of the implementation of the Site Development Plan in the EEZ. Therefore, the environmental effects of the Site Development Plan's rules do not go beyond the effects of the zero alternative (non-implementation of the plan), but in fact can be reduced by the Site Development Plan by way of steering.

The design for a voltage level of 220 kV enables the highest possible transmission capacity per cable system – for three-phase connection – to be achieved and allows transmission to take place with as few cable systems as possible. The sites for the cabling within the wind farm will be used independently of the implementation of the Site Development Plan in the EEZ. The environmental impacts of the rules of the Site Development Plan do not therefore exceed the effects of non-implementation of the plan. Rather, the Site Development Plan may serve to mitigate them with its steering effect.

The aim of the Site Development Plan is to specify the expansion of offshore wind turbines and the grid topology, in particular with regard to grid connection of offshore wind farms in the EEZ, coordinated in spatial terms in the sense of predictive and coordinated overall planning. If the Site Development Plan were not implemented, the previously practised system of project-specific individual planning and connection would remain in place; in other words, wind farms and their grid connections would be planned and implemented without systematic inclusion of the entire area. The required space requirements can be minimised and the potential environmental impact can be reduced by regulating planning and technical principles in the Site Development Plan. As the plan makes numerous rules relating to the most compatible possible design of the uses, it would probably be more difficult to ensure the protection of the individual factors if the Site Development Plan were not implemented than if the plan were implemented.

The grid connection of the individual sites provided for in the plan, staggered in terms of time, has the potential to minimise disturbances to protected species in particular. Failure to implement the plan would probably increase area use and the associated burden on the marine environment. Inadequate spatial coordination in the event of non-implementation of the plan could, for example, lead to significantly more fragmented wind farm areas and cable crossings with corresponding effects – caused by intersections becoming necessary – on the factors in question.

Although it is not possible to quantify in concrete terms the number of additional land uses or crossings and the associated additional land requirements it is clear from the rules in the Site Development Plan - in particular the areas for wind turbines, routing and the gates - that the planning of the TSO has already progressed to such an extent due to the earlier system characterised by individual approvals and connections, that complete overall coordination is no longer possible due to existing constraints. Taking these constraints into account, a considerable number of crossings could no longer be prevented at this planning stage. For future projects, the aim is to coordinate these and to plan ahead in accordance with the planning principles (see details in chapter 5 of the Site Development Plan).

3.1 Soil/Area

Whether or not the plan were to be implemented, soil or area to be protected, would, in parts be subject to heavy exploitation, both if the plan were to be put into effect or not put into effect, e.g. by fishing. Anthropogenic factors acting on the seabed include erosion, mixing, resuspension of sediment, material sorting, displacement and compaction. The natural sediment dynamics (sedimentation/ erosion) and the mass transfer between sediment and seabed water are influenced in this way. Global warming is also leading to changes in hydrographic conditions. Overall, however, this development is independent of implementation or non-implementation of the plan.

During the construction phase of wind turbines, platforms and submarine cable systems, effects on the soil may result from direct disturbance of near-surface sediments, sediment resuspension, pollutant inputs and sediment rearrangements. The seabed is tightly sealed when the foundation elements are installed. In the case of submarine cable systems, energy losses in the form of heat dissipation to the surrounding sediment may occur during operation. Potential effects on the factors soil/area are locally limited and arise independently of the implementation of the plan.

Failure to implement the plan would be likely to result in less coordinated laying in spatial terms and, where applicable, a larger number of submarine cables or longer submarine cable systems. This could lead to greater land use by the submarine cable, and thus to reinforcement of the possible effects on soil as a protected asset, compared to implementation of the Site Development Plan. An increased number of cable crossings would also be expected if the plan is not implemented. As a result, an increased insertion of rockfill would be necessary.

3.2 Water

Water as a protected asset would be affected to an extent in the case of both implementation and non-implementation of the plan due to various uses, such as shipping. Moreover, it is to be expected that the warming of the water already triggered by climate change will continue in the future. Overall, however, this development is independent of implementation or non-implementation of the plan.

Effects on the water body can occur during the construction phase of the platforms and the laying of submarine cable systems due to the resuspension of sediment, pollutant inputs and the formation of turbidity plumes. On a local level, an increase in turbidity in the course of scouring cannot be ruled out around the foundations, for operational reasons. The potential effects of the planned platforms and submarine cable systems on water as a protected asset are limited locally and are independent of the implementation of the plan. Failure to implement the plan would be likely to result in less coordinated laying in spatial terms and, where applicable, a larger number of submarine cables or longer submarine cable systems. This could lead to greater land use by the submarine cable systems, and thus to reinforcement of the possible effects on water as a protected asset, compared to implementation of the plan.

3.3 Plankton

Even if the plan were not implemented, phytoplankton and zooplankton as a protected asset would still be affected to an extent by the effects of various uses, such as fishing and shipping. Moreover, the effects of climate change on phytoplankton and zooplankton are now clearly noticeable (BEAUGRAND et al., 2003; WILTSHIRE and MANLY, 2004). Phytoplankton and zooplankton species will be increasingly affected by possible effects of climate change in future, particularly to changes to temperature, salinity and current. Overall, however, this development is independent of implementation or non-implementation of the plan.

The uses designated in the Site Development Plan for the North Sea according to available information do not have a significant impact on plankton; so if the plan is not implemented, plankton will develop in the same way as if the plan were implemented. There may be effects on phytoplankton and zooplankton due to the formation of sediment turbidity plumes during the construction of wind turbines and platforms and the laying of submarine cable systems. However, as these effects are small-scale and temporary, significant effects from the implementation of the Site Development Plan on phytoplankton and zooplankton can fairly safely be ruled out. Effects on plankton can be excluded with the necessary certainty even during normal operation.

3.4 Biotopes

Even if the plan were not implemented, biotopes as a protected asset would still be affected to an extent by the effects of various uses, such as fishing. Failure to implement the Site Development Plan would be likely to result in less coordinated spatial planning of the wind farm and submarine cable systems. Failure to implement the plan could lead to greater land use and thus reinforcement of possible effects on protected biotopes, compared to implementation of the plan. Possible effects on biotopes result from the insertion of the wind turbine and platform foundations as well as routing of the cables. During the construction phase, direct disturbance of near-surface sediments, pollutant inputs, resuspension of sediment, formation of turbidity plumes and an increase in sedimentation could all impact on sensitive biotope structures. The Site Development Plan formulates corresponding planning principles for the special protection of biotopes and habitat types listed in section 30 of the Federal Nature Conservation Act.

The artificial hard substrate inserted with the foundations or the rockfill required cable laying will cause local changes in habitat, which could lead to a change in the species composition of the benthos communities. An increased number of cable crossings would be expected if the plan is not implemented. As no areas and sites are planned inside conservation areas under the Site Development Plan, and the rules of the Site Development Plan, by reducing submarine cable systems and minimising crossings, are aimed at minimising the use of the seabed, even outside these areas, the non-implementation of the plan would presumably make it more difficult to protect marine biotopes than if the plan were implemented.

3.5 Benthos

Even if the plan were not implemented, benthos as a protected asset would still be affected to an extent by the effects of various uses, such as fishing. Moreover, it is to be expected that the warming of the water already triggered by climate change will continue in the future. This will also have an impact on the benthos. This may lead to settlement of new species, or a shift in the species composition as a whole. However, this development is independent of implementation or non-implementation of the plan.

Failure to implement the Site Development Plan would be likely to result in less coordinated spatial planning of the wind farm and laying of submarine cable systems. Failure to implement the plan could lead to comparatively greater land use and thus reinforcement of possible effects on the benthos, compared to implementation of the Site Development Plan. Possible effects on the benthos would result from installation of the foundations of the installations and platforms and the laying of cable systems. During the construction phase, direct disturbance of near-surface sediments, pollutant inputs, resuspension of sediment, formation of turbidity plumes and an increase in sedimentation could all impact on benthos communities.

Changes in the existing species composition in the vicinity of the foundations of the installations and platforms may occur in the artificial hard substrate introduced as a result of the installations. Failure to implement the plan would result in an increased number of cable crossings or intersections that would also require the introduction of hard substrate. Here, too, there would be small-scale changes to the habitat structures which could in turn lead to a shift or change in the species composition of the benthos.

As the rules of the Site Development Plan are aimed at minimising the use of the seabed by reducing submarine cable systems and minimising crossing structures, and additionally fully avoiding the use of conservation areas with their protected habitat types by the transmission cable routes of the Site Development Plan, the non-implementation of the plan would presumably make it more difficult to protect the benthos than if the plan were implemented.

3.6 Fish

Fish as a protected asset would be affected to an extent by the effects of fishing in the case of both implementation and non-implementation of the plan. Moreover, regardless of the implementation or non-implementation of the plan, it is to be expected that the warming of the water already triggered by climate change will continue in the future. This will also have an impact on fish as a protected asset. This may lead to the immigration of new fish species; which may not necessarily result in competition with native fish species, but this cannot be ruled out. During the construction phase of the wind farms and converter platforms and the laying of submarine cables on the planned routes, fish fauna – e.g. e.g. for visually hunting species and by sticking together of the gill lamellae, if the fish do not avoid it. Furthermore, fish may also be temporarily scared away by noise and vibrations during the construction phase. Further effects on fish fauna may be due to the additional hard substrates introduced owing to a possible change in the benthos. Failure to implement the plan would be likely to result in less coordinated laying of the submarine cable systems in spatial terms. This could lead to comparatively greater land use and a longer construction period, and thus to reinforcement of the potential effects on fish fauna compared to laying coordinated by the Site Development Plan. Therefore, without implementation of the Site Development Plan, protection of fish fauna would probably be more difficult to ensure than with its implementation.

3.7 Marine mammals

Even if the plan were not implemented, marine mammals as a protected asset would still be affected to an extent by the effects of various uses, such as shipping and fishing.

Marine mammals, particularly the sound-sensitive harbour porpoises, could be affected by the use of deep foundations by pile-driven sound when inserting the platform and turbine foundations. The plan includes a whole series of planning principles relating to the most compatible design of uses possible, in particular a noise reduction principle and the exclusion of wind turbines and platforms in Natura 2000 areas. These principles will reduce adverse impacts on marine mammals. Overall, however, the effects of the plan specifications on marine mammals will be comparable with the effects of the zero alternative, since project-specific and site-specific noise abatement measures are essentially arranged in the specific individual procedure, regardless of the implementation of the plan. The staggered grid connection of the individual sites provided for in the plan has the potential to minimise disturbances to marine mammals. Similarly, disturbances to marine mammals are reduced by avoiding the use of conservation areas.

The effects of climate change on marine mammals are complex and difficult to forecast. All species will be indirectly affected by possible effects of climate change on their food organisms, fish. Overall, however, this development is independent of the implementation of the plan.

3.8 Seabirds and resting birds

Even if the plan were not implemented, seabirds and resting birds as a protected asset would still be affected to an extent, as shown, by the effects of various uses such as fishing and shipping. The effects of climate change on the affected species are complex and difficult to predict. All species will be indirectly affected by possible effects of climate change on their food organisms, particularly fish. Overall, however, this development is independent of implementation or non-implementation of the plan.

Failure to implement the Site Development Plan would result in less spatially coordinated planning of wind farm projects, platforms and submarine cable systems. This would probably increase land use, which in turn could impact on species susceptible to disturbance. Furthermore, the Site Development Plan is based on planning principles which, in addition to spatial planning, also provide for temporal coordination of construction projects so as to be able to largely reduce factors affecting seabirds and resting birds, such as additional shipping traffic due to construction.

Even if similar factors would have an impact on seabirds in principle regardless of whether or not the Site Development Plan is implemented, it would be more difficult to ensure the protection of seabirds and resting birds if it were not implemented due to a lack of planning principles and their coordinating requirements.

3.9 Migratory birds

The factor Migratory birds would also be affected by various other uses in the event of non-implementation of the plan, e.g. shipping and fishing. The effects of climate change on the affected species are complex and difficult to predict. All species will be indirectly affected by possible effects of climate change on their food organisms, particularly fish. Overall, however, this development is independent of implementation or non-implementation of the plan.

If the Site Development Plan were not implemented, it would above all result in an increased area use of the seabed due to uncoordinated individual connections of offshore wind farms. This would not be an additional or altered negative impact on the avifauna. Moreover, the increase in shipping traffic due to construction/cable laying and maintenance would not exceed the level of shipping traffic generated during the implementation of the Site Development Plan. Additional construction and operational effects on avifauna are not to be expected. If the plan is not implemented, effects on migratory birds as a protected asset are likely to develop in the same way as if the plan were implemented.

3.10 Bats and bat migration

Migration movements of bats across the Baltic Sea are indeed documented to varying extents, but to date no specific information is available on migratory species, migration corridors, migration heights and migration concentrations. The only information to date confirms that bats, especially species that migrate long distances, fly over the Baltic Sea. However, some effects of climate change can be predicted on the basis of previous findings on factors such as the distribution and habitat preferences of bats. Loss of resting places along migratory routes, decimation of breeding habitats and changes in the food supply are examples of issues to be expected. The delayed occurrence of food in particular may have consequences for the reproductive success of bats (AHLEN 2002, RICHARDSON 2004). The observed insect mortality will have an increased adverse impact on bats.

Dangers to individuals due to collisions with wind farms or platforms cannot be ruled out. If the plan is not implemented, effects on bats as a protected asset are likely to develop in the same way as if the plan were implemented. It can also be expected that any negative effects on bats can be prevented by using the same prevention and mitigation measures devised to protect bird migration.

3.11 Biodiversity

Large-scale consequences of climate change can also be expected in the oceans. Many marine ecosystems are sensitive to climate change, so this will impact on biodiversity. There may be a shift in the species composition. A major influence on the population density and dynamics of fish would be conceivable, for example, which in turn would have significant consequences for the food chains. Overall, however, this development is independent of the implementation of the plan.

Temporary or permanent acoustic and visual stresses can lead to impairments of individual species in respect of the factors Fish, birds and marine mammals. However, effects on biodiversity are currently unimaginable, as no loss of species is to be expected. Effects of turbidity plumes, sedimentation and sediment warming or magnetic fields on biodiversity are also unlikely, as these are usually local adverse impacts. It is also to be expected that the avoidance and mitigation measures planned for the individual protected assets will also reduce the possible adverse impacts on biodiversity.

The exclusion of uses in Natura 2000 sites further reduces the potential impact on biodiversity. Local effects on the diversity of habitats and biodiversity cannot be fundamentally ruled out, e. g. when inserting hard substrate it is even to be expected. Overall, however, the benthic species settling here and any fish species that may be attracted as a result will be recruited from the immediate vicinity, so ultimately no large-scale changes in biodiversity are to be expected within the study area. As the specifications of the Site Development Plan aim to reduce the use of the seabed as far as possible by reducing the number of cable routes and minimising the number of intersections, and as a number of principles serve to ensure that the design of the specifications is as environmentally friendly as possible, the effects on biodiversity can probably be reduced compared with the zero alternative.

3.12 Air

Shipping traffic in the Baltic Sea will also increase as the intensity of use increases, which may have an adverse impact on air quality. However, this development is largely independent of implementation or non-implementation of the plan. The construction and operation of the platforms and the laying of submarine cable systems as part of the implementation of the Site Development Plan will have no measurable impact on air quality. If the plan is implemented, therefore, air as a protected asset will develop in the same way as if the plan were not implemented.

3.13 Climate

According to reports by the Intergovernmental Panel on Climate Change (IPCC 2001, 2007), an increase in sea surface temperature and average global sea levels are expected to be the large-scale consequences of climate change on the oceans. Many marine ecosystems are sensitive to climate change. Overall, however, this development is independent of implementation or non-implementation of the plan.

Adverse impacts on the climate from platforms are not expected, as there are no measurable emissions relevant to climate during construction or operation. Rather, the coordinated expansion of the grid infrastructure in the offshore region will create greater planning security for the expansion of offshore wind energy. The CO_2 savings associated with the expansion of offshore wind energy are expected to have a positive impact on the climate in the long term. This may make an important contribution to achieving the Federal Government's climate protection targets.

3.14 Scenery

Implementation of offshore wind farms will have an impact on the landscape as it will be altered by the construction of vertical structures. For safety reasons, the installations will also have to be illuminated at night or in poor visibility. This may also lead to visual impairments of the landscape. Section 3.5.1 (8) of the Spatial Development Plan for the North Sea stipulates a height limit of 125 m for wind turbines within sight of the coast and islands.

The construction of platforms may also lead to visual changes in the landscape. The extent to which the landscape is affected by offshore installations depends largely on the prevailing visibility conditions, but also on subjective perceptions and the fundamental attitudes of observers towards offshore wind energy. The vertical structures, which are atypical for the familiar image of a seascape, may be perceived as disruptive, but some people will find them technically interesting. In any case, they will bring about a change in the landscape and modify the character of the area. Due to the distance of more than 25 km between the planned platforms and the surrounding wind farms to the coast, the installations will mainly be visible to a very limited extent from land, and only when visibility is good. Evidence of this is provided by visualisations available from 2005 (Figure 40).

Figure 40: Visualisation of the perceptibility of offshore wind turbines in the special suitability area according to the Offshore Installations Ordinance "Western Adlergrund" on the left of the viewpoint Königsstuhl on Rügen; hub height of the wind turbine 100m; distance away of the observer approximately 33 km; eye height approximately 120m above sea level; right on the beach at the foot of the Königsstuhl on Rügen; eye height approximately 2 m above sea level (ARCADIS 2005, cited in BSH 2009).

In this respect, significant impairment of the landscape, as it is perceived from land, can be excluded. The fact that a glare-free, low-reflection coating is required as standard for the approval of individual projects also helps to minimise visibility.

It is also necessary to take into account the fact that platforms are always planned in spatial connection with offshore wind farms, so the change in the landscape will be increased only slightly by individual structures in immediate physical proximity to the offshore wind farms. In addition, the exclusion effect in the conservation areas (approximately 55% of the area of the German EEZ of the Baltic Sea) contributes to the fact that large parts of the EEZ remain free of turbines. The development of the landscape if the Site Development Plan is not implemented will probably not differ significantly from its development if the Site Development Plan is implemented.

For the submarine cable systems, adverse impacts on the landscape during the operating phase can be ruled out as they will be laid as underwater cables.

3.15 Cultural heritage and other material assets

There are indications of possible material assets or cultural heritage insofar as the spatial location of a large number of wrecks is known and recorded in the BSH's nautical charts. More detailed information about bottom monuments and also about the remains of settlements, is not available in the EEZ. Based on available hydroacoustic surveys and evaluation of the underwater obstacle database, there are no findings relating to material assets or cultural heritage in the region of the planned platforms. There is evidence of underwater obstacles along the planned submarine cable routes. Particular emphasis must be placed on these when taking them into account in the specific plan specification procedure.

If any culturally significant finds or material assets are discovered during the prescribed site survey in the approval procedures for the territories and areas, the construction of platforms and the laying of submarine cable systems, appropriate measures must be taken to preserve them. The Site Development Plan provides a corresponding specification so as to ensure that this protected asset cannot be affected adversely (see, for example, Planning principle 4.4.1.7 Site Development Plan). Subject to this condition, no significant impact on the factor "cultural heritage and other material assets" is expected as a result of the implementation of the Site Development Plan.

3.16 Human beings, including human health

Overall, the area for which the Site Development Plan is providing specifications is of little significance to human health and well-being. People are not directly affected by the rules of the plan, rather indirectly by their perception of the landscape factor (see Chapter 3.14) and possible influences on the recreational function of the landscape for water sports participants and tourists. These effects are considered insignificant due to the considerable distance of at least 25 km from the coast. These effects do not go beyond the effects of the zero alternative.

3.17 Interrelationships between the factors

It is assumed that the interactions between the protected assets will develop in the same way regardless of whether or not the Site Development Plan is implemented. Therefore, reference is made at this point to chapter 2.18.

4 Description and assessment of the likely significant effects of the implementation of the Site Development Plan on the marine environment

The following description and assessment of the environmental effects concentrate on factors for which significant effects cannot be excluded from the outset by implementation of the Site Development Plan.

According to section 40 subsection 1 of the Environmental Impact Assessment Act, the likely significant environmental effects of the implementation of the plan are to be assessed. Furthermore, according to section 40 subsection 3 of the Environmental Impact Assessment Act, the environmental effects of the plan are being assessed provisionally with a view to taking effective environmental precautions. According to section 3 sentence 2 of the Environmental Impact Assessment Act, the environmental assessment serves to ensure effective environmental precautions in accordance with the applicable laws. Within the framework of the Site Development Plan and the provisions of sections 4 et seq. WindSeeG, section 5, subsection 3 WindSeeG endangerment of the marine environment is to be excluded based on the rules contained in the plan. The marine environment includes the protected assets and their habitats described in this environmental report, including possible interactions.

The factors for which significant impairment could already be excluded in the previous chapter 2 are not taken into account. This concerns the protected assets Plankton, Water, Air, Cultural heritage and other material assets and Human beings, including human health. Possible effects on biodiversity as a factor are discussed for the individual biological factors. Overall, the protected assets listed in section 2 subsection 1 of the Environmental Impact Assessment Act will be examined before the wildlife conservation and legal territorial protection examinations are presented. Statements on the general protection of nature and landscape in accordance with section 13 of the Federal Nature Conservation Act are covered in the assessment of the individual factors.

4.1 Soil/Area

4.1.1 Areas, sites and platforms

The transformer or collector platform has, in terms of the soil factor, a local narrowly limited environmental impact. The sediment is permanently affected only in the immediate vicinity by the introduction of the foundation elements and the resulting area use.

Due to construction: Sediments are briefly agitated and turbidity plumes are formed during foundation work for wind turbines and platforms. The extent of resuspension is essentially dependent on the fine grain content in the soil. In areas with a lower fine fraction, most of the released sediment will settle relatively quickly in the area of the insertion or in its immediate vicinity. The suspension content rapidly decreases again to the natural background values due to dilution effects and sedimentation of the whirled-up sediment particles. Nevertheless, the to be expected impairments in areas with a greater fine fraction and the associated increased turbidity remain limited due to the low flow close to the seabed.

In the areas with soft sediments and a correspondingly high fine fraction (area O-2), the released sediment will settle much more slowly. However, since in the area O-2 the currents close to the seabed have a mean value of about 0.06 m/s (near the surface: 0.1 m/s, see Chapter 2.1) which is low, it can be assumed that here too the turbidity plumes that occur also have a more local occurrence and that the sediment will settle relatively close to the construction site. A simulation on the effects of the offshore wind farm "Beta Baltic" in the Mecklenburg Bight, which has similar sediment ratios to the area O-2, showed that at current velocities of 0.3 m/s the maximum sediment spread was approximately 2 to 3 km (MEYERLE & WINTER 2002). In this case, the released material remains long enough in the water column to spread over a wide area, so that due to the relatively small volumes barely detectable thicknesses of the deposited material are to be expected. No more than 12 hours after release, the concentration drops to less than 0.001 kg/m³.

As part of the environmental impact assessment for the "Nord Stream Pipeline", the monitoring results during the construction phase showed only minor to medium-scale, temporary effects due to sediment drifts (turbidity plumes) and confirmed the forecasts of the environmental expert (IFAÖ 2009), who overall classified the effects as minor structural and functional impairments. Based on these results, it can be assumed that turbidity plumes, which are released when the platform foundations are created in soft sediment areas, can extend for distances up to 500 m with the level of suspended matter above the natural suspended matter maxima.

In the short term, pollutants and nutrients may be released from the sediment into the bottom water. There may be a significant release of pollutants from the sediment into the bottom water in areas with silty and clay-like seabeds. These pollutants usually adhere to sinking particles which, due to the low currents in the Baltic Sea basins, scarcely drift over long distances and remain in their usual environment. In the medium term, this remobilised material will be redeposited in the silty basins. Effects in the form of mechanical stress on the soil due to displacement, compaction and vibrations, which are to be expected during the construction phase, are estimated to be low due to their small size.

Dependent on the installation, the seabed is permanently locally sealed by the introduction of foundation elements. The areas affected essentially comprise the diameter of the foundation piles of the wind turbines or platforms and possibly required scour protection. The area use by sealing (incl. scour protection measures) corresponds in order of magnitude to that specified for the North Sea.

Due to operation, there may be interaction between the foundation and hydrodynamics in the immediate vicinity of the installation, and permanent agitation and rearrangement of sediments may occur. According to existing experience in the North Sea, permanent sediment shifts caused by currents are only to be expected in the immediate environment of the platforms. No such experience is currently available for the Baltic Sea. Nevertheless, due to the low current velocities close to the seabed in the area of the platforms, here too only a local scour hole is to be expected. No significant substrate changes are to be expected due to the forecast locally limited scour coverage.

On the basis of the above statements and taking into account the condition assessment, the Strategic Environmental Assessment concludes that the specification of the location of the platforms does not have any significant impact on the soil factor.

4.1.2 Submarine cabling systems

As a result of construction resuspension of sediment increases the turbidity of the water column during cable laying work. The extent of resuspension is essentially dependent on the laying procedure and the fine grain content in the soil. In areas with a lower fine fraction, most of the released sediment will settle relatively quickly on the construction site or in its immediate vicinity. For the "Arkona Basin Southeast" wind farm in area O-1 LEDER (2003) estimates that significant sediment drift during construction is at most only to be expected in a small-scale radius of 500 m - even assuming extreme current conditions (saltwater inflow). Here, the suspension content decreases back to the natural background values due to dilution effects and sedimentation of the stirred up sediment particles. The expected adverse impacts due to increased turbidity remain limited locally to small areas.

In the areas with soft sediments and a correspondingly high fine fraction, the released sediment will settle much more slowly. However, since in these areas the currents close to the seabed have a mean value of about 0.06 m/s (near the surface: 0.1 m/s, see Chapter4.1) which is relatively low, it can be assumed that here too the turbidity plumes that occur also have a more local occurrence and that the sediment will settle out again in the immediate surroundings. A substantial change in sediment composition is not expected. A simulation on the effects of the offshore wind farm "Beta Baltic" in the Mecklenburg Bight, which has similar sediment ratios to area O-2, shows that at current velocities of 0.3 m/s the maximum sediment spread was approximately 2 to 3 km (MEYERLE & WINTER 2002). In this case, the released material remains long enough in the water column to spread over a wide area, so that due to the relatively small volumes barely detectable thicknesses of the deposited material are to be expected. No more than 12 hours after release, the concentration drops to less than 0.001 kg/m³.

In the context of the environmental assessments for the Nord Stream pipeline, only minor to medium-term, temporary effects from sediment drifting are expected (IFAÖ, 2009). Therefore, overall these are classified as minor structural and functional impairments. In the near range up to 50 m medium intensities of suspended matter are predicted, further away, up to 500 m, low to very low intensities of suspended matter are predicted (IFAÖ, 2009). Based on these results, it can be assumed that turbidity plumes, which are released during the laying of submarine cable systems in soft sediment areas, can extend for distances up to 500 m with the level of suspended matter above the natural suspended matter maxima. These are up to 3.9 mg/l in the Pomeranian Bight (IFAÖ, 2009), which is significantly exceeded in estuaries or highly silty coastal areas. Investigations by ANDRULEWICZ et al. (2003) also show that the Baltic seabed is re-levelled due to the natural sediment dynamics along the affected cable routes. Various model calculations and experience gained from the processes show that the re-levelling is more of a long-term press.

In the short term, pollutants and nutrients may be released from the sediment into the bottom water. The possible release of pollutants from the sandy sediment is negligible due to the relatively low fine grain content (silt and clay) and the low heavy metal concentrations. There may be a significant release of pollutants from the sediment into the bottom water in the vicinity of silty and clay-like seabeds. These pollutants usually adhere to sinking particles which, due to the low currents in the Baltic Sea basins, scarcely drift over long distances and remain in their usual environment. In the medium term, this remobilised material will be redeposited in the silty basins.

Effects in the form of mechanical stress on the soil due to displacement, compaction and vibrations, which are to be expected during the construction phase, are estimated to be low due to their small size.

During operation, heating of the sediment surrounding the cable systems occurs in a radial direction. Heat will be released due to thermal losses in the cable system during energy transmission.

These thermal losses depend on a number of factors (Table 16). The following output parameters are significant:

- Cable type: in principle, more heat release due to energy losses is to be assumed for AC submarine cable systems with the same transmission efficiency than for DC submarine cable systems (OSPAR COMMISSION 2010).
- Ambient temperature in the vicinity of the cable systems: depending on water depth and season, variation in the natural sediment temperature can be assumed, which has an influence on heat dissipation.
- Thermal resistance of the sediment: different types of soil with different thermal properties occur in the survey area. According to this, more efficient heat dissipation can be assumed for coarser sands than for finer-grained sediments. The thermal resistance is highest in densely deposited clays.

Table 16: Thermal properties of water-saturated soils (according to SMOLCZYK 2001)

Soil type	**Thermal conductivity, minimum**	**Thermal conductivity, maximum**	**Specific thermal resistance, maximum**	**Specific thermal resistance, minimum**
	W / (K*m)	W / (K*m)	K*m / W	K*m / W
Gravel	2.00	3.30	0.50	0.30
Sand	1.50	2.50	0.67	0.40
Clay	0.90	1.80	1.11	0.56
Till	2.60	3.10	0.38	0.32
Silt / mud	1.40	2.00	0.71	0.50

Temperature development in the near-surface sediment layer is also dependent on the depth at which the cable systems are laid. According to available information, no significant effects from cable-induced sediment warming are to be expected if a sufficient laying depth is maintained and if cable configurations according to the state of the art are used. Temperature measurements for an internal AC current cable system at the Danish "Nysted" offshore wind farm in the Baltic Sea showed sediment warming of max. 1.4 K directly above the cable system (transmission capacity 166 MW) 20 cm below the seabed (MEISSNER et al. 2007). Water movement close to the seabed also contributes to a rapid removal of local heat.

However, due to the heterogeneous geological conditions along the cable routes and the available laying methods, the laying depth in the Baltic Sea EEZ is fundamentally limited. Therefore, the definition of a uniformly applicable value for the covering to be created for all planned submarine cable routes does not appear to be advantageous here (see e.g. planning principle 5.4.2.7 BFO-O). Nevertheless, in accordance with the planning principle for covering, a secure depth of the cable systems must be permanently established. Therefore, definition of the coverage to be established is based on an individual approval procedure based on a comprehensive study to be submitted by the project developer. Here the needs of marine environmental protection must also be explicitly considered.

To comply with the "2 K criterion"[40], that is to ensure a maximum temperature increase of 2 degrees at 20 cm below the seabed surface, a corresponding principle for sediment warming was included in the Site Development Plan (see planning principle 4.4.4.8). This principle specifies compliance with the 2 K criterion in order to minimise potential adverse impacts on the marine environment due to cable-induced sediment warming. If there is compliance with the 2 K criterion in accordance with the planning principle, it can be assumed at present that no significant effects, such as structural and functional changes, are to be expected from cable-induced sediment warming of soil as a protected asset.

On the basis of the above statements, it should be noted in the findings of the Strategic Environmental Assessment that, according to the current state of knowledge taking into account damage-reducing measures, no significant effects are to be expected from the laying and operation of submarine cable systems on the soil factor. The extent to which adherence to the 2K criterion can be ensured in all cable route sections, taking into account the local subsoil conditions, must be examined in the context of the individual approval procedure when the detailed project-specific framework conditions become known.

[40] "What is known as the 2 K criterion represents a precautionary value which, in the BfN's estimation, ensures with reasonable certainty, on the basis of available information, that considerable adverse impacts of cable heating on nature or the benthic community are prevented" (http://www.stromeffizienz.de/page/fileadmin/offshore/documents/StAOWind_Workshops/Kabel_in_Schutzgebieten/Kabel_in_Schutzgebieten_Vortrag_Merck.pdf)

4.2 Benthos

The construction of platforms and wind turbines, as well as the installations themselves, may impact on the macrozoobenthos. The species inventory of the Baltic Sea EEZ is to be considered average, with about 260 species of macro-zoobenthos. The benthic communities are also typical of the Baltic Sea EEZ and for the most part have no special features. According to the currently available studies, the macrozoobenthos of the Baltic Sea EEZ is also considered average due to the identified number of Red List species. On the basis of the - macrozoobenthos survey undertaken according to the HELCOM provisions and the HELCOM Red List, at least 30 Red List species occur in the German EEZ according to RACHOR et al. (2013). This corresponds to about 12% of the total species inventory. Studies of macrozoobenthos within the framework of the approval procedures for offshore wind farms from 2002 to 2014 have confirmed this assessment. Also in the area of O-1 and the O-1.3 site, the present investigation results indicate an average importance of the survey area for benthic organisms.

4.2.1 Areas and sites

Due to construction: The deep foundation work for wind turbines will result in disturbances of the seabed, sediment agitation and formation of turbidity plumes. This may result in impairment of or damage to benthic organisms or communities in the immediate vicinity of the installations while construction activities are in progress.

The resuspension of sediment in particular will lead to direct impairments of the benthic community during construction of the installations. Turbidity plumes are to be expected during the foundation work for the installations. However, the concentration of the suspended material normally decreases very rapidly further away. The dispersion of sediment particles is largely dependent on the fine particle levels and the hydrographic situation (particularly waves and current) (HERRMANN & KRAUSE 2000). Due to the prevailing low currents near to the seabed, even in areas with soft sediments turbidity plumes will only occur up to a distance of about 500 m, where the level of suspended matter in the plumes is significantly higher than the natural suspended matter maxima. Simulations show that the sediment released will have resettled after a maximum of 12 hours. According to available information, therefore, the impairments during the construction phase will remain small-scale and generally short-term. Short-term occurrence of elevated concentrations of suspended matter does not appear to be harmful to adult molluscs.

However, eggs and larvae of a species generally react more sensitively than adult animals and could be damaged by turbidity plumes on a short-term and small scale. Although the concentration of suspended particles can reach levels that are harmful to certain organisms, the effects on macrozoobenthos are relatively small, as such concentrations are limited both spatially and temporally (HERMANN & KRAUSE 2000).

In the event of a decline in population due to natural or anthropogenic disturbance (e.g. cable laying), there remains sufficient potential in the overall system for organisms to repopulate (KNUST et al. 2003). Moreover, benthic organisms may be affected on a short-term, small-scale basis by the release of nutrients and pollutants associated with the resuspension of sediment particles. The possible release of pollutants from sandy sediment is negligible due to the relatively low fine grain content (silt and clay) and the low heavy metal concentrations. There may be a significant release of pollutants from the sediment into the bottom water in areas with silty and clay-like seabeds. These pollutants usually adhere to sinking particles which, due to the low currents in the Baltic Sea basins, scarcely drift over long distances and remain in their usual environment. In the medium term, this remobilised material will be redeposited in the silty basins.

Many soft soil types are relatively insensitive to covering and can survive several centimetres of additional sediment deposition (BIJKERK 1988). The construction-related effects of the turbidity plumes and the sedimentation are to be classified as short-term and small-scale.

Dependent on the installation changes in the benthic community may occur as a result of local surface sealing, the insertion of hard substrate and changes in the current conditions around the installations. In addition to local habitat losses or habitat changes, new hard substrate habitats that differ from the existing location habitat are created. Thus influencing of the soft bottom fauna in the immediate environment may occur. According to KNUST et al. (2003), the introduction of artificial hard substrate in sandy soils leads to the settlement of additional species. The recruitment of these species will most likely take place from the natural hard substrate habitats, such as superficial till and rocks. Thus there is little risk of atypical species having a negative influence on the soft-bottom benthic community.

