BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE

Environmental Report

for the Suitability Assessment of Site O-1.3*

Hamburg, December 2020

*This report has been translated into English by Proverb OHG, Stuttgart. In case of any differences between the the German and the English version the German version is binding.

Dieser Bericht ist durch die Fa. Proverb OHG, Stuttgart ins Englische übersetzt worden. Bei Abweichungen zwischen der deutschen und englischen Version des Berichts ist die deutsche Version maßgeblich.

Contents

List of figures

List of tables

List of abbreviations

TFEU	Treaty on the Functioning of the European Union
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas
EEZ	Exclusive Economic Zone
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
BGBl	Federal Law Gazette
BMU	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
BNatSchG	Act on Nature Conservation and Landscape Management (Federal Nature Conservation Act)
BNetzA	Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railways
BSH	Federal Maritime and Hydrographic Agency
CMS	Convention on the Conservation of Migratory Species of Wild Animals
EMSON	Recording of marine mammals and seabirds in the German EEZ in the North Sea and Baltic Sea
EnWG	Act on Electricity and Gas Supply (Energy Industry Act)
EUNIS	European Nature Information System
EUROBATS	Agreement on the Conservation of Populations of European Bats
R&D	Research and Development
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	Impact assessment pursuant to Art. 6(3) Habitats Directive and section 34 BNatSchG
FPN	North Sea Research Platform
OSI	Offshore Site Investigation
HELCOM	Helsinki Convention
IBA	Important Bird Area
ICES	International Council for the Exploration of the Sea
IfAÖ	Institute for Applied Ecosystem Research
IOW	Leibnitz Institute for Baltic Sea Research, Warnemünde
IUCN	International Union for Conservation of Nature and Natural Resources
K	Kelvin
LRT	Habitat type according to the Habitats Directive
MARPOL	International Convention for the Prevention of Pollution from Ships
MINOS	Marine warm-blooded animals in the North Sea and Baltic Sea: foundations for the assessment of offshore wind farms
MSP	Maritime Spatial Planning

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 (Marine Strategy Framework Directive)
NAO	North Atlantic Oscillation
NSG	Nature conservation area
MSL	Mean Sea Level
OSPAR	Oslo Paris Convention
OWF	Offshore Wind Farm
PAH	Polycyclic Aromatic Hydrocarbons
POD	Porpoise Click Detector
PSU	Practical Salinity Units
SCANS	Small Cetacean Abundance in the North Sea and Adjacent Waters
SeeAnlV	Ordinance on offshore installations seawards of the limits of German coastal waters (Offshore Installations Ordinance)
SEL	Sound Exposure Level
SPA	Special Protected Area
SPEC	Species of European Conservation Concern
StUK4	'Investigation of the Impacts of Offshore Wind Turbines on the Marine Environment' standard
StUKplus	Accompanying ecological research at the offshore test site 'alpha ventus'
SEA	Strategic Environmental Assessment
SEA Directive	Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the environmental impacts of certain plans and programmes on the environment
UBA	German Environment Agency
UVPG	Environmental Impact Assessment Act
EIA	Environmental Impact Assessment
EIS	Environmental Impact Study
EIR	Environmental Impact Review
Birds Directive	Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the Conservation of Wild Birds
WT	Wind turbine
WindSeeG	Act Concerning the Development and Promotion of Offshore Wind Energy (Offshore Wind Energy Act)

1 Introduction

1.1 Legal basis and tasks of environmental assessment

Pursuant to section 12(4) in combination with section 10(2) of the Act concerning the Development and Promotion of Offshore Wind Energy 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) (Offshore Wind Energy Act, WindSeeG), the BSH assesses the suitability of a site for the construction and operation of offshore wind turbines as a basis for the separate determination of suitability. Pursuant to section 12(5) WindSeeG, the result of the suitability examination/ suitability assessment and the capacity to be installed are approved by means of statutory ordinance if the suitability assessment shows that the site to be put out to tender is suitable pursuant to part 3 section 2. The suitability assessment is to include an environmental assessment within the meaning of the Environmental Impact Assessment Act in the version of the announcement of 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) (Environmental Impact Assessment Act – UVPG), the so-called Strategic Environmental Assessment (SEA).

The obligation to carry out a Strategic Environmental Assessment with the preparation of an environmental report arises from section 35(1)(1) UVPG in combination with no. 1.18 of Annex 5, according to which stipulations as to the suitability of a site and the installable capacity on the site in accordance with section 12(5) WindSeeG constitute plans or programmes within the meaning of the UVPG and are subject to the SEA obligation. Pursuant to section 33 UVPG, the Strategic Environmental Assessment (SEA) is a 'dependent part of official procedures for the preparation or amendment of plans and initiatives.' The official procedure for drawing up the plan, in this case for determining its suitability, is the suitability assessment, since a potential threat to the marine environment must be investigated within this framework.

The suitability and capacity determination itself is the 'plan' within the meaning of the UVPG, i.e. the formal act of confirmation based on the result of the suitability assessment.

In accordance with Article 1 of SEA Directive 2001/42/EC, the objective of the Strategic Environmental Assessment is to ensure a high level of environmental protection in order to promote sustainable development and to help ensure that environmental considerations are taken into account when drawing up and adopting plans well before concrete project planning. The Strategic Environmental Assessment is designed to identify, describe and assess the likely significant environmental impacts of the implementation of the plan. It serves to provide effective environmental protection in accordance with current laws and is implemented in accordance with uniform principles and with the participation of the public. All protected objects must be considered pursuant to section 2(1) UVPG:

- People, particularly human health,
- Fauna, flora and biodiversity,
- Ground, soil, water, air, climate and landscape,
- Cultural heritage and other material assets and
- the interrelationships between the above-mentioned protected objects.

The main document of the Strategic Environmental Assessment for site O-1.3 is this environmental report. This determines, describes and evaluates the likely significant environmental impacts of the plan at this site and considers potential planning alternatives, taking into account the essential purposes of the plan.

1.2 Summary of the content and main objectives of the determination of suitability and capacity

With the introduction of the central model, the funding system in the field of offshore wind energy was converted to a tender model. Calls for tenders for offshore wind energy cover sites in the German North Sea and Baltic Sea on which wind turbines are to be built. The Site Development Plan (FEP) upstream of this suitability determination defines areas and sites within these areas and determines the chronological order in which the sites are to be put out to tender by BNetzA. The definition of the sites is based on the current development targets of the Federal Government. The invitation to tender for a site by the Federal Network Agency requires that this concrete site is suitable for the construction of offshore wind turbines.

For this purpose, the suitability of the site and the respective capacity to be installed are determined by statutory ordinance according to section 12(5) WindSeeG. The suitability is determined if the previous suitability assessment shows that the site is essentially suitable for the construction of a wind farm.

The determination of suitability also serves as a means of planning level tiering to the later planning approval procedure. This site examination of the issues and criteria of the planning approval procedure, insofar as it is possible without knowledge of the concrete design of the project, is intended to avoid as far as possible a negative decision in the planning approval procedure since such a late rejection and therefore the loss of the site would endanger the primary objective of WindSeeG, which is to constantly increase the installed capacity of offshore wind turbines to meet the target in 2030.

This early assessment can be used to establish a tiering of issues relevant to approval and thereby accelerate subsequent planning approval procedures. This is primarily intended to simplify administration and will indirectly benefit the later project developer.

The main content of the statutory ordinance for determining suitability will be:

- determination of the suitability of the concrete sites at the time of the invitation to tender in accordance with part 3, section 2, WindSeeG, and
- definition of the respective capacity to be installed.

In accordance with section 10(2) WindSeeG, a site is suitable for the installation of wind turbines if

- the requirements of spatial planning are observed,
- there is no endangerment of the marine environment,
- in particular, no concern regarding pollution of the marine environment within the meaning of Art. 1(1)(4) United Nations Convention on the Law of the Sea (SRF) and
- there is no endangerment of bird migration,
- the safety and efficiency of shipping and air transport as well as
- the security of territorial and alliance defence is ensured,
- the sites are located outside conservation areas and clusters of the Spatial Offshore Grid Plan (BFO),
- there are no other overriding public or private interests,
- any construction is compatible with existing and planned cable and

offshore connections, pipelines and other lines and

- with existing and planned sites of transformer platforms or transformer stations, and
- other requirements pursuant to the Offshore Wind Energy Act and other provisions under public law are adhered to.

This Strategic Environmental Assessment is carried out with regard to the question of whether there is a threat to the marine environment.

The statutory ordinance for determining suitability can issue specifications for the later projects, if there is otherwise cause for concern that the construction and operation of offshore wind turbines on the site would cause impairments in relation to the criteria and issues mentioned. The proposed guidelines are summarised in the draft suitability determination for the marine environment in Chapter 0 (Planned measures to prevent, reduce and compensate for environmental impacts) and Chapter 11 (Planned measures to monitor impacts).

1.3 Staged planning procedure – relationship to other relevant plans, programmes and projects

1.3.1 Introduction

The suitability determination forms part of a staged planning process for offshore wind energy (Figure 1) which serves the purpose of tiering and begins with spatial planning as strategic spatial development for the entire Exclusive Economic Zone (EEZ). A Strategic Environmental Assessment must be carried out when drawing up the spatial development plan. This is followed by site development planning as a controlling planning tool which aims to plan the use of offshore wind energy by defining areas and sites as well as locations, routes and route corridors for network connections and for cross-border sea cable systems in a targeted and optimum manner under the given framework conditions. A Strategic Environmental Assessment (SEA) is carried out to support the preparation of the Site Development Plan (FEP).

This is followed by the suitability determination. This in turn provides the basis for the subsequent planning approval. If the suitability of a site is determined for the use of offshore wind energy, the site is put out to tender and the prevailing bidder may submit an application for approval (planning approval or plan authorisation) for the construction and operation of wind turbines on the site. An environmental impact assessment is carried out as part of the planning approval procedure if the conditions are met (Figure 1).

In the case of multi-stage planning and approval processes, it follows from the relevant legislation (such as the Spatial Planning Act ROG, WindSeeG and BBergG) or, more generally, from section 39(3) UVPG that, in the case of plans, the stages of the process at which certain environmental impacts are to be assessed should be determined at the time of defining the scope of the assessment. In this way, multiple assessments are to be avoided. The nature and extent of the environmental impacts, technical requirements, and the content and subject matter of the plan subject to decision must be taken into account.

For subsequent plans and subsequent project permits defined in the plan, environmental

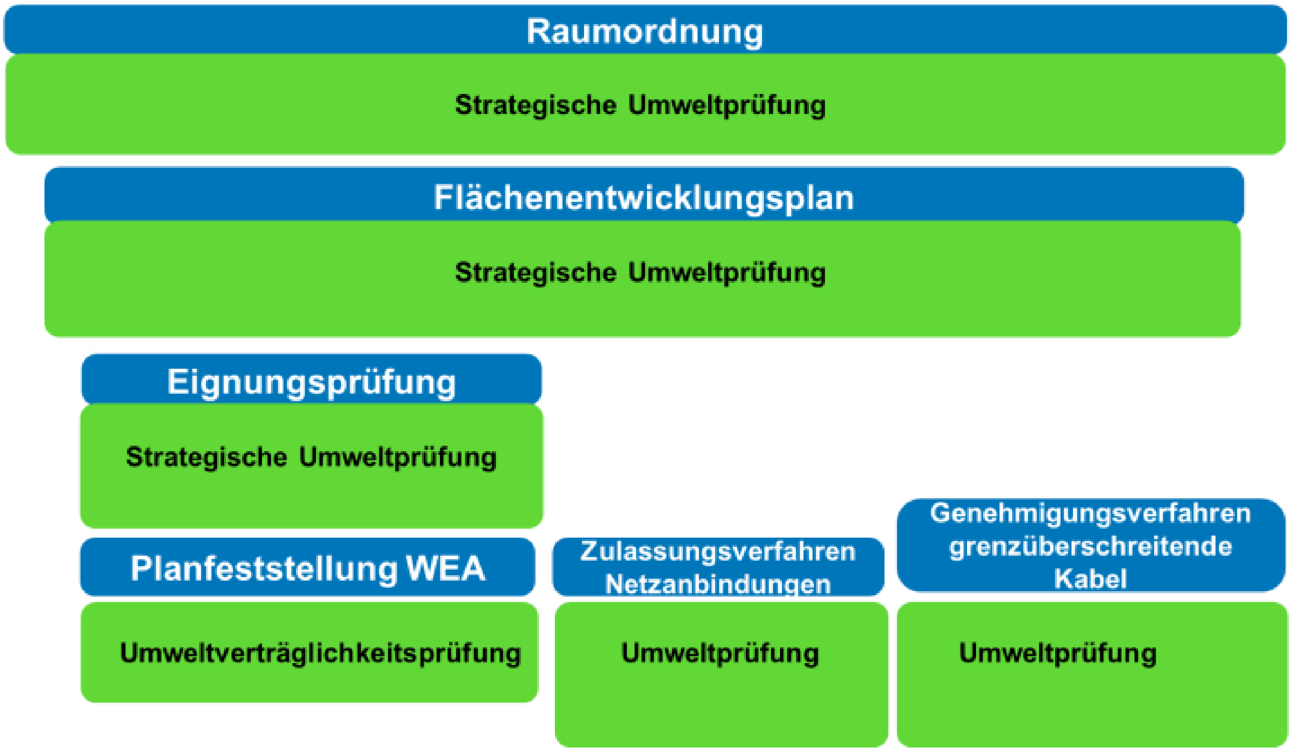

Figure 1: Overview of the environmental assessments to be carried out during each stage of the procedure

assessments pursuant to section 39 para. 3 Sentence 3 UVPG should then be limited to additional or deviating significant environmental impacts and to required updates and in-depth analyses.

Within the framework of the staged planning and approval process, all assessments have in common that environmental impacts on the protected objects listed in section 2(1) UVPG are considered, including their interactions (Figure 2).

According to the definition in section 2(2) UVPG, environmental impacts within the meaning of the UVPG are direct or indirect impacts of a project or the implementation of a plan or programme on the protected objects.

In accordance with section 3 UVPG, environmental impact assessments comprise the identification, description and assessment of the significant impacts of a project, a plan or a programme on the protected objects. They serve to ensure effective environmental precautions in accordance with the applicable laws and are carried out according to uniform principles and with public participation.

In the offshore sector, the following special protected objects have become established as sub-categories of the legally specified protected objects, namely animals, plants and biological diversity:

- Avifauna: seabirds, resting birds and migratory birds
- Benthos
- Plankton
- Marine mammals
- Fish
- Bats

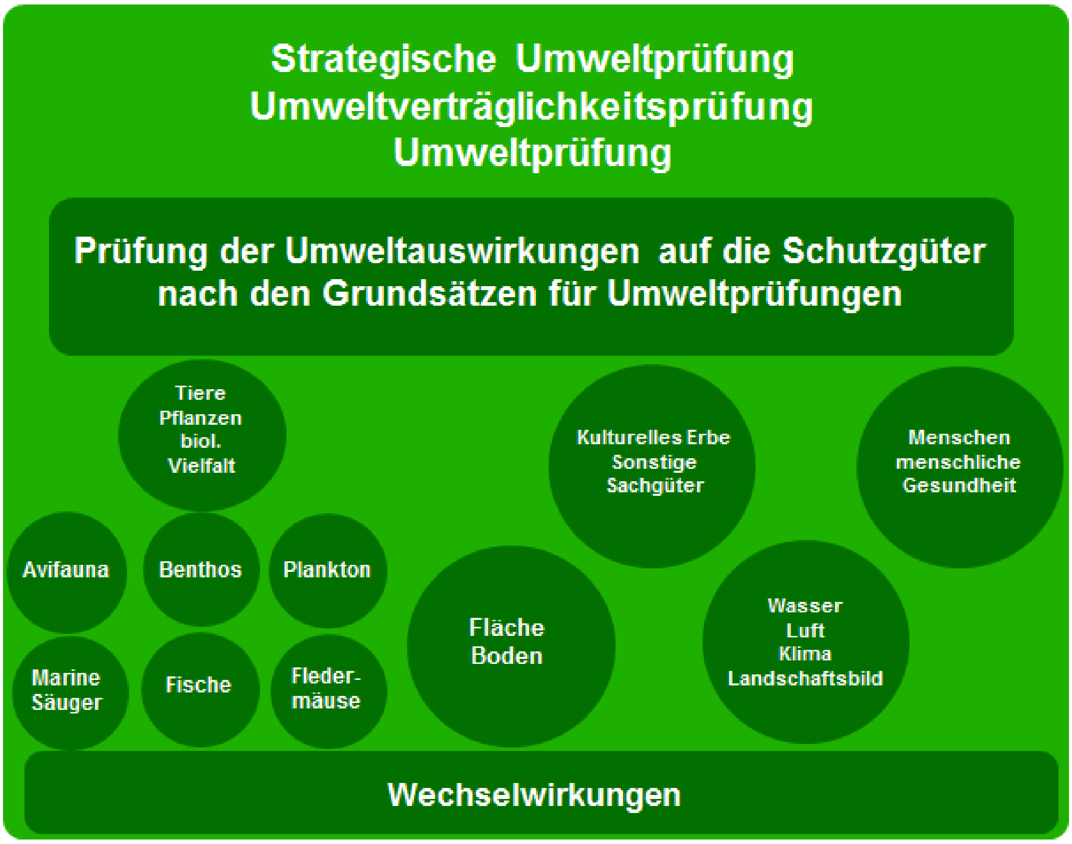

Figure 2: Overview of the protected objects in environmental assessments

The staged planning process is as follows:

1.3.2 Maritime Spatial Planning (EEZ)

The highest, overriding level is the instrument of Maritime Spatial Planning. For the purpose of sustainable spatial development in the EEZ, the BSH prepares spatial development plans on behalf of the responsible Federal Ministry, which come into force in the form of statutory ordinances. The ordinance issued by the (then) Federal Ministry of Transport, Building and Urban Affairs (BMVBS) on spatial planning in the German EEZ in the North Sea of 21 September 2009, Federal Law Gazette I p. 3107, came into force on 26 September 2009 and the ordinance for the area of the German EEZ in the Baltic Sea of 10 December 2009, Federal Law Gazette I p. 3861, came into force on 19 December 2009.

The spatial development plans are intended to issue specifications regarding the following matters, taking into account any interactions between land and sea and also taking safety aspects into consideration:

- Guarantee of the safety and efficiency of shipping,
- Other commercial uses,
- Scientific uses and
- Protection and improvement of the marine environment.

Spatial planning mainly involves determining priority and reservation areas as well as objectives and principles. In accordance with section 8(1) ROG (Spatial Planning Act), when drawing up spatial development plans, the body responsible for the spatial plan must carry out a Strategic Environmental Assessment in which the probable significant impacts of the respective spatial plan on the protected objects, including interactions, are to be identified, described and evaluated.

The aim of the instrument of spatial planning is to optimise overall planning solutions. A wider range of uses is considered. Fundamental strategic questions are to be clarified at the beginning of a planning process. As such, the instrument primarily functions as a steering planning instrument for the planning authorities in order to create a spatially and environmentally compatible framework for all uses.

In spatial planning, the depth of assessment of the SEA is generally characterised by a greater breadth of investigation, i.e. a fundamentally greater number of alternatives, and lesser depth of investigation in terms of detailed analyses. In particular, regional, national and global impacts are considered, along with secondary, cumulative and synergistic impacts.

As such the main of the focus of the Strategic Environmental Assessment is on potential cumulative impacts, strategic and large-scale alternatives and possible cross-border impacts.

1.3.3 Site Development Plan

The next level is the FEP.

The stipulations to be made by the FEP and to be examined within the framework of the SEA derive from section 5(1) WindSeeG. This plan mainly makes stipulations regarding areas and sites for wind turbines and the expected capacity to be installed at these sites. In addition, the FEP makes stipulations regarding routes, route corridors and locations. Planning principles and technical principles are also established. Although these serve, among other things, to reduce environmental impacts, they may in turn result in impacts themselves, so an evaluation is required as part of the SEA.

With regard to the aims of the FEP, it addresses fundamental questions of the use of offshore wind energy and grid connections based on statutory requirements, especially according to the need, purpose, technology and the identification of locations and routes or route corridors. The plan therefore primarily functions as a steering planning instrument to create a spatially and environmentally compatible framework for the implementation of individual projects, i.e. the construction and operation of offshore wind turbines, their grid connections, cross-border submarine cable systems and interconnections.

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 more limited depth of investigation. At the level of spatial offshore grid planning, detailed analyses are not yet carried out. In particular, local, national and global impacts are taken into account, as well as secondary, cumulative and synergistic impacts in order to provide a general overview.

As in the case of the instrument of maritime spatial planning, the assessment focuses on potential cumulative impacts as well as potential cross-border impacts. In addition, the FEP focuses on strategic, technical and spatial alternatives, especially for the use of wind energy and power lines.

1.3.4 Site examination including suitability assessment

The next step in the staged planning process is the suitability assessment of sites for offshore wind turbines. In addition, the capacity to be installed at the site in question is determined.

In the suitability determination, a review is undertaken as to whether, pursuant to section 10(2) WindSeeG, the construction and operation of offshore wind turbines at the site conflict with the criteria for the inadmissibility of defining a site in the Site Development Plan in accordance with section 5(3) WindSeeG or, insofar as this can be assessed independently of the later elaboration of the project, with the interests relevant to planning approval pursuant to section 48(4)(1) WindSeeG.

Both the criteria of section 5(3) WindSeeG and the interests under section 48(4)(1) WindSeeG require an examination of whether the marine environment is endangered. With regard to the latter, it is necessary in particular to verify that there is no cause for concern regarding pollution of the marine environment within the meaning of Article 1(1)(4) of the United Nations Convention on the Law of the Sea and that bird migration is not endangered.

As such, the suitability assessment is the instrument that is applied between the FEP and the planning approval procedure for offshore wind turbines. It refers to a specific site designated in the FEP and is therefore much smaller in scope than the FEP. It is distinguished from the planning approval procedure in that an investigatory approach is to be applied that is independent of the subsequent, specific installation type and layout. In this way, the impact forecast uses model parameters in 2 scenarios which are intended to present developments as realistically as possible (see table 3).

Compared to the FEP, the SEA of the suitability assessment is therefore characterised by a smaller area under analysis and a greater depth of examination. Essentially, fewer and more limited alternatives are given serious consideration. The two primary alternatives are firstly to determine the suitability of a site and secondly to determine its (possibly partial) unsuitability (see section 12(6) WindSeeG). However, restrictions on the type and extent of development that are included as specifications in the suitability determination are not alternatives in this sense (on this point, see Chapter 10).

The focus of the environmental assessment as part of the suitability assessment is to consider the local impacts of development with wind turbines in relation to the site and the location of the development at the site.

1.3.5 Approval procedure for offshore wind turbines

The next stage after the suitability assessment is the approval procedure for the construction and operation of offshore wind turbines. After the suitability of the site has been determined and the site has been put out to tender by the BNetzA, the winning bidder can, when the bid has been accepted by the BNetzA pursuant to section 46(1) WindSeeG, submit an application for planning approval or – if the prerequisites for planning approval are met – for the construction and operation of offshore wind turbines including the necessary ancillary installations at the previously examined site.

In addition to the statutory requirements under section 73(1)(2) VwVfG (Administrative Procedure Act), the plan must include the information contained in section 47(1) WindSeeG. The plan may only be approved subject to certain conditions listed in section 48(4) WindSeeG and only if, among other things, the marine environment is not endangered, in particular if there is no cause for concern regarding pollution of the marine environment within the meaning of Article 1(1)(4) of the Convention on the Law of the Sea and if bird migration is not endangered.

In accordance with section 24 UVPG, the competent authority prepares a summary of:

- the environmental impact of the project,
- the characteristics of the project and of the location, with the aim of preventing, reducing or compensating significant adverse environmental impacts,
- the measures to prevent, reduce or compensate significant adverse environmental impacts, and
- substitute measures in the event of interventions in the natural environment and landscape.

In accordance with section 16(1) UVPG, the project developer must submit a report to the competent authority on the anticipated environmental impacts of the project (EIA report), which must contain at least the following information:

- A description of the project, including information on the location, nature, scale and elaboration, size and other essential characteristics of the project,

- A description of the environment and its components within the project's sphere of influence,
- A description of the characteristics of the project and its location aimed at preventing, reducing or compensating the occurrence of significant adverse environmental impacts as a result of the project,
- A description of the measures planned to prevent, reduce or compensate any significant adverse impacts as a result of the project on the environment and a description of planned substitute measures,
- A description of the expected significant environmental impacts of the project,
- A description of the reasonable alternatives, relevant to the project and its specific characteristics, that have been considered by the developer and the main reasons for the choice made, taking into account the specific environmental impacts of the project, and
- A generally comprehensible, non-technical summary of the EIA report.

Pilot wind turbines are dealt with solely in the context of the environmental assessment as part of the approval procedure and not at earlier stages.

1.3.6 Summary overviews of environmental assessments

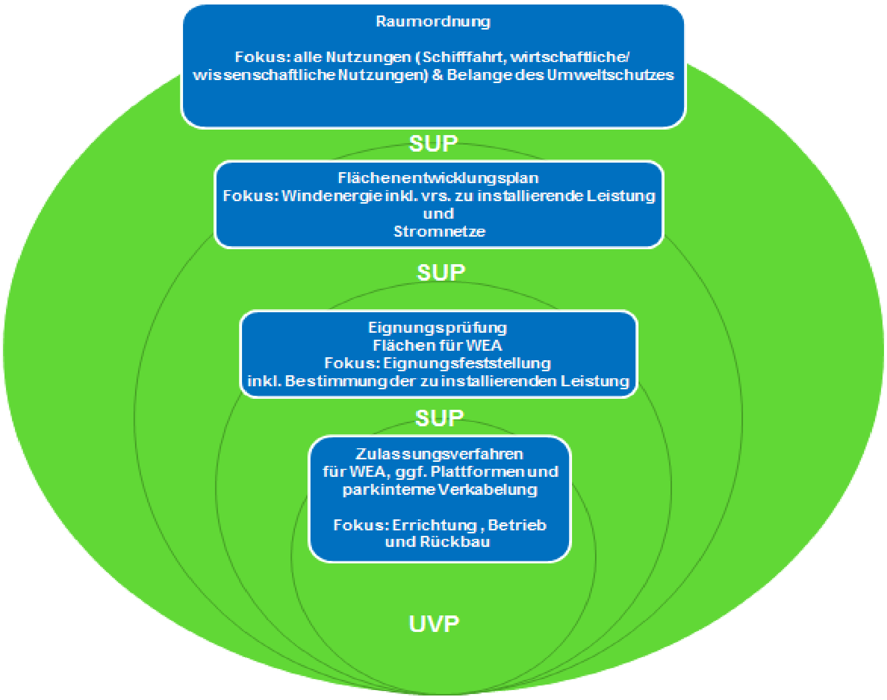

Figure 3: Subject of the planning and approval procedures focusing on environmental assessment

Figure 4: Subject of the planning and approval procedures focusing on environmental assessment

Table 1: Overview of key aspects of environmental assessments in the planning and approval procedures

Spatial planning (SEA)	**FEP (SEA)**	**Suitability assessment EA)**

Strategic planning for the stipulations	Strategic planning for the stipulations	Strategic Environmental Assessment for sites with WT
Determinations and subject of assessment		
– Priority and reservation areas • to guarantee of the safety and efficiency of shipping, • for further economic uses, especially offshore wind energy and pipelines • for scientific uses and • to protect and improve the marine environment – Objectives and principles – Application of the ecosystem approach	• Areas for offshore wind turbines • Sites for offshore wind turbines, including the anticipated capacity to be installed • Platform locations • Routes and route corridors for submarine cable systems • Technical and planning principles	• Assessment/determination of the suitability of the site for the construction and operation of wind turbines, including the capacity to be installed • on the basis of the assigned and collected data (STUK – standard investigation concept) as well as other information that can be determined with reasonable effort • Specifications in particular regarding the type, extent and location of the development
Environmental impact analysis		
Analyses (identifies, describes and assesses) the likely significant impacts of the plan on the marine environment.	Analyses (identifies, describes and assesses) the likely significant impacts of the plan on the marine environment.	Analyses (determines, describes and evaluates) the likely significant environmental impacts of the installation and operation of wind turbines, which can be assessed independently of the later elaboration of the project based on model assumptions.
Objective		
Aims to optimise overall planning solutions, i.e. comprehensive packages of measures. Considers a wider range of uses. Is applied at the beginning of the planning process to clarify fundamental strategic issues, i.e. at an early stage when there is greater scope for action.	Addresses the fundamental questions of: • Need and legal objectives in relation to the use of offshore wind energy • Purpose • Technology • Capacity • Identification of locations for platforms and routes. Seeks to establish bundles of measures without assessing the environmental impact of the planning in absolute terms.	Addresses the fundamental issues for the use of offshore wind energy in terms of: • capacity • suitability of the specific site Assesses the suitability of the site in particular with regard to: • type of development • extent of development • location of development within the site
Essentially serves as a steering planning instrument of the planning administrative bodies in order to create a spatially and environmentally compatible framework for all uses.	Serves mainly as a steering planning instrument to create a spatially and environmentally compatible framework for the realisation of individual projects (wind turbines and grid	Serves as an instrument between the FEP and the approval procedure for wind turbines at a specific site.

	connections, cross-border submarine cables)	
	Assessment depth	
Involves a wider range of investigations, i.e. a larger number of alternatives, and a more limited depth of investigation (no detailed analyses) Considers spatial, national and global impacts as well as secondary, cumulative and synergistic impacts in order to provide a general overview.	Involves a wider range of investigations, i.e. a larger number of alternatives, and a more limited depth of investigation (no detailed analyses) Considers spatial, national and global impacts as well as secondary, cumulative and synergistic impacts in order to provide a general overview.	Characterised by a small-scale area under analysis, greater depth of investigation (detailed analyses). Mainly considers local and national impacts and those affecting neighbouring countries, as well as additional/new secondary, cumulative and synergistic impacts where relevant.
	Focus of the assessment	
Cumulative impacts • Overall plan analysis • Strategic and large-scale alternatives • Potential cross-border impacts	**Cumulative impacts** • Overall plan analysis • Strategic, technical and spatial alternatives • Potential cross-border impacts	**Local impacts of a potential development** • Consideration of the specific site • Technical and small-scale alternatives

Approval procedure (planning approval or planning permission) for wind turbines (EIA)
Object of assessment
Environmental impact assessment on request for: • the construction and operation of wind turbines • at the site determined, pre-examined and assessed for suitability in the FEP • according to the determinations of the FEP and the requirements of the suitability determination
Assessment of environment impacts
Analyses (determines, describes and evaluates) the environmental impacts of the specific project (wind turbines, platforms and internal cabling of the wind farm, where applicable) In accordance with section 24 UVPG, the competent authority prepares a summary of: • the environmental impact of the project, • the characteristics of the project and of the location, with the aim of preventing, reducing or compensating significant adverse environmental impacts, • the measures to prevent, reduce or compensate significant adverse environmental impacts, and • the substitute measures in case of interventions in nature and landscape (note: exception in accordance with section 56(3) BNatSchG
Objective
Addresses questions of the concrete elaboration ('how') of a project (technical equipment, construction) at the request of the prevailing bidder/project developer
Assessment depth
Involves a wider range of investigations, i.e. a larger number of alternatives, and a more limited depth of investigation (no detailed analyses).

Assesses the environmental impact of the project at the previously examined site and formulates conditions for this. Considers mainly local impacts in the vicinity of the project.
Focus of the assessment
The main focus of the assessment is formed by: • construction-related and operation-related environmental impacts. • assessment relating to the concrete design of the installation. • dismantling of the installation.

1.4 Presentation and consideration of environmental protection objectives

The assessment and determination of suitability and of the capacity to be installed is to be carried out taking into account environmental protection objectives relevant to the plan. These provide information on the environmental status that is to be achieved in the future with regard to the relevant protected objects (environmental quality objectives). The objectives of environmental protection can be found in the following international, EU and national conventions or regulations, administrative provisions and strategies dealing with marine environmental protection, on the basis of which the Federal Republic of Germany has committed itself to certain principles and undertaken to achieve objectives.

1.4.1 International conventions concerning the protection of the marine environment

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

1.4.1.1 Globally applicable conventions that serve to protect the marine environment in whole or in part

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

Developed under the direction of the International Maritime Organization, the International Convention for the Prevention of Pollution from Ships of 1973 (announced by the Act on the International Convention for the Prevention of Pollution from Ships of 1973 and on the Protocol of 1978 to this convention dated 23 December 1981, Federal Law Gazette 1982 II p. 2) constitutes the legal basis for environmental protection in maritime shipping. It is aimed primarily at ship owners to prohibit operation-related discharges into the sea but also applies to offshore platforms pursuant to Art. 2(4) MARPOL. The objectives of the regulations of Annexes IV and V for avoiding and reducing the discharge of waste water and ship waste are particularly relevant to the determination of suitability. In the specifications for the prevention and reduction of material emissions, these objectives are implemented with regard to the admissibility of wastewater treatment systems and waste.

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

The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter of 29 December 1972 (notice concerning entry into force of the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, of 21 December 1977, Federal Law Gazette II 1977, p. 1492) covers the dumping of waste and other matter from ships, aircraft and offshore platforms While the 1972

London Convention only provides for bans on the dumping of certain substances (black list), the 1996 Protocol (notice concerning on 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) contains a general ban on dumping. Exceptions to this prohibition are only permitted for certain categories of waste, such as dredged material and inert, inorganic, geological materials. These regulations are implemented within the framework of the specifications.

- United Nations Convention on the Law of the Sea 1982

Art. 208 of the United Nations Convention on the Law of the Sea of 10 December 1982 (UNCLOS) must be taken into account in the construction of offshore installations for the extraction and production of energy. This requires coastal states to adopt and enforce legislation to prevent and reduce pollution caused by activities on the seabed or originating from artificial islands, installations and structures. Otherwise, the contracting states are generally obliged to protect the marine environment to the extent of their capabilities (cf. Art. 194(1) UNCLOS). Other countries and their environment must not be damaged by pollution. With regard to the use of technologies, it is stipulated that all necessary measures are to be taken to prevent and reduce resulting marine pollution (Art. 196 UNCLOS). The Strategic Environmental Assessment is used to identify, describe and assess the likely significant environmental impacts. The suitability of a site for the construction of a wind farm is examined with regard to the threat to the marine environment and conflicts of use. Measures to prevent and reduce impacts are elaborated and specifications established, including protection from pollution.

1.4.1.2 Regional conventions concerning the protection of the marine environment

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

Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention ratified by law on 9 April 1992, Federal Law Gazette volume II 1994 p. 1397) covers all anthropogenic sources of pollution. This requires the use of Best Environmental Practice and Best Available Technology (Section 3 para. 3 Helsinki Convention). The Convention not only regulates pollution but also obligates its member states to protect ecosystems and habitats. It specifies requirements to reduce emissions arising from the operation of wind farms, platforms and cables.

- UNECE Convention on Environmental Impact Assessment (EIA) in a Transboundary Context (Espoo Convention) and UNECE Protocol on Strategic Environmental Assessment (SEA Protocol)

The Convention of the United Nations Economic Commission for Europe (Convention of 25 2. 1991 on Environmental Impact Assessment in a Transboundary Context, implemented by the Espoo Convention Law of 7 6. 2002, Federal Law Gazette 2002 II, p. 1406 et seq. and the Second Espoo Convention Law of 17 3. 2006, Federal Law Gazette 2006 II, p. 224 f – UNECE) requires the contractual parties to carry out an EIA and notify affected parties of planned projects that may have significant adverse environmental impacts. The notification includes information on the planned project, including information on its cross-border environmental impact, and indicates the nature of the possible decision. The party in whose jurisdiction a project is planned ensures that EIA documentation is prepared as part of the EIA procedure and submits it to the affected party. The EIA documentation provides the basis for the consultations to be held with the affected party on matters such as the potential cross-border environmental impacts of the project and how to reduce and avoid them. The contractual parties ensure that the respective public in the country concerned is informed about the project and is given the opportunity to comment.

The SEA Protocol is a supplementary protocol to the Espoo Convention. The UNECE Protocol on Strategic Environmental Assessment – SEA Protocol – requires the contractual parties to take full account of environmental considerations in the preparation of plans and programmes.

The objectives of the Protocol include the integration of environmental (including health-related) aspects in the preparation of plans and programmes, the voluntary integration of environmental (including health-related) aspects in policies and legislation, the establishment of a clear framework for an SEA process and ensuring public participation in SEA processes. As part of the determination of suitability, neighbouring countries are informed and given the opportunity to comment.

1.4.1.3 Agreements specific to protected objects

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

The Convention on the Conservation of European Wildlife and Natural Habitats (see Act on 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) – Bern Convention) of 1979 governs the protection of species through restrictions on removal and use and the obligation to protect their habitats. Annex II also defines strictly protected species such as the harbour porpoise, divers, little gull and others. The contents are also included in the environmental impact assessment through law relating to species protection.

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

The 1979 Convention on the Conservation of Migratory Species of Wild Animals (see the Act on the Convention 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) obliges the contracting states to take measures to protect wild, cross-border migratory animal species and to ensure their sustainable use. The so-called range states in which the endangered species occur must conserve their habitats if they are important in order to protect the species from the threat of extinction (Art. 3(4 a) Bonn Convention). They are also required to eliminate, compensate for or minimise the adverse impacts of activities or obstacles which seriously impede the migration of the species (Art. 3(4 b) Bonn Convention) and prevent or reduce, as far as practicable, influences which threaten the species. The requirements are assessed according to species protection and territorial protection law and are presented in the environmental report.

Under the Bonn Convention, regional agreements for the conservation of the species listed in Annex II were concluded in accordance with Article 4(3) of the Bonn Convention.

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

The Agreement on the Conservation of African-Eurasian Migratory Waterbirds of 1995 (see 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) also covers bird species migrating over the North Sea. The aim is to maintain or restore migratory birds to a favourable conservation status on their migration routes. The environmental report examines the impact of the suitability determination on migratory bird movements in the EEZ.

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

The 1991 Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (see Act on the Agreement 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)) stipulates the protection of toothed whales with the exception of the sperm whale *Physeter macrocephalus* specifically for the region of the North and Baltic Seas. In particular, a conservation plan has been drawn up to reduce by-catch. The environmental report examines the impact of the determinations on mammals and, as a result of the suitability determination, noise reduction and prevention measures, coordination of pile driving, etc. may be required to protect small cetaceans.

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

The 1991 Agreement on the Conservation of Populations of European Bats (EUROBATS, see Act on the Agreement of 4 December 1991 on the Conservation of Bats in Europe, Federal Law Gazette II 1993 p. 1106) is intended to ensure the protection of all 53 European bat species based on appropriate measures. The agreement is open not just to European countries but to all range states that belong to the range of at least one European bat population. The main instruments of the agreement include rules on the removal of animals, the designation of important conservation areas and the promotion of research, monitoring and publicity. As a specially and strictly protected species according to section 7(2)(13) and (14) BNatSchG, bats are subject to assessment under species protection law and are also protected under territorial protection law, which is reflected in the impact assessment.

- Convention on Biological Diversity of 1993

The purpose of the Convention on Biological Diversity (see Act on the Convention of 5 June 1992 on Biological Diversity, of 30 August 1993, Federal Law Gazette II No. 72, p. 1741) is the conservation of biological diversity and the fair and equitable sharing of the benefits arising from the use of genetic resources. In addition, the sustainable use of natural resources, including for conservation for future generations, is enshrined as an objective. According to Art. 4b, the Convention also applies to procedures and activities outside of territorial waters in the EEZ. Biodiversity is a protected object as part of the Strategic Environmental Assessment, which is why significant environmental impacts are expected to be identified and assessed in relation to this protected object as well.

1.4.2 Environmental and nature protection requirements at EU level

The material scope of application of the TFEU (Treaty on the Functioning of the European Union, OJ EC No. C 115 of 9.5.2008, p. 47), and therefore in principle also that of secondary law, is extended to the extent that the Member States are subject to enhanced rights in an area outside their territory which they have transferred to the EU ((ECJ, Commission./.United Kingdom, 2005). In the field of marine environmental protection, nature conservation or water pollution control, EU law provisions therefore also apply in the EEZ.

The following relevant EU legislation must 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) and 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 (Strategic Environmental Assessment Directive, SEA 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 (OJ 1985 175 p. 40) (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; Directive 2011/92/EU of 28 November 2011, OJ 2011 26/11) was transposed into national law by the Act on Environmental Impact Assessment (UVPG). 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 (Strategic Environmental Assessment Directive, SEA Directive, OJ L 197, 21.07.2001) was also transposed into national law in the Act on Environmental Impact Assessment, which is why the objectives pursuant to UVPG are to be applied here as a matter of priority.

- Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (Habitats Directive, OJ L 206, 22.07.1992)

In designated Habitats Directive areas and for projects in their vicinity, the implementation of a Habitats Directive impact assessment pursuant to Art. 6(3) of the Habitats Directive is required as part of the approval procedures for projects if installations are to be constructed. If there are overriding reasons in the public interest, the construction may be justified even if it is incompatible. The Habitats Directive areas in the North Sea have now been designated as nature conservation areas according to national conservation area categories. The impact assessment is therefore geared towards the protection purposes of nature conservation areas. The Directive has been implemented in Germany through the Federal Nature Conservation Act (BNatSchG), in particular through the provisions that apply to the Natura 2000 areas and species protection legislation.

- 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 (Marine Strategy Framework Directive, MSFD)

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 (MSFD, OJ L 327, 22 December 2000) aims to achieve a good ecological status of surface waters. Monitoring, evaluation, target-setting and implementation of the measures are linked to this as steps. This also applies to transitional and territorial waters, but not to the EEZ. Accordingly, the provisions of the Marine Strategy Framework Directive are primarily relevant in the preparation of the environmental report.

- 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 (MSFD, OJ L 164, 25 June 2008) as the environmental pillar of an integrated European marine policy has the objective of 'achieving or maintaining a good environmental status in the marine environment by 2020 at the latest' (Art. 1(1) MSFD). Priority is given to the conservation of biodiversity and the maintenance or creation of diverse and dynamic oceans and seas that are clean, healthy and productive (see recital 3 on the MSFD). As a result, a balance is to be achieved between anthropogenic uses and the ecological equilibrium.

The environmental objectives of the MSFD were developed using an ecosystem approach to the management of human activities and in accordance with the precautionary principle and the 'polluter pays' principle:

- Seas without impairments caused by anthropogenic eutrophication
- Seas without pollution caused by pollutants
- Seas without impairments of marine species and habitats caused by the effects of human activities
- Seas with sustainably and ecologically used resources
- Seas without pollution caused by waste
- Seas without impairments caused by anthropogenic energy discharge
- Seas with natural hydromorphological characteristics (see Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) 2012).

The purpose of the environmental report is to systematically identify, describe and assess the impact of the regulations on the marine environment.

In particular, the impact on marine species and habitats is assessed and, with the aim of reducing environmental impacts, requirements are incorporated relating to waste treatment, resource use and pollutants.

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

Council Directive 2009/147/EC of 30 November 2009 on the conservation of wild birds (OJ L 20/7 of 26.01.2010) aims to conserve the populations of all bird species naturally occurring in the territories of the EU Member States, including migratory species, on a permanent basis and to regulate the management and use of birds in addition to their conservation. All European bird species within the meaning of Article 1 Directive 2009/147/EC are protected in accordance with section 7(2)(13) b) bb) BNatSchG. The requirements of the Directive are examined as part of the assessment under species protection law.

- Provisions on sustainable fisheries under the Common Fisheries Policy

The EU has exclusive competence in the field of fisheries policy (cf. Art. 3(1) (d) of the Treaty on the Functioning of the European Union). The rules include catch quotas based on maximum sustainable yield, management plans extending over several years, a landing obligation for by-catch and the funding of aquaculture facilities. The use of the EEZ for fishing is to be taken into consideration in the determination of suitability.

1.4.3 Environmental and nature protection requirements at national level

There are also various legal provisions at national level whose requirements must be taken into account in the environmental report.

- Water Resources Act (WHG)

The Water Resources Act of 31 July 2009 (Federal Law Gazette I p. 2585), as last amended by Article 1 of the Act of 18 July 2017 (Water Resources Act, WHG, Federal Law Gazette I p. 2771) transposes the MSFD into national law in sections 45a to 45l. Section 45a WHG implements the objective of ensuring a good marine water status by 2020. Deterioration of the status is to be prevented and human discharge is to be avoided or reduced. This is not linked to regulations regarding uses or permission requirements, however. Rather, sections 45a et seq. are to be interpreted as meaning that the state is commissioned to develop strategies for implementation, with section 45a WHG providing the benchmark of what environmental status is to be aimed for in future with regard to the relevant protected objects (environmental quality objectives). In turn, this standard is used in the interpretation of the technical statutory requirements. Section 45a et seq. WHG implements the requirements of the MSFD.

The purpose of the environmental report is to systematically identify, describe and assess the impact of the regulations on the marine environment.

- Act on Nature Conservation and Landscape Management (Federal Nature Conservation Act – BNatSchG)

The Act on Nature Conservation and Landscape Management (BNatSchG), last amended by Article 8 of the Act of 13 May 2019 (Federal Law Gazette I p. 706)) is also applicable in the EEZ pursuant to section 56(1) BNatSchG, with the exception of the landscape planning provisions. According to section 1 BNatSchG, the objectives of BNatSchG include safeguarding biological diversity, the efficiency and functionality of the ecosystem, and the diversity, uniqueness, beauty and recreational value of nature and the landscape. Sections 56 ff. BNatSchG contain provisions on marine nature conservation that require certain assessments; these are included in the environmental report. These concern the protection of legally protected biotopes in accordance with section 30 BNatSchG, the destruction or other significant impairment of which is prohibited. Furthermore, an impact assessment is to be carried out for plans in nature conservation areas or in the case of impacts on the protective purpose of nature conservation areas in accordance with section 34(2) BNatSchG. In terms of species protection law, section 44(1) BNatSchG prohibits the injury or killing of wild animals of specially protected species or the significant disturbance of wild animals of strictly protected species and of European bird species during reproduction, rearing, moulting, wintering and migration periods.

In order to assess the suitability of the site, an assessment is especially carried out to determine whether there is any risk to the marine environment. The Directive includes specifications to prevent an impairment of the marine environment.

- Environmental Impact Assessment Act (UVPG)

The Environmental Impact Assessment Act (UVPG) provides for a Strategic Environmental Assessment to be carried out for certain plans or programmes. Annex 5.1 of the UVPG includes the determination of suitability, so that pursuant to section 35(1)(1) UVPG there is a general obligation to carry out an SEA. Within this framework, the present environmental report is prepared in accordance with the requirements of the UVPG and national and cross-border public participation is implemented.

- Act Concerning the Development and Promotion of Offshore Wind Energy (Offshore Wind Energy Act)

The objective of the Act Concerning the Development and Promotion of Offshore Wind Energy (Offshore Wind Energy Act – WindSeeG) is to expand the use of offshore wind energy in the interest of climate and environmental protection pursuant to section 1(1) WindSeeG, whereby this is to be achieved, pursuant to para. 2, by means of the continuous and cost-efficient expansion of the installed capacity of offshore wind turbines from 2021 to a total of 15 gigawatts by 2030 (see also resolutions of the Climate Cabinet dated 20 September 2019 and of the Federal Cabinet dated 9 October 2019). Essential elements to ensure continuous expansion are the Site Development Plan, which identifies potential areas for the construction of wind turbines, and the suitability assessment undertaken prior to the planning approval procedure. However, this expansion to be promoted in the interests of climate and environmental protection is in turn to be carried out with due regard for environmental protection concerns: section 10(2) WindSeeG stipulates that in order to determine whether a site is suitable, it must be assessed whether the criteria for the inadmissibility of determinations in the FEP or the criteria relevant to subsequent planning approval do not conflict with this. In accordance with section 5(3) WindSeeG, determinations are not permitted if there are not permitted if there are overriding public or private interests that are in conflict with them. In the following list of impermissible determinations, the threat to the marine environment is listed as a ruling example (cf. section 5(3)(1)(2) WindSeeG). Furthermore, pursuant to section 48(4)(1) WindSeeG, a plan for the construction and operation of a wind farm may only be established if the marine environment is not endangered. Efficient expansion can only take place if the performance potential of an area is optimally exploited. At the same time, this expansion must not endanger the marine environment, which is why specifications are included to protect it. These two essential objectives of environmental protection from WindSeeG establish the guidelines for the preparation of the plan and planning considerations.

- Statutory ordinances for EEZ protected areas

Pursuant to section 57 BNatSchG, the existing nature conservation areas and Habitats Directive areas in the German EEZ were included in the national area categories and declared nature conservation areas by statutory ordinances of 22 September 2017. For example, the Ordinance on the Designation of the 'Bay of Pomerania – Rönnebank' Nature Conservation Area (Federal Law Gazettee I p. 3415, NSGPBRV), the Ordinance on the Designation of the 'Fehmarnbelt' Nature Conservation Area(Federal Law Gazette I p. 3405, NSGFmbV) and the Ordinance on the Designation of the 'Kadetrinne' Nature Conservation Area(Federal Law Gazette I p. 3410; NSGKdrV) have now established the nature conservation areas 'Bay of Pomerania – Rönnebank', 'Fehmarnbelt' and 'Kadetrinne'. This does not give rise to any differences in terms of spatial extension. In individual cases, some species, such as the skua (*Stercorarius skua*) and the pomarine skua (*Stercorarius pomarinus*), were put under protection for the first time.

The SEA assesses any impacts on the conservation areas or the impact of areas on which wind turbines are to be built for the conservation areas in order to verify whether these areas may be significantly affected in terms of the elements relevant to their protection. In the impact assessment pursuant to section 34(2) BNatSchG, the protective purposes of these ordinances must be taken into account. The specifications with regard to the dismantling of the installations, noise reduction, emission reduction, low-impact laying procedures, etc. also serve to avoid impairments of the conservation areas.

1.4.4 Energy and climate protection targets of the Federal Government

Offshore wind energy was already of particular importance according to the Federal Government's strategy for the expansion of offshore wind energy use of 2002. The aim was to increase the share of wind energy in power consumption to at least 25% within the next three decades. According to the resolutions of the Climate Cabinet of 20 September 2019 and the Federal Cabinet of 9 October 2019, the share

of power consumption from renewable energies is now to be increased to 65% by 2030. The target for the expansion of offshore wind energy is therefore to be raised to 20 gigawatts in 2030. The German government's climate policy objectives form the planning horizon for the determination of the plan.

1.5 Strategic Environmental Assessment methodology

1.5.1 Introduction

The Strategic Environmental Assessment is to identify the nature and extent of the environmental effects of the plan, taking into account the content and scope of the plan. The central document of the Strategic Environmental Assessment is the environmental report to be prepared in accordance with section 40 UVPG (Environmental Impact Assessment Act): 'The environmental report shall identify, describe and assess the likely significant environmental impacts and reasonable alternatives. [...] The environmental report is prepared in advance of the participation of the public and the authorities and is included in these procedural steps. The additional information arising in the course of the procedure is used in accordance with section 43 UVPG to update the information in the environmental report. Pursuant to section 40(3) EIA, the environmental report also presents a preliminary assessment of environmental impacts. As with the EIA, this is to be carried out in a precautionary manner in accordance with statutory requirements PETERS/BALLA/HESSELBARTH, UVPG commentary section 40, recital 1.)

In the present case, the environmental impacts of the suitability determination for site N-3.7 are examined. The environmental impact of the development of the area with an offshore wind turbine is assessed, including all the necessary facilities. The environmental impacts are assessed with a view to effective environmental precautions within the meaning of section 3 in connection with section 2(1) and (2) UVPG. Pursuant to section 10(2) in combination with sections 5(3) and 48(4)(1) WindSeeG, it must be ensured that the marine environment is not endangered by the plan.

1.5.2 Area under analysis

According to section 3(11) UVPG, the area under analysis is the geographical area in which environmental impacts relevant to the adoption of the plan are likely to occur. The definition depends, among other things, on the respective protected object and is partly limited to site O-1.3, but goes beyond its boundaries, e.g. when mobile species are considered.

1.5.3 Implementation of the environmental assessment

Pursuant to section 40(1) UVPG, the probable significant environmental impacts of the plan are to be identified and described and their significance is to be assessed.

The description and assessment of the state of the environment, taking into account the function and significance of the site for the individual protected objects, and the development of the state of the environment in the event of non-implementation of the plan form the reference state: this is the basis on which the changes brought about by the plan or programme can be assessed (see Chapter 4.12).

The environmental status is described and evaluated in relation to the protected objects (see Chapter 2). The description and assessment of the likely significant impacts of the implementation of the plan on the marine environment also refers to the protected objects described (cf. Chapter 4).

The following protected objects are considered:

- Ground
- Soil
- Water
- Biotope types
- Benthos
- Fish
- Marine mammals

- Avifauna
- Bats
- Biological diversity
- Air
- Climate
- Landscape
- Cultural heritage and other tangible assets
- Human beings, in particular human health

A forecast of the project-related impacts is made depending on the criteria of intensity, scope and duration of the effects (cf. Figure 5). All plan elements that might potentially have a significant environmental impact are assessed.

The effects of construction and dismantling are considered as well as those deriving from the installations themselves and their operation, as well as those caused by maintenance and repair work. The probable environmental impacts to be determined are both the direct and indirect impacts of implementing the plan (KMENT UVPG, section 40 recital 51.), including secondary, cumulative, synergistic, short-term, medium-term and long-term, permanent and temporary, positive and negative impacts. Secondary or indirect impacts are those that are not immediate and therefore may not occur for time and/or in other places (Wolfgang & Appold 2007; Schomerus et al. 2006).

This is followed by a presentation of potential interactions, a consideration of potential cumulative impacts and potential cross-border impacts.

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

- Qualitative descriptions and assessments
- Quantitative descriptions and assessments
- Evaluation of the results of the site investigation
- Evaluation of studies and technical literature
- Visualisations
- Worst-case assumptions
- Statistical evaluations, modelling and trend estimations (e.g. on the state of installations)
- Assessments by experts/the specialist community

Subsequently, pursuant to section 40(3) UVPG, the significance of the plan’s environmental impacts is provisionally assessed pursuant to section 3(2) UVPG with a view to effective environmental precautions in accordance with the applicable laws.

A uniform definition of the term 'materiality' does not exist, since it is an 'individually determined materiality' which cannot be considered independently of the 'specific characteristics of plans or programmes' (SUMMER 2005, 25 f.). The issue of materiality is closely linked to the issue of the subsequent influence on the decision regarding the acceptance of the plan or initiative pursuant to section 44 UVPG (comment in Hoppe/Beckmann/Kment, EIA – Environmental Impact Assessment Act – Environmental Appeals Act, Commentary, 5th edition, Section 40, recital 54) For the suitability assessment and the applicable section 10(2) in combination with sections 5(3), 48(4)(1) WindSeeG, the endangerment of the marine environment must be ruled out due to the determinations of the plan, or else materiality would apply if the marine environment were to be jeopardised. In general, significant impacts can be understood to be such effects as would be serious and significant in the context considered.

On the basis of the criteria set out in Annex 6 of the UVPG for the assessment during the site examination as to whether significant environmental impacts are likely to apply, the following characteristics are to be applied for the evaluation:

- The probability, duration, frequency and irreversibility of the impacts;
- Cumulation with other environmental impacts;
- The cross-border nature of the impacts;
- The risks to human health or the environment (e.g. in the event of accidents);
- The scale and spatial extent of the impacts;
- The importance and sensitivity of the area likely to be affected, due to its specific natural characteristics or cultural heritage, the exceeding of environmental quality standards or limit values and intensive land use;
- The impacts on areas or landscapes whose status is recognised as protected at national, Community or international level.