However, the colonisation of artificial hard substrates is associated with an accumulation of organic material, because organic components trickle down from the fauna that resides on the installations (e.g. earth, faeces, dead animals, etc.) (WOLFSON et al. 1979; DAVIS et al. 1982) and settle on the sediment at the foot of the installations. Here they are biodegraded, which can eventually lead to increased carbon and nitrogen levels and thus local oxygen deficiency in this area. These changing environmental conditions in the vicinity of the installations can over the course of time lead to small-scale influencing on the benthic community sited here.

According to available information, operational effects of the wind turbines on the macrozoobenthos are not to be expected.

Given the above statements and representations, the result of the SEA is that according to available information, no significant effects on benthos as a protected asset are to be expected from the specification of the territories and areas in the Site Development Plan. Overall, the effects on benthos as a protected asset are deemed to be short-term and small-scale. Only small-scale areas outside conservation areas will be used, and rapid repopulation is very likely because the populations of benthic organisms with short generation cycles and their widespread distribution in the German Baltic See are usually capable of rapid regeneration.

The impact forecasts described in chapter 4.2.3 apply correspondingly with regard to the construction, installation-related and operational effects of cabling within the wind farms.

4.2.2 Platforms

Due to construction: The deep foundation work for platforms will result in disturbances of the seabed, sediment agitation and formation of turbidity plumes. This may result in impairment of or damage to benthic organisms or communities in the immediate vicinity of the platforms to be erected while construction activities are in progress.

The effects of seabed disturbance, formation of turbidity plumes and sedimentation as described in chapter 4.2.1apply similarly to the construction of platforms. Overall, construction-related effects can be classified as short-term and small-scale.

Due to the installation, the sealing of local surfaces, the introduction of hard substrate and changes in the current conditions around the platforms may lead to changes in the benthic community. Besides habitat losses and habitat changes, new non-native hard substrate habitats will emerge. This will allow the soft soil fauna in the immediate vicinity to be influenced. The installation-related effects described in chapter 4.2.1 also apply similarly to the platforms. Although the effects are long-term, they are limited to the immediate vicinity of the platforms on a small scale.

Due to operation, the removal of cooling water and the introduction of heated water may result in damage to the eggs and larval stages of macrozoobenthos. If seawater is extracted for cooling purposes, the eggs and larval stages of various macrozoobenthos species are also sucked up and damaged or killed by the subsequent passage and heating. However, the amount of water removed is very small in relation to the size of the water body in which the eggs and larvae are distributed, so relevant effects on the population level are not to be expected at present.

The sea water required to cool the units is released back into the environment at a maximum temperature of 35 °C. This leads to local warming. In principle, increases in water temperature will lead to changes in the faunal communities, or to lethal damage to eggs and larvae at very high temperatures.

However, the amount of cooling water returned is very small in relation to the size of the water body in which the eggs and larvae are distributed, so there is no need to fear relevant effects on the eggs and larvae of macrozoobenthos.

Given the above statements and representations, the result of the SEA is that according to available information, no significant effects on benthos as a protected asset are to be expected from the specification of the platform locations in the Site Development Plan. Overall, the effects on benthos as a protected asset are deemed to be short-term and small-scale. Only very small-scale areas outside conservation areas will be used, and rapid repopulation is very likely because the populations of benthic organisms with short generation cycles and their widespread distribution in the German Baltic See are usually capable of rapid regeneration.

4.2.3 Submarine cabling systems

Due to construction: Possible effects on the benthos are dependent on the laying methods used. Only small-scale, short-term and thus minor disturbances of the benthos in the vicinity of the cable route are to be expected with the comparatively careful laying using the induction method. Local sediment rearrangement and turbidity plumes are to be expected during the laying of the submarine cable systems. This may result in small-scale and short-term habitat loss for benthic species or impairment of or damage to benthic organisms or communities in the vicinity of the cable systems while construction activities are in progress.

In more cohesive substrates, the cable systems are laid in trenches or laid using a heavy plough. These procedures are also associated with disturbance of the sediment and benthic fauna, as well as sediment turbulence. The dispersion of sediment particles is largely dependent on the fine particle levels and the hydrographic situation (particularly waves and current) (HERRMANN & KRAUSE 2000). Due to the prevailing low currents near to the seabed, even in areas with soft sediments turbidity plumes will only occur up to a distance of about 500 m, where the level of suspended matter in the plumes is significantly higher than the natural suspended matter maxima. Simulations show that the sediment released will have resettled after a maximum of 12 hours.

According to available information, therefore, the impairments during the construction phase will remain small-scale and generally short-term. Short-term occurrence of elevated concentrations of suspended matter does not appear to be harmful to adult molluscs. Growth of filter-feeding molluscs may even be promoted. However, eggs and larvae generally react more sensitively than adult animals and could be damaged by turbidity plumes on a short-term and small scale. Although the concentration of suspended particles can reach levels that are harmful to certain organisms, the effects on macrozoobenthos are relatively small, as such concentrations are limited both spatially and temporally (HERMANN & KRAUSE 2000).

In the event of a decline in population due to natural or anthropogenic disturbance (e.g. cable laying), there remains sufficient potential in the overall system for organisms to repopulate (KNUST et al. 2003). According to BOSSELMANN (1989), dispersion occurs not only through the larval stages, but also through the dispersion of postlarval and adult forms. Furthermore, accompanying surveys of the benthos and fish and decapod fauna (crabs) in the case of the Europipe pipeline laid in the North Sea in 1994 showed that just two years after completion of the construction work, the communities were already showing a clear return to the condition they were in prior to the construction work. It was assumed there that it would no longer be possible to identify the effects of the construction work two to three years after the construction activities (KNUST et al. 2003). The linear nature of the submarine cable systems favours repopulation from the undisturbed peripheral areas. In the monitoring of the Nord Stream pipeline (2011-2013) repopulating of the affected areas in the Bay of Greifswald and Pomeranian Bight by all native species was recorded. After two years, the community structure of the benthic organisms and abundance in the affected areas did not differ significantly from that of the reference areas. The total biomass of the benthic communities in the area of the filled trench after 2 years was still 50% lower compared to the reference areas because of the relatively slow growth of the long-lived mussel *Mya arenaria* (NORD STREAM 2014).

Moreover, benthic organisms may be affected on a short-term, small-scale basis by the release of nutrients and pollutants associated with the resuspension of sediment particles. The oxygen content may decrease if organic substances are dissolved (HERRMANN & KRAUSE 2000). The possible release of pollutants from the sandy sediment is negligible due to the relatively low fine grain content (silt and clay) and the low heavy metal concentrations. There may be a significant release of pollutants from the sediment into the bottom water in the vicinity of silty and clay-like seabeds. These pollutants usually adhere to sinking particles which, due to the low currents in the Baltic Sea basins, scarcely drift over long distances and remain in their usual environment. In the medium term, this remobilised material will be redeposited in the silty basins.

Potential effects that may result from repair work that may become necessary are comparable to the possible effects due to construction. As the damaged cable section can be located quite precisely as described, the effects are likely to be limited directly to the cable section in question.

If, due to geological conditions, it becomes necessary in local areas to lay individual cable sections directly on the seabed, benthic communities are directly overbuilt in the area of the cable route. This also applies to rockfill in the area of cable crossings. The resulting loss of habitat is permanent, but very small in scale.

<u>Dependent on the installation:</u> The locally necessary rockfill represents a permanent non-local hard substrate. This will offer a new habitat for the benthos, making it possible for species and communities to settle even in areas where they were not found previously, allowing them to extend their distribution ranges (SCHOMERUS et al. 2006).

<u>Operational</u> heating of the top sediment layer of the seabed may occur directly above the cable system, causing a reduction in winter mortality of the infauna which can lead to a change in species communities in the area of submarine cable routes. In this case, cold-water-loving species (e.g. *Arctica islandica*) which occur regionally particularly in deeper areas can be displaced from the area of the cable routes.

According to available information, no significant effects from cable-induced sediment warming are to be expected if a sufficient laying depth is maintained and if cable configurations according to the state of the art are used.

Due to the heterogeneous geological conditions along the cable routes and the available laying methods, the laying depth in the Baltic Sea EEZ is fundamentally limited. Therefore, the definition of a uniformly applicable value for the covering to be created for all planned submarine cable routes does not appear to be advantageous here. Accordingly, the planning principle 4.4.4.7 only requires a covering for the Baltic Sea without specification of a uniform value. Nevertheless, in accordance with the planning principle for covering, a secure depth of the cable systems must be permanently established. Therefore, definition of the coverage to be established is based on an individual approval procedure based on a comprehensive study to be submitted by the project developer. Here the needs of marine environmental protection must also be explicitly considered.

To comply with the 2K criterion, a corresponding principle for sediment warming was included in the Site Development Plan (see planning principle 4.4.4.8). This principle establishes compliance with the 2K criterion in order to reduce as much as possible the potential harm to the marine environment from cable-induced sediment warming. If the 2K criterion is adhered to in accordance with the planning principle and taking into account the fact that the effects are small-scale, that is occur only a few meters on each side of the cable, it can be assumed that no significant effects on the benthic communities are to be expected as a result of cable-induced sediment warming.

The same assumptions apply to electric or electromagnetic fields. Likewise, these are not expected to have any significant effects on macrozoobenthos. Electric fields outside the cable systems can be avoided with AC Subsea Cable Systems by use of suitable insulation or by appropriate cable configuration, so that significantly measurable electric fields do not occur. Avoidance behaviour of benthic organisms above cable systems is not known of (KNUST et al., 2003). Investigations into some cancers and mussels did not provide any evidence of harm to the animals due to low-frequency static magnetic fields in the µT range (BOCHERT & ZETTLER 2004).

Individual cable magnetic fields arising during operation largely cancel each other out in the planned three-wire AC Subsea Cable Systems and are significantly below the amplitude of the earth's natural magnetic field. Modelling for DC submarine cable systems resulted in values from 11 to max. 15 µT at the surface of the seabed (PGU 2012a & b). In comparison, the Earth's natural magnetic field is 30 to 60 µT, depending on its location. Due to the lower load current and the three-wire technology, a weaker magnetic field can be assumed for AC Subsea Cable Systems than for a DC Subsea Cable System. Values of the order of less than 10 µT are to be expected for AC Subsea Cable Systems. The strongest magnetic fields occur directly above the cable. Further away, the strength of the fields decreases relatively quickly.

On the basis of the above statements, it should be noted in the findings of the Strategic Environmental Assessment that, according to the current state of knowledge taking into account damage-reducing measures, no significant effects are to be expected from the laying and operation of submarine cable systems on the factor Benthos. The extent to which adherence to the 2K criterion can be ensured in all cable route sections, taking into account the local subsoil conditions, must be examined in the context of the individual approval procedure when the detailed project-specific framework conditions become known. These route-related findings must be considered accordingly in determining the required covering (see e.g. planning principle 4.4.4.7).

4.3 Biotopes

According to statements of the Federal Agency for Nature Conservation, unlike the FFH assessment of the implications in section 34 of the Federal Nature Conservation Act according to section 30 of the Federal Nature Conservation Act, the assessment of the presumably significant environmental impacts by rules of the Site Development Plan with regard to biotopes, as in the case of the BFO, is not required to accumulate any impairment due to various acts. Accordingly, no cumulative consideration of individual rules is made.

4.3.1 Areas and sites

Possible effects of territories and areas on biotopes as a protected asset may result from direct use of protected biotopes due to the foundations of the wind turbines, possible covering by sedimentation of material released during construction and potential habitat changes.

Considerable use of protected biotopes by the installations due to construction is not to be expected, as protected biotopes according to section 30 of the Federal Nature Conservation Act are to be avoided as far as possible within the framework of the specific approval procedure. Given the predominant sediment composition in areas in which protected biotopes can be expected to occur, impairments due to sedimentation are likely to be small-scale as the released sediment will settle quickly. Given the predominant low currents close to the seabed, turbidity plumes can only be expected in areas with soft sediments up to a distance of approx. 500 m which clearly exceed natural suspended matter maxima. The released material remains in the water column for long enough to be distributed over a large area, so barely detectable thicknesses of the deposited material are to be expected due to the comparatively small volumes. Simulations show that the sediment released will have resettled after a maximum of 12 hours. Thus, according to available information, the impairments will generally remain small-scale and temporary.

Due to the installation, permanent habitat changes will occur; although these will be limited to the immediate vicinity of the installations. The artificial hard substrate will provide benthic organisms with a new habitat and may lead to a change in species composition (Schomerus et al. 2006). Significant effects on biotopes as a protected asset are not to be expected on account of these small-scale areas. In addition, the recruitment of species will most likely take place from the natural hard substrate habitats, such as superficial till and rocks. Thus there is little risk of atypical species having a negative influence on the soft-bottom benthic community.

According to available information, operational effects of the wind turbines on biotopes are not to be expected.

The impact forecasts described in chapter 4.3.3 apply correspondingly with regard to the construction and installation-related effects of cabling within the wind farms.

4.3.2 Platforms

Possible effects of platforms on biotopes as a protected asset may result from direct use of protected biotopes due to the foundations of the platforms, possible covering by sedimentation of material released during construction and potential habitat changes.

The construction-related and installation-related effects on biotopes through direct use, sedimentation and habitat change as described in chapter 4.3.1 also apply similarly to the construction of platforms. Overall, construction-related and installation-related effects can be classified as short-term and small-scale. According to available information, operational effects on biotopes due to the platforms are not to be expected.

4.3.3 Submarine cabling systems

Potential construction-related effects of submarine cable systems on biotopes as a protected asset may result from direct use of protected biotopes, possible covering by sedimentation of released material and potential habitat changes. Direct use of protected biotopes will be avoided as far as possible through the planning of submarine cable systems. Furthermore, protected biotope structures according to section 30 of the Federal Nature Conservation Act are to be treated as being of special importance within the framework of the specific approval procedure and avoided as far as possible within the framework of fine routing (see planning principle 4.4.4.9).

Given the predominant sediment composition in areas in which protected biotopes can be expected to occur, impairments due to covering are likely to be small-scale as the released sediment will settle quickly. Given the predominant low currents close to the seabed, turbidity plumes can only be expected in areas with soft sediments up to a distance of approx. 500 m which clearly exceed natural suspended matter maxima. The released material remains in the water column for long enough to be distributed over a large area, so barely detectable thicknesses of the deposited material are to be expected due to the comparatively small volumes. Simulations show that the sediment released will have resettled after a maximum of 12 hours. Thus, according to available information, the impairments will generally remain small-scale and temporary.

Installation-related, permanent habitat alterations are confined to the immediate rockfill area, which is required for cable crossing or in the event that it is necessary to lay local cable sections on the seabed. These rockfills will permanently provide a hard, non-native substrate. This will provide benthic organisms with a new habitat and may lead to a change in species composition (SCHOMERUS et al. 2006). Significant effects on the factor Biotopes due to these small-scale regions are not to be expected. In addition, the recruitment of species will most likely take place from the natural hard substrate habitats, such as superficial till and rocks. Thus there is little risk of atypical species having a negative influence on the soft-bottom benthic community.

4.4 Fish

The species composition for fish fauna in the area is typical. In all areas, the fish community is dominated by cod, herring, sprat and flatfish, which is typical of the Baltic Sea.

4.4.1 Areas and sites

According to current knowledge, the planned locations are not a preferred habitat for any of the protected fish species. Consequently, the fish population in the planning area is of no prominent ecological importance.
The construction and operational effects of the wind farms on fish fauna will be limited spatially and temporally. Construction activities will lead to sediment agitation and turbidity plumes, which – although limited in terms of time and specific to species – may cause physiological impairments and deterrence. Carnivorous predators such as mackerel and horse mackerel avoid high-sediment areas and thus avoid the risk of gluing up of the gill apparatus (EHRICH & STRANSKY 1999). Due to their high mobility these species do not appear to be threatened as a result of the resuspension of sediment. Also adverse effects on bottom-dwelling fish are not to be expected as a result of their good swimming abilities and associated alternatives. Amongst plaice and sole, increased food foraging activity was detected after storm-induced resuspension of sediment (EHRICH et al., 1998). Essentially, fish can avoid disturbances due to their pronounced sensory abilities (lateral line) and their high

mobility, so that adverse effects are unlikely for adult fish. Eggs and larvae in which receipt, processing and then acting upon sensory stimuli is not or only slightly pronounced are generally more sensitive than their adult conspecifics. However, the spawning areas of most fish species are located either outside the developing wind farm areas in the German EEZ either near to the coast (spring spawning Baltic herring, OEBERST et al., 2009) or in the deep basin (Baltic cod, KÖSTER et al., 2005). After fertilisation, fish eggs form the dermis, which strengthens them against mechanical action, e.g. against whirled up sediment. The early stages of life may also be adapted to turbulence, as it regularly reoccurs as a result of natural phenomena such as storms or currents. It is likely that during the construction phase there will be short, intense sound events, especially during construction of the foundations that will deter fish. The sound intensity and frequency spectrum generated during pile driving can be perceived by almost all fish (KNUST et al., 2003). However, the range of perception and possible species-specific behavioural reactions have scarcely been studied thus far. The sound pressure generated during pile driving was sufficient to cause internal bleeding and barotrauma of the swim bladder in cod (*Gadus morhua*). This effect was detected at a distance of 1400 m or closer to a ram sound source (DE BACKER et al., 2017). However, here too an escape response of the fish is to be assumed; a return after the end of the disturbance is likely. Building activity in the "alpha ventus" test field in the southern North Sea resulted in a sharply reduced deep-sea fish population relative to the surrounding area (KRÄGEFSKY 2014), and also in the "BARD Offshore 1" project area there was clear evidence during the three-year construction phase of temporary repelling effects, probably caused by pile driving and increased shipping traffic. The fish returned quickly to the areas avoided previously after completion of pile driving. Hydroacoustic surveys at the first German wind farm "alpha ventus" showed a reduced fish density during the construction phase, probably due to pile driving and other construction activities. Neither deterrence nor attraction could be proven during subsequent operation (KRÄGEFSKY 2014). This finding was confirmed for the "BARD Offshore 1" and "Global Tech 1" wind farms for Atlantic herring (*Clupea harengus*) and European sprat (*Sprattus sprattus*) (FLOETER et al. 2017). An increased density of individuals near the turbine foundations (SCHRÖDER et al. 2013, KRÄGEFSKY 2014) suggests a trophic relationship between pelagic fish and vegetation, but hard substrate-associated organisms for Atlantic mackerel (*Scomber scombrus*) and Atlantic horse mackerel (*Trachurus trachurus*) are only insignificant food components (KRÄGEFSKY 2014). The filter-feeding species that make up most of the vegetation at the foundations could influence plankton density, which is also crucial for plankton-eating fish. However, this could not be measured by means of the abundance of pelagic fish. Instead, significantly increased meroplankton densities were observed in water bodies that had previously flowed through a wind farm (FLOETER et al. 2017). As fishing at the wind farms will largely be excluded, the installation of wind farms will create retreat areas from which the surrounding areas could also receive fish.

4.4.2 Platforms

The species composition for fish fauna in the vicinity of the planned converter platforms is also typical. In all areas, the fish community is dominated by cod, herring, sprat and flatfish, which is typical of the Baltic Sea. According to available information, the planned converter sites are not a preferred habitat for any of the protected fish species. As a result, the fish population in the vicinity of the planned converter platforms is of no prominent ecological importance. The construction, installation-related and operational effects of the converter platforms on fish fauna will be limited spatially and temporally.

Due to construction: construction activities cause resuspension of sediment and turbidity plumes, which can cause temporary and species-specific physiological adverse effects as well as deterrence effects. Open water-hunting predators such as mackerel and horse mackerel avoid areas with high sediment loads and thus avoid the risk of gluing up of the gill apparatus with an associated respiratory harm (EHRICH & STRANSKY 1999). Threatening of these species as a result of resuspension of sediment therefore seems unlikely due to evasive behaviour. Adverse effects on bottom-dwelling fish are not to be expected. For example, amongst plaice and sole, increased food foraging activity was detected after storm-induced resuspension of sediment (EHRICH et al. 1998). Overall, therefore, minor adverse effects are to be expected for adult fish. Due to the dominant sediment characteristics, the released sediment will settle quickly. Thus, the adverse effects are likely to remain small-scale and temporary. A short-term increase in sediment concentration in water does not seem to be harmful to adult fish, as fish avoid such areas (IFAF 2004). However, eggs and larvae are more sensitive than the adult animals, so that as a result of the turbidity plumes short-term and small-scale damage to fish eggs and fish larvae is possible. For most of the fish species occurring in the EEZ, spawning damage is not to be expected since the possible adverse effects acting on fish spawn depend on the reproduction strategy. The eggs of deep-sea spawning fish have a protective layer that protects them from mechanical effects, e.g. swirled up sediment. Although the concentration of suspended particles may reach values that are harmful to certain organisms, the effects on the fish are considered to be relatively low, since such concentrations are limited in time and space (HERMANN & KRAUSE 2000). This also applies to possible increases in the concentration of nutrients and pollutants due to resuspension of sediment particles, which are quickly reduced again by dilution and distribution effects (ICES 1992, 1998). The building activities result in noise emissions, which can exert a deterrence effect on fish. It is likely that during the construction phase short, intense sound events, especially during construction of the foundations will have a repelling effect. However, it is to be expected that the fish will return to the area after the noise source is eliminated. At sufficiently high intensity, physiological damage to the hearing apparatus or other organs with lethal consequences is conceivable. This applies in particular to noise emissions during pile driving (WOODS et al. 2001). KNUST et al. (2003) assume that the sound emissions during pile driving can be detected by almost all fish species due to the high sound intensity and the generated sound spectrum. However, the range of detection and possible species-specific behavioural responses have not been sufficiently investigated. The study of the construction-related effects of wind turbines on fish in the test field "alpha ventus" (KRÄGEFSKY 2014) demonstrated a deterrence effect of the construction measures, based on the greatly reduced population of deep-sea fish in the alpha ventus area during construction relative to the surrounding area. Also in the project area "BARD Offshore 1" during the three-year construction phase, there were clear indications of temporary repelling effects which presumably were primarily noise-induced. The small-area findings indicate a repelling effect and thus an adverse effect on the fish fauna for the areas affected by noise emissions in the construction area (intensification of shipping traffic) and during pile driving. However, the results also confirm that after completion of pile driving the respective areas are quickly re-populated by the fish fauna. Five months after pile driving, no significant effects could be found in the fish communities (PGU 2013). During construction of the converter platforms, noise emissions will result from the use of ships, cranes and construction platforms as well as the installation of platform foundations. The risk to the fish from the sound input from pile driving is expected to be reduced by mandated measures to reduce noise. Partial aspects of the deterrence measures for marine mammals are also likely to be applicable to fish. In accordance with the planning principle for noise reduction during pile driving, the noise protection value must comply with a sound exposure level of less than 160 dB re 1µPa²s outside a circle with a radius of 750 m around the piling or insertion point.

Due to the installation: The construction of the foundations of the converter platforms and the scour protection will build over local habitats. Demersal fish will lose habitats permanently as a result, but on a very small scale. An increase in the local biomass is predicted in all known studies to date due to the assumed colonisation of the foundation surfaces by benthic and algae species, which may lead to expansion of the food spectrum and food availability for individual species, as well as an increase in species diversity. While individual studies show attraction for demersal fish, these have not yet been demonstrated for the highly mobile pelagic species.

Due to operation: The converter platforms do not pose any significant risk to fish during operation. The removal of cooling water and the discharge of heated water may lead to impairment of fish larvae, but relevant effects on the ichthyoplankton or the fish community are not to be expected as the amount of water removed and heated is very small in relation to the size of the water body in which it is distributed.

In summary, it can be stated that given available information and taking into account the assessment of the situation, it is unlikely that the planned converter sites will significantly impair fish as a protected asset. The effects of construction on fish fauna are not considered to be significant overall, as they are small-scale and short-term in nature. Noise emissions from the construction phase are to be reduced by means of suitable measures. The specific design of these measures is to be dealt with by the individual approval procedure. No significant effects are to be expected with regard to possible operational effects of the converter platforms, either.

4.4.3 Submarine cabling systems

The species composition for fish fauna on the intended submarine cable routes is also typical. In all areas, the fish community is dominated by cod, herring, sprat and flatfish, which is typical of the Baltic Sea. According to current knowledge, the planned submarine cable routes are not a preferred habitat for any of the protected fish species. As a result, the fish population in the vicinity of the planned submarine cable routes is of no prominent ecological importance. The construction, installation-related and operational effects of the laying of submarine cables on fish fauna will be limited spatially and temporally.

Due to construction: When laying the cable systems, turbidity plumes may occur temporarily and local sediment agitation may occur. This may result in impairment of or damage to fish in the vicinity of the cable systems while construction activities are in progress. The released sediment will settle quickly due to the predominant sediment composition. Thus, the adverse effects remain temporary and small-scale. Fish may also be deterred temporarily, resulting in small-scale and short-term habitat loss due to construction-related noise and vibrations. A short-term increase in the concentration of sediment particles does not appear to be harmful for adult fish, as it is known that fish avoid areas with high levels of anthropogenic sediment agitation (IFAF 2004). These include predators that hunt in open waters, such as Atlantic mackerel and Atlantic horse mackerel, which avoid areas with high sediment loads, thereby avoiding the risk of the gills sticking together and restricting their respiration (Ehrich & Stransky 1999). However, eggs and larvae of a species are more sensitive than adult animals, so turbidity plumes may cause short-term and small-scale damage to fish eggs and larvae. For most fish species occurring in the EEZ, however, spawn damage is not to be expected as the potential impairment of fish spawn is dependent on the reproduction strategy. The eggs of pelagic spawning fish usually have a protective layer that protects them from mechanical effects caused by agitated sediments. Although the concentration of suspended particles may reach values that are harmful to certain organisms, the effects on fish are to be regarded as relatively small since such concentrations occur only spatially and temporally and are rapidly degraded again by dilution and distribution effects (Herrmann & Krause 2000). This also applies to potential increases in the concentration of nutrients and pollutants due to the resuspension of sediment particles (ICES 1992, 1998). The primary risk during sedimentation of the released substrate is that fish spawn deposited on the seabed may be covered. This may result in an insufficient supply of oxygen to the eggs and potentially leading to damage to or even death of the spawn, depending on efficiency and duration. For most fish species occurring in the EEZ, spawn damage is not to be expected as they either have pelagic eggs and/or their spawning sites are in shallow waters outside the EEZ. Moreover, the fish fauna is adapted to the natural sediment agitation that is typical here, caused by storms.

Due to operation: Generation of magnetic fields cannot be ruled out when submarine cables are operated. However, electric fields cannot be measured in either DC or AC submarine cable systems. The magnetic fields of the individual cable systems will be largely eliminated in the planned bipolar (outbound and return conductors) or three-wire cable configurations. Modelling for DC submarine cable systems resulted in values from 11 to max. 15 µT at the surface of the seabed (PGU 2012a & b). In comparison, the Earth's natural magnetic field is 30 to 60 µT, depending on its location. Due to the lower load current and the three-wire technology, a weaker magnetic field can be assumed for AC Subsea Cable Systems than for DC Subsea Cable Systems. Values of less than 10 µT are to be expected for AC Subsea Cable Systems. The strongest magnetic fields occur directly above the cable system. Further away from the cable system, the strength of the fields decreases relatively quickly. Orientation to the Earth's magnetic field is documented for a number of fish species, in particular migratory species such as Atlantic salmon and European eel. These species can perceive electric fields, which in some cases may lead to behavioural changes (Marhold & Kullink 2000, Öhmann 2007). According to Kullink & Marhold (1999), potential impairment of the orientation behaviour of adult individuals of species that use electric or magnetic fields for orientation (such as eels, sharks and salmon) is at most short-term, as experiments on the Baltic Sea eels have shown. Fish rely on different environmental parameters which are responsible for orientation in interaction.

In summary, it can be stated that according to available information, no significant impairment of fish as a protected asset is to be expected from the laying and operation of submarine cables. The overall impact of construction on fish fauna is not considered to be significant. As far as possible operational effects of the submarine cable systems are concerned, such as magnetic fields and the temperature increase of the sediment, no significant effects are to be expected either.

4.5 Marine mammals

4.5.1 Areas, sites and platforms

The three areas O-1, O-2 and O-3, like the entire western Baltic Sea, are part of the harbour porpoise habitat. According to the current state of knowledge, the three areas are used by harbour porpoises as transit areas. There is currently no evidence that these three sites have special functions as feeding grounds or rearing areas for harbour porpoises. Harbour seals and grey seals use areas O-1 and O-2 only sporadically as transit areas. On the basis of the findings from the monitoring of the Natura 2000 sites and investigations for offshore wind farms, a low to medium significance of the three sites for harbour porpoises can currently be inferred. These sites have no special significance for harbour seals and grey seals.

Due to construction: dangers may be caused for harbour porpoises, grey seals and harbour seals resulting from noise emissions during the installation of the foundations of wind turbines and transformer platforms where these are constructed as pile-driven foundations, if no mitigation and prevention measures are implemented.

In order to estimate the possible effects and potential risks for marine mammals, knowledge of the hearing of marine mammals is required, as well as knowledge of the intensity of sound emissions during pile-driving. To date, there exists only incomplete knowledge about the hearing of marine mammals, about the potential hazards of various activities and about hearing thresholds or changes in hearing thresholds (RICHARDSON 2002).

The first results on the acoustic resilience of harbour porpoises were obtained within the framework of the MINOSplus project. Following exposure to noise with a maximum receiving level of 200 pk-pk dB re 1 µPa and an energy flux density of 164 dB re 1 µPa2/Hz, a temporary threshold shift (known as a TTS) was detected for the first time at 4 kHz in an animal in captivity. It also showed that the threshold shift lasted more than 24 hours. Behavioural changes were registered in the animal from a receiving level of 174 pk-pk dB re 1 µPa (LUCKE et al. 2009). Besides the absolute volume, the duration of the signal also determines the effects on the exposure limit. The exposure limit decreases as the duration of the signal increases, i.e. permanent exposure may result in damage to animals' hearing even at lower volumes. On the basis of these latest findings, it is clear that harbour porpoises are subject to a threshold shift above 200 decibels (dB) at most, which may also result in damage to vital sensory organs. The scientific evidence that has led to the recommendation or establishment of noise control limits is based mainly on observations in other cetacean species (SOUTHALL et al. 2007), or on experiments on harbour porpoises in captivity using what are known as airguns or air pulsers (LUCKE et al. 2009).

Without the use of noise reduction measures, considerable impairments of marine mammals could not be excluded during installation in individual subareas. Therefore, insertion of the piles of wind turbines and transformer platforms will only be permitted in the specific approval procedure provided effective noise reduction measures are implemented. For this purpose, the plan includes a specification regarding the noise reduction principle. This states that pile driving of the foundations should only be performed in compliance with strict noise reduction measures. In the specific approval procedure, extensive noise reduction and monitoring measures are mandated so that the applicable noise protection values are met. A maximum sound exposure level (SEL) of 160 dB re 1µPa²s and a peak sound pressure level of 190 dB re 1µPa are specified at a distance of 750 m from the pile driving or insertion location. Appropriate measures must be implemented so as to ensure that no marine mammals are present in the vicinity of the pile driving site. During pile driving in particular, direct disturbances of marine mammals at individual level are to be expected for a limited time. Currently, the duration of pile driving for transformer platform installation is estimated at no more than one week; here the effective pile driving time, including deterrence, is about three hours. A loss of habitat around the construction site is to be expected during installation of the foundations. The effective pile driving time (including deterrence) to be adhered to in each case is specified in the approval procedure for specific sites and installations. Within the framework of the enforcement procedure, the coordination of noise-intensive work with other construction projects is also reserved so as to prevent or reduce cumulative effects.

The noise control limit recommended by the Federal Environment Agency has already been devised by means of preparatory work in various projects (UNIVERSITY OF HANOVER, ITAP, Research and Technology Centre 2003). For precautionary reasons, "margins of safety" were taken into account, e.g. for the previously documented interindividual distribution of hearing sensitivity, and above all because of the problem of repeated exposure to loud noise impulses as will occur during pile driving of foundations (ELMER et al., 2007). At present, only very limited reliable data is available for the purposes of evaluating the duration of exposure to noise from pile driving. However, pile driving that may take several hours has much higher potential for harm than the driving of a single pile. Currently, it is not clear what reduction should be applied to value the above limit for a sequence of individual events. A margin of 3 dB to 5 dB for each tenfold increase in the number of pile driving pulses is being discussed in expert circles.

The noise control limit used in approval practice is below the limit proposed by SOUTHALL et al. (2007), due to the uncertainties shown here in the evaluation of the exposure time. Nevertheless, on the basis of the new scientific work, it can be assumed that the noise protection values must be complied with to be able to prevent injuries to harbour porpoises with the required degree of certainty.

Since 2011, all construction projects in the German North and Baltic Sea EEZs have used technical noise reduction measures. In 2012 and 2013, the noise protection values could not always be reliably complied with. The lack of continuous compliance with noise protection values was linked to the lack of practical experience in the development and application of noise reduction measures. However, with the support of offshore operators and federal research projects, highly effective technical developments have been progressed. The development of technical noise protection in offshore construction sites has meant that since 2014 noise protection values have been reliably complied with and even undershot. Since 2014, events where the noise protection values have been exceeded have been rare, and have been associated with unforeseeable technical defects in the noise reduction systems.

In 2016, the "Viking" project was constructed in area O-1. The formation of the foundations on jacket structures was performed by pile driving. In 2017, the foundations were installed on monopiles for the project "Arkona Basin Southeast". Despite the difficult ground conditions, the use of combined noise protection measures consisting of an advanced bubble curtain system and a pile-near system ensured dependable compliance with the noise protection values and even undershooting of the sound exposure level SEL_{05} at 750 m distance by up to 6 dB re $1µPas^2$ were achieved. Equally good results were achieved during the installation of monopiles in the North Sea EEZ.

The results from existing applications of noise reduction systems confirm that, using suitable measures, it is possible to reduce the single event level (SEL) of the piling at a distance of 750 m to less than 160 dB re 1µPa.

The extent of the obligations required at licensing level is determined by the assessment of the individual project at site and project level on the basis of wildlife conservation and territorial protection requirements. In general, the above considerations for harbour porpoises relating to noise emissions arising from transformer platform construction activities also apply to grey seals and harbour seals. To assess the effects of stratification of the water under certain hydrographic conditions on the propagation of sound input from pile driving operations in the Baltic Sea and, if necessary, to be able to implement additional measures, special monitoring measures are mandated as part of the execution of individual projects.

In summary, it can be assumed, based on the latest scientific findings, that the noise from pile driving, without the use of deterrence and reduction measures, will have significant effects on marine mammals. However, current technical developments in the field of underwater noise reduction show that the use of suitable measures can significantly reduce or even eliminate the risk of the effects of noise pollution on marine mammals.

On the basis of the functional importance of the areas for harbour porpoises and the regulations implemented in the site development plan for the reduction of sound inputs, the effects of wind turbines and transformer platforms on harbour porpoises are evaluated in Table 17. The exclusion of the construction of wind turbines and transformer platforms in Natura 2000 sites helps to reduce the risk to harbour porpoises in important nature conservation areas.

Table 17: Assessment of the impact of wind turbines and transformer platforms on harbour porpoises in relation to the function and significance of the individual areas.