The characteristics of the plan are also relevant, in particular:

- the extent to which the plan sets a framework for projects and other activities in terms of location, type, size and operating conditions or through the use of resources;
- the extent to which the plan influences other plans and programmes, including those in a planning hierarchy;
- the importance of the plan for the incorporation of environmental considerations, in particular with a view to promoting sustainable development;
- the environmental issues relevant to the plan;
- the relevance of the plan to the implementation of Community environmental legislation (e.g. plans and programmes relating to waste management or water protection).

Specialist legislation specifies when an impact reaches the materiality threshold. Thresholds have also been drawn up at sub-statutory level in order to be able to draw distinctions

With regard to the consideration of the environmental objectives in the assessment of the likely significant environmental impacts resulting from the implementation of the plan, reference is made to Chapter 4.

.

Figure 5: General methodology for assessing likely significant environmental impacts.

1.5.4 Criteria for the description and assessment of the status

The assessment of the status of the individual protected objects in Chapter 2 is based on various criteria. For the protected objects of ground and soil, benthos and fish, the assessment is based on the aspects of rarity and vulnerability, diversity and peculiarity as well as existing cumulative effects. The description and assessment of marine mammals, seabirds, resting birds and migratory birds are based on aspects for the assessment of the status of the protected objects of ground/soil, benthos and fish. As these are highly mobile species, an approach analogous to that of these protected objects is not appropriate. For seabirds, resting birds and marine mammals, the criteria used are therefore protection status, assessment of occurrence, assessment of spatial units and existing cumulative effects. In addition to rarity, vulnerability and cumulative effect, the aspects of occurrence assessment and the area's significance for bird migration are also considered in relation to the protected object of migratory birds.

The following is a summary of the criteria that were used for the status assessment of the respective protected object. This overview deals with the protected objects that are the focus of the environmental assessment.

Water

Aspect: Naturalness
Criterion: Hydrographic conditions and water quality
Aspect: Existing cumulative effects
Criterion: Extent of existing cumulative anthropogenic effects on the water body

Surface/bed

Aspect: Rarity and vulnerability
Criterion: Area of sediments on the seabed and distribution of the inventory of morphological forms.
Aspect: Diversity and uniqueness
Criterion: Heterogeneity of the sediments on the seabed and formation of the morphological inventory of forms.
Aspect: Existing cumulative effects
Criterion: Extent of the existing cumulative anthropogenic effects of the sediments on the seabed and the morphological inventory of forms.

Benthos

Aspect: Rarity 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 the species communities. The assessment looks at the extent to which species or communities characteristic of the habitat occur and how regularly they occur.
Aspect: Existing cumulative effects
For this criterion, the intensity of fishing exploitation, which is the most effective disturbance variable, is taken as a benchmark. Eutrophication can also affect benthic communities. For other disturbance variables, such as shipping traffic, pollutants, etc., the appropriate measurement and detection methods are currently still lacking to be able to include them in the assessment.

Biotope types

Aspect: Rarity and vulnerability

Criterion: national conservation status and endangerment of biotope types according to the Red List of Endangered Biotope Types in Germany (FINCK et al. 2017).
Aspect: Existing cumulative effects
Criterion: Endangerment by anthropogenic influences.

Fish

Aspect: Rarity and vulnerability
Criterion: Proportion of species considered endangered according to the current Red List Marine Fish (Thiel et al. 2013) and for the diadromous species the Red List Freshwater Fish (Freyhof 2009) and 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'). Species composition can be used to assess the specific nature of a fish community, i.e. how regularly habitat-typical species occur. Diversity and specificity are compared and evaluated between the German EEZ in the North Sea and the individual site.
Aspect: Existing cumulative effects
Criterion: The existing cumulative effects of a fish community are defined by anthropogenic influences. Through the removal of target species and by-catches, and the impact on the seabed in the case of bottom fishing methods, fishing is considered the most effective disruption to the fish community and therefore serves as a measure of the existing cumulative effects of fish communities in the North Sea and Baltic Sea. There is no assessment of populations on smaller spatial scale, such as the German Bight. The discharge of nutrients into natural waters is another way in which human activities can affect fish communities, e.g. through algal blooms and oxygen depletion due to microbial degradation of organic matter. Eutrophication is therefore used to assess the existing cumulative effects.

Marine mammals

Aspect: Protection status
Criterion: Status under 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 occurrence
Criteria: Population, population changes/trends based on large-scale surveys, distribution patterns and density distributions
Aspect: Evaluation of spatial units
Criteria: Function and importance of the German EEZ and the concrete site as well as its immediate environment for marine mammals as a transit area, feeding or breeding ground.
Aspect: Existing cumulative effects
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 of BirdLife International
Aspect: Assessment of occurrence
Criteria: Distribution patterns, abundances, variability
Aspect: Evaluation of spatial units
Criteria: Function of the specific site and its surroundings for breeding birds, migrants, as resting areas, distances from conservation areas
Aspect: Existing cumulative effects
Criterion: Existing cumulative effects/threats due to anthropogenic influences and climate change.

Migratory birds

Aspect: The large-scale importance of bird migration
Criterion: Guidelines and areas of concentration
Aspect: Assessment of occurrence
Criterion: Migration activity and its intensity
Aspect: Rarity and vulnerability
Criterion: Number of species and endangered status of the species involved according to Annex I of the Birds Directive, AEWA (African-Eurasian Waterbird Agreement) and SPEC (Species of European Conservation Concern).
Aspect: Existing cumulative effects
Criterion: Existing cumulative effects/threats due to anthropogenic influences and climate change.

1.5.5 Specific assumptions for the assessment of likely significant environmental impacts

The description and assessment of the likely significant impacts of the implementation of the plan on the marine environment are carried out based on the status assessment described above.

1.5.5.1 Impact factors and potential impacts

The following table lists, based on the main effect factors, those potential environmental impacts which provide the basis for the assessment of the likely significant environmental impacts. The effects are differentiated according to whether they are due to construction/dismantling, operation or caused by the installation itself.

Table 2: Project-related impacts in the event of plan implementation

Protected object	Effect	Potential impact	Construc tion/dism	Installati	Operatio
Wind turbines					
Water	Resuspension of sediment	Habitat change	X		
	Changes in currents and swell	Habitat change		X	
	Material emissions	Habitat change			X
Soil	Insertion of hard substrate (foundations)	Habitat change		X	
	Permanent space usage	Habitat change		X	
	Scouring/sediment shift	Habitat change		X	
Benthos	Formation of turbidity plumes	Impairment of benthic species	X		
	Resuspension of sediment and sedimentation	Impairment or damage to benthic species or communities	X		
	Insertion of hard substrate	Habitat changes, habitat loss		X	
Fish	Sediment turbulence and turbidity plumes	Physiological effects and deterrence effects	X		
	Noise emissions during pile driving	Aversion	X		
	Space usage	Local habitat loss		X	

	Insertion of hard substrate	Lure effects, increase in species diversity, change in species composition		X	
Protected object	Effect	Potential impact	Construction/dismantli	Installation	Operation
Seabirds and resting birds	Visual disturbance due to construction work	Local deterrence and barrier effects	X		
	Obstacle in airspace	Deterrence effects ⇨ Habitat loss Collisions		X	
	Light emissions	Lure effects	X		X
Migratory birds	Obstacle in airspace	Collisions, barrier effect		X	
	Light emissions	Lure effects ⇨ Collisions	X		X
Marine mammals	Noise emission during pile driving	Hazard if no avoidance and reduction measures are taken	X		
Internal cabling					
Water	Resuspension of sediment	Habitat change	X		
Soil	Introduction of hard substrate (stone fill)	Habitat change		X	
Benthos	Heat emissions	Impairment/displacement of cold water-loving species			X
	Magnetic fields	Impairment of benthic species			X
	Turbidity plumes	Impairment of benthic species	X		
	Introduction of hard substrate (stone fills)	Habitat change, local habitat loss		X	
Fish	Turbidity plumes	Physiological effects and deterrence effects	X		
	Magnetic fields	Impairment of the orientation behaviour of individual migratory species			X

1.5.5.2 Cumulative analysis

In addition to the impacts on the individual protected objects, cumulative impacts and interactions between protected objects are also examined.

According to Art. 5(1) SEA Directive, the environmental report also includes an assessment of cumulative and secondary impacts. Cumulative impacts arise from the interaction between various independent individual effects, which either add up as a result of their interaction (cumulative impacts) or reinforce each other, thereby producing more than the sum of their individual effects (synergetic effects) (e.g. SCHOMERUS et al. 2006). Both cumulative impacts and synergistic effects can be caused by coincidence in time and space of the impacts of the same or different projects. Individual impacts are construction-related impacts, installation-related impacts and operational impacts, whereby the impacts of the construction phase are mainly short-term and temporary in nature, while installation-related and operational impacts can be permanent.

- WindSeeG, Part 2, Section 1: section 5(3)(2) WindSeeG:

'Determinations in accordance with paragraph 1, points 1 and 2 and 6 to 11 shall not be permitted if there are overriding public or private interests to the contrary. Such approvals are especially not permissible if … 2. they endanger the marine environment […]

- WindSeeG, Part 4, Section 1: section 48(4)(1) WindSeeG:

'The plan may only be adopted if there is no risk to the marine environment'

- UVPG: section 2(2) UVPG:

'Environmental impacts within the meaning of this Act are direct and indirect impacts of a project or the implementation of a plan or programme on the protected objects and, under section 3 UVPG, environmental assessments [...] serve to ensure effective environmental precautions in accordance with the applicable laws, [...]'

- BNatSchG and ordinances for the designation of nature conservation areas in the German EEZ, including section 34, paragraph 1 BNatSchG (impact assessment):

'Projects must be assessed for their compatibility with the conservation objectives of a Natura 2000 area before they are authorised or carried out if, either individually or in combination with other projects or plans, they are likely to significantly impair the area and do not directly serve the administration of the area.'

- Section 44(1)(2) BNatSchG: (prohibition of disturbance)

'[...] a significant disturbance exists when the disturbance causes the conservation status of the local population of a species to deteriorate.'

In some cases, concrete concepts such as the position paper on the cumulative assessment of diver habitat loss in the German North Sea (BMU 2009) and the BMUB noise control concept (2013) can be used for the cumulative assessment.

The cumulative impacts are assessed in relation to the protected object in Chapter 4.13.

In some cases, concrete concepts such as the position paper on the cumulative assessment of diver habitat loss in the German North Sea (BMU 2009) and the BMUB noise control concept (2013) can be used for the cumulative assessment.

The cumulative impacts are assessed in relation to the protected object in Chapter 4.13.

1.5.5.3 Reciprocal effects

In general, impacts on a protected object lead to various consequences and interactions between the protected objects. The essential interdependence of the biotic protected objects is based on food chains. Due to the variability of the habitat and the complexity of the food web and material cycles, interactions can only be described very imprecisely overall.

Details of the interactions can be found in Chapter 4.12.

1.5.5.4 Assumptions regarding wind turbines, including the capacity to be installed:

In accordance with section 12(5) WindSeeG, the capacity of offshore wind turbines to be installed is to be specified for the site. The suitability assessment describes how the capacity to be installed per site is determined and specified. Essentially, verification is carried out as to whether the expected capacity to be installed, which was determined in the context of the establishment of the FEP, will have to be adapted. For the FEP calculations, the sites within the areas are allocated to two categories based on criteria such as site geometry, wind speed, state of the art of offshore wind turbines and grid connection capacity within the framework of the statutory requirements. Based on these parameters and assumptions, the power density to be applied is determined in megawatts/km^2 per site. See the information provided in the context of the suitability assessment for details. For the consideration in this SEA with regard to protected objects, the model parameters already used for the environmental assessments for the FEP are assumed, including wind turbines that may be available in the future. In order to illustrate the range of possible developments, the assessment is essentially based on two scenarios. The first scenario assumes a large number of small turbines, while the second scenario assumes a small number of large turbines. Due to the range covered by this, this enables the most comprehensive description and assessment possible of the current state of planning with regard to the protected object.

The Strategic Environmental Assessment takes particular account of the following:

- Turbines already in operation (as reference and existing cumulative effects)
- Forecast of certain technical developments.

The following tables provide an overview of the parameters used. It should be noted here that these are only estimation-based assumptions, since project-specific parameters are not known at SEA level for the suitability assessment.

With regard to hub height information, it should be noted that objective 3.5.1 (7) of the Baltic Sea Spatial Development Plan specifies a height limit of 125 m for wind turbines within sight of the coast and islands. Accordingly, this requirement was applied in scenario 1.

Since sections 19, 6 ROG essentially provide for the possibility of a target deviation procedure to deviate from MRO targets, and since the height limitation is not relevant in the case of non-visible installations, a hub height of 175 m was taken as a basis for scenario 2.

1.5.5.5 Assumptions regarding other development

Further model assumptions are made regarding other developments, as summarised in table 4.

Table3: Model parameters for consideration of site O-1.3.

	Scenario 1	Scenario 2
Output per turbine [MW]	9	15
Hub height [m]	approx. 125	approx. 175
Height of lower rotor tip [m]	approx. 26	approx. 50
Rotor diameter [m]	approx. 200	approx. 250
Coated area of the rotor [m^2]	approx. 30,800	approx. 49,100
Total height [m]	approx. 225	approx. 300
Diameter of foundation [m]*	approx. 8.5	approx. 12
Area of foundation excl. scour protection [m^2]	approx. 57	approx. 113
Diameter of scour protection [m]	approx. 43	approx. 60
Area of foundation incl. scour protection [m^2]	approx. 1,420	approx. 2,830

* The calculation of space usage is based on the assumption of a monopile foundation. However, it is assumed that the monopile and jacket together have about the same total space usage on the seabed.

Table 4: Parameters for the consideration of other development at site O-1.3

Length of internal cabling (= 0.12 km/MW*) [m^2]	36
Voltage level of internal cabling	33kV
Number of wind turbines – scenario 1	34
Number of wind turbines – scenario 2	20
Number of transformer platforms	0
Number of residential platforms	0
Area sealing foundation incl. scour protection [m2] – scenario 1	48280
Area sealing foundation incl. scour protection [m^2] – scenario 2	56600
Area sealing of the transformer station incl. scour protection [m^2]	0

* The calculation of the length of the internal cabling is carried out in correlation with the capacity to be installed at the respective site. The applied value of 0.12 km/MW was determined by calculating the approximate average value of already erected wind farms and existing plans.

** The calculation of space usage is based on the assumption of a monopile foundation. It is assumed that the monopile and jacket together have about the same total space usage on the seabed.

1.5.6 Basis for the assessment of alternatives

In accordance with Art. 5(1)(1) of the SEA Directive in combination with the criteria in Annex I of the SEA Directive and section 40(2)(8) UVPG, the environmental report contains a brief description of the reasons for the choice of the reasonable alternatives examined.

The assessment of alternatives does not explicitly require the development and assessment of particularly environment-friendly alternatives. Rather, the 'reasonable' alternatives in the above sense are to be presented in a comparative manner with regard to their environmental impacts so the consideration of environmental concerns is clarified when deciding on the alternative to be pursued further (BALLA ET AL. 2009). At the same time, the effort required to identify and assess the alternatives under consideration must be reasonable. Here, the following applies: the greater the anticipated environmental impacts and therefore the need for planning conflict management, the more extensive or detailed investigations are required.

Within the framework of the upstream SEA on FEP 2019 (BSH 2019a), alternatives are already being examined. At this planning level these are mainly the conceptual/strategic design, the spatial location and technical alternatives.

As part of the suitability assessment, therefore, only alternatives that relate specifically to the site under review according to the FEP determinations, in this case O-1.3, are to be considered in the sense of the tiering between the planning instruments. In particular, these can be process alternatives, i.e. the (technical) design of the installations in detail (BALLA et al. 2009). At the same time, the exact design of the installations to be erected on the site is not yet known at the time of the suitability assessment. Within the framework of the SEA for the suitability assessment, therefore, only those alternatives that relate to the respective site and can already be carried out without detailed knowledge of the concrete construction project are to be examined.

1.5.7 Data basis and indications of difficulties in compiling the documents

The basis for the SEA is a description and assessment of the environmental status in the site under analysis. All protected objects must be included. The data basis provides the basis for the assessment of the likely significant environmental impacts, the assessment under territorial and species protection law and the assessment of alternatives.

Pursuant to section 39(2)(2) UVPG, the environmental report contains the information that can be determined with reasonable effort, taking into account the current state of knowledge and statements made by the public known to the authority, generally accepted assessment methods, the content and level of detail of the plan and its position in the decision-making process.

In accordance with section 40(4) UVPG, 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.

The present environmental report is based on the environmental analyses carried out in the context of preparing and updating the Spatial Offshore Grid Plans for the EEZ of the North and Baltic Seas. The present environmental report is considered to be an updated comprehensive document.

On the one hand, the present environmental report describes and evaluates the current status of the environment and presents the anticipated development if the plan is not implemented. On the other hand, it predicts and evaluates the foreseeable significant environmental impacts which would result from implementing the plan. Potential impacts are estimated based on a detailed description and assessment of the environmental status (Chapter 2).

The current status of the environment and the anticipated development if the plan is not implemented (Chapter 3), was described and evaluated in relation to the following protected objects:

- Ground/soil
- Water
- Plankton
- Biotope types
- Benthos
- Fish
- Marine mammals
- Avifauna
- Bats
- Biological diversity
- Air
- Climate
- Landscape
- Cultural heritage and other tangible assets
- Human beings in particular human health
- Reciprocal effects between protected objects

1.6 Data basis and indications of difficulties in compiling the documents

The basis for the SEA is a description and assessment of the environmental status in the site under analysis. All protected objects must be included. The data basis provides the basis for the assessment of the likely significant environmental impacts, the assessment under territorial and species protection law and the assessment of alternatives.

Pursuant to section 39(2)(2) UVPG, the environmental report contains the information that can be determined with reasonable effort, taking into account the current state of knowledge and statements made by the public known to the authority, generally accepted assessment methods, the content and level of detail of the plan and its position in the decision-making process.

This environmental report is based on the environmental assessment carried out in the context of the FEP for the EEZ in the North Sea.

In accordance with the requirements of section 10(2)(2) WindSeeG, the essential basis of this SEA are the investigation results and documents from the site investigation and the data acquired in this context.

In accordance with section 40(4) UVPG, 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.

On this basis, relevant data from the planning approval and enforcement proceedings conducted by the BSH are used as a supplement. The data and knowledge status has improved significantly in recent years, in particular as a result of extensive data collection in the context of environmental impact studies and the construction and operational monitoring of the offshore wind farm projects and the accompanying ecological research.

In summary, the following data bases were used for the environmental report:

- Data from the site investigation
- Data from the operational monitoring of existing offshore wind farms

- Data from approval procedures for offshore wind farms
- Scientific studies
- Insights and results from research projects and accompanying ecological research
- Results from projects
- Comments made by specialist authorities
- Comments from the public (especially experts)
- Literature

Since the data basis may vary depending on the protected object, the data basis in each case is discussed at the beginning of Chapter 2.

In accordance with section 40(2)(7) UVPG, indications of difficulties encountered in compiling the information, such as technical gaps or lack of knowledge, must be presented. The description and evaluation of the individual protected objects (Chapter 2) show that there are still gaps in knowledge in some areas. Information gaps exist in particular with regard to the following points:

- Long-term effects of the operation of offshore wind farms and associated installations, such as transformer platforms
- Data for assessing the environmental status of the various protected areas in the outer EEZ.

In principle, forecasts on the development of the marine environment at the time of implementation of the plan remain subject to certain uncertainties. There is often a lack of long-term data series or analytical methods, e.g. for combining extensive information on biotic and abiotic factors, in order to better understand complex interrelationships of the marine ecosystem.

In particular, there is a lack of detailed area-wide sediment and biotope mapping outside the nature conservation areas of the EEZ. As a result, there is no scientific basis for assessing the effects of the possible use of strictly protected biotope structures.

In addition, for some protected objects there is a lack of scientific assessment criteria, both with regard to the assessment of their status and with regard to the impacts of anthropogenic activities on the development of the living marine environment, in order to fundamentally consider cumulative impacts over time and space.

This is dealt with separately for each protected object in Chapter 2.

2 Description and assessment of the state of the environment

2.1 Introduction

In accordance with section 40(2)(3) UVPG, the environmental report contains a description of the characteristics of the environment and the current state of the environment in the site under analysis in the SEA. The description of the current state of the environment is necessary to be able to forecast its change when the plan is implemented. The survey examines the protected objects listed in section 2(1)(2)(1) to (4) UVPG and the interactions between them. The presentation is problem-oriented. Priority is therefore given to possible existing cumulative effects, to environmental elements that are particularly worthy of protection and to those protected objects on which the implementation of the plan will have a greater impact. In spatial terms, the description of the environment is based on the respective environmental impacts of the plan. Depending on the type of impact and the protected object concerned, these are of differing extent and may extend beyond the boundaries of the plan (Landmann/Rohmer section 40, marginal notes). Reference is made to the comments in Chapter 1.5.2. The following description and assessment of the state of the environment also characterise and evaluate the existing status and present the existing cumulative effects based on the above-mentioned information within the meaning of section 10(1)(1) UVPG.

2.2 Soil/ground

The soil as a protected object is the upper layer of the seabed, which consists of stones, gravel, sand and silt. This layer includes both the solids and the pore water. Soil also includes the extent of its surface area, which is now explicitly described as the protected object of 'ground', thereby focusing on its use.

Furthermore, the protected objects of area and soil are considered together. Where sensible or necessary, the ground as a protected object is discussed in more detail.

2.2.1 Data situation

The basis for the description of the surface sediments of site O-1.3 are the site investigations carried out in this site. The description and assessment of the environmental impacts with regard to the soil as a protected object are based primarily on the data currently available from the hydrographic surveys carried out in 2019 (VBW Weigt GmbH, 2020a), as well as on the report on object mapping (VBW Weigt GmbH, 2020b), insofar as they were already available at the time this report was prepared.

The sediment distribution map for the western Baltic Sea is another data basis (BSH/IOW, 2012).

The descriptions of the structure of the near-surface subsoil are essentially based on the data of the geophysical and geotechnical data and reports of the offshore site investigation.

The data and information used to describe the distribution of pollutants in the sediment, suspended solids and turbidity as well as the distribution of nutrients and pollutants are collected during the annual monitoring trips carried out by the BSH.

2.2.2 Status description

2.2.2.1 Geomorphology

The site O-1.3 is located in the eastern section of the Arkona Basin, north-west of Adlergrund. It has a balanced morphology. Water depth is between 40 m in the south of the site and 45.5 m in the north (depth stated in relation to NHN). Figure 6 shows the bathymetry of site O-1.3.

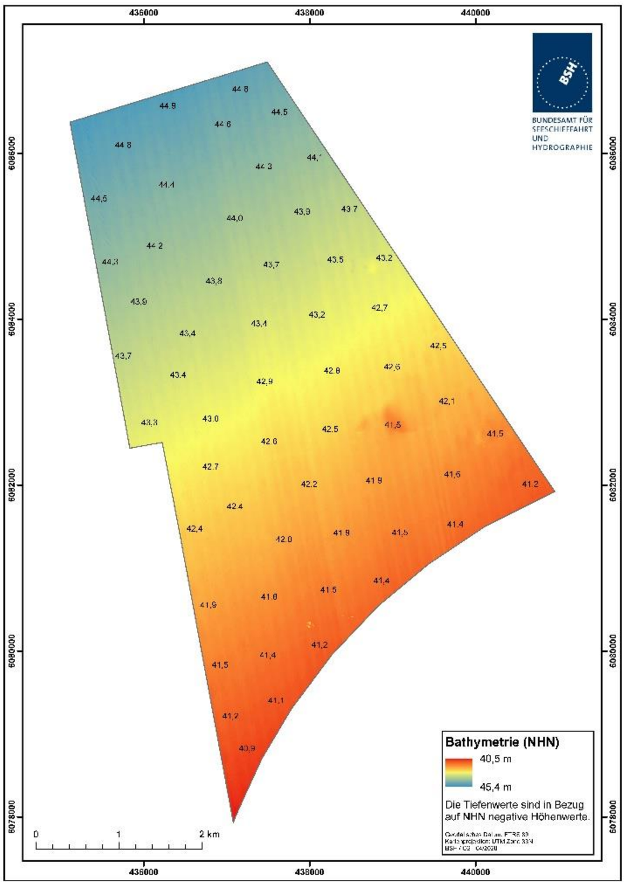

Figure 6: Bathymetry of site O-1.3 related to NHN

Numerous signs of fishing were observed throughout the site under investigation.

2.2.2.2 Sediment distribution on the seabed

The surface sediment distribution in the western Baltic sea (BSH/IOW, 2012) almost exclusively shows silt of different sorting for the area of the Arkona Basin. This was already described in the environmental report for the FEP 2019 (BSH, 2019).

As part of the site investigation, full-coverage surveys with side-scan sonar were carried out in 2019 at site O-1.3 and soil samples were taken. The sediment samples were classified in accordance with DIN 18123 and Folk 1954/1974. The particle size was determined based on the particle size distribution of the soil samples for site O-1.3 and predominantly consist of clayey silt (mud) with varying proportions of sandy sediment. Areas with sands and pebbles are encountered in the south-eastern and eastern parts of site O-1.3.

In the eastern area, the backscatter mosaic shows four extensive changes in intensities indicating coverage that deviates from the general ground cover (mud). Two of these areas consist of sand with a proportion of mud. One site consists of sand with a pebble content and one of pebbly sand.

Figure 1Figure 7 shows sediment mapping in accordance with the guidelines for mapping the sea floor (BSH).

Figure 7: Sediment classification according to the BSH Guidelines for Seabed Mapping

In addition to this sediment composition, 12 objects were verified in the area of site O-1.3. These were investigated in more detail. Eleven of these objects were rocks with an edge length of max. 1.5 m. One object was identified as an anthropogenic object. Based on the available data, further evaluations going beyond the specifications of the BfN reef mapping guide were carried out for area O-1.3, the results of which reveal further prominent objects (VBW Weigt GmbH 2020b, Objektkartierung).

165 objects with an edge length of 2 metres were identified. The occurrence of the type "Baltic Sea boulder field" as defined in the BfN reef animal guide can still be ruled out due to the distances between the objects. With regard to the possible presence of potential marine boulders, 165 objects were identified that meet the criteria of a marine boulders. Further video surveys are required to conclusively assess whether the other objects can also be confirmed as geogenic reefs or as anthropogenic objects and to exclude the reef type "marine erratic block" according to the BfN mapping instructions. The occurrence of marine erratic blocks as defined in the BfN reef mapping instructions can therefore not be ruled out (see also Chapter 2.4).

2.2.2.3 Geological structure of the near-surface subsoil

The description of the sea floor surface and the near-surface subsoil for the site O-1 is based on the sediment distribution map for the western Baltic Sea (BSH/IOW, 2012).

In the transitional zone to the Adlergrund (site O-1), there is a layer of fine to medium-grained clayey silt sand several metres in depth and of varying depth near the surface of the sea floor. In the near-surface subsoil, the sand in the substantial boulder clay is followed by a heterogeneous lithological mixture of clays, silts and sands of varying consistencies. In the substantial boulder clay, rocks of varying densities and sizes must be expected. This was already described in the environmental report for the FEP 2019 (BSH, 2019).

During the site investigation in 2019, detailed sediment sonar investigations with a 75 m profile interval were conducted on site O-1.3. These high-resolution investigations confirm the descriptions of the site O-1 described in the environmental report for the SDP 2019.

The near-surface subsoil of site O-1.3 consists of mud layer several dm to > 2.5 m in depth. These are followed by late glacial deposits of silts, clays and fine sands which may contain local sand or gravel proportions. There is no evidence of rocks either in the mud or in the underlying late glacial near-surface layers. In four locations, the Late-glacial sediments occur slightly further up. The thickness of the mud decreases there but is still present in a thin layer.

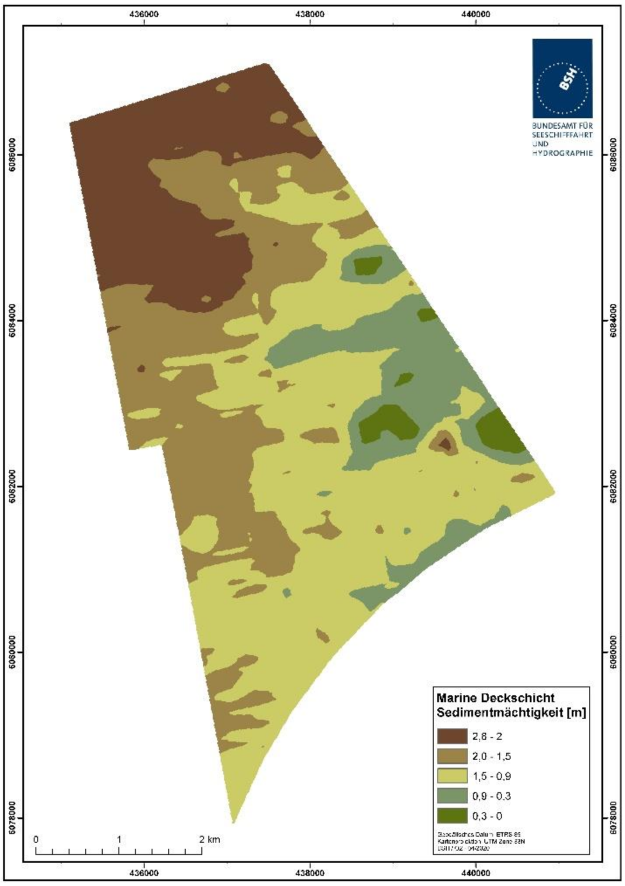

Figure 8: Thickness of the marine top layer (linear interpolation) at site O-1.3

2.2.2.4 Distribution of pollutants in the sediment

Metals

Due to the shortness of the available measurement series, it is not possible to identify a trend in the metal contents of the surface sediments in the western Baltic Sea (Bay of Mecklenburg and the Arkona Basin) up to the present day. Raised quicksilver and lead contents have been found in the western the Arkona Basin for several years. The causes of these anomalies are not known. Towards the coast, an increase in the element contents in the surface sediment can normally be observed. This applies particularly to quicksilver and cadmium but also to zinc and copper. By contrast, the lead contents measured in the EEZ are comparable to the values observed near the coast or even exceed them.

Organic substances

It is exceptionally difficult to provide a summary overview of the sediment load because offshore data tend to be incomplete and data for the coastal areas tend to be highly heterogeneous. A regional analysis is made more difficult by the fact that the published data usually do not include a reference to the TOC content (TOC = Total Organic Carbon) or to a particle size standard. The concentrations in the EEZ are consistently lower than in the coastal areas where there are frequent occurrences of local loads. Further regional evaluations must take into account sediment parameters (TOC, particle size distribution). The EEZ displays a relatively homogeneous distribution alongside comparable TOC contents in the sediments, while locations with a local particle size proportion and low TOC values (sandy sediments) have relatively low loads. Compared to the North Sea (German Bight), the concentrations in the EEZ of the Baltic Sea tend to be higher on average; this is most probably due to the higher TOC and mud contents of the Baltic Sea sediments. Longer-term data are not yet available for the sediments of the EEZ so that it is not possible to make any statements about trends over time.

Radioactive substances (radionuclides)

Compared to other marine areas, the surface sediments in the Baltic Sea have significantly higher specific activities than e.g. those in the North Sea. In most cases, this is also true of natural radionuclides. On the one hand, this effect is due to the small particle sizes of the more muddy and hence smaller particle sediments of the Baltic Sea, and hence also of site O-1.3, and on the other hand, this is because the lower turbulence of the Baltic Sea waters lead to a sedimentation of smaller particles. The radioactive load of the Baltic Sea is determined by deposits from the Chernobyl accident in 1986. The higher scale deposition of the Chernobyl input in the area of the western Baltic Sea compared to the North Sea also reflects the increased activities. It was possible to deserve from this development that the sediment stock rose consistently in the first years following the Chernobyl accident. This has stagnated in the last approx. 10 years, which can be explained by a quasi-equilibrium between radioactive decay (half-life of Cs-137: 30 years) and additional deposition. Even though the radioactive load of the Baltic Sea is higher due to artificial radionuclides than that of the North Sea, this does not constitute a risk to humans or nature based on the current level of knowledge.

Contaminated sites

Potential legacy pollution in the EEZ of the Baltic Sea may include munitions remnants. In 2011, a Federal-*Länder* working group published a basic report on the ammunition contamination of German marine waters, which is updated annually. According to official estimates, the seabed of the North Sea and Baltic Sea contains 1.6 million tonnes of old ammunition and unexploded ordnance of various kinds. A significant proportion of these ammunition dumps originate from the Second World War. Even after the end of the war, large quantities of ammunition were sunk in the North Sea and Baltic Sea during the disarmament of Germany. According to current knowledge, the unexploded ordnance contamination in the German Baltic Sea is estimated at up to 0.3 million tonnes. On the whole there is a lack of data, so it can be assumed that unexploded ordnance is also to be expected in the area of the German EEZ (e.g. remnants of mine barriers and combat operations). The location of the known ammunition dump sites can be found on the official nautical charts and in the 2011 report (which also includes suspected sites of ammunition contamination). The reports of the Federal-*Länder* working group are available at www.munition-im-meer.de.

2.2.3 Status assessment

The assessment of the status of the seabed with regard to sedimentology and geomorphology is limited to the area of site O-1.3 considered within the scope of the suitability assessment.

The evaluations especially of the aspects 'rarity and vulnerability' and 'diversity and uniqueness' reflect the present level of knowledge. Since results from the video investigations for site O-1.3 are still outstanding, the evaluation of the last two aspects may still change.

2.2.3.1 Rarity and vulnerability

The aspect of 'rarity and vulnerability' takes into account the surface area of the sediments on the seabed and the distribution of the morphological inventory of forms in the western Baltic Sea and throughout the entire Baltic Sea.

Both the sediment types of the sea floor surface described for site O-1.3 and the morphological diversity largely correspond to the basin sediments which can be found in all Baltic Sea basins in this or similar form. The aspect 'rarity and vulnerability' is thus evaluated as 'low'.

2.2.3.2 Diversity and uniqueness

The aspect of 'diversity and uniqueness' considers the heterogeneity of the described surface sediments and the characteristics of the morphological inventory of forms.

With the exception of individual locations in the eastern part of site O-1.3, the sediment composition of the surface sediments is highly homogeneous. The sea floor is also largely unstructured in terms of morphological diversity. The reports of the site investigation did not describe soil shapes in detail.

The aspect of "diversity and uniqueness' is therefore rated as 'low'.

2.2.3.3 Existing cumulative effects

Natural factors:
Climate change and sea level rise: In the course of the last 11,800 years, the Baltic Sea has seen a dramatic change in climate linked to a pervasive change to the land/sea spread as a result of the global increase in sea levels by 130 m. For the last 2,000 years, the level of the Baltic Sea has remained at roughly today's level except for short-term changes caused by meteorological phenomena. Storms cause the most drastic changes on the seabed. All processes of sediment dynamics can be explained by meteorological and climatic process which are largely controlled by the weather in the North Atlantic.

Anthropogenic factors:
Eutrophication: Increased primary production resulting from the anthropogenic input of nitrogen and phosphorus via rivers, the atmosphere and diffuse sources, leads to higher sedimentation of organic substances in the basin of the Baltic Sea. Microbial decomposition

normally results in anoxia which in turn leads to the formation of gyttja which has a much softer consistency than mud deposits.

Fishing: Since the end of the First World War, commercial fishing in the Baltic Sea has almost exclusively used bottom trawl nets and trawl doors. Beam trawling is not used in this marine area (RUMOHR 2003). Only occasional traces of fishing have been observed for the analysed area. LEMKE (1998) describes numerous traces of fishing in the mud area of the Arkona Basin. The penetration depths of the trawl doors can reach up to 23 cm in mud (WERNER et al. 1990), up to 15 cm in muddy fine sand (ARNTZ & WEBER 1970) and up to 5 cm in sand (Krost et al. 1990). Bottom rollers leave far fewer traces which, according to the observations of divers, can be 2 to 5 cm in depth (KROST et al. 1990).

Marine cables (telecommunications, energy transmission): In the context of the natural sediment dynamics, marine cables laid on sandy seabeds can become buried in less than a year, with no visible traces of cable laying remaining (ANDRULEWICZ et al. 2003). Currently, no information is available about the depth of this natural burying process. But it can be assumed that the range is between 10 and 30 cm. The laying methods chosen are largely based on the characteristics of the ground. If the sediments are suitable for sluicing, the sluicing process itself stirs up the sediment which is predominantly deposited again in the immediate vicinity. As a rule, sediment dynamics processes lead to a complete levelling of the laying tracks, especially after periods of bad weather. In areas with soft or pasty muds, marine cables can sink into the sea floor as a result of their specific weight, with a negligible creation of turbidity plumes. In areas with firm sediments not suitable for sluicing (e.g. boulder clay), cable channels need to be cut in which the cables can be laid. Highly compacted sediments or dense rocks normally require cables to be laid on the sea floor and protected by rock filling.

The anthropogenic factors affect the seabed through erosion, mixing, resuspension, sorting of material, displacement and compaction. These influence the natural sediment dynamics (sedimentation/erosion/rearrangement) and the material exchange between sediment and ground water.

The extent of anthropogenic cumulative effects is a key factor in the evaluation of the aspect 'existing cumulative effect'. While numerous traces of fishing were described in the area of site O-1.3, these have not resulted in a loss of ecological function. As a result, the aspect of 'existing cumulative effect' is evaluated as 'medium'

Table 5: Status estimate for the protected object 'soil' in relation to sedimentology and geomorphology in the analysed area.

Aspect: Rarity/vulnerability			
Criterion	Category		Estimate
Area of sediments on the seabed and distribution of the inventory of morphological forms	High	Sediment types and soil shapes occur exclusively in the EEZ.	MEDIUM – LOW
	Medium	Sediment types and soil shapes are widespread in the south-western Baltic Sea.	
	Low	Sediment types and soil shapes can be found throughout the Baltic Sea.	
Aspect: Diversity/uniqueness			

Criterion	Category		Estimate
Heterogeneity of the sediments on the seabed and formation of the morphological inventory of forms	High	Heterogeneous sediment distribution and distinct morphological conditions.	LOW
	Medium	Heterogeneous sediment distribution and no distinct soil shapes or homogeneous sediment distribution and distinct soil shapes.	
	Low	Homogeneous sediment distribution and unstructured sea floor.	
Aspect: Existing cumulative effects			
Criterion	Category		Estimate
Extent of the existing cumulative anthropogenic effects of the sediments on the seabed and the morphological inventory of forms	High	Hardly any change due to anthropogenic activities	MEDIUM
	Medium	Change due to anthropogenic activities without a loss of ecological function	
	Low	Change due to anthropogenic activities with a loss of ecological function	

2.3 Water

The Baltic Sea is an intracontinental sea. The Baltic Sea is linked to the Kattegat via the Little Belt, the Great Belt and the Øresund. This provides a link to the North Sea and the Atlantic via the Skagerrak. Given the low water depths of the straits, only a small amount of water is exchanged with the North Sea. All in all, the Baltic Sea spans an area of 415,000 km² with an average depth of 52 m (JENSEN & MÜLLER-NAVARRA 2008). Due to its low salt content, the Baltic Sea is a brackish sea. The water circulation of the Baltic Sea is

characterised by the inflow of freshwater from rivers and the exchange of water masses with the North Sea. Given its morphological features, an – in part quite pronounced – vertical salinity and temperature layering can form in the Baltic Sea which cannot be broken open by the predominantly wind-driven water currents and minimal tides (< 10 cm) (JENSEN & MÜLLER-NAVARRA 2008, FENNEL & SEIFERT 2008).

2.3.1 Data situation

The data and information to describe and evaluate the status of the protected object 'water' are based on secondary literature on the one hand and on the analysis of long-term measurement series, e.g. by the BSH, on the other hand. The annual monitoring trips of the BSH in collaboration with the IOW are another source of information.

2.3.2 Status description

2.3.2.1 Nutrients

Nutrients such as phosphate and inorganic nitrogen compounds (nitrate, nitrite, ammonium) as well as silicate are of basic importance for sea life (phytoplankton). An excess of these nutrients, which occurred in the 1970s and 1980s due to extremely high nutrient discharge caused by industry, transport and agriculture, leads to a high accumulation of nutrients in seawater and therefore to over-fertilisation (eutrophication). The eutrophication problem persists (BMEL and BMU 2020). It can result in more frequent occurrences of algal blooms (in the Baltic Sea, these are particularly cyanobacterial blooms), reduced visibility depth, shifts in the range of species as well as anoxic conditions near the sea floor (Sutton et al. 2013).

Typical seasonal fluctuations can be observed in the Baltic Sea, with high nutrient concentrations in winter followed by a noticeable decrease in concentrations when biological activity picks up in the spring (BMU 2018b).

Spatially, the nutrient concentrations in the inner coastal waters tend to be two to three times higher than on the outer coast preceding the open sea, with these differences being more noticeable for nitrate concentrations than for phosphate concentrations. Particularly in the shallow areas of the Baltic Seas, varying layers of temperature and salinity can lead to highly variable nutrient distributions. Moreover, in these shallower areas, transfer processes between the water and the sediment – especially the re-dissolution of phosphorus – play a key role for the concentrations in the water column.

The occurrence of anoxic areas in the Baltic Sea is a natural phenomenon in the Baltic Sea due to the low water transfer rate with the North Sea and the at times permanent layering of the body of water. But eutrophication and the linked increase in the decomposition of organic material results in higher frequencies, intensities and spatial extent of the anoxic zones. Since the re-dissolution of phosphorus from the sediment occurs especially under anoxic conditions, this further amplifies eutrophication.

2.3.2.2 Pollutants

Organic pollutants and metals reach the Baltic Sea waters via direct discharge, rivers and air, as well as via direct sources in the sea, such as offshore activities, extraction of raw materials and dredged material. Pollutants can accumulate in sediments and in marine organisms.

Organic pollutant have been shown to occur in increased concentrations in the Baltic Sea. The load near the coast tends to be higher than in the open Baltic Sea. Many persistent, bioaccumulative and toxic substances are still found in significant concentrations in the marine environment decades after being banned. For example, measurements have identified increased concentrations of the priority substance perfluorooctanesulfonic acid (PFOS) in the water. The load in Baltic Sea waters of petroleum hydrocarbons and polycyclic aromatic hydrocarbons (PAHs for short) is low and does not demonstrate any special spatial distribution. Given its high variability, no temporal trends can be identified for any of the different hydrocarbon classes, but seasonal differences with high values in winter apply for PAHs.

Metals occurs naturally in the marine environment. The presence of metals in the marine environment is therefore not necessarily considered to be pollution. Metals are dissolved and suspended in the water body. As the distance from the coast increases, the levels of Suspended Particulate Matter in the water column decrease. As such, the proportion of surfaces available for adsorption processes decreases and a proportionally increasing part of the metal content remains in solution. Similarly to nutrients, some metals are subject to periodic, seasonal fluctuations in their concentrations of solutes. This seasonal profiles roughly corresponds to the biological growth and remineralisation cycle, as also applies to the dissolved nutrient contents in marine water.

2.3.2.3 Currents

The circulation of the Baltic Sea is characterised by a transfer of water masses with the North Sea through the Belts and the Sound. In the near-surface area, the brackish waters of the Baltic Sea flow into the North Sea while the heavier, more saline North Sea water penetrates from the Kattegat into the Baltic Sea. This inflow of saline water is impeded by the Drogden Sill (sill depth

9 m) on the southern exist of the Sound and the Darss Sill (sill depth 19 m) to the east of the Belts. Specific weather situations lead to sporadic saltwater intrusions during which oxygen-rich waters with high salinity can penetrate as far as the lower eastern basin of the Baltic Sea.

Regarding these saltwater influx events from the Kattegat into the Baltic Sea which make a major contribution to the 'aeration' of the deep Baltic Sea basin, a distinction is made between two processes: One the one hand, there are major saltwater intrusions which transport vast volumes of saltwater into the Baltic Sea over a period of at least five days. These fill large parts of the Arkona Basin with saltwater. The second process consists of influx events of medium intensity which occur approx. 3 to 5 times each winter. In these cases, ground water enters the Arkona Basin as a dense bottom current after flowing over the Darss Sill and the Drogden Sill. The denser water flowing into the Arkona Basin over the Drogden Sill runs clockwise along the edge of the Arkona Basin as a relatively narrow band. It flows around Kriegers Flak and continues in the direction of the Darss Sill where the saltwater penetrating from over the Darss Sill forms a layer above this band. From there, the band continues along the southern edge of the Arkona Basin eastward 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 numeric model modify this picture: According to these, the greater proportion of the water entering via the Drogden Sill flows clockwise around Kriegers Flak, having less impact on the sector in the German EEZ than claimed in previously published observations and based on the results of modelling. Measurements performed using an Acoustic Doppler Current Profiler positioned on the ground to the east of Kriegers Flak could support the results of this model. Since the new model investigations are limited exclusively to the influx from the Öresund, no new findings are available for the influx from the Belts (Darss Sill). It can be assumed that this influx spreads predominantly towards the east along the southern edge of the Arkona Basin and hence also influences deeper sections of the Adlergrund.

Currents in the Baltic Sea arise primarily as a results of wind (drift currents). If a current meets the coast, the resulting banking can also lead to gradient currents. A third factor is freshwater efflux of rivers of approx. 480 km³/year. If precipitation and condensation are taken into account, this results in a freshwater excess of 540 km³/year or approx. 2.5% of the water volume of the Baltic Sea. Tidal currents are negligible in the Baltic Sea. In the Fehmarn Belt, a net surface efflux of 8 cm/s and a net ground influx of 7 cm/s can be observed on average per year (LANGE et al. 1991). Median speeds are in the range of 30 cm/s on the surface and 16 cm/s on the ground. Near-surface speeds in the large basins to the east of the Belts are 10-18 cm/s and ground speeds are 7-13 cm/s.

Table 6 shows the characteristic current parameters for the Fehmarn Belt, the Bay of Mecklenburg and the Arkona Basin.

2.3.2.4 Sea heave and water level fluctuations

In connection with sea heave a distinction is drawn between waves generated by the local wind – the so-called 'wind sea' – and swell. The term swell refers to waves which have left the area in which they were created. Given the limited size and strong fragmentation of the Baltic Sea, fully developed swell is rare. In

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

	Fehmarn Belt	Bay of Mecklenburg	Arkona Basin
Water depth [m]	28	26	31
Near-surface:			
mean [cm/s]	28.7	17.7	9.6
maximum [cm/s]	117.6	74.8	78.0
Residual current [cm/s]	7.6	1.4	2.3
Direction [°]	347	332	184
Near-ground:			
mean [cm/s]	16.4	12.9	6.0
maximum [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)		BSH measurement (2005)

of the Arkona Sea only has a swell proportion of approx. 4%. Swell has greater lengths and a longer timespan than wind sea.

The height of the wind sea depends on the wind speed and the time the wind acts on the water surface (duration of action), as well as on the wind stroke length (fetch), i.e. the distance over which the wind acts. Sea heave is measured as significant wave height (SWH), i.e. the mean wave height of the upper third of the wave height distribution.

During the climatological annual cycle (1961-1990), the top wind speeds in the Arkona Sea of around 19 kn are reached in December, falling continuously to 13 kn in June. Following this, wind speeds steadily increase again until the end of November. (BSH 1996). The annual average wind speed is 16.2 kn. This annual cycle can be applied to the mean wave height for sea heave.

This is close to 1.4 m in December, drops to approx. 1.15 m until the end of January and keeps this value until mid-March. The value then falls steadily to 0.7 m until the end of May. From June, wave height increases against continuously until December.

Tidal water level fluctuations are negligible in the Baltic Sea. The spring tidal range for the semidiurnal tide in the German EEZ is less than 10 cm. Due to its limited spread, the Baltic Sea is very quick to respond to meteorological influences (BAERENS & HUPFER 1999). Extreme high water and low water are caused primarily by the wind. Water levels in excess of 100 cm above or below NN are called storm highs or storm lows. As a long-term mean, these extreme water levels are approx. 110 to 128 cm above or 115 to 130 cm below NN. Individual events can be significantly higher than these values. In addition to storm highs and storm lows, natural oscillations of the Baltic Sea basin (seiche) can result in water level fluctuations in the range of up to one metre.

For the 20th century, the annual maximum water level of the Baltic Sea and the annual variability show a statistically significant positive trend, with a noticeable increase during the 1960s and 1970s. Fluctuations of the sea level lasting for periods of more than a year also correlate with the fluctuations of the North Atlantic Oscillation (NAO) index.

Long-term factors which influence the average sea level of the Baltic Sea are isostatic uplift 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 of the global sea level rise are in the range of 0.09 and 0.88 m up to 2100, assuming the ice mass in the western Antarctic remains stable. Melting of the ice mass would effectuate a global sea level rise of up to 6 m.

2.3.2.5 Surface temperature and temperature layering

Fig. 6 provides a large-scale distribution of the monthly mean surface temperatures based on the data from JANSSEN et al. (1999). Based on the climatological mean, the lowest temperatures occur in February. The data from JANSSEN et al. (1999) includes all available temperature measures from 1900 until 1996. The warming in the summer starts in April and reaches its maximum in August. The cooling phase starts in September.

Between May and June, an intense thermal layering is created which reaches its maximum of up to 12 °C in August with temperature differences between the surface and ground. During the course of September, this thermal layering quickly disintegrates, with the western Baltic Sea being largely vertical homotherm by October. Depending on meteorological constraints, significant deviations from the long-term mean can occur in individual years.

2.3.2.6 Surface salinity and salinity layering

The salt content of the western Baltic Sea tends to decrease from west to east, with the horizontal gradients particularly pronounced in the Belts and the Sound. Figure 10 shows the mean annual salinity cycle IN THE COVERING LAYER ACCORDING TO JANSSEN et al. (1999). Looking at the long-term mean, near-surface salinity in the Belts can vary between 10 and 20 during the course of a year, with values between 6 and 8 observed in the eastern Arkona Sea. The 10 isohaline has been highlighted to emphasise the boundary between the low-salt brackish Baltic Sea water and the more saline waters which flow from the Kattegat in the west through the Belts and the Sound into the western Baltic Sea. Due to the higher density of the more saline waters, this influx occurs primarily near the ground and is layered below the lighter surface waters. The 10 isohaline reaches its most westerly position in the summer months and its most easterly position in December when the strong winter storms cause waters from the

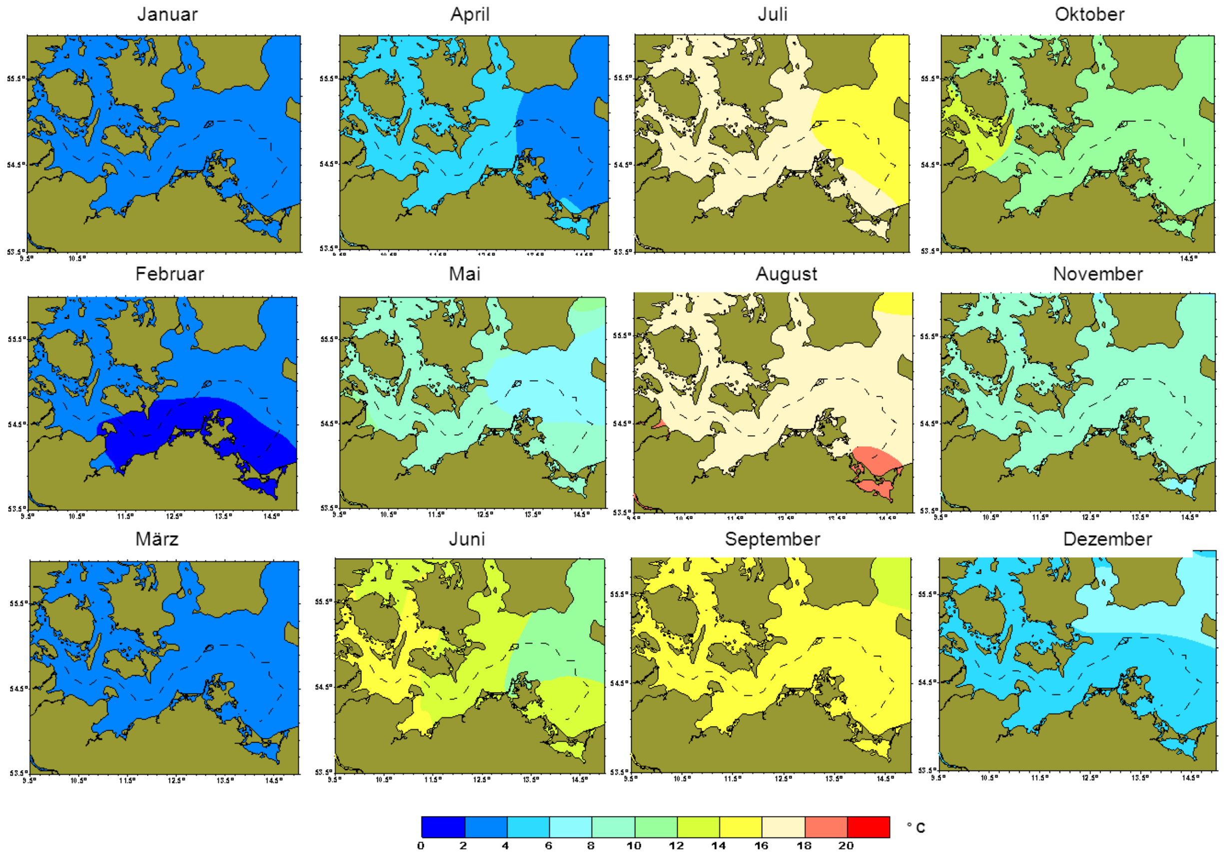

Figure 9: Monthly climatological mean surface temperature (1900 – 1996) according to JANSSEN et al. (1999).

Skagerrak and the Kattegat in the west to be driven into the western Baltic Sea.

Figure 11 shows the layering for salinity based on the difference between the ground and surface salt contents. Large sections of the Belt Sea and the deeper basin have a haline layering throughout the year (water layering caused by different salt contents), whereas more shallow regions such as the Bay of Pomerania are vertically homohaline throughout the year or only have minor layering. The haline layering in the Belt Sea and the deep bay intensifies in the spring, and in the summer reaches differences between the surface and ground salt contents of more than 10.

2.3.2.7 Ice conditions

In winter, ice only forms irregularly in the Baltic Sea south of 56° N. The type and consistency of large-scale weather patterns over Europe are responsible for the vast spatial and temporal fluctuations in the ice cover. In this region, icing can traverse four characteristic developmental stages which are determined by the harshness of the winter, regional oceanographic conditions, coastal morphology and ocean depth. They are reflected in Figure 12 in relation to the frequency distribution of icing.

In moderate winters in which icing occurs, only shallow bays experience full ice cover, as their relatively closed off locations from the open sea prevent notable water exchange with the warmer open seas. To a lesser extent, ice may also form along the outer coast, especially before the eastern coast of Rügen and off Usedom.

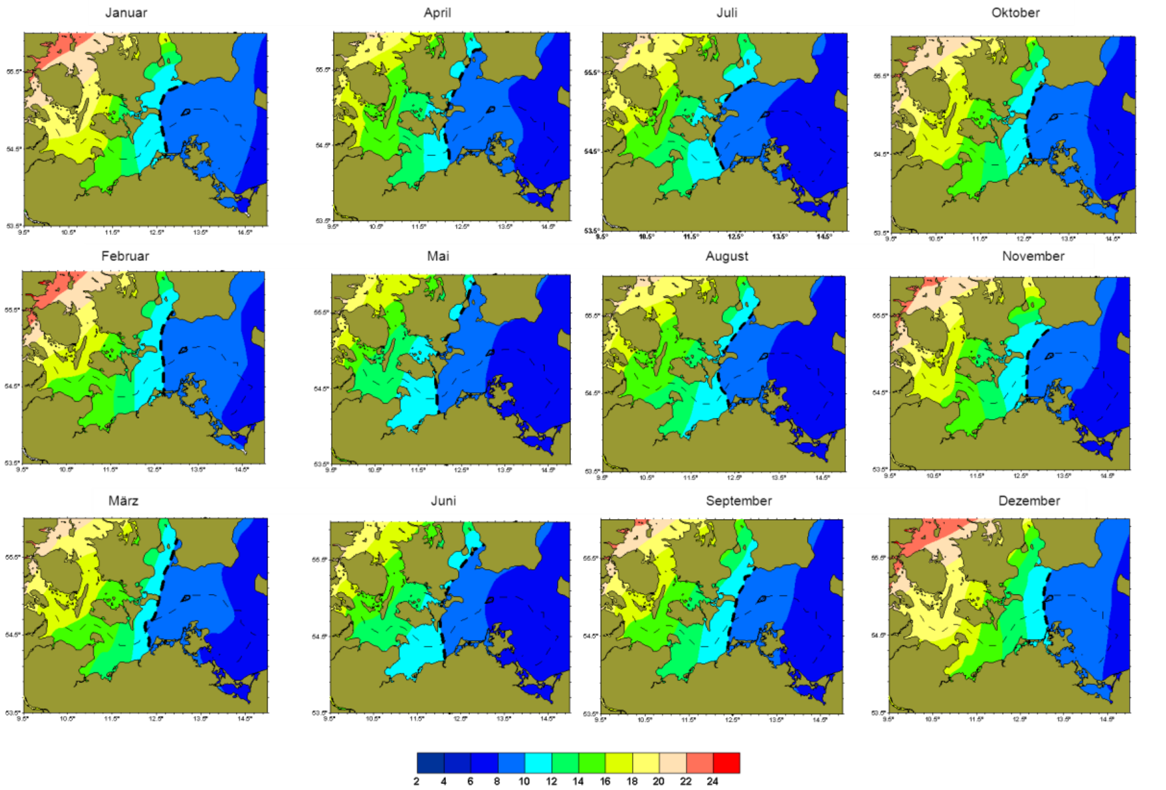

Figure 10: Monthly climatological mean surface salinity (1900 – 1996) according to Janssen et al. (1999).

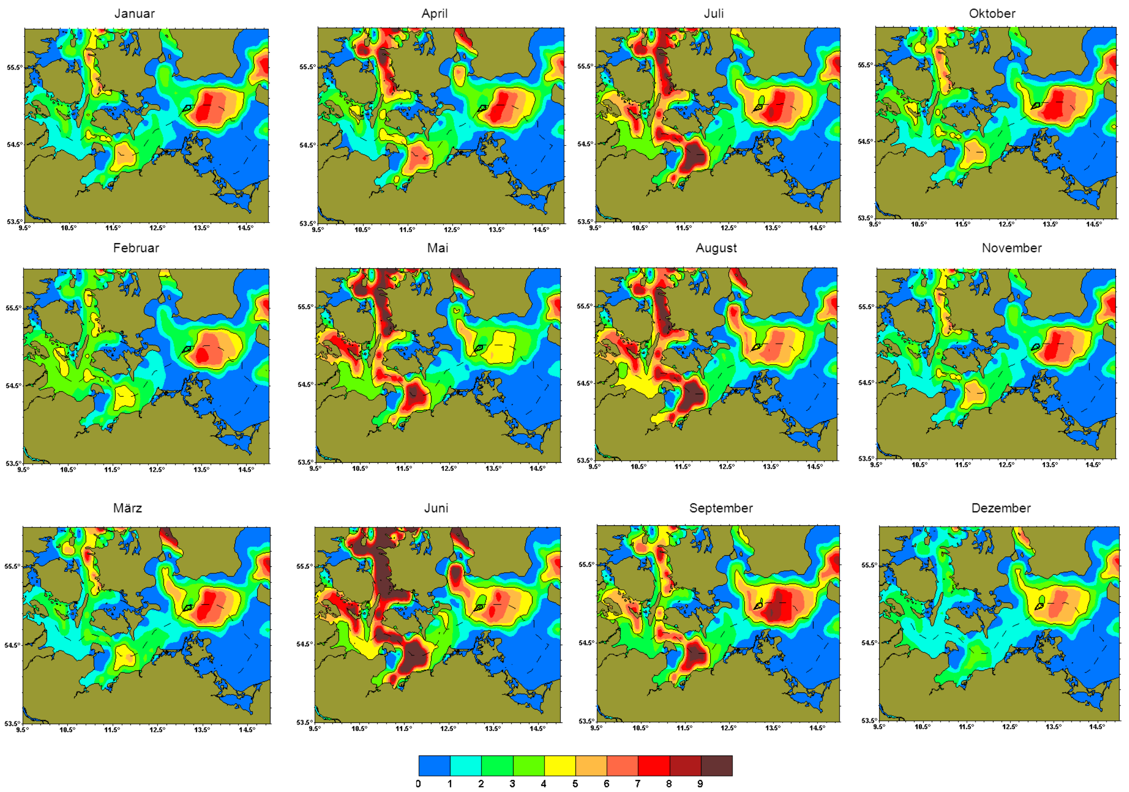

Figure 11: Salinity layering in the western Baltic Sea according to JANSSEN et al. (1999).

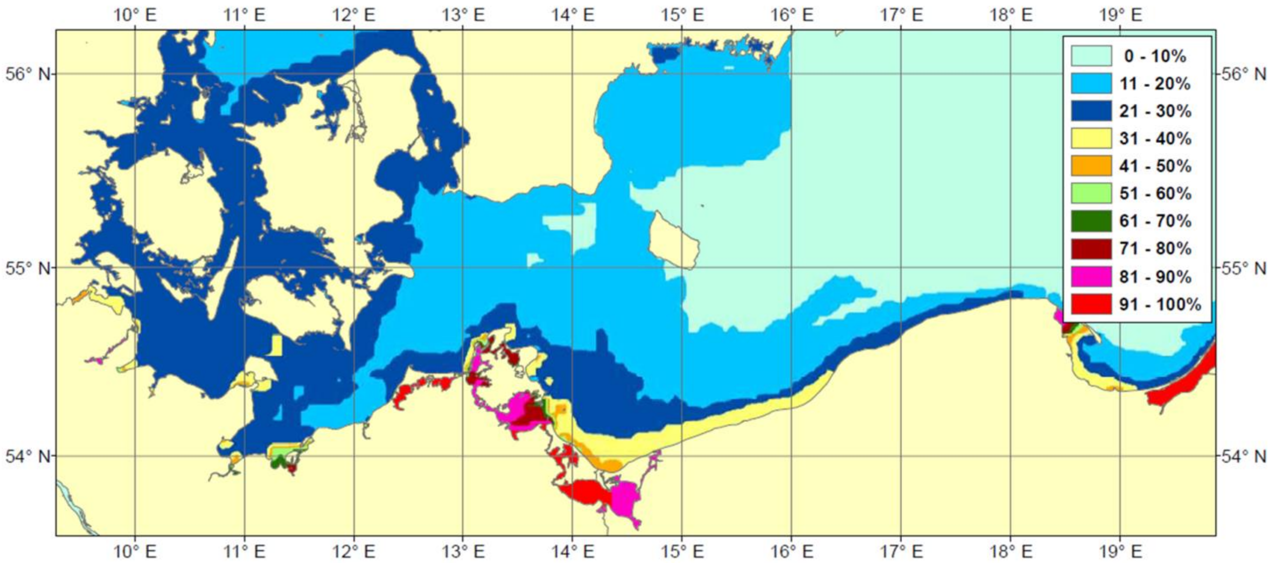

Figure 12: Frequency of icing in the Baltic Sea south of 56° N in the 50-year period from 1961-2010 (BSH 2012).

During harsher winters, only a small strip outside the Baltic Sea coast experiences icing, with a predominant coverage of less than 6/10.

During very harsh winters, the Baltic Sea freezes over completely west of Bornholm, and a wide strip of thick to very thick drift ice (coverage level of more than 7/10) forms before the Baltic and Swedish coasts. This is predominantly white ice with a thickness of 30-70 cm.

In the 50-year period from 1961-2010, in the Baltic Sea south of 56° N, ice formed with a frequency of 80 to 100% in shallow bays and bays in sheltered locations, of 20 to 50% along the outer coasts and of 5 to 30% in the open sea.

2.3.2.8 Suspended Particulate Matter and turbidity

The term 'Suspended Particulate Matter' refers to all particles with a diameter >0.4 µm that are suspended in seawater. Suspended Particulate Matter consists of mineral and/or organic material. The organic proportion strongly depends on the season, with the highest values occurring during the plankton blooms in the early summer. In stormy weather conditions and high waves, the Suspended Particulate Matter content in the entire water column rises sharply due to the whirling-up of silty-sandy bottom sediments. The wind sea and, in deeper waters, the swell have the strongest effects. In the shallow water areas of the Baltic Sea, the sandy sediment is often covered by a layer of flaky material (fluff) which is easily re-suspended and has a high proportion of organic material (EMEIS et al. 2000).

The data available for the German EEZ of the Baltic Sea based on in-situ measurements is highly heterogeneous and insufficient to make statistically reliable statements. For an initial estimate of the near-surface distribution of suspended matter, Figure 13 presents the monthly mean near-surface content of suspended matter (SPM = Suspended Particular Matter) using the MERIS data for 2004 from the ENVISAT satellite of the European Space Agency (ESA).

The highest concentrations are observed in the Szczecin Lagoon and in the Bodden. In the spring, strong freshwater outflows (snow melt) carry increased amounts of suspended matter into the Bay of Pomerania. Since easterly winds dominate in the spring,

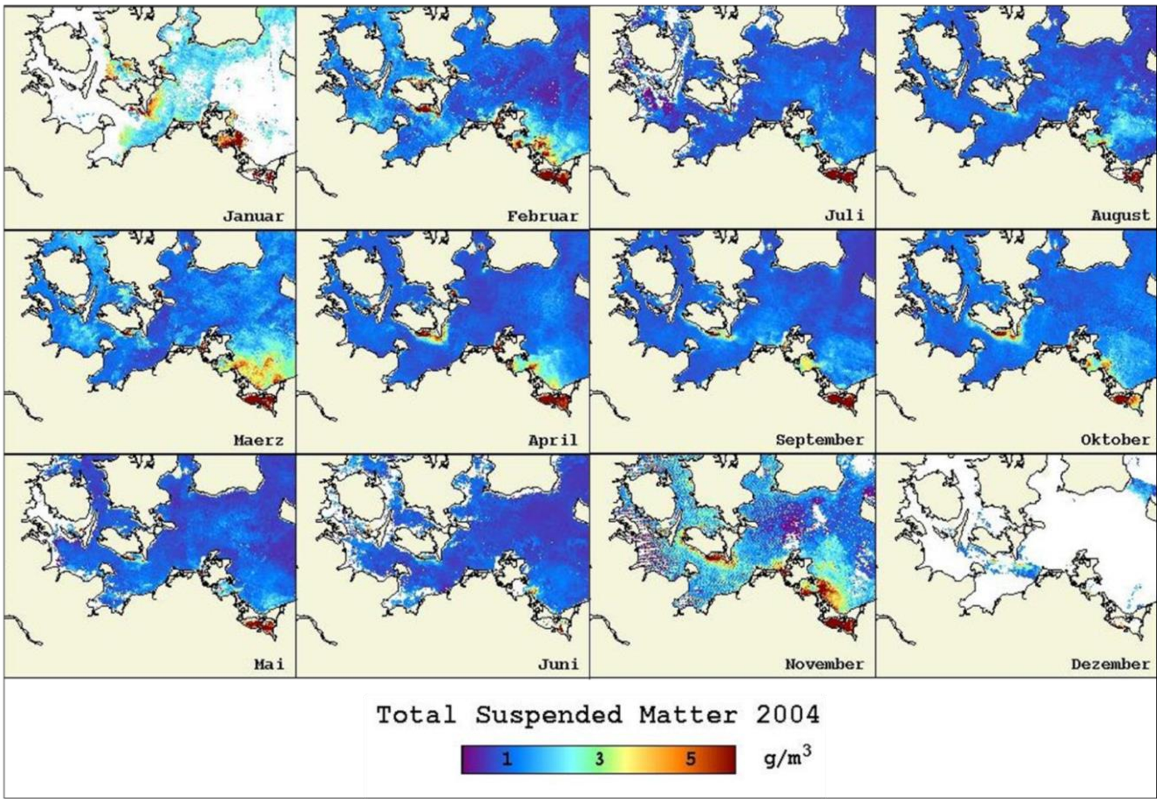

Figure 13: Monthly mean of total near-surface suspended matter for 2004 from the MERIS data of the ENVISAT satellite.

the suspended matter is primarily transported along the coast into the Arkona Sea (SIEGEL et al. 1999). EMEIS et al. (2000) estimate the sedimentation rate in the Arkona Basin to be approx. 600 g per m^2 per year.

2.3.3 Status assessment

The following parameters are used to evaluate the protected object of water:

- Thermohaline layering
- Salinity
- Water depth and geomorphology
- Turbidity
- Tides
- Circulation, currents
- Water temperature
- Water quality, nutrient and oxygen content
- Sea heave
- Ice conditions

2.3.3.1 Hydrography

The hydrographic conditions result from the complex interactions between the individual parameters, which in turn are largely influenced and controlled by larger-scale processes in the North Atlantic, by water exchange between the North and Baltic Seas and by inflows and climatological conditions.

2.3.3.2 Nutrients

Eutrophication continues to be one of the biggest environmental issues for the marine environment in the German waters of the Baltic Sea (BMU 2018b).

Even though the German influx loads of phosphorus and nitrogen compounds into the Baltic Sea have declined since the 1990s, eutrophication problems in the Baltic Sea, particularly due to internal fertilisation through the re-dissolution of phosphorus from the sediment, are only abating slowly. Therefore, the impact evaluation in accordance with the implementation of the MSFD comes to the conclusion that 100% of the German Baltic Sea continues to be subject to eutrophication (BMU 2018b). The HELCOM Commission presents similar findings, classing the entire Baltic Sea – apart from smaller areas in the northern Baltic Sea and in the Kattegat – as subject to eutrophication (HELCOM 2018).

2.3.3.3 Pollutants

The organic pollutants which have been measured in the waters of the Baltic Sea in increased concentrations, are mostly already we3subject to regulations or bans. Given the persistence of these substances, only a slow reduction on their concentrations can be expected. The HELCOM State of the Baltic Sea report (HELCOM 2018) concludes that all areas of the Baltic Sea contain organic pollutants. In recent years, the concentrations of pollutants have largely remained stable. According to current knowledge, the above-mentioned metal pollution of seawater does not pose any direct threat to the marine ecosystem.

The entrainment of nutrients and pollutants has a negative impact on the performance of the ecosystem of the North Sea and can significantly impair it. Given the limited water exchange of the Baltic Sea, the pollutant concentrations are diluted less than in the North Sea so that it displays a correspondingly greater sensitivity to the mentioned effects.

2.3.3.4 Conclusion

Due to the existing cumulative effects caused by eutrophication, water as a protected object is characterised by medium naturalness.

The status of the protected object 'water' is classed as 'high' as a result of these existing cumulative effects. Due to the complex natural mechanism of action and the unknown interactions between the large number of pollutants – even if they are largely present in low concentrations, assessment of the water also plays a role in assessing the populations of fish, macrozoobenthos and soil.

2.4 Biotope types

According to NORDHEIM & MERCK (1995), a marine biotope type is a characteristic, typed marine habitat. With its ecological conditions, a marine biotope type offers largely uniform conditions for marine biocoenoses which differ from 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 current biotope type classification for the Baltic Sea is published by the Federal Agency for Nature Conservation (BfN) in the Red List of Endangered Biotope Types for Germany (FINCK et al. 2017).

To date, there has been no comprehensive detailed mapping of biotope types, including legally protected biotopes in accordance with section 30 BNatSchG, in the EEZ outside nature conservation areas. Detailed, full-coverage mapping of marine biotope types in the EEZ is currently being prepared as part of ongoing BfN R&D projects with a spatial focus on the nature conservation areas.

2.4.1 Data situation

The data situation for describing and estimating the biotopes in the EEZ of the Baltic Sea is described in the environmental report for the SDP 2019 (BSH, 2019).

A current description of the biotope types at site O-1.3 is available from the first year of the baseline survey, which was carried out as part of the offshore site investigation (IFAÖ, 2019). Existing geological data from the area (geodata of the IOW/BSH from 2012 and 2015 and NAUTIK NORD & VBW (2012)) were used to map the biotopes.

The final report of the two-year basic study is expected to be available by 31.03.2020 and will then be considered in the environmental report and the suitability assessment.

The geological offshore site investigation maps several objects and structures at site O-1.3, with clusters in the eastern and southern area of the site. Studies have been conducted to classify these objects/structures in more detail (shallow depressions with a slight middle elevation) (see IFAÖ 2020).

2.4.2 Status assessment

The population assessment of biotope types occurring in the German marine area is based on the national conservation status and the threat to these biotope types according to the Red List of Endangered Biotope Types in Germany (FINCK et al. 2017).

The geophysical site investigations (NAUTIK NORD & VBW (2012)) identified a highly homogeneous covering of the sea floor with (at times sandy) silt. Sandy sediments and several rocks were only detected in a few locations in the eastern section of the site. Analyses using underwater video recordings largely confirmed the findings of the geophysical site investigations. In rare cases, marlstone nodules were found to lie on top of the fine surface substrate. Hard substrates occurred in the shape of individual rocks and, rarely, boulders.

According to the present level of knowledge, three biotopes were delimited in the site O-1-3 (Figure 11).

The biggest section of site O-1.3 is of the biotope type 'Sublittoral muddy Baltic Sea ground with infauna' (code 05.02.11.02) according to FINCK et al. (2017). The sediment of this biotope type is dominated by mud or soft clay (average grain size < 0.06 mm). This biotope type is not currently subject to any identifiable regional and/or national risk (both regarding its area balance and its qualitative development). The current development trend (total area balance) for this biotope type is estimated to be constant. According to FINCK et al. (2017), this biotope type is not currently at risk of being lost and its ability to regenerate is classed as 'conditional ability to regenerate'. This biotope type is not a legally protected biotope under section 30 BNatSchG and not a protected biotope type according to Annex I of the Habitats Directive.

A small area in the eastern section of site O-1.3, made up of three partial sites (with a total area of 776,507 m²), can be classed as the biotope type 'Sublittoral, even, sandy Baltic Sea ground with infauna' (code 05.02.10.02) (FINCK et al. 2017). The predominant sediments are sand (medium-grained sand, fine sand, some coarse sand) and silt. Individual stones and, rarely, boulders occur at a spread of < 10%. In addition, the video analysis documented individual marlstone nodules. The faunal community corresponds to a typical soft-bottom community with minor deviations in the area of the silt. Based on the present side-scan sonar data, the surface of the sea floor was categorised as sandy silt. This biotope type is currently not subject to any long-term regional or national risk. The current development trend regarding the total area balance of this biotope type is estimated to be constant with a stable incidence. Therefore, this biotope type is not at risk in relation to the criterion 'rarity'. The ability of this biotope type to regenerate is classed as 'conditionally regenerable' (FINCK et al. 2017). This biotope type is not a legally protected biotope under section 30 BNatSchG and not a protected biotope type according to Annex I of the Habitats Directive.

Another area of the size of 90,063 m² in the north-eastern section of site O-1.3 was identified as residual sediment based on the geophysical investigations. The video analysis for this area found fine-grained sediment and geogenic hard substrate (individual stones, rarely boulders) with a spread of mostly < 10%. Marlstone ridges were documented regularly. The substrate found corresponds to the biotope type 'Sublittoral mixed Baltic Sea substrate' (code 05.02.06) according to the Red List of Endangered Biotope Types for Germany (FINCK et al. 2017). This biotope type is characterised by a soft bottom (gravel, sand, mud) and by hard substrate (10-90%; stones, boulders, compacted soft bottom, boulder clay and turf) or shell detritus. According to FINCK et al. (2017), this biotope type is classed as endangered in relation to regional and national long-term risk because an endangerment (category 3) can be assumed both in relation to site development and to qualitative development. It is classed as having a 'conditional ly regenerable' (category B) and displaying a largely stable development trend. As a result, the Red List status aggregates an overall evaluation of '3-V' (acute early warning list) for these biotope types.

According to FINCK et al. (2017), the biotope type 05.02.06 can form part of a geogenic reef and thus of a legally protected biotope according to section 30 para. 2 S.1 No. 6 BNatSchG or a protected habitat type according to Habitats Directive Annex 1 (code 1170). Based on the BfN mapping instructions for reefs (BFN, 2018), the biotope found must be allocated to the reef type 'Residual sediment with individual rocks and/or boulders'. Since the density of the hard ground and thus the biological and functional significance of these residual sediments as reefs cannot be determined solely by hydroacoustic methods, it is generally considered necessary to verify this reef type using benthos-biological investigation methods (e.g. underwater videos) (BfN, 2018). According to the IFAÖ (2019), an examination of the criteria in the BfN mapping instructions using underwater video recordings for biological verification revealed that:

1. Of the at least six typical reef taxa to be substantiated, only the two taxa Mytilidae and Balanidea were recorded;

2. The existing hard substrates are colonised by structure-forming species with coverages of significantly < 50%;
3. The coverages of sessile epibenthic species in the areas containing the residual sediments was less than 10%.

Since none of the criteria of the BfN mapping guideline for the biological verification of the reef type 'Residual sediment with occasional stones and/or blocks' was fulfilled, the residual sediment area at O-1.3 is not to be regarded as a reef area pursuant to section 30 BNatSchG.

The objects and structured identified at site O-1.3 during the geological offshore site investigation were examined as part of a study by the IFAÖ (2020) to determine whether these locations contain legally protected biotope types according to § 30 BNatSchG. In addition to the video data, extensive up-to-date hydrographic measurement data (VBW 2020) and data from previous hydrographic (NAUTIK NORD & VBW 2012; IOW and BSH 2015 / 2018) and benthos-ecological (IFAÖ 2020) investigations were available.

All locations within the site (except for one location which contained a metal cylinder) were shown to have a soft bottom with hard substrate (boulders, stones). Given the present data situation, the suspected legally protected biotope types at the locations were narrowed down to geogenic reefs (type 'Boulder field Baltic Sea'). These were verified in accordance with the mapping instructions for reefs (BFN 2018).

Individual stones and boulders were detected at the locations of site O-1.3 which did not match the required criteria for the biotope type 'Boulder field Baltic Sea' according to the mapping instructions (BfN 2018), based either on their number (at least 21 boulders) or on their coverage density.

One area outside the SDP site O-1.3 (location 3) is suspected of being the legally protected biotope type 'Boulder field Baltic Sea'. However, given their location outside site O-1.3, these were not pursued further.

In accordance with the specifications of the BfN guidelines for mapping legally protected biotopes according to § 30 BNatSchG, video surveys of the objects were carried out at prominent positions, and various anthropological objects and small stones were found. A legally protected biotope could not be identified. For area O-1.3, further evaluations beyond the mapping instructions were carried out, the results of which revealed further prominent objects.

2.5 Benthos

Benthos is the term used to describe all biological communities bound to substrate surfaces or living in soft substrates at the bottom of water bodies. Benthic organisms are an important part of the North 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 material (KRÖNCKE 1995). The zoobenthos of the North Sea are composed of a large number of systematic groups and show a wide variety of behaviour. On the whole, this fauna has been quite well studied, thereby enabling comparisons to be made between today and the conditions a few decades ago.

2.5.1 Data situation

The data situation for describing and estimating the status of the macrozoobenthos in the EEZ of the Baltic Sea is described in the environmental report for the SDP 2019 (BSH, 2019).

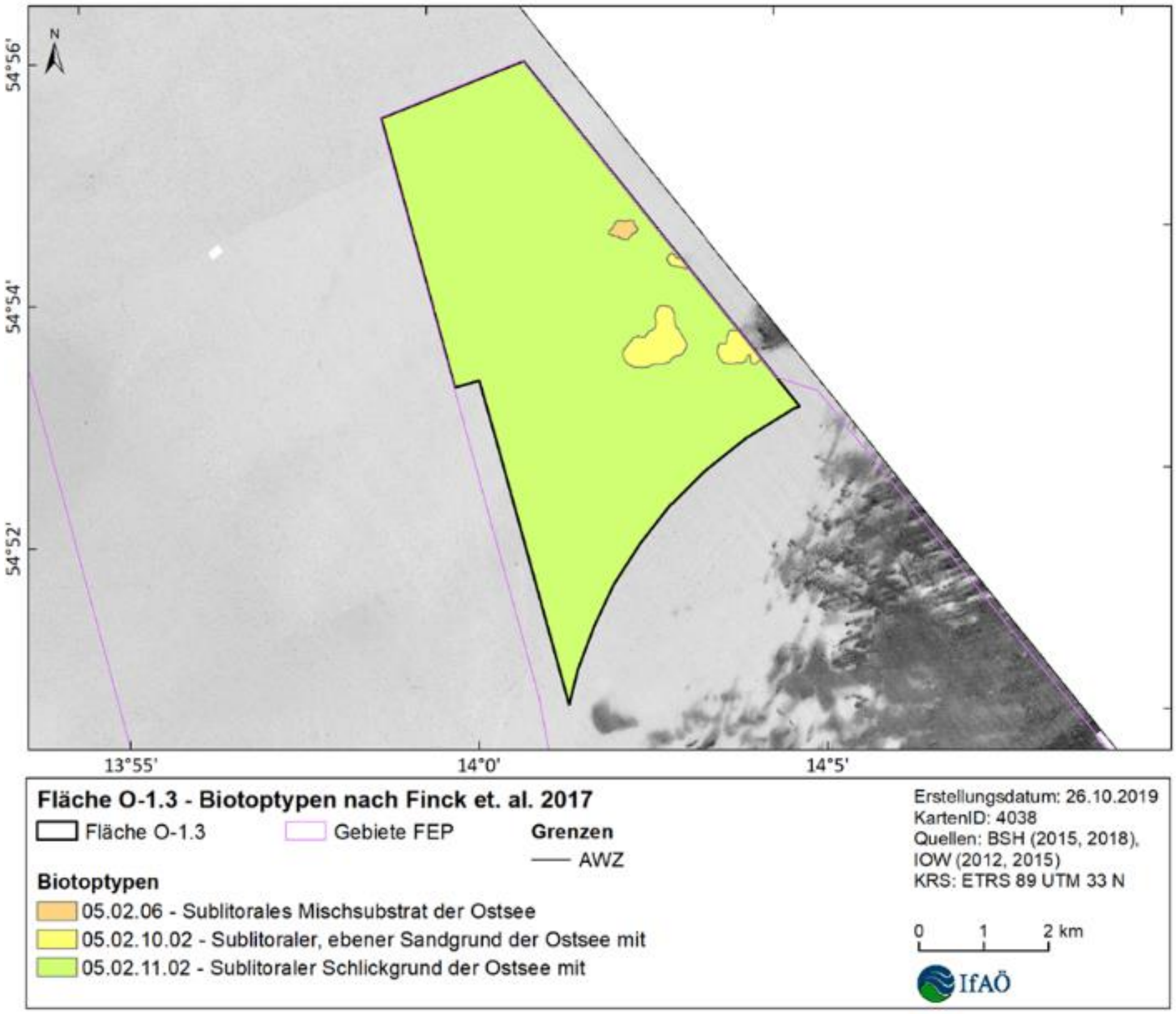

Figure 14: Results of the biotope mapping for site O-1.3 by the IfAÖ (2019).

Up-to-date macrozoobenthos data for site O-1.3 are available for the first year of the baseline study conducted as part of the offshore site investigation (IFAÖ, 2019).

The final report of the two-year basic study is expected to be available by 31.03.2020 and will then be considered in the environmental report and the suitability assessment.

It is currently not possible to reliably predict the likely effects of hard substrate insertion on the development of benthic communities.

2.5.2 Status description

As part of the offshore site investigation of site O-1.3, examinations of the benthic communities (infauna and epifauna) were carried out in accordance with the specifications of the investigation framework for the site investigation and StUK4 (BSH, 2013). Samples were taken at a total of 20 infauna stations using a Van Veen grab sampler and at 10 epifauna stations using a 2-metre beam trawl in autumn 2018 and spring 2019 respectively.

2.5.2.1 Infauna

At site O-1.3, a total of 43 taxa of infauna were identified, during the 1st year under investigation, 29 of which were identified by species. A total of 38 taxa were identified in autumn 2018, while 32 taxa were detected in spring 2019 . In terms of the mean number of species per station, no significant differences were detected between the sampling in the autumn (10 taxa) and the spring (11 taxa).

In the autumn of 2018, the polychaeta *Scoloplos armiger* and *Ampharete baltica* and the molluscs *Limecola balthica*, *Peringia ulvae* as well as the taxon *Tellinidae* gen. Sp. were found to occur very frequently with a minimum presence of 75%. In the spring, the crustacean species *Diastylis rathkei,* the polychaeta species *Scoloplos armiger* and the family Tellinidae gen. sp. (molluscs) were identified at all stations. In addition, the molluscs *Limecola balthica* and *Peringia ulvae* as well as the polychaeta *Bylgides sarsi* and *Ampharete baltica* occurred very frequently.

The average total abundance differ significantly between the samples taken in the autumn of 2018 (386.8 ind./m²) and those in the spring of 2019 (305.3 ind./m²). No eudominant principal species regarding total abundance were found in either campaign.

In autumn 2018, *Peringia ulvae* (27%) had the highest proportionate abundance. Other dominant principal species were the families Tellinidae (19.6%) and the bristleworm *Terebellides stroemii* agg. (18.5%). The subdominant principal species were the mussel *Limecola baltica* and the polychaeta *Ampharete baltica* (7%) and *Scoloplos armiger* (4.5%).

In spring 2019, the molluscs *Peringia ulvae* (24.6%) and the family Tellinidae (20.2%) were also dominant in the total abundance of the infauna community, alongside the crustacean *Diastylis rathkei* (10.1%) and the bristleworm *Scoloplos armiger* (11.5%). The subdominant principal species were the molluscs Astarte sp. (6.1%) and *Limecola baltica* (4.7%) as well as the polychaeta *Terebellides stroemii* agg. (7.4%) and *Ampharete baltica* (3.3%).

At 2.93, the mean diversity in spring 2019 was significantly higher than in autumn 2018 (1.56). By contrast, no significant difference regarding mean evenness was identified when comparing the autumn (values between 0.52 and 0.83) and the spring (values between 0.62 and 0.84).

In terms of average total biomass, no significant difference was found between the autumn (37.0 g/m²) and the spring (24.9 g/m²). In both seasons, the total infauna biomass was dominated by the molluscs. These were, above all, *Limecola balthica*, the eudominant principal species in terms of relative biomass during both campaigns (autumn 2018: 42.9%, spring 2019: (41.9%). Large, and therefore biomass-rich, molluscs were subdominant. In autumn 2018, these were *Astarte borealis* agg. (28.2%), Astarte sp. (8.4%) and *Arctica islandica* (8.9%).

In the spring, in addition to *Limecola balthica, Astarte* sp. (43.6%) was the eudominant principal species or principal taxon.

2.5.2.2 Epifauna

At site O-1.3, a total of 35 taxa of epifauna were recorded in autumn 2018 and spring 2019, 29 of which it was possible to determine at species level and three to species complex level. The mobile epifauna included a total of seven species (*Asterias rubens*, *Bylgides sarsi*, *Crangon crangon*, *Cyanophthalma obscura*, *Idotea balthica*, *Micrura baltica* and *Rhithropanopeus harrisii*). The most frequent epifauna species were the common shrimp *Crangon crangon,* making up 10% in autumn 2018 and 20% in spring 2019 and the common starfish *Asterias rubens* at 30% in spring 2019 (*Asterias rubens* was not found in autumn 2018).

Eight further species, one species complex and one supra-species taxon belonged to this sessile epibenthos community (*Alcyonidioides mytili*, *Amphibalanus improvisus*, *Amphiblestrum auritum*, *Balanus crenatus, Clava multicornis*, *Einhornia crustulenta*, *Electra pilosa*, *Gonothyraea loveni*, *Mytilus edulis* agg. and

Anthoathecata indet.). They were found on hard substrate or on other organisms. Of the predominantly stationary epifauna, *Mytilus edulis* agg. was the most common representative at 30% in autumn 2018 and 60% in spring 2019. The average number of taxa per station in spring 2019 (9 taxa) was significantly higher than in autumn 2018 (3 taxa).

At 0.4 ind./m² in spring 2019, the average total abundance was significantly higher than in autumn 2018 ($1.1*10^{-3}$ ind./m²). This difference was due primarily to *Mytilus edulis* agg. which was significantly more abundant in spring 2019. At a relative abundance of 63.6%, *Mytilus edulis* agg. was the eudominant principal species in autumn 2018. *Crangon crangon* was identified as the dominant principal species at a relative abundance of 27.3% and *Rhithropanopeus harrisii* as the subdominant principal species at 9.1%. *Mytilus edulis* agg. was dominant in the spring, making up a proportion of 99.8% of the epifauna abundance.

In terms of biomass, *Mytilus edulis* agg. was responsible for a proportion of 94.2%, making it the eudominant principal species in autumn 2018. The subdominant principal species was *Crangon crangon*. The share of concomitant species was 0.5%. In spring 2019, the total biomass was dominated by *Mytilus edulis* agg. at 99.9%.

2.5.2.3 Red List species

Of the total of 54 taxa of infauna and epifauna recorded at site O-1.3 in autumn 2018 and spring 2019, it was possible to determine 40 taxa at species level. A total of five of these species are included in the Red List for Germany (RACHOR et al. 2013) due to their population situation or development. The Red List species therefore amount to 9.4% of the total number of species.

No species considered extinct/lost (RL Category 0), critically endangered (RL Category 1) or endangered (RL Category 2) were recorded.

The black clam *Arctica islandica* is classed as a vulnerable species (RL Category 3). It was recorded regularly in autumn 2018 and spring 2019 using both investigative methods. The species complex *Astarte borealis* agg. and the species *Astarte elliptica* and *Platynereis dumerilii* are species at an unknown level of risk (RL Category G). They were only found in spring 2019 using a beam trawl. The amphipod *Pontoporeia femorata* is included in the early warning list (category V).

On the whole, it can be stated that none of the macrozoobenthos species found at site O-1.3 have a protection status under BArtSchV or are listed in Annexes II and IV of the Habitats Directive.

2.5.2.4 Benthic algae

The biotopes of the EEZ of the Baltic Sea are populated primarily by benthic invertebrates. Submerged vegetation exists in the shape of macroalgae (dulse and wakame) on hard bottoms (coarse gravel, boulders) in the region of the crests (Adlergrund, Kriegers Flak) and runnels (Kadetrinne). No marine eelgrass (*Zostera marina*) has been observed in the region of the EEZ, even though this could occur at this water depth.

No macrophyte populations were found at site O-1.3.

2.5.3 Status assessment

The benthos of the EEZ in the Baltic Sea is subject to changes arising from both natural and anthropogenic influences. Apart from natural and weather-related variability (severe winters), the main influencing factors are demersal fishing, sand and gravel extraction, the introduction of non-native species, eutrophication of the water body and climate change.

2.5.3.1 Rarity and vulnerability

The criterion 'Rarity and vulnerability' of populations takes into account the number of rare or vulnerable species. These can be estimated based on the recorded Red List species.

At site O-1.3, 5 species were recorded from the Red List according to RACHOR et al. (2013). No extinct species (RL Category 0), species at risk of extinction (RL Category 1) or endangered species (RL Category 2) were recorded at site O-1.3. Regular populations of the vulnerable black clam *Arctica islandica* (RL Category 3) were found. The species complex *Astarte borealis* agg. and the species *Astarte elliptica* and *Platynereis dumerilii* are species at an unknown level of risk (risk category G). They were only found in spring 2019. In light of its stock situation, the crustacean species *Pontoporeia femorata* is included in the early warning list (category V). Based on the Red List species found and their abundance, the benthic communities at site O-1.3 are assigned medium importance with regard to the criterion of rarity and vulnerability. This confirms the evaluation of the environmental report for the SDP 2019 (BSH, 2019) which found that the benthic community in O-1.3 was neither rare nor vulnerable and classed as of medium importance.

2.5.3.2 Diversity and uniqueness

This criterion refers to the number of species and the composition of the species communities. The assessment looks at the extent to which species or communities characteristic of the habitat occur and how regularly they occur.

The benthos coenosis shown to occur at site O-1.3 is a typical community for this habitat. It comprises numerous species which are characteristic of the silt-rich sea floor of the western Baltic Sea below a water depth of 40 m. In addition to the typical soft bottom species, hard substrate colonisers were also documented. The non-native species *Mya arenaria* and *Amphibalanus improvisus* were found to occur at site O-1.3.

On the basis of these results, the benthic zone of site O-1.3 is assigned medium importance with regard to the criterion of diversity and uniqueness. This confirms the evaluation of the environmental report for the SDP 2019 (BSH, 2019) according to which site O-1.3 is home to a benthic community with average species diversity and individuality.

2.5.3.3 Existing cumulative effects

For this criterion, the intensity of fishing exploitation, which is the most effective disturbance variable, is taken as a benchmark. For other disturbance variables, such as eutrophication, shipping traffic, pollutants, etc., the appropriate measurement and detection methods are currently still lacking to be able to include them in the assessment.

Especially in the spring, site O-1.3 is used for fishing with pelagic and bottom trawl nets. While total fisheries expenditure fell by approx. 50% between 2004 and 2012 (ICES, 2019), fisheries continue to materially influence the benthos communities in this area of the Baltic Sea. In addition, it is assumed that the smell of hydrogen sulphide which was regularly identified particularly during the sampling in autumn 2018, is due to an oxygen limitation on the sea floor promoted by eutrophication. According to the Helcom report for the period 2011 to 2016, the Baltic Sea was classed as subject to eutrophication to the largest extent (ICES 2019). The investigations in autumn 2018 and spring 2019 found long-living mussel types like *Mya arenaria* and *Arctica islandica* at site O-1.3. However, since these species occurred in low abundances, the area is not assumed to be of greater significance.

In terms of the criterion 'existing cumulative effects', the benthos coenosis at site O-1.3 is thus classed as of medium importance in line with the evaluation of this site in the environmental report for the SDP 2019 (BSH, 2019).

2.5.3.4 Importance of site O-1.3 for benthos

The individual criteria classified as 'medium' in each case result in an average overall rating for the benthic zone of site O-1.3. This estimate confirms the overall evaluation of medium for site O-1.3 in the environmental report for the SDP 2019 (BSH, 2019).

2.6 Fish

As the most species-rich of all vertebrate groups alive today, fish are equally important as both predators and prey in marine ecosystems. The most important influences on fish populations, i.e. fisheries and climate change, also interact (HOLLOWED et al. 2013, HEESSEN et al. 2015), making it difficult to identify the relative effect on fish population dynamics (DAAN et al. 1990, VAN BEUSEKOM et al. 2018).

2.6.1 Data situation

As data are available almost exclusively from bottom trawl fishing and not from pelagic sampling, the following assessment can only be made for demersal fish. No reliable estimates can be made for pelagic fish. The status estimate for the protected object of (bottom-dwelling) fish is based on the current biological surveys for fish from the offshore site investigations of the area O-1.3 in autumn 2018 and spring 2019. The information from the offshore site investigation is supplemented by the results of the up-to-date baseline study offshore wind farm (OWF) 'Baltic Eagle' from autumn 2018 (IFAÖ 2019) and the cluster investigations for the Western Adlergrund from March 2017-February 2018 (BIOCONSULT SH 2019). The latter rely on the data by the Thünen Institute for Baltic Sea Fishing (BaltBox-Survey 2016 and BITS-Survey 2016/2017). EHRICH et al. (2006) is used for the historic comparison.

2.6.2 Status description

In order to be able to narrow down possible impacts of offshore wind farms on fish later in chapter 4.5, it is advisable to first differentiate the species according to their way of life and life cycle. Moreover, knowledge of their feeding habits, reproduction and habitat use can give important indications of the importance of an area or site for fish.

2.6.2.1 Way of life

At 53%, demersal fish make up the largest proportion of fish in the Baltic Sea before benthopelagic (27%) and pelagic (17%) species. Only approx. 3% cannot be assigned to any of the three lifestyles due to their close habitat links (FROESE & PAULY 2019). FOLLOWING MÖBIUS & HEINCKE (1883). the species are split into four categories based on the way in which they use the area as a habitat:

- resident marine fish which migrate but can always be found in the area and also reproduce there,
- migrating marine fish or vagrant fish which regularly, sporadically or extremely rarely immigrate from the North Sea but do not reproduce in the Baltic Sea,
- diadromous migratory fish which reproduce in freshwater and grow up in the sea or vice versa,
- freshwater fish which are either resident or migratory and reproduce in brackish water or freshwater.

According to MOYLE & CECH (2000), a distinction can be made between diadromous migratory species into

- anadromous species such as salmon, twait shad *Alosa fallax* and the European river lamprey *Lampetra fluviatilis* which spawn in freshwater and grow up in estuaries or in the sea,

- semi-anadromous species like the vimba bream *Vimba vimba*, the sabrefish *Pelecus cultratus,* the whitefish *Coregonus maraena* or the European smelt *Osmerus eperlanus* which spawn in the upper estuary/low-salt brackish water or freshwater, and
- catadromous species like the eel or flounder which spawn in the sea and grow up in brackish water or freshwater

While visiting species mostly seek out the area to find food, vagrant species are almost impossible to predict and usually occur as a result of unusual hydrographic or meteorological phenomena. Nearly half of all species in the Baltic Sea are resident fish, 18% can be classed as regular visitors, 29% as vagrants and 8% tend to enter the Baltic Sea for a short time only as a result of intentional or unintentional stock measures.

2.6.2.2 Spatial and temporal distribution

The special hydrography and the salt content gradient which reduces from west to east are also reflected in the fish fauna of the Baltic Sea. Whereas marine species prevail in the North Sea, freshwater fish make up the biggest proportion of the fish community in the Baltic Sea. While resident marine fish like the herring *Clupea harengus* and the European sprat *Sprattus sprattus* can be found in the area permanently and also reproduce there, marine visitors and vagrants from the North Sea make a regular, sporadic or extremely rare appearance (e.g. the pollock *Pollachius virens*), but do not reproduce in the Baltic Sea. Diadromous migratory fish like the European smelt *Osmerus eperlanus* and the salmon *Salmo salar* reproduce in freshwater and grow up in the sea. Finally, there are freshwater fish which are either resident or migratory and reproduce in brackish water or freshwater.

The spatial and temporal distribution of fish is determined first and foremost by their life cycle and the associated migrations of the various developmental stages (HARDEN-JONES 1968, WOOTTON 2012, KING 2013). The framework for this is established by a number of different factors which act on different spatial and temporal scales. From a large-scale perspective, the biggest effects are those of hydrographic and climatic factors in the broadest sense, such as swell and above all wind-driven currents which cool down influx and drive the oxygen-rich salt water from the North Sea, which materially impacts on the living conditions for fish in the Baltic Sea. The medium (regional) to small (local) space-time scale is affected by water temperature and other hydrophysical and hydrochemical parameters, as well as food availability, intra-species and inter-species competition and predation, which includes fishing in the broadest sense. Another key factor in terms of the distribution of fish in time and space is habitat, which in a broader sense does not only mean 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 in motion and maintain entire trophic cascades.

The wide spectrum of human activities and influences are other factors that can structure fish distribution. These range from nutrient and pollutant discharge to the construction of migration routes for migratory species and fishing, structures in the sea which the fish use as a spawning substrate (sheet piling for herring spawning) or food source (growth of artificial structures) or even as a refuge from which fishing is likely to be excluded (offshore wind farms) (EEA 2015).

2.6.2.3 Characterisation of the fish

community

The fish communities typical of the habitat of the Baltic Sea are represented by pelagic, benthic (demersal) and littoral species (NELLEN & THIEL 1995). These are not clear-cut boundaries and interactions occur, e.g. when pelagic fish like herring look for spawning grounds along the coast. In addition to spawning grounds, many fish species also use the coast to find food. The pelagic fish community is dominated by herring which occurs throughout the Baltic Sea. Sprat, salmon and the brown trout *Salmo trutta* are other characteristic representatives. The economically most important representative of the benthic fish community are the Atlantic cod *Gadus morhua*, the flounder *Platichthys flesus* and the European plaice *Pleuronectes platessa*. In addition to the mentioned commercially used species, other species of small fish (e.g. gobies) are important links in the Baltic Sea fish communities. These also include the black spotted goby *Neogobius melanostomus*, one of the world's most widely distributed, invasive fish species. In the western Baltic Sea, apart from a few rare exceptions, all frequently occurring marine fish have cold adaptations, e.g. the Atlantic cod, the whiting *Merlangius merlangus*, the European plaice and the common dab *Limanda limanda*. By contrast, some fish species distributed predominantly in the southern areas can be rare visitors to the western Baltic Sea, including the mackerel *Scomber scombrus*, the Atlantic horse mackerel *Trachurus trachurus*, the haddock *Melanogrammus aeglefinus*, the tub gurnard *Chelidonichthys lucernus*, the European anchovy *Engraulis encrasicolus* and the thicklip grey mullet *Chelon labrosus*. Nevertheless, resident fish in the western Baltic Sea also include some representatives of the 'southern type' with the turbot *Scophthalmus maximus*, the garfish *Belone belone*, the sprat, the black goby *Gobius niger* and the sand goby *Pomatoschistus minutus* (NELLEN & THIEL 1995). In the Baltic Sea, the occurrence of freshwater fish is limited to the river estuaries and the lagoons (THIEL et al. 1996).

2.6.3 Status assessment of the protected object 'fish'

The assessment of the status of the demersal fish community is based on:

i) rarity and vulnerability,
ii) diversity and uniqueness and
iii) existing cumulative effects.

These three criteria are defined below and applied to site O-1.3. The importance of the area is then considered in relation to the life cycle of the fish community.

2.6.3.1 Rarity and vulnerability

The rarity and vulnerability of the fish community are assessed on the basis of the proportion of species in the respective surveys (see 2.6.1) that have been assigned to one of the standardised Red List categories according to the current Red List and Total Species List of marine fish (THIEL et al. 2013) and, for diadromous species, to the standardised Red List of freshwater fish (FREYHOF 2009):

0: Extinct or lost
1: Critically endangered
2: Endangered
3: Vulnerable
G: Not evaluated
R: Extremely rare
V: Early warning list
D: Data deficient
*: of least concern

The relative proportions of the species assessed in the Red List in these assessment categories are related to the relative proportions of species from the data sources mentioned in 2.6.1. Particular attention is also paid to the threat situation of species listed in Annex II of the Habitats Directive. These are the focus of Europe-wide conservation efforts and require special conservation measures. The rarity or risk situation is high if the species of the categories '0' ('Extinct or lost') and '1' ('Critically endangered') occur regularly, i.e. if more than just a single example was found at one time. It is medium for the categories '2' ('Endangered') and '3' ('Vulnerable') and low for the categories 'Potential' and 'Least concern'. Species in Annex II of the Habitats Directive are generally classed as high. These taxa are the focus of Europe-wide protection efforts and their habitats require special protection measures.

No species of the risk categories 0, 1, 2, 3, G or R were identified at site O-1.3 during either of the two campaigns. In addition, no species on the early warning list (V) were found. For three species (grey gurnard, glass goby and sand goby), the data situation for a risk estimate is insufficient (D), whereas 16 species, by far the largest proportion of the species caught (84,2%), were not endangered (*) (THIEL et al. 2013) (
Table 7). The poor cod *Trisopterus minutus* was caught during the offshore site investigation but this species has not been evaluated in the Red List (THIEL et al. 2013).

The monitoring catches in the cluster of the Western Adlergrund and the Baltic Eagle in the marine area around site O-1.3 did not find any species of the risk categories 0, 1, G or R. With the European eel *Anguilla anguilla*, the twaite shad *Alosa fallax* and the viviparous eelpout *Zoarces viviparus*, the catches included one endangered species, one vulnerable species and one species on the early warning list. The data available for the lesser sand eel *Ammodytes tobianus*, the common dragonet *Callionymus lyra*, the red and grey gurnard, the halibut *Hippoglossus platessoides*, the great sand eel *Hyperoplus lanceolatus*, the shorthorn sculpin *Myoxocephalus scorpius* and the lesser pipefish *Syngnathus rostellatus,* were too limited for an evaluation, whereas 27 species (nearly three quarters of all species) were classed as least concern (THIEL et al. 2013;
Table 7). The poor cod, the snake pipefish *Entelurus aequoreus* and the greater pipefish *Syngnathus acus* were found during monitoring catches in the cluster of the Western Adlergrund and the Baltic Eagle but these have not been evaluated in the Red List for the Baltic Sea (THIEL et al. 2013).

Of the 89 fish and lamprey species established in the Baltic Sea whose risk level was evaluated in the current Red List (THIEL et al. 2013), 9% (8 species) are classed as extinct or at risk of extinction to varying extents (0, 1, 2, 3, G). Taking into account extremely rare species, the proportion of Red List species increases to 16.9% (15 species). The viviparous eelpout is included in the early warning list. Insufficient data make an evaluation impossible for around a fifth of established species, and 55 species (61.8%) are classed as least concern (
Table 7).

Only species which are not endangered as well as species for which there is an insufficient data basis, were found at site O-1.3. Nevertheless, there is evidence that some vulnerable species occur in the surrounding areas. For example, the offshore site investigations in the reference area in autumn 2018 revealed the presence of at least one vulnerable species according to THIEL et al. (2013), i.e. the Atlantic Salmon (risk 3), which is also listed in Annex II of the Habitats Directive (THIEL & WINKLER 2007). Even though only one individual of this species was caught, this nevertheless demonstrates that the occurrence of vulnerable, protected or rare species cannot be excluded in this area. Earlier surveys (EHRICH et al. 2006) also concluded that it is probable that rare, vulnerable or especially protected species are present in this area.

In the overall assessment, the fish fauna at site O-1.3 is rated as average in terms of the criterion of rarity and vulnerability, in spite of the dominance class as being of least concern.

2.6.3.2 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 evaluate the individuality of a community of fish, i.e. how regularly the typical species occur in the habitat. The assessment looks at the extent to which communities characteristic of the habitat occur and how regularly they occur. Diversity and individuality are classed as high if there is a high number of regularly occurring species or if a high density of the typical species for the habitat is identified. They are classed as medium if the typical communities are present but

Table 7; Absolute number of species and relative proportion of the Red List Categories of fish which were identified during the offshore site investigation (FVU) for site O-1.3 and during the environmental impact investigations (UVUs) (Western Adlergrund & Baltic Eagle) and for the entire German Baltic Sea (Red List and Full Species List, Thiel et al. 2013).

Red List Category	**FVU O-1.3**		**UVUs Western Adlergrund & Baltic Eagle**		**German Baltic Sea (Thiel et al. 2013)**	
	Absolute species number	relative proportion [%]	Absolute species number	relative proportion [%]	Absolute species number	relative proportion [%]
0: Extinct or lost	0	0	0	0	1	1.1
1: Critically endangered	0	0	0	0	2	2.2
2: Endangered	0	0	1	2.6	1	1.1
3: Vulnerable	0	0	1	2.6	3	3.4
G: Not evaluated	0	0	0	0	1	1.1
R: Extremely rare	0	0	0	0	7	7.9
V: Early warning list	0	0	1	2.6	1	1.1
D: Data deficient	3	15.2	8	21.1	18	20.2
***:** Of least concern	16	84.2	27	71.1	55	61.8
Total number of species	**19**[1]		**38**[2]		**89**	

[1] The poor cod was caught during the offshore site investigation but not evaluated in the Red List Baltic Sea. [2] The poor cod, the snake pipefish and the greater pipefish were found during monitoring catches in the cluster of the Western Adlergrund and the Baltic Eagle but these have not been evaluated in the Red List for the Baltic Sea.

the relevant taxa or parts thereof only occur in unusually low densities or frequencies. The medium rating is also used if the density of the demersal fish community as a whole is medium to high but it also contains smaller to medium proportions of uncharacteristic taxa. Individuality and diversity are classed as low if predominantly, species occur which are foreign to the habitat.

Taking into account all documented species, the Baltic Sea has 176 species (WINKLER et al. 2000). According to the fish database Fishbase, a total of 160 fish species have been recorded in the Baltic Sea as a whole as of November 2015 (FROESE & PAULY 2019). WINKLER & SCHRÖDER (2003) list 151 species for the whole of the German Baltic Sea coast for which scientifically confirmed evidence is available for the German Baltic Sea region. THIEL ET AL. (1996) put the number of Baltic Sea species at 144, including 97 marine fish species, 7 migratory and 40 freshwater fish species. Between 1977 and 2005, EHRICH et al. (2006) provided evidence of 58 fish species in the Baltic Sea. Most of these tend to be rare individual finds and only approx. half regularly reproduce in the German Exclusive Economic Zone or can be found there as larvae, young animals or adults. According to these criteria, only 89 species are considered established in the Baltic Sea (THIEL et al. 2013). During the 'Baltic International Trawl Surveys' (BITS) in 2018 (1st and 4th quarters) and 2019 (1st quarter) of the southern Baltic Sea, 59 fish species were identified. In the German EEZ, in this case represented by the cluster-related fishing data from the Environmental Impact Assessments, a total of 41 species were found in 127 catches. The 60 catches of the offshore site investigation for site O-1.3 revealed 20 species, the same number of species per catch as during the monitoring catches in the area of the Western Adlergrund and Baltic Eagle (Table 8).

Table 8: List of all fish species detected at project site O-1.3 and in the surrounding marine areas Western Adlergrund and Baltic Eagle showing their Red List Baltic Sea status (RLS; Thiel et al. 2013) and their lifestyle (LW; p = pelagic, d = demersal).