Effects	Area	Function	Importance	Estimation[1]
Construction phase (time limited, local, medium impact at most)	O-1	Migration area	medium	negligible
		Feeding ground	medium	negligible
		Rearing ground	low	negligible
	O-2	Migration area	medium	negligible
		Feeding ground	low	negligible
		Rearing ground	none	negligible
	O-3	Migration area	low	negligible
		Feeding ground	low	negligible
		Rearing ground	none	negligible
Operating phase (local, permanent low impact arising from attraction effects)	O-1	Migration area	medium	negligible
		Feeding ground	medium	negligible
		Rearing ground	low	negligible
	O-2	Migration area	medium	negligible
		Feeding ground	low	negligible
		Rearing ground	none	negligible
	O-3	Migration area	low	negligible
		Feeding ground	low	negligible
		Rearing ground	none	negligible

[1] Assuming strict compliance with noise reduction measures according to the planning principle.

<u>Operational and installation-related:</u> Based on the current state of knowledge, substantial effects caused by the transformer platforms on marine mammals during the operating phase can be excluded. Thus, investigations into the operating noise of wind turbines in the "alpha ventus" test field have shown that the operating noise levels scarcely differ from background noise levels at distances of a few hundred meters (BETKE et al. 2012). The results support the assumption that at a distance of 1000 m from the wind turbine the noise level is 12 to 15 dB below the hearing level of the porpoise. Based on the current state of knowledge, comparable noise levels can be expected at most from transformer platform operation. However, in accordance with the established approval practices, it is also stipulated for the transformer platforms that only state-of-the-art technology is to be used that ensures the lowest possible noise emissions in the water body.

A study conducted on the Dutch offshore wind farm "Egmond aan Zee" provides new findings on the habitat use of offshore wind farms during operation. With the aid of acoustic recording, the use of the site of the wind farm or of two reference sites by harbour porpoises was investigated before the turbines were constructed (baseline survey) and in two consecutive years of the operating phase. The results of the study confirm a pronounced and statistically significant increase in acoustic activity in the inner area of the wind farm during the operating phase compared to activity or use during the baseline survey (SCHEIDAT et al. 2011). The increase in harbour porpoise activity within the wind farm during operation significantly exceeded the increase in activity in both reference areas. The increase in use of the wind farm area was clearly independent of seasonality and interannual variability. The authors of the study see a direct correlation between the presence of the turbines and the increased use by harbour porpoises. They suspect the causes lie in factors such as the increase in the food supply by what is known as the "reef effect" or the calm waters in the site due to the absence of fishing and shipping, or possibly a positive combination of these factors. Also, results from "Horns Rev I" indicate an increased presence of harbour porpoises inside the wind farm during the operating phase in comparison with the baseline survey (BLEW et al. 2006).

On the basis of the above statements, it should be noted in the conclusion to the Strategic Environmental Assessment that during the pile driving significant negative impacts on marine mammals in partial areas cannot be excluded. Therefore, the plan includes a noise reduction principle for the construction of transformer platforms. Assuming compliance with existing noise protection values after implementation of the noise reduction measures mandated in the individual approval procedure in accordance with the planning principle and because of the high mobility of the animals, no significant adverse effects on marine mammals are currently expected.

4.5.2 Submarine cabling systems

Due to construction: During the installation phase, which is limited temporally and spatially, short-term deterrence for marine mammals may occur due to construction-related shipping traffic. However, these effects will not go beyond the disruptions generally associated with slow ship movements. As the Baltic Sea is intensively used for shipping, no significant additional disruption of marine mammals is to be expected due to the increased shipping traffic arising during the construction phase or subsequently for repair and maintenance purposes. Possible changes in the sedimentary structure and associated temporary benthos changes have no effect on marine mammals because marine mammals hunt their prey in extensive areas in the water column.

Operational sediment warming has no direct effect on highly mobile animals such as marine mammals. The influence of electromagnetic fields from submarine cables on the migration behaviour of marine mammals is largely unknown (GILL et al. 2005). However, since the magnetic fields occurring are significantly below the Earth's natural magnetic field, no significant effects on marine mammals are to be expected.

As a result of the Strategic Environmental Assessment, it should be noted that based on the current state of knowledge no significant effects on the factor Marine mammals are to be expected due to the laying and operation of submarine cable systems.

4.6 Seabirds and resting birds

All existing findings point to a medium importance for area O-1, and low importance for areas O-2 and O-3 for seabirds and resting birds. On the whole, area O-1 has an average incidence of seabirds and similarly only an average incidence of endangered species and species requiring special conservation measures. Areas O-2 and O-3 have a low incidence of endangered species and species that are particularly worthy of protection. All three sites are not amongst the main resting, feeding and wintering habitats of species listed in Annex I of the Wild Birds Directive or protected species of the "Pomeranian Bight – Rönnebank" nature conservation area. The areas are unimportant for breeding birds because of their distance from the coasts. Due to the depth of the water, they are also not amongst the important feeding grounds for diving sea ducks.

4.6.1 Areas and sites

<u>Due to construction</u>: Effects on seabirds and resting birds are to be expected during the construction of offshore wind turbines, although their nature and extent will be limited temporally and spatially.

Avoidance of the construction site is to be expected in the case of species susceptible to disturbance. In this context, construction-related shipping traffic will not exceed the extent of the impact that regular shipping already has on seabirds in some areas of the German Baltic Sea. Moreover, the planning principles on which the Site Development Plan is based provide for temporal and spatial coordination of construction projects and a reduction in the volume of shipping traffic. Turbidity plumes will also occur only locally, and for a limited time. Attraction due to site lighting and site vehicles cannot be ruled out. Corresponding ancillary provisions for minimising emissions are included in the individual approval procedures, however, in order to reduce these to a necessary minimum.

To summarise, due to the generally high mobility of birds and the measures to be taken to avoid and reduce intensive disruptions, significant effects on all species during the construction phase can be excluded with the necessary certainty.

<u>Due to operation and the installation:</u> Erected wind turbines may present an obstacle in the air and may also cause collisions of seabirds and resting birds with the vertical structures (GARTHE 2000). It is difficult to estimate the extent of such incidents to date, as it is assumed that the majority of birds that collide with solid structures are not seen (HÜPPOP et al. 2006). However, for species susceptible to disruption, such as divers and black-throated divers, the collision risk is very low as they do not fly directly to or near wind farms due to their avoidance behaviour. Furthermore, factors such as manoeuvrability, altitude and proportion of time spent flying determine the collision risk of a species (GARTHE & HÜPPOP 2004). The risk of collision for seabirds and resting birds must therefore be assessed differently for each species.

As part of StUKplus, the "TESTBIRD" project determined the range of flight altitudes of, amongst others, the three large seagull species herring, lesser black-backed and greater black-backed gulls, as well as the smaller species of common gull and little gull, using rangefinders. In the majority of recorded flights, the large gulls flew at heights of 30 - 150 m, common and little gulls were mainly observed at lower altitudes up to 30 m (MENDEL et al. 2015). A recent study at the British Thanet Offshore Wind Farm investigated the flight altitude distribution of the three large seagull species European herring gulls, great black-backed gulls and lesser black-backed gulls, for example, also using the Rangefinder (SKOV et al. 2018). The flight altitude measurements for the large seagulls showed heights comparable to those identified by Mendel et al. (2015).

To estimate the potential risk of seabirds and resting birds colliding with wind turbines at sea, the corresponding height parameters of the turbines are an important indicator. In accordance with current technical developments with regard to the dimensions of future wind turbines, scenarios were included in the Site Development Plan which take the altitude parameters into consideration (see chapter 1.5.5 of the environmental report). Wind turbines with a hub height of 125 m and a rotor diameter of 198 m would be used in scenario 1, thereby reaching a total height of 224 m. In scenario 2, the wind turbines would have a hub height of 175 m, a rotor diameter of 250 m and a total height of 300 m. This means that the lower, rotor-free area from the surface of the water to the lower tip of the rotor blade would be 26 m in scenario 1 and 50 m in scenario 2.

In general, large and small seagulls are highly manoeuvrable and can react to wind turbines with corresponding evasive manoeuvres (GARTHE & HÜPPOP 2004). This was also shown by the study by SKOV et al. (2018), in which not only the flight altitude but also the immediate, small-scale and large-scale evasive behaviour of the species in question were investigated. Furthermore, the surveys by means of radar and a thermal imaging camera showed low nocturnal activity. The risk of collision at night due to attraction as a result of illumination of the wind turbines can therefore also be deemed to be low.

Although Garthe & Hüppop (2004) confirmed that diving sea ducks as well as great crested grebes and red-necked grebes lack manoeuvrability, these species generally fly at altitudes of no more than 5-10 m and are thus outside the area of the rotor.

Overall, the implementation of the wind turbines at the sites as specified in scenarios 1 and 2 in the Site Development Plan will thus not involve an increased risk of collision for seabird and resting bird species. According to available information, this also applies to species whose flight altitudes are in the vicinity of the rotating rotor blades. Furthermore, the exclusion of wind farm projects in Natura 2000 areas minimises the risk of collisions in important feeding grounds and resting grounds in the EEZ.

A species-specific avoidance of wind farm sites can be assumed for disturbance-sensitive species during the operating phase of wind farms.
Red-throated divers and black-throated divers (collectively referred to as divers in the following) are considered to be particularly sensitive to wind farms and also moving ships. A 'scarecrow' reaction occurs in the latter case with the birds flying up at a distance of 2 km from the ship (GARTHE et al. 2002, SCHWEMMER et al. 2011).

In the meantime, on-going investigations as part of the operational monitoring of wind farm projects in the North Sea have revealed area-dependent significant avoidance distances of up to 15 km. It should be noted that these distances are not cases of total avoidance, rather partial avoidance with increasing diver densities up to the corresponding distances (BIOCONSULT SH & Co.KG 2017b, BIOCONSULT SH & Co.KG 2018, IFAÖ et al. 2017b, IFAÖ 2018b, IBL UMWELTPLANUNG GMBH et al. 2017, IBL UMWELTPLANUNG GMBH et al. 2018).

Such wide-area avoidance reactions by the divers have not been observed in the Baltic Sea (IfAÖ 2018a). This may be due to the fact that the areas planned in the Site Development Plan and Baltic Sea EEZ in general have no special importance for this species group and divers are only occasionally encountered - as passage migrants and in the winter. The same applies to other species, such as guillemots, razorbills and little gulls, for which so far small-scale avoidance behaviour has been observed (IFAÖ et al. 2017b, IBL UMWELTPLANUNG GMBH et al. 2017, IBL UMWELTPLANUNG GMBH et al. 2018). Significant effects in the form of habitat loss can therefore be safely ruled out.

The Site Development Plan will also define specifications regarding the consideration of best environmental practice and the relevant state of the art. In this context, regulations on the prevention and reduction of adverse impacts on seabirds and resting birds due to the construction and operation of wind turbines, in particular in the form of measures to minimise pollutant and light immissions, are to be adopted at approval level. This corresponds to the current approval practice.

Furthermore, it is not possible to rule out the recovery of fish populations during the operating phase as a result of a fishing ban within the wind farm, which will be accompanied by a ban on ships. Besides the introduction of hard substrate, the species composition of the fish present could thus increase and provide an attractive food supply for seabirds searching for food. Significant impairment cannot be predicted for this aspect.

4.6.2 Platforms

Due to construction: Direct disruptions to seabirds due to deterrence are to be expected during the construction phase, at most locally and limited in terms of time. Due to the high mobility of birds and the measures to be taken – in the respective individual approval procedures – to avoid and reduce intensive disturbances, considerable effects can be excluded with a high degree of certainty. The construction of platforms is limited spatially, so any effects such as avoidance behaviour or attraction from construction ships can only occur locally.

However, given the existing prior impact from shipping traffic, the effects of traffic due to construction will not lead to a significant increase in disturbances and barrier effects. In summary, therefore, it can be stated that the impairments to seabirds that may be associated with construction operations are not significant.

Due to operation and the installation: According to available information, platforms are not expected to have a significant impact on seabirds and resting birds during the operating phase. The platforms will be constructed in the immediate vicinity of the wind farms. Thus any effects from the platforms will not go beyond the extent of the possible effects of the directly adjacent wind farms.

Should the benthic species composition change in the vicinity of the platforms and wind farms, this change could attract fish and predators such as seabirds. However, the effects of sediment changes and benthos changes in the immediate vicinity of the platforms would remain insignificant for seabirds, as they predominantly search for their prey organisms in very extensive areas in the water column. Deterrence due to shipping and helicopter traffic during maintenance and repair work may occur for a limited period of time during the operation of the platforms.

Offshore platforms have often been found to be used as resting places by many bird species. Therefore, it is not possible to exclude attraction to the platforms for many seagull species.

The Site Development Plan will also define specifications regarding the consideration of best environmental practice and the relevant state of the art. In this context, regulations on the prevention and reduction of adverse impacts on seabirds due to the construction and operation of platforms, in particular in the form of measures to minimise pollutant and light immissions, are to be adopted at approval level. This corresponds to the current approval practice.

Therefore, installation and operating-induced impacts of platforms on seabirds and resting birds can be safely ruled out.

4.6.3 Submarine cabling systems

According to available information, the laying and operation of submarine cable systems is not expected to have any significant effects on seabirds and resting birds. Short-term deterrence may occur due to construction-related shipping traffic, but only during the installation phase, which is limited temporally and spatially. However, these effects will not go beyond the disruptions generally associated with slow ship movements. Significant effects on resting birds due to construction-related turbidity plumes or due to sediment changes and benthos changes in the vicinity of the crossing structures are not to be expected either, as these birds seek their prey in very extensive areas in the water column.

Installation-related and operational effects of the planned submarine cable systems on seabirds and resting birds can be excluded with the necessary certainty. A possible collision risk due to construction vehicles can be classified as very low due to the short-term nature of the construction phase.

In summary, it can be stated that considerable effects on seabirds and resting birds as a protected asset due to the laying and operation of submarine cable systems are not to be expected.

4.7 Migratory birds

The Baltic Sea EEZ is of average to above-average importance for bird migration. Every year, up to a billion birds migrate over the Baltic Sea. For sea ducks and geese from Northern Europe and Russia, the Baltic Sea is an important transit area, with a large part of the migration occurring in the autumn in the east-west direction close to the coast. The western Baltic Sea is flown over, sometimes in high intensities, by several species that require special protection (e.g. barnacle goose, whooper swan, eider duck, common and velvet scoter). Nighttime migration occurs on a wide front without discernible gradients in the migration intensities. Concentration areas and leading lines are present for diurnal bird migration in the western Baltic Sea. Thermal soarers (and other diurnal migratory land birds) prefer to travel along the "flyway" (Islands of Fehmarn, Falster, Møn and Seeland, and on to Falsterbo). East of this main route, these birds migrate in much lower density (e.g. FRANSSON & PETTERSSON 2001).

For land bird migration, the Baltic Sea is of above-average importance due to the very high number of birds. The Baltic Sea is of above-average importance for crane migration, because the majority of the biogeographic population on its way south must inevitably cross the Baltic Sea. In total, up to 50,000 Scandinavian raptors migrate south from Falsterbo across the Baltic Sea. The German Baltic Sea EEZ also has an average to above-average importance for migrating water birds. This is derived from the fact that there are two main routes along the Swedish and German coasts in the western Baltic for the diurnal migratory water birds and the German EEZ can at the very least be said to lie on the border of the coastal focus of the migration along the Mecklenburg coast (KNUST et al. 2003).

Due to construction: In the first instance, disturbances during the construction phase will be caused by noise and light emissions and visual upheaval. These may cause varying degrees of deterrence and barrier effects on migratory birds, depending on the species. However, the lights from construction equipment may also attract migratory birds and increase the risk of collision.

Due to the installation and operation: The planned offshore wind turbines, transformer platforms and offshore transformer platforms may present a barrier to migratory birds or a risk of collision during the operating phase. In the clear weather conditions preferred by the birds for migration, the probability of a collision with vertical structures is very low because the flight altitude of most birds will be far above the turbine height and also the rotor height of the surrounding wind turbines and the turbines are clearly visible. Bad weather conditions increase the risk.

As a general rule, bird migration will not be endangered if there is an abstract risk that single individuals will come to harm as they migrate through an offshore wind farm. A risk to bird migration will only be present if sufficient information justifies the prediction that the number of birds that may potentially be affected is such that significant impairment of one or more different populations could be assumed with sufficient probability, taking into account their respective population sizes. The biogeographical population of the migratory bird species in question provides the reference value for quantitative observation.

There is agreement that, under existing legislation, individual losses must be accepted during bird migration. In particular, it must be borne in mind that bird migration in itself already entails many dangers and that populations are subjected to harsh selection. The mortality rate for small birds can be about 60 to 80%, while the natural mortality rate is lower for larger species. The individual species also have different reproduction rates, which means that the loss of individuals for each species can have different implications.

A generally valid acceptance limit has not yet been determined due to the absence of conclusive findings. However, the threshold value of one percent, which is often used by experts in avifaunistic studies, can be used at least as a guideline.

The potential danger for the respective biogeographical population lies firstly in the loss due to bird strikes and secondly in other adverse effects that may result from forced changes in flight routes.

4.7.1 Areas and sites

Since the marine areas O-1, O-2 and O-3 do not differ significantly in terms of their importance for bird migration with the exception of crane migration, this does not give rise to any divergent risk in the development of offshore wind farms. Previous findings of monitoring studies (INSTITUTE FOR APPLIED ECOSYSTEM RESEARCH 2016a, BIOCONSULT SH 2017) have not provided any evidence of significant adverse impacts on bird migration.

It must be noted here that the previous wind turbines did not exceed the total height of 200 m, which is the basis for the previous impact forecasts. The future plans according to the Site Development Plan, on the other hand, envisage two scenarios in order to account for current technical developments. Scenario 1 assumes a hub height of 125 m, a rotor diameter of 198 m and a total height of 224 m, with the height of the lower rotor tip at 26 m. In scenario 2, the corresponding values are 175 m, 250 m, 300 m and 50 m. Due to these larger dimensions, the swept area of the rotor also increases. However, this influence is reduced as the number of turbines decreases. The higher turbines, however, can increase the risk of collision.

Altitude profiles obtained based on migration observations carried out by a visual spotter in the areas O-1, O-2 and O-3 (OECOS 2015, IFAÖ 2016A AND BIOCONSULT SH 2017) indicate a high concentration at altitudes up to 20 m. Thus, about 90% of the migration movements in the O-3 area occurred at altitudes of up to 20 m (BIOCONSULT SH 2017).

Previous investigations of bird migration using vertical radar in the EEZ in the Baltic Sea showed that the altitude distribution was dependent on the time of day. In area O-3, bird migration predominantly took place at altitudes below 500 meters. The preference for low altitudes also results in a high proportion of flight movements in the potential risk area of the rotors. During the day, between 65.2% (spring) and 66.7% (autumn) of flight movements were recorded in the altitude range up to 200m, while the corresponding figures at night were 28.8%

(spring) and 26.8% (autumn). Furthermore, it was found that the migration altitude depended on the migration intensity. Thus, especially at night, bird sightings in periods of low migration were more often at lower altitudes. This could reflect poorer migration conditions (weather) which reduces the number of migrating birds and causes them to migrate at lower heights to avoid the worse weather.

During the long-term study of bird migration in the North Sea EEZ in the "Northern Borkum" area, a bimodal distribution pattern of the recorded bird movements was recorded in the dark in the spring of 2016. At night, both the lowest altitude ranges up to 100 m (35,018 flights; 13.2%) as well as the highest ranges between 900 and 1,000 m (30,295 flights; 11.4%) were the most frequented. About one third of the echoes were each recorded at altitudes up to 300 m, above 300 m to 700 m and above 700 m to 1,000 m (AVITEC RESEARCH 2017). Corresponding to the conditions in spring, however, bird migration with altitude profiles different from the basic pattern were also recorded at night in autumn. In the busy bird migration night of 25/26 October 2016, the altitude range above 900 m to 1,000 m was the most frequented, suggesting that bird migration that night was underestimated, and a high (but unknown) percentage of migrating birds flew above the radar measurement range. By comparison, bird migration also shifted heavily to the higher altitudes during the very busy bird migration night 9/10 November.

Avitec Research therefore assumes that its vertical radar system, with its data basis of up to an altitude of 1,000 m, records an average of at least 2/3 of all bird migration. In individual cases, the percentage of bird migration may be significantly higher, depending on the vertical wind profile. Conversely, on nights with an altitude distribution that decreases only slowly or even increases, more than half of all migratory birds are missed. However, this is usually only the case for a small number of nights.

If we consider the low flight altitudes of the birds migrating during the day, most of which fly below 20 m and thus also below the lower rotor tip according to above scenarios 1 and 2, no significant impacts can be expected for birds that migrate during the day as a result of planning in the Site Development Plan. An exception could be the crane. Where the crane is concerned 91% of the visible migration was detected at altitudes between 20 and 200 meters (BIOCONSULT SH 2017). Intensive radar surveys of migrating cranes on Rügen between 2005 and 2008 revealed a high variability in flight altitudes (20 m - 1,300 m) for migration between the northern tip of Rügen and the south coast of Sweden (IFAÖ 2010). On average, groups of cranes flew at about 300 meters. Here, two different flight behaviours were recorded: the 'simple' straight flight without loss of altitude and straight flight interrupted by regular circles. Altitude was gained during circling, while the straight flight travel was associated with a loss of altitude. The circling flight movements were mainly observed close to land and probably exploited updrafts in such areas. A study with 3-D GPS devices on eight cranes crossing the Baltic Sea between the south coast of Sweden and the German Baltic Sea coast displayed similar flight behaviour (SKOV et al. 2015). Four cranes migrated the entire distance over the open sea at a constant height of less than 200 m. By contrast, two birds ascended to altitudes of about 1,000 m before reaching the Swedish coast, continuously lost altitude during the crossing and reached land at an altitude of about 200 m.

Extensive measurements with a "laser rangefinder" from the platform FINO2 in the vicinity of the "Baltic 2" OWP also showed a clear preponderance of altitudes below 200 m in spring and autumn as well as a dependence of altitude distribution on wind conditions (SKOV et al. 2015). In contrast to radar surveys, visual observations, even with the help of rangefinders, suffer from methodological constraints which reduce the probability of detecting higher flying birds. This probably leads to a systematic underestimation of the proportion of cranes in the altitude range greater than 200 m (see IFAÖ 2010).

In summary, it can be concluded from the aforementioned studies and the results of the visual observations in 2014 and 2015 (BIOCONSULT SH 2017) that a section of the migrating cranes use the altitude range up to 200 m, and thus are potentially flying at the heights at which the rotors are located. However, the observed high concentration of flying altitudes within the rotor height range can at least partially be traced back to the detection methodology.

Taking into account the migratory patterns, there is a particular risk of collision for small birds migrating at night as a result of migration in the dark, high migratory volume and the strong attraction of artificial light sources.

As already described, migrating birds tend to fly higher in good weather than in bad weather. It is also an undisputed fact that most birds usually start their migration in good weather and are able to choose their departure conditions in such a way that they are reasonably likely to reach their destination in the best possible weather (Federal Maritime and Hydrographic Agency 2009). In the clear weather conditions preferred by the birds for migration, the probability of a collision with a wind turbine is therefore low because the flight altitude of most birds will be above the range of the rotor blades and the turbines are clearly visible. A potentially dangerous situation, on the other hand, is posed by unexpected fog and rain, which lead to poor visibility and low flight altitudes.

A particular problem is when bad weather conditions coincide with what are known as mass migration events. According to information from various environmental impact studies, mass migration events in which birds of various species fly across the North Sea at the same time occur approx. 5 to 10 times a year. On average, two to three of them take place during bad weather. Consequently, even the larger turbines in scenarios 1 and 2 are not expected to have any significant effects according to the current state of knowledge. However, the risk of collision may vary depending on existing offshore wind farms in the marine areas. This applies to areas O-1 and O-3. These areas already have constructed wind turbines which are about 50 m lower in area O-3 and about 80 m lower based on scenario 1. In scenario 2, the values are 120 m (O-3) and 160 m (O-1).

The individual areas are considered below in respect of their effects on bird migration. In the following consideration of the collision risk, the main migration directions are North (spring) and South (autumn) as well as East-West and vice versa.

Overall, **area O-1** is of average to above-average importance for bird migration. The area already has constructed wind turbines in the northern part with heights of 165 to 179 m. If site O-1.3 was developed according to scenarios 1 and 2, there would be a stepped structure in the north-south direction. In the spring, when the birds migrate north, they first encounter the existing turbines with heights of 165 m to 179 m. If they then encounter the turbines planned according to scenario 1 with a total height of 224 m and a hub height of 125 m, there could be limited visibility, since only the rotors of these turbines would protrude above the existing turbines. This could lead to a higher collision risk.

In scenario 2 with a hub height of 175 m, the massive gondola will in general also be visible, so visibility is increased and an increase in the collision risk is unlikely. However, here the total height of 300 m comes into consideration, because here the proportion of migrating birds within the area of the rotor would presumably increase. This is especially true for crane migration. Although for the crane 91% of the visible migration was detected at altitudes between 20 and 200 meters (BIOCONSULT SH 2017), collision events could not be recorded within the scope of the environmental monitoring for the "Western Adlergrund" cluster. Furthermore, it must be borne in mind that migrating cranes exhibit a high variability in flight altitudes (20 m - 1,300 m) during migration between the northern tip of Rügen and the south coast of Sweden (IFAÖ 2010). Moreover, it can be assumed that the cranes identify the wind turbines promptly and avoid them.

Overall, **area O-2** is of above-average importance for bird migration. The area currently has no constructed wind turbines. However, an offshore wind farm is at the planning stage. More precise information on the wind turbine type and its dimensions is not currently available. Ultimately, it is probable that there will not be any significant effects on bird migration here. Nevertheless, the high occurrence of migrating cranes (1.3 percent of the biogeographic population) must be taken into account in the individual procedure. Due to the not to be excluded considerable effects on the migration of birds when considered as a whole, the site O-2.2 in the northern region of area O-2 was placed under investigation. More detailed explanations about this can be found in chapter 4.12.5.

Overall, **area O-3** has an above-average importance for bird migration. The very high importance of crane migration must be highlighted here. Approximately 3.9% of the biogeographic population crosses the area. The area already has constructed wind turbines in the northern part with a height of 138 m. Since there are no further developments included in the current Site Development Plan, a further consideration of the endangerment of bird migration is not necessary.

Despite the possible increased risk of collision due to the step-by-step expansion, based on the above statements, it can be asserted for the Strategic Environmental Assessment (SEA) that, according to the current state of knowledge, the planned offshore wind farm projects are unlikely to have any significant effects on migratory birds. However, any increased risk of collision due to the higher turbines should be taken into account when planning the individual projects. This is especially true for crane migration.

4.7.2 Platforms

Since the transformer and collector platforms are individual structures, which are also routinely planned in the immediate vicinity of offshore wind farms, no significant impairment of bird migration is to be expected. It can also be assumed that any negative effects can be reduced by lighting that is as compatible as possible during operation of the transformer or collector platforms can be reduced to the greatest extent possible to decrease attraction effects. This includes for example an on-demand switching on and off of the obstruction lights, the choice of suitable light intensities and light spectra or lighting intervals.

Based on the above statements, it can be asserted for the SEA that, based on the current state of knowledge, the planned transformer and collector platforms are unlikely to have any significant effects on resting and migratory birds. Deterrence effects are likely to be temporary and in any event locally limited. A threat to the bird migration by the planned transformer and collector platforms is also not expected. Potential cumulative effects of the transformer and collector platforms in combination with the offshore wind farms are discussed in chapter 4.12.

4.7.3 Submarine cabling systems

According to available information, the laying and operation of submarine cable systems is not expected to have any significant effects on migratory birds as a protected asset. Short-term deterrence may occur due to construction-related shipping traffic, but only during the installation phase, which is limited temporally and spatially. However, these effects will not go beyond the disruptions generally associated with slow ship movements. As the Baltic Sea is used intensively for shipping traffic, no significant additional disturbance of sensitive species is to be expected due to the increase in shipping traffic during the construction phase or for repair and maintenance purposes.

Installation-related and operational effects of the planned submarine cable systems on migratory birds can be excluded with the necessary certainty. A possible collision risk due to construction vehicles can be classified as very low due to the short-term nature of the construction phase.

4.8 Bats and bat migration

Migration movements of bats across the Baltic Sea are documented to varying extents, but to date no specific information is available on migratory species, migration corridors, migration heights and migration concentrations. The only information to date confirms that bats, especially species that migrate long distances, fly over the Baltic Sea.

4.8.1 Areas and sites

The possibility of collisions of individuals with the turbines of offshore wind farms cannot be ruled out. The sensitivity of bats to onshore high buildings and the associated risk of collisions is well known, as is the risk of collisions with wind turbines. Furthermore, possible barrier effects as well as habituation or attraction effects are known on land (JOHNSON 2004). However, apart from a pilot study from Sweden and first observations from the Kalmar Strait, so far the impacts of offshore structures remain largely unknown (AHLEN 2002, AHLEN et al. 2005). The pilot study (AHLEN 2002) found that both migratory and non-migratory species are occasionally the victims of collisions. However, the causes of the collisions remain largely unexplained. Overall, the study demonstrated that there are very large information gaps concerning the migration behaviour and the migration routes of bats. On the basis of previous observations, it is assumed that bats tend to migrate across the sea in concentrations (swarms), probably at considerable altitudes and on migration routes that are regularly used (AHLEN et al. 2005).

Currently, there are insufficient observations and findings in respect of bat migration and the potential effects of offshore structures on bats. Therefore, the cumulative collision risk with existing and future wind farms cannot be conclusively assessed. Therefore, an assessment of the possible hazard potential is ultimately not currently possible. However, it can be expected that any negative effects on bats can be prevented by using the same prevention and mitigation measures devised to protect bird migration.

4.8.2 Platforms

Dangers to individuals due to collisions with platforms cannot be ruled out. However, as the platforms are individual structures also situated in the immediate vicinity of offshore wind farms, the possibility that flying or possibly migrating bats will be significantly impaired can be ruled out based on the current state of knowledge. It can also be expected that any negative effects on bats can be prevented by using the same prevention and mitigation measures devised to protect bird migration.

4.8.3 Submarine cabling systems

The possibility that bats will be significantly affected by laying and operating submarine cable systems can be excluded with the necessary certainty.

4.9 Climate

Adverse impacts on the climate due to the construction and operation of converter platforms are not expected, as there are no measurable emissions relevant to climate during construction or operation. Rather, the coordinated expansion of offshore wind energy and grid connections will increase planning reliability for the expansion of offshore wind energy.

The CO_2 savings associated with the expansion of offshore wind energy are expected to have a positive impact on the climate in the long term. This may make an important contribution to achieving the Federal Government's climate protection targets.

4.10 Scenery

4.10.1 Areas and sites

As outlined in chapter 3.14, the creation of offshore wind farms in the areas defined by the Site Development Plan will have an impact on the landscape as a factor as it will be altered by the construction of vertical structures and safety lighting. The scope of these visual impairments to the landscape caused by the planned offshore turbines will depend to a large extent on the respective visibility conditions. Due to the distance of more than 25 km between the planned sites and the Baltic Sea coast, the installations will only be visible to a very limited extent from land (HASLØV & KJÆRSGAARD 2000), and only when visibility is good. This also applies to navigation lights for safety purposes at night. Due to subjective sensitivities and the fundamental attitude of the viewer towards offshore wind energy, the vertical structures – which are atypical for a marine and coastal landscape – can be perceived as both disturbing and technically interesting. In any case, they will bring about a change in the landscape and modify the character of the area.

Beyond the coast, the visual impairment of the landscape changes with greater spatial proximity to the offshore areas. The type of use is the key factor here. The value of the landscape plays a secondary role in industry and transport. The landscape, however, is very important for recreational use, as in the case of water sports enthusiasts and tourists. However, direct use for recreation and leisure by recreational and tourism boats is only sporadic in the planned areas and wind farms. These are mainly located in areas used by shipping and the offshore industry, which means that the impact on the recreational use of water sports enthusiasts is considered low.

As a result, the impact on the landscape of the planned wind turbines along the coast can be classified as low.

For the submarine cable systems, adverse impacts on the landscape can be ruled out as they will be laid as underwater cables.

4.10.2 Platforms

As previously described for the wind farm areas and sites, the construction of platforms can also bring about visual changes to the landscape. As these platforms are always planned in close proximity to or physically connected to the wind energy areas, the change in the landscape caused by these individual structures is only marginally increased. In addition, the platforms are more than 25 km from the coast and will only be visible from land to a very limited extent (as will their safety lighting).

4.11 Interdependency

In general, effects on a factor lead to various consequences and interrelationships between the factors. Impacts on the soil or water body thus usually also affect the biotic factors in these habitats. For example, emissions of pollutants can reduce water and/or sediment quality and be absorbed by benthic and pelagic organisms from the surrounding medium. The essential interdependence of the biotic factors results from the food chains. These correlations between the different factors and possible impacts on biodiversity are described in detail for the respective factors.

Possible interactions during the construction phase will result from sediment shifts and turbidity plumes, as well as noise emissions.

However, these interdependencies will occur only very briefly and be limited to a few days or weeks.

Sediment shifts and turbidity plumes

Sediment shifts and turbidity plumes occur during the construction phase of wind farms and platforms or when submarine cables are laid. Fish are temporarily deterred. The macrozoobenthos is covered locally. Consequently, the feeding conditions for benthos-eating fish and for fish-eating seabirds and harbour porpoises also change temporarily and locally (decrease in the supply of available food). However, due to the mobility of the species and the temporal and spatial limitation of sediment shifts and turbidity plumes, the possibility of considerable impairments to the biotic factors and thus to the existing interdependencies between them can be eliminated with the necessary certainty.

Noise emissions

The installation of the foundations of the wind turbines and platforms can lead to temporary flight responses and temporary avoidance of the area by marine mammals, some fish species and seabird species. Nevertheless, the use of noise-minimising measures during the pile driving of the foundations of platforms and wind turbines is mandatory. As a result, significant effects on the interaction with the factors can be safely excluded.

Mutual interdependencies in the <u>operating phase</u> are to be expected on a permanent basis, but generally limited to the respective area or site. Possible impacts on the interdependencies for platforms and submarine cable systems can only be expected locally.

Area use

When foundations are introduced, benthic biocoenoses are locally depopulated, which can result in a potential deterioration of the food base for the fish, birds and marine mammals that follow in the food pyramid. However, none of the areas and sites included in the Site Development Plan represent special feeding grounds for top predators such as seabirds, resting birds and marine mammals. A significant impairment of food availability can be safely excluded.

Introduction of artificial hard substrate

The introduction of artificial or non-local hard substrate (foundations, required rockfill in cable crossing structures or local cable laying on the seabed) leads locally to a change in soil conditions and sediment conditions. The composition of the macrozoobenthos may change as a result. According to KNUST et al. (2003), the introduction of artificial hard substrates into soft soils leads to colonisation by additional species. The recruitment of these species will most likely take place from the natural hard substrate habitats, such as superficial till and rocks. Thus there is little risk of atypical species having a negative influence on the soft-bottom benthic communities. However, settlement areas of the soft bottom fauna are lost at these points. By changing the species composition of the macrozoobenthos population, the food resources for the fish biocoenoses at the site can be influenced (bottom-up regulation).

However, as a result, certain fish species could be attracted, which in turn increasingly prey on the benthos and thus shape the dominance relationships by selecting certain species (top-down regulation). Furthermore, plant covering on the hard substrate could act as a new food source for the benthic-feeding sea ducks.

Prohibition of use and navigation

Fishing is prohibited within and around wind farms and platforms. The resulting loss of fishing can lead to an increase in the stock of both fishery target species and unexploited species. A shift in the length spectrum of these fish species is conceivable. If fish populations grow, the food supply for harbour porpoises can be expected to increase. A macrozoobenthos community undisturbed by fishing activity is also expected to develop. This could mean that the diversity of the species community will increase as sensitive and long-living species of the current epi- and infauna have better chances of survival and stable populations develop.

Interrelationships can only be described very imprecisely due to the variability of the habitat. It can generally be said that the implementation of the Site Development Plan does not currently have any discernible effects on existing interdependencies that could endanger the marine environment. The SEA therefore concludes that the definition of sites and areas for offshore wind turbines and platforms and the definition of submarine cable routes in the Site Development Plan are not expected to have any significant impacts on the living marine environment as a result of interdependencies according to the current state of knowledge, but rather that adverse impacts can be prevented when compared to non-implementation of the plan.

4.12 Cumulative effects

The review of cumulative effects is currently concerned with the EEZ and those areas in which transboundary impacts are to be expected. Based on the administrative agreement with Mecklenburg-Western Pomerania, statements are also made on the cumulative effects of the rules in the coastal waters and the EEZ.

4.12.1 Soil/Area, benthos and biotopes

A significant proportion of environmental effects on soil, benthos and biotopes due to the areas and sites, platforms and submarine cable systems will occur solely during the construction period (formation of turbidity plumes, sediment shifts, etc.) and over a limited area. Cumulative environmental effects due to construction are unlikely, particularly due to the step-by-step implementation of the construction projects. Possible cumulative effects on the seabed, which could also have a direct impact on the factor Benthos and specially protected biotopes, result from permanent direct area use due to the foundations of the wind turbines and platforms, as well as from the installed cable systems. The individual effects are essentially small-scale and local.

In order to estimate the direct area use, a rough calculation is made on the basis of the areas/sites, platforms and submarine cable systems planned in the Site Development Plan in conjunction with existing installations and planning within the framework of the transitional system. The calculated area use is based on ecological aspects; in other words, the calculation is based on the direct ecological loss of function or the possible structural change of the site due to the installation of foundations and cable systems. In the area of the cable trench, however, the impairment of the sediment and benthic organisms will essentially be temporary. Permanent impairment could be assumed when crossing particularly sensitive biotopes such as reefs.

According to a model assumption, there will be a mostly temporary loss of function over a site of around 42 ha due to existing cables, cables in the transitional system and the submarine cable systems provided for in the Site Development Plan. The calculation is based on the assumption of a cable trench 1 m wide. The rockfill necessary for intersections also have to be taken into account here. Based on a surface area per crossing construction of approximately 900 m², the direct area use by rockfill for a predicted number of 24 crossing structures is equal to about 2.2 ha. Assuming that cable laying on the seabed is required only in small-scale sections, e.g., in the southern part of area 1, an additional surface sealing of around 10 ha is assumed for the associated rockfill and for sections of the grid connection systems.

For the Site Development Plan rules in the areas, the parameters of scenario 2 of the model wind farm were used as a basis for a conservative estimate (number of installations calculated in accordance with the stated capacity, diameter of the foundation and diameter of any scour protection required, number of platforms). In contrast, the model wind farm parameters of scenario 1 were used to calculate area use within the framework of the transitional system, assuming that no installations in the dimension of scenario 2 will be implemented in the transitional system. The functional loss due to the cabling within the wind farm was calculated in accordance with the capacity shown, assuming a cable trench 1 m wide. On the basis of this conservative estimate, approx. 35 ha of land will be used for the areas and sites by means of the Site Development Plan rules, planning within the framework of the transitional system and the existing systems, or temporarily impaired in the case of the farm's internal cabling.

In total, therefore, a surface area of about 90 ha is required or in the case of submarine cables, temporarily compromised. This corresponds to well below 0.2‰ of the total EEZ site. In comparison, about 55% of the Baltic Sea EEZs are protected. Since the construction of wind turbines and platforms in nature conservation areas is generally not permitted (see objective of Spatial Planning 3.5.1 (3) and for example planning principle 4.4.4.2 Site Development Plan), the spatial use of the conservation area is limited to submarine cable routes. No statement can be made on the use of specially protected biotopes according to section 30 of the Federal Nature Conservation Act due to the current absence of a sound scientific basis. Area-wide sediment and biotope mapping of the EEZ currently being carried out will lead to more reliable information in the future.

Besides the direct use of the seabed and hence the habitat of the organisms living there, the foundations and intersections will lead to an additional supply of hard substrate. This allows non-local species with a preference for hard substrates to colonise and change the species composition. This effect can lead to cumulative effects through the construction of several offshore structures such as platform and wind turbine foundations or rockfill. The benthic fauna adapted to soft substrates will also lose habitat on account of the hard substrate. However, as the area use for both the grid connection systems and the wind farms will be in the ‰ (per-mille) range, according to current knowledge no significant impairments are to be expected in the cumulation that would endanger the marine environment with regard to the seabed and the benthos.

4.12.2 Fish

Understanding the interactions between the installation of wind farms in the Baltic Sea and the ecology of the fish makes it possible to predict the cumulative effects of this new development. As a result of the operation of offshore wind farms, the area where fishing is not permitted will increase. These non-fishing zones could have a positive impact on the Baltic Sea fish biocoenoses by eliminating negative fishing impacts such as disturbance or destruction of the seabed and catch and by-catch of many species. These areas could develop into places that attract fish, although it has not yet been conclusively clarified whether wind farms attract fish and, if so, why. In addition to the absence of fishing, improved food resources for fish species with different feeding habits would also be conceivable. The growth of sessile invertebrates on the wind turbine foundations could encourage benthos-eating species or cause a change in the food composition of species that have previously eaten otherwise. The wind farms could have an additive effect beyond their immediate location by distributing the mass and measurable production of planktonic distribution stages of the benthic organisms growing on the foundations by currents and thus influencing the qualitative and quantitative composition of the zooplankton (FLOETER et al. 2017). This, in turn, could have an impact on planktivore fish, including pelagic schooling fish such as herring and sprat, which are targets of one of the largest fisheries in the Baltic Sea. The species composition could also change directly, as species with different habitat preferences than the established species, e.g. reef dwellers, find more favourable living conditions and become more prevalent. So far, there are no signs of this in either the pelagic or the demersal component of the fish community. (LEONHARD et al. 2011). However, in the Danish wind farm Horns Rev, a horizontal gradient was found between the surrounding sandy areas and near the turbine foundations 7 years after construction: species with an affinity for hard substrates including the goldsinny wrasse *Ctenolabrus rupestris*, viviparous eelpout *Zoarces viviparous* and lumpsucker *Cyclopterus lumpus* near the wind turbine foundations were much more frequent than on the surrounding sand surfaces (LEONHARD et al. 2011). No effects of the wind farm could be demonstrated for sand eels, one of the most important fishing resources. The cumulative effects of an extensive expansion of offshore wind energy could include

- further establishment and distribution of fish species adapted to reef structures
- the recolonisation of areas and sites previously subject to intensive fishing, including sand eels
- better living conditions for territorial species such as fish similar to cod

The natural mechanism for limiting populations, besides predation, is intra- and interspecies competition, also known as density limitation. The possibility cannot be ruled out that local density limits may occur within individual wind farms before the favourable effects of the wind farms spread geographically, e.g. through the migration of "surplus" individuals. In this case, the effects would be local and not cumulative. The impacts that changes in fish fauna may have on other elements of the food web, both below and above their trophic level, cannot be predicted based on the current state of knowledge.

4.12.3 Marine mammals

Cumulative impacts on marine mammals, harbour porpoises in particular, can occur mainly due to noise emissions during installation of the foundations. These factors could be significantly affected by the fact that – if pile-driving takes place simultaneously at different locations within the EEZ – there is not enough room available to escape and retreat. Since thus far usually only one offshore construction site has been active at the same time, there is a lack of experience regarding overlaps in time and space of the propagation of pile driving noise. Initial findings are expected from the projects currently under construction. In addition, research projects are running in parallel that calculate and model multi-source sound propagation. Similarly, there is no scientific basis for evaluating possible cumulative effects on marine mammals. Therefore, the licensing authority reserves the right to coordinate the timings and spatial locations for the pile-driving work of individual projects to minimise overall noise output times.

It is also clear from the sequencing of the grid connection of the individual sites scheduled in the Site Development Plan that the grid connection systems and the individual offshore wind farms will be built gradually, that is sequentially over the coming years and not all at the same time.

4.12.4 Seabirds and resting birds

Vertical structures such as platforms or offshore wind turbines may have different effects on resting birds, such as habitat loss, an increased risk of collision or deterrence and barrier effects. For resting birds, habitat loss due to the construction of several structures may be particularly significant.

A cross-area assessment of the cumulative effects of offshore wind farms and platforms on seabirds and resting birds may be carried out on the basis of previous results and observations from offshore wind farm projects that have already been implemented, e.g. in the German North Sea EEZ. Here, not only is the natural local incidence of seabird species, as dictated by the hydrographic conditions to be considered, but also the species-specific behaviour. In particular, endangered and disturbance-sensitive seabird species such as divers are to be taken into account in respect of cumulative effects due to the implementation of offshore wind farms and grid connection projects. GARTHE & HÜPPOP (2004) certify that divers are very sensitive to structures, as confirmed by the latest results from the monitoring of construction and operation according to StUK. In view of the cumulative consideration of the hazard risk for divers, the effects of shipping traffic (and for the operation and maintenance of cablesystems and platforms as well) must be included in addition to the structures themselves.

Possible effects must be assessed on a species-specific basis in order to assess the significance of cumulative effects in seabirds. In particular, Annex I species of the Wild Birds Directive, species of the "Pomeranian Bight" bird sanctuary, and species for which an avoidance response to structures has already been identified (such as divers) must be considered with respect to cumulative effects. This raises the question of biological limit values in terms of population and the relevant reference for a limit value of this kind. In the literature, it is proposed for resting birds that an intervention be considered inadmissible if 1% of the biogeographical population is affected by habitat loss. Reference is made to criteria of the 1971 Ramsar Convention on Wetlands of International Importance, according to which a resting area is of international importance if it is home to at least 1% of the biogeographical population of a waterbird species at least once a year (DIERSCHKE et al. 2003).

This 1% criterion can also be found in the classification of Important Bird Areas (IBA). An area is designated an IBA by Birdlife International if it is home to more than 1% of the biogeographical population (HEATH & EVANS, 2000). However, this 1% Ramsar Convention threshold cannot currently be transferred in terms of population biology for the assessment of the significance of work encroachments or disturbances (DIERSCHKE et al. 2003).

Since the Ramsar Convention uses the 1% criterion to assess the significance of wetlands, the very different intentions mean that it does not appear technically and scientifically justifiable to apply this criterion to the assessment of a work encroachment. Nevertheless, for the want of other reliable criteria, the 1% criterion does at least appear suitable for the quantification of a work encroachment.

The reference quantity or the relevant reference population is defined in a species-specific manner in cumulative considerations of effects. Thus, for example, for divers, the reference value of the relevant winter resting population of north-western Europe is 110,000 animals (SKOV et al. 1995). This figure was used as the basis for the first decisions of the licensing authority in the evaluation of the possible cumulative effects of the operation of offshore wind farms.

All existing findings indicate a low importance for species of Annex I of the Wild Birds Directive for the areas and sites included in the Site Development Plan for wind turbines and platforms. Therefore, according to the current state of knowledge, there are no impediments that oppose the execution of the plan. The platforms are all planned in the immediate vicinity of offshore wind farms, so that no cumulative additional habitat loss for disturbance-sensitive species is to be expected. Due to the distance of the areas to the nature conservation area "Pomeranian Bight – Rönnebank" a disturbance of the overwintering birds in the conservation area can be ruled out. This also applies to any disruption caused by the shipping related to the operation and maintenance of wind turbines, platforms and submarine cable systems. As the Baltic Sea is used extensively for shipping, no additional disruption of sensitive species is to be expected from shipping traffic during construction or for repair and maintenance. Significant disturbances within the nature conservation area can also be excluded by avoiding the use of Natura 2000 sites.

The conclusion of the Strategic Environmental Assessment is that cumulative effects resulting from the construction/laying, and the subsequent operation of wind farms, platforms and submarine cable systems acting on the factor Seabirds and resting birds in the EEZ of the Baltic Sea can be safely excluded.

4.12.5 Migratory birds

With respect to the cumulative effects on bird migration, it will be investigated whether the planned wind turbines, transformer and collector platforms will increase the risk of migratory birds being endangered in conjunction with adjacent wind farms or wind farms on the flight path. Thus far no serious licensing obstacles have been identified, however, this can only be checked in detail on a project and location-specific basis.

A potential danger for migratory birds results firstly from the collision risk with the transformer and collector platform and the individual offshore wind turbines and secondly from adverse effects on the energy resources of the birds due to forced changes in the flight route. Under normal migratory conditions preferred by migratory bird species, there is so far no evidence for any species that the birds typically migrate in the danger zone of the turbine and/or do not recognise and avoid these obstacles. In the clear weather conditions preferred by the birds for migration, the probability of a collision with transformer or collector platforms or wind turbines is very low.

A potentially dangerous situation is posed by unexpected fog and rain, which lead to poor visibility and low flight altitudes. A particular problem is when bad weather conditions coincide with what are known as mass migration events. This forecast is qualified by more recent research results obtained on the "FINO1" research platform in the North Sea. It was found that birds migrate at higher altitudes in very poor visibility (less than 2 km) than in medium visibility (3 to 10 km) or good visibility. (> 10 km; HÜPPOP et al. 2005). However, these results are based on only three nights of measurement. For the Baltic Sea, it should also be borne in mind that migration routes over water bodies are, with a maximum extent of about 100 km, short when compared to the greater than 400 km distances over the North Sea. Based on the air speed of the thrush species (between 35 and 50 km/h, depending on the species), which are particularly numerous participants in night migrations (BRUDERER & BOLDT 2001), corresponding migration times of about two to three hours result. Due to these short migration times, the probability of the coincidence of bad weather conditions with mass migration events is small.

The collision risk for sea and waterbirds migrating during the day is generally estimated to be low. They orient themselves visually and are usually able to land on water. Studies on lightships in Denmark (HANSEN, 1954) have shown that light sources are rarely approached by sea and water birds, but more by small bird species such as song thrushes, starlings and skylarks The risk of bird strikes could therefore be more likely to occur in large songbird populations that migrate at night. Also for diurnal migratory land birds (e.g. cranes and raptors) a low risk of collision is currently envisaged because these also position themselves visually and avoid the wind turbines. However, cumulative effects on some sites could increase the risk of collision.

This applies in particular to the site O-2.2 and primarily concerns crane migration. In the spring, the cranes migrating towards Bornholm must first pass the approved Arcadis Ost 1 wind farm in coastal waters and then will encounter the planned wind farm of site O-1.3. In the autumn this applies analogously - only in the reverse sequence. Although a large proportion of the cranes migrate over the Baltic Sea in the altitude range between 100 and 400 m, no significant risk of collision can be derived per se from this condition, because, based on generally accepted knowledge, the cranes avoid the obstacles by either vertical or horizontal deviations.

To verify this state of knowledge, additional monitoring of diurnally migrating land birds was commissioned focusing on cranes, raptors and geese using Rangefinders as part of the site preliminary investigation of site O-1.3 implemented in accordance with StUK 4. For this reason, and due to the high rate of sighting of cranes in area O-4 (up to 20% of the biogeographic population) site O-2.2 was placed under investigation in order to await the aforementioned investigation results. By contrast, there is no heightened risk of collision for the north-south migratory land birds, even cumulatively.

To minimise the risk, the installations must be constructed in such a way that light emissions are avoided as far as possible during construction and operation, provided that these are not required and are unavoidable due to the safety requirements of ship and air traffic, and health and safety. Lighting that is as compatible as possible during the operation of the transformer or collector platforms to reduce attraction effects as far as possible such as an on-demand switching on and off of the obstruction lights, the choice of suitable light intensities and light spectra or lighting intervals.

Barrier effect/migration lengthening due to cumulative effects

Cumulative effects of the wind turbines planned in the Site Development Plan and in the coastal waters of Mecklenburg-Western Pomerania, the transformer and collector platforms and the adjacent wind farms could also result in a lengthening of the migration route for the migrating birds. If migratory birds fly within the range of influence of wind farms (up to a height of approx. 300 m), they are forced to fly around or over the turbines through evasive movements. They are thus diverted to a greater or lesser extent from their migration route.

It is a known fact that wind farms are avoided by birds, i.e. they fly around or over them. This behaviour has been seen not only on land but also offshore (e.g. KAHLERT et al. 2004). Lateral avoidance reactions appear to be the most common reaction (HORCH & KELLER 2004).

The transformer platforms form part of the individual wind farms, also the possibly planned collector platform will be erected in the immediate vicinity of the wind farms. In this context, the flying around of the platforms is negligible because they do not create their own barrier effect due their immediate proximity to a wind farm and nor do they reinforce the wind farm barrier effect. However, the planned project on site O-1.3, leads to an extension of the already existing barrier by 6.5 km in an east-west direction.

Even if the proportion of affected birds is higher, if an accumulation with other installations occurs on the migration route, the energy expenditure for the individual bird is only slightly increased. The effects will be somewhat greater for individuals who have to avoid a number of structures.

The potential impairment to bird migration as a barrier depends on many factors, in particular the orientation of the wind farms to the main migration directions. Based on the current state of knowledge, birds that migrate at night migrate mainly from north to south across the Baltic Sea in a broad front. Many diurnally migrating species use migration corridors such as the flyway from Falsterbo arriving at Fehmarn.

Amongst the water birds, however, a coastal east-west migration and vice-versa is also widespread. Based on this assumption, it is conceivable that the species migrating from east to west could encounter the wind farm areas.

Area O-1 extends about 20 km in a north-south direction, area O-2 about 16 km. Area O-3 has a north-south extent of about 9 km, so that a barrier of about 30 km could result for the east-west migration. The planned site O-1.3 increases the barrier by about 6.5 km. Consequently, a maximum detour of about 73 km might result for the migratory birds that would have to fly around all three areas.

However, this would affect only those species, which, coming from the east then fly north around O-1 and O-2 and then maintain their migration direction. If the same species fly south around areas O-1 and O-2, they encounter another barrier in the coastal waters, Arcadis Ost 1 (area O-4) which extends 4.5 km north-south. For these species, the result is a detour of about 30 km. If any of these species are migratory birds that have a strong coastal orientation such as common scoters (see Fig. 34), there are more obstacles on their westwards migration route in the form of areas O-5 and O-6, which respectively have north-south extents of 3.2 or 9.8 km. The result is another migration route lengthening of about 10 km. Adjacent wind farms of the same area form a single barrier, so that a single evading movement suffices.

Considering the north-south migration direction, the potential barrier effect is of a similar magnitude. Area O-1 extends about 11 km in a east-west direction, area O-3 about 18 km. Area O-2 has an extent of about 10 km in the east-west direction. The same applies to areas O-4, O-5 and O-6 in the coastal waters. Here the extents in the east-west direction are 11.9, 9.5 and 18.3 km. The spatial separation between these areas is so large that there is enough space for flying around obstacles. The distance between the individual areas O-1 to O-6 is between 4.2 and 10.3 km.

Including the approved "Arcadis Ost 1" wind farm (area O-4) in the coastal waters, whose site adjoins area 2 to the south-west, there is a maximum barrier effect in the east-west direction of 25 km extent. This would correspond to a maximum detour of some 50 km. Taking into account the fact that the non-stop flying ranges of the majority of migratory bird species, including small bird species, are of the order of more than 1000 km (BERTHOLD 2000), a significant impact on the energy budget of the migratory birds can be excluded. Thus, a detour caused by the barrier effect of the wind farm area of no more than 60 km in relation to the migration distances should not endanger bird migration because weather-related deviations can also occur.

This is also confirmed by the results of a F&E project to develop suitable analysis and evaluation methods of cumulative impacts of offshore wind turbines on bird migration (HÜPPOP et al. 2005a). On the basis of thirteen mainly nocturnally migrating songbird species, including short-, medium- and long-distance migratory species, HÜPPOP et al. investigated the conditional conditions under which they cross the German Bight.

The results show that short- to medium-distance migratory species have on average lower body reserves and are therefore probably more affected by potential barriers than species that migrate over long distances. The authors calculated a loss of body reserves for a migration route over sea extended by approx. 110 km due to barriers (with no wind), which could result in a lower reproductive performance in the absence of compensation (additional rest of 1 to 2 days). There is no discussion of an increase in the mortality rate of migrating birds themselves.

Consideration of existing knowledge on the migration patterns of the various bird species, the usual flight altitudes and the daytime distribution of bird migration suggests that potential extensive effects on bird migration caused by the implementation of the already approved projects in the priority areas are, according to the current state of knowledge and even allowing for cumulative effects, not likely. Diversion-flying around of the priority areas is not currently expected to cause a significant negative effect on the continued development of populations.

It must be borne in mind that, based on the current state of science and technology, this forecast is based on premises that are not yet suitable to adequately secure the basis for the factor. Insufficient knowledge exists particularly about species-specific migration patterns. This applies, in particular, to bad weather conditions (rain, fog).

These gaps in the knowledge could not be filled despite extensive research activities carried out in the North and Baltic Sea EEZs as part of the ecological accompanying research, such as the test field research on bird migration at the "alpha ventus" offshore pilot farm, assessment of the data continuously collected on "FINO1" (2008-2011), detection of bird collisions using the VARS system and detection of evading movements of migratory birds using pencil beam radar.

Due to the mentioned knowledge gaps, a cumulative final consideration of all the offshore wind farms that are to be taken into account including projects in areas in which there are not yet any final approvals or planning approval decisions resulting from the implementation of an EIA, is not possible at this stage.

This concerns the projects in area 2 and the projects in area 1 outside the priority area, as well as other offshore wind farms outside the German EEZ. Indeed, the environmental impact studies available for the projects in area 2 do not indicate any particular importance of these areas in respect of bird migration, for example a migration corridor of prominent importance in relation to the surroundings. However, investigations carried out for example within the framework of the basic investigations for the projects in area 2 have observed a temporary increase in crane migration sightings. Experts attributed this to a drifting of the birds due to unfavourable changing winds during crossing of the Baltic Sea. Based on these observations, especially against the background that it is assumed that there is a concentration of the bird migration, primarily for narrow-front migratory birds such as cranes in the sea area between Rügen and Scania (see FEDERAL AGENCY FOR NATURE CONSERVATION 2006), significant cumulative effects cannot currently be ruled out.

4.13 Transboundary impacts

This SEA comes to the conclusion that as things stand at present, the specifications in the Site Development Plan have no significant effects on the areas of neighbouring states bordering on the German EEZ in the Baltic Sea.

Substantial transboundary impacts can generally be excluded for the factors Landscape, Cultural heritage and Other material assets and Human beings including Human health. Possible substantial transboundary impacts could only arise if considered cumulatively in the area of the German Baltic Sea, for the highly mobile biological factors Fish, Marine mammals, Seabirds and resting birds, as well as Migratory birds and Bats.

The SEA comes to the conclusion that, according to the current state of knowledge, the implementation of the Site Development Plan is not expected to have any substantial transboundary impacts on the factor Fish, since on the one hand the areas for which the Site Development Plan defines rules have no prominent function for fish fauna, and on the other the discernible and predictable effects are small-scale and temporary in nature.

This also applies to the factors Marine mammals and Seabirds and resting birds. These use the areas predominantly as transit areas. There will be no significant habitat loss for strictly protected seabird and resting bird species. According to current knowledge and taking into account measures to minimise impact and limit damage, substantial transboundary impacts can also be ruled out. The installation of the foundations of wind turbines and converter platforms, for example, is only permitted in the specific approval procedure if effective noise mitigation measures are taken (see e. g. planning principle 4.4.1.7 Site Development Plan). Against the background of the particular endangerment of the separate Baltic Sea harbour porpoise population, intensive monitoring measures must be performed as part of the project and, if necessary, the noise reduction measures be adapted or the construction work coordinated in order to exclude any cumulative effects.

For migratory birds, the wind turbines and platforms erected in Site Development Plan sites may constitute a barrier or present a risk of collision. The risk of collision must be minimised by taking appropriate measures to prevent attraction by the lighting. As regards the barrier effect, a final cumulative consideration is not possible given the current state of knowledge.

Nor is a cumulative assessment of the hazard risk for bat migration possible at this time, as there is still insufficient information on migration routes, migration heights and migration intensities. It can generally be assumed that any significant transboundary impacts resulting from the Site Development Plan rules will be prevented by appropriate prevention or minimisation measures as they are to be applied for bird migration.

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5 Assessment of wildlife conservation regulations

According to section 37 of the Federal Nature Conservation Act, general wildlife conservation generally includes

- protection of wild species of fauna and flora and their communities from human interference, and safeguarding of their other living conditions,
- protection of habitats and biotopes of wild animal and plant species, and
- reintroduction of fauna and flora of displaced wild species in suitable biotopes within their natural distribution area.

Special provisions with prohibitions are applicable to fauna of specially or strictly protected species. Wild animals of specially protected species may not be injured or killed according to section 44 subsection 1 no. 1 of the Federal Nature Conservation Act. Pursuant to section 44 subsection 1 no. 2 of the Federal Nature Conservation Act, wild animals of strictly protected species and of European bird species may not be significantly disturbed during their breeding, rearing, moulting, hibernation and migration periods. Significant disturbance occurs when the conservation status of the local population of a species deteriorates as a result of the disturbance. Furthermore, according to section 44 subsection 1 no. 3 of the Federal Nature Conservation Act, reproduction or resting places of wild fauna of specially protected species must not be removed from the environment, damaged or destroyed.

It does not matter whether a relevant injury or disturbance is due to reasonable grounds; nor do reasons, motives or subjective tendencies play any part in respect of compliance with the prohibitions (Landmann/Rohmer, 2018).

This species conservation assessment investigates whether the Site Development Plan fulfils the species conservation requirements of section 44 of the Federal Nature Conservation Act for specially protected species. It will examine in particular whether the plan violates prohibitions under wildlife conservation regulations. This assessment of wildlife conservation regulations takes place at the primary level of the sectoral plan. A detailed assessment of wildlife conservation regulations for the individual sites and projects must be carried out as part of the assessment of the suitability of specific sites or the individual approval procedure in question.

5.1 Marine mammals

The harbour porpoise, harbour seal and grey seal, which are species listed in Annex II (animal and plant species of Community interest whose conservation requires designation of special areas of conservation) and Annex IV (animal and plant species of Community interest in need of strict protection) of the Habitats Directive and are to be protected in accordance with Art. 12 of the Habitats Directive, occur in the investigation area. The sites of the three areas form part of the harbour porpoise habitat, as does the whole of the western Baltic Sea. According to the current state of knowledge, the three areas are used by harbour porpoises as transit areas. There is currently no evidence that these three sites have special functions as feeding or rearing areas for harbour porpoises. Harbour seals and grey seals use the three areas only sporadically as transit areas.

5.1.1 Section 44 subsection 1 no. 1 of the Federal Nature Conservation Act (prohibition of injury and killing)

Pursuant to section 44 subsection 1 no. 1 of the Federal Nature Conservation Act, which is to be interpreted in light of Art. 12 (1a) of the Habitats Directive, the killing or injury of wild animals of specially protected species, i.e. animals listed in Annex IV of the Habitats Directive, is prohibited.

5.1.1.1 Areas and sites for offshore wind turbines

Pursuant to section 44 subsection 1 no. 1 of the Federal Nature Conservation Act, which is to be interpreted in light of Art. 12 (1a) of the Habitats Directive, the killing or injury of wild animals of specially protected species, i.e. animals listed in Annex IV of the Habitats Directive, is prohibited. The Federal Agency for Nature Conservation regularly assumes in its comments that, according to the current state of knowledge, porpoises suffer injuries in the form of temporary hearing loss when exposed to a single event sound pressure level (SEL) of 164 dB re 1 $\mu Pa^2 Hz$ or a peak level of 200 dB re 1 µPa.

According to the Federal Agency for Nature Conservation, based on the current state of knowledge, it can be assured with sufficient certainty that if the specified limit values of 160 dB for the sound event level (SEL_{05}) and 190 dB for the peak level at a distance of 750 m from the emission site are complied with, the prohibition of killing and injury as defined in section 44 subsection 1 no. 1 of the Federal Nature Conservation Act is not violated for the harbour porpoise.

The Federal Agency for Nature Conservation takes into account the currently common use of monopiles with diameters of up to 8.2 m for wind turbines and jacket piles with diameters of up to 4 m for transformers. The Federal Agency for Nature Conservation assumes that suitable means such as deterrence, soft-start procedure etc. are used to ensure that no harbour porpoises are present within the 750 m radius around the pile-driving location.

The Federal Maritime and Hydrographic Agency agrees with this assessment.

In addition, the Federal Maritime and Hydrographic Agency imposes a series of noise protection measures under the scope of the planning approval and implementation. These measures are designed to rule out the possibility of the prohibition being violated or to reduce the intensity of any impairments (known as conflict avoidance or mitigation measures), see inter alia *Lau* in: Frenz/ Müggenborg, Federal Nature Conservation Act, comment, Berlin 2011, section 44 marg. no. 3. The measures are strictly monitored in order to ensure with the necessary certainty that the prohibition of killing and injury as defined in section 44 subsection 1 no. 1 of the Federal Nature Conservation Act is not violated.

In order to ensure with the necessary certainty that the prohibition of killing and injury as defined in section 44 subsection 1 no. 1 of the Federal Nature Conservation Act is not violated, the Federal Maritime and Hydrographic Agency prescribes suitable deterrent measures and a slow increase in pile-driving energy, known as "soft starts", under the scope of individual planning approval decisions as well as under the scope of implementation. The prescribed deterrence measures and "soft starts" ensure that no harbour porpoises or other marine mammals are present in an adequate area around the pile/driving site, but at least up to 750 m from the construction site. Until 2017, a combination of pingers was used as a pre-warning system followed by the use of the so-called seal scarers for the purpose of deterrence. However, deterrence using seal scarers is associated with a large habitat loss caused by the flight responses of the animals and therefore represents a disturbance (BRANDT et al. 2012). The development of new systems, such as the FaunaGuard system, creates the possibility of adapting deterrence of harbour porpoises and seals in such a way that the possibility that the prohibition of killing and injury as defined in section 44 subsection 1 no. 1 of the Federal Nature Conservation Act being violated can be ruled out with certainty without simultaneously violating the prohibition of disturbance as defined in section 44 subsection 1 no. 2 of the Federal Nature Conservation Act.

Since 2017, the FaunaGuard system has been used as a deterrence measure in all construction projects in the German EEZ of the Baltic Sea. The use of the FaunaGuard system is accompanied by strict monitoring measures with good results. Within the scope of a research project, the effects of the FaunaGuard system are to be systematically analysed and, if necessary, the application of the system for future construction projects optimised.

In addition, the required degree of noise mitigation is such that it can be assumed that no deadly or long-term adverse effects will occur outside the area where no harbour porpoises can be expected due to the deterrent measures to be implemented.

The measures prescribed by the Federal Maritime and Hydrographic Agency will prevent with sufficient certainty any violation of the prohibition under species conservation law as defined in section 44 subsection 1 no. 1 of the Federal Nature Conservation Act.

5.1.1.2 Platforms

The platforms are currently being installed with pile-driven deep foundations on a regular basis. Creating foundations using alternative methods, such as gravity foundations, is currently the exception. With regard to the possible effects of pile-driving on marine mammals, the information provided under "Areas and sites for wind energy" for the construction of wind turbines applies.

Without the use of effective noise-minimising and damage-limiting measures, the possibility of marine mammals being impaired during the installation of the foundations cannot be ruled out. The planning principle for noise mitigation in the Site Development Plan therefore also applies to platforms without restriction.

For this reason, the environmental impact assessment is carried out on the condition that noise mitigation measures are used to comply with the applicable noise protection values. For the construction of platforms with driven-in piles, all measures apply, as explained under "Areas and sites for wind energy".

The Federal Maritime and Hydrographic Agency assumes that if the specified noise protection values for the sound event level of 160 dB re 1µPa²s and 190 dB re 1µPA for the maximum peak level at a distance of 750 m from the sound source from the sound source are complied with and deterrence measures and what are known as "soft starts" are used, according to the current state of knowledge, it can be guaranteed with sufficient certainty that the prohibition of killing and injury in relation to harbour porpoises and seals is not violated as defined section 44 subsection 1 no. 1 of the Federal Nature Conservation Act. This applies to all areas analysed.

5.1.1.3 Submarine cabling systems

Based on the current state of knowledge, the laying and operation of submarine cable systems will not have any significant negative impacts on marine mammals that violate the prohibition of killing and injury as defined in section 44 subsection 1 no.1 of the Federal Nature Conservation Act.

5.1.2 Section 44 subsection 1 no. 2 of the Federal Nature Conservation Act (prohibition of disturbance)

According to section 44 subsection 1 no. 2 of the Federal Nature Conservation Act it is also prohibited to significantly disturb wild animals of strictly protected species during their breeding, rearing, moulting, hibernation and migration periods, whereby a disturbance shall be deemed significant if it causes the conservation status of the local population of a species to worsen.

The harbour porpoise is a strictly protected species in accordance with Annex IV of the Habitats Directive and thus within the meaning of section 44 subsection 1 no. 2 of the Federal Nature Conservation Act, so that a species conservation assessment must also be conducted in this respect.

The species conservation assessment pursuant to section 44 subsection 1 no. 2 of the Federal Nature Conservation Act refers to population-relevant disturbances of local stocks, the occurrence of which varies in the areas covered by the plan. The results of the species conservation assessment are therefore subsequently represented for individual areas or groups of areas with comparable occurrences.

5.1.2.1 Areas and sites for offshore wind energy

The Federal Agency for Nature Conservation assesses in its comments whether a disturbance as defined in section 44 subsection 1 no. 2 of the Federal Nature Conservation Act exists under the scope of planning approval and implementation procedures. It concludes that the occurrence of a significant disturbance caused by underwater noise due to construction can be avoided for the factor Harbour porpoise provided that the sound event level of 160 dB or the peak level of 190 dB is not exceeded at a distance of 750 m from the emission point and sufficient alternative areas are available in the German Baltic Sea The latter could be achieved in accordance with the BfN's request, by coordinating the timing of the sound-intensive activities of the various project developers.

The species conservation assessment is based on the following considerations:

According to Art. 12 (1b) Habitats Directive in conjunction with section 44 subsection 1 no. 2 of the Federal Nature Conservation Act any intentional disturbance of these species, particularly during their breeding, rearing, hibernation and migration periods, is prohibited. According to section 44 subsection 1 no. 2 of the Federal Nature Conservation Act it is prohibited to disturb wild animals of strictly protected species, i.e. animals listed in Annex IV of the Habitats Directive, among others, during breeding, rearing, hibernation and migration periods.

According to the legal definition found in section 44 subsection 1 no. 2, 2nd clause of the Federal Nature Conservation Act, a disturbance shall be deemed significant if it causes the conservation status of the local population of a species to worsen. According to the guidelines on the strict protection system for species of Community interest under the Habitats Directive (marg. no. 39) a disturbance as defined in Art. 12 of the Habitats Directive is deemed to exist if the action in question reduces the chances of survival, reproductive success or reproductive capacity of a protected species or if this action leads to a reduction in its distribution range On the other hand, occasional disturbances without foreseeable negative impacts on the species in question are not to be regarded as disturbances within the meaning of Art. 12 of the Habitats Directive.

Possible impacts of <u>pile-driving work</u> during the construction phase of offshore wind farms on harbour porpoises:

The existence of a disturbance as defined in Art. 12 (1b) of the Habitats Directive in conjunction with section 44 subsection 1 no. 2 of the Federal Nature Conservation Act for the harbour porpoises cannot be assumed during the temporary pile-driving work.