Artname	Deutscher Trivialname	LW	RLS	O-1.3 (Herbst 2018 & Frühjahr 2019, 60 Hols)	Westl. Adlergrund & Baltic Eagle (2016/ 2017, 127 Hols)
Agonus cataphractus	Steinpicker	d	*		x
Alosa fallax	Finte	p	3		x
Ammodytes tobianus	Tobiasfisch	p	D		x
Anguilla anguilla	Aal	d	2		x
Aphia minuta	Glasgrundel	p	D	x	
Callionymus lyra	Gestreifter Leierfisch	d	D		x
Chelidonichthys lucerna	Roter Knurrhahn	d	D		x
Clupea harengus	Hering	p	*	x	x
Cyclopterus lumpus	Seehase	d	*		x
Enchelyopus cimbrius	Vierbärtelige Seequappe	d	*	x	x
Engraulis encrasicolus	Sardelle	p	*	x	x
Entelurus aequoreus	Große Schlangennadel	p	-		x
Eutrigla gurnardus	Grauer Knurrhahn	d	D	x	x
Gadus morhua	Dorsch	d	*	x	x
Gasterosteus aculeatus	Dreistachliger Stichling	p	*	x	x
Gobius niger	Schwarzgrundel	d	*		x
Hippoglossoides platessoides	Doggerscharbe	d	D		x
Hyperoplus lanceolatus	Großer Sandaal	p	D		x
Limanda limanda	Kliesche	d	*	x	x
Liparis liparis	Großer Scheibenbauch	d	*		x
Melanogrammus aeglefinus	Schellfisch	d	*		x
Merlangius merlangus	Wittling	d	*	x	x
Myoxocephalus scorpius	Seeskorpion	d	D		x
Neogogius melanostomus	Schwarzmundgrundel	d	*		x
Osmerus eperlanus	Stint	p	*	x	x
Perca fluviatilis	Flussbarsch	p	*		x
Platichthys flesus	Flunder	d	*	x	x
Pleuronectes platessa	Scholle	d	*	x	x
Pollachius virens	Seelachs	d	*	x	
Pomatoschistus minutus	Sandgrundel	d	*	x	x
Scomber scombrus	Makrele	p	*		x
Scophthalmus maximus	Steinbutt	d	*	x	x
Scophthalmus rhombus	Glattbutt	d	*	x	x
Solea solea	Seezunge	d	*	x	x
Sprattus sprattus	Sprotte	p	*	x	x
Stizostedion lucioperca	Zander	p	*		x
Syngnathus acus	Große Seenadel	p	-		x
Syngnathus rostellatus	Kleine Seenadel	p	D		x
Syngnathus typhle	Grasnadel	p	*		x
Trachinus draco	Großes Petermännchen	d	*		x
Trachurus trachurus	Stöcker	p	*	x	x
Trisopterus minutus	Zwergdorsch	d	-	x	x
Zoarces viviparus	Aalmutter	d	V		x
SUMME Arten				**20**	**41**

The offshore site investigation for site O-1.3 showed a typical species composition and dominance structure for this Baltic Sea region (Arkona Sea) (cf. THIEL et al. 1996). In terms of abundance and biomass, Atlantic cod, flounder, European plaice and whiting were dominant both at O-1.3 and in the corresponding reference area, as confirmed by the results of investigations from 2011-2013 (IFAÖ 2013). The abundances and biomasses of the other attested species were comparatively low during these investigations (IFAÖ 2013) and during the offshore site investigations. The species composition and dominance structure of the fish community at site O-1.3 is typical for this Baltic Sea region. In addition, the typical and characteristic species of both the pelagic and the demersal components of the analysed fish communities were represented (Table 8). The abundances and biomasses of the catches were dominated by Atlantic cod, flounder, European plaice and whiting. Compared to earlier investigations (see references above), this indicates a stable species and dominance structure in the area of O-1.3. Accordingly, site O-1.3 is classed as medium for the criterion 'Diversity and individuality'.

2.6.3.3 Existing cumulative effects

Fishing is the most important anthropogenic source of existing cumulative effects for the fish fauna of the North Sea. In addition, nutrient contamination can also affect the natural habitat. Moreover, fish are subject to other direct and indirect human influences, such as marine traffic, pollutants and sand and gravel extraction, whose effects on the fish fauna are almost impossible to quantify. In addition to this, the relative impact of individual anthropogenic factors on the fish community and their interactions with natural biotic (predators, prey, competitors, reproduction) and abiotic (hydrography, meteorology, sediment dynamics) parameters of the German EEZ cannot be reliably separated. However, fishing can be considered to be the most effective means of disturbing the fishing community by depleting the target species and by-catch, as well as causing damage to the seabed in the case of bottom fishing methods. Populations are not estimated on a spatial scale smaller than the EEZ Baltic Sea, such that the information can only be linked with that from the offshore site investigation in part on the same spatial scale.

Of the 89 species which are considered to be established in the Baltic Sea (THIEL et al. 2013), 17 populations of 9 species are subject to commercial fishing (ICES 2019). The existing cumulative effects are evaluated based on the 'Fisheries overview – Baltic Sea Ecoregion' by the International Council for the Exploration of the Sea (ICES 2019). 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 by-catch species. The latter often include protected, vulnerable or threatened species, not just of fish but also of reptiles, birds and mammals (ICES 2019). The German fleet covers more than 700 fishing vessels of which just 60 operate in regions far from the coast. In the coastal regions, 650 smaller units exclusively operate gillnets. On the German Baltic Sea coast alone, the number of anglers catching Atlantic code, herring, brown trout, whiting and flatfish from the shore or from boats within 5 nautical miles is estimated at 161,000 (Hyder et al. 2017). Commercial fishing and the size of spawn populations are evaluated in relation to the maximum sustainable yield

(MSY) while applying the precautionary principle. A total of 17 populations were analysed in relation to fishing intensity; for 14, a scientific population estimate was carried out, with only 3 populations left out. Of the 17 analysed populations, 7 are being managed sustainably, 5 are overfished, and no reference points were defined for a further 5 (Fig. 15 & ICES 2019). Ten of the 17 populations were evaluated in relation to their reproductive capacity (spawn biomass). Six of them have full reproductive capacity, 2 are below this level, while no reference points regarding reproductive capacity have been defined for 9 populations (Fig. 15 & ICES 2019). The biomass proportion of populations which are fished at too high intensity in relation to total fishing for the Baltic Sea (756,100 t in 2019) by far outweighs the proportions of populations fished sustainably and populations which were not evaluated (>75%, Fig. 1). Nevertheless, fish from populations whose reproductive capacity is above the defined reference values, make up the predominant proportion of catches (>75%). The biomass of the analysed populations whose reproductive potential is below the reference threshold, makes up less than 25% (Fig. 15).

A direct influence of fishing on population development must be assumed for the target species and the incidental catches of Baltic Sea fisheries, such as due to the targeted removal of larger individuals which make an important contribution to the stability of the population through offspring of disproportionate size and ability to survive. During the offshore site investigation, this effect became apparent for Atlantic cod, flounder and European plaice: The relative proportion of caught Atlantic cod above 50 cm was relatively low, and the proportion of larger or older individuals (age group IV) compared to the total number of measured individuals was also relatively low for flounder and plaice. Even though trawler tracks from ground-based fishing equipment are ubiquitous at site O-1.3 and in the surrounding areas (BSH, unpublished), a high proportion of fish biomass is caught in a comparatively gentle process using gillnets or pelagic trawl nets. As of 2019, fishing intensity was classed as too high, but reproductive capacity does not appear to have been impacted.

In addition to fishing, eutrophication is one of the biggest environmental issues for the marine environment of the Baltic Sea (BMU 2018). In spite of reduced nutrient inputs and lower nutrient concentrations, the German Baltic Sea continues to be eutrophicated. Nitrates and phosphates enter predominantly via rivers which results in a pronounced nutrient concentration gradient from the coast towards the open sea (BROCKMANN et al. 2017).
The main direct effects of eutrophication are increased chlorophyll-a concentrations, reduced visibility depths, local declines in marine eelgrass areas and growth densities with the concomitant mass propagation of green algae and higher cell numbers of potentially harmful phytoplankton species. The coastal marine eelgrass meadows of the Baltic Sea play an important role in protecting fish spawn and young fish (BOBSIEN & BRENDELBERGER 2006). The advancing decline in marine eelgrass meadows due to eutrophication means that fewer retreats are available leading to potentially higher predation rates. The indirect effects of nutrient enrichment such as oxygen deficiency and changed species composition of macrozoobenthos can also have an impact on the fish fauna. For many species, the survival and development of fish eggs and larvae depend on oxygen concentration (SERIGSTAD 1987). Depending on how much oxygen is needed, a lack of oxygen can lead to the death of the fish spawn and larvae.

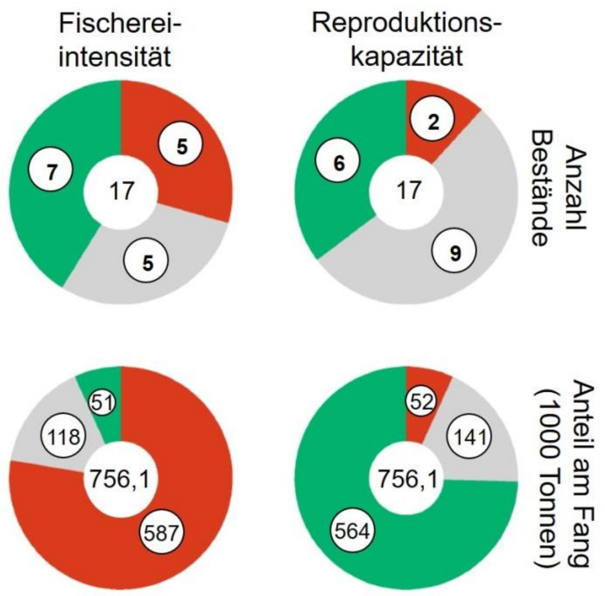

Figure 15: Fishing intensity and reproductive capacity of 17 fish populations in the North Sea, which together accounted for more than 750,000 tonnes caught in 2019. Number of populations (top) and biomass share of the catch (bottom). Reference level of fishing intensity: sustainable long-term yield (FMSY; red: above FMSY, green: below FMSY, grey: not defined); reference level of reproductive capacity: spawning biomass (MSY Btrigger; red: below MSY, green: above MSY, grey: not defined). Amended based on ICES (2019)

Furthermore, the changed benthos species composition can also influence the biodiversity of the fish community, especially for specialised feeders. According to the overview of key fishing figures (ICES 2019) and the ecosystem effects of ground-based fishing (WATLING & NORSE 1998, HIDDINK et al. 2006) and gillnet fishing, fish fauna at site O-1.3 is thus classed as average in relation to the existing cumulative effects.

2.6.3.4 Importance of site O-1.3 for fish

The overriding criterion for the significance of site O-1.3 for fish is the relationship to the life cycle, within which different stations are linked to stage-specific habitat requirements by more or less extensive migration between them. The Arkona Sea (ICES square 24) which also includes site O-1.3, is one of the main spawning grounds of Baltic cod, in which mature adult animals from surrounding sea areas can gather during the spawning season (Bleil & Oeberst 2012). During the offshore site investigations, mostly sexually immature cod were caught, presumably from the main spawning grounds in the south-western Baltic Sea (BLEIL et al. 2009). The site O-1.3 must therefore be classed as part of the nursery ground. By contrast, most flounder and plaice were already sexually mature, with only a very low proportion of juveniles found. Presumably, these species do not use the O-1.3 as a nursery ground. The methods used did not provide any evidence of spawning activity (eggs, larvae, mature spawning fish), but the conditions of O-1.3 meet the habitat requirements of both species (HEESSEN et al. 2015) so that spawning activity cannot be excluded. Both young and mature whiting were found, leading to the conclusion that this area enjoys varied use by this species. However, in the Baltic Sea, whiting only spawn in the Belts and in the Kattegat (HEESSEN et al. 2015), so that it is unlikely that site O-1.3 would be a spawning ground for this species.

The four demersal characteristic species use site O-1.3 as a nursery ground (Atlantic cod and whiting), possibly as a spawning ground (flounder and European plaice) and as a feeding area (all four species). These species occur throughout the Baltic Sea and are feed generalists. The localised site O-1.3 is therefore assigned average importance as a habitat.

2.7 Marine mammals

Three species of marine mammals regularly occur in the German EEZ in the Baltic Sea: porpoises (*Phocoena phocoena*), grey seals (*Halichoerus grypus*) and harbour seals (*Phoca vitulina*). All three species are characterised by a high degree of mobility. Migration, particularly for foraging, is not restricted merely to the EEZ but also includes coastal waters and wide areas of the Baltic Sea across borders. Both seal species have their resting and breeding sites on islands and sandbanks in the territorial sea. In order to search for food, they go on long journeys into the open sea from their resting places. Given their high mobility and very large areas, their occurrence must be observed not just in the German EEZ but across the whole area of the western Baltic Sea.

Marine mammals are among the top consumers of the marine food chain. As such, they depend on the lower components of the marine ecosystem: firstly on their direct food organisms (mainly fish and zooplankton) and secondly indirectly on phytoplankton. As top-level consumers in the marine food chain, marine mammals also influence the occurrence of their feed organisms.

2.7.1 Data situation

Current data on the occurrence of marine mammals are good. Most of the data is collected using standardised recording methods in accordance with the standard for the investigation of the impacts of offshore wind turbines on the marine environment (StUK4, BSH 2013), systematically quality-assured and used for studies, so the current state of knowledge on the occurrence of marine mammals in German waters can be classified as good. This good data situation allows a reliable description and assessment of occurrence as well as an estimation of the current status. It should be noted that data on large-scale occurrence are important when describing and assessing the occurrence of highly mobile species such as the harbour porpoise, as are data that provide insights into the temporal and spatial use of selected habitats.

The occurrence of the harbour porpoise in the German EEZ of the Baltic Sea is characterised by a strong gradient of decreasing density from the west in the direction of the central Baltic Sea. Its occurrence is also subject to seasonal variability.

Different data are available for various spatial levels:

- for the whole area of the northern European waters, surveys carried out in the context of SCANS I, II and III (Small Cetacean Abundance in the North Sea and Adjacent Waters) in 1994, 2005 and 2016 as well as the so-called mini-SCANS from 2012 (SCANS only covers the western Baltic Sea up to the German part of the Bay of Pomerania),
- for the whole area of the Baltic Sea, acoustic surveys carried out in the context of the EU research project SAMBAH (Static Acoustic Monitoring of the Baltic Sea Harbour Porpoise),
- research projects in the German EEZ and in the coastal waters, such as MINOS ('Marine Warmblüter in Nord- und Ostsee: Grundlagen zur Bewertung von Windkraftanlagen im Offshore-Bereich') – and surveys between 2002 and 2006 as part of MINOSplus,
- investigations in the context of approval and planning approval procedures for offshore wind farms in the areas O-1, O-2 and O-3 (SDP, 2019) which were re-evaluated for the offshore site investigation of site O-1.3,
- investigations in the context of approval procedures for pipelines and cables,
- monitoring of the Natura2000 areas / acoustic monitoring by the German Marine Museum on behalf of the Federal Agency for Nature Conservation (BfN),

SAMBAH is an international monitoring project whose objective is to promote the conservation of the Baltic harbour porpoise using scientific data. Between May 2011 and May 2013, 300 click detectors were installed in the central Baltic

Sea in order to determine the density, frequency and distribution of the harbour porpoise population.

2.7.2 Spatial distribution and temporal variability

The high level of mobility – depending on specific marine environment conditions – results in the high spatial and temporal variability of marine mammal occurrence. Both the distribution and abundance of the animals vary with the seasons. A good data basis is needed to be able to draw conclusions about their seasonal distribution patterns and about how they use the sub-areas of the German Baltic Sea. In order to be able to identify intra-annual and interannual variability, large-scale, long-term investigations are needed.

2.7.2.1 Harbour porpoises

The harbour porpoise is a common cetacean species found in the temperate waters of the North Atlantic and North Pacific and in some marginal 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 regularly occurring cetacean in the Baltic Sea.

The harbour porpoise is present in the German EEZ of the Baltic Sea throughout the year but its occurrence and spatial distribution is focused on specific regions depending on the season (GILLES et al. 2008, 2009). Nevertheless, its seasonal distribution patterns are less pronounced than in the North Sea.

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

Harbour porpoises migrate when searching for abundant food sources and intermittently congregate in areas with a high quality and/or quantity of food (REIJNDERS 1992, EVANS 1990). The preferred diet of the harbour porpoise consists of fish, primarily species related to herring and cod. Harbour porpoises tend to hunt shoals of fish (READ 1999). Their diet is dominated by pelagic and semipelagic fish species. Their nursery grounds tend to be in coastal areas with a water depth of less than 20 m, e.g. the Belts and the coast of Mecklenburg-West Pomerania (KINZE 1990, SCHULZE 1996).

Occurrence of the harbour porpoise in the German Baltic Sea

Population numbers in the whole area of the Kattegat, Belts, Sound and the western Baltic Sea have declined significantly between 1994 and 2005. While in 1994, SCANS I still found 27,800 (95% confidence interval = 11,946-64,549) animals in this area, in 2005 only 10,900 animals were recorded (KI = 5,840-20,214) (TEILMANN et al. 2011). Given the wide range of the 95% confidence intervals, this difference may not be significant (ASCOBANS 2012). The SCANS survey does not cover the area to the east of the Darss Sill.

SCHEIDAT et al. (2008) have demonstrated that the population density in the south-western Baltic Sea is subject to seasonal as well as spatial fluctuations. There are higher densities in the region of the Bay of Kiel. The abundance determined in surveys of harbour porpoises varied between 457 individuals in March 2003 (CI: 0-1,632) and the highest estimates in May 2005 of 4,610 animals (CI: 2,259-9,098). The most recent population estimates for the Bay of Kiel (including Danish waters up to Funen) in

2010 and 2011 found low densities of less than 0.4 individuals per km² (GILLES et al. 2011).

In 1995, a total of only 599 animals was detected for the area to the east of Darss Sill and Limhamn Sill to Øland and the outer Gulf of Gdansk(HIBY & LOVELL 1995). These values reflect a significant drop in the population density along a gradient from the Kattegatt to Polish waters (KOSCHINSKI 2002).

An evaluation of data from aircraft-supported counts, incidental sightings and beachings 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 activities of harbour porpoises (GILLESPIE et al. 2003, VERFUSS et al. 2004). When stationary click detectors (POD) were used near Fehmarn, harbour porpoises were detected nearly every day. In the period under investigation from 2008 to 2010, 90 to 100% porpoise-positive days were recorded around Fehmarn and the Bay of Mecklenburg. The results for the Aldergrund and the Odra Bank showed significantly lower harbour porpoise registration rates overall than in the western areas under investigation, which displayed a maximum of 21% porpoise-positive days in February 2010 (GALLUS et al. 2010).

The data from long-term monitoring by the German Maritime Museum revealed that the German waters of the Baltic Sea are populated primarily by harbour porpoises from the Belts population. The presence rates for harbour porpoises west of the Darss Sill are significantly higher than in the east (GALLUS A., K. KRÜGEL UND H. BENKE, 2015. 'Akustisches Monitoring von Schweinswalen in der Ostsee, Teil B in Monitoring von marinen Säugetieren 2014 in der deutschen Nord- und Ostsee im Auftrag des BfN').

Current findings of the research project SAMBAH involving the Baltic Sea littoral states have shown that there are three habour porpoise populations in the Baltic Sea: a) the North Sea population in the Skagerrak, b) the Belts population in the western Baltic Sea –Kattegat, Belts, Sound – through 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 based on acoustic data to be 447 individuals (95% confidence interval, 90 – 997) (SAMBAH 2014 & 2016).

Taking into account the results of acoustic, morphological, genetic and satellite-supported surveys, the winter boundary of the vulnerable harbour porpoise of the central Baltic Sea is at the level of Rügen at 13°30' east (SVEEGARD et al., 2015). The results of the multi-year project SAMBAH also showed that in the winter months to April, the animals of the central Baltic Sea population cover a large area and can be encountered near the coast. In the summer, they stick to a clearly defined boundary east of Bornholm (SAMBAH 2015, CARLEN et al. 2019).

Occurrence in nature conservation areas

Based on the results of the MINOS and EMSON studies (survey of marine mammals and seabirds in the German EEZ of the North Sea and Baltic Sea), five areas were defined in the German EEZ of the Baltic Sea that are of particular importance to harbour porpoises. These are the Habitats Directive areas 'Fehmarn Belt', 'Kadetrinne', 'Adlergrund', 'Western Rönnebank' and 'Bay of Pomerania with Odra Bank'.

The gradient of decreasing abundance from west to east is also reflected in the occurrence rates of harbour porpoises in the nature conservation areas. Systematic aerial counts on the Adlergrund and the Bay of Pomerania only spotted harbour porpoises in May 2002 (GILLES et al. 2004).

Abundance for the Habitats Directive areas 'Western Rönnebank' and 'Adlergrund' can only be estimated with a very high estimate error range. This relates to the generally low number of animals that use this part of the western Baltic Sea.

With the 2017 directives, the Habitats Directive areas in the German EEZ of the Baltic Sea were granted the status of nature conservation areas.

Occurrence at site O-1.3

Site O-1.3 and its surrounding area form part of the habitat of the harbour porpoise based on the findings for the wider surrounding area from the research projects MINOS and SAMBAH, the monitoring of the Natura2000 areas for the BfN and the monitoring for the offshore projects 'Wikinger' and 'Arkona Basin South-East'.

In addition, the investigations in the context of the ongoing monitoring for the cluster 'Western Adlergrund' for the offshore wind farm 'Wikinger' and 'Arkona Basin South-East' provide extensive up-to-date results for area O-1 including site O-1.3 (MIELKE et al., 2017, SCHULTZE et al. 2018, 2019).

From March 2015 up to and including February 2018, 30 video-supported aerial recordings were made in the approx. 2,400 km^2 area under investigation. From March 2015 until February 2016, before the two wind farms 'Wikinger' and 'Arkona Basin South-East' were erected, there were sightings of a total of eight harbour porpoises, two harbour seals and one unidentified seal. In the investigation period 2016/2017, two foundations were installed for the wind farm 'Wikinger'. During the erection phase, three harbour porpoises, including one mother-calf pair and five seals were recorded. In the subsequent investigation period from March 2017 until February 2018, five harbour porpoises and eight seals were recorded. During this investigation period, the foundations of the wind farm 'Arkona Basic South-East' were installed. All sightings took place in the period between July and October. In the phase before construction started and during the subsequent phases of the building activities and during operations of the turbines, all sighted animals were spotted in the areas far outside those of the two wind farms 'Wikinger' and 'Arkona Basin South-East' and outside site O-1.3.

Between March 2015 and February 2018, monthly ship-based surveys of sea birds were conducted. These also observed marine mammals. However, ship-based records of harbour porpoises are not reliable, so that these observations can only be used as a reference. The information gleaned from the ship-based surveys both spatially and temporally support the findings of the aerial surveys.

In order to describe and evaluate the use of this area by harbour porpoises, additional data from acoustic surveys from 2015 to 2018 based on C-PODS at two long-term measuring stations were used, at a distance to site O-1.3 of 1.8 km and 11.5 km.

The data from the acoustic survey using C-PODs showed that between June and October, harbour porpoises only use this area of the German EEZ to a limited extent. The measuring station in section I of the nature conservation area 'Bay of Pomerania – Rönnebank' at a distance of 11.5 km recorded a total of 17.8% detection-positive days between March 2015 and February 2016, meaning harbour porpoises were present in the area on 65 out of 365 days (Mielke et al., 2017). In subsequent years, the station at a distance of 11.5 km also always recorded greater activity than the station at 1.8 km distance. The activity at the station at 1.8 km distance tended to be registered during the day, whereas at the station at 11.5 km distance, night-time activity was greater than day-time activity.

The findings from all investigations confirm that site O-1.3 and its surrounding area see little use by harbour porpoises compared to the areas west of Darss Sill, while also displaying a pronounced interannual variability. For this reason, the evaluation of habitat use is based on the proportion of days in which harbour porpoise clicks were recorded in a month (PPT/month).

In addition, the area to the east of Sassnitz and the Odra Bank sees pronounced seasonal patterns in use by harbour porpoises. The presence rates of harbour porpoises rise slowly from June. The highest presence rates were recorded in the late summer and autumn. During the winter months and in the spring, harbour porpoises only use the area sporadically.

All past results from the mentioned investigations and for the further surrounding area can be summarised as follows in relation to the occurrence of harbour porpoises at site O-1.3:

- Harbour porpoises use site O-1.3 and its surrounding area on a regular basis but only to a very limited extent.
- The occurrence of harbour porpoises at site O-1.3 is low compared to occurrence rates east of Darss Sill, especially surrounding Fehmarn island, the Bay of Kiel, the Belts and the Kattegat.
- Based on the current level of knowledge, the site is not known to be used as a nursery ground.

2.7.2.2 Harbour seals and grey seals

The harbour seal is the most widely distributed seal species in the North Atlantic and is found throughout the North Sea and the Kattegatt. In the Baltic Sea, its regular distribution area is limited to the Øresund and the areas around the Danish islands Falster, Lolland and Møn. Its south-eastern distribution boundary is Scania (Sweden) (HARDER 1996, TEILMANN & HEIDE-JØRGENSEN 2001, SCHWARZ et al. 2003). There are currently no harbour seal colonies on the German coast (HELCOM 2005). Every years, around 5 to 10 harbour seals are sighted in Mecklenburg-West Pomerania. These sightings are distributed across the entire coastal region and are focused in the area of the West Rügen Bodden lagoons and the Bay of Wismar (HARDER & SCHULZE 2001). In rare cases, young animals are born there.

Suitable undisturbed resting areas are crucial for the presence of seals. Telemetric investigations have observed significantly shallower diving depths of harbour seals – compared to grey seals – and significantly shorter distances travelled,(DIETZ et al. 2003) with the result that the coastal shallow waters are the most likely hunting grounds of harbour seals. Potential food habitats can also be found in German waters along the Bodden coast of Mecklenburg-West Pomerania, especially in the up to 60 km perimeter of resting places. Telemetric studies show that adult seals in particular rarely move more than 50 km away from their original resting areas (TOLLIT et al. 1998).

Based on regular aerial counts in 2002 and 2003 for the resting places on the Danish and Swedish coasts nearest the German EEZ, the authors deduce a total population of 655 animals in the area of the southern Baltic Sea in 2003, taking into account a correction factor for harbour seals under water at the time (TEILMANN et al. 2004).

Suitable, undisturbed resting places and breeding sites also play a key role in the presence of grey seals. Sandbanks and unused beach sections (e.g. in the core area of the West Pomeranian Bodden national park) are potential resting places. There are currently no colonies of grey seals on the German Baltic Sea coast. The resting places nearest the German EEZ are at Rødsand on the Danish islands of Falster, Øresund and Måkläppen near Falsterbo in southern Sweden(TEILMANN & HEIDE-JØRGENSEN 2001, SCHWARZ et al. 2003). In the German EEZ, especially habitats to the east of the Darss are used to find food, while western areas are presumed to only play a minor role (SCHWARZ et al. 2003).

Grey seal counts at the time of their moult, which in the Baltic Sea takes place between May and June, recorded a total of 17,640 animals for the Baltic Sea in 2004 (KARLSSON & HELANDER 2005). This figure is used to deduce a total population of approx. 21,000 animals.

It is likely that the distribution of Baltic Sea grey seals depends on ice cover, among other factors. As hunting grounds, grey seals use coastal shallow waters and shallow areas far from the coast as well as underwater slopes and reefs (SCHWARZ et al. 2003). Therefore, potential hunting grounds in the EEZ are, among others, Kadetrinne, Adlergrund or the Odra Bank. However, based on present findings, it is not possible to predict how these potential habitats may be used, as both the diet composition and preferences when choosing food areas may vary greatly during the course of the year and across several years (SCHWARZ et al. 2003).

The relevant literature describes both relatively short trips of less than 10 km which end in a return to the same resting place, and food excursions to at times more than 100 km distant feeding grounds alongside some quite protracted migrations to other colonies. DIETZ et al. (2003) determined the positions of tracked grey seals near Rødsand based on the '95% Kernel Home Range'. This illustration shows the area in which an animal is likely to be sighted at all times with a probability of 95%. For four out of six animals, the 'Kernel Home Range' included parts of the German EEZ.

The aerial harbour tortoise counts in the Baltic Sea (GILLES et al. 2004) spotted neither harbour seals nor grey seals so that it is not possible to make any statement about their use of the areas. The telemetric investigations from the southern Baltic Sea (DIETZ et al. 2003) and observations in the area of the Bay of Wismar (HARDER & SCHULZE 1997) suggest an occasional use of the Fehmarn Belt as a food habitat for harbour seals. The telemetric study from the southern Baltic Sea (DIETZ et al. 2003), individual observations as well as dead animals found (HARDER et al. 1995) suggest that the Kadetrinne, Adlergrund or the Odra Bank are used as a migratory corridor or food habitat for grey seals. According to a recent population survey by the BfN, around 50 to 60 grey seals live in the waters around Rügen – 30 of them at Greifswald Bodden.

Harbour seals and grey seals sporadically cross the area of the German EEZ in the Baltic Sea in which site O-1.3 is located, during their migrations.

2.7.3 Status assessment of marine mammals

2.7.3.1 Protection status

Harbour porpoises are protected under several international conservation agreements. They fall under the protection mandate of the European Habitats Directive (Directive 92/43/EEC) on the conservation of natural habitats and of wild fauna and flora, under which special areas are designated for the protection of the species. The harbour porpoise is listed in both Annex II and Annex IV of the Habitats Directive. As a species in Annex IV, they are subject to general, strict species protection in accordance with Sections 12 and 16 of the Habitats Directive.

The porpoise is also listed in Annex II to the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention, CMS). The Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) was also adopted under the auspices of CMS.

In addition, the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) should also be mentioned: here the harbour porpoise is listed in Annex II. In Germany, the harbour porpoise is also included in the Red List of endangered animals (Binot et al., 1998). Here it is classified in endangerment category 2 (critically endangered).

In the IUCN list of endangered species, the harbour porpoise population of the central Baltic Sea is classed as endangered (Cetacean update of the 2008 IUCN Red List of Threatened Species). In Germany, the harbour porpoise is also listed in the Red List of Endangered Animals (Haupt et al., 2009). Here it is classified in endangerment category 2 (critically endangered).

The grey seal and harbour seal are also listed in Annex II of the Habitats Directive. The Red List also classes the grey seal as risk category 2, while the harbour seal is classed as least concern.

The protection purposes of the nature conservation areas in the German EEZ of the Baltic Sea include, among others, the preservation and restoration of a favourable conservation status for the species in Annex II of the Habitats Directive, especially the harbour porpoise, grey seal and harbour seal and the preservation of their habitats (nature conservation area 'Bay of Pomerania – Odra Bank' (NSGPBRV), Federal Law Gazette Vol. I, I p. 3415 of 22.09.2017).

2.7.3.2 Assessment of occurrence

The harbour porpoise population in the Baltic Sea has decreased in the course of the last centuries. The situation of the harbour porpoise in the Baltic Sea has been further aggravated by commercial fishing of the animals in the past as well as by extreme icy winters and, finally, by incidental catches, pollutants, noise pollution and food limitation (ASCOBANS 2003). The separate population of the Baltic Sea is particularly at risk due to the small number of individuals, its geographic restriction and the lack of gene exchange, with the result that it is critically endangered (ASCOBANS 2010).

2.7.3.3 Importance of site O-1.3 for marine mammals

The site O-1.3 and its surrounding area, like the whole of the western Baltic Sea, form part of the habitat of the harbour porpoise.

The BSH has a solid data basis for evaluating the importance of site O-1.3 in the German EEZ.

Based on the present level of knowledge, site O-1.3 and its surrounding area are also allocated to the habitat of the endangered harbour porpoise of the Baltic Sea population. However, harbour porpoises only use the site irregularly as a crossing point, to rest and for food. The occurrence of harbour porpoises in this area of the German EEZ of the Baltic Sea is low compared to occurrence rates west of Darss Sill, especially surrounding Fehmarn island, the Bay of Kiel, the Belts and the Kattegat. There is no evidence to suggest that the site and its surrounding area is being used as a nursery ground. For the harbour porpoise, this area of the EEZ of the Baltic Sea is of medium importance to high importance seasonally during the winter. The importance of site O-1.3 and its surrounding area results from their possible use during the winter months by individuals of the separate, endangered Baltic Sea harbour porpoise population. Research findings have shown that during the winter months in particular, individuals of the endangered harbour porpoise population of the central Baltic Sea migrate to German waters and also use site O-1.3 and its surrounding area.

According to the current level of knowledge, the importance of site O-1.3 and its surrounding area for the harbour porpoise can be summarised as follows:

- Harbour porpoises use site O-1.3 and its surrounding area irregularly as a crossing point, to rest and for food.
- The occurrence of harbour porpoises in the area of site O-1.3 is low compared to occurrence rates east of Darss Sill, especially surrounding Fehmarn island, the Bay of Kiel, the Belts and the Kattegat.
- There is no clear evidence to show that this area of the German EEZ of the Baltic Sea in which site O-1.3 is located, is being used as a nursery ground.
- Site O-1.3 and its surrounding area are of medium importance to, seasonally, high importance for harbour porpoises.
- The high importance of this area of the German EEZ of the Baltic Sea results from its possible use by the individuals of the separate, endangered harbour porpoise population of the central Baltic Sea during the winter months.
- Site O-1.3 and its environment are of minor to, at most, medium importance for seals and common seals.

2.7.3.4 Existing cumulative effects

The existing cumulative effects on the harbour porpoise population in the Baltic Sea result from various anthropogenic activities, from changes to the marine ecosystem and from climate change. The existing cumulative effects on marine mammals result from fisheries, underwater noise emissions and pollutant loads. The biggest existing cumulative effect for the harbour porpoise population in the Baltic Sea is due to fisheries as a result of the unintentional incidental catches in gillnets (ASCOBANS 2010). Incidental catches in the Baltic Sea are much higher than in the North Sea. The separate Baltic Sea population in particular is endangered even as a result of few incidental catches.

The International Whaling Commission (IWC) has agreed that mortality due to incidental catches must not exceed 1% of the estimated population(IWC, 2000). In case of higher incidental catch rates, the protection target, i.e. population recovery to 80% of the habitat carrying capacity, is put at risk (ASCOBANS 2010).

Individual reports of incidental catches in the Baltic Sea (KASCHNER 2001) suggest that ground gillnets for turbot, Atlantic cod, European plaice and lumpfish as well as driftnet fishing for salmon are primarily responsible for incidental catches. However, it is not possible to determine the incidental catch rates for the Baltic Sea due to the limited information available (KASCHNER 2001, 2003). Around 5 incidental catches per year are reported in Poland, and Sweden reported another 5 in the early 1990s (SGFEN 2001). An extrapolation based on questionnaires for German fisheries in the western Baltic Sea assumes 57 incidental catches per year (21 from secondary fishing, 36 by professional fisheries) (RUBSCH & KOCK 2004).

In the area to the east of Darss Sill, 25 incidental catches are reported to occur (1 from secondary fishing, 24 by professional fisheries). This is much higher than the official figures reported by fishermen and exceeds the tolerable incidental catch rates according to the IWC and ASCOBANS (IWC 2000).

Current anthropogenic uses in the vicinity of site O-1.3 with high sound exposure are, apart from shipping traffic, seismic exploration, and military uses or blasting of non-transportable ammunition. Hazards to marine mammals may arise during the construction of deep-foundation wind farms and transformer platforms, in particular noise emissions during the installation of the foundations, if no mitigation or avoidance measures are implemented.

2.8 Seabirds and resting birds

According to the 'Quality standards for the use of ornithological data in spatially significant planning' (Deutsche Ornithologen-Gesellschaft 1995), resting birds are defined as 'birds which stay in an area outside their breeding territory, usually for a long period of time, e.g. for the purpose of moulting, feeding, resting, wintering'. Foraging guests are defined as birds ‘that regularly seek food in the area under investigation, do not breed there, but breed or may breed in the wider region’.

Seabirds are species of birds that are mainly bound to the sea by their way of life and only come ashore for breeding for a short time. These include fulmar, gannet and auks (common guillemot, razorbill). Terns and gulls, on the other hand, are more common near the coast than seabirds.

2.8.1 Data situation

The BSH has a comprehensive data basis available for the suitability assessment of site O-1.3 with regard to the protected object of 'seabirds and resting birds'. It largely consists of the results and findings of mandatory monitoring by the operator during the construction and operation phase of offshore wind farms according to the standard investigation concept (StUK 4). As part of the monitoring, since 2014 the numbers of seabirds and resting birds for wind farm projects in area O-1 have been recorded using large-scale ship-based and aerial (digital) recordings for the research cluster 'Western Adlergrund'. The records for 2014 and 2015 include the basic recordings for the now implemented wind farm project in the area O-1; the years 2016 – 2018 cover the building phase. The findings from the monitoring can also be used to describe and evaluate seabirds and resting birds in the environment of site O-1.3 (BIOCONSULT SH 2016a, BIOCONSULT SH 2017a, IFAÖ & BIOCONSULT SH 2018, IFAÖ & BIOCONSULT SH 2019).

Important information on the large-scale presence of seabirds in the German EEZ of the Baltic Sea is available from the marine bird monitoring carried out on behalf of the Federal Agency for Nature Conservation in recent years (e.g. MARKONES et al. 2015). In addition, use has been made of extensive scientific literature and evaluations of various specific aspects.

The data basis can therefore be assessed as very good overall. Nevertheless, the following points should be taken into account:

- The species-specific risk of collision of seabirds with offshore wind turbines can only be partially predicted and is currently being surveyed by means of studies according to StUK4 in the operational phase, but also as part of ongoing research projects.
- Behavioural changes or habituation effects of disturbance-sensitive types of use in the

German EEZ have only been studied since the first large-scale commercial wind farms, including the transformer platforms, were commissioned. Operational monitoring is still ongoing.

- The effects of disturbance or habitat loss at the population level of the species are still poorly understood and are only being investigated based on the data now being collected.

2.8.2 Spatial distribution, temporal variability and abundance of seabirds and resting birds in the German Baltic Sea

Marine birds have the highest mobility level among the upper consumers of marine food chains. This enables them to search vast areas for food or, in case of some species, to follow their prey organisms, e.g. fish, for long stretches. The high level of mobility – depending on specific marine environment conditions – results in the high spatial and temporal variability of seabird occurrence. The distribution and abundance of birds vary during the course of the seasons and interannually.

The distribution of seabirds in the Baltic Sea is determined primarily by the food available, the hydrographic conditions, the water depth and the sediment conditions. Furthermore, their occurrence is influenced by pronounced natural events (e.g. icy winters) and by anthropogenic factors such as nutrient and pollutant discharge, marine traffic and fisheries. Generally speaking, open, largely shallow areas with water depths of up to 20 m and a rich supply of food provide ideal conditions for seabirds as resting places or for overwintering. In addition, the importance of resting areas increases if populations move further west in winter because ice forms or covers the eastern Baltic Sea (VAITKUS 1999).

Several million birds overwinter in the Baltic Sea each year. It is one of the most important areas for marine and water birds in the Palaearctic realm. A series of studies has shown the great significance of the German Baltic Sea for marine and water birds – not just nationally but also internationally (DURINCK et al. 1994, GARTHE et al. 2003, SONNTAG et al. 2006, SKOV et al. 2011). It is especially worth mentioning the nature conservation area 'Bay of Pomerania – Rönnebank' with its important resting and feeding grounds Adlergrund and Odra Bank which since 2007 has formed part of the European protection area network Natura2000 and was designated a nature conservation area with the ordinance of 22.09.2017.

The western Baltic Sea is of great importance to many marine and water birds as a resting and overwintering habitat. 38 marine and resident bird species regularly occur in the German Baltic Sea (SONNTAG et al. 2006). Table 9 shows estimated populations for the most important marine bird species in the EEZ and the whole of the German Baltic Sea in winter. Detailed descriptions of seasonal and spatial occurrence for the most common marine and resident bird species and species of special importance for the nature conservation area

'Bay of Pomerania – Rönnebank' in the EEZ of the Baltic Sea, can be found in the relevant chapters of the environmental report for the Site Development Plan from 2019 for the German Baltic Sea (BSH 2019).

2.8.3 Occurrence of seabirds and resting birds in the vicinity of site O-1.3

The extensive studies of seabirds as part of environmental impact studies and during the construction or operation phases of offshore wind farms in the 'Western Adlergrund' study cluster unanimously show that a seabird community is present in the area surrounding site O-1.3, as is to be expected for the prevailing water depths and hydrographic conditions, the distance from the coast and site-specific influences.

Red-throated loons (*Gavia stellata*) and black-throated loons (*Gavia arctica)* are winter visitors and transitory birds in the Baltic Sea (Mendel et al. 2008). Red-throated loons use the coastal waters and the German EEZ in the spring and winter, while black-throated loons tend to be more frequent in the autumn and winter. Both species prefer an area to the east of the island of Rügen and the Bay of Pomerania to the Odra Bank (Sonntag et al. 2006). Red-throated loons prefer areas with water depths of less than 20 – 30 m (Durinck et al. 1994, Mendel et al. 2008). In contrast to the North Sea, black-throated loons can be observed comparatively frequently in the Baltic Sea. According to Dierschke et al. (2012), the proportion of black-throated loons to red-throated loons in the western Baltic Sea ranges from 43% in winter to 8% in the spring. In the vicinity of site O-1.3, the highest average seasonal densities of red-throated loons in past years during the investigation were identified in the spring and winter. The densities from the ship-based transect surveys were lower than the densities from the flight-based transect surveys. This can be explained, on the one hand, with reference to the fact that red-throated loons are more likely to fly into the air when ships approach and, on the other hand, by the fact that flight investigations cover larger areas, including those predominantly used by red-throated loons. Average seasonal densities from ship-based investigations in the investigation years 2016 to 2018 were max. 0.32 ind./km^2 in spring 2016 (IfAÖ & BioConsult SH&Co KG 2018). According to the flight-based investigations, the maximum average seasonal density was 0.58 ind./km^2 in spring (IfAÖ & BioConsult SH&Co KG 2019). The maximum monthly densities according to the flight-based transect surveys for the investigation years 2016 – 2018 were 1.22 ind./km^2 in March 2017 and 0.64 ind./km^2 in March 2016. An analysis of spatial distribution reveals that the maximum values in the southernmost section of the investigation area were determined within the bird protection area 'Bay of Pomerania – Rönenbank' and in the very east of the investigation area. No focal points were identified in the immediate vicinity of site O-1.3 (IfAÖ & BioConsult SH&Co KG 2018, IfAÖ & BioConsult SH&Co KG 2019). This was already shown by the studies preceding construction in area O-1, which suggested a natural gradient in the distribution of red-throated loons (BioConsult SH 2016a, BioConsult SH 2017a).

The main occurrence of horned grebes (*Podiceps auritus)* in the German Baltic Sea is in the Bay of Pomerania. This is the most important overwintering area in NW-European waters (Durinck et al. 1994). Distribution is focused on the

Table 9: Midwinter populations of the most important resident bird species in the German Baltic Sea and the EEZ after Mendel et al. (2008).

Common name *(scientific name)*	**Population in the**	**Population in the**
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 (*Podiceps auritus*)	1,000	700
Red-throated loon (*Gavia stellata*)	3,200	550
Black-throated loon (*Gavia arctica*)	2,400	550
Great cormorant (*Phalacrocorax carbo*)	10,500	< 50

Common name *(scientific name)*	**Population in the**	**Population in the**
Razorbill *(Alca torda)*	3,600	310
Common 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

Odra Bank, especially waters with a depth of less than 10 m. This is also confirmed by past surveys in the investigation areas of the cluster 'Western Adlergrund' during which only individual horned grebes were sighted. Accordingly, the occurrence of horned grebes is not focused in the direct vicinity of site O-1.3 (BioConsult SH 2016a, BioConsult SH 2017a, IfAÖ & BioConsult SH 2018, IfAÖ & BioConsult SH 2019).

Only limited numbers of little gulls occur in the offshore area in spring and summer. During their autumn migration, they can be spotted in larger numbers in the Bay of Pomerania (Sonntag et al. 2006). The investigations for the cluster 'Western Adlergrund' tended to record little gulls only during the larger-scale flight-based transect surveys. The highest average seasonal densities were sighted in autumn 2017 at 0.12 ind./km^2. They have a large-scale spatial distribution, and no focal points were identified in the immediate vicinity of site O-1.3 (IfAÖ & BioConsult SH&Co KG 2018, IfAÖ & BioConsult SH&Co KG 2019).

Long-tailed ducks (*Clangula hyemalis)* are the most frequent ducks in the Baltic Sea. However, according to a study by Skov et al. (2011), their winter resting population has dropped by 65.3% in the period from 1992 to 2009. The Bay of Pomerania in the southern Baltic Sea is one of their most important winter resting areas. In line with the development of the whole of the Baltic Sea, a reduction in the occurrence rates for long-tailed ducks was also recorded here, of 82% by 2010 (Bellebaum et al. 2014). An investigation of other resting habitats suggests a northward shift (Skov et al. 2011). Generally speaking, it is assumed that the Bay of Pomerania can continue to absorb larger numbers (Bellebaum et al. 2014). The long-tailed duck has further extended principal resting habitats in the winter and spring to the east of Rügen and north of Usedom (Garthe et al. 2003, Garthe et al. 2004). Like other duck species in the Baltic Sea, long-tailed ducks prefer shallow coastal areas and shallow offshore areas with water depths of up to 20 m (Sonntag et al. 2006, Markones & Garthe 2009). Past investigations for the cluster 'Western Adlergrund' have shown that long-tailed ducks only occur in larger densities to the east, i.e. in the Adlergrund, and to the south of site O-1.3. The highest average seasonal densities were mostly determined in winter and in the period 2016 – 2018 were 10.31 ind./km^2 and 12.38 Ind./km^2. Their occurrence did not focus on the immediate vicinity of site O-1.3 (IfAÖ & BioConsult SH&Co KG 2018, IfAÖ & BioConsult SH&Co KG 2019).

In addition to the northern Kattegat and the Bay of Riga, Velvet scoters *(Melanitta fusca)* primarily use the northern Bay of Pomerania as an overwintering location. In the Bay of Pomerania, velvet scoters in winter and spring are predominantly present in the area between the Odra Bank and the Adlergrund (Garthe et al. 2003, Garthe et al. 2004). During ice-free winter months, velvet scoters primarily use the central areas of the Odra Bank; if there is ice cover, their occurrence is limited to the immediately adjacent ice-free areas in the northern section of the Odra Bank (MARKONES et al. 2013, MARKONES et al. 2014). Past investigations of the cluster 'Western Adlergrund' confirm that velvet scoters are present primarily in the shallow grounds far to the south and east of the O-1.3. The smaller-scale ship-based transect surveys rarely recorded velvet scoters, but the larger-scale flight-based transect surveys found average seasons densities for the years 2016 – 2018 of between 0.65 and 1 ind./km^2 (IFAÖ & BIOCONSULT SH&CO KG 2018, IFAÖ & BIOCONSULT SH&CO KG 2019).

The Odra Bank in the Bay of Pomerania is one of the most important resting areas for the common scoter (*Melanitta nigra)* of the whole of the Baltic Sea (DURINCK et al. 1994, GARTHE et al. 2003). According to GARTHE et al. (2003, 2004) and SONNTAG et al. (2006), common scoters are present in the German Baltic Sea throughout the year. In recent years, the highest densities in the areas investigated for the cluster 'Western Adlergrund' were recorded in the spring. The average seasonal densities in the spring were 0.30 ind./km^2 according to flight-based transect surveys (spring 2017) and 0.23 – 0.32 ind./km^2 according to ship-based transect surveys. Their occurrence in the areas examined during the larger-scale flight-based surveys were focused to the south and south-east of site O-1.3 (IFAÖ & BIOCONSULT SH&CO KG 2018, IFAÖ & BIOCONSULT SH&CO KG 2019).

So far, investigations have only observed common eiders (*Somateria mollissima)* rarely or in flight in the vicinity of site O-1.3 (BIOCONSULT SH 2017a, IFAÖ & BIOCONSULT SH 2018, IFAÖ & BIOCONSULT SH 2019). In the same way as for the other marine duck species, their occurrence did not focus on the area of O-1.3.

Common guillemots (*Uria aalge*) and razorbills (*Alca torda)* are the most frequent representatives of auks in German marine waters. Common guillemots only occasionally visit the Baltic Sea in spring, summer and autumn. The highest number of individuals are recorded in winter. Their distribution focuses on the offshore areas of the Bay of Pomerania, especially the deeper waters between the Odra Bank and the Adlergrund and those north-west of the Adlergrund (SONNTAG et al. 2006). Razorbills can be spotted in the German Baltic Sea primarily in winter. Their winter resting area is above the deeper sections of the central Baltic Sea. They occur in low to medium densities in large parties of the coastal and offshore waters of the Bay of Pomerania (MENDEL et al. 2008). Given their similar appearance and comparable habitat requirements and distribution patterns, common guillemots and razorbills are often analysed together. The past investigations for the cluster 'Western Adlergrund' consistently recorded the highest average seasonal densities in winter. In the years from 2016 to 2018, average seasonal densities in winter were between 0.33 and 0.66 ind./km^2 according to ship-based surveys and between 0.70 and 1.07 ind./km^2 according to flight-based surveys (IFAÖ & BIOCONSULT SH&CO KG 2018, IFAÖ & BIOCONSULT SH&CO KG 2019). In the preceding years, their densities especially from the large-scale flight transect surveys were higher, at 3.81 ind./km^2 in winter 2014/2015 and 2.83 ind./km^2 in winter 2015/2016 (BIOCONSULT SH 2016a, BIOCONSULT SH 2017a). An analysis of the spatial distribution of common guillemots and razorbills during a winter with high occurrences shows a large-scale distribution of auks, at times over whole areas, dominated primarily by common guillemots. This is also true of more recent investigations which found lower densities than in 2014 and 2015. Their occurrence has not been found to focus on the vicinity of site O-1.3 (BIOCONSULT SH 2016a, BIOCONSULT SH 2017a, IFAÖ & BIOCONSULT SH 2018, IFAÖ & BIOCONSULT SH 2019).

Black guillemot (*Cepphus grylle*) are also auks but are observed more rarely in the Baltic Sea due to lower populations. The preferred winter resting sites of black guillemots include more shallow areas and stony ground. In the German Baltic Sea, they are predominantly present in the area of the Adlergrund between autumn and spring. In spite of relatively low densities, their occurrence according to GARTHE et al. (2003) must be classed as internationally significant (MENDEL et al. 2008). In the investigation areas of the cluster 'Western Adlergrund', black guillemots are only sighted occasionally. The site O-1.3 did not seem to play any special role (BIOCONSULT SH 2016a, BIOCONSULT SH 2017a, IFAÖ & BIOCONSULT SH 2018, IFAÖ & BIOCONSULT SH 2019)

The main occurrence of red-necked grebes (*Podiceps auritus)* in the German Baltic Sea is in the Bay of Pomerania. Similarly to red-throated loons, they are predominantly winter visitors and transitory birds. They reach the highest resting populations in winter which decrease again in the spring (MENDEL et al. 2008). Past investigations of the cluster 'Western Adlergrund' only observed red-necked grebes very occasionally. The proportion of unidentified grebes compared to overall occurrence in past investigations did not suggest a focus in the vicinity of site O-1.3. These also include the great crested grebe (*Podiceps cristatus*) (BIOCONSULT SH 2016a, BIOCONSULT SH 2017a, IFAÖ & BIOCONSULT SH 2018, IFAÖ & BIOCONSULT SH 2019).

In the Baltic Sea, yellow-billed loons (*Gavia adamsii)* are transitory birds during migratory periods and resting birds in the western Baltic Sea during winter. Their occurrence in winter is low and limited to the sections of the Bay of Pomerania far from the coast (BELLEBAUM et al. 2010). During previous cluster investigations of the 'Western Adlergrund', only two yellow-billed grebes were clearly identified during flight-based surveys in the investigation year 2015/2016 (BIOCONSULT SH 2017a).

Common gulls (*Larus canus*) are present in the Baltic Sea in much lower densities than in the North Sea. In the summer, they are only occasionally spotted in the German Baltic Sea. The maximum number of individuals are observed In winter and spring. During these times, common gulls occur primarily in the coastal areas and in the areas far from the coast in the Bay of Pomerania (SONNTAG et al. 2006). In the investigation years 2016 to 2018, the maximum average densities in winter were 0.19 Ind./km^2 in 2017/2018 according to ship-based surveys and 0.23 ind./km^2 according to flight-based surveys, also in 2017/2018. Their occurrence is distributed over a large area and does not seem to focus on the vicinity of site O-1.3 (IFAÖ & BIOCONSULT SH 2018, IFAÖ & BIOCONSULT SH 2019).

Herring gulls (*Larus argentatus*) are the most frequent gull species found in the Baltic Sea and occur throughout the year. In winter and spring, a high number of individuals can be observed both in coastal waters and in the EEZ. Especially high concentrations arise in the context of fishing activities (SONNTAG et al. 2006). Presumably, European herring gulls do not naturally breed in the western Baltic Sea. It was the establishment of motorised trawl net fishing in the 1930s which led to their immigration and the rise in their populations (VAUK & PRÜTER 1987). The past investigations of the cluster 'Western Adlergrund' identified high densities in the spring and winter as well as in the autumn, but these always remained below 1 ind./km^2. No focal points were identified in the vicinity of site O-1.3 (IFAÖ & BIOCONSULT SH 2018, IFAÖ & BIOCONSULT SH 2019).

Great black-backed gulls *(Larus marinus)* spend time in the western Baltic Sea all year round. But during their breeding period between April and July, their populations are low. Winter populations may be dependent on the ice conditions in the Baltic Sea. Great black-backed gulls occur in higher numbers during the migratory period and in the winter months. Like European herring gulls, this species also tends to be found in the proximity of fishing vessels (SONNTAG et al. 2006). The densities in the investigation areas of the cluster 'Western Adlergrund' determined so far are rarely higher than a 0.2 ind./km². No focal points were identified in the area of site O-1.3 (IFAÖ & BIOCONSULT SH 2018, IFAÖ & BIOCONSULT SH 2019).

2.8.4 Status assessment and importance of site O-1.3 for seabirds and resting birds

Given the high number of surveys in recent years, it is possible to reliably estimate the importance and status of the area surrounding site O-1.3 as a habitat for seabirds.

2.8.4.1 Protection status

Of the marine bird species which regularly occur in the vicinity of site O-1.3, albeit in low densities, red-throated loons, black-throated loans, little gulls and horned grebes are listed in Annex I of the EU Bird Protection Directive. Red- and black-throated loons and little gulls are also assigned to SPEC category 3 (species not concentrated in Europe, but with negative population development and unfavourable conservation status in Europe). European herring gulls are considered a 'species with global population concentrated in Europe and with negative population development and unfavourable conservation status in Europe' (SPEC category 2). Horned grebes, common eiders, long-tailed ducks and common scoters are assigned to SPEC category 1 (European species requiring global protection measures, i.e. globally classed as 'Critically Endangered', 'Endangered', 'Vulnerable', 'Near Threatened' or 'Data Deficient') (BIRDLIFE INTERNATIONAL 2017).

According to the European Red List, long-tailed ducks, velvet scoters and common eiders are classed as 'vulnerable' (VU) based on their negative population development in recent years. The drastic drop in the winter resting population of the long-tailed duck in the Baltic Sea (SKOV et al. 2011) is also reflected in the HELCOM Red List (HELCOM 2013b). This classes the long-tailed duck, in addition to other marine duck species, as 'endangered'. The winter resting populations of red-throated and black-throated loons in the Baltic Sea are 'critically endangered' (CR), while their populations across the whole of Europe and in the 27 EU states is classed as 'least concern' (LC). The populations of little gulls and horned grebes in the whole of Europe and in the Baltic Sea (winter resting populations) are listed as 'near threatened' (NT). Great black-backed gulls and common gulls are generally classed as 'least concern' (LC). European herring gulls, common guillemots and razorbills are classed as 'near threatened' (NT) in the pan-European Red List, but their winter resting populations in the Baltic Sea were not assigned a protection status. The reverse is the case for black guillemots (HELCOM 2013b, BirdLife International 2015). The evaluated aspect 'protected status' in the vicinity of site O-1.3 is classed as being of medium to high importance in relation to the identified species.

2.8.4.2 Assessment of the occurrence of resting birds and seabirds

The environment of site O-1.3 only touches the boundary areas of the extended resting habitats of the Bay of Pomerania and Adlergrund in the south and southeast. All in all, site O-1.3 and its environment reveal an average seabird population and also an average population of species that are endangered and require protection. This area of the EEZ does not form part of the principal resting, feeding and overwintering habitats of the species listed in Annex I of the Birds Directive or of the species requiring special protection from the nature conservation area 'Bay of Pomerania – Rönnebank'.

2.8.4.3 Evaluation of spatial units

The surrounding area of site O-1.3 is of medium importance as a food and resting habitat for ocean-going birds and gulls. Given its distance from the coast, it is of low importance for breeding birds. In light of its water depth (more than 20m) and ground properties, the surrounding area of site O-1.3 does not constitute an important feeding ground for diving marine ducks. European herring gulls occur frequently in this area, and great black-backed gulls and common gulls in comparatively low densities. The surrounding area of site O-1.3 touches on the outermost edges of the winter resting habitats of razorbills and common guillemots. Black guillemots are sighted extremely rarely. All in all, site O-1.3 is located in the transitional zone between the deeper waters of the Arkona Basin and the shallower waters of the Bay of Pomerania and the Adlergrund. As a result, the function of the surrounding area of site O-1.3 and the occurrence of seabirds are classed as 'low' to, seasonally, 'medium'.