Based on the current state of knowledge, it cannot be assumed that disturbances potentially resulting from noise-intensive construction measures would worsen the conservation status of the "local population".

Effective noise protection management, in particular if suitable noise mitigation systems are used as stipulated in the Federal Maritime and Hydrographic Agency's planning approval decisions and the requirements of the Federal Agency for Nature Conservation are taken into account, means that negative impacts of the pile-driving work on harbour porpoises are not to be expected.

The planning approval decisions of the Federal Maritime and Hydrographic Agency therefore contain provisions which ensure effective noise protection management by means of suitable measures.

In accordance with the precautionary principle, measures to prevent and reduce the impacts of noise during construction must be defined in accordance with the latest scientific and technical knowledge. The measures required in the planning approval decisions to guarantee the requirements of species protection will be coordinated with the Federal Maritime and Hydrographic Agency over the course of implementation. Noise reduction and environmental protection measures include:

- Creation of a concrete noise report taking into account the site- and turbine-specific properties (basic design) before the start of construction
- Selection of a construction method that is as quiet as possible in line with state-of-the-art technology
- Creation of a concrete noise protection concept, adapted to the selected foundation structures and construction processes, to carry out the pile-driving work taking
- Into account noise reduction support measures in line with the current state of science and technology
- Taking into account the properties of the hammer and the options for managing the pile-driving process
- Concept for deterring animals from the hazardous zone (a radius of at least 750 m around the pile-driving location)
- Concept to assess the efficiency of the deterrence and noise reduction measures
- Turbine designed to minimise operational noise in line with the current state of technology

Deterrent measures and a "soft start" are to be used to ensure that animals present in the vicinity of the pile-driving work have the opportunity to leave the area or move away in due time Since 2017, a new system, the FaunaGuard system, has been used in construction projects in the German EEZ of the Baltic Sea to deter animals from the hazardous zone of construction sites. The newly optimised FaunaGuard deterrence system has the advantage over the seal scarers system used up to and including 2017 of effectively driving the animals out of the hazardous zone without causing a disturbance through large-scale displacement of the animals out of the habitat.

The selection of noise mitigation measures must be based on state-of-the-art science and technology and on experience already gained in other offshore projects. Practical knowledge on the application of technical noise-minimising measures as well as from experience with control of the pile driving process in connection with the characteristics of the impact hammers were in particular obtained from the foundation work in the projects "EnBW Baltic 2", "Viking", and "Arkona Basin Southeast" and from construction projects in the German North Sea EEZ.

In addition, monitoring measures and noise measurements are stipulated in the planning approval decisions in order to record any potential on-site dangers and, if necessary, to initiate damage-limiting measures. Overall, to the best of our knowledge, the impact of the pile-driving operations on the harbour porpoise population in the North Sea can be ruled out with sufficient certainty.

New findings confirm that the reduction of noise emissions through the use of technical noise mitigation systems clearly reduces disturbances for harbour porpoises. Minimising effects involves the spatial as well as the temporal scope of disturbances. (BRANDT et al. 2016).

The Federal Maritime and Hydrographic Agency concludes that if strict noise protection and noise mitigation measures are implemented in accordance with the planning approval decisions and the noise limit of 160 dB SEL_5 is observed at a distance of 750 m, considerable disturbances as defined in section 44 subsection 1 no. 2 of the Federal Nature Conservation Act are not to be expected. Furthermore, the Federal Agency for Nature Conservation's requirement to coordinate the timing of noise-intensive construction phases of various project developers in the German North Sea EEZ remains.

Possible impacts of operation of the offshore wind farm on harbour porpoises:

The existence of a disturbance as defined in Art. 12 (1b) of the Habitats Directive in conjunction with section 44 subsection 1 no. 2 of the Federal Nature Conservation Act caused by operation of offshore wind turbines can also not be assumed. Based on the current state of knowledge, no negative long-term effects are to be expected from the noise immissions of the turbines for harbour porpoises, even in the design of the turbines. Any impacts are limited to the immediate vicinity of the turbine and depend on the noise distribution in the specific area and not least on the presence of other noise sources and background noise, such as shipping traffic (MADSEN et al. 2006). There are also recent findings available from experimental work on the detection of low-frequency acoustic signals by harbour porpoises with the aid of simulated operating noises from offshore wind turbines (LUCKE et al. 2007b). Masking effects were recorded for simulated operating noises of 128 dB re 1 µPa at frequencies of 0.7, 1.0 and 2.0 kHz. In contrast, no significant masking effects were observed for operating noises of 115 dB re 1 µPa. The initial results thus indicate that only masking effects are to be expected from operating noises, depending on the type of turbine or intensity of the operating noises and only in the immediate vicinity of the respective turbine.

A study conducted on the Dutch offshore wind farm "Egmont aan Zee" provides findings on the habitat use of offshore wind farms by harbour porpoises during operation. With the aid of acoustic recording, the use of the site of the wind farm or of two reference sites by harbour porpoises was investigated before the construction of the turbines (baseline survey) and in two consecutive years of the operating phase. The results of the study confirm a pronounced and statistically significant increase in acoustic activity in the inner area of the wind farm during the operating phase compared to activity or use during the baseline survey (SCHEIDAT et al. 2011). The increase in harbour porpoise activity within the wind farm during operation significantly exceeded the increase in activity in both reference areas. The increase in use of the area of the wind farm was clearly independent of seasonality and interannual variability. The authors of the study see a direct correlation between the presence of the turbines and the increased use by harbour porpoises. They suspect the causes to lie in factors such as the increase in the food supply by what is known as the "reef effect" or the calm waters in the area due to the absence of fishing and shipping, or possibly a positive combination of these factors.

The results from the investigations in the operating phase of the "alpha ventus" project also suggest a return to distribution patterns and abundances of the harbour porpoise, which are comparable – and in some cases higher – to those in the baseline survey of 2008. In addition, further results from offshore wind farms with a large number of wind turbines must be obtained in order to arrive at a final assessment of the possible effects of operation.

In order to ensure with sufficient certainty that the prohibition of disturbance as defined in section 44 subsection 1 no. 2 of the Federal Nature Conservation Act is not violated, a turbine design that uses state-of-the-art technology to minimise operating noise must be guaranteed against this background in accordance with the provision in section 4.1.

Suitable monitoring is obligatory in the operating phase of the individual project in order to be able to record and assess any site- and project-specific impacts).

As a result, the prescribed mitigation measures are sufficient to ensure that, in relation to harbour porpoises, the operation of the wind farm does not violate the prohibition as defined in section 44 subsection 1 no. 2 of the Federal Nature Conservation Act.

Other marine mammals

The detailed considerations for harbour porpoises regarding noise emissions caused by construction and operation activities of offshore wind turbines generally apply to all marine mammals otherwise present in the planning area. However, the hearing levels, sensitivity and behavioural reactions among marine mammals vary considerably depending on the species. The differences in detection and evaluation of sound events among marine mammals are based on two components: first, the sensory systems are morphoanatomically and functionally different depending on the species. As a result, marine mammal species hear and react differently to noise. Second, both detection and reaction behaviour depend on the respective habitat (KETTEN 2004).

Seals are generally considered to be tolerant of noise, especially when food is abundant. However, telemetric investigations have found flight responses during seismic activities (RICHARDSON 2004). According to all previous findings, seals can still hear pile-driving noises at a distance of more than 100 km. Operating noise from 1.5 - 2 MW wind turbines can still be detected by harbour seals at a distance of 5 to 10 km (LUCKE et al. 2006).

5.1.2.2 Platforms

Subject to the use of effective noise mitigation measures in the concrete project to comply with specified noise mitigation values in accordance with the planning principle for noise mitigation and applying the requirements outlined in the noise protection concept of the Federal Minister for the Environment, Nature Conservation, and Nuclear Safety, there is no reason to worry that the installation of the platform foundations will cause disturbance of harbour porpoises in terms of species protection law as defined in section 44 subsection 1 no. 2 of the Federal Nature Conservation Act. The conservation status of the local harbour porpoise populations is not expected to worsen.

In addition to the results of the species conservation assessment for offshore wind farms, the following considerations apply to platforms:

The installation of the transformer platforms is a time-limited work process. The effective pile-driving time to be observed (including deterrence) is specified in the approval procedure in a site-specific and installation-specific manner. As part of the enforcement procedure, coordination of sound-intensive work with other construction projects is also required to ensure that sufficient avoidance areas are available for the harbour porpoise populations in the German EEZ. According to the current state of knowledge, it can be assumed that the insertion of the piles for pile-driven platforms, taking into account strict noise reduction measures and accompanied by intensive monitoring measures, will not cause any disturbance relevant to species protection regulations in accordance with section 44 subsection 1 No. 2 of the Federal Nature Conservation Act.

5.1.2.3 Submarine cabling systems

Based on the current state of knowledge, the laying and operation of submarine cable systems will not involve any disturbances of marine mammals relevant to species conservation law as defined in section 44 subsection 1 no. 2 of the Federal Nature Conservation Act.

5.2 Avifauna (seabirds, resting birds and migratory birds)

The plan must be evaluated on the basis of species conservation regulations in accordance with section 44 of the Federal Nature Conservation Act in conjunction with Art. 5 of the Wild Birds Directive for avifauna (resting and migratory birds).

Protected bird species listed in Annex I of the Wild Birds Directive occur in varying densities in the vicinity of the planned areas for offshore wind farms and platforms as well as along the planned submarine cable routes. Against this background, the compatibility of the plans with section 44 subsection 1 no. 1 of the Federal Nature Conservation Act (prohibition of killing and injury) and section 44 subsection 1 no. 2 of the Federal Nature Conservation Act (disturbance of strictly protected species and European bird species) must be assessed and ensured.

The individual areas for offshore wind energy in the Baltic Sea EEZ are of differing significance for seabirds and resting birds. Overall, area O-1 is expected to be of medium importance for seabirds. The area boundaries on the extensive resting habitats of the Pomeranian Bight and the Adlergrund to the south and south-east. Overall, the area has a medium seabird population and a medium incidence of endangered species and species that are particularly worthy of protection. According to current knowledge, areas O-2 and O-3 are of low importance as feeding and resting habitats for seabirds. Both areas have a low incidence of endangered species and species that are particularly worthy of protection. They are not amongst the main resting, feeding and wintering habitats of Annex I species of the Wild Birds Directive.

In addition, the EEZ is of average to above-average importance for bird migration. Annually, up to a billion birds migrate over the Baltic Sea. For sea ducks and geese from Northern Europe and Russia (as far as West Siberia), the Baltic Sea is an important transit area, with a large part of the migration occurring in the autumn in the east-west direction close to the coast. Thermal soarers (and other diurnal migratory land birds, such as common wood pigeon) preferably migrate along the "flyway" (islands of Fehmarn, Falster, Møn and Seeland, Falsterbo). East of this main route, these birds migrate in much lower densities. The western Baltic Sea is of above-average importance for crane migration, because the majority of the biogeographic population on its way south must inevitably cross the Baltic Sea. In addition, the western Baltic Sea is flown over, sometimes in high intensities, by several species that require special protection (e.g. barnacle goose, whooper swan, eider duck, common and velvet scoter).

5.2.1 Section 44 subsection 1 no. 1 of the Federal Nature Conservation Act (prohibition of injury and killing)

The species conservation assessment pursuant to section 44 subsection 1 No. 1 of the Federal Nature Conservation Act refers to the killing and injury of individual birds and animals and therefore applies uniformly to all plan areas from O-1 up to and including O-3. It should be noted at this point that the species protection review of the plan in the sense of section 44 subsection 1 No. 1 of the Federal Nature Conservation Act can only be implemented at a higher level. Any impacts of the structural design of the installations and their spatial configuration requires a detailed review at the approval level of the individual projects.

5.2.1.1 Areas and sites for offshore wind turbines

Pursuant to section 44 subsection 1 no. 1 of the Federal Nature Conservation Act, it is prohibited to hunt, catch, injure or kill wild animals of specially protected species. This applies to all development forms of the affected species. Pursuant to section 7 subsection 2 no. 12 and no. 13 b) bb) of the Federal Nature Conservation Act, species that are naturally native to Europe in the sense of Article 1 Annex I of the Wild Birds Directive also form part of the specially protected species.

Accordingly, any injury or killing of resting birds as a result of collisions with wind turbines is prohibited. The risk of collision depends on the behaviour of the individual birds and is directly related to the species in question and the environmental conditions. For example, divers are unlikely to collide due to their pronounced avoidance behaviour towards vertical obstacles.

When planning and approving public infrastructure and private construction projects, it must be assumed that unavoidable killings or injuries of individuals for operational reasons (e.g. through collision of bats or birds with wind turbines) are not covered by the prohibition as socially adequate risks (Bundestag Printed Paper 16/5100, p. 11 and 16/12274, p. 70 f.). They are only attributed if the risk of success for the project increases significantly due to special circumstances, such as the construction of the turbines, the topographical conditions or the biology of the species. Risk avoidance and mitigation measures are to be included in the assessment; see LÜTKES/EWER 2011, BVERWG, 12 MARCH 2008; BVERWG 09 July 2008; FRENZ/MÜGGENBORG, 2011.

The Federal Agency for Nature Conservation regularly states in its comments that, due to changes in the technical size parameters of the wind turbines in current projects, the vertical obstacles in the airspace are generally increased compared to farms constructed from 2011 to 2014. However, based on the current state of knowledge, an increased risk of bird strikes cannot be quantified by simultaneously reducing the number of turbines. Although collision-related individual losses due to the construction of a stationary system in previously unobstructed spaces cannot be completely ruled out, The prescribed measures, such as minimising light emissions, ensure that collisions with offshore wind turbines are avoided as far as possible or at least that this risk is minimised. In addition, monitoring is carried out during the operating phase to improve the nature conservation assessment of the actual risk of bird strikes posed by the turbines. The right to prescribe additional measures is also explicitly reserved.

Based on the current state of knowledge, there is no evidence of a significantly increased risk of a site-related collision of individual species of seabirds and resting birds in areas O-1 to O-3 of the plan.

Therefore, it cannot be assumed that the prohibition of injury and killing will be realised in accordance with section 44 subsection 1 no. 1 of the Federal Nature Conservation Act for sea and resting birds is thus not to be assumed.

Against this background, the Federal Maritime and Hydrographic Agency does not expect any significant increase in the risk of killing or injuring migratory birds. Any increased risk of collision due to the structural design of the installations must be taken into account when planning the individual projects. This is especially true for crane migration. Consequently, the plan does not violate the prohibition on killing and injuring in accordance with section 44 subsection 1 no. 1 of the Federal Nature Conservation Act.

5.2.1.2 Platforms

Collisions with platforms may result in the death or injury of birds. It can be assumed that the species affected will mainly be songbirds migrating at night and only a few species of seabirds and resting birds. Based on current case law, the BfN points out that the killing or injuring of individual birds does not always constitute fulfilment of the prohibitory provision of section 44 (1) No. 1 of the Federal Nature Conservation Act, rather it is only fulfilled if a significant increase in the risk of collision-induced losses of individual birds occurs. In view of the fact that a transformer or collector platform is a single building in close spatial association with an offshore wind farm, it can be assumed, as far as the platform is concerned, that there is no significantly increased risk of collision.

Whether the risk of a violation of the prohibitions under species protection law can also be ruled out for the case of cumulative consideration taking into account the wind farms to be connected, cannot be clarified with the required certainty within the framework of the present Strategic Environmental Assessment. A final cumulative assessment will only be possible at the concrete project level after carrying out a detailed assessment of wildlife conservation regulations. To minimise the risk of collision of birds with the installations, appropriate minimisation measures should be laid down in the specific approval procedure.

5.2.1.3 Submarine cabling systems

According to the current state of knowledge, the operation of submarine cable systems will not have any significant negative impacts on seabirds and migratory birds that violate the prohibition of killing and injury pursuant to section 44 subsection 1 no.1 of the Federal Nature Conservation Act. When laying the submarine cable systems, the tall cable-laying ships can attract migratory birds with their intense lighting. Due to the short duration of the laying phase, the risk of a violation of species conservation prohibitions can be excluded according to the current state of knowledge. Suitable measures must also be taken on the construction ships to minimise attraction from lighting, taking into account occupational safety aspects.

5.2.2 Section 44 subsection 1 no. 2 of the Federal Nature Conservation Act (prohibition of disturbance)

As described above, the planning area has occurrences of the red-throated diver, the black-throated diver, the little gull, the horned grebe, the common gull, the long-tailed duck and the common guillemot, various native European wild bird species listed in Art. 1 of the Wild Birds Directive and Annex I species of the Wild Birds Directive. Against this background, the compatibility of the plan with section 44 subsection 1 no. 2 of the Federal Nature Conservation Act in conjunction with Article 5 of the Wild Birds Directive must be ensured.

According to section 44 subsection 1 no. 2 of the Federal Nature Conservation Act it is prohibited to significantly disturb wild animals of strictly protected species during their breeding, rearing, moulting, hibernation and migration periods, whereby a disturbance shall be deemed significant if it causes the conservation status of the local population of a species to worsen.

The species conservation assessment pursuant to section 44 subsection 1 no. 2 of the Federal Nature Conservation Act refers to population-relevant disturbances of local populations, the occurrence of which, however, varies only slightly in the areas covered by the plan. The species conservation assessment pursuant to section 44 subsection 1 no. 2 of the Federal Nature Conservation Act is therefore applied uniformly for all areas of the plan.

5.2.2.1 Areas and sites for offshore wind turbines

All available evidence shows a low to at most medium importance for Annex I species of the Wild Birds Directive for the areas intended to be used for offshore wind energy in the Baltic Sea EEZ. Red-throated divers and black-throated divers only visit the planning area sporadically as winter stopover or passage migrant birds. The occurrence of Slavonian grebes and little gulls is similarly low. The areas are unimportant for diving sea ducks as feeding grounds because of their depth. For auks, such as guillemots and razorbills, area O-1 belongs only to the southern fringes of their main winter resting area in the Baltic Sea. Black guillemots are only seen sporadically to the east of this area.

In summary, in view of the low incidence of protected species listed in Annex I of the Wild Birds Directive and other wild native bird species, significant disturbance caused by implementation of the plan can be safely ruled out for seabirds and resting birds. Therefore, it cannot be assumed that the conditions which would mean that the offence had occurred will be fulfilled in accordance with section 44 subsection 1 no. 2 of the Federal Nature Conservation Act can therefore not be assumed.

The Baltic Sea EEZ is of average to above-average importance for bird migration. Worthy of note here is the importance of the Baltic Sea for the migration of the crane, another Annex I bird species of the Wild Birds Directive. Taking into account the available knowledge on the migratory behaviour and the migration intensity of individual species and the crane in particular, the wind energy areas planned in the Site Development Plan, taking into account the respective area-related planning of further projects, can be assumed not to cause a serious disturbance to bird migration. A cumulative consideration taking into consideration existing pre-stresses and future developments cannot currently be concluded due to existing knowledge gaps. These gaps in bird migration knowledge still require attentive and intensive observation and monitoring in the planning and implementation of individual projects. For this purpose, it makes sense to add additional detection methods to the investigation methods in accordance with StUK 4, such as the rangefinder for determining flight altitudes, so that specific questions can be considered separately.

5.2.2.2 Platforms

All transformer or collector platforms are planned in direct physical proximity to offshore wind farms and thus in their immediate vicinity. It can therefore be assumed that the adjacent wind farms' deterrence of seabirds sensitive to disturbance and the associated loss of habitat by the transformer and or transformer platforms will only increase marginally. The same applies to the deterrence and barrier effect on migratory birds. Based on the current state of knowledge, it therefore cannot be assumed that there will be a disturbance of seabirds, resting birds and migratory birds as defined in section 44 subsection 1 no. 2 of the Federal Nature Conservation Act relevant to species conservation law.

5.2.2.3 Submarine cabling systems

Deterrence of migratory birds, seabirds and resting birds is limited to the small-scale laying of submarine cables, which is very temporary. These disturbances will not go beyond the disruptions generally associated with slow shipping traffic. Therefore, no species-protection relevant disturbance in accordance with section 44 subsection 1 no. 2 of the Federal Nature Conservation Act is to be expected from the planned submarine cable systems.

5.3 Bats

Migration movements of bats across the Baltic Sea are documented to varying extents, but to date no specific information is available on migratory species, migration corridors, migration heights and migration concentrations. The only information to date confirms that bats, especially species that travel long distances, fly over the Baltic Sea. On the basis of previous observations, it is assumed that bats tend to migrate across the sea in concentrations (swarms), probably at considerable altitudes and on migratory routes that are used regularly.

5.3.1 Section 44 subsection 1 no. 1 and no. 2 of the Federal Nature Conservation Act

In its statements, the BfN regularly indicates that, according to the current state of knowledge, the killing or injury (section 44 subsection 1 no. 1 of the Federal Nature Conservation Act) of other specially protected species, such as bats, can be excluded where offshore wind farms, platforms and submarine cable systems are concerned. According to the BfN, based on the current state of knowledge, the implementation of a prohibitory provision relating to a significant disturbance according to species protection law (section 44 subsection 1 no. 2 of the Federal Nature Conservation Act) for other strictly protected species is not to be expected either.

The BSH agrees with the BfN and is of the opinion that any temporary threats to bats may be avoided by the same prevention and mitigation measures used for the protection of migratory birds.

Experience and results from research projects and wind farms already in operation will also be sufficiently accounted for in other assessments.

According to the current plans, violation of neither the prohibition of killing and injury pursuant to section 44 subsection 1 no. 1 of the Federal Nature Conservation Act nor the prohibition of a significant disturbance pursuant to 44 subsection 1 no. 2 of the Federal Nature Conservation Act is the be expected.

Based on the current state of knowledge, the laying and operation of submarine cable systems will not have any relevant effects on bats under species conservation law.

6 Assessment of the implications

Within the framework of this SEA, the areas, sites, platforms and submarine cable routes in the Site Development Plan will be subject to a separate assessment as to their implications for the conservation objectives of the nature conservation areas.

6.1 Legal basis

The German Baltic Sea EEZ includes the nature conservation areas "Pomeranian Bight – Rönnebank", "Fehmarn Belt" and "Kadetrinne", which were established by decree on 22.09.2017.

Essentially, construction of artificial installations and buildings in nature conservation areas is prohibited. However, this does not apply to certain projects and plans, subject to an admissibility assessment being performed (see sections 8 subsection 1, 9 subsection 6 Ordinance on the establishment of the conservation area "Pomeranian Bight – Rönnebank" (NSGPBRV) [41] ; sections 4 subsection 1, 5 subsection 6 Ordinance on the Establishment of the Nature Conservation Area "Fehmarn Belt" (NSGFmbV) [42] ; section 4 subsection 1, 5 subsection 6 Ordinance on the Establishment of the Nature Conservation Area "Kadetrinne"(NSGKdrV)[43]). These projects and plans must be assessed for their implications for the conservation objectives of the respective ordinance. In doing so, they are permissible if they, in accordance with section 34 subsection 2 of the Federal Nature Conservation Act cannot lead to significant damage to the constituent parts of the nature conservation area that are relevant to the conservation objectives or fulfil the requirements of section 34 subsections 3 to 5 of the Federal Nature Conservation Act (see section 9 subsection NSGPBRV, section 4 5 subsection 2 NSGFmbV, section 5 subsection 2 NSGKdrV. The implications according to the Federal Nature Conservation Act are to be assessed in accordance with the assessment previously carried out for the Fauna-Flora-Habitat areas (FFH areas). By a decision made by the EU Commission dated 12.11.2007, the nature conservation areas in the EEZ were previously included under European law as FFH areas in the first updated list of areas of Community importance in the Atlantic biogeographical region under Art. 4 subsection 2 of the Habitats Directive (Official Journal of the EU, 15.01.2008, L 12/1), so an FFH assessment of the implications has already been carried out within the framework of the Spatial Offshore Grid Plan.

sections 34 and 36 of the Federal Nature Conservation Act stipulate that plans or projects which, individually or in conjunction with other plans or projects, may significantly affect an FFH and EU bird sanctuary and which do not directly serve the administration of the area must be assessed for their implications for the conservation objectives and protective aims of a Natura 2000 site. This is also applicable to projects outside the site which, individually or in combination with other projects or plans, are likely to significantly undermine the conservation objectives of the sites. With the designation of the nature conservation areas, this assessment now refers to the conservation objective of these

[41] Ordinance on the establishment of the conservation area "Pomeranian Bight – Rönnebank" of 22 September 2017 (Federal Law Gazette I p. 3415)

[42] Ordinance on the establishment of the conservation area "Fehmarn Belt" of 22 September 2017 (Federal Law Gazette I p. 3405)

[43] Ordinance on the establishment of the conservation area "Kadetrinne" of 22 September 2017 (Federal Law Gazette I p. 3410)

nature conservation areas. The assessment of the implications under the Habitats Directive has a narrower scope than the SEA as it is limited to reviewing the impact using the protective aims established for the protected area. Other environmental effects do not need to be assessed.

The total site of the three nature conservation areas amounts to 2,472 km²; the nature conservation area "Pomeranian Bight – Rönnebank" covers an area of 2,092 km², the nature conservation area "Fehmarn Belt" covers an area of 280 km², and the nature conservation area "Kadetrinne" covers 100 km².

The factors are the habitat types "reefs" and "sandbanks" according to Annex I of the Habitats Directive, certain fish species and marine mammals according to Annex II of the Habitats Directive (sturgeon, twaite shad, harbour porpoise, grey seal), as well as various bird species according to Annex I of the Wild Birds Directive (red-throated diver, black-throated diver, Slavonian grebe, red-necked grebe, white-billed diver, long-tailed duck, common scoter, velvet scoter, common gull, guillemot, razorbill, black guillemot). Species listed in Annex IV of the Habitats Directive, e.g. the harbour porpoise, must be strictly protected everywhere, including outside the defined protected areas.

Within the framework of the Site Development Plan, individual rules are planned near the nature conservation areas "Pomeranian Bight – Rönnebank" and "Fehmarn Belt". Thus, the assessment of implications in the EEZ area is limited to these protected areas. In addition, the assessment of the implications also takes into account the remote effects of the rules defined within the EEZ on the conservation areas in the adjacent 12 nautical milezone and the adjacent waters of the neighbouring states. This also concerns assessment and consideration of functional relationships between the individual conservation areas and the coherence of the network of conservation areas under section 56 subsection 2 of the Federal Nature Conservation Act, since the habitats of some target species (e.g. avifauna, marine mammals) may extend over several conservation areas due to their large range. There are also FFH areas and bird sanctuaries outside the German EEZ that are taken into account. A re-examination of the areas and testing grounds in the coastal waters is not taking place because this has already occurred with the establishment of the Mecklenburg-Western Pomerania regional spatial development programme.

Apart from the effects within the EEZ, this assessment of the implications explicitly examines only possible remote effects of the areas and sites, converter platforms and submarine cable routes that are planned in the EEZ in protected sites in adjacent sites. However, this consideration is not made with regard to routes in coastal waters, which are connected to the gates provided for in the Site Development Plan. This assessment is the subject of the coastal states' environmental reports on Spatial Plans or secondary procedures.

An assessment of the implications pursuant to section 34 subsection 2 to 5 of the Federal Nature Conservation Act must be carried out if a preliminary assessment pursuant to section 34 subsection 1 of the Federal Nature Conservation Act concludes that significant impairment of a protected area is a serious concern.

Pursuant to section 34 subsection 1 of the Federal Nature Conservation Act, projects and plans must be reviewed for their implications for the protective aims of a protected area prior to their implementation if, individually or in conjunction with other projects or plans, they are likely to have a significant impact on the Natura 2000 site and do not directly serve the administration of the area.

For this reason, a possible negative impact on the conservation objectives, as set out in the conservation objective of the Conservation Area Ordinance of 22 September 2017, should be checked for.

The BSH is responsible for the assessment of the implications according to section 34 of the Federal Nature Conservation Act.

6.2 Impact assessment of the Site Development Plan with respect to the habitat types

6.2.1 Assessment of implications with the conservation objective of the nature conservation area "Pomeranian Bight – Rönnebank"

6.2.1.1 Impact assessment of the Site Development Plan for sites and platforms in area O-1 with regard to habitat types

No significant effects are expected for "reef" and "sandbar" habitats with their characteristic and endangered communities and species due to the construction and operation of sites and platforms in the area O-1 because of the small scale of, in particular, reef-related effects, such as sediment drift and sediment overlaying with the material released during the construction phase, and because of the location of the area outside nature conservation areas. Significant damage to the nature conservation areas due to sediment drift during the construction phase can be excluded based on current knowledge. The closest nature conservation area "Pomeranian Bight – Rönnebank" is located at a distance of at least 5.8 km and thus outside of the drift distances discussed in the scientific literature. In this respect, no release of nutrient and pollutant concentrations that could affect the nature conservation area is to be expected.

6.2.1.2 Impact assessment of the Site Development Plan for sites and platforms in area O-2 with regard to habitat types

No significant effects are expected for "reef" and "sandbar" habitats with their characteristic and endangered communities and species due to the construction and operation of sites and platforms in the area O-2 (site O-2.2 under investigation) because of the small scale of, in particular, reef-related effects, such as sediment drift and sediment overlaying with the material released during the construction phase, and because of the location of the area outside nature conservation areas. Significant damage to the nature conservation areas due to sediment drift during the construction phase can be excluded based on current knowledge. The closest nature conservation area "Pomeranian Bight – Rönnebank" is located at a distance of at least 9.2 km and thus outside of the drift distances discussed in the scientific literature. In this respect, no release of nutrient and pollutant concentrations that could affect the nature conservation area is to be expected.

6.2.1.3 Impact assessment of the Site Development Plan for cable routes for connection of the O-1 and O-2 areas and parallel cross-border submarine cable systems in respect of habitat types

Significant impairments to the conservation areas due to sediment drifting during the construction phase are excluded based on current knowledge. The nature conservation area "Pomeranian Bight – Rönnebank" is located at a distance of at least 900 m to the cable routes and thus outside the drifting distances discussed in the literature. The soft sediments that occur along the course of the cable route do indeed settle more slowly than coarser sediment. However, given the predominant low currents close to the seabed, turbidity plumes can only be expected in areas with soft sediments up to a distance of approx. 500 m which clearly exceed natural suspended matter maxima. Moreover, the released material remains in the water column for long enough to be distributed over a large area, so barely detectable thicknesses of the deposited material are to be expected due to the comparatively small volumes. Simulations show that the sediment released will have resettled after a maximum of 12 hours.

Thus, according to available information, the impairments will generally remain small-scale and temporary. In this respect, no release of nutrient and pollutant concentrations that could affect the nature conservation area is to be expected.

6.2.1.4 Impact assessment of the Site Development Plan for a cross-border submarine cable system between the gates O-XIII and O-XII in respect of habitat types

Eight routes for interconnectors are specified in the Baltic Sea EEZ. A cross-border submarine cable system is planned to run parallel to the Nord Stream gas line or between "Nord Stream" and "Nord Stream 2", connecting gates O-XII and O-XIII. It crosses the nature conservation area "Pomeranian Bight – Rönnebank" over a distance of 32.3 km. No crossings with other cables are necessary within the protected area.

Within the German EEZ, the biotope "Sublittoral, flat sandy Baltic seabed with brackish water mussel community (*Cerastoderma glaucum, Macoma baltica, Mya arenaria*)" (Code 05.02.10.02.01, FINCK et al., 2017) can be found in the area of the Nord Stream routes. According to current knowledge, there are no other biotopes and habitat types along the route. The shortest distance of the route from the habitat type "sandbank" is approx. 9.6 km, while the distance from the habitat type "reef" is at least approx. 10.7 km. Thus, no significant effects on the habitat types "reef" and "sandbank" within the nature conservation area with their characteristic and endangered communities and species, are to be expected.

6.2.2 Impact assessment of planned cable routes on the conservation objective of the nature conservation area "Fehmarn Belt"

6.2.2.1 Impact assessment of the Site Development Plan for a cross-border submarine cable system between the gates O-V and O-VI

One cross-border submarine cable system is planned in the area of the Fehmarn Belt crossing (O-V to O-VI) and crosses the Fehmarn Belt nature conservation area over a distance of 4.3 km. The possibility of co-using the existing infrastructure of the future Fehmarn Belt tunnel for a cross-border submarine cable system is being considered, so no further negative effects due to an interconnector, beyond the effects of the construction of the tunnel, are to be expected.

6.3 Impact assessment of the Site Development Plan for protected species

6.3.1 Impact assessment of areas, sites and submarine cable systems on the conservation objective of the "Pomeranian Bight – Rönnebank" nature conservation area

6.3.1.1 Impact assessment of the Site Development Plan for protected bird species

The areas O-1 and O-2 are located near the nature conservation area "Pomeranian Bight – Rönnebank" (Federal Law Gazette I, I S, 3415), which was established by the Ordinance of 22/09/2017.

Pursuant to section 34 subsection 1 of the Federal Nature Conservation Act and section 9 subsection 1, no. 3 NSGPBRV, the impairment of the conservation objectives of subdivision IV of the nature conservation area caused by the implementation of the plan is to be assessed.

The impact assessment of the Site Development Plan is based on the conservation objective of subdivision IV according to section 7 of the NSGPBRV.

According to section 7 NSGPBRV, the conservation objective of subdivision IV is as follows:

According to section 7 subsection 1 NSGPBRV, the conservation objectives of subdivision IV include the conservation or, where necessary, the restoration of a favourable conservation state

- according to no. 1, of the species occurring in this subdivision listed in Annex I to Directive 2009/147/EC, red-throated diver (*Gavia stellata*), black-throated diver (*Gavia arctica*), Slavonian grebe (*Podiceps auritus*),
- according to no. 2, of the regularly occurring migratory bird species in this area, red-necked Grebe (*Podiceps grisegena*), yellow-billed diver (*Gavia adamsii*), long-tailed duck (*Clangula hyemalis*), common scoter (*Melanitta nigra*), velvet scoter (*Melanitta fusca*), common gull (*Larus canus*), guillemot (*Uria algae*), razorbill (*Alca torda*) and black guillemot (*Cepphus grylle*) as well as
- according to no. 3 of the function of this area as a feeding, overwintering, moulting, transit and resting area for the species mentioned.

Pursuant to section 7 subsection 2 NSGPBRV, in order to protect the habitats and to ensure the survival and reproduction of the bird species listed in subsection 1 and to protect the area in its functions referred to in subsection 1, of particular importance are the conservation or, if necessary, restoration

- according to no. 1, of the qualitative and quantitative populations of bird species with the aim of achieving a favourable conservation state, taking into account the natural population dynamics and population development of their biogeographic population,
- according to no. 2, of the essential food sources of bird species, in particular population densities, age-group distributions and distribution patterns of the organisms serving as a food source for the bird species,
- according to no. 3, of the characteristic features of the area, in particular in respect of the salinity, the freedom from ice even in severe winters and the geo- and hydromorphological properties with their species-specific ecological functions and effects, as well as
- no.4: of the natural quality of habitats with their species-specific ecological functions, their integrity and spatial interdependence, and unhindered access to adjacent and neighbouring marine areas.

The areas O-1 and O-2 and the sites and platforms contained within them are, as already shown, outside the known resting areas of protected bird species. According to the current state of knowledge, a disturbance to resting and migratory birds caused by the construction and operation of offshore wind turbines is not expected. The monitoring of the offshore wind farms "Viking" and "Arkona Basin Southeast" has confirmed that a population-relevant disturbance of bird species to be protected and an impairment of the conservation objectives of the conservation area can be excluded.

The laying and operation of submarine cable systems for the connection of areas O-1 and O-2 and parallel Interconnectors are not expected to have significant effects on bird species.

According to the current state of knowledge, it is thus possible to safely exclude significant adverse effects on the conservation objectives of the "Pomeranian Bight – Rönnebank" nature conservation area in respect of protected bird species, whether considering the plan on its own or based on its interaction with other projects.

The area O-3 is located at a distance of more than 50 km from the nature conservation area "Pomeranian Bight – Rönnebank". In addition, the results from the monitoring of the offshore wind farm "EnBW Baltic2" have confirmed that no significant effects on protected bird species are to be expected.

6.3.1.2 Impact assessment of the Site Development Plan with regard to marine mammals

Pursuant to section 34 subsection 1 of the Federal Nature Conservation Act and section 9 subsection 1, no. 3 NSGPbrV, the impairment of the conservation objectives of subdivisions II and III of the nature conservation area caused by the execution of the plan, is to be assessed.

The assessment of the plan's implications is based on the conservation objective of the "Pomeranian Bight - Rönnebank" nature conservation area. According to section 3, subsection 1 NSGPbrV the implementation of the conservation objectives of the Natura 2000 sites through permanent protection of the maritime zone, the diversity of its habitats, communities and species relevant for these areas and the particular character of this part of the Baltic Sea characterised by the Oder Bank, Adlergrund, Rönnebank and the Arkona Basin. According to section 3 subsection 2, No. 3 NSGPbrV comprises the conservation and, if necessary, the restoration of the specific ecological values and functions of the area, in particular the populations of harbour porpoises, grey seals and seabird species as well as their habitats and natural population dynamics.

Finally, under section 5 subsection 1 to subsection 3 NSGPbrV as well as under section 6 subsection 1 to subsection 3 NSGPbrV to ensure the survival and reproduction of the marine mammal species of harbour porpoise and harbour seals listed in section 3 subsection 2 NSGPbrV of the Annex II to the Habitats Directive and the preservation and restoration of their habitats.

Pursuant to section 6 subsection 1, No. 2 NSGPbrV comprise the conservation of or, where necessary, the restoration of a favourable conservation state for the conservation objectives aimed at in subdivision III of the nature conservation area for the species porpoise (*Phocoena phocoena*) according to Annex II of Directive 92/43/EEC.

Pursuant to section 6 subsection 3 NSGPbrV are for the protection of the species referred to in subsection 1 No. 2 NSGPbrV the conservation or, where necessary, the restoration:

- of the natural population densities of these species with the aim of achieving a favourable conservation status, their natural spatial and temporal distribution, health and reproductive fitness, taking into account natural population dynamics, the natural genetic diversity within the population and genetic exchanges with populations outside of the area,
- of the area as a largely disturbance-free and pollution-free habitat for the harbour porpoise,
- undivided habitats and the possibility of migration of the species referred to in subsection 1 No. 2 NSGPbrV within the central Baltic Sea, western Baltic Sea and Belt Sea
- of the essential organisms serving as food resources for the harbour porpoise, in particular the natural population densities, age-group distributions and distribution patterns.

According to the current state of knowledge and based on the findings from the monitoring of the construction and operation of the offshore wind farms "Viking" and "Arkona Basin Southeast" impairment of the conservation objectives of subdivision III of the nature conservation area "Pomeranian Bight – Rönnebank" can be safely excluded. Any adverse effects from the implementation of the plan on the conservation objectives of subdivision II "Adlergrund" of the nature conservation area "Pomeranian Bight – Rönnebank" in respect of marine mammals can also be safely excluded.

The area O-3 is located at a distance of more than 50 km from the nature conservation area "Pomeranian Bight – Rönnebank". In addition, the results from the monitoring of the offshore wind farm "EnBW Baltic2" have confirmed that no significant effects on protected marine mammal species are to be expected. An impairment of the conservation objectives of the "Pomeranian Bight – Rönnebank" nature conservation area in respect of marine mammals can be safely ruled out.

6.3.2 Impact assessment of areas, sites, platforms and submarine cable systems on the conservation objective of the "Fehmarn Belt" nature conservation area

Pursuant to section 34 subsection 1 of the Federal Nature Conservation Act and section 5 subsection 6 of the NSGFmbV, the plan in question must take into account the provisions pursuant to section 5 subsection 4 NSGFmbV in the official decision. Projects and plans must be assessed for their implications for the protective aims of a protected area before being approved or implemented if, individually or in combination with other projects or plans, they are likely to have a significant impact on the nature conservation area.

The Federal Maritime and Hydrographic Agency is responsible for the assessment of the implications according to section 34 of the Federal Nature Conservation Act and section 5 subsection 7 NSGFmbV.

According to section 3 subsection 1 NSGFmbV the implementation of the conservation objectives of the Natura 2000 site through permanent protection of the maritime zone, the diversity of its habitats, communities and species relevant for this area and the particular character of the sandbank in the form of 'megaripples'.

The protection comprises

- the conservation or, where necessary, the restoration of the specific ecological values and functions of the area, in particular its characteristic morphodynamics and the hydrodynamics resulting from the water exchange between the North and Baltic Seas, natural or near-natural characteristics of the marine macrophyte stocks and the species-rich gravel, coarse sand and shell layers, the populations of harbour porpoises and harbour seals including their habitats and natural population dynamics, as well as its connecting and stepping stone function for the ecosystems of the western and central Baltic Sea;
- the conservation or, where necessary, the restoration of a favourable conservation status of the habitat types characteristic of the area, in accordance with Annex I of Directive 92/43/EEC - sandbanks which are slightly covered by sea water all the time (EU code 1110) and reefs (EU code 1170) and the species listed in Annex II of Directive 92/43/EEC - harbour porpoise (Phocoena phocoena, EU code 1351) and harbour seal (Phoca vitulina, EU code 1365);
- the conservation or, where necessary, the restoration of the ecological quality of habitat structures and their areal extent, the natural quality of these habitats with largely natural distribution, population density and dynamics of the populations of the characteristic species and the natural characteristics of their communities, the unfragmented nature of the habitats and their function as a regeneration space, especially for the benthic fauna, as well as

the function as a starting point and distribution corridor for the repopulation of surrounding areas by the benthic species and communities;

- for the protection of harbour porpoises and grey seals the conservation of or, if necessary, the restoration
  - o of the natural population densities of these species with the aim of achieving a favourable conservation status, their natural spatial and temporal distribution, health and reproductive fitness, taking into account natural population dynamics, the natural genetic diversity within the population and genetic exchanges with populations outside of the area,
  - o of the area so that it is as undisturbed as possible and as a largely unpolluted feeding and migration habitat of the harbour porpoise and harbour seal and as a reproductive and rearing habitat for harbour porpoises,
  - o undivided habitats and the possibility of migration of harbour porpoises and harbour seals within the Baltic Sea, in particular in the adjacent and neighbouring nature conservation areas of Schleswig-Holstein and Mecklenburg-Western Pomerania and to seal lying places along the Danish (especially Rødsand) and German coast as well as
  - o the basic food resources of harbour porpoises and harbour seals, in particular the natural population densities, age-group distributions and distribution patterns of the organisms serving as a food source for the - porpoises and seals.

The areas O-1, O2 and O3 and the associated sites and platforms as well as the associated grid connection systems are located at very large distances from the "Fehmarn Belt" nature conservation area. A planned cross-border submarine cable system crosses the conservation area over a length of 4.3 km. The possibility of co-using the existing infrastructure of the future Fehmarn Belt tunnel for a cross-border submarine cable system is being considered, so no further negative effects due to an interconnector, beyond the effects of the construction of the tunnel, are to be expected.

An impairment of the conservation objectives of the "Fehmarn Belt" nature conservation area in respect of marine mammals can be safely ruled out.

6.3.3 Impact assessment of areas, sites, platforms and submarine cable systems on the conservation objective of the "Kadetrinne" nature conservation area

Pursuant to section 34 subsection 1 of the Federal Nature Conservation Act and section 5 subsection 6 of the NSGKdrV, the plan in question must take into account the provisions pursuant to section 5 subsection 4 NSGKdrV in the official decision. Projects and plans must be assessed for their implications for the protective aims of a protected area before being approved or implemented if, individually or in combination with other projects or plans, they are likely to have a significant impact on the nature conservation area.

The Federal Maritime and Hydrographic Agency is responsible for the assessment of the implications according to section 34 of the Federal Nature Conservation Act and section 5 subsection 7 NSGKdrV.

According to section 3 subsection 1 the implementation of the conservation objectives of the Natura 2000 site through permanent protection of the maritime zone, the diversity of its habitats, communities and species relevant for this area and the particular importance of the channels system existing here for water exchange between the North and Baltic Seas. The protection comprises

- the conservation or, where necessary, the restoration of the specific ecological values and functions of the area, in particular its characteristic morphodynamics and the hydrodynamics resulting from the water exchange between the North and Baltic Seas, the harbour porpoise populations, including their habitat and natural population dynamics, and its connection and stepping stone function for the ecosystems of the western and central Baltic Sea.
- The aimed for conservation objectives include the conservation of or, where necessary, the restoration of a favourable conservation state of the characteristic reef habitat type (EU code 1170) in accordance with Annex I of Directive 92/43/EEC, and of the harbour porpoise species (Phocoena phocoena, EU code 1351) in accordance with Annex II of Directive 92/43/EEC.
- To protect the referred to habitat type, including its characteristic species, of particular importance is the conservation or, where necessary, the restoration
    - of the ecological quality of the habitat structures and their areal extent,
    - of the natural quality of the habitats with largely natural distribution, population density and dynamics of the populations of the characteristic species and the natural characteristics of their communities,
    - of the unfragmented nature of the habitats and their function as a regeneration space, especially for the benthic fauna, as well as
    - of the function as a starting point and distribution corridor for the repopulation of surrounding areas by the benthic species and communities;
- To protect the harbour porpoises the following are of particular importance for conservation or, if necessary, restoration
    - of the natural population densities of the species with the aim of achieving a favourable conservation status, their natural spatial and temporal distribution, health and reproductive fitness, taking into account natural population dynamics, the natural genetic diversity within the population and genetic exchanges with populations outside of the area,
    - of the area so that it is as undisturbed as possible and so that it remains as a largely unpolluted feeding, migration, reproductive and rearing habitat for harbour porpoises,
    - of unfragmented habitats and the possibility of migration of marine mammals within the central Baltic Sea and into the western Baltic Sea as well as
    - of the essential organisms serving as food resources for harbour porpoises, in particular the natural population densities, age-group distributions and distribution patterns.

The areas O-1, O-2 and O-3 and the associated sites, platforms and submarine cable systems are located at very large distances from the "Kadetrinne" nature conservation area. In addition, the results of the monitoring of the offshore wind farm "EnBW Baltic2" have confirmed that no significant impact on the protected marine mammals or protected bird species is to be expected.

An impairment of the conservation objectives of the "Kadetrinne" nature conservation area in respect of marine mammals can thus be safely ruled out.

6.4 Natura 2000 areas outside the

German EEZs

In addition, the assessment of the implications also takes into account the remote effects of the rules defined in the Site Development Plan on the protected areas in the adjacent 12 nautical mile zone and the adjacent waters of the neighbouring states. This also affects the assessment and consideration of functional relationships between the individual protected areas and the coherence of the network of protected areas pursuant to section 56 subsection 2 of the Federal Nature Conservation Act since the habitat of some target species (e.g. avifauna, marine mammals) can extend over several protected areas due to their large radius of activity.

In particular, the bird sanctuary "Westliche Pommersche Bucht", the FFH and bird sanctuary "Plantagenetgrund", the FFH area "Darss Sill", the bird sanctuary "Vorpommersche Boddenlandschaft und nördlicher Strelasund" and the FFH area "Greifswalder Boddenrandschwelle und Teile der Pommerschen Bucht" in the coastal waters of Mecklenburg-Western Pommerania are taken into consideration. In adjacent areas of the neighbouring countries, the FFH areas "Adler Grund og Rønne Banke" and "Klinteskov kalkgrund" in Danish waters, the Swedish FFH area "Sydvästskånes utsjövatte", the Polish bird sanctuary "Zatoka Pomorska" and the Polish FFH area "Ostoja na Zatoce Pomorskiej" were taken into consideration.

The conservation objectives and protective aims for the Natura 2000 sites outside the EEZ have been taken from the following documents:

- Bird sanctuary "Westliche Pommersche Bucht" (coastal waters Mecklenburg-Western Pomerania, DE1649 401): EUNIS factsheet
- FFH and bird sanctuary "Plantagenetgrund" (coastal waters Mecklenburg-Western Pomerania, DE 1343 301/ DE 1343 401): FFH area
- FFH area "Darss Sill" (coastal waters Mecklenburg-Western Pomerania, DE 1540 302)
- Bird sanctuary "Vorpommersche Boddenlandschaft und nördlicher Strelasund" (coastal waters Mecklenburg-Western Pomerania, DE 1542 401)
- FFH area "Greifswalder Boddenrandschwelle und Teile der Pommerschen Bucht" (coastal waters Mecklenburg-Western Pomerania, DE 1749-302)
- Danish FFH area "Adler Grund og Rønne Banke" (DK 00VA 261)
- Danish FFH area "Klinteskov kalkgrund" (DK 00VA 306): EUNIS Factsheet
- Swedish FFH area "Sydvästskånes utsjövatte" (SE 0430187)
- Polish bird sanctuary "Zatoka Pomorska" (PLB 990003)

Polish FFH area "Ostoja na Zatoce Pomorskiej" (PLH 990002): In addition, under Art. 12 of the Habitats Directive, for species listed in Annex IV to the Habitats Directive, the EU Member States shall take the necessary measures in and outside of protected areas to establish a strict system of protection for these species in their natural distribution range. These include all whale species according to the Habitats Directive. Parts of the feeding habitat are to be preserved by the FFH areas.

Apart from the effects of the plan within the EEZ, this assessment of the implications explicitly examines only possible remote effects of the areas, sites, platforms and submarine cable routes that are planned in the EEZ in protected areas in adjacent areas. The planned areas, sites, platforms and submarine cable routes are located sufficiently far away from the protected areas in coastal waters, so no significant effects on these protected areas can be assumed in this respect. However, this consideration is not made with regard to routes in coastal waters, which are connected to the gates provided for in the Site Development Plan. This assessment is the subject of the coastal states' environmental reports on the respective Spatial Plans or secondary procedures. Moreover, no re-assessment of the implications for the areas and testing grounds in the coastal waters is taking place because this has already occurred in respect of the areas and testing grounds in the coastal waters with the establishment of the Mecklenburg-Western Pomerania regional spatial development programme.

The results of the impact assessment of the Site Development Plan in respect of protected marine mammals and protected bird species with the conservation objectives of the "Pomeranian Bight – Rönnebank" nature conservation area apply to the nearest nature conservation area "Greifswalder Boddenrandschwelle und Teile der Pommerschen Bucht" in German coastal waters and to the FFH "Adler Grund og Rønne Banke" in the Danish EEZ and the FFH area "Ostoja na Zatoce Pomorskiej" in the Polish EEZ.

As a result, it was found that the present plan, individually or in conjunction with other plans and projects, did not compromise the conservation and restoration objectives of the above mentioned nature conservation areas.

6.5 Results of the assessment of the implications

As a result, a significant impairment of the conservation objectives of the assessed nature conservation areas caused by the implementation of the plan and taking into consideration prevention and mitigation measures can be safely ruled out. This applies both to the assessed nature conservation areas within the German EEZ and to Natura 2000 sites outside the German EEZ. A re-assessment of the implications for the areas and testing grounds in the coastal waters is not being implemented because it was already carried out when the Mecklenburg-Western Pomerania regional spatial development programme was established.

The possibility of significant impairment of the FFH habitat types "reefs" and "sandbanks which are slightly covered by sea water all the time" can be excluded according to the current state of knowledge, even with cumulative assessment of the plan and already existing projects for the assessed nature conservation areas.

7 Overall plan evaluation

In summary, with regard to the planned areas and sites, platforms and submarine cable routes, the effects on the marine environment will be minimised as far as possible by means of orderly, coordinated overall planning of the Site Development Plan. By adhering strictly to prevention and mitigation measures, in particular for noise mitigation during the construction phase, considerable effects can be prevented by implementing the planned sites, areas and platforms.

The laying of submarine cable systems can be made as eco-friendly as possible by preventing protected areas and biotopes and by choosing a laying method that is as unobtrusive as possible. The planning principle for sediment warming should ensure that significant negative effects of cable heating on benthic communities are prevented. Preventing crossings between submarine cable systems as far as possible also serves to prevent negative effects on the marine environment, in particular on the factors Soil, Benthos and Biotopes. Given the above descriptions and assessments, the SEA concludes that, with regard to possible interrelationships, no significant effects on the marine environment within the investigation area are to be expected from the planned rules based on current knowledge and the comparatively abstract level of technical planning. The potential effects are frequently small-scale and mostly short-term, as they are limited to the construction phase.

A large part of the areas and sites are within the wind energy priority areas of the Spatial Plan for the Baltic Sea EEZ. Sufficient knowledge is available for these regions. To date, sufficient scientific knowledge and consistent evaluation methods are lacking for cumulative assessment of the effects on individual factors such as bird migration and bat migration. Therefore, these effects cannot be assessed conclusively within the framework of the present SEA or are subject to uncertainties and need to be assessed more closely within the framework of subsequent planning stages.

8 Measures to prevent, mitigate and offset significant negative effects of the Site Development Plan on the marine environment

8.1 Introduction

Pursuant to section 40 subsection 2 UVPG, the environmental report includes a description of the planned measures to prevent, mitigate and, as far as possible, compensate for significant adverse environmental effects resulting from implementation of the plan. In principle, the Site Development Plan will take marine environment concerns into account more effectively when expanding power generation by means of offshore wind turbines and the corresponding connecting lines. The rules of the Site Development Plan will prevent negative effects on the development of the state of the environment of the Baltic Sea EEZ. This is due in particular to the fact that there is always a need to expand offshore wind energy and the corresponding connecting lines and that the corresponding infrastructure (wind farms, platforms and submarine cable systems) would have to be created even without the Site Development Plan (see chap.3). If the plan were not implemented, the uses would, however, develop without the space-saving and resource-conserving steering and coordination effect of the Site Development Plan.

Moreover, the rules of the Site Development Plan are subject to a continuous optimisation process, as the knowledge obtained on a rolling basis within the framework of the SEA and the consultation process is taken into account when the plan is compiled.

While individual prevention, mitigation and compensation measures may begin even at the planning level, others only come into play at the specific implementation stage and are regulated there in the individual approval procedure according to the project and location. With regard to planning prevention and mitigation measures, the Site Development Plan defines spatial and textual rules which, according to the environmental protection objectives set out in chapter 1.1, serve to prevent or mitigate significant negative effects in the marine environment due to implementation of the Site Development Plan. This mainly concerns

- Consideration of nature conservation areas and legally protected biotopes
  - Exclusion effect of wind turbines in Natura 2000 areas,
  - Exclusion effect of platforms in Natura2000 areas
  - the principle of laying submarine cable systems outside these areas as far as possible,
- as little land usage as possible, ensured by the planning principles
  - economic area use when arranging wind turbines
  - maximum possible bundling of submarine cable routes in the sense of parallel routing,
  - prevention of cable and pipeline crossings,
- the planning principle for noise mitigation,
- the planning principle for sediment warming,
- Reduction of scour protection measures to a minimum so as to prevent having to introduce artificial hard substrate
- rules for the dismantling of structural installations, and

- consideration of best environmental practice in accordance with the OSPAR Convention and the state of the art.

The measures listed below serve to prevent and mitigate insignificant and significant negative effects in the specific implementation of the Site Development Plan. These mitigation and prevention measures are specified and ordered by the competent licensing authority at project level for the planning, construction and operation phases.

8.2 Areas and sites for offshore wind turbines

The following measures to prevent and mitigate significant and insignificant negative environmental effects must be taken into account in the specific planning and construction of wind turbines:

- When installing foundations, suitable measures must be implemented to ensure that noise emissions (sound pressure SEL_{05}) at a distance of 750 m does not exceed 160 decibels (dB re 1 μPa²s) and the peak sound pressure level does not exceed 190 decibels (dB re 1 μPa).
- Adherence to pile-driving times, including aversive conditioning measures, of no more than 180 minutes during the insertion of monopiles and no more than 140 minutes per pile for jacket structures.
- Monitoring measures during the construction phase, in particular by recording the underwater noise level when foundations are being installed. Monitoring of noise level and compliance with limits must be carried out by an accredited facility. The suitability of the measuring equipment is to be demonstrated by accreditation in accordance with DIN EN ISO/IEC 17025 with regard to ISO 18406:2017 and DIN SPEC 45653:2017.
- Noise mitigation measures: use of the relevant best available method according to the state of the art in science and technology in order to reduce the level of underwater noise so as to comply with applicable noise protection specifications during the installation of foundation piles, e.g. large bubble curtains, hydro silencers or sheathing. These noise protection measures must be specified in detail in the individual approval procedures for specific locations and installations.
- Adaptation of the pile-driving process to location- and project-specific conditions by control of the pile-driving energy and impact frequency
- Noise prevention measures: use appropriate methods to prevent killing and injuring fauna near the pile-driving site:
  - Use of suitable deterrent devices such as the FaunaGuard system or, in special cases, "pingers" and "seal scarers"
  - "Soft-start procedure": delaying the increase of pile-driving energy should allow fauna in the vicinity of the pile-driving site to move away from the construction site.
- Coordination of pile-driving work for various projects in order to minimise overall noise output times
- Consideration of the noise protection concept of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2013)
- Assessment of alternative, low-noise foundation forms, such as suction buckets or gravity foundations. The environmental impact of alternative forms of foundation must always be assessed with regard to any additional significant effects on the marine environment, in particular due to the introduction of continuous noise.

- Reduction of shipping traffic for construction and operation of installations and the associated acoustic and visual impairments to a minimum, by optimum construction and time planning
- Ensuring that no preventable emissions of pollutants, noise or light occur during the construction or operation of the installation in accordance with the state of the art
- Lighting that is as compatible as possible with nature during operation of the installations in order to reduce attraction as far as possible, taking into account the requirements of safe shipping and air traffic and occupational safety, e.g. switching obstruction lighting on and off as required, selection of suitable lighting intensities and spectra or lighting intervals
- Restriction of the introduction of hard substrate to a minimum
- Use of low-pollution paints
- Use of traffic safety vehicles during the construction and commissioning phases in order to prevent collisions
- Correct disposal of oil residues from machinery, faeces, packaging, waste and wastewater on land. Preparation of a "waste concept" for construction and operation
- Compilation of emergency plans, including for accidents involving water-polluting substances during the construction and operation phases
- Monitoring of possible effects on the marine environment due to the construction or operation of the installations by means of mandatory ecological monitoring during the construction and operation phase in accordance with StUK 4
- If, during planning or installation of plants, so far undiscovered ordnance is found on the seabed, corresponding protective measures must be taken.

8.3 Platforms

The following measures to prevent and mitigate significant and insignificant negative environmental effects must be taken into account in the specific planning and construction of platforms (converter platforms, collector platforms, transformer platforms and residential platforms):

- When installing foundations, suitable measures must be implemented to ensure that noise emissions (sound pressure SEL_{05}) at a distance of 750 m does not exceed 160 decibels (dB re 1 μPa²s) and the peak sound pressure level does not exceed 190 decibels (dB re 1 μPa).
- Adherence to pile-driving times, including aversive conditioning measures, of no more than 180 minutes during the insertion of monopiles and no more than 140 minutes per pile for jacket structures.
- Monitoring measures during the construction phase, in particular by recording the underwater noise level when foundations are being installed. Monitoring of noise level and compliance with limits must be carried out by an accredited facility. The suitability of the measuring equipment is to be demonstrated by accreditation in accordance with DIN EN ISO/IEC 17025 with regard to ISO 18406:2017 and DIN SPEC 45653:2017.
- Noise mitigation measures: use of the relevant best available method according to the state of the art in science and technology in order to reduce the level of underwater noise so as to comply with applicable noise protection specifications during the installation of foundation piles, e.g. large bubble curtains, hydro silencers or sheathing. These noise protection

measures must be specified in detail in the individual approval procedures for specific locations and installations.

- Adaptation of the pile-driving process to location- and project-specific conditions by control of the pile-driving energy and impact frequency
- Noise prevention measures: use appropriate methods to prevent killing and injuring fauna near the pile-driving site:
  - Use of suitable deterrent devices such as the FaunaGuard system or, in special cases, "pingers" and "seal scarers"
  - "Soft-start procedure": delaying the increase of pile-driving energy should allow fauna in the vicinity of the pile-driving site to move away from the construction site.
- Coordination of pile-driving work for various projects in order to minimise overall noise output times
- Consideration of the noise protection concept of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2013)
- Assessment of alternative, low-noise foundation forms, such as suction buckets or gravity foundations. The environmental impact of alternative forms of foundation must always be assessed with regard to any additional significant effects on the marine environment, in particular due to the introduction of continuous noise.
- Reduction of shipping traffic for construction and operation of platforms, and the associated acoustic and visual impairments, to a minimum by optimal construction and time planning
- Ensuring that no preventable emissions of pollutants, noise or light occur during the construction or operation of platforms in accordance with the state of the art
- Lighting that is as compatible as possible with nature during operation of the platforms in order to reduce attraction as far as possible, taking into account the requirements of safe shipping and air traffic and occupational safety, e.g. switching obstruction lighting on and off as required, selection of suitable lighting intensities and light spectra or lighting intervals
- Restriction of the introduction of hard substrate to a minimum
- Use of low-pollution paints
- Use of traffic safety vehicles during the construction and commissioning phases in order to prevent collisions
- Correct disposal of oil residues from machinery, faeces, packaging, waste and wastewater on land; preparation of a "waste concept" for construction and operation
- Compilation of emergency plans, including for accidents involving water-polluting substances during the construction and operation phases
- If, during planning or installation of the platforms, so far undiscovered ordnance is found on the seabed, corresponding protective measures must be taken.

8.4 Submarine cabling systems

Measures for prevention and mitigation must be taken into account as early as the route planning and technical design stages. The magnetic field development of the cable systems is kept to a minimum due to the cable configurations specified in the Site Development Plan in accordance with the state of the art. The planning principle for sediment warming should ensure compliance with the "2K criterion", i.e. a maximum permissible temperature increase of 2 K at a sediment depth of 20 cm.

Moreover, the following measures that help to prevent and mitigate environmental effects are to be implemented in the specific implementation of the individual projects:

- Selection of the shortest possible route
- Optimisation of route selection within the framework of fine routing in order to prevent and not effect known occurrences of particularly sensitive biotopes as far as possible in accordance with section 30 of the Federal Nature Conservation Act
- Use of laying methods that protect the soil as much as possible for installation of the cable systems, depending on sediment conditions and water depths and taking into account the required minimum coverage
- Use of cable types that develop electric and magnetic fields that are as low as possible
- Use of materials in cable systems that are as eco-friendly as possible
- Reduction of intersections to the required minimum
- Use of inert, natural materials for filling and intersections that become necessary
- If, during planning or installation of submarine cable systems, so far undiscovered ordnance is found on the seabed, corresponding protective measures must be taken.

The aim is to implement the following measures with a view to achieving the most eco-friendly design possible:

- Investigation and description of the effects of platforms and submarine cable systems on the marine environment as part of a monitoring process, including monitoring of the cover during the operating phase of the cables;
- Evaluation of the monitoring results in respect of cumulative effects or interrelationships of various uses;

Consideration of the monitoring results within the framework of the update, i.e. experience from implementation of the projects is used to continuously improve mitigation and prevention measures.

9 Investigated alternatives

According to Art. 5 subsection 1 sentence 1 of the SEA Directive in conjunction with the criteria in Annex I of the SEA Directive and section 40 subsection 2 no. 8 of the Environmental Impact Assessment Act, the environmental report contains a brief description of the reasons for choosing the reasonable alternatives assessed. The reasonable alternatives under consideration are explained below. Essentially, different types of alternatives can be considered for an assessment of alternatives; in particular strategic, spatial or technical alternatives. The prerequisite is always that these are reasonable or can be seriously considered.

Thus not all conceivable alternatives need to be assessed. However, it is no longer sufficient to identify, describe and evaluate only those alternatives that "seriously offer" or "impose" themselves. The obligation to investigate thus extends to all alternatives that "are not obviously ... remote" LANDMANN & ROHMER 2018. Assessment of alternatives does not explicitly require the development and assessment of particularly eco-friendly alternatives. Rather, the "reasonable" alternatives in the above sense should be presented in a comparative manner with regard to their environmental effects so that consideration of environmental concerns becomes transparent when deciding on the alternative to be pursued (BALLA 2009).

At the same time, the effort required to identify and assess the alternatives under consideration must be reasonable. This means that the greater the expected environmental effects and hence the need for planning conflict resolution, the more likely it is that comprehensive or detailed investigations will be required.

By way of example, Annex 4 no. 2 UVPG refers to the assessment of alternatives with regard to the design, technology, location, size and scope of the project, but explicitly refers only to projects. Conceptual/strategic design, the spatial location and technical alternatives therefore play a part at the planning level.

In principle, it should be noted that preliminary examination of possible and conceivable alternatives is already inherent in all rules in the form of standardised technical and planning principles. As can be seen from the justification of the individual planning principles, in particular those relating to the environment – such as, for example, routing that is as bundled as possible and implementation that is as free from crossings as possible – the principle in question is already based on consideration of possible public concerns and legal positions, so that a "preliminary assessment" of possible alternatives has already been carried out. There are already a large number of different uses and legally protected concerns in the EEZ. There is also a "Regulation on Spatial Planning in the German EEZ in the Baltic Sea" of 10 December 2009, which defines objectives and principles, to regulate the usage interests within the Baltic Sea EEZ. An overall assessment of the uses and functions in the EEZ has already been carried out as part of the preparation of the Spatial Plan. The objectives and principles of the Spatial Plan have largely been adopted in the Spatial Plan and are being reviewed and weighed against the specific regulatory issues of the concerns and rights presented in this procedure.

Possible reasonable alternatives in detail:

9.1 Zero alternative

The zero alternative, i.e. not implementing the Site Development Plan, is not a sensible alternative since the lack of coordination would probably lead to greater area use, more cable intersections and thus additional environmental impacts (see chapter 3).

Although it is not possible to quantify the number of additional intersections that will be created and the additional space that will be required as a result, it is clear from the defined rules that a considerable number of intersections can no longer be avoided at this planning stage due to the existing system of individual connections. For future projects, the aim is to coordinate these and to plan ahead in accordance with the planning principles (see details in chapter 4 of the Site Development Plan).

The purpose and objective of introducing a technical plan with not only spatial rules , but also longer time limits and standardised principles vis-à-vis the BFO is precisely the precautionary management of the offshore expansion. This is intended to ensure at the planning level that the offshore expansion is carried out in a physically well-organised and space-saving way in accordance with section 4 subsection 2 no. 2 WindSeeG and that environmental concerns are also assessed at the planning level. Thus, problems of the past such as wind farms in Natura 2000 (or current nature conservation) areas can already be addressed at the planning level.

9.2 Strategic alternatives

A strategic alternative, e.g. with regard to the goals of the Federal Government on which the planning is based, is currently not being considered for the Site Development Plan since the expansion goals of the Federal Government represent, as it were, the planning horizon for the Site Development Plan. The expansion targets arise from legal requirements (in particular the Renewable Energy Sources Act (EEG)). These are also an essential basis for the requirements planning of onshore grid expansion. Since a well-coordinated, synchronised approach to onshore and offshore grid and capacity expansion to reduce idle capacity or cut-offs would appear to make sense, the choice of an alternative expansion strategy is out of the question in this context.

Accordingly, it was assumed that the expansion target of 15 GW of installed capacity of offshore wind turbines in 2030 would be achieved. For informational purposes, other possible future expansion scenarios, some with a planning horizon extending beyond 2030, and their effects on the rules in the Site Development Plan were outlined in the Annex (see chap. 13 Site Development Plan).

9.3 Spatial alternatives

As far as assessment of spatial alternatives is concerned, the Site Development Plan defines both spatial and textual rules in the form of planning principles and standardised technical principles for areas and sites, submarine cable systems and platforms in the German Baltic Sea EEZ. To a large extent, these requirements serve to ensure that uses are designed to be as eco-friendly as possible and that the different concerns and legal positions are balanced in a manner that is in line with the various interests. Taking into account the above-mentioned existing uses and rights of use, only a few feasible alternatives to these rules are apparent which, in an objectively plausible manner, can be expected to have significantly lower environmental effects. The spatial rules of the Spatial Plan fit in with the existing uses such as shipping traffic, military usage, marine research, etc. and the area designations defined for the Baltic Sea EEZ within the framework of the Spatial Plan and the BFO-N. This means that the planning of areas and sites, but also of platforms and routes, is limited from the outset. Areas, sites and platforms are specified according to the planning principles, taking into account nature conservation sites and legally protected biotopes, as well as economic area use and distance regulations.

The cable routes are planned to cover the shortest possible route in accordance with the planning principles, with a view to minimising environmental impact, as long as there are no overriding concerns to the contrary. The cable systems are also predominantly planned in parallel with infrastructures (pipelines, cables, wind farms) applied for/approved/constructed so as not to slice up any additional spaces.

The spatial location of the gates results from the regional planning rules and other planning considerations in the coastal states adjoining the plans of the EEZ. In turn, the plans of the coastal states are based on the routing to suitable high-voltage and ultra-high-voltage grid connection points on land. In Mecklenburg-Western Pomerania coastal waters, lines to gates O-I and O-III have been designated in the current LEP M-V[44] reservation areas. A reservation area for lines along the "NordStream" pipeline was also specified. The reservation areas of the LEP M-V lines are buffers around routes that have already been specified in area planning or as part of the planning approval.

No direct spatial alternative assessment is being carried out for the two routes for future interconnectors crossing nature conservation areas. This is because the route in the area of the Fehmarn Belt crossing (gate O-V to O-VI) through the "Fehmarn Belt" nature conservation area is planned only with the proviso that the existing infrastructure of the future Fehmarn Belt tunnel can be co-used. Under this condition, as things stand at present, no environmental effects would be expected from a interconnector beyond the effects of the tunnel construction work (see chapter 6.5).

A further interconnector is planned parallel to the Nord Stream pipeline or between "Nord Stream" and "Nord Stream 2" and connects the gates O-XII and O-XIII. As the entire eastern boundary of the Baltic Sea EEZ is located in the nature conservation area "Pomeranian Bight – Rönnebank", a possible Interconnector heading eastwards, e.g. an interconnector between Germany and Poland, would inevitably have to pass through the nature conservation area. In the event of spatial bundling with existing infrastructure, as provided for in the Site Development Plan, the environmental effects can therefore be assessed as lower, as things stand at present, than in the case of unbundled routing through the protected area. For the specified route, the assessment of the implications concludes that no significant effects on the habitat types "reef" and "sandbank", as well as legally protected biotopes within the nature conservation area with their characteristic and endangered communities and species, are to be expected (see chapter 6.5).

9.3.1 Examination of alternatives for areas

With regard to the examination of alternatives for areas, reference is made to the information in the Site Development Plan on the definition of the individual areas (chap. 5.1). There are no serious alternatives to areas N-1 to N-13 due to the rules of the applicable Spatial Plan for the EEZ of the North Sea or conflicts with other uses such as nature conservation areas or military training areas. Areas to the north-west of the spatially defined shipping route 10 are not seriously alternatives to the areas designated in the Site Development Plan. The defined areas N-1 to N-13 (areas N-4 and N-5 will be assessed for possible subsequent use) in the North Sea represent firstly a coherent planning area and secondly the areas north-west of shipping route 10 are significantly farther from the coast. This results in a significant extension of the necessary connection systems and thus a major intervention in the seabed in every case. In addition, the available data and information basis for the area north-west of shipping route 10 is much worse than for the area designated in the Site Development Plan due to the lack of project-related monitoring data.