2.8.4.4 Existing cumulative effects

The surrounding area of site O-1.3 is subject to significant anthropogenic influences, above all fisheries and marine traffic. The traffic separation scheme Bornholm Skag is located at a distance of approx. 5 km. In addition, two wind farm projects have already been realised in the immediate vicinity of the site. Furthermore, ongoing climate change is impacting on marine bird occurrence in the Baltic Sea in general and in the vicinity of site O-1.3 in particular. The following factors can cause changes in the marine ecosystem and thus also in seabirds:

- Fishing: It can be assumed that fishing has a significant influence on the composition of the seabird community in the EEZ, and thus also in the area surrounding site O-1.3. Fishing can lead to a reduction in food supply, even to the point of food limitation. Selective catching of fish species or fish sizes can lead to changes in the food supply for seabirds. Gillnet fishing in the Baltic Sea causes a high loss of seabirds each year as they become trapped and drown in the nets (ERDMANN et al. 2005). Red-throated loons, grebes and diving ducks are among the victims of gillnets (SCHIRMEISTER 2003, DAGYS & ZYDELIS 2002). According to ZYDELIS et al. (2009), the incidental catch each year is approx. 73,000 birds for the whole of the Baltic Sea or 20,000 birds in the southern Baltic Sea. The discards of fisheries also provide additional food sources for some marine bird species (CAMPHUYSEN & GARTHE 2000). Birds that follow ships like the European herring gull and the great black-backed gull tend to profit from the discards.

- ***Shipping:*** Ships has a deterrence effect on species sensitive to disruptions, such as red-throated loons (MENDEL et al. 2019, FLIEßBACH et al. 2019, Burger et al. 2019). In addition, shipping carries a risk of oil contamination. The rapid development of professional shipping has resulted in seabirds noticeably avoiding the main marine traffic routes in the western Baltic Sea (BELLEBAUM et al. 2006).

- ***Technical structures (e.g. offshore wind turbines)***: Technical structures can have similar effects on disturbance-sensitive species as shipping traffic. In addition, there is an increase in shipping traffic, e.g. due to maintenance trips. There is also a risk of collision with such structures.

- ***Hunting:*** Nearly all migratory ducks are affected by hunting in the Baltic Sea area. Between 1996 and 2001, 122,500 common eiders were shot in Scandinavia per year, 92,820 in Denmark alone (ASFERG 2002). The corresponded to 16% of the estimated winter population of 760,000 individuals at the time (DESHOLM et al. 2002).

- ***Climate change***: Changes to the water temperature result, among other aspects, in changes to water circulation, plankton distribution and the composition of fish faun which serve as food for seabirds. Since the 1990s, global climate change has affected the winter rest of seabirds and resting birds in the western Baltic Sea: Their main occurrence has shifted eastward and regularly occurring seasonal anoxia leads to the permanent decrease of mussels at local level (e.g. the old Odra riverbed in the western Bay of Pomerania).

In addition, seabirds and resting birds face dangers due to eutrophication, pollutant accumulation in marine food chains and waste floating on water, such as from fishing nets and plastic particles. Epidemics of viral or bacterial origin also pose a threat to populations of resting birds and seabirds.

The existing cumulative effect of the described influences on site O-1.3 and its surrounding area must thus be classed as 'medium'.

2.8.4.5 Conclusion

Based on the present level of knowledge, the vicinity of site O-1.3 is of medium overall importance for resting birds and seabirds seeking food in accordance with the underlying criteria.

2.9 Migratory birds

Bird migration is usually defined as periodic migrations between the breeding area and a separate non-breeding area, which in the case of birds at higher latitudes normally includes the wintering grounds. Since bird migrations are annual, they are also called annual migrations – and have a global distribution. Migratory birds are either “loop migrants” – birds that make a round trip – or “seasonal migrants” – those that migrate annually. In addition to a resting destination, one or more intermediate destinations are often visited for the purposes of moulting, to visit favourable feeding grounds, or for other reasons. Based on the distance travelled and on physiological criteria, a distinction is made between long-distance and short-distance migrants (ALERSTAM 1990, BERTHOLD 2000, NEWTON 2008, NEWTON 2010).

2.9.1 Data situation

The BSH has a comprehensive data basis available for the suitability assessment of site O-1.3 with regard to the protected object of 'migratory birds'. This consists mainly of the results and findings of the mandatory monitoring by operators during the construction and operation phases of offshore wind farm projects in accordance with the standard investigation concept (StUK 4, BSH 2013). As part of monitoring, since 2014, migrations in the vicinity of the area O-1 have been investigated using radar, sightings and recording of nocturnal migrations for the investigation cluster 'Western Adlergrund'. The findings from the monitoring are also suitable for describing and evaluating migrations in the vicinity of site O-1.3 which is located in the northern section of the area O-1 (BIOCONSULT SH 2016B, BIOCONSULT SH 2017b, BIOCONSULT SH 2018, BIOCONSULT SH 2019).

In addition, the BSH commissioned a separate migration study as part of the site investigations for site O-1.3 during which recording methods in accordance with StUK 4 as well as supplementary and novel methods and combinations of methods were used. The investigations, which were conducted in autumn 2019, focused on the occurrence of species and species groups which are sensitive to wind energy, such as cranes, birds of prey, geese, marine ducks and waders, during the day and their reactions to an existing wind farm to the south of site O-1.3 (IFAÖ et al. 2020). This study provides valuable insights for assessing site O-1.3 in general and for assessing the potential impacts of a wind farm at this site in light of the model parameters in particular (Chapter 1.5.5.4, Table3). At the time of preparing the present draft of the environmental report, for some questions only site study results were available. When the environmental report is finalised, the final results of the bird migration study for O-1.3 will be available and will also be taken into account. No deviations from the evaluation conducted here is expected given the results already available.

Generally speaking it must be stated that the methods required by the StUK can only cover parts of a complex migration event. Visual observations provide information on the species, number and direction of migration of birds during the day, but the height of migration is difficult to determine. Night sound tracking only provides information on the calling species – the number of individuals remains undetermined. Radar is able to give clear indications of migratory patterns but does not record individual species or the number of animals and migratory patterns are only recorded up to a height of 1,000 m or max. 1,500 m (AVITEC RESEARCH GBR 2017). Based on the findings regarding migratory patterns over the North Sea, experts are assuming that vertical radar capturing migrations up to a height of 1,000 m will at least registered 2/3 of all bird migrations. This means that it can be assumed that approx. 1/3 of bird migration takes place above the detection range of standard vertical radars.

In addition, long-time data series for different offshore and coastal locations are available to classify migrations in the area of site O-1.3 (PFEIFER 1974, ALERSTAM 1990, BERTHOLD 2000, KNUST et al. 2003, BELLEBAUM 2008).

All in all, the present data basis provides a sufficient foundation for the suitability assessment of site O-1.3. Due to the above-mentioned methodological limitations and the general difficulties in capturing a dynamic phenomenon such as bird migration, gaps in knowledge still exist with regard to the following points:

- Sufficient knowledge as to the effects of offshore buildings is currently still lacking in some areas. Knowledge from territorial sea and land can only be transferred to a very limited extent due to the different conditions.
- The species-specific collision risk for migratory birds with offshore wind turbines is largely unknown.
- Potential barrier effects of offshore wind turbines on species-specific migration routes across the sea are largely unexplored.

2.9.2 Bird migration over the western Baltic Sea – spatial distribution and temporal variability of migratory birds

Various methods have been used to record bird migrations over the western Baltic Sea all year round, revealing strong seasonal fluctuations with a focus on the spring and autumn. Based on previous estimates, approx. 500 million birds migrate across the western Baltic Sea each year, from their Nordic breeding areas further south to their overwintering areas. The numbers for the spring are much lower (200-300 million). This is due to the high mortality of young birds during their first winter. More than 95% of these birds are land-dwelling small birds (BERTHOLD 2000).

The Baltic Sea forms part of the migratory route of many bird species. Around 200 bird species take part in bird migrations in the western Baltic Sea each year. Added to this are a further 100 rare species and vagrants. Figure 16 shows the general pattern of the migration systems across the western Baltic Sea. The arrows represent migratory areas where a more precise course cannot be determined (BELLEBAUM et al. 2008). The important migratory aquatic bird populations (marine ducks, loons, geese and swans) mostly come from Siberia so that their migratory route is predominantly but not exclusively in an east-west direction. In terms of diurnal migrants, three main migratory routes over the western Baltic Sea can be identified for aquatic fowl:

- along the Swedish coast (principal route of most common eiders, barnacle geese and brent geese)
- along the German coast (principle route of most common scoters, many loons and sea swallows) and
- in a north-south direction (swans, grey geese, dabbling ducks, mergansers).

Relatively few wading birds were spotted in the Baltic Sea (BELLEBAUM et al. 2008). Birds of prey of Swedish populations which are diurnal migrants largely come from Falsterbo and use the typical 'migratory bird route' (south Sweden – Danish islands (Zealand, Møn, Falster, Lolland) – Fehmarn). But some also cross the Baltic Sea in the autumn in a north-south direction. All in all, up to 50,000 Scandinavian birds of prey cross southward over Falsterbo (BELLEBAUM et al. 2008). Flying behaviour varies both by species and seasonally. Active flapping flyers tend to fly over the sea whereas thermal gliders like the common buzzard generally use the 'migratory bird route'.

As narrow-front migrants, cranes tend to stick to fixed or easily delimitable migratory routes during their migrations. Cranes from different breeding areas in northern Europe use different migratory routes to their overwintering areas.

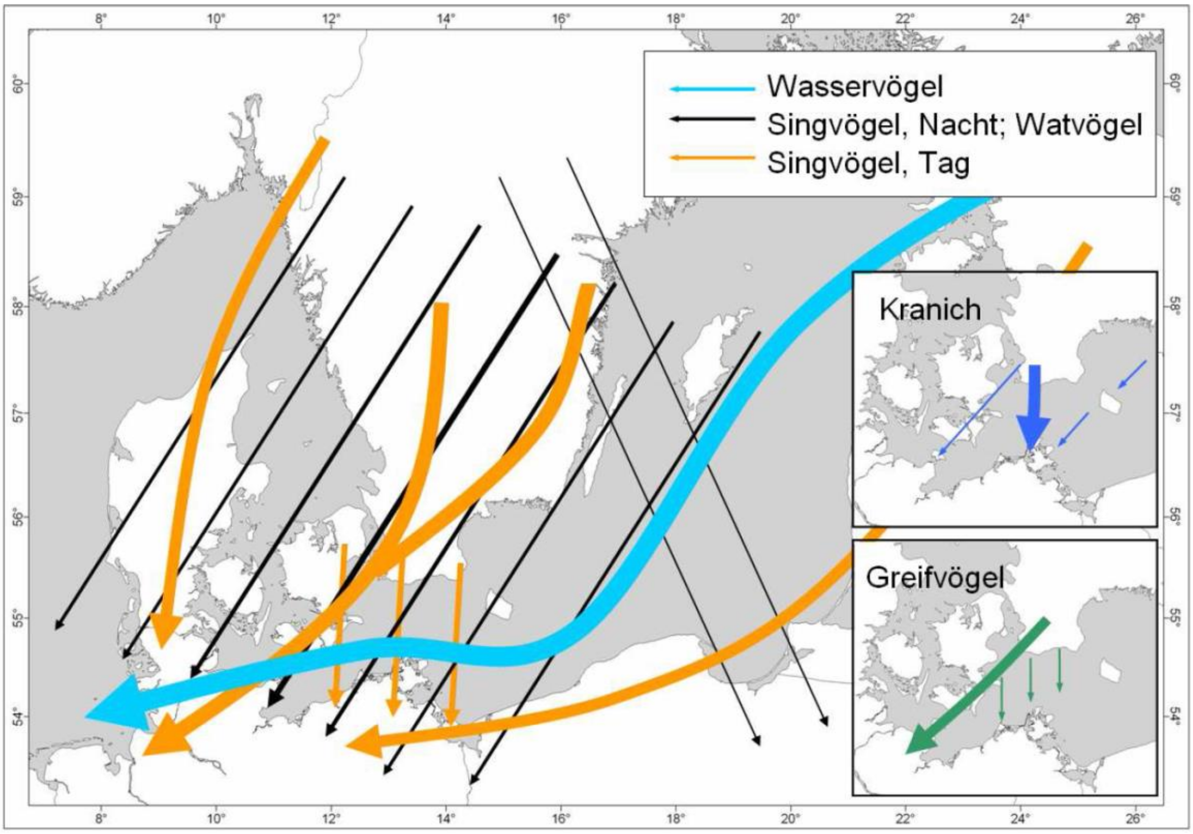

Figure 16: Schematic representation of the most important flight routes for autumn migrations in the Baltic Sea area (BELLEBAUM et al. 2008).

For the western Baltic Sea, cranes breeding in Scandinavia are especially important as they cross the Baltic Sea during their migrations. Crane migrations over the Baltic Sea take place primarily between the Rügen-Bock region in the West Pomeranian Bodden national park and the southern Swedish coast in a north-south direction (ALERSTAM 1990, SKOV et al. 2015).

The 'migratory bird route' is also important for songbirds which migrate during the day, especially short and medium-distance migrants like finches and wagtails (BERTHOLD 2000), because these can provide route orientation markers for lower-flying individuals.

To summarise, according to PFEIFER (1974), three principal routes can be distinguished in the western Baltic Sea for diurnal migrants that orient themselves based on geographic barriers or markers such as estuaries and large expanses of water:

- southern Sweden – Danish islands (Zealand, Møn, Falster, Lolland) – Fehmarn (the so-called 'migratory bird route'). This is the preferred route especially for diurnal migrants such as songbirds and thermal gliders like birds of prey. It only requires short stretches over expanses of water.
- southern Sweden – Rügen. This route is used by cranes and birds of prey and in the spring presumably above all by songbirds crossing the Baltic Sea northward from the Darss and Rügen.
- coming from the Baltic/Finland/Siberia following the narrowing funnel shape of the western Baltic Sea in a south-westerly/westerly direction. Here, a distinction is made between two principal coastal routes, 1) along the coast of Mecklenburg and 2) along the southern Swedish coast and the Danish islands to Fehmarn.

Nocturnal migrants make up more than half of all migratory birds in the western Baltic Sea (long-distance and short-distance migrants). Pronounced nocturnal migrants primarily include insectivorous small birds like typical warblers, leaf warblers, flycatchers, Northern wheatears (*Oenanthe oenanthe*) and European robins (*Erithacus rubecula*) as well as thrushes. A number of bird species migrate at night as well as during the day (ducks, geese, swans, wading birds and gulls). However, these species tend to migrate greater distances during the day. In light of the limited optical orientation aids, smaller nocturnal migrants, especially medium-distance migrants like thrushes and robins and long-distance migrants like reed warblers, tend to travel by broad-front migration (BERTHOLD 2000, ZEHNDER et al. 2001, BRUDERER & LIECHTI 2005). KNUST et al. (2003) identified a principal migratory direction from SW to SSW in the German Baltic Sea region near the locations of Fehmarn and Rügen during autumn migrations.

Seasonal migration intensity is closely linked to species-specific or population-specific life cycles (e.g. BERTHOLD 2000). In addition to these largely endogenously controlled annual rhythms in migration activity, the actual route of migration activity is determined above all by weather conditions. Weather factors also influence the height and speed at which the birds fly. Generally speaking, birds tends to wait for favourable weather conditions (e.g. good visibility, tailwind, no precipitation) until they migrate in order to optimise energy use during their migrations. As a result, bird migrations in the autumn and spring can be delayed by several days or nights. According to the results of an R&D project, half of all birds migrate during only 5 – 10% of all days (KNUST et al. 2003).

More detailed descriptions on large-scale bird migration patterns as well as migration intensities over the western Baltic Sea by species and species group can be found in the environmental report for the 2019 Site Development Plan for the German Baltic Sea (BSH 2019b).

2.9.3 Bird migration in the vicinity of site O-1.3

2.9.3.1 Species spectrum

Current investigations recording bird migrations for the investigation cluster 'Western Adlergrund' in area O-1 identified a total of 112 species in the autumn and spring of 2017 based on sightings during the light phase and on nocturnal sound recordings (BioConsult SH 2019). In the preceding years, 103 (2015) to 113 species (2016) were observed (BioConsult SH 2016b, BioConsult SH 2017b).

The migratory patterns during the light phase for the past recording periods were dominated by various species and species groups. Whereas, at 35.4% of all individuals recorded (n = 8,398), cormorants were the most frequent species in spring 2017, their proportion in spring 2016 was only 8.5% of all sighted individuals (n = 7,211 ind.). In addition, higher proportions of the migratory bird populations in spring 2017 were made up by songbirds (20.5%), ducks (15.4%) and gulls of the genus *Larus* (14%). In the spring 2016, migrations were dominated by ducks at 57.2%. Of these, common scoters were the most common. In addition, songbirds (12.1%) and geese (10.2%) made up higher proportions of migratory birds (BioConsult SH 2018, BioConsult SH 2019).

During the 2016 autumn migration, a total of 14,862 individuals were observed, whereas 23,548 individuals were recorded during the 2017 autumn migration (BioConsult SH 2018, BioConsult SH 2019). In autumn 2016, the migratory bird populations were dominated by songbirds (41.6%) and gulls of the genus Larus (24.6%). In autumn 2017, geese (52.2%), songbirds (19.1%) and ducks (13.4%) were spotted especially frequently (BioConsult SH 2018, BioConsult SH 2019.

Species and species groups like loons, swans, wading birds, auks and cranes in the past migration periods seasonally only occurred at less than 2% of the observed total migratory populations (BioConsult SH 2018, BioConsult SH 2019).

Nocturnal migratory patterns, based on sound recordings of bird calls, were dominated by songbirds. In autumn 2017, 96.4% of all recorded calls during flight (n = 2,839) were made by songbirds, the majority of which were thrushes, and in autumn 2016, this figure even rose to 99.1% (n = 5,789). In spring 2017, the proportion was only 49.2% (n = 1,159), while in spring 2016, it was 70.9% (n = 1,200) of all recorded calls during migrations. Nocturnal songbird migrations were dominated by redwings, song thrushes and blackbirds. Robins also displayed higher proportions in all migratory periods. In spring 2017, at 43.9%, the proportion of wading bird calls was also relatively high. Most calls were identified as belonging to the Eurasian curlew. The proportion of non-songbirds like ducks, gulls and cranes was very low (BioConsult SH 2018, BioConsult SH 2019).

2.9.3.2 Migration intensities, migration heights, migration direction

The bird migration surveys conducted as part of the investigations for the cluster 'Western Adlergrund' for the years 2014 – 2017 showed that no individual months displayed constantly higher migration intensity during autumn migration or spring migration with the result that it was not possible to narrow down bird migrations to individual months. Comparing the individual years under investigation revealed seasonal as well as interannual differences. Migratory events of different intensities were recorded in all years (BioConsult SH 2019).

Migration intensities

In spring 2017, the average migratory intensity based on vertical radar investigations for the investigation cluster 'Western Adlergrund' was 99.6 echos/h*km during the light phase and 357.4 echos/h*km during the dark phase. For autumn 2017, an average migratory intensity of 26.2 echos/h*km was determined for diurnal migrations and of 68.6 echos/h*km for nocturnal migrations (BioConsult SH 2019). A comparison with the determined average migration rates for the previous year clearly shows interannual fluctuations. The average migratory intensities during spring 2016 were 19.6 echos/h*km for diurnal migrations and 55.5 echos/h*km for nocturnal bird migrations. During the autumn migratory period, the respective average migratory intensities were 48.6 echos/h*km during the day and 55.5 echos/h*km at night (BIOCONSULT SH 2019). All in all, these interannual differences were also identified in the years 2014 and 2015 (BIOCONSULT SH 2016b, BIOCONSULT SH 2017b). The present findings thus easily match the overall context of highly variable bird migration patterns in the vicinity of site O-1.3.

During the last investigation years, there were individual instances of nocturnal migrations with very high migratory intensities. The highest average migratory intensity determined so far was in the night of 26/03/2016 at 2,252 echos/h*km. The highest average migratory intensity in 2017 was recorded during one night in May at 1,176.8 echos/h*km (BIOCONSULT SH 2019).

An analysis of the time of day when migrations occurred in the vicinity of site O-1.3 in the period from 2014 to 2017 shows that bird migrations were registered at all times of time both in the spring and in autumn. In all years, the intensity of bird migrations was higher during the day than during the night. In the spring, migration numbers were highest in the first third of the night. In the autumn, deviations from this basic pattern were also observed, with the highest migratory intensities occasionally recorded in the first hour after sunrise (BIOCONSULT SH 2019).

Migration heights

An investigation of flight altitudes based on vertical radar surveys in the migratory periods during 2014 – 2017 shows that migratory birds in the vicinity of site O-1.3 choose a flight altitude of up to 500 m within the recorded range of up to 1,000 m. This observation applies independently of the migratory period and independently of the time of day or night. The area up to 200 m is the busiest area (BIOCONSULT SH 2019). IN AN EVALUATION OF MONITORING DATA SPANNING DIFFERENT PROJECTS, WELCKER (2019a) identified that migrations during nights with greater bird migratory intensities happen at greater heights (more than 400 m). This is also confirmed by the individual survey for the cluster 'Western Adlergrund' (BIOCONSULT SH 2019).

Standardised migration observations with reference to the species provide information on the distribution of migration heights in the lower 200 m in the light phase. These surveys show that during the day, around two thirds of all bird migrations in the wider surrounding area of site O-1.3 take place below 20 m (BIOCONSULT SH 2019).

Migration direction

According to horizontal radar surveys from 2014-2017, flight directions are inconsistent in the spring and in the autumn. The principal direction expected for the spring is north-east but this is only clearly visible in individual cases (e.g. spring 2017). This is due to omnidirectional flights by seabirds in search of food which eclipse the intensities of directional bird migrations. Neither was it possible to clearly confirm the expected principal south-westerly direction expected during autumn migrations (BIOCONSULT SH 2019).

2.9.3.3 Flight activity of individual species or species groups in the vicinity of site O-1.3

Below is shown a more detailed assessment of the occurrence of a number of species and species groups, some of which are strictly protected, and which are known to cross the Baltic Sea along fixed migratory routes or the western Baltic Sea in greater numbers in the area of site O-1.3.

Common crane (Grus grus)

As a bird species listed in Annex I of the European Bird Protection Directive, common cranes enjoy a special protection status. Past investigations for the cluster 'Western Adlergrund' recorded differing numbers of common cranes during the day in the spring and autumn. During the spring migrations of the years 2014 to 2017, between 23 (spring 2016) and 99 cranes (spring 2017) were observed. During autumn migrations, the number of common cranes sighted varied from six cranes in autumn 2017 to 546 cranes in autumn 2014 (BioConsult SH 2016b, BIOCONSULT SH 2017b, BIOCONSULT SH 2018, BIOCONSULT SH 2019). The fluctuations in the number of observed individuals could be due to natural interannual variability and other potential parameters such as wind conditions or due to a greater concentration of crane migrations to only a few migration days in each migratory period. To give an example, the 546 cranes recorded in autumn 2014 were all sighted during the course of only two days (BIOCONSULT SH 2016b). As a result, it cannot be excluded that planned survey efforts in line with StUK 4 may have missed greater intensity migratory events if not focused on dynamic migratory patterns. For this reason, ship-based investigations for site O-1.3 in autumn 2019 were planned and implemented such that the concentration of cranes at Falsterbo, an especially important meeting point for cranes migrating south from Scandinavia, was observed based on publicly accessible survey data and the investigations near O-1.3 commenced when they proceeded on their flight southward. During the investigations in autumn 2019, a total of 1,609 cranes were sighted (adjusted for the survey time: 2,878 individuals). At a proportion of 11.6%, common cranes were the third most frequent species of all recorded species and species groups whose migrations were observed (IFAÖ et al. 2020). During a total of 15 survey days at sea, cranes were sighted on four days in the period between 03.10 and 25.10.2019. At 844 individuals, more than half of all cranes observed were recorded on 03.10.2019. An analysis of the weather records showed that this day saw north-westerly crosswinds of wind forces between 3 and 5 Bft. It is possible that the cranes travelling from southern Sweden to Rügen drifted eastward as a result of the north-westerly winds. Monitoring of the cluster 'Western Adlergrund' in autumn 2014 made similar observations in relation to increased migratory events (BIOCONSULT SH 2016). This assumption is supported by the observation that the cranes recorded in autumn 2019 predominantly followed a southerly flight direction. The second most frequent flight direction was south-west which could indicate a partial compensation for wind drift over the sea. The other days with crane migratory activity in autumn 2019 were dominated by tailwinds from the east and north-east of wind forces 2 – 4 Beaufort (04.10 + 06.10.2019) and strong headwinds from south-west to west (6 Bft, 25.10.2019). On 25.10.2019, the second highest crane migratory activity was recorded based on sightings (IFAÖ et al. 2020).

Birds of prey

The birds of prey that migrate over the Baltic Sea also include species listed in Annex I of the Bird Protection Directive. These are, among others, the European honey buzzard (*Pernis apivorus*), the red kite (*Milvus milvus*), the western marsh harrier (*Circus aeruginosus*), the hen harrier (*Circus cyaneus*), the osprey (*Pandion haliaetus*) and the merlin (*Falco columbarius*).

During past investigation years, the species mentioned above were only spotted occasionally, with the exception of the western marsh harrier of which 70 individuals were recorded in autumn 2016 (BioConsult SH 2018), as part of the cluster investigations 'Western Adlergrund' and the investigations for site O-1.3. The most frequent species occurring in all investigated migratory periods is the Eurasian sparrowhawk (*Accipiter nisus)* for which a maximum figure of 60 individuals was logged in autumn 2016 (BIOCONSULT SH 2016b, BIOCONSULT SH 2017b, BIOCONSULT SH 2018, BioConsult SH 2019; IfAÖ et al. 2020). In autumn 2019, a total of 57 birds of prey were spotted in the immediate vicinity of site O-1.3 on 8 out of 15 investigation days, including 47 sparrowhawks. Of the species in Annex 1 of the Birds Directive, 1 red kite and 1 merlin were observed (IfAÖ et al. 2020). On days with high bird of prey activity, crosswinds (19.09.2019) and headwinds (20 and 25.10.2019) predominated. On 19.09 and 20.10, wind forces of between 2 and 4 Bft were registered, as well as between 5 and 7 Bft on 25.10.2019 (IfAÖ et al. 2020).

Waterbirds

The flyways of most (predominantly) diurnal migrant waterbirds, like marine ducks, geese and loons) cross the western Baltic Sea in an east-west direction to travel from their Arctic breeding areas in western Siberia to their winter habitats in western Europe. The birds mostly use the coasts of southern Sweden and Germany for orientation. Other species that breed in Scandinavian wetlands and use freshwater biotopes as their habitats, such as swans, travel in a north-south direction.

Waterbird migrations are dominated above all by geese and marine ducks, both in general and in the vicinity of site O-1.3 in particular. Loons and swans occur in comparatively low numbers. Below, more details are provided of the occurrence of individual species from the mentioned species groups because they have a special protection status or were sighted in greater numbers in past investigations for the cluster 'Western Adlergrund' and for site O-1.3 in autumn 2019.

During past investigations in the vicinity of site O-1.3, the greater white-fronted goose (*Anser albifrons*), the barnacle goose (*Branta leucopsis*), the greylag goose (*Anser anser*) and the brant (*Branta bernicla bernicla*) were among the most frequent types of geese based on sightings. Barnacle geese are listed in Annex I of the European Bird Protection Directive. Greylag geese and barnacle geese are also allocated to protection category C1 according to the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) (Populations that number less than around 100,000 individuals for which could benefit greatly from international cooperation and which do not meet the conditions of columns A or B). Brant geese are classed as category B 2b (Populations that number more than around 100,000 individuals but which may require special attention because of their dependence on a habitat type which is under severe threat).

During the investigation years 2014 to 2017, greater white-fronted geese were only recorded in the 'Western Adlergrund' in some migratory periods (BioConsult SH 2016b, BioConsult SH 2017b, BioConsult SH 2018, BioConsult SH 2019). Most sightings also occurred during their outward migration (autumn). The highest number of individuals so far was observed in autumn 2017 at 1,497 greater white-fronted geese (BioConsult SH 2019). Visual observations near site O-1.3 counted 1,441 individuals (IfAÖ et al. 2020).

In past investigations, barnacle geese were observed in numbers from six individuals in spring 2015 up to 612 individuals in autumn 2019 (BioConsult SH 2016b, IfAÖ et al. 2020).

Greylag geese were observed in all investigated migratory periods. In autumn 2014, at 23 individuals, the fewest greylag geese were sighted, with the highest number recorded in autumn 2017 at 426 individuals (BioConsult SH 2016b, BioConsult SH 2019).

At three (autumn 2015) to 93 (autumn 2017) individual, brant geese were not only observed more rarely, their numbers were also the most irregular in individual years or migratory periods (BioConsult SH 2017b, BioConsult SH 2019).

Across all investigations in the vicinity of site O-1.3, it was frequently not possible to make an identification down to species level where larger numbers of individuals were sighted. The number of unidentified geese ranged from 19 individuals in spring 2015 to 9,456 in autumn 2017 (BioConsult SH 2017b, BioConsult SH 2019). In autumn 2019, 3,194 unidentified geese were logged during investigations for site O-1.3 (IfAÖ et al. 2020). A south-westerly flight direction as expected for geese dominated across all visual observations. In addition, the flight directions west and south occurred at lower proportions (IfAÖ et al. 2020).

According to visual observations, migrations of marine ducks were dominated by common scoters (*Melanitta nigra*) and long-tailed ducks (*Clangula hyemalis*) Common eiders (*Somateria mollissima*) and velvet scoters (*Melanitta fusca*) also occurred regularly and in larger numbers. According to the AEWA, long-tailed ducks and velvet scoters have the risk category A 1b (species listed as 'threatened' in the current IUCN Red List), common eiders the risk category A 4 (species listed as 'near threatened' in the current IUCN Red List but which do not meet the criteria for classification in categories A 1, A 2 or A 3) and common scoters the risk category B 2a (populations that number more than around 100,000 individuals but which may require special attention because of a concentration onto a small number of sites at any stage of their annual cycle) (AEWA 2019).

At 3,786 individuals, the highest number of common scoters on their migratory route in the vicinity of site O-1.3 was observed in spring 2016, while in autumn 2015, the lowest number of individuals was recorded at 321 common scoters (BioConsult SH 2017b, BioConsult SH 2018).

Long-tailed ducks reached their maximum in spring 2014 at 6,557 individuals (BioConsult SH 201b7). By contrast, in spring 2017, only 58 individuals were observed in the vicinity of site O-1.3 (BioConsult SH 2017b).

By far the most sightings of common eiders occurred in spring 2015 at 2,718 individuals. In the other migratory periods, the number of individuals varied from 28 in spring 2016 to 739 in autumn 2017 (BioConsult SH 2017b, BioConsult SH 2018, BioConsult SH 2019).

Velvet scoters were observed in lower numbers in the vicinity of site O-1.3 compared to the other marine duck species. The number of individuals sighted ranged from 15 individuals in spring 2017 to 158 in autumn 2016 (BioConsult SH 2018, BioConsult SH 2019).

As expected, the direction of travel of marine ducks was south-west, with proportions of north-westerly and westerly migrations. In addition, there were some species-specific deviations with easterly migration components (IfAÖ et al. 2020).

Among swans, the mute swan (*Cygnus olor*) dominated migrations in the vicinity of site O-1.3. By contrast, the swan species listed in Annex I of the Birds Directive, i.e. the whooper swan (*Cygnus cygnus)* and the Bewick's swan (*Cygnus bewickii*), only occurred rarely and in lower numbers.

During past investigations, the number of individual mute swans fluctuated between 9 in autumn 2019 and 88 in spring 2014 (BioConsult SH 2016b, IfAÖ 2020).

11 Bewick's swans were observed during their migrations in spring 2014 and 26 in autumn 2015 (BioConsult SH 2016b, BioConsult SH 201b7).

Most sightings of whooper swans occurred in autumn 2014, at 44 individuals (BioConsult SH 2016b).

Loons, whose most frequent representatives in German waters are the red-throated loon (*Gavia stellata*) and the black-throated loon (*Gavia arctica*), were recorded in all bird migration investigations for the cluster 'Western Adlergrund' in the years 2014 to 2017.

The sightings red-throated loons ranged from one individual in autumn 2017 to 69 in spring 2016 (BioConsult SH 2018, BioConsult SH 2019).

At 2 individuals, the lowest number of black-throated loons was observed in spring 2014 and the highest number in spring 2017 at 23 individuals (BioConsult SH 2016b, BioConsult SH 2019). In autumn 2019, 12 loons were spotted during investigations for site O-1.3 (IfAÖ et al. 2020).

Waders (shorebirds)

Adult wading birds coming from their Arctic breeding areas mostly migrate across the Baltic Sea to the Wadden Sea at great height, often also flying over southern Sweden. Younger birds tend to travel in smaller sections along the coast, resting in mudflats en route several times (Kube & Struwe 1994). In the spring, nearly all shorebirds travel from the Wadden Sea to western Siberia at great heights. Their average flight altitude is approx. 2,000 m (Green 2005). Shorebirds prefer tailwind for their migrations (Green 2005). Strong headwind or precipitation can occasionally result in emergency rests or in flight closer to the sea surface in the western Baltic Sea along the Swedish (in case of a SW wind in the autumn) or the German (in case of a NW wind in autumn) coast. Sightings of shorebirds on the open sea are very rare. It must be assumed that the preferred greater flight altitudes are why recent migration surveys in the vicinity of site O-1.3 largely only recorded shorebirds in small numbers based on sightings during the day or calls recorded at night. Dunlins (*Calidris alpina*), common snipes (Gallinago gallinago), Eurasian curlews (*Numenius arquata*) and northern lapwings (*Vanellus vanellus*) are among the species recorded in greater numbers in recent years but only during individual migratory periods. Dunlins and common snipes are listed as SPEC category 3 (widely distributed species not concentrated in Europe, but with negative population development and unfavourable conservation status in Europe); Eurasian curlews are listed as category 2 (species with global population concentrated in Europe and with negative population development and unfavourable conservation status in Europe) and northern lapwings as category 1 (European species requiring global protection measures, i.e. globally classed as 'Critically Endangered', 'Endangered', 'Vulnerable', 'Near Threatened' or 'Data Deficient') (BirdLife International 2015).

Dunlins were primarily detected at night using acoustic call recordings. Even though this method does not allow for a precise survey of individuals, estimates indicate that 62 individuals flew through the detectable area in the vicinity of site O-1.3 in autumn 2014.

During the same period, approx. 72 common snipes were detected (BioConsult SH 2016b).

Nocturnal call recordings in spring 2017 also logged approx. 460 Eurasian curlews (BioConsult SH 2016b).

The investigations for site O-1-3 in autumn 2019 recorded a sighting of 500 northern lapwings on a single day (IfAÖ et al. 2020).

Songbirds

Songbirds include species which migrate predominantly during the day as well as exclusively diurnal migrants. Night-time songbird migrations tend to involve many times the numbers of day-time migrations (see the details in the environmental report for the 2019 Site Development Plan for the German Baltic Sea). Past investigations in the vicinity of site O-1.3 recorded large numbers of songbirds both during the day and at night, with the latter making up the vast majority. The most frequent songbird species spotted during the day were the Eurasian siskin (Spinus spinus), the meadow pipit (*Anthus pratensis*) and the common starling (*Sturnus vulgaris*), with maximum sightings of 1,055 Eurasian siskins in autumn 2017, 1,664 meadow pipits in autumn 2014 and 1,802 common starlings in autumn 2016 (BioConsult SH 2016b, BioConsult SH 2018, BioConsult SH 2019). However, nocturnal recordings of migratory calls in autumn 2015 registered 2,878 calls of migrating Eurasian siskins (BioConsult SH 2017b). Nocturnal migrations in the vicinity of the site O-1.-3 based on call recordings were dominated above all by robins (*Erithacus rubecula*), common blackbirds (*Turdus merula*) as well as song thrushes and redwings (*Turdus philomelos*, *Turdus iliacus*). The highest number of calls were recorded during the autumn migrations, with those of robins reaching 5,701 calls in autumn 2015, those of song thrushes 4,557 calls in autumn 2016 and those of redwings 3,742 calls in autumn 2014 (BioConsult SH 2016b, BioConsult SH 2017b, BioConsult SH 2018). Common blackbirds were an exception, with their calls recorded most frequently in spring 2014 and 2015 at 1,092 and 1,078 calls respectively. During outward migrations in the two years, 1,749 and 1,418 common blackbird calls were registered (BioConsult SH 2016b, BioConsult SH 2017b). In addition, in autumn 2015, approx. 18,311 calls of goldcrests (*Regulus regulus*) were logged (BioConsult SH 2016b). Many species encountered in the vicinity of site O-1.3 have a special protection status. Bramblings, skylarks and starlings are listed as SPEC category 3 (widely distributed species not concentrated in Europe, but with negative population development and unfavourable conservation status in Europe); goldcrests are listed as category 2 (species with global population concentrated in Europe and with negative population development and unfavourable conservation status in Europe) and redwings and meadow pipits as category 1 (European species requiring global protection measures, i.e. globally classed as 'Critically Endangered', 'Endangered', 'Vulnerable', 'Near Threatened' or 'Data Deficient') (BirdLife International 2015).

2.9.4 Status assessment and significance of site O-1.3 and its surroundings for bird migration

The status assessment of the protected object of migratory birds and the significance of site O-1.3 and its surroundings for bird migration is based on the following evaluation criteria:

- The large-scale importance of bird migration
- Assessment of occurrence
- Rarity and vulnerability
- Existing cumulative effects

Based on the present findings regarding migrations in the vicinity of site O-1.3, first the importance of the site for the principal groups of cranes, birds of prey, waders and songbirds is estimated. Species requiring special protection according to Annex I of the Birds Directive, bird species requiring special protection according to Art. 4(2) Birds Directive and especially frequently occurring species will be assessed separately. Following this, a summary evaluation of bird migrations will be provided based on the findings for the individual species and species groups according to the criteria mentioned above.

Common crane (Grus grus)

Cranes in northern European breeding areas which approach their overwintering habitats from a south-westerly direction are allocated to the north-western European biogeographical population (Wahl et al. 2007). This population also includes common cranes which cross the western Baltic Sea between the south coast of Sweden and the Rügen-Bock region. According to current estimates, the north-western European biogeographical population is made up of approx. 350,000 individuals (Wetlands International 2018). Measures such as hunting restrictions and habitat restoration have resulted in a large increase in crane populations in recent decades (Deinet et al. 2013). According to Skov et al. (2019), 84,000 cranes cross the Arkona Basin in the autumn each year.

In early October 2019, 86,000 common cranes are estimated to have rested in the Rügen-Bock region and the Darss-Zingster-Bodden Chain, the highest value so far compared to previous years (NDR 2019). Based on past findings, common cranes of the north-western European population also head towards the resting areas in this region even where these do not cross the Baltic Sea directly in one to two hours but migrate from Finland along the eastern and southern Baltic Sea coast towards the south-west (ALERSTAM 1975, LEITO et al. 2015).

In autumn 2019, ship-based visual observations recorded 1,609 common cranes or 0.46% of the biogeographical population of north-western Europe passing in the immediate vicinity of site O-1.3, i.e. 1.9% of the estimated total of 84,000 individuals which cross the Arkona Basin. If these sightings are extrapolated and adjusted for survey time, this corresponds to 2,878 individuals or 0.8% of the biogeographical population of north-western Europe or 3.4% of the estimated total of 84,000 common cranes crossing the Arkona Basin. In light of the predominant wind conditions on days with increased crane migratory activity, it can be assumed that the cranes migrating southward drifted eastward because of north-westerly crosswinds and south-westerly headwinds. A preliminary analysis of wind data from the measuring station Darss Sill for autumn 2019 revealed that westerly winds tend to occur alongside greater wind forces (Copernicus 2020, data from the measuring station Darss Sill, autumn 2019). However, in autumn 2019, crane migrations were also registered during favourable tailwind conditions, albeit at lower intensity (see chapter 2.9.3.3). An evaluation of available data from telemetry studies of tracked cranes migrating southward from southern Sweden across the Baltic Sea also indicates that cranes tend to travel in a straight line in a north-south direction, using sprawling neighbouring areas along the way (from Falster in the west to Bornholm in the east). In spite of low sample sizes so far (n = 19), this information provides important clues about crane migrations over the Arkona Basin (movebank.org, SKOV et al. 2015, SKOV et al. 2019).

The present findings on crane migrations show that during migratory periods, and especially at the time of intense migrations in the autumn, crane migratory activity must be expected in the vicinity of site O-1.3 on a number of days, both under favourable (tailwind) and under unfavourable (crosswind or headwind) migration conditions. Past results indicate that an increased number of cranes must be expected in the vicinity of site O-1.3 especially during westerly winds. Based on these findings and taking into account the relevant biogeographical population, the importance of site O-1.3 for the common crane is evaluated as average to above average.

Birds of prey

Birds of prey of the species listed in Annex I of the Birds Directive were only occasionally sighted in the vicinity of site O-1.3. All in all, sightings in previous investigations were low. Based on current investigation results, the immediate vicinity of site O-1.3 is only of minor importance for the migrations of birds of prey. According to the current level of knowledge, this also applies to migratory and wind conditions which result in drifts eastward from the north-south migratory direction (see chapter 2.9.3.3).

Waterbirds

Waterbird species and species groups occurred in varying frequencies in past investigations on bird migrations in the vicinity of site O-1.3.

Based on current estimates, the total biogeographical populations of the species of geese most frequently observed in the vicinity of site O-1.3 were: 960,000 greylag geese, 211,000 brant geese, 1,200,000 barnacle geese and 1,000,000 – 1,200,000 greater white-fronted geese (WETLANDS INTERNATIONAL 2018). Taking into account the observed maximum individuals based on past investigation years in the vicinity of site O-1.3, this means that the maximum sightings of greylag geese and brant geese made up approx. 0.04% of the relevant biogeographical populations, with barnacle geese and greater white-fronted geese constituting 0.05% and 0.14% of the relevant biogeographical populations.

Current estimates of the relevant biogeographical populations of marine ducks are also available according to WETLANDS INTERNATIONAL (2018). According to this source, the populations of long-tailed ducks amounted to 1,600,000 individuals, of common eiders to 930,000 individuals, of common scoters to 687,000 – 815,000 individuals and of velvet scoters to 320,000 – 550,000 individuals. The maximum number of sighted individuals based on survey in the vicinity of site O-1.3 thus constituted 0.04% of the biogeographical population of velvet scoters, while the proportions of the other marine duck species were higher at 0.29% (common eider), 0.4% (long-tailed duck) and 0.5% (common scoter).

Swans and loons were only observed in low numbers, so that their proportions of the relevant biogeographical populations remained extremely low.

All in all, the vicinity of site O-1.3 is of medium importance for migratory waterbirds. This is deduced from the fact that, while several species subject to special protection cross this area (e.g. barnacle geese, greater white-fronted geese, common eiders, long-tailed ducks and velvet scoters), it is situated outside the principal flyways along the coast, as apparent based on the low number of individuals of less than 1% of the relevant biogeographical populations.

Waders

Past investigations in the vicinity of site O-1.3 only occasionally detected wading birds. Dunlins, common snipes, Eurasian curlews and northern lapwings were recorded during only a few, irregular migratory events. It must be assumed that the migrations of wading birds mostly take place at greater heights which fall outside the area surveyed by the methods used and also outside the area affected by the offshore wind farm (chapter 4.8.1). Based on the current level of knowledge, the vicinity of site O-1.3 is only of low to medium importance for wading bird migrations given the irregular occurrence of protected wader species.

Songbirds

It is assumed that diurnal migrations of songbirds over the Baltic Sea happen along a wide front. The majority of nocturnal bird migrations across the Baltic Sea are also likely to occur along a wide front (BSH 2019). The surveys of bird migrations in the vicinity of site O-1.3 regularly recorded sightings or acoustic detections of high numbers of individuals or calls. All in all, the songbird species observed tend to belong to those populations of northern Europe which are present in high numbers (BIRDLIFE INTERNATIONAL 2004, BSH 2019). Given the very high number of individuals which can be expected and the proportion of vulnerable species in bird migrations, the vicinity of site O-1.3 is of average to above-average importance for songbirds migrating at night.

2.9.4.1 Summary status assessment and importance of site O-1.3 for bird migrations

Below, bird migrations as a whole are evaluated. This estimate is based on the remarks on individual species and species groups in chapter 2.9.4.

The large-scale importance of bird migration

In contrast to the North Sea, diurnal migrant species or species groups are known to use special migration corridors or flyways when crossing the western Baltic Sea. By contrast, based on present findings, nocturnal migrations of small birds are assumed to occur along a wide front (chapters 2.9.2 and 2.9.3.3). The main migratory directions depending on the species and species groups are north-south and east-west, with deviating east/west and north/south components. The site O-1.3 is not situated immediately within known migration corridors or flyways. As a result, its significance is classed as medium.

Assessment of occurrence

In the area around site O-1.3, bird migration occurs continuously during migration periods. In individual cases, very intense bird migrations occur at night. During the day, high migration intensities of individual species or species groups can be observed. This can be due to the predominant weather situation if individuals drift from their original flypaths or are forced to adapt their flight behaviour in light of migratory conditions. As a result, migrations and their intensity in the vicinity of site O-1.3 are classed as medium to, at times, high.

Rarity and vulnerability

Past investigations on bird migrations in the vicinity of site O-1.3 used visual observations and nocturnal call recordings to identify the species listed in Annex I of the Birds Directive and in other protection and risk categories (SPEC, AEWA) (chapter 2.9.3.3) in varying frequencies. In light of the species numbers recorded in the vicinity of site O-1.3 in relation to the range of species which migrate across the whole of the Baltic Sea (see chapter 2.9.2), the number of species is evaluated as average and their risk status as above average.

Existing cumulative effects

Migratory birds are subject to a number of anthropogenic effects. These include losses of breeding, resting and overwintering areas through human activities and climate change. The most important factors include active hunting, collision with anthropogenic structures, fisheries and oil and chemical environmental contamination. The various factors have a cumulative impact, so it is usually difficult to determine the significance of each in isolation. Wind farm projects have already been realised and are being operated in areas close to site O-1.3 which might increase the species-specific risk of collision in its immediate vicinity (chapter 4.8.1). All in all, the existing cumulative effects on bird migrations are classed as medium to high.

Conclusion

For specific species or species groups and under certain migration conditions, site O-1.3 and its environment as a whole are of medium to occasionally high importance for bird migration.

2.10 Bats and bat migration

Bats exhibit 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 bat ranging, bat migrations are periodic or seasonal. Both bat ranging and bat migrations can vary greatly depending on species and gender. Differences in ranging and migratory behaviour can also occur within a species population. Based on their ranging behaviour, bats are classed as short-distance, medium-distance and long-distance migratory species.

In their search for nesting, feeding and resting places, bats travel short and medium distances. Medium-distance ranging is known to use corridors along flowing waters, around lakes and in the mudflats (BACH & MEYER-CORDS 2005). There has been virtually no investigation of long-distance movement to date, however. In contrast to bird migrations for which extensive studies are available, little is known about bat migrations due to a lack of suitable methods and large-scale specialised monitoring programmes.

2.10.1 Data situation

There is little research on bat migrations over the Baltic Sea. This is due primarily to a lack of appropriate survey methods suited to supplying reliable data on bat migrations in the marine area. Visual observations, e.g. along the coast and from ships, provide some clues, but these are little suited to recording the migratory behaviour of nocturnal bats migrating over the sea at night in full. In addition, visual observations have very little or only very limited applicability for recording migratory behaviour given the height of the flight movements (e.g. 1,200 m for the noctule bats). WALTER et al. (2005) have summarised all past sightings of bats from ships and platforms.

Tagging only provides evidence of individual stop-overs by the tagged individuals and not about the migratory routes taken. There is currently no suitable method to precisely record the flight routes of individual bats over longer distances (HOLLAND & WIKELSKI 2009). This means that the number of bats migrating regularly cannot be deduced.

Ultrasound detectors, so-called bat detectors, provide good results about bat occurrence on land (SKIBA 2003). But they can cause problems when used offshore. The low range of the system means that recordings confirm that bats are present in the offshore area. But this survey method is strongly affected by winds, which occur frequently on the sea, resulting in background noise and making it difficult to clearly identify bat signals. There is a need for further research in this area.

The impact assessment for the site O-1. uses available data from acoustic and visual bat surveys for the vicinity of site O-1.3 to present the current level of knowledge. There is currently no reliable data basis for a detailed description and evaluation of potential migratory events in the vicinity of site O-1.3. Past results can only provide clues. The relevant chapters of the environmental report for the 2019 Site Development Plan for the German Baltic Sea (BSH 2019) contain more detailed information about the current level of knowledge of bat activity over the Baltic Sea. To summarise, the following gaps in the knowledge of the protected object 'bats and bat migrations' apply:

- The size and status of migrating bat populations over the Baltic Sea are not known.
- There are no reliable findings regarding their flight behaviour, species occurrence and flight paths over the Baltic Sea.
- Adequate knowledge as to the effects of high offshore buildings is currently still lacking. Knowledge from territorial sea and land can only be transferred to a very limited extent due to the different conditions.
- The species-specific collision risk for migratory bats with offshore wind turbines is largely unknown.

2.10.2 Spatial distribution and status assessment

A good summary of the current level of knowledge can be found in the expert report 'Fledermauszug im Bereich der deutschen Ostseeküste [Bat migrations in the area of the German Baltic Sea coast]' which was compiled for the BSH (SEEBENS et al. 2013). This summarises and discusses the findings of various bat surveys off the coast of Mecklenburg-West Pomerania. It also takes into account surveys conducted on Greifswalder Oie, from the platform 'Reff Rosenort“ and on one ferryboat.

The findings regarding the occurrence of bats in the offshore area were gained using a bioacoustic surveying system installed on a ferryboat. The ferry shuttles between Rostock and Trelleborg in Sweden. In May 2012, 11 echolocation bat calls were recorded offshore during 180 out of a total of 540 night hours relevant to migrations. Of these, seven were contacts within 20 km of the coast of Mecklenburg-West Pomerania, two were within 20 km of the Swedish or Danish coasts and two provided evidence of calls more than 20 km from the nearest coast. It was possible to identify the calls as having been made by noctule bats and Nathusius' pipistrelle bats (SEEBENS et al. 2013).

Based on the results of the above expert opinion, bat migration surveys were included in the current standard investigation concept (StUK4) in order to obtain more detailed information about the importance of the EEZ of the Baltic Sea as a transit area for bats. The investigations are to be implemented alongside the night-time recordings of migratory birds using bat detectors to record their call activity. As part of this mandatory bat monitoring for wind farm projects in the area O-1, a mere four bats, two of which were Nathusius' pipistrelle bats (*Pipistrellus nathusii*, were detected in eight nights in spring 2014 (May). In the autumn (August - October) of the same year, three Nathusius' pipistrelle bats were recorded in 20 nights. One of the three bat detections was conducted during unfavourable weather conditions. In 18 nights in spring 2015 (April - May), a total of six bats were logged, according to the expert. All detections occurred at night, based on favourable recording conditions as defined under StUK 4. The six individuals included four Nathusius' pipistrelle bats, one common pipistrelle (*Pipistrellus pipistrellus*) and one unidentified bat of the genus *Nyctalus.* In 21 nights in autumn 2015 (August - October), a total of four Nathusius' pipistrelle bats and one unidentified bat of the genus *Nyctalus* were detected. The majority of the detections occurred at night during weather conditions which made acoustic identification difficult. (wind forces > 3 Beaufort) (BIOCONSULT SH 2017c).

During basic recordings for offshore wind farm projects in the area O-1, individual bats were sighted in the context of the bird migration surveys carried out at night. During investigations for the offshore wind farm project 'Arkona Basin South-East' in autumn 2003 and 2004, one bat each was sighted from the ship. Another bat was spotted in autumn 2003 during basic investigations for the offshore wind farm project 'Wikinger'.

In spite of this evidence, there are insufficient data available to quantify bat migrations over the Baltic Sea and specifically in the vicinity of site O-1.3. This is also the case for migratory species, migration corridors, flight altitude, flight direction and focus areas. Results obtained so far only indicate that bats, especially long-distance migrants, travel across the Baltic Sea and that they have been detected occasionally, though only very rarely, in the vicinity of site O-1.3. However, some of the detections in the vicinity of site O-1.3 were conducted under wind and weather conditions which made it difficult to obtain clear sound recordings of bats.

A total of 25 species of bats are native to Germany. Of these two species are classified as ‘not evaluated’, four species are classified as ‘endangered’ and three species are classified as ‘critically endangered’ in the current Red List of Mammals (MEINIG et al. 2008). The common bent-wing bat (*Miniopterus schreibersii*) is considered 'extinct or lost'. Of the species that have been observed more frequently in the sea and coastal areas of Germany to date, the common noctule (*Nyctalus noctula*) has near-threatened status, the common pipistrelle and the Nathusius's pipistrelle are considered to be 'of least concern'. The data available for the lesser noctule (*Nyctalus leisleri*) is insufficient for a risk status classification.

Anthropogenic risks for migrating bats particularly result from the loss of summer habitats due to deforestation, the loss of winter habitats through renovations of old buildings and the use of wood preservers, the intensification of agriculture and the use of pesticides. According to the report of the BTO (British Trust for Ornithology) regarding the impacts of climate change on migratory species, past findings on bat abundance, distribution and habitat preferences can be used to forecast some of the effects of climate change. For instance, we can expect resting sites along migratory routes to be lost, breeding habitats decimated and food sources being altered (ROBINSON ET AL. 2005). All species will be indirectly affected by the possible impacts of climate change on their food organisms, in this case insects. The observed insect mortality will have an increased negative impact on bats. In particular, the reduced overlap between bat breeding and food availability is likely to have negative consequences for bat breeding success. In addition, high structures, such as buildings, bridges or wind turbines, cause risks for bats due to their barrier effects and potential collisions (e.g. AHLEN 2002).

2.11 Biological diversity

Biodiversity comprises the diversity of habitats and biotic communities, the diversity of species and genetic diversity within species (Art. 2 Convention on Biological Diversity, 1992). Public focus is on the diversity of species. Species diversity is the result of an evolutionary process that has been going on for over 3.5 billion years, a dynamic process of extinction and species formation. Of the approximately 1.7 million species described by science to date, about 250,000 occur in the sea, and although there are considerably more species on land than in the sea, the sea is more comprehensively and phylogenetically highly developed than the land in terms of its phylogenetic biodiversity. 32 of the 33 known phyla can be found in the seas, with 15 even being exclusively marine phyla (VON WESTERNHAGEN & DETHLEFSEN 2003). Recent extrapolations by MORA et al. (2011) have shown that there are around 8.7 million species around the world, of which 2.2 million occur in the seas.

Marine diversity cannot be directly observed and is therefore difficult to assess. For its assessment, aids such as nets, traps, grabs, traps or optical registration procedures have to used. However, the use of such equipment can only ever provide a partial picture of the actual range of species, namely exactly that which is specific to the trap in question. This leaves us to deduce that areas which cannot be reached with the equipment available (e.g. the deep ocean) are likely to be populated with a multitude of species still unknown to us. The situation in the Baltic Sea differs from this, because, as a semi-enclosed, relatively shallow sea, it is fairly accessible. As a result, intensive marine research was conducted as early as the mid-19th century, adding to our knowledge of animal and plant life. During HELCOM monitoring, more than 800 phytoplankton taxa were registered in the Baltic Sea (WASMUND et al. 2016a). In addition, around 61 zooplankton taxa were recorded (WASMUND et al. 2016a). In terms of macrozoobenthos, the Bay of Kile alone is known to contain more than 700 species (GERLACH 2000). According to WINKLER et al. (2000), the fish fauna of the Baltic Sea is currently made up of 176 fish and lamprey species. Only four marine mammal species are known to occur. The German Baltic Sea is the regular home of 38 marine and resident bird species.

Regarding the current status of biological diversity in the Baltic Sea, countless evidence points to the changes to biodiversity and species communities in all systematic and trophic levels of the Baltic Sea. Changes in biodiversity are mainly due to human activities, such as fishing and marine pollution, or to climate change.

Red lists of endangered animal and plant species have an important monitoring and warning function in this context, as they show the status of the populations of species and biotopes in a region. The Red Lists demonstrate that more than 17% of macrozoobenthos species (GOSSELCK et al. 1996) and around 16.9% of the cyclostomata and marine fish species in the Baltic Sea (THIEL et al. 2013) are endangered.

Marine mammals are a species group of which all current representatives are endangered (VON NORDHEIM et al. 2003). Of the 38 seabirds and resting birds which occur regularly, four species are listed in Annex I of the Birds Directive. In general, all native bird species living in the wild must be preserved and therefore protected under the directive.

2.12 Air

Shipping causes emissions of nitrogen oxides, sulphur dioxides, carbon dioxide and soot particles. These can have a negative impact on air quality and are largely discharged into the sea as atmospheric deposition. Since the Baltic Sea has been an emission control area in accordance with Annex VI of the MARPOL Convention, a so-called 'Sulphur Emission Control Area' (SECA) since 2006, it is subject to stricter regulations regarding the emissions of marine traffic. Since 1 January 2015, ships on the Baltic Sea are only permitted to use heavy fuel with a maximum sulphur content of 0.10%. According to HELCOM, this has led to an 88% reduction in sulphur emissions compared to 2014. The limit value at the end of 2019 was still 3.50%. According to a decision by the International Maritime Organisation (IMO) in 2016, this limit is to be reduced worldwide to 0.50% from 2020.

Nitrogen oxide emissions are especially relevant for the Baltic Sea as an additional nutrient load. Marine traffic is among the biggest sources of nitrogen oxide inputs from the air (HELCOM). To this end, the IMO decided in 2017 that the Baltic Sea is to be declared a 'Nitrogen Emission Control Area' (NECA) from 2021. The total reduction of nitrous oxide discharges into the Baltic Sea region through the North Sea and Baltic Sea ECA measure is estimated at 22,000 tonnes (European Monitoring and Evaluation Programme (EMEP, 2016)).

2.13 Climate

The German Baltic Sea is located in a temperate climate zone. As a semi-enclosed sea, it is not influenced by the Gulf Stream. It is too small to develop its own maritime climate and the salt content of Baltic Sea water is also relatively low. As a result, parts are covered in ice each winter, with the whole Baltic Sea freezing over occasionally. There is widespread agreement among climate researchers that the global climate system is being noticeably affected by the increasing release of greenhouse gases and pollutants and that the first signs of this are already being felt. 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. In the Baltic Sea, global warming is also likely to have a significant impact.

2.14 Landscape

The marine landscape is characterised by vast open spaces which are largely free from disruptions. So far, the German EEZ of the Baltic Sea contains only a few tall structures. These are the offshore wind farm 'Baltic 2' located approx. 33 km north-west of Rügen and the wind farms 'Wikinger' and 'Arkona Basin South/East'. The latter two wind farms are situated approx. 34 km north-east of Rügen. Other tall structures are two measuring masts using for measurements and research purposes: the measuring mast in the Arkona Basin located approx. 35 km north-east of Rügen and the research platform 'FINO2' in the area of the Kriegers Flak, approx. 39 km north-west of Rügen. These are too far distant from land to be visible. The construction of additional wind farms will change the landscape even further in future. The required lighting may also result in visual impairments of the landscape. The extent to which vertical structures influence the landscape strongly depends on visibility.

The Land Use Plan for the Baltic Sea includes the aim according to Section 3.5.1 (7) that the hub height of wind turbines visible from the coast and from islands must not exceed 125 m. Due to this, height deviations are clarified in target deviation procedures according to the ROG (Regional Planning Act).

The space in which a building becomes visible in the landscape is known as the visual active area. This is defined by the visual link between a building and its surroundings, whereby the intensity of an effect decreases as the distance increases (GASSNER et al. 2005). Measuring masts, platforms and offshore wind farms to be erected more than 30 km from the coast have a low impact on landscape as viewed from land. At such distances, the platforms and wind farms are unlikely to be discernible even at times of high visibility. This also applies to safety lighting at night. Site O-1.3, which has not yet been built on, is located to the north of existing wind farms at a relevant distance from the coast.

2.15 Cultural heritage and other material assets

Indications of possible material assets or cultural heritage are present in so far as the spatial location of a large number of wrecks is known based on the evaluation of existing hydroacoustic recordings and the BSH wreck database and are recorded in BSH nautical charts. An enquiry to this effect regarding known cultural heritage such as settlement remains or other material assets was also submitted to the German Maritime Museum.

In addition, the sonograms (side-scan sonar recordings) recorded during the offshore site investigation are evaluated with regard to possible objects and soil structures. All objects and soil structures recognisable in the sonograms are mapped out (either directly in the so-called waterfall mode of the recording software or from side-scan sonar mosaics with a maximum resolution of 25x25 cm) and classified using visual methods (video). The BSH shipwreck database does not contain any entries for site O-1.3 itself. However, the south-western edge of the area at a distance of approx. 120 m contains a shipwreck, presumably that of a fishing vessel. The German Maritime Museum does not hold any details on possible ground monuments or other material assets. Evaluations of the side-scan sonar recordings did not provide any information either.

2.16 Human beings, including human health

All in all, the area considered for SDP approvals is of low importance for the protected object human beings. This is also the case for site O-1.3. In a broader sense, maritime space is the working environment for people working on ships. No exact numbers are available of people regularly who regularly spend time in this area. However, the activities in the vicinity of site O-1.3 will increase as a result of the existing and planned WEA.

The EEZ of the Baltic Sea only plays a minor role for active recreational use. It is occasionally used directly for recreation and leisure by pleasure craft and tourist vessels. A special significance of site O-1.3 for human health and well-being cannot be deduced.

2.17 Interactions between the protected objects

The components of the marine ecosystem, from bacteria and plankton to marine mammals and birds, influence one another via complex processes. The plankton conclusively described in the environmental report for the North Sea SDP (BSH, 2019b) and the individual biological protected objects plankton, benthos, fish, marine mammals and birds described separately in chapter 2, are mutually dependent as part of marine food chains.

Phytoplankton serves as a food source for organisms that specialise in filtering water for their food. The main primary consumers of phytoplankton are zooplanktonic organisms such as copepods and water fleas. Zooplankton has a key role to play 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 serves as food for secondary consumers in marine food chains, from carnivorous zooplankton species to benthos, fish, marine mammals and seabirds. One of the uppermost components of the marine food chains are the so-called predators. 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, the availability of food regulates the growth and distribution of species. Exhaustion of the producer results in the decline of the consumer. In turn, consumers control the growth of producers through eating. Food limitation has an impact at individual level in that it impairs the fitness of individuals. 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 , fish (species, length, biomass, energetic value). Temporal or spatial offset of the occurrence of succession and abundance of species at various trophic levels leads to interruption of food chains. Temporal offset, known as trophic 'mismatch', causes organisms in their early developmental stages in particular to be undernourished, or even to starve to death.

Disruptions of marine food chains can affect not just individuals but populations as well. Predator-prey ratios and trophic relationships between size or age groups of a species or between species also regulate the balance of the marine ecosystem. For example, the decline in Atlantic cod populations in the Baltic Sea has had a positive effect on the development of sprat populations. However, this unusual increase in sprat numbers has been limited by the food sources available (zooplankton). This meant that the abundant sprats ultimately remained undernourished and only had limited energy content. The weak nutritional condition of the sprats was reflected in the nutritional condition of their consumers, young common guillemots. The growth and chances of survival of young common guillemots decreased temporarily as a result of 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 act upwards from the lower part of the food chains, starting with the availability of nutrients, oxygen or light, to the upper predators. A 'bottom-up' control mechanism of this kind can act 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 activity also exerts 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 such as 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. For example, jellyfish can be subject to extreme dispersion if their fish predators have been fished away. Moreover, marine traffic and mariculture an additionally cause positive or negative changes to marine food chains through the introduction of non-native species. The discharge of nutrients and pollutants via rivers and the atmosphere also has an impact on marine organisms and may lead to changes in trophic conditions. Natural or anthropogenic effects on one of the components of 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 the description of the individual protected objects.

Finally, the complex reciprocal effects between the different components result in changes to the entire marine ecosystem of the Baltic Sea, e.g. the trophic reciprocal relationships between common guillemot, Atlantic cod, sprats and zooplankton. Based on the changes already presented in chapter 2 for the individual protected objects, the following summary is provided for the marine ecosystem of the Baltic Sea:

- The biotic marine environment is experiencing slow changes.
- Rapid changes in the living marine environment have been observed since 1987/88.

The following aspects or changes may influence interactions between the various components of the living marine environment: changes to the species composition (phytoplankton and zooplankton, benthos, fish), introduction and, at times, establishment of non-native species (phytoplankton and zooplankton, benthos, fish), changes to abundance and dominance relationships (phytoplankton and zooplankton), changes to the available biomass (phytoplankton), decline in many typical species for the area (plankton, benthos, fish), decline in the food available for the top predators (seabirds).

3 Anticipated development if the plan is not implemented

Pursuant to section 40(2)(3) UVPG, not only is the current state of the environment to be described, its development in the event of non-implementation of the plan must also be forecast. This presentation 'provides […] a reference state which can be used to measure the changes resulting from the plan or programme.' (WULFHORST, 'Die Untersuchung von Alternativen im Rahmen der Strategischen Umweltprüfung' (NVwZ 2011, 1099). It must be assessed which developments in the state of the environment will occur during the forecast period if the plan is not implemented (KMENT in UVPG, section 40, recital 46), i.e. if no offshore wind turbines are erected and operated at the site. In this connection, any environmental pollution that already exists in the area and whose impact may even spread if planning is not carried out must also be included. (KMENT in UVPG, section 40, recital 46.)

3.1 Soil/ground

Even if the building project was not implemented, the protected object soil/ground in the vicinity of site O-1.3 would be under significant strain from various uses, such as fisheries. The anthropogenic factors affect the seabed through erosion, mixing, resuspension, sorting of material, displacement and compaction. This exerts an influence on natural sediment dynamics (sedimentation/erosion) and on the mass transfer between sediment and bottom waters. Global warming also leads to changes in hydrographic conditions. On the whole, however, this development is independent of the non-implementation or implementation of the construction project.

The potential consequences for the seabed of the construction phase for wind turbines and of internal wind farm cabling (i.e. direct disruption to the near-surface sediments, suspension of sediment, inputs of pollutants and sediment rearrangement) would not occur if the building project was not implemented. Equally, the permanent, locally limited sealing of the seabed due to the installation of the base elements would also not apply.

3.2 Water

Water as a protected object would be affected by various uses, e.g. shipping to some extent, both during implementation and, in the event of non-implementation of the construction project at site O-1.3. In addition, the warming of water already triggered by climate change is expected to continue in the future. On the whole, however, this development is independent of the non-implementation or implementation of the construction project.

3.3 Biotope types

If the plan were not implemented, the protected object of biotope types would be particularly affected by the impacts of fishing, including disturbance of the seabed and increased turbidity. If the plan were not implemented, the biotopes would no longer recover as a result of the suspension of fishing.

3.4 Benthos

If the plan were not implemented, the protected object of benthos would be particularly affected by the impacts of fishing, including disturbance of the seabed and increased turbidity. The function of the wind farm area as a refuge for the benthic communities due to the suspension of fishing would no longer be available if the plan were not implemented. By contrast, the locally limited effects of introducing hard substrate through the foundations would no longer apply.

3.5 Fish

As for the protected object of benthos, the protected object of fish would be particularly affected by the impacts of fishing, including disturbance of the seabed and increased turbidity, if the plan were not implemented. The function of the wind farm area as a refuge for the fish due to the ban on shipping in offshore wind farms, which is regularly imposed, and thus the suspension of fishing, would no longer exist if the plan were not implemented. By contrast, the locally limited effects of introducing hard substrate through the foundations would no longer apply.

3.6 Marine mammals

The protected object of marine mammals would continue to be affected by the impacts of various uses, such as shipping and fishing, even if offshore wind turbines were not installed at site O-1.3.

Marine mammals, in particular noise-sensitive harbour porpoises, could be affected by noise pollution during the installation of foundations by means of pile driving for offshore wind turbines, transformer stations and transformer platforms if no noise control measures are implemented. Alternative foundation methods are currently being developed, and trial phases have already begun in some cases, such as jacket-suction buckets. The power transmission from site O-1.3 to the land is realised by means of AC cables. The operation of AC cables is state-of-the-art for the distances required for connecting offshore wind farms in the EEZ in the North Sea at site O-1.3.

The draft determination of suitability also includes a whole series of planning requirements geared towards the most compatible design of offshore wind energy generation, in particular noise reduction requirements to coordinate noise-intensive work in order to avoid and reduce significant disturbance to harbour porpoises and to avoid significant impairment of the protection and conservation objectives of nature conservation areas. On the whole, however, the effects of the implementation of offshore wind turbines at site O-1.3 on marine mammals will be comparable to the effects of the zero variant, as project-specific and site-specific noise reduction measures are always required in the specific individual approval procedure. Furthermore, a trend is an emerging in terms of capacity and the resulting reduction in the number of installations. If offshore wind turbines were not installed, site O-1.3 might not be used for the production of renewable energy in an economic and environmentally sound manner.

The effects of natural variability as a result of climate change on marine mammals are complex and difficult to predict. All species are indirectly affected by possible impacts of climate change on the marine food chain. On the whole, this development is independent of the installation and operation of offshore wind turbines at site O-1.3.

3.7 Seabirds and resting birds

Even if the plan were not implemented, seabirds and resting birds as a protected object would still be affected to some extent, as shown, by the effects of various uses such as fishing and shipping. The effects of climate change on the species in question are complex and difficult to predict. All species are indirectly affected by possible impacts of climate change on their food organisms, in particular fish. On the whole, however, this development is independent of implementation or non-implementation of the plan.

If the plan were not implemented, the suitability of site O-1.3 would not be determined and consequently it would not be developed. As a result, there would be no potential project-related impact on seabirds and resting birds due to a wind farm at site O-1.3. However, existing cumulative effects of already realised projects and other uses in the vicinity of site O-1.3 would still exist. In view of this, the impact on the protection of seabirds and resting birds would not differ significantly if the plan were implemented or not.

3.8 Migratory birds

Even if the plan were not implemented, migratory birds as a protected object would still be affected to some extent, as shown, by the effects of various uses such as fishing and shipping. The effects of climate change on the species in question are complex and difficult to predict. All species are indirectly affected by possible impacts of climate change on their food organisms, in particular fish. On the whole, however, this development is independent of implementation or non-implementation of the plan.

If the plan were not implemented, the suitability of site O-1.3 would not be determined and consequently it would not be developed. As a result, there would be no potential pre-emptive impact on migratory birds from a wind farm at site O-1.3. However, existing cumulative effects of already realised projects and other uses in the vicinity of site O-1.3 would still exist.

3.9 Bats and bat migration

Even though bat migrations over the Baltic Sea have been documented in various ways, there is still no reliable information available on the migratory species, migration corridors, flight altitudes and migration concentrations. Previous evidence only confirms that bats fly over the Baltic Sea, especially long-distance migratory species.

Past findings, e.g. on the distribution and habitat preferences of bats, can be used to predict some of the effects of climate change. For example, resting sites are likely to be lost, breeding habitats decimated and food sources altered. The delayed occurrence of food can have consequences in terms of the reproductive success of bats in particular (AHLEN 2002, RICHARDSON 2004). The observed insect mortality will have an increased negative impact on bats.

The protected object of bats is expected to develop in the same way if the plan is not implemented. It is also expected that any adverse effects on bats can be avoided by the same prevention and mitigation measures used to protect bird migration.

3.10 Biological diversity

Large-scale consequences of climate change are also to be anticipated in the oceans. As many marine ecosystems are sensitive to climate change, this has implications for biodiversity. There may be a shift in the species spectrum. For example, it is conceivable that the population density and population dynamics of fish could be strongly influenced, which in turn would have significant consequences for the food chains. On the whole, however, this development is independent of the implementation of the plan.

Temporary or permanent acoustic and visual strains could also impair individual species in the protected objects 'fish', 'birds' and 'marine mammals'. It is currently not conceivable that biological diversity would be impacted as no species are expected to be lost. Impacts on biological diversity due to turbidity plumes, sedimentation / sediment heating or magnetic fields are also unlikely as these normally occur locally only. In addition, it can be expected that the avoidance and mitigation measures planned for certain protected objects would also reduce possible negative effects on biological diversity.

The exclusion of certain uses in Natura2000 areas further reduces potential impacts on biodiversity. Local impacts on habitat and species diversity also cannot be excluded and must even be expected where hard substrate is added. Ultimately, the benthos species likely to settle and any fish species attracted as a consequence will presumably come from the immediate surrounding area so that there will be no major changes to biodiversity within the area under investigation. Since planning approval requires the use of the sea floor to be minimised, and a number of principles are applied to ensure that the plan is as environmentally friendly as possible, the consequences for biodiversity compared to the null variant are likely to be reduced even further.

3.11 Air

Greater intensity of use also leads to increased marine traffic in the Baltic Sea, which in turn can have a negative impact on air quality. However, this development is largely independent of any building project at site O-1.3 since the construction and operations of the turbines and the laying of wind farm cabling in the vicinity of the site do not result in any measurable impacts on air quality. For this reason, the air as a protected object will develop in the same way if the construction project is carried out as it would if the construction project were not carried out.

3.12 Climate

Impacts on the climate from the construction and operation of wind turbines, a transformer platform and the internal cabling of the wind farm are not expected, as there are no measurable climate-related emissions during construction or operation. For this reason, the development of the protected object of climate is independent of the non-implementation or implementation of the construction project at site O-1.3.

3.13 Landscape

The realisation of offshore wind farms has an impact on the landscape, as it is altered by the erection of vertical structures and safety lighting. The extent of these visual impairments of the landscape due to the planned offshore installations depends very much on the respective visibility conditions. Site O-1.3 is more than 35 km from the island of Rügen, which means that the existing and planned installations are/will be very limited in visibility from land (HASLØV & KJÆRSGAARD 2000), even in good visibility conditions. It is likely that the development of the landscape will not vary greatly based on whether the building project at site O-1.3 is implemented or not because the site is situated to the north of two existing offshore wind farms.

3.14 Cultural heritage and other material assets

There are no indications of possible material assets or cultural heritage (e.g. wrecks or settlement remains) in the area around site O-1.3. As such, no significant impacts on the protected object of cultural heritage and other material assets are to be expected either during the implementation or in the event of non-implementation of the construction project at site O-1.3.

3.15 Human beings, including human health

On the whole, the site has little significance for human health and well-being. Humans are not directly affected by the plan, at most indirectly through their perception of the landscape as a protected object and possible influences on the landscape's recreational function for water sports enthusiasts and tourists (cf. Chapter 2.16). If the plan was not implemented, this site would theoretically be available for such use. However, due to the considerable distance of more than 30 km from the coast, the site is actually used very little or not at all for these purposes. In addition, the undeveloped area would be surrounded by other offshore wind farms and their safety zones with navigation regulations, so use by pleasure craft would be limited even if the plan were not carried out. Site O-1.3 is already used as a working environment due to the construction activities of the wind farms situated to the south. This use would continue if the construction project were not carried out. Development would increase the importance of site O-1.3 as a working environment as compared to non-development.

3.16 Interactions between the protected objects

It is assumed that if the plan were not implemented, the interactions between the protected objects would develop in the same way as if the plan were implemented. In this context, please refer to chapter 4.12 .

4 Description and assessment of the likely significant effects of the implementation of the plan on the marine environment

In accordance with section 40(1) UVPG, the likely significant environmental impacts of implementing the plan must be described and assessed. The general procedure is described above in Chapter 1.5.4.

Those protected objects are excluded for which it was possible to rule out any significant impairment in the previous Chapter 3. This applies to the protected objects of air, cultural heritage and other material assets as well as human beings, including human health. Possible impacts on biodiversity as a protected object are dealt with for each individual biological protected object. On the whole, the protected objects listed in section 2(1) UVPG are examined before the assessments under species protection law and territorial protection law are presented. Statements on the general protection of nature and landscape in accordance with section 13 BNatSchG are also covered in the assessment of the individual protected objects. In the following, the description and assessment of environmental impacts focuses on the protected objects for which significant impacts cannot be excluded from the outset as a result of the implementation of the plan.

4.1 Soil/ground

4.1.1 Wind turbines

Wind turbines and platforms are currently installed almost exclusively as deep foundations.

To protect against scouring, scour protection is primarily applied in the form of stone fills around the foundation elements, or the foundation piles of deep foundations are driven deeper into the ground.

Wind turbines have a locally limited environmental impact with regard to soil as a protected object. The sediment is only permanently affected in the immediate vicinity by the insertion of foundation elements and the resulting space usage.

<u>Construction-related:</u> During foundation work for wind turbines, sediments are briefly stirred up and turbidity plumes are formed. The extent of resuspension depends mainly on the fine grain content of the soil. In the areas with a lower proportion of fine grains, most of the released sediment will settle relatively quickly directly in the area of the intervention or in its immediate vicinity. The suspension content decreases to natural background levels due to dilution effects and sedimentation of the stirred up sediment particles. However, the impairments to be expected in areas with a higher proportion of fine grain and the associated increased turbidity remain limited to a small area due to the limited current near the ground.

In areas with softer sediments and correspondingly higher small particle contents, the released sediment is likely to settle a lot more slowly. However, since near-ground currents in the Arkona Basin are low at an average of 0.06 m/s (near-surface: 0.1 m/s), it can be assumed that the turbidity plumes occurring in this area will also have a predominantly local effect and that the sediment will settle relatively close to the construction site. A simulation of the impacts of the offshore wind farm 'Beta Baltic' in the Bay of Mecklenburg, which has sediment conditions comparable to those of the Arkona Basin, showed that current speeds of 0.3 m/s resulted in a maximum sediment distribution of approx. 2 to 3 km (MEYERLE & WINTER 2002). The released material remains in the water column for long enough to spread over a large area so that traceable masses of deposited material are not expected given the comparatively low volumes.

The concentration again drops to below 0.001 kg/m³ within 12 hours.

The monitoring results obtained during the construction phase of the environmental impact assessment for the 'North Stream Pipeline' also only revealed of temporary sediment drifts (turbidity plumes) over a small to medium-sized area and confirmed the predictions of the environment expert (IFAÖ 2009) who had classed the overall consequences as low structural and functional impacts. Based on these results, it can be assumed that turbidity plumes released in soft-sediment areas when the platform foundations are installed will be above the natural maxima for suspended matter up to a distance of 500 m.

In the short term, pollutants and nutrients can be released from the sediment into the bottom water. In areas with soft, silty and clayey marine floors, this can lead to a significant release of pollutants from the sediment into the soil waters. The pollutants normally attach themselves to sinking particles which, given the low currents in the Baltic Sea basin, rarely drift across larger distances and tend to remain in their original environment. In the medium term, this remobilised material again settles in the muddy basin. Impacts 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 the small size of the area.

In terms of the installation-related impact, the seabed is permanently sealed in a locally limited area through the installation of the foundation elements. The affected areas largely cover the diameter of the foundation pillars of the wine turbines and any scour protection that may be required. The sealed area (including scour protection measures) matches the sizes as specified for the North Sea.

From an operation-related perspective, the interaction of foundation and hydrodynamics in the immediate vicinity of the installation may lead to a permanent turbulence and rearrangement of sediments. Based on previous experience in the North Sea, current-related permanent sediment shift can only be expected in the immediate vicinity of the wind turbines. Such experience is currently not available for the Baltic Sea. However, given the low near-soil current speeds in the area of the turbines, only local scouring is expected. Due to the predicted spatially limited extent of scouring, no significant substrate changes are to be expected.

Based on the above statements and taking into account the status estimate, no significant impacts on the protected object 'soil' are expected as a result of erecting and operating wind turbines.

4.1.2 Internal cabling

In terms of the construction-related impact, clouding of the water column is expected to increase due to sediment swirls caused by the laying of the cables. The extent of the resuspension depends mainly on the laying method and the fine grain content of the soil. In the areas with a lower proportion of fine grains, most of the released sediment will settle relatively quickly directly at the construction site or in its immediate vicinity. LEDER (2003) estimates for the wind farm 'Arkona Basin Southeast' in area O-1 that significant sediment drifts during construction work can only be expected in a small radius of 500 m – even assuming extreme current conditions (saltwater inflow). The suspension content decreases to natural background levels due to dilution effects and sedimentation of the stirred up sediment particles. The expected adverse effects of increased turbidity remain locally limited within a small area.

In areas with softer sediments and correspondingly higher small particle contents, the released sediment is likely to settle a lot more slowly. However, since near-ground currents in these areas are relatively low at an average of 0.06 m/s (near-surface: 0.1 m/s), it can be assumed that the turbidity plumes occurring in this area will also have a predominantly local effect and that the sediment will settle in the immediate surroundings. A substantial change in the sediment composition is not expected. A simulation of the impacts of the offshore wind farm 'Beta Baltic' in the Bay of Mecklenburg, which has sediment conditions comparable to those of area O-2, shows that current speeds of 0.3 m/s resulted in a maximum sediment distribution of approx. 2 to 3 km (MEYERLE & WINTER 2002). The released material remains in the water column for long enough to spread over a large area so that traceable masses of deposited material are not expected given the comparatively low volumes. The concentration again drops to below 0.001 kg/m³ within 12 hours.

In the context of the environmental expert opinion for the North Stream Pipeline, only temporary, small to medium-scale effects of sediment drifts are expected (IFAÖ, 2009). As a result, these are classed as a low structural and functional impairment overall. In the nearby area of up to 50 m distance, a medium-level suspended particle content is predicted, but only low to very low intensities in the further area of up to 500 m distance (IFAÖ, 2009). Based on these results, it can be assumed that turbidity plumes released in soft-sediment areas where submarine cables are installed will be above the natural maxima for suspended matter up to a distance of 500 m. These values for the Bay of Pomerania are up to 3.9 mg/l (IFAÖ, 2009), being much higher in estuaries or muddy coastal areas. Moreover, investigations by ANDRULEWICZ et al. (2003) provide evidence that the sea floor of the Baltic Sea is seeing a re-levelling along the affected routes due to natural sediment dynamics. Different model calculations implemented in the context of procedures and experience gained in these procedures show that this re-levelling tends to occur over the longer term.

In the short term, pollutants and nutrients can be released from the sediment into the bottom water. The possible release of pollutants from the sandy sediment is negligible due to the low fine-grain content (silt and clay) and low heavy metal concentrations. In the area of soft, silty and clayey marine floors, this can lead to a significant release of pollutants from the sediment into the soil waters. The pollutants normally attach themselves to sinking particles which, given the low currents in the Baltic Sea basin, rarely drift across larger distances and tend to remain in their original environment. In the medium term, this remobilised material again settles in the muddy basin.

Impacts 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 the small size of the area.

In terms of the operation-related impact, the sediment in a radius around the cable systems will be heated up. The heat emission results from the thermal losses of the cable system during energy transfer.

These thermal losses depend on a range of factors (Table 10). The following initial parameters have a significant influence:

- Cable type: In principle, a higher level of heat emission due to energy loss can be assumed for AC submarine cable systems than for DC submarine cable systems for the same transmission capacity (OSPAR COMMISSION 2010).
- Ambient temperature in the area of the cable systems: Depending on water depth and season, it can be assumed that the natural sediment temperature fluctuates, which has an influence on heat dissipation.

- Thermal resistance of the sediment: The area under investigation contains different soil types with differing thermal properties. Accordingly, a more efficient heat dissipation can be assumed for the rougher sediments compared to the sediments with smaller particle sizes. Densely packed clays have the highest heat resistance.

Table 10: Thermal properties of water-saturated soils (according to SMOLCZYK 2001)

Soil type	**Thermal conductivity – minimum**	**Thermal conductivity – maximum**	**Maximum specific thermal resistance**	**Minimum specific thermal resistance**
	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
Boulder clay	2.60	3.10	0.38	0.32
Silt/sludge	1.40	2.00	0.71	0.50

The depth at which the cable systems are laid is also key in terms of temperature development in the sediment layer near the surface. According to the current state of knowledge, no significant impacts from cable-induced sediment heating are to be expected if a sufficient installation depth is maintained and if state-of-the-art cable configurations are used. Temperature measurements for an internal wind farm AC cable system at the Danish offshore wind farm 'Nysted' in the Baltic Sea showed sediment heating directly above the cable system (transmission capacity 166 MW) 20 cm below the sea flow of max. 1.4 K (MEISSNER et al. 2007). In addition, local heat quickly dissipates due to near-ground water movement.

However, given the heterogeneous geological conditions along the routes and the laying processes available, the laying depth in the EEZ of the Baltic Sea is generally limited and the specific impacts of the cables also depend on their diameters and other properties. Therefore, setting a consistently applicable value for the coverage required for all planned marine cable routes without knowledge of the specific project parameters does not lead to the desired result. The specific covering to be created will be determined in the individual approval procedure based on a comprehensive study to be submitted by the project developer. The concerns of marine environmental protection must also be explicitly taken into account.

In order to ensure that the so-called '2 K criterion, i.e. a maximum temperature increase by 2 degrees within 20 cm below the sea floor surface' is observed, a corresponding sediment heating principle was included in the suitability approval as section 6 (also see SDP2019 planning principle 4.4.4.8). This specification stipulates compliance with the 2 K criterion in order to reduce potential adverse effects on the marine environment caused by cable-induced sediment warming as far as possible. If the 2 K criterion/the respective requirement in the draft suitability approval (section 6) is observed, it can be assumed based on the current level of knowledge that no significant impacts for the protected object 'soil', such as structural or functional changes, need to be expected to result from cable-induced sediment heating.

Based on the above statements, the result of the SEA must record that, based on the current level of knowledge, no significant impacts for the protected object 'soil' are expected to result from the laying and operation of marine cable systems taking into account the mitigating measures. It must be determined in the context of the individual approval procedure how compliance with the 2 K criterion can be ensured in all route sections, taking into account the local ground conditions, once more detailed, project-specific framework conditions are known.

4.2 Water

4.2.1 Wind turbines

4.2.1.1 Construction-related effects – resuspension of sediment

The insertion of the foundation elements causes sediments in the immediate vicinity to be swirled up. Depending on the fine-grain proportion in the sediment, formation of turbidity plumes in the lower water column can occur, which further reduce the already low visibility ranges at these water depths. Where the proportion of small particles is high, more intense turbidity plumes can form which, in exceptional cases, may also impact on primary plankton production. Depending on the organic content, higher oxygen consumption and the release of nutrients and pollutants can result in the short term.

On the whole, small-scale impacts of short duration and low intensity are expected. The structural and functional impairments are minimal.

4.2.1.2 Installation-related effects – changes in currents and sea heave

The supporting structures of offshore wind turbines represent obstacles in the water body that cause changes in flow conditions in both small and medium areas. Numerical models of the current conditions in offshore wind farms have been presented as part of the project GIGAWIND (ZIELKE 2000, MITTENDORF & ZIELKE 2002) and the R&D project 'QuantAS' (BUCHARD et al.)

From the modelling results it can be derived that the flow velocity in the immediate vicinity of the structure will increase. The influence of a single structure on the flow extends laterally over a very small area. This can lead to a change in the dynamics of stratification in the water body in the immediate vicinity of the supporting structures. In turn, this can lead to increased oxygen inputs at higher water depths in a layered body of water. The current speeds in the Baltic Sea, with the exception of the Belts in the western transitional zone, are generally low.

Furthermore, the sea heave is changed by the supporting structures, as these cause additional friction in the wave field. This leads to a slight decrease in wave height on the side facing away from the sea heave and a slight increase in wave height on the side facing the current (HOFFMANNS & VERHEIJ 1997, CHAKRABARI 1987). According to the results of the Gigawind project, the influence of a single structure on the sea heave, similar to that of the current, is limited laterally to distances of about one to two structure diameters and behind it to a few diameters. Wave dissipation results in slight dampening. At the same time, the wind input resulting from the slipstream effect is reduced slightly.

Investigations using numerical models for the R&D project 'QuantAS' showed that wind turbines do not have a significant impact on saltwater intrusion and the related oxygen input in the Arkona Basin in the western Baltic Sea (BURCHARD et al.)

The changes in the current regime and sea heave resulting from wind turbines or offshore wind parks in the long term and medium-term. The effects have a low intensity or could be positive, e.g. due to increased oxygen inputs. Based on this intensity assessment, the structural and functional changes are slight. Immediately after construction has ended, the natural conditions will become re-established.

4.2.1.3 Operation-related effects

To ensure the operation of offshore installations (wind turbines and platforms in general), techniques are used which may involve material discharges into the marine environment. In particular, the protection of structural installations from corrosion involves permanent emissions to the marine environment. At the same time, corrosion protection is indispensable for the structural integrity of the installations. Galvanic anodes (sacrificial anodes) are used on the foundation structures as a common corrosion protection variant in the underwater area. By gradually dissolving these anodes, the components are released into the marine environment. The anode mass required for a service life of 25 years varies depending on the foundation structure, type of building and local environmental conditions. Based on current experience in the offshore industry, the emissions of wind turbines are e.g. at around 150-700 kg per facility per year. Galvanic anodes in offshore wind energy typically consist of aluminium-zinc-indium alloys (approx. 95% aluminium, 2.5 – 5.75% zinc, 0.015 – 0.04% indium; DNV GL 2010). In principle, galvanic anodes can also contain small quantities of particularly environmentally critical heavy metals (e.g. cadmium, lead, copper) as a result of the production process (REESE et al. 2020), which are also released into the marine environment during the course of operation. In this context, it must be taken into account that the inputs from corrosion protection are distributed in the Baltic Sea system through distribution and dilution processes and do not necessarily accumulate locally which would result in harmful concentrations.

As an alternative to galvanic anodes, external current anodes have since become established on the market and are increasingly being used. These external current anodes are inert and only cause minimal emissions (e.g. through material removal).

With regard to the effects of emissions relating to corrosion protection in the area of offshore wind farms, BSH is conducting the 'OffCHEm' research project (https://www.bsh.de/DE/THEMEN/Forschung_und_Entwicklung/Aktuelle-Projekte/OffChEm/OffChEm_node.html) in collaboration with the Helmholtz-Zentrum Geesthacht. Initial results indicate that the metal content in water and sediment samples of the wind farms investigated are within the variability of the North Sea. Therefore, according to the current state of investigation and knowledge, the existing environmental quality standards (where available for the substances concerned) are not currently exceeded in these areas as a result of corrosion-related discharge.

Corresponding to the precautionary principle, material discharge must nevertheless be avoided in accordance with the state of the art so as to protect the marine environment. It should be noted in particular that the use of external current systems is to be preferred. Furthermore, the use of galvanic anodes is only permitted in combination with coatings; this significantly reduces emissions from galvanic anodes into the water body. Subsequently, only those galvanic anodes may be used whose production-related content of environmentally critical heavy metals is reduced to a minimum. These points are specific in the context of the impact assessment.

Taking into account these requirements and based on the current level of knowledge, the impacts of corrosion protection are classed as long-term, small-scale and of low intensity. The structural and functional changes are minor.

In addition to the material emissions from corrosion protection, further selective discharges into the water can occur during the regular operation of platforms. Any rainwater and drainage water may contain oil due to the operating materials contained in the platform's installations (e.g. operating materials released by leakages). Light liquid separators (oil separators) are therefore to be used to reduce the oil content of these waste waters. Depending on the technical availability and the current state of implementation, the oil content can be reduced to 5 ppm for procedural reasons so that the oil content falls below the MARPOL directive for maritime shipping (limit value 15 ppm for bilge water). On manned platforms, waste water from sanitary facilities, laundry and canteen operations can be treated by certified waste water treatment plants and reduced with regard to the potential environmental impact of inadequate waste water treatment. On platforms with low manning densities, such waste water is normally collected and disposed of on land. Closed cooling systems without substance inputs have become established for the purpose of facility cooling so that their use has become a requirement of suitability approval. Only in justified exceptional cases, where these systems are unable to achieve the required cooling capacity, may additional state-of-the-art 'open' marine cooling water systems be used. In order to ensure the permanent operational readiness of these system-relevant cooling systems, biocides (usually sodium hypochlorite) are added to protect pipelines and pumps from marine growth. The sea cooling water is subsequently returned to the sea; the components are then subject to local distribution and dilution processes.

The effects of the above-mentioned emissions from the platform into the water are also assessed as long-term, small-scale and of low intensity according to current knowledge, provided the state of the art is implemented and the minimisation requirement is complied with. The structural and functional changes are minor.

For the operation of the wind turbines and platforms, high volumes of water-polluting operating materials are inevitably required (including hydraulic oils, greases, transformer oils and diesel for emergency power generators, extinguishing agents). Due to their material properties, these have a fundamental risk potential for the marine environment. The risks arising from leaks of operating fluids and accidents can be prevented by implementing precautionary and safety measures in the construction and operation of the installation (e.g. enclosures, double-walled tanks, collecting pans, management concepts). The same applies to operating material changes and refuelling measures to be performed. If the substances used are as environmentally compatible as possible and preferably biodegradable as well, the overall impact on the marine environment resulting from accidental discharge is considered to be low, taking into account the probability of occurrence.

4.2.2 Internal cabling

Construction-related effects – resuspension of sediment

The insertion of internal cabling leads to a turbulence of sediments in the immediate vicinity. Depending on the fine-grain proportion in the sediment, formation of turbidity plumes in the lower water column can occur, which further reduce the already low visibility ranges at these water depths. Where the proportion of small particles is high, more intense cloudy plumes can form which, in exceptional cases, may also impact on primary plankton production. Depending on the organic content, higher oxygen consumption and the release of nutrients and pollutants can result in the short term.

On the whole, small-scale impacts of short duration and low intensity are expected. The structural and functional impairments are minimal.

4.3 Biotope types

4.3.1 Wind turbines

Possible impacts on the protected object of biotope types may result from direct use of protected biotopes, possible covering by sedimentation of construction-related material released during construction and potential habitat changes.

According to current knowledge, there are no biotopes or FFH habitat types protected under §30 BNatSchG in site O-1.3. Thus, significant construction-related, installation-related and operational impacts of the turbines on protected biotopes can be ruled out. It cannot be ruled out that the biotope type of the marine erratic block according to the BfN mapping instructions occurs in the site. In accordance with § 35 of the 1st WindSeeV, the objects must be taken into account when planning the routes and locations. If, contrary to the results of the previous video surveys, marine erratic blocks or stone fields are found, these would have to be buffered in accordance with the requirements of the mapping guidelines and the areas excluded from development.

4.3.2 Internal cabling

According to current knowledge, it cannot be ruled out that the biotope type of the marine erratic block according to the BfN mapping guidelines occurs in the area. In accordance with § 35 of the 1st WindSeeV, the objects must be taken into account when planning the routes and locations. If, contrary to the results of the previous video surveys, marine erratic blocks or stone fields are found, these would have to be buffered in accordance with the requirements of the mapping guidelines and the areas excluded from development.

4.4 Benthos

The construction of wine turbines and the turbines themselves can have impacts on the macrozoobenthos.

Site O-1.3 is of average importance with regard to the species inventory of benthic organisms. The benthos zoonosis identified at site O-1.3 does not have any special characteristics and is typical for the habitat of the western Baltic Sea below a water depth of 40 m. The species inventory found and the number of Red List species indicate an average importance of site O-1.3 for benthic organisms.

The construction-related, installation-related and operation-related impacts of the plan are listed in detail in the environmental report for FEP 2019 (BSH, 2019) and are summarised below.

4.4.1 Wind turbines

Construction-related: Deep foundations of wind turbines cause disturbances of the seabed, sediment turbulence and the formation of turbidity plumes. This may result in the impairment of or damage to benthic organisms or communities in the immediate vicinity of the installations for the duration of construction activities.

Due to the predominant sedimentary composition, the released sediment will settle quickly. After drifting within a small area, the sand portion is deposited once again and can lead to impairments of the macrozoobenthos due to covering at these points.

According to current knowledge, the construction-related impacts caused by turbidity plumes and sedimentation are to be classified as short-term and limited to a small area.

From an installation-related perspective, changes in the benthic community may occur due to area sealing, the insertion of hard substrates and changes in the flow conditions around the installations. In the area of the installations and the associated scour protection, there is area sealing/space usage and therefore a total loss of macrozoobenthos habitats of the soft soil.

Recruitment of additional species will most likely come from natural hard substrate habitats, such as superficial boulder clay and stones. This means that the risk of negative impacts on the benthic sandy soil community from non-native species is low.

In the immediate vicinity of the structures, benthic communities are influenced by a change from formerly sedentary and sessile species to mobile species, caused by sediment erosion and an increase in predators.

Only natural rocks and biologically inert, natural materials must be used for scour protection (section 15 of the draft suitability approval) so that no pollutants can be expected to be emitted by the structures.

According to current knowledge, operation-related impacts of the wind turbines on macrozoobenthos are not expected.

On the basis of the above statements and representations, the result of the SEA is that, according to current knowledge, no significant impacts on the protected object of benthos at site O-1.3 are to be expected. The impacts on benthos as a protected object are assessed overall as short-term and being limited to a small area. Only small-scale areas outside conservation areas are used and, due to the usually rapid regeneration capacity of the existing populations of benthic organisms with short generation cycles and their widespread distribution in the western Baltic Sea, rapid recolonisation is very likely.

4.4.2 Internal cabling

Construction-related: Possible effects on benthic organisms depend on the installation methods used. Local sediment turbulence and turbidity plumes are to be expected during the laying of the internal cabling. This can lead to the small-scale and short-term loss of habitat for benthic species or to the impairment of or damage to benthic organisms or communities during construction activities in the vicinity of the cable systems. The linear character of submarine cable systems favours repopulation from the undisturbed peripheral areas.

Benthic organisms can also be affected in the short term and on a small scale by the release of nutrients and pollutants associated with the resuspension of sediment particles. The effects are generally considered to be minor, as burying the cable systems is limited in time and space and the pollution load in the EEZ area is comparatively low, while nutrients or pollutants are rapidly diluted.

Installation-related: In the area of possible cable crossings, the disturbances are permanent, but also small-scale. The required cable crossings are secured with a stone fill which permanently constitutes a hard substrate that is exogenous to the location. This exogenous hard substrate provides new habitat for benthic organisms.

Only natural rock or biologically inert, natural materials must be used for rock fillings at the site of cable crossings. The use of cable protection systems which contain plastics are only permitted in exceptional cases and must be reduced to a minimum (section 15 of the draft suitability approval). As such, installation-related emissions of pollutants are not to be expected according to current knowledge.

From an operation-related perspective, warming of the uppermost sediment layer of the seabed directly above the cable system can also occur, which can reduce the winter mortality of the infauna and lead to a change in species communities in the area of the cable routes.

According to current knowledge, the 2 K criterion is met if a sufficient installation depth is maintained and if cable configurations according to the state of the art are used, and no significant effects on benthos from cable-induced sediment heating are to be expected (section 6 of the draft of the statutory ordinance).

The same assumptions apply to electric and electromagnetic fields. These are not expected to have a significant impact on macrozoobenthos either.

If a sufficient installation depth is ensured and taking into account that the effects will occur within a small area, i.e. only a few metres on both sides of the cable, no significant impacts on benthic communities are expected from the installation and operation of the submarine cable systems according to current knowledge. According to current knowledge, the ecological impacts are limited to a small area and mostly short-term.

4.5 Fish

The fish fauna at site O-1.3 has a species composition typical for the southern Baltic Sea. Based on the current level of knowledge, site O-1.3 is not a preferred habitat for any of the fish species on the Red List or any of the fish species protected under the Habitats Directive. As a result, the fish population at the planned site O-1.3 is not ecologically exceptional.

4.5.1 Wind turbines

In order to estimate the impacts of construction and dismantling and the installation-related and operation-related impacts of a wind farm on the fish community, two scenarios are used to show the range of probable technical specifications at the time of potentially erecting a wind farm at site O-1.3 (table 11). In scenario 1, planning is based on 34 wind turbines, while scenario 2 considers the installation of 20 larger turbines. Possible impacts of the different wind farm phases on the fish fauna are presented below and transferred to the load criteria of the two model wind farm scenarios.

Table 11: Relevant wind farm parameters for the assessment of the effects of the model wind farm scenarios on the fish fauna.

	Scenario 1	Scenario 2
Output per turbine [MW]	9	15
Diameter of foundation [m]	8.5	12
Area of foundation excl. scour protection [m²]	57	113
Diameter of scour protection [m]	43	60
Area of foundation incl. scour protection [m²]	1420	2,830

4.5.1.1 Impacts of construction and dismantling

- Noise emissions caused by foundation pile driving
- Sedimentation and turbidity plumes

Noise emissions: All fish species and their life stages studied so far can perceive sound as particle movement and pressure change (KNUST et al. 2003, KUNC et al. 2016, WEILGART 2018, POPPER & HAWKINS 2019). Depending on the intensity, frequency and duration of sound events, sound can have a direct negative impact on the development, growth and behaviour of fish or can overlay environmental acoustic signals which are sometimes crucial to the survival of fish (KUNC et al. 2016, WEILGART 2018). However, most of the evidence to date on the effects of sound on fish comes from laboratory studies (WEILGART 2018). Very little research has been carried out so far on the range of perception and possible species-specific behavioural responses in the marine habitat. The construction-related and dismantling-related effects of wind farms on the fish fauna are limited in space and time. It is likely that short, intense sound events during the construction phase – especially during the installation of the foundations – will have an aversive effect on fish. In the Belgian EEZ, DE BACKER et al (2017) showed that 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 observed at a distance of 1400 m or closer from a pile driving sound source without any noise control (DE BACKER et al. 2017).

Such investigations indicate that significant disturbances or even the killing of individual fish in the vicinity of the pile-driving points are possible. Hydroacoustic measurements show that construction measures (pile driving and other construction activities) in the test field 'alpha ventus' resulted in a strongly reduced population of pelagic fish relative to the surrounding area (KRÄGEFSKY 2014). However, after temporary displacement, it is likely that the fish will return once the noise-intensive construction work is completed.

The wind farm scenarios are considered based on the specifications for noise reduction measures originally introduced to protect marine mammals, so the noise level emitted is below 160 dB outside a circle with a radius of 750 m around the pile-driving site. The duration of construction activities and the associated noise emissions are comparable in both scenarios. In scenario 1, the duration of pile driving for the individual offshore wind turbines is shorter than in scenario 2 due to the smaller foundations(Table 11). However, the installation of 34 smaller turbines takes longer in total, so all in all a similar pile driving time is assumed for both scenarios. The risk of injury to fish in the vicinity of the pile-driving sites could be increased in the first scenario due to the greater number of pile-driving sites with sudden noise levels. However, previous aversive action should cause the fish to flee. Measures to minimise noise and its propagation could further reduce injuries to a minimum. According to the requirements of the draft suitability determination, noise emissions caused by pile-driving work for noise pressure (SEL05) must not exceed the value of 160 decibels (dB re 1 μPa² s) at a distance of 750 m (section 8). This approach ensures that the noise caused by construction remains below the critical threshold for fish at all times (POPPER et al. 2014). Therefore, the predicted risk of injury to fish is minimised, especially in the vicinity of the pile-driving site. If the deterrent and mitigation measures are used, the protected object 'fish' is not expected to be significantly impaired as a result of the construction of the wind farm. <u>Sedimentation and turbidity plumes:</u> The construction work on the foundations of offshore wind turbines causes sediment turbulence and turbidity plumes, which – although temporary and species-specific – can have physiological impairments and deterrence effects. Predator hunting in open waters tend to avoid areas with high sediment loads, thereby evading the risk of gill agglutination (EHRICH & STRANSKY 1999). It therefore seems unlikely that these species will be endangered as a result of sediment turbulence, given their high degree of mobility. Neither is any impairment of bottom-dwelling fish to be expected due to their good swimming properties, which will give them plenty of opportunity for evasion. In the case of plaice and sole, increased foraging activity has actually been observed after storm-induced sediment turbulence (EHRICH et al. 1998). In principle, however, fish can evade disturbances due to their pronounced sensory abilities (lateral line) and their high degree of mobility, so impairments are unlikely to occur for adult fish. Eggs and larvae which are not yet sensitive or only slightly sensitive to sensory stimuli are generally more susceptible than more mature stages. However, the spawning grounds of most fish species are located outside the wind farm areas to be developed in the German EEZ. After fertilisation, fish eggs form a dermis which makes them robust against mechanical stimuli, e.g. sediments that have been stirred up. Even though particle concentrations can reach harmful values for specific organisms, the effects on fish must be seen as relatively low because such concentrations are limited in space and time and dissipate quickly due to dilution and distribution effects (HERRMANN & KRAUSE 2000). This also applies to possible increases in concentrations of nutrients and pollutants due to the resuspension of sediment particles (ICES 1992, ICES WGEXT 1998). In the sedimentation of the released substrate, the main risk is covering fish spawn deposited on the bottom. This can result in an insufficient supply of oxygen to the eggs and, depending on the degree and duration, can lead to harm to or even the death of the spawn. For most fish species present in the EEZ, no spawning damage is expected as they either have pelagic eggs and/or their spawning grounds are in shallow waters outside the EEZ. The early stages of life may also be adapted to turbulence, which regularly occurs in the North Sea due to natural phenomena such as storms or currents.

The level of the construction activity at site O-1.3 will determine the amount of sedimentation and turbidity plumes. Accordingly, sediment suspension in the immediate vicinity of the 34 foundation structures of the first scenario is higher than the construction of 20 offshore wind turbines (scenario 2). As a result, possible impairment of the fish fauna is more likely in scenario 1 than in scenario 2. Sediment turbulence is limited in time and space, so impairments are only temporary. In addition, fish have many adaptations to sediment swirls caused by natural turbulence (e.g. storms). No significant impairment of the fish fauna due to construction activities is expected for either scenario.

4.5.1.2 Installation-related effects

- Space usage
- Insertion of hard substrate
- Fishing ban

Space usage: After the wind turbine foundations have been completed, part of the site will no longer be available to fish. Habitat loss will occur for benthic fish species and their food source (including macrozoobenthos) due to local overbuilding.

With a total area of 48,280 m² in scenario 1, the habitat loss is significantly lower than the area loss of 56,600 m² in scenario 2 (number of installations x surface area of foundation including scour protection). For fish and their benthic prey organisms, the implementation of the first model wind farm scenario means that a larger area of their habitat remains available.

The loss of additional space would impair the fish if their occurrence was already limited by the capacity of the area to serve as their habitat even before a wind farm is built on site O-1.3. Evidently, this is not the case: In autumn 2018, significantly higher abundances of nearly all species, especially the characteristic species, were identified in the neighbouring area 'Baltic Eagle' (IfAÖ 2019) than during the site investigation of site O-1.3. The recorded abundance of fish therefore indicates that the area can accommodate more fish than were spotted at O-1.3. Accordingly, the habitat available does not limit density.

Even though the insertion of artificial hard substrate in an area otherwise characterised by mud and gravel sediments, changes the abiotic habitat factors for fish, the area sealed off by the sediments is relatively small compared to the overall size of site O-1.3. The area between the offshore wind turbines continues to be available for the ground-dwelling fish species typically occurring in this habitat.

Insertion of hard substrate: The construction of wind farms is changing the habitat structure of site O-1.3 due to the insertion of hard substrate (foundations, scour protection). The majority of studies observed an attraction effect of artificial reefs on fish (METHRATTA & DARDICK 2019). However, whether this is the result of a concentration of fish which would otherwise go elsewhere or whether it is the result of increased productivity has not yet been conclusively clarified (BOHNSACK & SUTHERLAND 1985). Catches of cod and saithe near Norwegian oil platforms were higher than before these installations were constructed (VALDEMARSEN 1979, SOLDAL et al. 1998). In the North Sea, large adult predators are increasingly observed above shipwrecks and rocky areas (EHRICH 2003) where they are caught through shipwreck fishing using gillnets. Increased densities of flatfish have been spotted in the vicinity of artificial reefs (POLOVINA & SAKI 1989). According to the expert report and video recording of the accompanying monitoring, a large number of fish species that use the artificial hard substrate occur at the monopiles of the existing 'Horns Rev I' wind farm (STENBERG et al. 2011). In addition to this positive effect, changes in the dominance and size structure within the fish community as a result of the increase in large predatory fish could lead to increased feeding pressure on one or more prey fish species.

The attractiveness of artificial substrates for fish depends on the size of the hard substrate introduced (OGAWA et al. 1977). An effective radius of 200-300 m for pelagic fish and 1-100 m for benthic fish is assumed (GROVE et al. 1989). STANLEY & WILSON (1997) found increased fish densities within a 16 m radius of an oil rig in the Gulf of Mexico. If this is applied to the foundations of wind turbines, it must be assumed, given the distance between the individual wind turbines, that each individual foundation, be it monopile or jacket, would be perceived as a separate, relatively structured substrate and that the effect would not cover the whole area of the wind farm.

COUPERUS et al. (2010) found up to 37 times higher concentrations of pelagic fish in the vicinity (0- 20 m) of wind turbine foundations using hydroacoustic methods compared to the areas between the individual wind turbines. REUBENS et al. (2013) found significantly higher concentrations of whiting-pout Trisopterus luscus on wind turbine foundations than on the surrounding soft substrate, mainly feeding on the vegetation on the foundations.

With reference to the model wind farm scenarios, the presence and abundance of fish species could increase in scenario 1 due to the higher number of wind turbines, thereby potentially increasing biodiversity at site O-1.3 more than in scenario 2. As a result of colonisation by benthic invertebrates, more fish individuals could accumulate in the vicinity of the 34 wind turbines than at 20 wind turbines. As mentioned above, consequential effects would then be increased feeding pressure or a change in the dominance ratios. On the whole, the first scenario could have a stronger positive effect on the fish fauna than the second scenario due to the increased insertion of hard substrate.

Anticipated fishing ban: The discontinuation of fishing due to the expected traffic ban at site O-1.3 could have a further positive effect on the fish fauna.

Larger fish could settle there due to the greater food supply and the loss of fishing pressure, and the length distribution of individuals of a species could possibly shift in favour of larger length classes. In addition, fish species which are particularly loyal to their habitat would benefit from the no-take zone. So far, the effects on fish fauna that could result from the disappearance of fishing in the area of wind turbines have not been directly investigated.

Regardless of the design of the future wind farm, it is expected that fishing will be prohibited in the entire area of site O-1.3, thus creating retreat areas for fish fauna. Taken together with the 'new' food source of the hard structures projecting through the water column, this might lead to the fish living in the area aggregating there (METHRATTA & DARDICK 2019).

Taken together with the expected exclusion of fisheries (see BKompV), the effects of offshore wind farms for fish must be viewed as positive overall. Internal wind farm cabling

If a wind farm is erected on site O-1.3, the electricity produced would be conducted away via internal wind farm cabling (33 kV) and a joint grid connection. Therefore, it would not be necessary to construct a transformer platform or lay an additional marine cable.

4.5.1.3 Construction-related effects

- <u>Noise emissions</u>
- <u>Sedimentation and turbidity plumes</u>

During the construction phase of submarine cable systems, the fish fauna can be temporarily disturbed by noise and vibrations both from the use of ships and cranes and from the installation of the cable systems.