[44] Mecklenburg-Western Pomerania regional spatial development programme (LEP), June 2016

Also in the EEZ of the Baltic Sea, no reasonable alternatives to areas O-1 to O-3 are discernible due to the rules of the applicable Spatial Plan for the EEZ of the Baltic Sea. In the coastal waters of Mecklenburg-Western Pomerania, areas O-4, O-5 (area currently under review) and O-6 and a test field are designated by an administrative agreement. For these areas, reference is made to the evaluations of the SEA on the Mecklenburg-Western Pomerania regional development programme.

9.3.2 Comparison of the sites with one another

Within the scope of the Site Development Plan (chap. 5.2.2), the sites designated or assessed in the Site Development Plan are compared with one another from the perspective of the criteria for the decision concerning the stipulation of the areas, including conflicts with other uses. In addition to the information provided in the Site Development Plan, possible conflicts from a nature conservation perspective are examined in detail here.

The following criteria are used to compare sites using nature conservation criteria:

- distance to nearest protected area in km (broken down into FFH areas and bird sanctuaries)
- location inside/outside the main concentration area of divers
- location inside/outside of the main distribution area of the harbour porpoise
- impact on biotopes protected under section 30/suspected areas on the site pursuant to section 30
- route of the connecting line through a nature conservation area (EEZ) in km
- route of the connecting line through section 30 biotope/section 30 suspected areas (EEZ) in km
- importance of the site to the individual factors (textual).

Table 18. Comparison of sites using nature conservation criteria

Site	Minimum distance (km) to the closest protected area pursuant to the Habitats Directive | Wild Birds Directive		Site inside the main concentration area of divers	Site inside the main distribution area of the harbour porpoise	Impact on section 30 biotopes/ suspected areas on the site	Connecting line through nature conservation area (proportion EEZ, km)	Connecting line through section 30 biotype/ suspected areas (proportion of route EEZ, km)
N-3.7	26	21	No	No	Unknown	No	No
N-3.8	20	22	No	No	Unknown	No	No
O-1.3	9	13	-	-	Suspected area	No	No
N-7.2	28	58	No	No	Unknown	No	Yes, 2 km suspected area
N-3.5	14	18	No	No	Unknown	No	No
N-3.6	11	21	No	No	Unknown	No	No
N-6.6	27	6	No	No	Unknown	No	Yes, approx. 10 km (chap. 9.3.4)
N-6.7	40	33	No	No	Unknown	No	Yes, approx. 10 km (chap. 9.3.4)
N-9.1 TF	48	30	No	No	Unknown	No	Yes, approx. 10 km (chap. 9.3.4)
O-2.2 (under assessment)	12	23	-	-	Unknown	No	No
N-5.4 (under assessment in the drafts)	5	17	Yes	Yes	Yes	Yes, approx. 157 km (chap. 9.3.3)	Yes, approx. 3 km sandbank + 13 km suspected area (chap. 9.3.3)

Specifically:

North Sea

The designated sites N-3.7, N-3.8, N-3.5 and N-3.6 in area N-3 are more than 10 km from the nearest nature conservation area "Borkum Reef Ground". The closest distance to the main concentration area of divers is about 40 km, while the main distribution area of harbour porpoises is at least 34 km away from the individual sites. According to the current state of knowledge, the sites areconsidered to be of medium importance for resting birds and birds searching for food (see chap. 2.9.3.1 North Sea Environmental Report). For harbour porpoises, the importance of the sites in area N-3 is currently assumed to be medium to high – seasonally in spring. For areas N-1 to N-3, monitoring results show a significantly higher occurrence in the "Borkum Reef Ground" nature conservation area with decreasing densities in an easterly direction (chap. 2.8.3.1 North Sea Environmental Report). No occurrence of protected biotopes is known in the designated sites N-3.5, N-3.6, N-3.7 and N-3.8. Due to the small overlap of area N-3 with the "Borkum Reef Ground" sandbank and the otherwise predominantly homogeneous, fine to medium sandy sediment conditions, area N-3 is considered to be of minor importance with regard to the protected asset Biotopes in the southwestern subarea.

The connecting lines for all four sites run in the EEZ outside nature reserves and outside known occurrences of legally protected biotopes.

According to the current state of knowledge, no significant nature conservation conflicts can therefore be identified for the sites designated in area N-3.

Site N-7.2 is located at a considerable distance from nature conservation areas (min. 28 km). The main concentration area of divers and the main distribution area of harbour porpoises are both more than 50 km away from N-7.2. According to the current state of knowledge, area N-7 is assigned medium importance for harbour porpoises (see chapter 2.8.3.1 North Sea Environmental Report) and seabirds and resting birds (Chap. 2.9.3.1 North Sea Environmental Report). This area is most frequently used by deep-sea bird species, which occur widely throughout the North Sea. Species such as divers that are susceptible to disturbance are only present in the areas for a short period as they search for food, and during the main migration periods. The benthic community in the location of the designated site N-7.2 is assigned average to above-average importance due to the occurrence of burrowing megafauna species (chapter 2.6.3.1 North Sea Environmental Report). According to the current state of knowledge, the occurrence of legally protected biotopes in site N-7.2 is not to be expected (chap. 2.5.3.1 North Sea Environmental Report). The connecting line for site N-7.2 in the EEZ runs outside nature conservation areas, but the cable crosses suspected areas of "species-rich gravel, coarse sand and shell layers" over a distance of around 2 km. Based on the current state of knowledge, any potential small-scale conflicts can therefore be identified with regard to the route of the connecting line.

Sites N-6.6 and N-6.7 are also located far away from nature conservation areas (min. 25 km) and at a considerable distance from the main concentration area of divers and the main distribution area of harbour porpoises (each more than 55 km). The sites are assigned medium importance for harbour porpoises as well as for seabirds and resting birds. Due to the occurrence and ecological significance of the burrowing soil megafauna, the benthic biocoenosis is considered to be of average to above-average importance in the area of the designated sites of area N-6 (chap. 2.6.3.1 North Sea Environmental Report). According to the current state of knowledge, the designated sites N-6.6 and N-6.7 are not expected to contain legally protected biotopes (chap. 2.5.3.1 North Sea Environmental Report). The connecting lines for both sites in area N-6 in the EEZ run completely outside of nature conservation areas; the routes cross the protected sandbank biotope type over a distance of around 10 km. Thus, according to the current state of knowledge, potential conflicts would be conceivable in terms of the route of the connecting line, but less so in terms of the sites themselves. Refer to the examination of alternatives of the cable routes to bypass the sandbank in chap. 9.3.4.

Sub-sites N-9.1 is about 30 km away from the nearest protected area. The distance to the main distribution area of harbour porpoises is 58 km, while the distance to the main concentration area of divers is as far as 63 km. The overall site is of medium importance for the protected areas of marine mammals and sea birds and resting birds. For the factor Benthos, the siteis assigned an average to above-average importance due to the occurrence of species of the burrowing soil megafauna in site N-9.1. The possibility of the occurrence of legally protected biotopes in the site can be excluded based on the current state of knowledge. In spite of the occurrence of sediments with partly high silt content and species of the burrowing soil megafauna (chap. 2.6.3.1 North Sea Environmental Report), the legally protected biotope type "silt bottom with burrowing soil megafauna" can be excluded due to the lack of sea feathers. The connecting cable for area N-9.1 runs for almost 10 km through the protected biotope type "sandbank", but in the EEZ completely outside of protected areas. Thus, according to the current state of knowledge, potential conflicts could arise with regard to the route of the connecting cable (see also the examination of alternatives to bypassing the sandbank in chap. 9.3.4).

Site N-5.4, which is described in the (preliminary) drafts of the Site Development Plan, is at a minimum distance of 5 km from the "Sylt Outer Reef – Eastern German Bight" nature conservation area. The distance to the nearest bird sanctuary "Eastern German Bight" is about 17 km. The site lies both in the main concentration area of divers and in the main distribution area of harbour porpoises. Due to the sometimes extensive occurrence of the biotopes "sublittoral sandbank", "reefs" and "species-rich gravel, coarse sand and shell layers", site N-5.4, which is described in the preliminary drafts of the Site Development Plan, is of high importance with regard to the factor Biotope types. In view of the relatively high diversity of species and the high structural heterogeneity, the benthic community can be regarded as above average in terms of the overall site. According to the current state of knowledge, the environment of site N-5.4, which is described in the (preliminary) drafts of the Site Development Plan and is currently under assessment, is of high importance for harbour porpoises and represents the core area of the identified main distribution area of harbour porpoises in the German North Sea (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2013; see chapter 2.8.3.1 North Sea Environmental Report). For the factor Seabirds and resting birds, the very high importance of the surroundings of the entire area N-5 for the red-throated and black-throated divers listed in Annex I of the V Directive must be emphasised (chap. 2.9.3.1 North Sea Environmental Report). Research and monitoring results consistently show that the avoidance behaviour of divers in relation to offshore wind farms and the associated habitat loss is much more pronounced than originally assumed. Current results from the wind farm projects in area N-5 show significant average avoidance distances of approx. 15 km in the western part of the area (see chapter 5.2.2.1 North Sea Environmental Report). In accordance with the precautionary principle and in order to exclude the possibility of a threat to the marine environment as defined in section 5 subsection 3 WindSeeG and a significant disturbance as defined in section 44 subsection 1 no. 2 of the Federal Nature Conservation Act with the necessary certainty, the Site Development Plan does not designate site N-5.4 as described in the (preliminary) drafts of the Site Development Plan (see chap 7.4 and 7.5 of the Site Development Plan).

The connecting line for site N-5.4, which is described in the (preliminary) drafts of the Site Development Plan, runs in the EEZ over a distance of 157 km, and thus almost completely, through the "Sylt Outer Reef – Eastern German Bight" nature conservation area. The route crosses known occurrences of the FFH habitat type "sandbank" over a distance of about 3 km and suspected areas of the section 30 biotope "species-rich gravel, coarse sand and shell layers" over a distance of about 13 km. The procedure for the parallel SylWin1 connection system showed that bypassing these occurrences of gravel, coarse sand and shell layers was problematic. From a nature conservation perspective, this gives rise to considerable conflicts with regard to site N-5.4, which is the area under assessment in the (preliminary) drafts of the Site Development Plan.

For migratory birds, the individual marine areas in sites N-1 to N-13 are of average to above-average importance. The current state of knowledge does not reveal any significant differences between the individual areas and areas. Also it is not currently possible to draw a definitive conclusion on a possible decreasing migration intensity with increasing distance from the coast. This means that the factor Migratory birds is no longer taken into account in the comparison of the sites in the North Sea that have been designated and assessed. The same applies to the factor Fish, for which the available catch data and methods can only provide a general description of the importance of sites and areas. The overview of the species records by area did not show any particular significance of a specific area for the constant, frequent character species.

The results show that site N-9.1 represents a reasonable alternative to site N-5.4, which was assessed in the (preliminary) drafts of the Site Development Plan, at least in terms of the nature conservation concerns examined here.

Baltic Sea

Site O-1.3 in the Baltic Sea is just 10 km away from the nearest protected area "Pomeranian Bight – Rönnebank". According to the current state of knowledge, the benthic biocoenosis in site O-1.3 is of medium importance overall (chap. 2.6.3.1). In the north/eastern part of site O-1.3, a residual sediment area with coarser sediments and occurrence of overgrown rocks was found. The area occurring here is a suspected area of the legally protected biotope type "reefs" (chap. 2.5.4.1). This residual sediment area with scattered stones overgrown with macrozoobenthos is to be considered as a reef suspected area of higher value. For harbour porpoises, site O-1.3 is of medium to seasonal importance in the winter months. The significance results from the possible use by individuals of the separate and highly endangered Baltic Sea population of the harbour porpoise. However, the area is used irregularly by harbour porpoises as a transit area, as a stopover and as a feeding ground (chap. 2.8.3.1). For seabirds, all previous findings indicate an average importance of site area O-1.3. Area O-1, in which the site is located, has an average occurrence of seabirds overall and also only an average occurrence of endangered and species requiring strict protection (chap. 2.9.3.1). With regard to the factor migratory birds, site O-1.3 is of average importance for migrating water birds, and of average to above-average importance for birds that migrate at night. A differentiated analysis is necessary for the crane migration. Well-known main routes are undoubtedly of above-average importance. The adjacent areas of these main migration routes, e.g. site O-1.3, are likely to be of average to above-average importance depending on wind force and direction. Cranes may drift from the main migration route to site O-1 in strong westerly winds (chap. 2.10.3.3). The route for the connection of site O-1.3 in the EEZ runs outside of protected areas and outside of known occurrences of protected biotopes. There are indications of possible conflicts with bird migration or biotope protection on site O-1.3. These indications will be examined as part of the subsequent preliminary investigation to close existing gaps in knowledge. The results of the preliminary investigation will also be taken into account in the spatial development planning.

The site under assessment O-2.2 is at a distance of 12 km from the nearest nature conservation area. The route for the connection of the site in the EEZ also runs outside nature conservation areas and outside of known occurrences of protected biotopes. Site O-2.2 shows low structural abundance overall. The occurrence of legally protected biotopes is not to be expected in this area (chap. 2.5.4.1). The area has little significance for the Benthos. The predominant benthic species consist mainly of species that regenerate rapidly (chap. 2.6.3.1). According to the current state of knowledge, the area is used by harbour porpoises as a transit area. Based on the current knowledge, a medium to high seasonal importance of site O-2 for harbour porpoises can be inferred. The seasonally high importance of the area results from the possible use by individuals of the separate and highly endangered Baltic Sea population of the harbour porpoise in the winter months (chap. 2.8.3.1). All previous findings indicate that site O-2 is of little importance for seabirds. The area has a low occurrence of endangered species and species requiring special protection (chap. 2.9.3.1). Overall, the part of site O-2.2 under assessment for migratory water birds is of average to above-average importance. In particular, the baseline survey of the area south of O-2.2 identified a high number of individual common scoters. In 2011, 8,174 birds were counted. Thus approx. 1.5 % of the biogeographical population moved through site O-2. Thus the area has above-average importance for common scoter migration. The largest part of nocturnal bird migration takes place in a broad front over the Baltic Sea. Due to the very high numbers of individuals to be expected and the significant proportion of endangered species, site O-2.2 is of average to above-average importance for the night migration.

A differentiated analysis is necessary for crane migration. In the area of O-2, a total of 1,231 migrating cranes were recorded during the 2008 autumn migration, which corresponds to about 3.1% of the Pomeranian resting population or 1.37 % of the biogeographical population. Most of these birds probably drifted here from a flight route South Sweden-Rügen to the southeast by north-westerly winds. Site O-2.2 is located close to known main migration routes and is therefore probably of average to above-average importance for bird migration, depending on the wind force and direction (chap. 2.10.3.3). Thus, nature conservation conflicts are evident at site O-2.2 with regard to the factor Migratory birds, especially from a cumulative point of view.

9.4 Technical alternatives

The task of the Site Development Plan is to specify the necessary routes and locations for the entire grid topology in the German EEZ up to the boundary of the 12 n.m. zone within the scope of the existing framework conditions in spatial and temporal terms with regard to the calendar years of commissioning.

The TSO, which is obliged to connect the offshore wind farms in the Baltic Sea to the grid, has so far pursued a connection concept based on three-phase current technology. When using the three-phase current technology, offshore wind farms are connected to the grid by combining the electricity generated by the individual wind turbines from one or more wind farms at a transformer platform, and from here it is routed directly ashore via AC Subsea Cable and on to the grid connection point. In contrast to the standard concept in the North Sea (HVDC), this means that no separate converter platform is required for the grid connection itself, thereby saving space. However, for discharging a given output, a higher number of cable systems is required when using three-phase technology due to the lower transmission capacity of AC Subsea Cable.

Due to the expected low wind farm capacity in the German EEZ of the Baltic Sea for commissioning activities from 2026 compared to the capacity of an HVDC system, a connection by means of a direct current system would probably lead to permanent vacancies.

The transmission system operator plans, builds and operates the transformer platform of the grid connection system. A separate offshore wind farm platform is unlikely to be required due to the proximity to the coast; in addition, the transformer platform may be used by agreement with the transmission system operator. This may prevent firstly the costs incurred by the grid user as a result of an additional platform, and also the additional space required and the environmental impact during construction, operation and dismantling.

The offshore connection cables in the Baltic Sea are therefore basically similar to the connection concept known from the BFO-O based on three-phase current technology, with a shift of responsibility in respect of planning, construction and operation of the transformer platform to the transmission system operator.

Two of the grid connection systems already implemented by the TSO in the Baltic Sea area for the connection of offshore windenergy projects in area O-3 of the Site Development Plan and in coastal waters are based on a transmission voltage of 150 kV. The transmission voltage for the other three systems currently being implemented for connection of offshore wind farm projects in area O-1 was increased to 220 kV. The design for a voltage level of 220 kV enables the highest possible transmission capacity per cable system – for three-phase connection – to be achieved and allows transmission to take place with as few cable systems as possible. Using a lower transmission voltage would therefore lead to a higher number of cable systems and thus be less eco-friendly.

A possible further increase in the voltage level is not required for the connection systems in the Baltic Sea EEZ due to the limited power to be transmitted. Moreover, an increase would not cause a reduction in the number of cable systems required.

With regard to an alternative use of the areas and sites, generation of hydrogen by means of electrolysis was introduced within the framework of the consultation as an alternative to the grid-bound transport and use of the electricity generated. A more detailed analysis is planned within the framework of the Site Development Plan update.

10 Measures envisaged for monitoring the environmental impacts

The potential significant effects on the environment resulting from the implementation of the plan are to be monitored in accordance with section 45 UVPG. The aim is to identify unforeseen adverse effects at an early stage and take appropriate remedial action.

Accordingly, in accordance with section 40 subsection 2 no. 9 UVPG, the environmental report is to specify the measures envisaged for monitoring the significant environmental effects of implementation of the plan. Monitoring is the responsibility of the Federal Maritime and Hydrographic Agency as it is the authority responsible for the SEA (see section 45 subsection 2 of UVPG). As intended by Art. 10 subsection 2 of the SEA Directive and section 45 subsection 5 UVPG, existing monitoring mechanisms can be used to avoid duplicating monitoring work. Pursuant to section 45 subsection 4 UVPG, the results of monitoring are to be taken into account in the update of the spatial development plan.

With regard to the planned monitoring activities, it should be noted that the actual monitoring of the potential effects on the marine environment can only begin when the Site Development Plan is implemented, i.e. when the decisions made within the framework of the plan are implemented. Nevertheless, the natural development of the marine environment, including climate change, should not be disregarded when assessing the results of monitoring activities. However, general research cannot be carried out within the framework of monitoring. Therefore, project-related monitoring of the effects of the uses regulated in the plan is of particular importance.

The main function of plan monitoring is to bring together and evaluate the results of different phases of monitoring at the level of individual projects or clusters of projects developed in a spatial and temporal context. The assessment will also cover the unforeseen significant effects of the implementation of the plan, the marine environment and the review of the forecasts in the environmental report. In this context, in accordance with section 45 subsection 3 UVPG, the Federal Maritime and Hydrographic Agency will ask the competent authorities for the monitoring results available there; these are required for implementation of the monitoring activities.

Results from existing national and international monitoring programmes must also be taken into account, also with a view to preventing duplication of work. The monitoring of the conservation status of certain species and habitats required pursuant to Art. 11 of the Habitats Directive must also be included, as must the investigations to be carried out in the context of the management plans for the nature conservation area "Pomeranian Bight – Rönnebank". It will also provide links with the measures provided in the Marine Strategy Framework Directive and the Water Framework Directive.

In summary, the planned measures for monitoring the potential effects of the plan can be summarised as follows:

- The collection of data and information that can be used to describe and assess the status of areas, factors and potential effects of the development of individual projects,

- Development of suitable procedures and criteria for evaluation of the results from effect monitoring of individual projects,
- Development of procedures and criteria for evaluation of cumulative effects,
- Development of procedures and criteria for forecasting possible effects of the plan in a spatial and temporal context,
- Development of procedures and criteria for evaluating the plan and adapting or, where appropriate, optimising it as part of the update,
- Evaluation of measures to prevent and mitigate significant effects on the marine environment,
- Development of norms and standards.

The following data and information are required in order to assess the possible effects of the plan:

1. Data and information available to the Federal Maritime and Hydrographic Agency within the scope of its responsibility:
    - Data resources from previous EISs and monitoring activities of offshore projects that are available to the Federal Maritime and Hydrographic Agency for review (according to the Offshore Installations Ordinance),
    - Data resources from the right of subrogation (according to WindSeeG),
    - Data resources from the site investigations (according to WindSeeG),
    - Data resources from the construction and operation monitoring of offshore wind farms and other uses,
    - Data from national monitoring, collected by the Federal Maritime and Hydrographic Agency or by the Leibniz Institute for Baltic Sea Research on behalf of the Agency,
    - Data from Federal Maritime and Hydrographic Agency research projects.
2. Data and information from the areas of responsibility of other Federal and State authorities (on request):
    - Data from national monitoring of the North Sea and the Baltic Sea (formerly BLMP),
    - Data from monitoring activities as part of the implementation of the Marine Strategy Framework Directive,
    - Data from the monitoring of Natura 2000 sites,
    - Data provided by States from monitoring activities in coastal waters,
    - Data from other authorities responsible for the authorisation of uses at sea according to other legal bases, e.g. the Federal Mining Act, maritime traffic monitoring (AIS), fisheries monitoring (VMS)
3. Data and information from Federal and State research projects,

    e.g.:

    - HELBIRD / DIVER,
    - Sediment EEZ
4. Data and information from evaluations carried out within the scope of international committees and conventions
    - HELCOM
    - ASCOBANS
    - AEWA
    - BirdLife International.

For reasons of practicability and appropriate implementation of requirements from the SEA, the Federal Maritime and Hydrographic Agency will pursue an approach focusing on the interdisciplinary compilation of information on the marine environment that is as ecosystem-oriented as possible when monitoring the possible effects of the plan. To be able to assess the causes of planned changes in parts or individual elements of an ecosystem, the anthropogenic variables from spatial observation (e.g. technical information on shipping traffic from AIS data resources) must also be considered and included in the assessment.

When combining and evaluating the results from monitoring at project level and from other national and international monitoring programmes, and from the accompanying research, it will be necessary to review the gaps in knowledge and uncertain forecasts presented in the environmental report. This applies in particular to forecasts concerning assessment of significant effects on the marine environment from the uses regulated in the Site Development Plan. The cumulative effects of defined uses are to be assessed regionally and supraregionally.

10.1 Monitoring of potential effects of areas and sites for offshore wind turbines

The investigation of the potential environmental impacts of areas and sites for offshore wind energy must be carried out at project level in accordance with the standard "Investigation into the impacts of offshore wind turbines (StUK 4)" and in coordination with the Federal Maritime and Hydrographic Agency. The results from the investigations of the offshore wind farm projects are to be used as a basis for assessing the location in respect of the biological factors. Monitoring during construction of foundations by means of pile-driving work involves measuring underwater noise and acoustic recordings of the effects of pile-driving noise on marine mammals using POD measuring instruments. In addition, additional monitoring measures are planned to detect the effects of the stratification of the water under certain hydrographic conditions on the propagation of the pile-driving sound into the Baltic Sea and, if necessary, to take further actions. These measures can amongst others include additional sound measurements coupled with CTD measurements at different water depths to detect possible changes in sound propagation attenuation due to stratification of the water body.

Investigations are required for all factors in accordance with the requirements of StUK4 for the entire duration of the construction phase and for a period of between three and five years. No special monitoring is required during the operating phase.

The Federal Maritime and Hydrographic Agency implements a whole range of projects as part of its accompanying research into the possible impacts of offshore wind turbines on the marine environment.

The Federal Maritime and Hydrographic Agency's research projects directly related to the possible effects on factors and the development of norms and standards include the following:

- Project ANKER "Approaches to cost reduction in the surveying of monitoring data for offshore wind farms", FKZ 0325921, with funding from the Federal Ministry for Economic Affairs and Energy/PtJ,
- R&D study BeMo "Evaluation approaches for underwater noise monitoring in connection with offshore licensing procedures, spatial planning and the Marine Strategy Framework Directive", with funding from the Federal Ministry of Transport and Digital Infrastructure/Federal Maritime and Hydrographic Agency,
- R&D project "Sound mapping", with funding from the Federal Ministry of Transport and

Digital Infrastructure/Federal Maritime and Hydrographic Agency,

- R&D cooperation, NavES "Eco-friendly offshore developments", with funding from the departmental research plan of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety; several sub-projects belong to NavES:
  - MultiBird, investigation of the collision risk of migratory birds,
  - ProBird, forecast of migratory bird activity,
  - ERa, field report on pile-driving noise,
  - Noise I and II. development of technical information systems for underwater noise,
  - Noise I and II, evaluation of underwater noise measurements

The measures implemented to date include development of measurement regulations for measuring underwater noise (2011), development of measurement regulations for determining the effectiveness of noise mitigation systems (2013), and cooperation on the development of ISO 18406:17 and DIN SPEC 45653.

The results from ongoing Federal Maritime and Hydrographic Agency projects will be directly incorporated into the further development of standards, such as the development of StUK5.

10.2 Monitoring of potential effects of platforms

The same monitoring measures as stated in 10.1 are to be applied to the platforms provided for in the Site Development Plan.

10.3 Monitoring of the potential effects of submarine cables

The potential effects of submarine cable systems on the marine environment can only be assessed in specific projects. For the first time, StUK4 also includes minimum requirements for investigation of submarine cable routes with regard to benthos, biotope structure and biotopes during the baseline survey and the operating phase of the submarine cable systems. Thus, during the baseline survey, each biotope structure identified by sediment surveys along the cable route must be documented with at least three transverse transects for the benthic surveys. Additional transverse transects must also be defined at the start and end points of the route. In turn, each transverse transect consists of five stations. Identified suspected sites of biotopes that are protected in accordance with section 30 of the Federal Nature Conservation Act must also be examined in terms of spatial delimitation in accordance with the current mapping instructions from the Federal Agency for Nature Conservation.

After the cable system has been laid, its position must be indicated annually to the licensing authority during the first five years of operation, in accordance with current licensing practice, by implementing at least one survey of the depth of the system. The number of surveys in subsequent years is determined by the licensing authority on a case-by-case basis. Investigations with regard to the marine environment are to be carried out in coordination with the licensing authority on a project-specific basis. The investigation methods are to be presented, as far as possible, as described in the "Standard – Investigation of the impacts of offshore wind - turbines on the marine environment (StUK4)". Investigations of the benthic communities on the same transects as in the baseline survey are to be carried out one year after commissioning of the submarine cable systems in order to examine possible effects from the construction and operation phases.

In addition, measures are planned to monitor implementation of the plan, which will help to verify and, if necessary, to evaluate forecasts of the significant impacts of offshore wind energy. Adapting use strategies and planned avoidance and mitigation measures or reviewing assessment criteria, especially with regard to cumulative impacts.

The SEA for the plan will use new findings from the environmental impact studies and from the joint evaluation of research and EIA data (see chapter 2). Through a joint analysis of the research and EIA data, products will also be developed that provide a better overview of the distribution of biological factors in the EEZ. Consolidation of information is leading to an increasingly solid basis for impact forecasting.

In general, the intention is to ensure that data from research, projects and monitoring is consistent and make this available for competent evaluation. In particular, attempts should be made to create common overview products in order to review the effects of the plan. The existing geodata infrastructure at the Federal Maritime and Hydrographic Agency, which includes data from physics, chemistry, geology, biology and usage of the sea, will be used as a basis for consolidating and evaluating ecologically relevant data and will be further developed accordingly.

With regard to the consolidation and archiving of ecologically relevant data from project-related monitoring activities and accompanying research, it is specifically provided that data collected within the scope of accompanying ecological research will also be consolidated at the Federal Maritime and Hydrographic Agency and archived on a long-term basis. The Federal Maritime and Hydrographic Agency is already collecting and archiving the data on biological factors from the baseline surveys of offshore wind energy projects and the monitoring of construction and operating phases in the MARLIN (MarineLife Investigator), a specialist information network for environmental assessments.

11 Non-technical summary

Subject and reason

According to sections 4ff. Offshore Wind Energy Act (WindSeeG), the Federal Maritime and Hydrographic Agency is compiling a Site Development Plan in agreement with the Federal Network Agency and in coordination with the Federal Agency for Nature Conservation, the Directorate-General for Waterways and Shipping (GDWS) and the coastal states. The Site Development Plan will be established for the first time and must be announced by 30 June 2019 in accordance with section 6 subsection 8 WindSeeG. When the Site Development Plan was drawn up, anenvironmental assessment as defined by the Environmental Impact Assessment Act (UVPG), known as a Strategic Environmental Assessment (SEA), was carried out. The main content of the SEA is this environmental report. This identifies, describes and assesses the likely significant environmental impact of the implementation of the Site Development Plan, as well as possible planning alternatives, taking into account the essential purposes of the plan.

The Site Development Plan has the character of a technical plan. As an important control instrument, the sectoral plan is designed to plan the use of offshore wind energy in a targeted and optimal manner by defining areas and sites as well as locations, route corridors and routes for grid connections and interconnectors.

The Site Development Plan contains rules for the expansion of offshore wind turbines and the necessary offshore connection lines for the period from 2026 to at least 2030 with the aim of

- achieving the expansion target in section 4 No. 2b of the Renewable Energy Act,
- expanding the power generation from offshore wind turbines in a spatially ordered and compact fashion, and
- ensuring an ordered and efficient utilisation and loading of the offshore connecting cables, and planning, installation, commissioning and use of offshore connecting cables in parallel with the expansion of power generation from offshore wind turbines.

Within the framework of the central model, the Site Development Plan is the control instrument for orderly expansion of offshore wind energy in a staged planning process. The Site Development Plan SEA is associated with upstream and downstream environmental audits. The Site Development Plan is classified as a technical plan according to the higher-level spatial planning. In the next step, the sites defined in the Site Development Plan for offshore wind turbines undergo preliminary investigation. If a site is deemed suitable for the use of offshore wind energy, the site is put up for tender and the winning bidder can apply for approval (planning permission or planning approval) for the construction and operation of offshore wind turbines on the site. No preliminary investigation will be carried out for the specified platform locations and cable routes.

With regard to the character of the Site Development Plan as a steering planning instrument, the depth of the assessment of likely significant environmental impacts is characterised by a greater scope of investigation and generally a lower depth of investigation. As with the marine spatial planning instrument, the focus of the assessment is on evaluating cumulative effects and examining alternatives.

The establishment of the Site Development Plan and implementation of the SEA take into account the environmental protection objectives. These provide information on what state of the environment is being sought in the future (environmental quality targets). The environmental protection objectives can be seen in synopsis from the international, common and national conventions and regulations that deal with protection of the marine environment and on the basis of which the Federal Republic of Germany has committed itself to certain principles and objectives.

Strategic Environmental Assessment methodology

This environmental report builds on the methodology of the SEA of the Spatial Offshore Grid Plan, which has already been used as a basis, and develops it further with a view to the additional rules defined in the Site Development Plan that go beyond the Spatial Offshore Grid Plan.

The methodology is based primarily on the rules of the plan that are to be assessed. Within the framework of this SEA, whether the rules are likely to have significant effects on the factors in question is identified, described and evaluated for the individual rules. The subject matter of the environmental report is compliant with the provisions of the Site Development Plan as set out in section 5 subsection 1 WindSeeG. However, it is not so much the actual time specifications that are significant here as the time sequence of the invitation to tender or the calendar years for commissioning, as this has no further environmental impacts with regard to the spatial specifications. Although some planning and technical principles serve to mitigate environmental effects, they can also lead to effects, making a review necessary.

The assessment of the likely significant environmental effects of the implementation of the Site Development Plan includes secondary, cumulative, synergistic, short-, medium- and long-term, permanent and temporary, positive and negative effects related to the factors.

The assessment of possible impacts is based on a detailed description and assessment of the environmental status. The SEA was carried out for the following factors:

- Site
- Ground
- Water
- Plankton
- Biotopes
- Benthos
- Fish
- Marine mammals
- Avifauna
- Bats
- Biodiversity
- Air
- Climate
- Scenery
- Cultural heritage and other material assets
- Human beings, in particular human health
- Interrelationships between factors

The description and evaluation of the expected significant environmental impacts is carried out separately for protected areas and sites, platforms and submarine cable systems. Furthermore, where necessary, a differentiation is made according to different technical designs. The description and assessment of the likely significant effects of the implementation of the Site Development Plan on the marine environment also refer to the factors described. All plan contents that may potentially have significant environmental effects are examined.

The effects of construction and dismantling, as well as system-related and operational factors, are taken into account. Moreover, effects that may arise in the course of maintenance and repair work are taken into account. This is followed by a description of possible interrelationships and consideration of possible cumulative effects and potential transboundary impacts.

The effects of the Site Development Plan rules are assessed on the basis of the description and assessment of the condition and the function and significance of the individual areas, sites and routes for the individual factors on the one hand, and the effects originating from these rules and the resulting potential effects on the other. A forecast of the project-related effects in the case of implementation of the Site Development Plan is compiled as a function of the criteria of intensity, scope and duration of the effects.

In the context of the impact forecast, specific framework parameters for areas and sites, for platform locations and for cable routes are used as a basis for evaluation. Although no wind farm layouts are defined in the Site Development Plan to determine the projected output to be installed, certain parameters are assumed in the SEA for the analysis of the factor. To illustrate the range of possible (realistic) developments, the assessment is essentially based on two scenarios. Scenario 1 assumes many small installations, while scenario 2 assumes a small number of large installations. Because of the resulting range covered, a description and evaluation of the current state of planning that are as comprehensive as possible in relation to the protected assets become possible.

Regarding the areas, a total of 13 areas is assumed in a worst-case scenario, regardless of the concrete rule in the plan and the probability of implementation. According to section 5 subsection 1 no. 5 of the Offshore Wind Energy Act, the expected generation capacity of offshore wind turbines must be specified in the Site Development Plan for the areas or specifically for the sites. To determine the projected capacity to be installed, one or more layouts for offshore wind farm planning are not taken as a basis, but certain parameters such as number of turbines, hub height, height of the lower rotor tip, rotor diameter, total height, diameter of foundation types and scour protection are assumed for a factor-based analysis in this SEA.

Certain parameters, such as the number of platforms or the length of the farm's internal cabling, are also taken as a basis when assessing the locations for platforms. The definition of routes and route corridors for submarine cable systems is based on certain widths of the cable trench and the number and area of intersections and converter platforms.

Benthos

The species inventory of the Baltic Sea EEZ is to be considered average, with about 250 species of macro-zoobenthos. The benthic communities are also typical of the Baltic Sea EEZ and for the most part have no special features. According to the currently available studies, the macro-zoobenthos of the Baltic Sea EEZ is also considered average due to the proven number of Red List species. Studies of macro-zoobenthos within the framework of the approval procedures for offshore wind farms and grid connections from 2002 to 2015 have confirmed this assessment. The species inventory previously found and the number of Red List species indicate that the study area for benthic organisms is of average importance.

The deep foundation work for wind turbines and platforms will result in small-scale and short-term disturbances of the seabed, sediment turbulence and formation of turbidity plumes. The re-suspension of sediment and subsequent sedimentation may lead to impairment or damage to the benthos in the immediate vicinity of the foundations for the duration of the construction activities. However, these impairments are expected only to be small-scale and short-term. Local land sealing and the introduction of hard substrates in the immediate vicinity of the structure as a result of construction work may lead to changes in the species composition. As the colonisation of artificial hard substrates is associated with an accumulation of organic material, the biological degradation process may lead to local oxygen deficiency.