Furthermore, construction can cause turbidity plumes near the ground and local sediment shifts can occur, which can harm fish spawn and larvae in particular. The ecological effects of the turbidity plumes on the fish are described in detail in chapter 4.5.1. The effects on fish in areas with sediment shifting are short-term and spatially limited.

The more construction activities take place at site O-1.3, the higher the noise emissions and sedimentation. In scenario 1, more wind turbines have to be connected by means of cables within the wind farm, so sediment turbulence will be greater than in scenario 2, especially when the submarine cables are buried. As a result, possible impairment of the fish fauna is more likely in scenario 1 than in scenario 2. Sediment turbulence is limited in time and space, so impairments are only temporary. In addition, fish are adapted in many ways to sediment turbulence in the North Sea. No significant impairment of the fish fauna due to construction activities is expected for either scenario 1 or scenario 2.

4.5.1.4 Installation-related effects

- <u>Habitat changes due to cable crossings</u>

The stone fills in the area of the planned pipeline crossings are expected to cause a local change in the fish community. A change in fish coenosis can lead to a change in the dominance relationships and the food web. However, these effects are to be assessed as minor due to the small area covered by the cable crossing structures.

4.5.1.5 Operation-related effects

- Warming of the sediment
- Electric/electromagnetic fields

The maximum sediment warming in the immediate vicinity of the cables is stipulated by the suitability determination and must not exceed the specified 2 K value at 20 cm sediment depth. If this value is observed, no significant impacts on the fish fauna are expected. Experience indicates that direct electric fields do not occur due to the shielding. Induced magnetic fields of the individual conductors are usually significantly below the strength of the earth's natural magnetic field. On the whole, the expected moderate and spatially limited change in the magnetic field in the area of the cable makes it unlikely that the migration of marine fish will be blocked.

4.6 Marine mammals

The site O-1.3 and its surrounding area, like the whole of the western Baltic Sea, form part of the habitat of the harbour porpoise. Based on the current level of knowledge, harbour porpoises use this area of the German EEZ as a transit area. There are currently no indications that this site plays any special role as a feeding ground or rearing ground for the harbour porpoise.

Harbour seals and grey seals only use this area sporadically as a transit area. Based on the findings of the monitoring conducted for the Natura2000 areas and the investigations for offshore wind farms, a medium to seasonally high importance of site O-1.3 and its surrounding area for harbour porpoises can be deduced. These sites do not play any special role for harbour seals and grey seals.

4.6.1 Wind turbines

Construction-related: Harbour porpoises, harbour seals and grey seals can be at risk due to noise emitted while installing the foundations of wind turbines and converter platforms, where these are implemented as pile-driven deep foundations and no mitigation or avoidance measures are taken.

An estimate of the possible impacts and risk potential for marine mammals requires knowledge about the auditory capacity of marine mammals on the one hand and of the intensity of the noise emissions during pile-driving on the other hand. Up until now, only incomplete knowledge is available of the auditory capacity of marine mammals, the risk potential of different activities and of auditory thresholds and threshold shifts (RICHARDSON 2002).

Initial results regarding the acoustic resilience of harbour porpoises were obtained in the MINOSplus project. After sound exposure with a maximum receiving level of 200 pk-pk dB re 1 µPa and an energy flux density of 164 dB re 1 µPa^2/Hz, a temporary hearing threshold shift (so-called TTS) was detected for the first time in a captive animal at 4 kHz. It was also shown that the hearing threshold shift lasted for more than 24 hours. Behavioural changes were registered in the animal from a reception level of 174 pk-pk dB re 1 µPa (LUCKE et al. 2009). In addition to the absolute volume, however, 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. if exposure is prolonged, damage to the animals' hearing can occur even at lower volumes. Based on these latest findings, it is clear that porpoises suffer a hearing threshold shift above 200 decibels (dB) at the latest, which may also cause damage to vital sensory organs. The scientific evidence that has led to the recommendation or setting of sound exposure limits is based mainly on observations of other cetacean species (Southall et al. 2007) and on experiments on harbour porpoises in captivity using airgun pulses (Lucke et al. 2009).

Unless sound-reducing measures are used, significant impairments of marine mammals during the installation cannot be excluded in individual sub-areas. As a result, the specific approval procedure will only permit the pillars of wind turbines and converter platforms to be installed if effective noise reduction measures are implemented. The draft suitability approval stipulates this in text format by stating the principle of noise reduction (section 8). This states that platform foundations may only be pile-driven if strict noise reduction measures are observed. The specific approval procedure orders extensive noise reduction measures and monitoring measures in order to comply with the applicable noise control limits. A maximum sound exposure level (SEL) of 160 dB re 1µPa^{2}s and a peak noise pressure level of 190 dB re 1µPa is specified for a distance of 750 m from the pile-driving and installation site. Suitable measures must be taken to ensure that no marine mammals are present in the vicinity of the pile driving site. In particular, direct disruptions to marine mammals during pile-driving work at the level of individuals are expected to be limited. Currently, the duration of pile-driving work to install a converter platform is estimated to be no longer than one week; the effective pile-driving time including the deterrent lasts approx. three hours. While the foundations are being installed, the area around the construction site is unavailable as a habitat. The effective pile-driving period (including deterrent) to be observed is specified in the approval procedure based on the location and installation. The enforcement procedure is also subject to the coordination of noise-intensive work with other construction projects so as to prevent or reduce cumulative impacts.

The noise protection level recommended by the Federal Environment Agency was already developed based on preliminary work on various projects (UNIVERSITY OF HANOVER, ITAP, FTZ 2003). For precautionary reasons, 'safety reductions' were taken into account, e.g. for the inter-individual scattering of hearing sensitivity documented to date and, above all, because of the problem of repeated exposure to loud sound pulses, as will occur during foundation pile driving (ELMER et al., 2007). At present, there is only very limited data available to evaluate exposure time to pile driving noises. However, pile driving operations, which can take several hours, have a much higher damage potential than a single pile driving impact. It remains unclear at present what reduction to apply to the above-mentioned limit value for a series of individual events. A deduction of 3 dB to 5 dB for each tenfold increase in the number of pile driving impulses is being discussed among experts.

In light of the uncertainties presented here in evaluating the exposure time, in practice the permitted noise protection level is below the limit value suggested by SOUTHALL et al. (2007). At the same time, based on the latest scientific work, it must be assumed that the noise control limits must be observed in order to be able to exclude injuries to harbour porpoises with the required certainty.

Since 2011, technical noise reduction measures have been used for all construction projects in the German EEZ of the North and Baltic Sea. In 2012 and 2013, it was not possible to consistently observe the noise control limits. This inconsistent compliance with the noise control limits was due to the limited practical experience at the time in developing and applying noise control measures. With the support of offshore operators and federal research projects, it was nevertheless made possible to promote highly effective technical developments. The development of technical noise protection on offshore construction sites has resulted in reliable compliance with, or even undercutting of, the noise control limits since 2014. Since 2014, it has been rare for the noise control limits to be exceeded, with such events being due to unforeseeable technical defects in the noise reduction systems.

In 2016, the project 'Wikinger' was realised in the area O-1. The jacket structure foundations were inserted by means of pile driving. In 2017, monopile foundations were installed for the project 'Arkona Basin Southeast'. In spite of difficult ground conditions, it was possible to reliably observe the noise protection levels by using combined noise control measures consisting of a further developed bubbling system and a near-pile system. In fact, the sound event level SEL_{05} at a distance of 750 m was even undercut at 6 dB re 1µPas^2. Similarly promising results were also achieved when monopiles were installed in the EEZ of the North Sea.

The results of using noise reduction systems so far confirm that suitable measures can reduce the sound event level (SEL) of pile-driving at a distance of 750 m to below 160 dB re 1µPa.

At the level of the specific approval procedure, the required level is determined for the location and project based on the species and habitat protection law requirements after the individual project has been assessed. Generally speaking, the mentioned considerations for harbour porpoises resulting from the noise pollution caused by the construction activities of converter platforms also apply to harbour seals and grey seals. In order to be able to record the impacts of water layering on pile-driving noise distribution under certain hydrographic conditions in the

Baltic Sea, and to take any additional measures if applicable, special monitoring measures are ordered during the execution of the individual projects.

To summarise, it can be assumed based on the latest scientific findings that pile-driving noise will result in significant impacts on marine mammals if no deterrent or mitigation measures are taken. However, current technical developments in underwater noise reduction have shown that suitable measures can significantly reduce or even exclude the risk of noise impacts on marine mammals.

During the laying phase of internal wind farm cabling, which occurs over a limited area and for a limited time, construction-related marine traffic can result in short-term deterrence effects for marine mammals. However, these effects do not go beyond the disturbances generally associated with slow ship movements. Since the Baltic Sea is subject to intense shipping, the increased marine traffic during the construction phase or for repair and maintenance purposes is not expected to cause any significant additional disruptions for marine mammals. Potential changes to the sediment structure and related temporary changes to the benthos do not affect marine mammals because marine mammals find their prey across broad sections of the water column.

<u>Operation-related and installation-related:</u> According to the present level of knowledge, significant impacts of offshore wind turbines and converter platforms on marine mammals during the operations phase can be excluded. Investigations of the noise level of wind turbines in the test area 'alpha ventus' showed that the operational noise level is barely distinguishable from background noise at distances of even a few hundred metres (BETKE et al. 2012). The results lead to the assumption that the noise level at a distance of 1000 m from the wind turbine will be 12 to 15 dB below the auditory threshold of the harbour porpoise. Based on the current level of knowledge, at most comparable noise levels can be expected from the operations of converter platforms. In accordance with applicable approval practices, however, converter platforms are ordered to only use state-of-the-art technology which ensures the lowest possible noise level in the body of water.

A study of the offshore wind farm 'Egmond aan Zee' in the Netherlands provides findings on the habitat use of operational offshore wind farms. With the help of acoustic recording, the use of the wind farm area and of two reference areas by harbour porpoises was examined before the turbines were erected (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 the 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 the use of the wind farm area was extensively independent of seasonality and interannual variability. The authors of the study see a direct link between the presence of the installations and the increased use by harbour porpoises. They suspect the causes in factors such as the enrichment of the food supply through a so-called 'reef effect' or the calming of the area through the absence of fishing and shipping or possibly a positive combination of these factors. The results of 'Horns Rev I' also point to a greater presence of harbour porpoises inside the wind farm during the operations phase compared to the base survey (BLEW et al. 2006).

Based on the above statements, it can be stated as the result of the SEA that significant impairments of marine mammals during pile-driving work cannot be excluded. As a result, the draft suitability approval includes noise reduction requirements for the installation of offshore wind turbine and converter platform foundations. Assuming that the applicable noise control limits are observed once the reduction measures ordered in the individual approval procedure have been implemented in line with the requirements, and given the high mobility of the animals, no significant negative impacts on marine mammals are expected based on the current level of knowledge.

4.6.2 Internal cabling

Construction-related: During the laying phase, which is limited in time and space, short-term deterrence effects can occur due to construction-related shipping traffic. However, these effects do not go beyond the disturbances generally associated with slow ship movements. Possible changes in sediment structure and associated temporary benthic changes do not have a significant impact on marine mammals, as they seek their prey in vast areas of the water column.

Operation-related sediment warming has no direct impact 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 that occur are significantly below the earth's natural magnetic field, no significant effects on marine mammals are expected.

As a result of the SEA, it can be concluded that, according to current knowledge, no significant impacts on the protected marine mammal species are to be expected from the laying and operation of the internal wind farm cabling.

4.7 Seabirds and resting birds

4.7.1 Wind turbines

If the suitability of site O-1.3 is determined and an offshore wind farm project is realised on this site, the following general effects may occur:

Construction-related: During the construction of offshore wind turbines, impacts on seabirds and resting birds are to be expected, although the type and extent of these will be limited in time and space.

Species sensitive to disturbance can react with avoidance behaviour to the construction site or construction site traffic. The installation process can generate turbidity plumes. Lure effects caused by the lighting of the construction site and construction site vehicles cannot be ruled out either.

Operation-related and installation-related: Installed wind turbines can be an obstacle in the airspace and can also cause collisions with the vertical structures by seabirds and resting birds (GARTHE 2000). It is difficult to estimate the extent of such incidents to date, as it is assumed that a large proportion of the colliding birds do not land on a solid structure (HÜPPOP et al. 2006). The collision risk of a species is determined by factors such as manoeuvrability, flight altitude and the proportion of time spent flying (GARTHE & HÜPPOP 2004). The risk of collision for seabirds and resting birds must therefore be assessed differently for each species.

For disturbance-sensitive species, it can be assumed that wind farm areas are avoided during the operating phase of the wind farms to a species-specific extent. Furthermore, it cannot be ruled out that during the operational phase, fish populations may recover as a result of a ban on fishing within the wind farm, which will result from a ban on vessels. In addition to the insertion of hard substrate, this could thus increase the species spectrum of the fish found and provide an attractive food supply for foraging seabirds.

The potential impacts during the construction phase of an OWF at site O-1.3 are to be assessed as local in terms of both space and time. Construction-related marine traffic will not exceed the level of influence of regular marine traffic in this area of the Baltic Sea. Likewise, turbidity plumes will only occur locally and for a limited time. With regard to possible lure effects caused by lighting, the draft suitability determination includes a requirement for minimising emissions to a necessary minimum level and therefore also reducing potential lure effects. In conclusion, due to the generally high mobility of birds and if measures to avoid and reduce intensive disturbance are in place, significant impacts on all seabird and resting bird species during the construction phase can be ruled out with the necessary certainty.

For the assessment of a possible collision risk for seabirds and resting birds with offshore wind turbines, the relevant height parameters of the turbines are an important key indicator. In the suitability assessment, therefore, in analogy to the Site Development Plan, two scenarios are examined in accordance with current technical developments with regard to the dimensions of future wind turbines which take into account possible relevant turbine parameters (cf. Chapter 1.5.5.4). According to scenario 1, wind turbines with a hub height of 125 m and a rotor diameter of 198 m would be used, thereby extending to a total height of 224 m. According to scenario 2, these would be wind turbines with 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 water surface to the lower tip of the rotor blades would be 26 m in scenario 1 and 50 m in scenario 2.

As part of StUKplus, the 'TESTBIRD' project used a rangefinder to determine the flight altitude distribution of a total of seven species of seabirds and resting birds. The large gull species lesser and great black-backed gull and European herring gull predominantly flew at heights of 30 – 150 m. Species such as the common gull and little gull were mainly observed at lower heights of up to 30 m (MENDEL et al. 2015). A recent study carried out at Britain's Thanet Offshore Wind Farm examined the flight altitude distribution of the European herring gull, the great black-backed gull and the lesser black-backed gull, likewise using the rangefinder (SKOV et al. 2018). This recorded similar flight altitude measures for larger gulls as MENDEL et al. (2015).

In general, large and small gulls have a high degree of manoeuvrability and are able to react to wind turbines by means of the relevant evasive manoeuvres (GARTHE & HÜPPOP 2004). This was also shown in the study by SKOV et al. (2018), which examined not only the flight altitude but also the immediate, small-scale and large-scale avoidance behaviour of the species under consideration. Furthermore, the surveys using radar and thermal imaging cameras revealed low levels of night-time activity. The risk of collision at night due to lure effects caused by the lighting of the wind turbines can therefore also be rated as low.

However, the risk of collision is estimated to be very low for species sensitive to disturbance, such as red-throated divers and black-throated divers, as they do not fly directly into or near wind farms due to their avoidance behaviour.

On the whole, the realisation of the wind turbines specified in scenarios 1 and 2 at site O-1.3 does not lead to an increased risk of collision for seabird and resting bird species. According to current knowledge, this also applies to those species whose flight altitudes are in the area of the rotating rotor blades but whose flight behaviour allows them to avoid the turbines at an early stage.

For disturbance-sensitive species, it can be assumed that wind farm areas are avoided during the operating phase of the wind farms to a species-specific extent.

It is known from wind farm projects in the EEZ of the North Sea that red-throated and black-throated loons display pronounced avoidance behaviour in relation to offshore wind farms. A recent study conducted by the FTZ on behalf of the BSH and BfN, which took into account data from wind farm monitoring in the EEZ of the North Sea as well as research data and data from Natura 2000 monitoring, revealed a statistically significant decrease in the abundance of divers up to 10 km from the periphery of a wind farm across all built-up areas in the EEZ (GARTHE et al. 2018). This is not total avoidance, but partial avoidance with increasing densities of divers up to 10 km away from a wind farm. For the quantification of habitat loss, early decisions on individual approval procedures were based on a deterrence distance of 2 kilometres (defined as complete avoidance of the wind farm area including a 2-kilometre buffer zone) for divers. The assumption of a habitat loss of 2 km was based on data from the monitoring of the Danish wind farm 'Horns Rev' (PETERSEN et al.2006). The latest study by GARTHE et al. (2018) shows that the deterrence distance more than doubles to an average of 5.5 km. This distance, or calculated total habitat loss, is based on the purely statistical assumption that there are no divers within 5.5 km of an offshore wind farm.

Such large-scale avoidance reactions on the part of loons are not yet known from any wind farm projects in the EEZ of the Baltic Sea or, more specifically, from the cluster 'Western Adlergrund' in which the present site O-1.3 is located. This may be because the areas of wind farm projects in the EEZ of the Baltic Sea and, more specifically, the vicinity of site O-1.3, generally have no special importance of this group of species and loons visit only occasionally as transitory birds or in winter. Comparable analyses on potential avoidance reactions in the cluster 'Western Adlergrund' showed that there was already a natural gradient in the distribution of loons at the time of the base survey, before the construction of the wind farm in the area O-1 had commenced. Increasing numbers of individuals were identified at a distance of 6 km to the project sites. The analysed data from the building phase monitoring did not give a clear picture (IFAÖ & BIOCONSULT SH&CO KG 2019), and findings from the operations phase monitoring of the realised wind farms in the area O-1 are not yet available. The evaluation of the spatial occurrence of loons in the vicinity of site O-1.3 in all previous investigations showed a preference for the area to the south of O-1 within the nature conservation area 'Bay of Pomerania – Rönnebank' as well as to the east of O-1 (see chapter 2.8.3). As a result, the immediate vicinity of site O-1.3 does not play any special role for loons as a resting or feeding area.

Findings regarding partial avoidance behaviour on the part of diving marine ducks are available for Danish offshore wind farms, some of which show a crossover with preferred feeding grounds (e.g. FOX & PETERSEN 2019). Due to its water depth, the vicinity of site O-1.3 does not play a special role as a feeding and resting habitat for these species. Long-tailed ducks, velvet scoters and common scoters only occasionally visit the vicinity of site O-1.3, with their clear occurrence preferences in this area of the EEZ being the shallow areas of the Odra Bank or the Adlergrund.

There are also findings available for the small- to medium-scale avoidance behaviour of auks in relation to offshore wind farms (e.g. IFAÖ & BIOCONSULT SH&CO KG 2019). However, the surrounding area of site O-1.3 only touches on the outermost edges of the large-scale winter resting habitats of common guillemots and razorbills.

All in all, the vicinity of site O-1.3 only plays a secondary role for species and species groups whose avoidance behaviour in relation to offshore wind farms is known. The observed species do not have preferred occurrences in the immediate vicinity of the present site. Significant impacts in the shape of habitat loss can be excluded with the required certainty.

4.7.2 Internal cabling

The impacts of submarine cable systems have already been examined and assessed at the level of the Strategic Environmental Assessment for the Site Development Plan (BSH 2019). The result here was that the impact of submarine cable systems on seabirds and resting birds was not considered significant. This assessment remains valid.

4.8 Migratory birds

Where bird migrations are put at risk, this constitutes a reason for rejecting offshore wind farm projects in accordance with section 48(4)(1)(b) WindSeeG, which is also relevant for the impact assessment pursuant to section 10(2) WindSeeG.

The following general impairments and impacts may result from suitability approval of site O-1.3 and from the realisation of an offshore wind farm project on this site:

Construction-related: In the first instance, disturbances during the construction phase are caused by light emissions and visual disturbance. These can have varied species-specific deterrence and barrier effects on migrating birds. However, lighting for construction equipment can also attract migrating birds and increase the risk of collision.

Installation-related and operation-related: The potential impact of an offshore wind farm at site O-1.3 in the operational phase may be that it will create a barrier to migrating birds or pose a risk of collision. Flight diversion or other changes in flight behaviour can lead to higher energy consumption, which can affect the birds' fitness and consequently their survival rate or breeding success after spring migration. Bird collision events may occur at the vertical structures (such as rotors and support structures of the wind turbines). Bad weather conditions – especially at night or during heavy winds – increase the risk of bird collisions. Added to this are possible glare or lure effects caused by the safety lighting of the installations, which can lead to birds becoming disoriented. Furthermore, birds that get caught in wake currents and air turbulence at the rotors could be affected in their manoeuvrability. In terms of the above-mentioned impacts, it can be assumed that the sensitivities and risks vary for each species. For this reason, when considering the likely considerable impacts at site O-1.3 (chapter 4.8.1), the threat potential is considered on a species-group-specific basis.

Generally speaking, it holds true that bird migrations are not yet endangered where there is only an abstract risk that individual birds may be injured during their migrations through an offshore wind farm. Bird migrations are only deemed to be endangered if sufficient findings justify the prediction that the number of potentially affected birds is so high that, taking into account their respective population size, a significant impairment of individual or several different populations can be assumed with sufficient probability. The biogeographical population of the respective migratory bird species is used as the reference value for the quantitative assessment.

There is a general consensus that, in accordance with the present legal situation, losses of individual birds during migrations must be accepted. In particular, it must be considered that bird migrations are full of risks anyway and that the populations are subject to hard selection. The mortality rate among small birds is approx. 60 to 80 %, with the natural mortality rate being lower among larger species. In addition, the different species have different reproduction rates so that the loss of individual birds can be of varied import.

It has not been possible so far to determine a generally applicable acceptance threshold due to insufficient findings. However, the threshold of one percent often applied by experts in avifauna assessments can be used as a basic value.

The risk potential for the respective biogeographical population depends, on the one hand, on the loss due to collisions and, on the other hand, on other negative impacts resulting from enforced changes to the flight routes. In addition to the importance of the site for all migratory species or species groups, the assessment prediction also takes into account general and specific findings for the vicinity of site O-1.3 regarding the flight behaviour and reactions of the most relevant species, in this case the most frequent species and protected species.

The relevant chapters of the environmental report for the Site Development Plan for the German Baltic Sea (BSH 2019) provide more details on the general risk potential for bird migrations.

4.8.1 Wind turbines

Within the scope of the suitability assessment, as in the Site Development Plan 2019, two scenarios regarding turbine size are to be examined in order to take account of current technical developments. According to scenario 1, a hub height of 125 m, a rotor diameter of 198 m and a total height of 224 m can be expected, with the height of the lower rotor tip at 26 m. In scenario 2 the corresponding figures are 175 m, 250 m, 300 m and 50 m. These larger dimensions also increase the swept area of the rotor. However, this influence is reduced by the decrease in the number of installations, but the higher installations may increase the risk of collision.

Assessment of the conflict potential for bird migration is differentiated by species group based on different lifestyles, navigational ability and migratory behaviour (day/night migratory birds). Within the framework of the sensitivity assessment to be performed, rarity, endangerment status and reproduction strategy must also be taken into account. The assessment of individual species or species groups below only accounts for species which were registered in notable numbers in the vicinity of site O-1.3 and species with protected status.

Common crane (*Grus grus)*

Common cranes have been sighted in different numbers in the vicinity of site O-1.3 in all investigations of outward and return migrations for the cluster 'Western Adlergrund' in the past investigation years 2014 to 2017 (see chapter 2.9.3.3). The past peak value for common cranes in the targeted investigations for site O-1.3 was recorded in autumn 2019. According to current estimates, the 1,609 individuals counted on four days in October 2019 correspond to approx. 0.46 % of the biogeographical population of north-western Europe (WETLANDS INTERNATIONAL 2018) or 1.9 % of the estimated 84,000 common cranes which migrate over the Arkona Basin according SKOV et al. (2019). If these sightings are extrapolated and adjusted for survey time, this corresponds to 2,878 individuals or 0.8% of the biogeographical population of north-western Europe or 3.4% of the estimated total of 84,000 common cranes crossing the Arkona Basin.

Of the 1,609 common cranes spotted in autumn 2019, a total of 1,439 individuals were assigned to directional migrations. The area surveyed by the visual observations was split into a sector facing the wind farm and a sector facing away from the wind farm in order to be able to identify potential avoidance of an existing wind farm in the immediate vicinity of site O-1.3 based on the migratory events recorded in the two sectors and hence potential future behaviour in relation to an offshore wind farm at the site O.1-3. In light of the position of the anchored vessel, it was not possible to capture flight through the wind farm and flight behaviour inside the wind farm. The 1,439 common cranes on a targeted migratory route were distributed across a total of 20 migratory events with an average group size of 72 individuals. A total of 727 individuals flew through the sector facing the wind farm in 8 migratory events, whereas 712 individuals in 12 migratory events travelled through the sector facing away from the wind farm. Accordingly, 51 % of the observed individuals were spotted in the sector facing the wind farm (sector 1) and 49 % in the sector facing away from the wind farm (sector 2). As a result, no avoidance through horizontal circumvention of the wind farm area was apparent (IFAÖ et al. 2020).

The flight altitudes of the cranes, which were determined based on visual observations, were preferentially above 200 m in both the sector facing the wind farm and the sector facing away from the wind farm (sector 1: 50 % of all observed cranes at altitudes > 200 m; sector 2: 58% of all observed cranes at altitudes > 200 m). The average flight altitude in the sector facing the wind farm was 239 m, and 259 m in the sector facing away from the wind farm (IFAÖ et al. 2020). Compared to current findings, the investigations for the cluster 'Western Adlergrund' in the years 2014 to 2017 were dominated by the height classes 20 – 200 m, at 77 % (2017) to 98 % (2016) of all observed common cranes. These investigations covered a two-year base survey before the construction of the now erected wind farm project commenced in the area O-1, as well as a two-year construction phase. As early as 2017, the second year of the construction phase, an increased flight altitude for common cranes was apparent in the area above 200 m. That year, 77 % of common cranes used the altitude range 20 – 200 m and 23 % used the height range > 200m (BIOCONSULT SH 2019). In the preceding years, common cranes were only very rarely spotted in this height range (BioConsult SH 2016b, BIOCONSULT SH 2017b, BIOCONSULT SH 2018). This comparison could indicate that common cranes in the area of site O-1.3 are already reacting to the existing wind farms by adapting their flight altitude. The observation from the surveys of site O-1.3 in autumn 2019 that common cranes based on visual observations only flew either above or below the rotor area of the existing wind farm 'Wikinger' supports this assumption (IFAÖ et al. 2020). The present findings indicate a vertical rather than a horizontal evasion in relation to the existing wind farm.

During the base surveys of the Danish offshore wind farm 'Kriegers Flak' in 2015, the avoidance rates of common cranes were evaluated at macro, meso and micro level. These surveys were based on the data of behavioural reactions collected in the immediate vicinity of the offshore wind farm 'Baltic 2'. These identified only limited reactions on the part of common cranes to the offshore wind farm 'Baltic 2' as only one of 14 groups approaching the wind farm avoided flying into the first row of turbines (macro avoidance) (SKOV et al. 2015).

When the common cranes were in the neighbouring wind farm, they displayed relatively strong horizontal and vertical avoidance (meso avoidance). Of the 20 recorded groups, 16 avoided flying into the rotor area, with seven groups displaying horizontal avoidance and nine groups vertical avoidance. All in all, based on the observations collected as part of the investigations for the base survey 'Kriegers Flak' and additional findings for the common crane, a total avoidance rate of 83 % is estimated (SKOV et al. 2015). By way of comparison, based on offshore surveys, large gulls are assumed to have an avoidance rate of 99.8 % (SKOV et al 2018).

In addition to determining flight altitude based on visual observations, migratory birds were measured with the rangefinder (often at the same time in autumn 2019) in the sectors facing the wind farm and facing away from the wind farm in order to obtain a more precise measurement of flight altitude. Based on the information provided by the experts, the bird sightings recorded as part of the rangefinder surveys are 74 % identical to the sightings during the sector-based migration observations. The remaining 26 % of the total of 5,313 individuals were not recorded during the visual observations. During the rangefinder survey, approx. 877 common cranes were observed. All in all, the flight altitude evaluations based on the rangefinder took into account 12 migratory events, three of which occurred in the sector facing the wind farm. Regarding the estimated risk potential for common cranes from a collision with turbines in scenarios 1 and 2 according to the SDP (chapter 1.5.5.4), the rangefinder surveys and visual observations provided consistent results. The estimates are based only on migratory events from the sector facing the wind farm (sector 1).

The rotor area defined for scenario 1 (26 – 224 m) affected 38 % of the observed migrating common cranes based on the visual observations and 33 % based on the rangefinder measurements. According to both investigation methods, the area above the assumed rotor blade tip was frequented most often at 50 % (visual observations) and 67 % (rangefinder). In scenario 2, 75 % of the recorded common cranes based on visual observations and 100 % of the common cranes measured with the rangefinder flew at the height of the rotor area (50 – 300 m) (IFAÖ et al 2020).

For both methods, the flight altitudes were highest during prevailing tailwind. According to the visual observations, the average flight altitude during tailwind was 331 m (median: 375 m); based on the rangefinder survey, this was 328 m (median: 304 m). For both investigation methods, crosswind conditions prevailed at average flight altitudes of 251 m (visual observation, median 263 m) and 242 m (rangefinder, median 225 m). Flight altitudes in case of headwind were only determined for 1-2 migratory events, with the crane groups flying only a few up to max. 35 m above the sea surface (IFAÖ et al. 2020).

Based on the results from investigations for the site O.1-3 and additional findings regarding the migratory behaviour of common cranes, it can be assumed in line with the current level of knowledge, that common cranes are highly likely to cross site O-1.3 at the rotor height of the turbines in scenarios 1 and 2 of the SDP. According to the findings on general flight altitude distribution and the information about flight behaviour during prevailing crosswind which resulted in higher numbers of individuals being spotted in the vicinity of site O-1.3 (see chapter 2.9.3.3), it makes sense to assume that the collision potential for the larger turbines in scenario 2 is higher than that of the smaller turbines in scenario 1.

The bird migration study for site O-1.3 commissioned by the BSH involved not just targeted investigations of the migrations of common cranes and other species sensitive to wind turbines, but also collision modelling for the autumn migration period using the stochastic collision risk model (CRM) of MCGREGOR et al. (2018) (IFAÖ et al 2020). However, the experts only recommend using collision risk models for a qualitative comparison of different wind farm scenarios because of the sensitivity of collision risk models to its input parameters, e.g. avoidance rates, flight altitude distribution and migration rates based on vertical radar tracks, and the fact that CRMs have so far not been validated for the offshore area. In addition, the experts also refer to scientific recommendations to further develop CRMs so that in future, the models will be able to take into account different precise survey methods and realistically estimate the probability of collisions based on the recorded reactions of the birds (CUTTAT & SKOV 2020, IFAÖ et al. 2020). In view of the existing significant uncertainties of the collision risk models, the specific numerical results of the CRM for site O-1.3 are not provided below. Instead, these are only discussed qualitatively and in the context of the findings from the migration surveys of common cranes.

The models for cranes predict that the highest number of victims will be among the species migrating during the day. Based on the estimate of the experts, this result can be explained with reference to the observed flight altitude distribution and the low avoidance rate which is assumed based on the observations for 'Krieger‘s Flak' by Skov et al. (2015). There were significant differences between the underlying turbine scenarios 1 and 2. Scenario 2 with bigger turbines (total height: 300 m, scenario 1: 224 m) and lower number of turbines (20 turbines, scenario 1: 33 turbines) had significantly lower predicted collision figures than scenario 1. The median numbers of collision victims for common cranes in scenario 2 are approx. 38 % compared to scenario 1. According to the experts, the two scenarios have neither significant impacts on the protected object nor do they endanger the common crane population. The so-called 'Potential Biological Removal' (PBR) value from a study by Skov et al. (2019) is used to measure this evaluation by determining the cumulative bird collision risk for common cranes in 18 wind farms in the Baltic Sea. The PBR value states the extent of additional mortality for which a population must compensate without endangering their continued existence (WADE 1998). SKOV et al. (2019) used the population of 84,000 common cranes above the Arkona Sea as their reference population for the PBR value.

All in all, the general data and findings and, more specifically, crane migrations at site O-1.3, show based on the results of collision risk modelling that common cranes are subject to an increased conflict potential with offshore wind turbines due to their flight behaviour and flight altitude distribution in both scenario 1 and scenario 2.

The expert comes to the conclusion that no significant impacts on the crane population are expected nor that the population would be endangered. This can be ensured under the condition that effective mitigation measures are taken. There have been no observations of actual collisions between cranes and offshore wind turbines to date, and there is evidence to suggest that cranes react to existing wind farms in the vicinity of site O-1.3 by increasing their flight altitude. However, investigations of other wind farms in the western Baltic Sea have shown that cranes also cross wind farms and only rarely avoid them on a large scale. As outlined in chapter 2.9.4, the population figures for the common crane have increased continuously in recent years. Based on observations at and in the vicinity of site O-1.3 that, during prevailing crosswinds, cranes more frequently drift from their migratory path into this area of the western Baltic Sea (see chapter 2.9.4), a higher overall occurrence of cranes must be expected at site O-1.3 under certain conditions. In favourable weather conditions for crane migrations, site O-1.3 is only on the margins of the migration corridor between Rügen and Schonen.

Taking into account the available findings, the evaluation of whether the deaths defined in species protection law manifest pursuant section 44 (1)(1) BNatschG (chapter 6.3.1), comes to the conclusion that suitable measures must be taken to reduce the collision risks for cranes. These should involve comprehensive observations of migrations in order to identify situations with increased migration numbers in good time and be able to take effective measures to mitigate the collision risk for cranes in these situations. For this reason, a requirement was included in section 44 of the suitability approval to reduce a significantly increased collision risk for cranes at site O-1.3. In particular, given its location at the very edge of the known migration corridor, no significant impacts of the plan are expected if this requirement is implemented nor would bird migrations be endangered pursuant to section 48(4)(1)(b) WindSeeG. This estimate applies independently of the specific dimensions of the turbines at site O-1.3.

Waterbirds

During the past migration surveys, geese and marine ducks were observed most frequently in the principal group of waterbirds in the vicinity of site O-1.3. Loons and swans were only observed in limited numbers (see chapter 2.9.3.3). Below, more details are provided of the risk potential for the mentioned species groups.

In the course of the diurnal migration surveys at site O-1.3 in autumn 2019, a total of 5,190 geese were observed during 138 migration events. In the sector facing the wind farm, 2,145 individuals were spotted in 49 migration events, with 3,045 individuals sighted in 89 migration events in the sector facing away from the wind farm. This means that, across all goose species, significantly more migration events were recorded in the sector facing away from the wind farm, which suggests avoidance of the existing wind farm in the immediate vicinity of site O-1.3. A consideration of the most frequent goose species reveals that the behaviour varied by species. While the avoidance behaviour which dominated across all goose species was also identified in individual observations of greater white-fronted geese and barnacle geese, no statistically significant differences in occurrence were found for greylag geese in the sector facing the wind farm compared to the sector facing away from the wind farm (IFAÖ et al. 2020). In the investigation year 2017 for the cluster 'Western Adlergrund', no statistically significant avoidance effect was identified across all goose species. However, that year, the wind farm near site O-1.3 was still partially under construction (BIOCONSULT SH 2019).

The flight altitudes estimated based on the visual observations for site O-1.3 in autumn 2019 determined an average flight altitude for the sector facing the wind farm of 100 m, and of 71 m for the sector facing away from the wind farm. All in all, around 80 % of the geese flew in the height range of 20 – 200 m in the sector facing the wind farm, with 61 % of geese doing so in the sector facing away from the wind farm. An evaluation of the prevailing wind conditions at the time of the migration events showed that the flight altitudes did not vary significantly during crosswind, headwind and tailwind conditions (IFAÖ et al. 2020). Visual observations for the cluster 'Western Adlergrund' from past surveys for geese also identified a preference for the height range 20 – 200 m, with proportions of 36 % (2016) to 63 % (2014) of the observed geese flying in this height class (BIOCONSULT SH 2019). Applied to the turbines in scenarios 1 and 2, the results of the visual observations for site O-1.3 indicate that approx. 80 % of geese were flying within the turbine rotor range in scenario 1 and 76 % did so in scenario 2 (IFAÖ et al. 2020). The precise measurements of the rangefinder surveys in the sector facing the wind farm determined an average flight altitude of 76 m, while the average flight altitude in the sector facing away from the wind farm was 59 m. Based on the rangefinder measurements, a total of 62 % of geese flew within the rotor range in scenario 1, with 48 % doing so in scenario 2 (IFAÖ et al. 2020).

Based on the identified flight altitude distribution, an increased conflict potential of geese with turbines was identified in scenarios 1 and 2. For scenario 2, this is slightly reduced compared to scenario 1 due to the greater distance between the water surface and the lower rotor blade edge (50 m). However, the present investigations showed that geese also displayed larger-scale avoidance in relation to an existing wind farm in the vicinity of site O-1.3. This behaviour was particularly observed among the strictly protected species greater white-fronted geese and barnacle geese (IfAÖ et al. 2020). Other studies also came to the result that the collision risk for geese is reduced due to their pronounced avoidance behaviour (BLEW et al. 2008, LINDEBOOM et al. 2011, FOX&PETERSEN 2019). This was explained with reference to the fact that geese are predominantly diurnal migrants and are therefore able to see and avoid obstacles in time (KAHLERT et al. 2004, DESHOLM & KAHLERT 2005, PETERSEN et al. 2006). In addition, being waterbirds, they are generally able to land on the water surface under unfavourable conditions before continuing their migrations under more favourable conditions.

In light of the present findings on flight behaviour and the fact that the vicinity of site O-1.3 is only of average importance for geese (chapter 1.1.4), significant impacts on geese can be excluded with the required certainty.

For marine ducks, the evaluations of migratory activities in the respective sectors come to comparable results as for geese. All in all, visual observations for site O-1.3 identified 811 marine ducks during 136 migratory events. Of these, 243 individuals in 44 migratory events were in the sector facing the wind farm, with 568 individuals in 92 migratory events sighted in the sector facing away from the wind farm. As a result, a statistically significant increase in the migratory activities of marine ducks in the sector facing away from the wind farm can be identified across all species. However, an examination of the individual species reveals differences. Where a statistically significant, increased migratory activity in the sector facing away from the wind farm was identified for common scoters and long-tailed ducks, velvet scoters and common eiders displayed no significant difference between the two sectors (IFAÖ et al. 2020). Investigations for the cluster 'Western Adlergrund' in 2017 also observed significantly fewer marine ducks in the sector facing the wind farm ($p \leq 0.001$). This behaviour was most pronounced with common scoters (BIOCONSULT SH 2019). In addition, common scoters also displayed deviations from their expected migration directions during investigations for site O-1.3 which indicate a horizontal avoidance of the wind farm area (chapter 2.9.3.3, IFAÖ et al. 2020).

An analysis of all flight altitude distribution data available for the vicinity of site O-1.3 consistently show that marine ducks predominantly use the height range of the bottom 20 m. Investigations for site O-1.3 estimated based on visual observations that the flight altitudes of 85 % of marine ducks in the sector facing the wind farm were below 20 m, with this applying to approx. 95 % of marine ducks in the sector facing away from the wind farm. According to rangefinder measurements, these figures were 68 % in the sector facing the wind farm and 81 % in the sector facing away from the wind farm (IFAÖ et al. 2020). The investigations for the cluster 'Western Adlergrund' also revealed a clear preference for the height range of the bottom 20 m (BIOCONSULT SH 2019). Applied to the turbine scenarios used in the impact assessment, this reveals based on visual observations and the rangefinder measurements that approx. 80 % of marine ducks flew below the rotor range in scenario 1 and 94 % of marine ducks did so in scenario 2 (IFAÖ et al. 2020).

All in all, based on the observed flight altitude distribution and the generally dominant avoidance behaviour, significant impacts for the species group marine ducks due to collisions with wind turbines at site O-1.3 can be excluded with the required certainty.

For loons, in spite of low sample numbers totalling 12 individuals in 10 migratory events, a statistically significant increase in migratory activity was identified in the sector facing away from the wind farm. Given the limited number of loons sighted in the vicinity of site O-1.3 (chapter 1.1.3.3) in conjunction with the significant avoidance behaviour of flying loons which was observed, significant impacts on loons within the meaning of an endangerment of bird migrations, can be excluded with the required certainty.

Given the low number of sightings of swans during the surveys of site O-1.3, no differentiated analysis of the migratory activities in the sectors facing the wind farm and facing away from the wind farm was possible (IFAÖ et al. 2020). During the investigations for the cluster 'Westerns Adlergrund' in 2017, it was identified that, of the 16 migratory events across the whole year, 63 % took place in the sector facing away from the wind farm and 37 % in the sector facing the wind farm. However, given the low sample size, this difference was not statistically significant (BIOCONSULT SH 2019). Due to the low number of sightings and the indicated avoidance behaviour of swans in relation to existing wind farms, significant impacts for this species group of a wind farm at site O-1.3 can be excluded with the required certainty.

Birds of prey

During the visual observations as part the investigations for site O-1.3, a total of only 57 birds of prey were spotted, 47 of which were Eurasian sparrowhawks. An evaluation of their migratory activity in the two sectors under investigations revealed higher migratory activity at 58 % in the sector facing away from the wind farm compared to the sector facing the wind farm, but this difference was not statistically significant (IFAÖ et al. 2020). During the investigations for the cluster 'Western Adlergrund' in 2017, however, at 67 % significantly more birds of prey were observed in the sector facing the wind farm. By contrast, the evaluation of flight altitudes based on visual observations showed that 69 % of the recorded birds of prey flew in the range of up to 20 m (BIOCONSULT SH 2019). The investigations for site O-1.3 also revealed a clear preference for the lower height range. In the sector facing the wind farm, approx. 76 % of migratory events occurred at heights of up to 20 m. Applied to scenarios 1 and 2, therefore, approx. 76 % of birds of prey flew below the rotor range in scenario 1 and 81 % did so in scenario 2 (IFAÖ et al. 2020). In line with past findings, the vicinity of site O-1.3 is only of minor importance for the migrations of birds of prey due to their low occurrence rates (chapter 1.1.4). The risk potential for birds of prey due to collisions with wind turbines is estimated to be low based on their observed flight behaviour and particularly their height distribution.

Waders

During the day, larger numbers of waders have only been recorded in the vicinity of site O-1.3 at irregular intervals (chapter 1.1.3.3). In the course of the investigations at site O-1.3 in autumn 2019, a total of 526 waders were observed during the day in 6 migratory events. In total, 502 individuals were observed in the sector facing away from the wind farm and only 24 individuals in the sector facing the wind farm. Since the 502 were only split across two of the total of six migratory events, it can be assumed that the statistical test between the sectors was not significant in relation to migratory events (IFAÖ et al. 2020). The day-time investigations for the cluster 'Western Adlergrund' in 2017 also identified increased use of the area facing away from the wind farm, however this was not statistically significant given the low sample size (BIOCONSULT SH 2019). Moreover, it was apparent across all years of the investigation that diurnally migrant waders primarily use the height range of up to 20 m (BIOCONSULT SH 2017b, BIOCONSULT SH 2018, BIOCONSULT SH 2019).

During favourable weather conditions, waders fly at night as well as during the day at heights averaging 2,000 m (GREEN 2005). Presumably this is the reason why larger numbers were only rarely recorded in the vicinity of site O-1.3. Past findings from the monitoring of the cluster 'Western Adlergrund' indicate avoidance of existing wind farms by diurnal waders. With regard to nocturnal wader migrations, it can be assumed that they only cross the area of site O-1.3 at lower flight altitudes if the weather conditions are unfavourable. Based on past findings, these conditions only occur rarely. According to the current level of knowledge, no significant impacts on diurnal or nocturnal wader migrations of a wind farm at site O-1.3 are expected, regardless of whether the turbines of scenario 1 or of scenario 2 are used.

Songbirds

Past investigations for the vicinity of site O-1.3 regularly observed songbirds based on visual observations during the light phase. During the investigations for site O-1.3 in autumn 2019, a total of 1,828 songbirds were observed across 224 migratory events. Of these, 883 individuals in 108 migratory events were in the sector facing the wind farm, with 995 individuals in 116 migratory events sighted in the sector facing away from the wind farm. Even though approx. 52 % of migratory events were registered in the sector facing away from the wind far, the difference between the two sectors was not statistically significant (IFAÖ et al. 2020). Investigations for the cluster 'Western Adlergrund' in 2017 observed significantly more frequent use of the sector facing the wind farm (BIOCONSULT SH 2019). However, an evaluation of the flight altitudes of diurnal songbirds in all available investigations in the vicinity of site O-1.3 indicate a significant preference for the height range below 20 m. At 88 % and 89 % the respective migratory events, the lower height range of up to 20 m dominated in 2019 both in the sector facing the wind farm and in the sector facing away from the wind farm. Due to the limited physical size of diurnal songbirds, rangefinder measurements could not be used reliably (IFAÖ et al. 2020). The flight altitudes estimated during visual observations for the cluster 'Western Adlergrund' in 2014 through to 2017 also identified songbird sighting proportions of 65 % (2016) to 95 % (2015) in the bottom 20 m (BIOCONSULT SH 2016b, BIOCONSULT SH 2017b, BIOCONSULT SH 2018, BIOCONSULT SH 2019). Applied to the turbine scenarios, these results from the visual observations of site O-1.3 indicate that approx. 89 % or 94 % of diurnally migrant songbirds were observed below the rotor ranges of scenarios 1 and 2. In light of the observed flight altitude distribution in all investigations for the vicinity of site O-1.3 in recent years, no significant impacts on diurnally migrant songbirds can be expected for songbird migrations during the light phase.

Songbirds dominate nocturnal bird migrations. The most frequent species based on call recordings in the vicinity of site O-1.3 in the past investigation years were redwings, song thrushes, robins and blackbirds (see chapters 2.9.3.1 and 2.9.3.3). All of these species belong to those populations of northern Europe which are present in high numbers (BIRDLIFE INTERNATIONAL 2004, BSH 2019). Taking into account migratory behaviour, small birds are subject to a special collision risk during night-time migrations due to the darkness, high migration volume and strong attraction effect of artificial light sources.

Generally, migrating birds fly higher in good weather than in bad. It is also undisputed 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 likely to reach their destination in the best possible weather (BSH 2009).

In addition, among the birds who favoured clear weather conditions for their migration, collisions with offshore wind turbines were less likely as the flight altitudes of most birds are above the range of the rotor blades and the turbines are clearly visible. An evaluation of all existing vertical radar data from bird migration monitoring for offshore wind farm projects showed for projects in the EEZ of the Baltic Sea that the flight altitudes of nocturnal bird migrations in the spring and autumn average at approx. 400 m (WELCKER 2019a). By contrast, sudden mist and rain constitute a potential risk situation which can result in poor visibility and lower flight altitudes. One particular problem is the coincidence of bad weather conditions with so-called mass migration events. Based on the information available from various environmental impact studies, these events occur approx. 5 to 10 times a year. On average, two to three of these coincide with poor weather. An analysis of all existing bird migration surveys from the mandatory monitoring of offshore wind farms in the EEZ of the North and Baltic Seas (period under investigation: 2008 – 2016) confirm that 1

% of especially intense bird migrations coincide with extremely bad weather conditions (WELCKER 2019b).

However, it cannot be ruled out that the lighting in the installations may exert a lure effect, especially on birds migrating at night, causing them to fly into the installations or at least causing glare. Research conducted at lightships in Denmark has shown that light sources are rarely approached by seabirds and waterfowl but are increasingly approached by small bird species such as starlings, song thrushes and skylarks in poor visibility (Hansen 1954). In a recent study, REBKE et al (2019) investigated the influence of luminous light sources of varying colour and intensity on the nocturnal migration of songbirds under different degrees of cloud cover. It showed that birds were attracted more by continuous lighting rather than flashing lighting. In addition, the authors recommend the use of red light in cloudy weather conditions to reduce lure effects in poor visibility.

In the draft suitability determination and in individual approval procedures, instructions are also issued to prevent or minimise, among other things, light emissions, unless these are imperative and deemed to be unavoidable by shipping and air traffic regulations. All in all, based on the current level of knowledge, no significant impacts on nocturnal songbird migrations are expected even for the larger turbines in scenarios 1 and 2.

4.8.2 Internal cabling

The impacts of submarine cable systems have already been examined and assessed at the level of the Strategic Environmental Assessment for the Site Development Plan (BSH 2019b). The result here was that the impact of platforms and submarine cable systems on seabirds and resting birds was not considered significant. This assessment remains valid.

4.9 Bats and bat migration

Even though bat migrations over the Baltic Sea have been documented in various ways, there is still no reliable information available on the migratory species, migration corridors, flight altitudes and migration concentrations. Previous evidence only confirms that bats fly over the Baltic Sea, especially long-distance migratory species. Since only individual occurrences have been detected, there is currently an insufficient basis for describing and evaluating potential bat activities in the vicinity of site O-1.3 .

The sensitivities of bats to high structures on land and the related risk of collisions is well-known; the same holds true for the collision risk with wind turbines. Furthermore, potential barrier effects as well as habituation and attraction effects on land are known (JOHNSON 2004). Apart from a Swedish pilot study and initial observations from the Kalmarsund, the impacts of offshore structures are largely unknown (AHLEN 2002, AHLEN et al. 2005). The pilot study (AHLEN 2002) identified that both migrating and non-migratory species were occasionally affected by collisions. However, the causes of the collisions remained largely unclear. All in all, the study showed that there are vast knowledge gaps regarding the migratory behaviour and migratory routes of bats (AHLEN et al. 2005).

In addition, the strong air pressure fluctuations near the rotors which cause barotrauma (lung collapse) are frequent causes of the deaths involving wind turbines on land (BAERWALD et al. 2008). It cannot be excluded that the wake flows might influence flight behaviour. But no concrete evidence of the effects is available for the offshore area.

To date, no verifiable findings exist for bat migrations and the potential impacts of offshore structures, specifically wind turbines, on bats. There is currently insufficient data to identify significant impacts on bats or raise questions about the suitability of site O-1.3. In addition, it is expected that any adverse effects on bats can be avoided by the same prevention and mitigation measures used to protect bird migration.

4.10 Climate

Negative impacts on the climate from the construction and operation of wind turbines and the internal cabling of the wind farms or transformer platforms are not expected, as there are no measurable climate-related emissions during construction or operation.

4.11 Landscape

4.11.1 Areas and sites

The realisation of offshore wind farms has an impact on the landscape, as it is altered by the erection of vertical structures and safety lighting. The extent of these visual impairments of the landscape due to the planned offshore installations depends very much on the respective visibility conditions. Area N-3 is more than 30 km from the North Sea coast, which means that the existing and planned installations are/will be very limited in visibility from land (HASLØV & KJÆRSGAARD 2000), even in good visibility conditions. The implementation of the building project at site O-1.3 will not significantly impact on the development of the landscape because this site is situated north of two existing offshore wind farms.

4.12 Reciprocal effects

In general, impacts on a protected object lead to various consequences and interactions between the protected objects. For example, impacts on the soil or the water body usually also have consequences in terms of the biotic assets to be protected in these habitats. Pollutant discharge can reduce water and/or sediment quality, for instance, and be absorbed by benthic and pelagic organisms from the surrounding medium. The essential interdependence of the biotic protected objects is based on food chains. These interrelationships between the various protected objects and possible impacts on biological diversity are described in detail for the respective protected objects.

Possible effects during the construction phase result from sediment shift and turbidity plumes as well as noise emissions. However, these interactions occur only very briefly and are limited to a few days or weeks.

4.12.1.1 Sediment shift and turbidity plumes

During the construction phase of the wind farm and when the internal wind farm cabling is laid, sediment rearrangements and turbidity plumes can occur. Fish are temporarily scared away. The macrozoobenthos is covered within a local area. As such, the feeding conditions for benthic-eating fish and for fish-eating seabirds and harbour porpoises also change in a short-term and locally limited manner (decrease in the supply of available food). However, considerable impairments to the biotic protected objects and therefore of the existing interactions with one another can be ruled out with the necessary certainty due to the mobility of species and the temporal and spatial limitation of sediment shifts and turbidity plumes.

4.12.1.2 Noise emissions

The noise-intensive installation of the foundations of the offshore wind turbines and the transformer station can lead to temporary flight reactions and to temporary avoidance of the area by marine mammals, some fish species and seabird species. According to current knowledge, no significant noise emissions are to be expected from the operation of offshore wind turbines, power cables and transformer stations. Only the operationally bound shipping traffic can lead to a temporary and local increase in underwater noise.

4.12.1.3 Land use

The installation of foundations results in local loss of settlement area for the benthic zone, which can lead to a potential deterioration of the food base for the fish, birds and marine mammals following within the food pyramid. However, site O-1-3 is not a special feeding ground for the top predators, such as seabirds and resting birds and marine mammals. Therefore, a significant impairment of food availability can be excluded with the required certainty.

4.12.1.4 Insertion of artificial hard substrate

The addition of artificial or foreign hard substrate (foundations, rock filling required for the cable crossing structures or local cable laying on the sea floor) results in a local change in the ground and sediment conditions. As a result, the composition of macrozoobenthos can change. According to KNUST et al. (2003), the insertion of artificial hard substrate in soft ground causes additional species to settle. Recruitment of these species will most likely come from natural hard substrate habitats, such as superficial boulder clay and stones. As such, the risk of negative impacts on benthic soft soil communities by non-native species is low. However, settlement areas for soft soil fauna are lost at these sites. By changing the species composition of the macrozoobenthos community, the food base of the fish community at the site can be influenced (bottom-up regulation).

However, certain fish species could be attracted, which in turn could increase feeding pressure on the benthos due to predation, thereby influencing the dominance relationships through the selection of certain species (top-down regulation). Moreover, growth on the hard substrate could serve as a new food source for the benthos-eating marine ducks.

4.12.1.5 Prohibition of use and shipping

A fishing ban is expected to be imposed within site O-1.3.

. The resulting discontinuation of fishing can lead to an increase in the population of both target fish species and non-utilised fish species. A shift in the length range of these fish species is also conceivable. If fish populations increase, the food supply for harbour porpoises can be expected to increase. It is also expected that a macrozoobenthos community undisturbed by fishing activity will develop. This could mean an increase in the diversity of the species community by giving sensitive and long-lived species of the current epifauna and infauna better chances of survival and of developing stable populations. The growth of sessile invertebrates on wind turbines could favour benthos-eating fish species and provide the fish with a larger and more diverse food source (LINDEBOOM et al. 2011). This could improve the condition of the fish, which in turn would have a positive effect on their fitness. However, research is currently needed to transfer such cumulative impacts to the fish population level.

Due to the variability of the habitat, interactions can only be described in a very imprecise manner overall. All in all, the implementation of the plan cannot currently be identified as having any effects on existing reciprocal effects which could result in endangering the marine environment. As a result, it can be concluded for the SEA that, according to the current level of knowledge, site O-1.3 is not expected to have any significant impacts on the biotic marine environment due to reciprocal effects.

4.13 Cumulative impacts

The assessment of cumulative impacts relates to site O-1.3 and to areas in which transboundary effects can be expected. In accordance with the administrative agreement with Mecklenburg-West Pomerania, statements on the cumulative impacts of approvals in the coastal waters and the EEZ are included.