Due to the laying of the submarine cable systems, only small-scale disturbances of the benthos due to sediment turbulence and turbidity plumes are to be expected in the area of the cable route. Possible effects on the benthos are dependent on the installation methods used and the geological and hydrographic conditions. With comparatively unobtrusive laying using the injection method, only minor disturbances of the benthos in the vicinity of the cable route are to be expected. Local sediment shifts and turbidity plumes are to be expected while the submarine cable systems are being laid. In more cohesive substrates, the cable systems are laid in trenches or laid using a heavy plough. These procedures are also associated with disturbance of the sediment and benthic fauna, as well as sediment turbulence.

In areas with a lower proportion of fine matter, most of the sediment released will settle relatively quickly in the immediate vicinity of the cable route. In areas with soft sediments and correspondingly high proportions of fine matter, currents close to the bed are relatively low, so only temporary, local effects can be expected for these areas too. In the short term, pollutants and nutrients may be released from the sediment into the bottom water. The possible release of pollutants from the sandy sediment is negligible. There may be a significant release of pollutants from the sediment into the bottom water in the vicinity of silty and clay-like seabeds. These pollutants usually adhere to sinking particles which, due to the low currents in the Baltic Sea basins, scarcely drift over long distances and remain in their usual environment. In the medium term, this remobilised material will be redeposited in the silty basins.

Benthic habitats will be directly built over in the vicinity of rockfills required for cable crossings, or if laying cable sections on the seabed becomes necessary at a local level. The resulting loss of habitat is permanent, but small in scale. This will result in a non-native hard substrate that may cause small-scale changes to the species composition.

Warming of the upper sediment layer of the seabed may occur directly above the cable system due to operation, and this may lead to impairments of benthic communities. With the planning principle for sediment warming, the Site Development Plan specifies that the 2K criterion must be adhered to. According to the assessment by the Federal Agency for Nature Conservation, this precautionary value ensures, with sufficient probability, that significant negative effects of cable warming on the marine environment will be prevented.

As things stand present, the planned transformer and collector platforms and submarine cable routes are not expected to have any significant effects on the factor Benthos if the 2K criterion is met. Only very small areas outside protected areas will be used. Rapid re-population is very likely due to the usually rapid regeneration capability of populations of benthic organisms with short generation cycles and their widespread distribution in the German Baltic Sea.

Biotopes

Wind turbines, platforms and submarine cable systems may possibly affect the factor Biotopes due to direct use of protected biotopes, possible covering by sedimentation of material released during construction and potential habitat changes. Direct use of nature conservation areas is essentially not permitted for wind turbines and platforms. According to the planning principles of the Site Development Plan, known occurrences of protected biotopes are to be bypassed as far as possible in accordance with section 30 of the Federal Nature Conservation Act or treated as particularly important within the framework of the specific approval procedure. In addition, the planned routes bypass the currently known occurrence of reef sites and suspected contaminated reef sites.

Given the predominant sediment composition in areas in which protected biotopes can be expected to occur, impairments due to coverage are likely to be small-scale as the released sediment will settle quickly. Given the predominant low currents close to the seabed, turbidity plumes can only be expected in areas with soft sediments up to a distance of approx. 500 m which clearly exceed natural suspended matter maxima. The released material remains in the water column for long enough to be distributed over a large area, so barely detectable thicknesses of the deposited material are to be expected due to the comparatively small volumes. Simulations show that the sediment released will have resettled after a maximum of 12 hours. Thus, according to available information, the impairments will generally remain small-scale and temporary.

Permanent habitat changes are limited to the immediate area of the foundations and rockfills required for cable crossings and when laying cables on the seabed. These rockfills will permanently provide a hard, non-native substrate. This will offer a new habitat for benthic organisms and may lead to a change in the species composition. Significant effects on the factor Biotopes due to these small-scale regions are not to be expected. Moreover, the risk of negative impact on the benthic sediment community due to species atypical for the area is low, as recruitment of the species is very likely to take place from the natural hard substrate habitats.

Fish

According to previous knowledge, fish communities typical for the habitat occur in the German EEZ. The pelagic fish community, represented by herring, sprat, salmon and sea trout, has been identified; as has the demersal fish community, consisting of large fish species such as cod, plaice, flounder and dab. The fish fauna is of average importance with regard to its specific characteristics on account of the fish communities typical for the habitat. In the eastern part of the EEZ, a total of 45 fish species have been identified in various studies, including six Red List species. According to current knowledge, the planned locations are not a preferred habitat for any of the protected fish species. Consequently, fish stocks in the planning area are of no overriding ecological - importance compared to adjacent marine areas. According to the current state of knowledge, the planned construction of wind farms and the associated converter platforms and submarine cable routes is not expected to significantly affect the factor Fish. The effects of the construction of wind farms, converter platforms and submarine cable systems on fish fauna are limited both spatially and temporally. Sediment turbulence and the formation of turbidity plumes during the construction phase for the foundations and converter platforms and the laying of the submarine cable systems may lead to small-scale and temporary impairments of fish fauna. The turbidity of the water is expected to decrease rapidly due to the prevailing sediment and flow conditions. Thus, according to the current state of knowledge, the impairments will remain small-scale and temporary. Overall, small-scale impairments can be assumed for adult fish. Moreover, the fish fauna is adapted to the natural sediment turbulence caused by storms that are typical here. During the construction phase, fish may also be temporarily scared away by noise and vibrations. Noises from the construction phase are to be reduced by means of suitable measures. Further local effects on fish fauna may be due to the additional hard substrates introduced owing to a possible change in the benthos. Likewise, sediment warming and the magnetic fields that could emanate from submarine cables are not expected to have any permanent effects on the mobile fish fauna.

Marine mammals

The areas and sites defined in the Site Development Plan in the Baltic Sea EEZ form part of the habitat of the harbour porpoises, as indeed does the whole western Baltic Sea. According to the current state of knowledge, these areas are used by harbour porpoises as transit areas. There is currently no evidence that the areas and sites have special functions as feeding grounds or rearing areas for harbour porpoises. Harbour seals and grey seals use the three areas O-1 to O-3 only sporadically as transit areas. The findings from the monitoring of the Natura 2000 sites and investigations for offshore wind farms currently indicate a medium to high seasonal importance of areas O-1 and O-2 for harbour porpoises. The seasonal high significance of the area results from the possible use by individuals of the separate and highly endangered Baltic Sea population of the harbour porpoise in the winter months. These areas are of no particular importance for harbour seals and grey seals.

Threats to marine mammals can be caused by noise emissions during the installation of the foundations of transformer or collector platforms. Without the use of noise reduction measures, considerable impairments of marine mammals cannot be excluded during pile driving in individual subareas. The pile-driving of the transformer or collectors platforms will therefore only be permitted in the specific approval procedure where the use of effective noise reduction measures is specified. For this purpose, the Site Development Plan includes a specification regarding the noise reduction principle.

This states that the installation of the foundations must be carried out only subject to strict noise reduction measures. In the specific approval procedure, extensive noise reduction measures and monitoring measures are mandated to ensure compliance with applicable noise protection values (sound exposure level (SEL) of 160 dB re 1μPa²s and peak level of 190 dB re 1μPa 750 m away from the pile-driving or insertion point). Appropriate measures must be taken to ensure that no marine mammals are present in the vicinity of the pile driving point. Based on the current state of knowledge, significant effects on marine mammals arising from the operation of the transformer or collector platforms can be excluded.

The exclusion of the construction of transformer and collector platforms in Natura 2000 sites contributes to lowering the threat to harbour porpoises in important feeding and rearing areas. The construction and operation of the planned transformer or collector platforms are not expected to have significant adverse effects on marine mammals after implementation of the reduction measures mandated in the individual approval procedures in accordance with the planning principle and appropriate compliance with applicable noise protection values. Also the laying and operation of submarine cable systems is not expected to have a significant impact on marine mammals.

Seabirds and resting birds

The individual areas for offshore wind energy in the Baltic Sea EEZ are of differing significance for seabirds and resting birds. Overall, area O-1 is expected to be of medium importance for seabirds. The area boundaries on the extensive resting habitats of the Pomeranian Bight and the Adlergrund to the south and south-east. Overall, the area has a medium seabird population and a medium incidence of endangered species and species that are particularly worthy of protection. According to current knowledge, areas O-2 and O-3 are of low importance as feeding and resting habitats for seabirds. Both areas have a low incidence of endangered species and species that are particularly worthy of protection. These are not amongst the main resting, feeding and wintering habitats of species included in Annex I of the Wild Birds Directive. All three areas are of low importance as feeding grounds for diving sea ducks due to the depth of the water and the seabed composition. Just like divers, these birds predominantly use the areas for transit purposes. The areas are of no particular importance as feeding grounds for breeding birds due to the distance from the breeding colonies on the coast.

In the first instance, disturbances for seabirds and resting birds during the construction phase will be caused by light emissions and visual upheaval. These may cause varying degrees of deterrence and barrier effects, depending on the species. Direct disturbances during the construction phase are only to be expected locally and for a limited time. Significant effects can be excluded with a high degree of certainty due to the high mobility of birds. During the temporary construction phase, neither the construction of the planned wind turbines and platforms nor the laying of the planned submarine cable systems are expected to have any significant effects on seabirds and resting birds, according to current knowledge. Any deterrence caused by construction will be local and not exceed the disturbances generally associated with slow ship movements.

For certain bird species, wind farms and platforms will cause permanent but – according to current knowledge, insignificant – disturbances and deterrence. A possible collision risk for species at risk of collision can be excluded with the required certainty by means of species-specific behaviour and possible system configurations. The exclusionary effect of wind farms and platforms at Natura 2000 sites means that habitat losses in important habitats are reduced.

As a result, substantial effects caused by the construction or installation of platforms, wind turbines and submarine cable systems, and by their operation, on the factor Seabirds and resting birds, can be excluded with the necessary certainty.

Migratory birds

The Baltic Sea EEZ is of average to above-average importance for bird migration. Annually, up to a billion birds migrate over the Baltic Sea. For sea ducks and geese from Northern Europe and Russia (as far as West Siberia), the Baltic Sea is an important transit area, with a large part of the migration occurring in the autumn in the east-west direction close to the coast. The western Baltic Sea is flown over, sometimes in high intensities, by several species that require special protection (e.g. barnacle goose, whooper swan, eider duck, common and velvet scoter). Thermal soarers and other diurnal migratory land birds prefer to travel along the "flyway" (Islands of Fehmarn, Falster, Møn and Seeland, and on to Falsterbo). East of this main route, these birds migrate in much lower densities. The western Baltic Sea is of above-average importance for crane migration.

Possible effects of the planned wind farms and transformer or collector platforms for migratory birds may comprise a barrier effect or a collision risk. In the clear weather conditions preferred by the birds for migration, the probability of a collision with a wind turbine, transformer or collector platform is low. Bad weather conditions increase the risk. It can be assumed that any negative effects can be reduced by lighting that is as compatible as possible during operation of the wind turbines, transformer or collector platforms. Potential cumulative effects from the wind turbines, transformer and collection platforms in conjunction with other planned offshore wind farms are covered in the chapter "Cumulative effects".

According to the current state of knowledge, during the temporary construction phase, neither the construction of the planned wind turbines, transformer or collector platforms nor the laying of the planned submarine cable systems are expected to have a significant impact on migratory birds. Any deterrence caused by construction will be local and not exceed the disturbances generally associated with slow ship movements.

Bats

Migration movements of bats across the Baltic Sea are documented to varying extents, but to date no specific information is available on migratory species, migration corridors, migration heights and migration concentrations. The only information to date confirms that bats, especially species that travel long distances, fly over the Baltic Sea. On the basis of previous observations, it is assumed that bats tend to migrate across the sea in concentrations (swarms), probably at considerable altitudes and on migratory routes that are used regularly.

There may be hazards for bats during the operating phase of wind turbines and platforms. The sensitivity of bats to onshore structures and the associated risk of collisions is well known, as is the risk of collisions with wind turbines. Furthermore, possible barrier effects as well as habitat or attraction effects are known on land. However, the effects of offshore structures are largely unknown.

A cumulative assessment of the hazard risk is currently not possible due to the lack of reliable data sources.

Air quality

The construction and operation of the platforms and the laying of submarine cable systems as part of the implementation of the Site Development Plan will have no measurable impact on air quality.

Biodiversity

Biodiversity involves the diversity of habitats and communities, the diversity of species and the genetic diversity within species (Art. 2 of the Convention on Biological Diversity, 1992). Public attention is focused on biodiversity.

With regard to the current state of biodiversity in the Baltic Sea, there is a wealth of evidence of changes in biodiversity and species patterns in all systematic and trophic levels of the Baltic Sea. These are mainly due to human activities, such as fishing and marine pollution, or to climate change. In this regard, Red Lists of endangered animal and plant species have an important control and warning function as they indicate the state of populations of species and biotopes in a region. Possible effects on biodiversity are discussed in connection with the individual factors in the environmental report. In summary, it can be stated that according to current knowledge, the planned expansion of offshore wind energy and the accompanying grid expansion are not expected to have any significant effects on biodiversity.

Interdependency

In general, effects on a factor lead to various consequences and interrelationships between the factors. The essential interdependence of the biotic factors results from the food chains. Possible interactions during the construction phase will result from sediment shifts and turbidity plumes, as well as noise emissions. However, these interdependencies will occur only very briefly and be limited to a few days or weeks.

Construction-related interrelationships, e.g. due to introduction of hard substrate, will indeed be permanent but are only to be expected locally. This could lead to a small-scale change in the food supply. Furthermore, the areas and sites included in the Site Development Plan are not regarded as feeding grounds of particular importance for factors of the higher food web stage.

Interrelationships can only be described very imprecisely due to the variability of the habitat. In principle, it can be stated that according to the current state of knowledge, no interrelationships are discernible that could endanger the marine environment.

Cumulative effects

Soil, benthos and biotopes

A significant proportion of environmental effects on soil, benthos and biotopes due to the areas and sites, platforms and submarine cable systems will occur solely during the construction period (formation of turbidity plumes, sediment shifts, etc.) and over a limited area. Cumulative environmental effects due to construction are unlikely, particularly due to the step-by-step implementation of the construction projects.

Possible cumulative effects on the seabed, which could also have a direct impact on the factor Benthos and specially protected biotopes, result from permanent direct area use due to the foundations of the wind turbines and platforms, as well as from the installed cable systems. The individual effects are essentially small-scale and local.

In order to estimate the direct area use, a rough calculation is made on the basis of the areas/sites, platforms and submarine cable systems planned in the Site Development Plan in conjunction with existing installations and planning within the framework of the transitional system. The calculated area use is based on ecological aspects; in other words, the calculation is based on the direct ecological loss of function or the possible structural change of the site due to the installation of foundations and cable systems. In the area of the cable trench, however, the impairment of the sediment and benthic organisms will essentially be temporary. Permanent impairment could be assumed when crossing particularly sensitive biotopes such as reefs.

On the basis of a model assumption, the planning of the Site Development Plan and the transitional system, and the actual inventory of wind turbines, submarine cables, rockfills and platforms, mean that a total site of approx. 90 ha will be taken up or, in the case of submarine cables, will be temporarily impaired. This corresponds to well below 0.2‰ of the total EEZ site. In comparison, about 55% of the Baltic Sea EEZs are protected. As construction of wind turbines and platforms is generally not permitted in nature conservation areas, use of the protected areas is limited to submarine cable routes. No statement can be made on the use of specially protected biotopes according to section 30 of the Federal Nature Conservation Act due to the current absence of a sound scientific basis. Area-wide sediment and biotope mapping of the EEZ currently being carried out will lead to more reliable information in the future.

Besides the direct use of the seabed and hence the habitat of the organisms living there, the foundations and intersections will lead to an additional supply of hard substrate. The benthic fauna adapted to soft substrates will also lose habitat on account of the hard substrate. However, as the area use for both the grid connection systems and the wind farms will be in the ‰ (per-mille) range, according to current knowledge no significant impairments are to be expected in the cumulation that would endanger the marine environment with regard to the seabed and the benthos.

Marine mammals

Cumulative impacts on marine mammals, harbour porpoises in particular, can occur mainly due to noise emissions during pile-driving of the foundations. These factors could be significantly affected by the fact that – if pile-driving takes place simultaneously at different locations within the EEZ – there is not enough room available to escape and retreat. To date, there has been a lack of sufficient experience regarding the temporal and spatial overlap in the spread of noise from pile-driving.

It is, however, clear from the descriptions of the Site Development Plan that the individual offshore wind farms and the grid connection systems will be constructed gradually, i.e. in stages, in the coming years and not simultaneously.

Seabirds

Vertical structures such as platforms or offshore wind turbines may have different effects on resting birds, such as habitat loss, an increase in the risk of collision, or deterrence and barrier effects. For resting birds, habitat loss due to the construction of several structures may be particularly significant.

In particular, vulnerable and disturbance-sensitive seabird species such as divers are to be taken into account with regard to cumulative effects. For disturbance-sensitive species, the effects of shipping traffic (including maintenance and operation of cable systems and platforms) should be included in addition to offshore wind farms and platforms.

As all previous findings for the areas and sites included in the Site Development Plan indicate low importance for species contained in Annex I of the Wild Birds Directive, there are no apparent obstacles to the enforceability of the plan according to the current state of knowledge. Due to the distance of the areas to the nature conservation area "Pomeranian Bight – Rönnebank" a disturbance of the overwintering birds in the conservation area can be ruled out. This also applies to any disruption caused by shipping related to the operation and maintenance of the submarine cable systems, platforms and wind turbines. As the Baltic Sea is used extensively for shipping, no additional disruption of sensitive species is to be expected from increased shipping traffic during construction or for repair and maintenance. Significant disturbances within the nature conservation area can be excluded by avoiding the use of Natura 2000 sites.

Migratory birds

A potential hazard for migratory birds arises on the one hand from the risk of collision with the transformer platform and the individual offshore wind turbines, and on the other hand from adverse effects due to forced changes in the flight route.

Under normal migratory conditions preferred by migratory bird species, there is so far no evidence for any species that the birds typically migrate in the danger zone of the turbine and/or do not recognise and avoid these obstacles. In the clear weather conditions preferred by the birds for migration, the probability of a collision with a wind turbine or transformer or collector platforms is very low. A potentially dangerous situation is posed by unexpected fog and rain, which lead to poor visibility and low flight altitudes. A particular problem is when bad weather conditions coincide with what are known as mass migration events, but due to the low migrations distances or migration times across the Baltic Sea these are rare. The collision risk for sea and waterbirds migrating during the day is generally estimated to be low. They orient themselves visually and are usually able to land on water. Also for diurnal migratory land birds (e.g. cranes and raptors) a low risk of collision is currently envisaged because these also position themselves visually and avoid the wind turbines. However, cumulative effects on some sites could increase the risk of collision. To verify this state of knowledge, additional monitoring of diurnally migrating land birds was commissioned focusing on cranes, raptors and geese using Rangefinders as part of the site preliminary investigation of site O-1.3 implemented in accordance with StUK 4. For this reason, and due to the high rate of sighting of cranes in area O-4 (up to 20% of the biogeographic population) site O-2.2 was placed under investigation in order to await the aforementioned investigation results. By contrast, there is no heightened risk of collision for the north-south migratory land birds, even cumulatively. The risk of bird strikes could therefore be more likely to occur in large songbird populations that migrate at night.

To prevent or minimise the risk, turbines must be designed so that light emissions are avoided as far as possible during construction and operation, unless they are unavoidable and required by safety requirements for ship and air traffic and occupational safety requirements.

Cumulative effects of the wind turbines planned in the Site Development Plan and in the coastal waters of Mecklenburg-Western Pomerania, the transformer and collector platforms and the adjacent wind farms could also result in a lengthening of the migration route for the migrating birds. If migratory birds fly within the range of influence of wind farms (up to a height of approx. 300 m), they are forced to fly around or over the turbines through evasive movements. They are thus diverted to a greater or lesser extent from their migration route. It is a known fact that wind farms are avoided by birds, i.e. they fly around or over them. This behaviour has been seen not only on land but also offshore (e.g. KAHLERT et al. 2004). Lateral avoidance reactions appear to be the most common reaction (HORCH & KELLER 2004). The transformer or Collector platforms are part of the individual wind farms or are directly spatially connected. In this context, the flying around of the transformer or collector platforms is negligible because they do not create their own barrier effect due their immediate proximity to a wind farm and nor do they reinforce the wind farm barrier effect.

For birds migrating in east-west direction, which would have to fly around the areas O-1 to O-4, a maximum detour of about 70 km would be conceivable. For birds that have a strong coastal orientation (e.g. common scoter), the detour could be extended because they must still fly around areas O-5 and O-6. Considering the north-south migration direction, the potential barrier effect is of a similar magnitude. The spatial distance between the individual clusters is so large that there is enough space for flying around obstacles. Taking into account the fact that the non-stop flying ranges of the majority of migratory bird species, including small bird species, are of the order of more than 1000 km (BERTHOLD 2000), a significant impact on the energy budget of the migratory birds can be excluded. Thus, a detour caused by the barrier effect of the wind farm area of no more than 70 km in relation to the migration distances should not endanger bird migration because weather-related deviations can also occur.

Consideration of existing knowledge on the migration patterns of the various bird species, the usual flight altitudes and the daytime distribution of bird migration suggests that potential extensive effects on bird migration caused by the implementation of the already approved projects in the priority areas are, according to the current state of knowledge and even allowing for cumulative effects, not likely. At present, no significant negative effect on the further development of the populations can be expected from possibly flying around the priority areas.

It must be borne in mind that, based on the current state of science and technology, this forecast is based on premises that are not yet suitable to adequately secure the basis for the factor. Insufficient knowledge exists particularly about species-specific migration patterns. This applies, in particular, to bad weather conditions (rain, fog). These gaps in the knowledge could not be filled despite extensive research activities carried out in the North and Baltic Sea EEZs as part of the ecological accompanying research, such as the test field research on bird migration at the "alpha ventus" offshore pilot farm, assessment of the data continuously collected on "FINO1" (2008-2011), detection of bird collisions using the VARS system and detection of evading movements of migratory birds using pencil beam radar.

Due to the mentioned knowledge gaps, a cumulative final consideration of all the offshore wind farms that are to be taken into account including projects in areas in which there are not yet any final approvals or planning approval decisions resulting from the implementation of an EIA, is not possible at this stage. This concerns the projects in area 2 and the projects in area 1 outside the priority area, as well as other offshore wind farms outside the German EEZ. Indeed, the environmental impact studies available for the projects in area 2 do not indicate any particular importance of these areas in respect of bird migration, for example a migration corridor of prominent importance in relation to the surroundings. However, investigations carried out for example within the framework of the basic investigations for the projects in area 2 have observed a temporary increase in crane migration sightings. Experts attributed this to a drifting of the birds due to unfavourable changing winds during crossing of the Baltic Sea. Based on these observations, especially against the background that it is assumed that there is a concentration of the bird migration, primarily for narrow-front migratory birds such as cranes in the sea area between Rügen and Scania (see FEDERAL AGENCY FOR NATURE CONSERVATION 2006), significant cumulative effects cannot currently be ruled out.

Transboundary impacts

This SEA comes to the conclusion that as things stand at present, the specifications in the Site Development Plan have no significant effects on the areas of neighbouring states bordering on the German EEZ in the Baltic Sea.

Substantial transboundary impacts can be excluded in principle for the factors Soil and water, Plankton, Benthos, Biotopes, Landscape, Material assets and Human beings, including human health. Possible substantial transboundary impacts could only arise if considered cumulatively in the area of the German Baltic Sea, for the highly mobile biological factors Fish, Marine mammals, Seabirds and resting birds, as well as Migratory birds and Bats.

The SEA comes to the conclusion that, according to the current state of knowledge, the implementation of the Site Development Plan is not expected to have any substantial transboundary impacts on the factor Fish, since on the one hand the areas for which the Site Development Plan defines rules have no prominent function for fish fauna, and on the other the discernible and predictable effects are small-scale and temporary in nature.

This also applies to the factors Marine mammals and Seabirds and resting birds. These use the areas predominantly as transit areas. There will be no significant habitat loss for strictly protected seabird and resting bird species. According to current knowledge and taking into account measures to minimise impact and limit damage, substantial transboundary impacts can also be ruled out. The installation of the foundations of wind turbines and converter platforms, for example, is only permitted in the specific approval procedure if effective noise mitigation measures are taken (see e. g. planning principle 4.4.1.7 Site Development Plan). Against the background of the particular endangerment of the separate Baltic Sea harbour porpoise population, intensive monitoring measures must be performed as part of the project and, if necessary, the noise reduction measures be adapted or the construction work coordinated in order to exclude any cumulative effects.

For migratory birds, the wind turbines and platforms erected in Site Development Plan sites may constitute a barrier or present a risk of collision. The risk of collision must be minimised by taking appropriate measures to prevent attraction by the lighting. As regards the barrier effect, a final cumulative consideration is not possible given the current state of knowledge.

Nor is a cumulative assessment of the hazard risk for bat migration possible at this time, as there is still insufficient information on migration routes, migration heights and migration intensities. It can generally be assumed that any significant transboundary impacts resulting from the Site Development Plan rules will be prevented by appropriate prevention or minimisation measures as they are to be applied for bird migration.

Assessment of wildlife conservation regulations

In addition, the environmental report contains a species conservation assessment pursuant to section 44 subsection 1 of the Federal Nature Conservation Act. At the more abstract level of technical planning, it concludes that, according to the current state of knowledge and in strict compliance with avoidance and reduction measures, the areas and sites, platform locations and submarine cable routes defined in the Site Development Plan will not have any significant negative effects that would violate species conservation law. A detailed assessment of wildlife conservation regulations is the responsibility of the individual approval procedure.

Assessment of the implications

Within the framework of this SEA, the areas, sites, platforms and submarine cable routes in the Site Development Plan will be subject to a separate assessment as to their implications for the conservation objectives of the nature conservation areas.

The German Baltic Sea EEZ includes the nature conservation areas "Pomeranian Bight – Rönnebank", "Fehmarn Belt" and "Kadetrinne", which were established by decree on 22.09.2017. The implications according to the Federal Nature Conservation Act are to be assessed in accordance with the assessment previously carried out for the Fauna-Flora-Habitat areas (FFH areas).

sections 34 and 36 of the Federal Nature Conservation Act stipulate that plans or projects which, individually or in conjunction with other plans or projects, may significantly affect an FFH and EU bird sanctuary and which do not directly serve the administration of the area must be assessed for their implications for the conservation objectives and protective aims of a Natura 2000 site. This is also applicable to projects outside the site which, individually or in combination with other projects or plans, are likely to significantly undermine the conservation objectives of the sites.

The factors are the habitat types "reefs" and "sandbanks" according to Annex I of the Habitats Directive, certain fish species and marine mammals according to Annex II of the Habitats Directive (sturgeon, twaite shad, harbour porpoise, grey seal), as well as various bird species according to Annex I of the Wild Birds Directive (red-throated diver, black-throated diver, Slavonian grebe, red-necked grebe, white-billed diver, long-tailed duck, common scoter, velvet scoter, common gull, guillemot, razorbill, black guillemot). Species listed in Annex IV of the Habitats Directive, e.g. the harbour porpoise, must be strictly protected everywhere, including outside the defined protected areas.

Within the framework of the Site Development Plan, individual rules are planned near the nature conservation areas "Pomeranian Bight – Rönnebank" and "Kadetrinne". Thus, the assessment of implications in the EEZ area is limited to these protected areas. In addition, the assessment of the implications also takes into account the remote effects of the rules defined within the EEZ on the protected areas in the adjacent 12 nautical mile zone and the adjacent waters of the neighbouring states.

Impact assessment of areas and sites and planned platforms

According to the current state of knowledge, a disturbance to resting and migratory birds in the nature conservation areas under consideration caused by the construction and operation of offshore wind turbines and platforms in the areas specified in the Site Development Plan is not expected.

According to the current state of knowledge and based on the findings from the monitoring of the construction and operation of the wind farms "Viking" and "Arkona Basin Southeast" in area O-1, and taking into account strict effect-minimising and damage-limiting measures, impairment of the conservation objectives of the assessed nature conservation areas can be safely excluded. To this end, the Site Development Plan defines textual rules, in particular with regard to noise mitigation.

It is to be expected that the construction and operation of wind turbines and platforms will have no significant impact due to the small-scale extent of especially reef-relevant effects such as sediment drift and sediment overlaying with the material released during the construction phase, and because of the location outside the nature conservation areas on the "reef" and "sandbank" habitat types with their characteristic and endangered communities and species.

Assessment of implications of the planned cable routes

Possible effects of submarine cable systems are usually limited to the laying phase and are therefore limited both temporally and spatially. Effects on the nature conservation areas in their component parts relevant to the conservation objectives or protective purpose are only to be expected if the cable routes run through or in the immediate vicinity of protected areas; according to the current state of knowledge, no remote effects on legally protected biotopes or FFH habitat types are assumed.

Considerable impairment of marine mammals can be ruled out, in particular because of the small size of the area and the short duration of the installation work. With regard to possible operational effects, no significant effects are to be expected on the basis of the cable configurations specified in the Site Development Plan and the planning principle for sediment cover. Possible significant adverse effects on bird sanctuaries in their constituent parts significant to the conservation objective from the installation and operation of submarine cable systems should also be excluded. Cable laying work only takes a few days and is only associated with noise and scare impacts typical for ships. Considerable impairments due to sediment drifting during the construction phase are excluded on the basis of current knowledge. Known occurrences of legally protected biotopes and FFH habitat types in the protected areas lie outside the drift distances discussed in the technical literature. The possibility of significant impairment of the FFH habitat types "reefs" and "sandbanks which are slightly covered by sea water all the time" can thus be excluded according to the current state of knowledge, even with cumulative assessment of the plan and already existing projects for the assessed nature conservation areas.

Based on the current state of knowledge, the Federal Maritime and Hydrographic Agency expects that a significant impairment of the protective purposes of the nature conservation areas under consideration caused by the execution of the plan, considered on its own or even in conjunction with other projects, can be safely ruled out. A re-assessment of the implications for the areas and testing grounds in the coastal waters is not taking place because this was already carried out with the establishment of the Mecklenburg-Western Pomerania regional spatial development programme.

Measures to prevent, mitigate and offset significant negative effects of the Site Development Plan on the marine environment

The measures planned in order to prevent, mitigate and – as far as possible – offset significant negative environmental effects resulting from the implementation of the Site Development Plan are presented in accordance with the requirements of the SEA Directive.

In principle, the provisions of the Site Development Plan prevent negative effects on the development of the state of the environment of the EEZ in the Baltic Sea. If the plan were not implemented, the uses would develop without the space-saving and resource-conserving steering and coordination effect of the Site Development Plan.

In specific terms, the Site Development Plan defines spatial and textual rules which, according to the environmental protection objectives set out in chapter 1.1 of the environmental report, serve to prevent or mitigate significant negative effects in the marine environment due to implementation of the Site Development Plan. This essentially concerns textual rules in respect of space-saving planning, preventing the use of protected areas and structures in accordance with section 30 of the Federal Nature Conservation Act, noise mitigation, compliance with the 2K criterion, dismantling of structures and consideration of best environmental practice and the relevant state of the art.

Mitigation and prevention measures are specified and ordered by the competent licensing authority at project level for the planning, construction and operation phases. With regard to the planned sites for wind turbines and platforms, this applies in particular to noise mitigation and noise prevention measures, as well as eco-friendly lighting during operation of the structures. Measures for prevention and mitigation of possible effects of submarine cable systems must be taken into account during the route planning and technical design stages. The Site Development Plan includes a planning principle relating to sediment warming so as to prevent considerable negative effects of cable warming on the benthos.

Examination of alternatives

According to Art. 5 subsection 1 sentence 1 of the SEA Directive in conjunction with the criteria in Annex I of the SEA Directive and section 40 subsection 2 no. 8 of the Environmental Impact Assessment Act, the environmental report contains a brief description of the reasons for choosing the reasonable alternatives assessed. Conceptual/strategic design, spatial and technical alternatives play a part at the planning level.

In principle, it should be noted that preliminary examination of possible and conceivable alternatives is already inherent in all rules in the form of standardised technical and planning principles. As can be seen from the justification of the individual planning principles, in particular those relating to the environment – such as, for example, routing that is as bundled as possible and implementation that is as free from crossings as possible – the principle in question is already based on consideration of possible public concerns and legal positions, so that a "preliminary assessment" of possible alternatives has already been carried out.

In detail, this environmental report examines spatial and technical alternatives in addition to the zero alternative.

Measures envisaged for monitoring the environmental impacts

The potential significant effects on the environment resulting from the implementation of the Site Development Plan are to be monitored in accordance with section 45 subsection 1 UVPG. The aim is to identify unforeseen adverse effects at an early stage and take appropriate remedial action. Monitoring also serves to review the gaps in knowledge presented in the environmental report and the forecasts which contain uncertainties. Pursuant to section 45 subsection 4 UVPG, the results of monitoring are to be taken into account in the update of the Site Development Plan. The actual monitoring of potential impacts on the marine environment can only start when the uses regulated under the plan are in place. Project-related monitoring of the impacts of offshore wind farms, platforms and submarine cable systems is therefore of particular importance. The primary aim of monitoring is to compile and evaluate the findings from the various monitoring results at the project level. Existing national and international monitoring programmes must also be taken into account, also with a view to preventing duplication of work.

The investigation of the potential environmental impacts of areas and sites for offshore wind energy or platforms must be carried out at project level in accordance with the standard "Investigation into the impacts of offshore wind turbines (StUK 4)" and in coordination with the Federal Maritime and Hydrographic Agency. Monitoring during construction of foundations by means of pile-driving work involves measuring underwater noise and acoustic recordings of the effects of pile-driving noise on marine mammals using POD measuring instruments. In addition, additional monitoring measures are planned to assess the effects of the stratification of the water under certain hydrographic conditions on the spread of noise from pile-driving in the Baltic Sea and, if necessary, to take further measures.

The Federal Maritime and Hydrographic Agency implements a whole range of projects as part of its accompanying research into the possible impacts of offshore wind turbines on the marine environment. These include the ANKER project "Approaches to cost reduction in the surveying of monitoring data for offshore wind farms", R&D study BeMo "Evaluation approaches for underwater noise monitoring in connection with offshore licensing procedures, spatial planning and the Marine Strategy Framework Directive" and various sub-projects within the R&D cooperation, NavES "Eco-friendly offshore developments". The results from the current projects of the Federal Maritime and Hydrographic Agency will be directly incorporated into the further development of standards and norms, such as the development of the StUK5.

The StUK4 for the first time also contains monitoring requirements for the investigation of submarine cable routes with regard to benthos, biotope structure and biotope types during the baseline survey and the operational phase. Identified suspected sites of biotopes that are protected in accordance with section 30 of the Federal Nature Conservation Act must also be examined in terms of spatial delimitation in accordance with the current mapping instructions from the Federal Agency for Nature Conservation. After the cable system has been laid, its position must be checked by means of operational monitoring measures. Investigations of the benthic communities on the same transects as in the baseline survey are to be carried out one year after commissioning of the submarine cable systems.

Consolidation of information creates an increasingly solid basis for impact forecasting. The research projects serve the continuous further development of a uniform, quality-assured basis of marine environmental information for the assessment of possible impacts of offshore installations and form an important basis for updating the Site Development Plan.

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