4.13.1 Soil/ground, benthos and biotope types

A substantial proportion of the environmental impacts caused by the development of the site, construction of the transformer platform and the wind farm's internal submarine cable systems on the soil, benthos and biotopes will take place exclusively during the construction period (formation of turbidity plumes, sediment shift, etc.) and in a spatially narrowly defined area. Possible cumulative impacts on the seabed, which could also have a direct impact on benthos and specially protected biotopes, result from the permanent direct space usage by the foundations of the wind turbines and platforms, and from the cable systems laid. The individual impacts are essentially limited to a small area and are local in nature.

To estimate direct space usage, a rough calculation is made using the model wind farm scenarios. The calculated space usage is based on ecological aspects, i.e. the calculation is based on the direct ecological loss of function or the possible structural change in the area caused by the installation of foundations and cable systems. In the area of the cable trench, however, the impairment of the sediment and benthic organisms will be essentially temporary. In the case of crossing particularly sensitive biotope types such as reefs or species-rich gravel, coarse sand and shell layers, permanent impairment would have to be assumed.

Based on the allocated capacity of 300 MW for site O-1.3 and an assumed capacity per installation of 9 MW (model wind farm scenario 1) or 15 MW (model wind farm scenario 2), the calculated number of installations for the area is between 34 (scenario 1) and 20 (scenario 2).

On the basis of the model wind farm parameters, this results in area sealing of 48,280 m² (scenario 1) and 56,600 m² (scenario 2), including assumed scour protection. Compared to the total area of site O-1.3 of approx. 25 km², the model wind farm scenarios result in calculated area sealing of between 0.19% (scenario 1) and 0.23% (scenario 2).

Calculation of the loss of function due to the wind farm's internal cabling was carried out in accordance with the stated capacity, assuming a 1-metre wide cable trench. On the basis of this conservative estimate, site O-1.3 is temporarily impaired by approx. 36 km of cabling within the wind farm, which corresponds to a temporary space usage of 0.14% of the total area of O-1.3.

Even the sum of area sealing and temporary space usage results in a conservatively estimated impairment in the order of magnitude of well below 1% of the total area of site O-1.3. Therefore, according to current knowledge, no significant, cumulative impairments are expected that would endanger the marine environment with regard to the seabed and benthos.

4.13.2 Fish

Wind farms in the southern North Sea could have an additive effect beyond their immediate location by spreading the mass and measurable production of plankton by currents, which could influence the qualitative and quantitative composition of the zooplankton (FLOETER ET AL. 2017). This in turn could affect planktivore fish, including pelagic schooling fish such as herring and sprat, which are the target of some of the largest fisheries in the North Sea. Species composition could also change directly, as species with habitat preferences different from those of established species, e.g. reef dwellers, find more favourable living conditions and occur more frequently. At the Danish wind farm Horns Rev, seven years after construction, a horizontal gradient of the occurrence of species with an affinity for hard substrates was found between the surrounding sand areas and near the turbine foundations: Goldsinny wrasse *Ctenolabrus rupestris*, viviparous eelpout *Zoarces viviparous* and lumpsucker *Cyclopterus lumpus* were much more common near the wind turbine foundations than in the surrounding sandy areas (LEONHARD ET AL. 2011). The cumulative impacts of a major expansion of offshore wind energy could include:

• an increase in the number of older individuals,
• better conditions for fish due to a larger and more diverse food base,
• the further establishment and distribution of fish species adapted to reef structures,
• the recolonisation of previously heavily fished areas and zones,
• better living conditions for territorial species such as cod-like fish.

Besides predation, the natural mechanism for limiting populations is intra-species and inter-species competition, also called density limitation. It cannot be ruled out that within individual wind farms, local density limitation will set in before the favourable effects of the wind farms are spatially reproduced, e.g. through the migration of 'surplus' individuals. In this case the effects would be local and not cumulative. What effects changes in fish fauna could have on other elements of the food web, both below and above their trophic level, cannot be predicted with current knowledge.

4.13.3 Marine mammals

Cumulative impacts on marine mammals, in particular harbour porpoises, may occur mainly due to noise exposure during the installation of foundations using impulse pile driving. For example, marine mammals can be severely affected if pile driving takes place simultaneously at different locations within the EEZ without equivalent alternative habitats being available.

The implementation of offshore wind farms and platforms so far has been relatively slow and gradual. In the period from 2009 to 2018, pile driving work was carried out on twenty wind farms and eight transformer platforms in the German EEZ in the North Sea. Since 2011, all pile driving work has been carried out using technical noise reduction measures. Since 2014, the noise control limits have been reliably met and even undercut by the successful use of noise reduction systems (BELLMANN, 2020 in preparation).

The majority of construction sites were located within 40 km to 50 km of each other, so there was no overlap of noise-intensive pile driving that could have led to cumulative impacts. Only in the case of the two directly adjacent projects Meerwind Süd/Ost and Nordsee Ost in area N-4 was it necessary to coordinate the pile driving, including aversive measures.

The evaluation of the results with regard to sound propagation and the possible resulting cumulation has shown that the propagation of impulsive sound is greatly restricted when effective noise-reducing measures are applied (DÄHNE et al., 2017).

Two studies from 2016 and 2019 commissioned by the Association of German Offshore Wind Farm Operators (BWO) provide current findings on possible cumulative impacts of the impact noise on the occurrence of harbour porpoise in the German EEZ in the North Sea. In connection with these two studies, extensive data from the monitoring of the construction phases of offshore wind farms by means of acoustic and visual/digital recording of harbour porpoise were evaluated and assessed across projects (Brandt et al., 2016, Brandt et al., 2018, DIEDERICHS et al., 2019). In the context of the studies, new evaluation approaches were described and elaborate statistical analyses were carried out in a reliable manner. Already known seasonal and area-related activity patterns were confirmed again. However, strong interannual as well as spatial variations in harbour porpoise activity were also found. The aim of the second study (GESCHA 2) was to evaluate possible effects of the optimised technical noise control measures from 2014 up to and including 2016 with regard to the disturbance of harbour porpoise in the form of displacement.

The study comes to the conclusion that the optimised use of the technical noise reduction measures since 2014 and the resulting reliable compliance with the limit has not led to any reduction in the displacement effects on harbour porpoises as compared to the phase from 2011 to 2013 with noise reduction systems that were not yet optimised. From a noise level of just 165 dB (SEL05 re 1µPa^2 s at a distance of 750 m), it was not possible to detect any reduction in the displacement effects. The displacement effects were evaluated analogous to the GESHA 1 study from 2016 (period 2011 to 2013 inclusive) based on the range and duration before, during and after pile driving. The authors put forward five hypotheses to explain the results (DIEDERICHS et al., 2019):

- The stereotypical response of harbour porpoise can lead to the animals leaving the area above a certain noise level and not returning for a period of time, regardless of the course of the noise emissions.
- Displacement effects caused by the use of seal scarers are more intense than effectively insulated pile driving noise.
- Shipping traffic and other construction-site-related noise lead to displacement effects.
- Very short consecutive installations (pile driving) at intervals of less than 24 hours lead to displacement.
- Finally, differences between habitats and in relation to food availability have an impact on the results of the study, as do differences in the quality of the data.

Having evaluated the latest findings, the BSH assumes that the observed avoidance effects on harbour porpoises during the installation phase are due to a variety of site-related factors as well as natural processes. However, it can be assumed that the avoidance effects would be greater if effective technical noise control and compliance with the noise control limit were lacking. Reducing impact noise at source is all the more important as it has become more and more apparent since 2014 that increased activity at offshore construction sites due to the optimisation and acceleration of logistics and construction processes could potentially lead to additional sources of disturbance for the harbour porpoise.

The findings from monitoring were always taken into account in the course of enforcement. For example, the BSH and BfN decided to switch the deterrent effect from pinger and seal scarer to the Fauna Guard System as of 2018. The use of the novel Fauna Guard System was monitored closely, the data were analysed and the results evaluated as part of a study.

Cumulative impacts on harbour porpoise numbers from the erection of offshore wind turbines and transformer stations at site O-1.3 and possibly other sites realised at the same time are monitored in accordance with the requirements of the BMU noise control concept of 2013. In accordance with the BMU noise control concept (2013), all pile driving activities have to be coordinated in such a way that less than 10% of the area of the German EEZ in the North Sea will always be affected by pile driving noise. The aim is always to keep sufficient alternative possibilities free in the conservation areas, in equivalent habitats and in the entire German EEZ.

4.13.4 Seabirds and resting birds

Vertical structures such as platforms or offshore wind turbines can have different effects on resting birds, such as loss of habitat, an increased risk of collision or a deterrence and disturbance effect. These effects have already been considered site-specifically in Chapter 4.7.1, taking into account the possible technical scenarios with regard to the turbine parameters. A further project-specific examination will be carried out as part of the environmental impact assessment of the individual project and within the subsequent mandatory monitoring of the construction and operation phase of offshore wind farm projects.

For resting birds, habitat loss due to cumulative impacts of several structures or offshore wind farms can be particularly significant. In order to assess the significance of cumulative impacts on seabirds, any effects must be assessed on a species-specific basis. In particular, species listed in Annex I of the Birds Directive, species in sub-area IV of the nature conservation area 'Bay of Pomerania' – Rönnebank' and species for which avoidance behaviour towards structures has already been established must be considered with regard to cumulative impacts. For the vicinity of site O-1.3, chapter 4.6.1 more closely examined the species groups loons, marine ducks and auks.

Based on the present findings for the project and the distribution of those marine bird species for which avoidance behaviour in relation to offshore wind farms has been documented in research and monitoring, the BSH comes to the conclusion that site O-1.3 and its surrounding area are not especially important for the marine bird populations under investigation in the German Baltic Sea regions. The present site and the neighbouring, already realised wind farm projects are located outside the main distribution areas of the Bay of Pomerania and only on the margins of larger-scale resting areas. Owing to the fact that an offshore wind farm has already been erected at the site N-3.7, cumulative impacts with already realised projects in the immediate vicinity of site O-1.3 as well as further activities relating to the construction of a wind farm, can be excluded with the required certainty.

4.13.5 Migratory birds

The risk potential for bird migrations not only results from the impacts of the individual project due to collisions or the negative effects of forced changes to the flight routes, but also applies cumulatively in conjunction with other approved or already erected wind farm projects in the vicinity of site O-1.3. An assessment of the potential cumulative impacts of already realised or future wind farms on the sites identified on the Site Development Plan (SDP) was already carried out as part of the SEA for the SDP (BSH 2019b).

The wind turbines of the wind farms 'Wikinger' and 'Arkona' situated to the south are approx. 59 m or up to 135 m lower than the turbines in scenarios 1 and 2. This creates a step effect where, coming from the south, lower turbines in the south of area O-1 are followed by larger turbines in the north. Depending on the turbine scenario (1 or 2), the visibility of the taller turbines could be limited to the turning rotors. This is particularly true of the smaller turbines in scenario 1. In scenario 2, at a hub height of 175 m, it can be assumed that the massive nacelles will also be visible.

The collision risk for the majority of the diurnally migrating species is generally considered to be low as these use visual orientation. In addition, waterbirds migrating during the day are generally able to land on water and continue their flight at a later time. Moreover, some species groups tend to prefer lower flight altitudes of up to 20 m or display large-scale avoidance behaviour (chapter 4.7.1). During nocturnal songbird migrations, sudden mist and rain combined with especially intense migratory activity (so-called mass migrations) can constitute a potential risk situation. At up to 100 km, the migratory route across the Baltic Sea is relatively short. If the air speed of the especially numerous thrush species participating in nocturnal migrations is taken as a basis (between 35 and 50 km/h depending on the species) (BRUDERER & BOLDT 2001), this results in migration times over the Baltic Sea of approx. two to three hours. In light of these short migration times, the probability of unfavourable weather situations coinciding with so-called mass migration events is considered to be low. Findings from the monitoring of offshore wind farms confirm this assumption (chapter 4.7.1).

Based on the current level of knowledge, cranes are at increased risk of collision with the wind turbines in scenarios 1 and 2 due to their flight behaviour and the observed flight altitude distribution. Initial findings indicate that cranes appear to react to the smaller wind turbines already in place in the area O-1 by adjusting their flight altitude (chapter 3.1.1). During spring migrations, the described step effect could occur on the way from Rügen to Schonen, while in the autumn, cranes would encounter the larger turbines in scenarios 1 and 2 first. Taking into account the present findings, suitable measures for cranes must be taken at site O-1.3 in order to closely observe migratory events and in this way identify situations involving increased migratory events in good time and be able to take effective measures to reduce the collision risk for cranes in these situations. Based on the current level of knowledge, these measures also contribute to reducing the cumulative collision risk in the area O-1. To summarise, if this requirement is implemented, the plan is not expected to result in any significant cumulative impacts.

A more detailed cumulative analysis in relation to the barrier effects was already implemented as part of the SEA for the Site Development Plan (BSH 2019b). Where the birds travel around the projects examined cumulatively, this is not currently expected to have any significant negative effects on the further development of the populations owing to the generally high flight capacity of the migratory species. Based on the current level of knowledge, this also applies to a cumulative analysis.

In this context, it must be taken into account that present scientific and technological findings are incomplete, particularly regarding species-specific migratory behaviour during unfavourable weather conditions (rain, mist).

To summarise, significant cumulative effects of a wind farm at site O-1.3 on bird migrations in the area O-1 can nevertheless be excluded with the required certainty, so long as the requirements of section 43 of the draft suitability approval are implemented to reduce the collision risk for cranes with the taller turbines in scenarios 1 and 2.

4.14 Transboundary effects

As things stand at present, site O-1.3 has no significant impact on the areas of neighbouring countries bordering on the German EEZ in the Baltic Sea.

Transboundary environmental impacts are defined pursuant to section 2(3) UVPG as environmental impacts in another country.

Whether the development of site O-1. 3Auswirkungen have an impact on the environment in neighbouring countries and whether this impact is also to be classified as significant depends on the circumstances of the individual case.

According to the assumptions in an agreement on implementing transboundary participation between German and the Netherlands, which distinguishes between projects located up to 5 km from the border and those at a greater distance, impacts are more likely in the event of greater proximity.

The site O-1.3 is immediately on the border of the Danish EEZ surrounding the island of Bornholm at a distance of 500 m. The Danish islands surrounded by the Danish EEZ and situated to the west of site O-1.3 are at a distance of at least 54 km. The distance to Swedish waters is approx. 4 km.

The Polish EEZ is at a distance of at least 50 km. For this reason, local impacts on Polish waters with regard to benthos, soil or biotopes neighbouring states due to turbidity plumes and area sealing, for example, or effects on marine mammals and fish due to noise or impacts on the landscape, and therefore on tourism, are generally not to be expected. Owing to the large distance, impacts on birds are also not expected.

No significant transboundary impacts on the Danish and Swedish EEZ are expected. In this case, given the comparable species occurrence, the evaluation for the individual projected objects in chapters 4.1 to 4.12 can be applied.

On the one hand, the stipulated mitigation measures, such as noise reduction, are also effective across borders. On the other hand, certain project-related impacts are only short-term and across a small area, and accordingly not significant.

Likewise, there is no anticipation of extensive transboundary effects.

According to the Guide on the Practical Implementation of the Espoo Convention, prepared by the Netherlands, Sweden and Finland in 2003, projects that could have an extensive impact in a transboundary context would be those that cause air or water pollution, projects that pose a potential threat to migratory species and projects related to climate change. Possible significant transboundary effects could be expected for the highly mobile protected objects of fish, marine mammals, seabirds and resting birds, migratory birds and bats if the (local) effects of the project were to have a significant impact on the respective population/migratory species.

Significant transboundary effects for the protected objects 'soil and water', 'plankton', 'benthos', 'biotope types', 'landscape', 'cultural heritage and other material assets' and 'human beings, including human health' can generally be excluded. At most, potential significant transboundary effects for the highly mobile biological protected objects 'fish', 'marine mammals', 'seabirds and resting birds' as well as 'migratory birds and bats' could occur cumulatively in the area of the German Baltic Sea.

For the protected object 'fish', the SEA comes to the conclusion that, based on the current level of knowledge, the implementation of the plan is not expected to have any significant transboundary effects on the protected object because the area does not play any special role for fish fauna and, on the other hand, any notable foreseeable effects would be small-scale and temporary. This also rules out transboundary effects.

The same holds true for the protected objects 'marine mammals' and 'seabirds and resting birds'. These predominantly use this site as a transit area. No significant habitat loss for strictly protected marine and resident bird species is expected. Based on the current level of knowledge and taking into account the measures to minimise impacts and limit damage, significant transboundary effects can be excluded. For example, in the specific approval procedure, the installation of the wind turbine and platform foundations will only be permitted if effective noise reduction measures are used (e.g. see planning principle 4.4.1.7 SDP). In light of the special risk to the separate Baltic Sea population of the harbour porpoise, close monitoring measures must be implemented during execution and, if applicable, the noise reduction measures must be adjusted or construction work must be coordinated in order to exclude any cumulative impacts.

The wind turbines erected on site O-1.3 could create a barrier and constitute a collision risk for migratory birds. This collision risk must be reduced in general and for nocturnal migrations of smaller birds in particular, by taking measures to reduce the attraction effects of lighting. Moreover, due to the higher size of the wind turbines at site O-1.3, additional measures for cranes are required in order to closely observe migratory events and in this way identify situations involving increased migratory events in good time and be able to take effective measures to reduce the collision risk for cranes in these situations. As concerns the barrier effect, the total length of the migratory routes taken by the different migrating species and the relatively short migratory section across the Baltic Sea mean that significant transboundary effects can be excluded with the required certainty.

For bat migrations, it is also not possible to give a cumulative estimate of the endangerment risk at the present time because insufficient findings are available to date on bat migratory routes, flight altitudes and flight intensities. It can generally be assumed that the mitigation and minimisation measures taken will prevent any significant transboundary effects of the plan in the same way as for bird migrations.

.

5 Assessment under biotope protection law

Pursuant to section 7(2)(4) BNatSchG, a biotope is the habitat of a community of wild fauna and flora. The term community – or biocoenosis – refers to a community of organisms of different species in a definable habitat (SCHÜTTE/ GERBIG in Schlacke GK-BNatSchG, section 7, recital 36.) 36). For Germany, 764 biotope types are distinguished (HENDRISCHKE/ KIEß in Schlacke GK-BNatSchG, section 30, recital 8.). Certain parts of the natural environment and landscape that are of special importance as biotopes are protected by law, section 30(1) BNatSchG.

5.1 Legal basis

Section 30 BNatSchG provides legal protection for those biotopes which require special protection because of their rarity, endangerment or special importance as habitats for particular animal or plant species (HENDRISCHKE/KIEß in Schlacke GK-BNatSchG, section 30, recital 8). Pursuant to section 56(1) BNatSchG, the Federal Nature Conservation Act standards are also applicable in the German EEZ.

Section 30(2)(6) BNatSchG lists the coastal and marine biotopes protected by law. Reefs, sublittoral sandbanks, species-rich gravel, coarse sand and sedimentary grounds as well as seapen and burrowing megafauna communities are relevant for the EEZ. The latter have never been detected in the EEZ due to the absence of the sea pen species characteristic of the biotope.

The legal protection of these biotopes is directly applicable without the need for additional administrative designation of the area. Explanations and definitions of the individual biotope types are to be found in the explanatory memorandum to the Federal Nature Conservation Act. The BfN has also published mapping instructions for various marine biotope types. In addition, the 'Interpretation Manual of European Habits – EUR27' (HENDRISCHKE/ KIEß in Schlacke GK-BNatSchG, section 30, margin note 11) can be used for biotopes that also constitute FHH habitat types (e.g. reefs, sandbanks).

The present assessment under biotope conservation law examines whether legally protected biotope types pursuant to section 30 BNatSchG are present at the site or in the area under review and, if so, whether the prohibition of destruction and impairment is complied with if the plan is implemented.

Pursuant to section 30(2)(1) BNatSchG, all acts that may cause destruction or other significant impairment of the marine biotope types listed in section 30(2)(1)(6) BNatSchG are prohibited.

The direct and permanent use of a biotope protected in accordance with section 30 BNatSchG generally constitutes a significant impairment. Following the methodology of LAMBRECHT & TRAUTNER (2007), an impairment can be classified as not significant in individual cases if various qualitative-functional, quantitative, absolute and relative criteria are met, taking into account all impact factors and considering these cumulatively. A central component of this assessment approach is the orientation values for quantitative absolute area losses of an affected biotope occurrence, which may not be exceeded depending on its overall size. In principle, an orientation value of 1% has been established as the maximum value for the relative loss of space.

5.2 Legally protected biotope types

According to current knowledge, there is no evidence of the existence of legally protected biotopes in accordance with section 30 BNatSchG for site O-1.3.

The geological offshore site investigation maps several objects and structures at site O-1.3, with clusters in the eastern and southern area of the site. Further investigations of the exact classification of these objects/structures were able to exclude the occurrence of legally protected biotope types according to section 30 BNatSchG at site O-1.3 (IFAÖ 2020, also see chapter 2.4.2). For area O-1.3, additional evaluations going beyond the mapping guidelines were carried out, the results of which revealed further prominent objects. The objects are to be taken into account in the planning of the routes and sites in accordance with § 35 of the 1st WindSeeV. If, contrary to the results of the previous video surveys, marine boulders or stone fields are found, these would have to be buffered in accordance with the requirements of the mapping instructions and the areas excluded from development.

5.3 Result of the assessment

Significant impairments of legally protected biotopes within the meaning of § 30 para. 2 BNatSchG can be excluded. No reefs were identified on the basis of the investigations according to the mapping instructions of the BfN. Since the other prominent objects are to be taken into account in the planning and, if necessary, buffered and kept free from development, there is no impairment of the protected property in this respect either.

6 Assessment under species protection law

When implementing the plan with the construction and operation of offshore wind turbines including the ancillary installations required for operation, the provisions under species protection law are observed.

6.1 Legal basis

The protection of species is regulated in sections 37 ff. BNatSchG as a tiered protection regime and is also applicable in the German EEZ due to its extension pursuant to section 56(1) BNatSchG.

Section 39 BNatSchG establishes general basic protection for all wild species.

Pursuant to section 44(1)(1), (3) and (4) BNatSchG, a higher level of protection applies to specially protected species, and pursuant to section 44(1)(2) BNatSchG the highest level of protection applies to strictly protected species, including European bird species.

Pursuant to section 7(1)(13) BNatSchG, specially protected species are animal and plant species listed in Annex A or B of the Washington Convention on International Trade in Endangered Species of Wild Fauna and Flora (Regulation (EC) No. 338/97), animal and plant species listed in Annex IV of the Habitats Directive (Directive 92/43/EEC), as well as European bird species and the species listed in the Ordinance on the Protection of Wild Fauna and Flora (Bundesartenschutzverordnung – BArtSchV).

Those species strictly protected pursuant to section 7(1)(14) BNatSchG are listed in Annex A or B of the Washington Convention on International Trade in Endangered Species of Wild Fauna and Flora (Ordinance (EC) No. 338/97), animal and plant species listed in Annex IV of the Habitats Directive (Directive 92/43/EEC) and the strictly protected species under BArtSchV.

Wild animals of the specially protected species may not be injured or killed in accordance with section 44(1)(1) BNatSchG. The prohibition of access under section 44(1)(1) BNatSchG aims to protect individuals and as such is inaccessible to population-based relativisation (Landmann/Rohmer UmweltR/Gellermann BNatSchG section 44 recital 9). Pursuant to section 44(5)(2)(1) BNatSchG, there is no violation of the prohibition of killing and injury in accordance with section 1(1), among other things, for the animal species and European bird species listed in Annex IV of the Habitats Directive 'if the impairment caused by the intervention or the project does not significantly increase the risk of killing and injury to specimens of the species concerned and this impairment cannot be avoided by applying the necessary protective measures as recognised by experts.'

In accordance with section 44(1)(2) BNatSchG, wild animals of strictly protected species and European bird species may not be significantly disturbed during the reproduction, rearing, moulting, wintering and migration periods. In this context, it is of no consequence whether relevant harm or a relevant disturbance is based on reasonable grounds, nor do motives, inducements or subjective tendencies play a role in the meeting the criteria of the bans (LANDMANN/ROHMER UMWELTR GELLERMANN BNATSCHG SECTION 44 RECITALS 10-14).

A disturbance is not significant if it applies to individual specimens, only if it impairs the conservation status of the local population of a species (BVerwGE 130, 299; BVerwGE 131, 274).

In the explanatory memorandum to the amendment of BNatSchG 2007, the term local population is defined as follows: 'A local population comprises those (sub-)habitats and activity areas of individuals of a species which are spatially and functionally significant in terms of the habitat (space) requirements of the species'.

In accordance with the guidance document on the strict system of protection for animal species of Community interest under the Habitats Directive (recital 39), a disturbance applies within the meaning of Art. 12 of the Habitats Directive if the act in question reduces the chances of survival, reproductive success or ability of a protected species to reproduce or if this act leads to a reduction in its range. By contrast, occasional disturbances without likely negative effects on the species concerned are not to be considered as a disturbance within the meaning of Art. 12 of the Habitats Directive.

According to the explanatory memorandum to the law, a deterioration in the conservation status of the local population can also be assumed if the chances of survival, breeding success or reproductive capacity are reduced (Bundestag Printed Document. 16/5100, p. 11), although this must be assessed on a species-specific basis in each individual case. What is important is whether the disturbance involves effects which, in view of the circumstances of the individual case and the conservation situation of the species concerned, would seem to have an obvious negative impact on the conservation status of the local population (similar to Berlin Higher Administrative Court (OVG) NuR 2009, 898 (899)), for example if specimens of rare or critically endangered species are disturbed, the disturbed individuals belong to small local populations or a disturbance affects all animals of the population in question (LANDMANN/ROHMER UMWELTR GELLERMANN BNATSCHG SECTION 44 RECITAL 13). By contrast, a significant disturbance can be mitigated by the widespread distribution of a species with possibly large local populations (Federal Administrative Court (BVerwG) NuR 2008, 633 recital 258) or the existence of low-disturbance alternative areas which can be used by the animals (LANDMANN/ROHMER UMWELTR GELLERMANN BNATSCHG SECTION 44 RECITAL 14).

Within the context of the present assessment under species protection law, a review is undertaken as to whether the requirements of section 44 (1)(1) and (2) BNatSchG for specially and strictly protected animal species are met as a result of the implementation of the plan, i.e. during the construction and operation of wind turbines and other facilities. In particular, it is examined whether the construction and operation of the installations violates the prohibitions under species protection law.

The present assessment is carried out at the level of verification of the basic suitability of site O-1.3 for the generation of electricity from wind energy. At this point in time, the technical design of the specific project has not been defined. In this respect, an update of the legal assessment under species conservation law is required within the scope of the subsequent individual approval procedure, taking into account the concrete project parameters.

6.2 Marine mammals

As explained above, site O-1.3 contains the harbour porpoise, a species listed in Annex IV (animal and plant species of Community interest requiring strict protection) of the Habitats Directive, as well as the harbour seal and grey seal as native mammals and specially protected species under the Federal Species Protection Ordinance (Annex 1 BArtSchV). Harbour porpoises are found in varying numbers throughout the year. Harbour seals and grey seals are found in small numbers and irregularly.

In view of this, the suitability of the site with regard to section 44(1) BNatSchG must also be ensured.

Utilisation by marine mammals varies considerably between the different FEP areas in the German EEZ in the North Sea. Area O-1, which also includes site O-1.3, is of medium to high importance for harbour porpoises, but of low to medium importance for grey seals and harbour seals in spring.

6.2.1 Harbour porpoise

6.2.1.1 Section 44(1)(1) BNatSchG (prohibition of killing and injury)

Pursuant to section 44(1)(1) BNatSchG, the killing or injury of wild animals of specially protected species, i.e. including animals listed in Annex IV of the Habitats Directive, such as the harbour porpoise, is prohibited.

The BfN regularly assumes in its statements that, according to current knowledge, injury to harbour porpoises occurs in the form of temporary hearing loss when animals are exposed to a single-event sound exposure level (SEL) of 164 dB re 1 µPa^2/Hz or a peak level of 200 dB re 1 µPa.

According to the BfN, it is sufficiently certain that, if the established limits of 160 dB for the Sound Exposure Level (SEL_{05}) and 190 dB for the peak level at a distance of 750 m from the emission point are complied with, killing and injury pursuant to section 44(1)(1) BNatSchG cannot occur.

The BfN takes into account the currently common use of monopiles with a diameter of up to 8.2 m and jacket piles with a diameter of up to 4 m. The BfN assumes that suitable means such as aversive devices, soft-start procedures, etc. are used to ensure that no harbour porpoises are present within the 750 m radius around the pile driving site.

The BSH agrees with this assessment and, in connection with the suitability determination and later in the individual approval procedures as well as, where appropriate, in their enforcement, it orders the necessary noise mitigation measures and other mitigation measures to be applied (so-called conflict avoidance or mitigation measures, according to Lau in:, FRENZ/MÜGGENBORG, BNatSchG, Commentary, Berlin 2011, section 44 recital 3)). The measures are strictly supervised by the specified monitoring to ensure with the necessary certainty that killing and injury in accordance with section 44(1)(1) BNatSchG do not occur.

The draft suitability determination envisages that the subsequent project developer will be required to use the quietest working method available under the circumstances while the facilities are being set up and installed. On this basis, the BSH can order appropriate specifications with regard to individual work stages, such as aversive measures and a slow increase in pile driving energy, by means of so-called 'soft-start' procedures in connection with the individual approval procedure as well as during implementation. Containment measures and 'soft-start' can be used to 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 a distance of 750 m from the construction site.

In addition, the required degree of noise reduction specified in the suitability determination must be based on the assumption that outside the area in which no harbour porpoises are to be expected as a result of the aversive measures to be taken, no lethal and no long-term detrimental noise impacts are to be expected.

The measures specified by the BSH in the suitability determination and later ordered as part of the individual approval procedure prevent with sufficient certainty that the species protection prohibitions of section 44(1)(1) BNatSchG are met.

According to current knowledge, neither the operation of the energy-generating installations nor the laying and operation of the internal cabling at site O-1.3 will have any significant negative impacts on marine mammals that correspond to the killing and injury criteria in accordance with section 44 (1)(1) BNatSchG.

6.2.1.2 Section 44(1)(2) BNatSchG (prohibition of disturbance)

Pursuant to section 44(1)(2) BNatSchG, it is prohibited to significantly disturb wild animals of strictly protected species during the reproduction, rearing, moulting, wintering and migration periods.

The harbour porpoise is a species listed in Annex IV of the Habitats Directive and is therefore a species within the meaning of section 44(1)(2) in combination with section 7(1)(14) BNatSchG, so an assessment under species protection law must also be carried out in this respect.

The assessment under species protection law pursuant to section 44(1)(2) BNatSchG relates to population-related disturbances of the local population, the occurrence of which varies in the German EEZ in the Baltic Sea.

In its statements in the context of planning approval and enforcement procedures, the BfN regularly examines the presence of a disturbance under species protection law within the meaning of section 44(1)(2) BNatSchG. It comes to the conclusion that the occurrence of a significant disturbance due to construction-related underwater noise in relation to the protected harbour porpoise can be avoided, provided the Sound Exposure Level of 160 dB and the peak level of 190 dB are not exceeded at a distance of 750 m from the point of emission and sufficient alternative areas are available in the German North Sea. According to the requirements of the BfN, the latter is to be ensured by coordinating the timing of noise-intensive activities of different project developers with the aim of ensuring that no more than 10% of the area of the German EEZ in the North Sea are affected by noise (noise control concept, BMU, December 2013).

Impacts of the construction phase

The temporary implementation of pile-driving work is not expected to cause any disturbance to harbour porpoises within the meaning of section 44(1)(2) BNatSchG.

According to current knowledge, it cannot be assumed that disturbances which may occur due to sound-intensive construction measures would worsen the conservation status of the 'local population'.

By means of effective noise control management, in particular by the application of suitable noise control systems as defined by the specifications in the draft suitability determination, based on subsequent orders in the individual approval procedure of the BSH, and taking into account the specifications from the noise control concept of the BMU (2013), negative impacts of pile driving on harbour porpoises are not to be expected.

For this purpose, the draft suitability determination contains instructions for the project developer to coordinate the pile driving work required for its project with that of other projects which could potentially be constructed in the same period. The planning approval decision of the BSH will contain specific requirements which ensure effective noise control management by means of suitable measures.

In accordance with the precautionary principle, measures to avoid and reduce the effects of noise during construction are specified according to the state of the art in science and technology. The measures to ensure compliance with the requirements of species protection specified in the suitability determination or later in the planning approval decision will be coordinated with the BSH during the course of implementation and adapted if necessary. The following noise-reducing and environmental protection measures are regularly ordered as part of the planning approval procedure:

- Preparation of a sound prognosis under consideration of the site-specific and installation-specific characteristics (basic design) before the start of construction,
- Selection of the most appropriate construction method according to the state of the art and the prevailing noise levels,
- Preparation of a concrete noise control concept, adapted to the selected foundation structures and erection processes, for carrying out the pile driving work, always required two years before the start of construction, and in any case before the conclusion of contracts concerning components relating to noise,
- Use of accompanying noise-reducing measures, individually or in combination, pile-remote (bubble curtain system) and, if necessary, pile-linked noise-reducing systems in accordance with the scientific and technological state of the art,
- Consideration of the characteristics of the hammer and the possibilities of controlling the pile driving process in the noise control concept,
- Concept for averting the animals from the endangered area (at least within a radius of 750 m around the pile driving site),
- A scheme to verify the effectiveness of the aversive and noise-reducing measures,
- State-of-the-art installation design to reduce operational noise.

Aversive measures and a 'soft-start' procedure are to be applied to ensure that animals in the vicinity of the pile driving operations have the opportunity to move away or to avoid them in time.

A measure ordered to avoid the risk of killing pursuant to section 44(1)(1) BNatSchG, such as averting a species, can in principle also meet the requirement of a prohibition of disturbance if it takes place during the protected periods and is significant (Federal Administrative Court, judgement of 27 November 2018 – 9 A 8/17, cited in juris).

Until 2017, a combination of pingers was used as a pre-warning system for aversion purposes, followed by the use of so-called seal scarers as a warning system. All the results of the monitoring by means of acoustic detection of harbour porpoise in the vicinity of offshore construction sites with pile driving confirmed that the use of aversive devices was always effective. The animals left the danger zone of the respective construction site. However, aversion by means of seal scarers involves extensive habitat loss as a result of the escape reactions of the animals and therefore constitutes a disturbance (BRANDT et al., 2013, DÄHNE et al., 2017, DIEDERICHS et al., 2019).

In order to prevent this, a new system for averting animals from the danger zone of the construction sites, the so-called Fauna Guard System, has been used in construction projects in the German EEZ in the North Sea since 2018. For the first time, the development of new aversive systems such as the Fauna Guard System opens up the possibility of adapting the aversive system to harbour porpoises and seals in such a way that realisation of the killing and injury criterion within the meaning of section 44(1)(1) BNatSchG can be ruled out with certainty and without simultaneous realisation of a disturbance within the meaning of section 44(1)(2) BNatSchG.

Use of the Fauna Guard System involves monitoring measures. The effects of the Fauna Guard System are being systematically analysed as part of a research project. If necessary, adjustments in the application of the system will have to be implemented in future construction projects.

Based on the above-mentioned requirement, this or another type of aversive device can be required if it proves to be more suitable based on the given level of knowledge and the state of the art

The selection of noise control measures by the subsequent project developer must be based on the scientific and technological state of the art in and on experience already gained from other offshore projects. Findings from practical experience in the application of technical noise-reducing systems as well as from experience with the control of the pile driving process in connection with the properties of the impulse hammer were gained in particular during foundation work in connection with the 'Butendiek', 'Borkum Reef Ground I', 'Sandbank', Gode Wind 01/02', 'NordseeOne', 'Veja Mate', 'Arkona Basin Southeast', 'Merkur Offshore' projects and others. A recent study commissioned by the BMU (BELLMANN,) provides a cross-project evaluation and presentation of the results from all technical noise control measures used in connection with German projects to date.

The results of the very extensive monitoring of the construction phase of 20 offshore wind farms confirm that the measures to avoid and reduce disturbances to harbour porpoise as a result of impact noise are effectively implemented and that the requirements of the BMU's noise control concept (2013) are reliably met. The current state of knowledge considers construction sites in water depths of 22 m to 41 m, in soils with homogeneous sandy to heterogeneous and difficult-to-penetrate profiles and piles with diameters up to 8.1 m. It has been shown that the industry has found solutions in the various procedures to effectively harmonise installation processes and noise control.

According to current knowledge and based on the development of technical noise control to date, it can be assumed that considerable disturbance to the harbour porpoise can be ruled out during foundation work at site O-1.3, even assuming the use of piles with a diameter of up to 10 m.

In addition, the planning approval decision of the BSH will order more detailed monitoring measures and noise measurements in order to detect a possible hazard potential on site based on the concrete project parameters and, if necessary, to initiate damage-limiting measures.

Recent findings confirm that the reduction of noise pollution through the use of technical noise reduction systems clearly reduces disturbance effects on harbour porpoises. The minimisation of effects concerns both the spatial and temporal extension of disturbances (BRANDT et al. 2016).

As a result, by applying the above-mentioned stringent noise control and noise reduction measures in accordance with the specifications of the draft suitability determination and the instructions in the planning approval decisions and by adhering to the limit of 160 dB SEL5 at a distance of 750 m, significant disturbances within the meaning of section 44(1)(2) BNatSchG are not a cause of concern. Furthermore, the requirement of the BfN applies to coordinate the timing of noise-intensive construction phases of different project developers in the German EEZ in the North Sea in accordance with the requirements of the BMU’s noise control concept (2013).

Effects during operation

According to current knowledge, the operation of offshore wind turbines cannot be assumed to constitute a disturbance pursuant to section 44(1)(2) BNatSchG. Based on current knowledge, no negative long-term effects from noise emissions from the turbines are expected for harbour porpoises if the installations are designed as usual. Any effects are limited to the immediate vicinity of the installation and depend on the noise propagation in the specific area and ultimately on the presence of other sound sources and background noise such as shipping traffic (MADSEN et al. 2006). This is confirmed by findings from experimental work on the perception of low-frequency acoustic signals by harbour porpoises using simulated operating noise from offshore wind turbines (LUCKE et al. 2007b): masking effects were recorded at simulated operating noises of 128 dB re 1 µPa at frequencies of 0.7, 1.0 and 2.0 kHz. On the other hand, no significant masking effects were found at operating noise levels of 115 dB re 1 µPa. The first results therefore indicate that masking effects due to operating noise are only to be expected in the immediate vicinity of the respective installation, whereby the intensity again depends on the type of installation.

The results of a study on the habitat use of operational offshore wind turbines by harbour porpoises at the Dutch offshore wind farm 'Egmont aan Zee' confirm this assumption. With the help of acoustic recording, the use of the wind farm area and of two reference areas by harbour porpoises was examined before the turbines were erected (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 the 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 the use of the wind farm area was extensively independent of seasonality and interannual variability. The authors of the study see a direct link between the presence of the installations and the increased use by harbour porpoises. They suspect the causes in factors such as the enrichment of the food supply through a so-called 'reef effect' or the calming of the area through the absence of fishing and shipping or possibly a positive combination of these factors.

The results of the investigations during the operational phase of the 'alpha ventus' project also indicate a return to distribution patterns and abundances of harbour porpoise that are comparable to – and in some cases higher than – those of the baseline survey of 2008.

The results from the monitoring of the operational phase of offshore wind farms in the EEZ have so far not provided clear results. The investigation according to StUK4 by means of aircraft-based recording has so far revealed fewer sightings of harbour porpoises inside the wind farm areas than outside. However, acoustic recording of habitat use by means of special underwater measuring devices, the so-called C-PODs, shows that harbour porpoises use the wind farm areas (Butendiek 2017, North Helgoland, 2019, Krumpel et al., 2017, 2018, 2019). The two methods – visual/digital recording from the aircraft and acoustic recording – are complementary, i.e. the results of both methods must be used to identify and evaluate possible effects. Joint analysis of data, the development of appropriate evaluation criteria and the description of biological relevance are to be the subject of a research programme.

In view of this, in order to ensure with sufficient certainty that the criteria are not met for a disturbance in accordance with section 44(1) (2) BNatSchG, a state-of-the-art operational noise-mitigating facility design is required in the draft suitability determination (section 8(4)).

Suitable monitoring is also specified for the operating phase of the individual project at site O-1.3 in order to be able to record and assess any site-specific and project-specific impacts.

As a result, the protective measures ordered are sufficient to ensure that, with regard to harbour porpoises, the operation of the installations at site N-3.7 also fails to comply with the criteria of prohibition of section 44(1)(2) BNatSchG.

6.2.2 Other marine mammals

In addition to the harbour porpoise, animal species listed as specially protected in a statutory ordinance in accordance with section 54(1) are considered specially protected pursuant to section 7(1)(13)(c) BNatSchG. In BArtSchV, which was enacted based on section 54(1)(1) BNatSchG, native mammals are listed as specially protected, and therefore also fall under the species protection provisions of section 44(1)(1) BNatSchG. In principle, the detailed considerations for harbour porpoises regarding noise pollution from the construction and operation of offshore wind turbines apply to all marine mammals otherwise present at site O-1.3. However, hearing thresholds, sensitivity and behavioural response vary considerably among marine mammals, depending on the species. Differences in the perception and evaluation of sound events among marine mammals are based on two components: firstly, the sensory systems are morpho-anatomically and functionally species-specific. This means that marine mammal species hear, and react differently to, sound. Secondly, both perception and reaction behaviour depend on the respective habitat (KETTEN 2004).

Harbour seals are generally considered tolerant of sonic activity, especially when they have a plentiful food supply. However, telemetric investigations have revealed escape reactions during seismic activity (RICHARDSON 2004). According to all findings so far, harbour seals are able to hear pile driving noises even at a distance of more than 100 km. Harbour seals are also able to hear the operating noises of 1.5 – 2 MW wind turbines at distance of 5 to 10 km (LUCKE et al. 2006).

On the whole, it can be assumed that the species protection requirements can be met due to the distances to breeding and resting sites areas mentioned above and the measures specified.

6.3 Avifauna (seabirds, resting and migratory birds)

The suitability of site O-1.3 for offshore wind energy use is to be assessed based on species protection regulations pursuant to section 44(1) BNatSchG for avifauna (resting and migratory birds).

Protected bird species pursuant to Annex I of the Bird Directive (especially red-throated and black-throated loons, little gulls and horned grebes) as well as regularly occurring migratory bird species (long-tailed ducks, common scoters, velvet scoters, common guillemots and razorbills), which are present at site O-1.3 as resting birds, occur in the surrounding area of site O-1.3 in varying densities. In view of this, the compatibility of the plans with section 44(1)(1) BNatSchG (prohibition of killing and injury) and section 44(1)(2) BNatSchG (prohibition of disturbance) is to be assessed and ensured.

All findings to date indicate that site O-1.3 and its surroundings are of medium importance for seabirds, including species listed in Annex I of the Birds Directive. Site O-1.3 is located outside the preferred habitats of the different bird species listed in Annex I of the Birds Directive, including loons, little gulls and grebes, and of other species regularly occurring in this area of the EEZ of the Baltic Sea.

What is more, site O-1.3 and its surroundings are of average to above-average importance for migratory bird species. In this context, the presence of common cranes, another bird species listed in Annex I of the Birds Directive, during migratory periods must be mentioned in particular.

6.3.1 Section 44(1)(1) BNatSchG (prohibition of killing and injury)

Pursuant to section 44(1)(1) BNatSchG, it is prohibited to hunt injure or kill wild animals of specially protected species. The specially protected species according to section 7(2)(13)(b)(bb) BNatSchG also include European bird species.

The prohibition of access under section 44(1) (1) BNatSchG aims to protect individuals and, as such, is inaccessible to population-based relativisation (Gellermann, in: LANDMANN/ROHMER Umweltrecht, version: 91. edition September 2019, section 44 BNatSchG, recital 51.

The assessment under species protection law requires an assessment based on the principle of practical reasoning (common sense). The authorities are not obligated to ascertain that no impairments occur (BVerwG, ruling of 09/ 7. 2009 – 4 C 12/07, NVwZ 2010, 123, recital 45.

6.3.1.1 Significant increase in risk of killing and injury

The killing and injury prohibition pursuant to section 44(5)(2)(1) BNatSchG is not deemed to have been violated in relation to the species listed in Annex IV lit a of the Bird Directive and European bird species in case of unavoidable impairments through interventions in nature and the landscape pursuant to section 15(1) BNatSchG, if the impairment caused by the intervention or project does not significantly increase the risk of killing and injuring individuals of the affected species (see 6.3.1.1.1) and this impairment cannot be avoided if the required, expert-approved protection measures are applied (see 6.3.1.1.2).

Significance must be assessed based on the explanatory memorandum 'Project- and species-related criteria and other natural conservation parameters' (Bundestag Printed Document 18/11939, p. 17). Circumstances which play a role in assessing significance are, in particular, species-specific behaviours, regular frequenting of the crossed space and effectiveness of the planned protection measures, as well as, if applicable, further criteria relating to the biology of the species. A significant increase in the risk of killing requires indications that operating the system significantly increases this risk; it is neither sufficient for individuals to be injured e.g. through collisions nor for individuals of the affected species to merely be present in the intervention area (BVerwG, resolution of 07/01/2020 – 4 B 20.19, BeckRS 2020, 1633, recital 5.

6.3.1.1.1 Significance

It must be checked whether the risk of killing or injuring individuals of the affected species is significantly increased.

6.3.1.1.1.1 Project-related criteria

The following assessment is based on the two model wind farm scenarios already described under 1.5.5.4 in Table3: Model parameters for consideration of site O-1.3..

6.3.1.1.1.2 Species-related criteria

Importance of the site

For specific species or species groups and under certain migration conditions, site O-1.3 and its environment as a whole are of medium to occasionally high importance for migratory birds. In contrast to the North Sea, specific migration corridors and lanes over the western Baltic Sea are known for some species and species groups that migrate during the day, At the same time, site O-1.3 is located on the margins of these corridors.

The importance of the site is estimated specifically based on the following considerations relating to specific species or specific groups of species:

Common cranes (*Grus grus*)

For the western Baltic Sea, cranes breeding in Scandinavia are especially important as they cross the Baltic Sea during their migrations. As narrow-front migrants, cranes tend to stick to fixed or easily delimitable migratory routes during their migrations. Crane migrations over the Baltic Sea take place primarily between the Rügen-Bock region in the West Pomeranian

Bodden national park and the southern Swedish coast in a north-south direction and neighbouring areas (Alerstam 1990, Skov et al. 2015).

As a bird species listed in Annex I of the European Bird Protection Directive, common cranes enjoy a special protection status. Cranes in northern European breeding areas which approach their overwintering habitats from a south-westerly direction are allocated to the north-western European biogeographical population (Wahl et al. 2007). This population also includes common cranes which cross the western Baltic Sea between the south coast of Sweden and the Rügen-Bock region. According to current estimates, the north-western European biogeographical population is made up of approx. 350,000 individuals (Wetlands International 2018). Measures such as hunting restrictions and habitat restoration have resulted in a large increase in crane populations in recent decades (Deinet et al. 2013). According to Skov et al. (2019), 84,000 cranes cross the Arkona Basin in the autumn each year. In early October 2019, 86,000 common cranes are estimated to have rested in the Rügen-Bock region and the Darss-Zingster-Bodden Chain, the highest value so far compared to previous years (NDR 2019). Based on past findings, common cranes of the north-western European population also head towards the resting areas in this region even where these do not cross the Baltic Sea directly in one to two hours but migrate from Finland along the eastern and southern Baltic Sea coast towards the south-west (Alerstam 1975, Leito et al. 2015).

In autumn 2019, ship-based visual observations recorded 1,609 common cranes or 0.46% of the biogeographical population of north-western Europe passing in the immediate vicinity of site O-1.3, i.e. 1.9% of the estimated total of 84,000 individuals which cross the Arkona Basin. If these sightings are extrapolated and adjusted for survey time, this corresponds to 2,878 individuals or 0.8% of the biogeographical population of north-western Europe or 3.4% of the estimated total of 84,000 common cranes crossing the Arkona Basin. In light of the predominant wind conditions on days with increased crane migratory activity, it can be assumed that the cranes migrating southward drifted eastward because of north-westerly crosswinds and south-westerly headwinds. A preliminary analysis of wind data from the measuring station Darss Sill for autumn 2019 revealed that westerly winds tend to occur alongside greater wind forces (Copernicus 2020, data from the measuring station Darss Sill, autumn 2019). However, in autumn 2019, crane migrations were also registered during favourable tailwind conditions, albeit at lower intensity (see chapter 2.9.3.3). An evaluation of available data from telemetry studies of tracked cranes migrating southward from southern Sweden across the Baltic Sea also indicates that cranes tend to travel in a straight line in a north-south direction, using sprawling neighbouring areas along the way (from Falster in the west to Bornholm in the east). In spite of low sample sizes so far (n = 19), this information provides important clues about crane migrations over the Arkona Basin (movebank.org, Skov et al. 2015, Skov et al. 2019).

The present findings on crane migrations show that during migratory periods, and especially at the time of intense migrations in the autumn, crane migratory activity must be expected in the vicinity of site O-1.3 on a number of days, both under favourable (tailwind) and under unfavourable (crosswind or headwind) migration conditions. Past results indicate that an increased number of cranes must be expected in the vicinity of site O-1.3 especially during westerly winds. Based on these findings and taking into account the relevant biogeographical population, the importance of site O-1.3 for the common crane is evaluated as average to above average.

Birds of prey

The birds of prey that migrate over the Baltic Sea also include species listed in Annex I of the Bird Protection Directive. These are, among others, the European honey buzzard (*Pernis apivorus*), the red kite (*Milvus milvus*), the western marsh harrier (*Circus aeruginosus*), the hen harrier (*Circus cyaneus*), the osprey (*Pandion haliaetus*) and the merlin (*Falco columbarius*).

During past investigation years, the species mentioned above were only spotted occasionally, with the exception of the western marsh harrier of which 70 individuals were recorded in autumn 2016 (BioConsult SH 2018), as part of the cluster investigations 'Western Adlergrund' and the investigations for site O-1.3. The most frequent species occurring in all investigated migratory periods is the Eurasian sparrowhawk (*Accipiter nisus)* for which a maximum figure of 60 individuals was logged in autumn 2016 (BioConsult SH 2016b, BioConsult SH 2017b, BioConsult SH 2018, BioConsult SH 2019; IfAÖ et al. 2020). In autumn 2019, a total of 57 birds of prey were spotted in the immediate vicinity of site O-1.3 on 8 out of 15 investigation days, including 47 sparrowhawks. Of the species in Annex 1 of the Birds Directive, 1 red kite and 1 merlin were observed (IfAÖ et al. 2020). On days with high bird of prey activity, crosswinds (19.09.2019) and headwinds (20 and 25.10.2019) predominated. On 19.09 and 20.10, wind forces of between 2 and 4 Bft were registered, as well as between 5 and 7 Bft on 25.10.2019 (IfAÖ et al. 2020).

Birds of prey of the species listed in Annex I of the Birds Directive were only occasionally sighted in the vicinity of site O-1.3. All in all, sightings in previous investigations were low. Based on current investigation results, the immediate vicinity of site O-1.3 is only of minor importance for the migrations of birds of prey. According to the current level of knowledge, this also applies to migratory and wind conditions which result in drifts eastward from the north-south migratory direction.

Waterbirds

Waterbirds migrations are dominated above all by geese and marine ducks in the vicinity of site O-1.3. Loons and swans occur in comparatively low numbers.

During past investigations in the vicinity of site O-1.3, the greater white-fronted goose (*Anser albifrons*), the barnacle goose (*Branta leucopsis*), the greylag goose (*Anser anser*) and the brant (*Branta bernicla bernicla*) were among the most frequent types of geese based on sightings. Barnacle geese are listed in Annex I of the European Bird Protection Directive. Greylag geese and barnacle geese are also allocated to protection category C1 according to the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) (Populations that number less than around 100,000 individuals for which could benefit greatly from international cooperation and which do not meet the conditions of columns A or B). Brant geese are classed as category B 2b (Populations that number more than around 100,000 individuals but which may require special attention because of their dependence on a habitat type which is under severe threat).

Based on current estimates, the total biogeographical populations of the species of geese most frequently observed in the vicinity of site O-1.3 were: 960,000 greylag geese, 211,000 brant geese, 1,200,000 barnacle geese and 1,000,000 – 1,200,000 greater white-fronted geese (Wetlands International 2018). Taking into account the observed maximum individuals based on past investigation years in the vicinity of site O-1.3, this means that the maximum sightings of greylag geese and brant geese made up approx. 0.04% of the relevant biogeographical populations, with barnacle geese and greater white-fronted geese constituting 0.05% and 0.14% of the relevant biogeographical populations.

According to visual observations, migrations of marine ducks were dominated by common scoters (*Melanitta nigra*) and long-tailed ducks (*Clangula hyemalis*) Common eiders (*Somateria mollissima*) and velvet scoters (*Melanitta fusca*) also occurred regularly and in larger numbers. According to the AEWA, long-tailed ducks and velvet scoters have the risk category A 1b (species listed as 'threatened' in the current IUCN Red List), common eiders the risk category A 4 (species listed as 'near threatened' in the current IUCN Red List but which do not meet the criteria for classification in categories A 1, A 2 or A 3) and common scoters the risk category B 2a (populations that number more than around 100,000 individuals but which may require special attention because of a concentration onto a small number of sites at any stage of their annual cycle) (AEWA 2019).

Current estimates of the relevant biogeographical populations of marine ducks are also available according to Wetlands International (2018). According to this source, the populations of long-tailed ducks amounted to 1,600,000 individuals, of common eiders to 930,000 individuals, of common scoters to 687,000 – 815,000 individuals and of velvet scoters to 320,000 – 550,000 individuals. The maximum number of sighted individuals based on survey in the vicinity of site O-1.3 thus constituted 0.04% of the biogeographical population of velvet scoters, while the proportions of the other marine duck species were higher at 0.29% (common eider), 0.4% (long-tailed duck) and 0.5% (common scoter).

Among swans, the mute swan (*Cygnus olor*) dominated migrations in the vicinity of site O-1.3. By contrast, the swan species listed in Annex I of the Birds Directive, i.e. the whooper swan (*Cygnus cygnus)* and the Bewick's swan (*Cygnus bewickii*), only occurred rarely and in lower numbers.

Swans and loons were only observed in low numbers, so that their proportions of the relevant biogeographical populations remained extremely low.

All in all, the vicinity of site O-1.3 is of medium importance for migratory waterbirds. This is deduced from the fact that, while several species subject to special protection cross this area (e.g. barnacle geese, common eiders, long-tailed ducks and velvet scoters), it is situated outside the principal flyways along the coast. In the same way as for the assessment of the importance of site O-1.3 for bird migrations (see chapter 2.9.4.1), the threshold value of 1 % of the reference population (in this case to relevant biogeographical population), which is commonly used by experts in avifauna evaluations, will also be able applied here.

Waders

Past investigations of the vicinity of site O-1.3 only irregularly spotted waders based on visual observations during the day and call recordings at night. Dunlins (*Calidris alpina*), common snipes (Gallinago gallinago), Eurasian curlews (*Numenius arquata*) and northern lapwings (*Vanellus vanellus*) are among the species recorded in greater numbers but only during individual migratory periods. Dunlins and common snipes are listed as SPEC category 3 (widely distributed species not concentrated in Europe, but with negative population development and unfavourable conservation status in Europe); Eurasian curlews are listed as category 2 (species with global population concentrated in Europe and with negative population development and unfavourable conservation status in Europe) and northern lapwings as category 1 (European species requiring global protection measures, i.e. globally classed as 'Critically Endangered',

'Endangered', 'Vulnerable', 'Near Threatened' or 'Data Deficient') (BirdLife International 2015).

Past investigations in the vicinity of site O-1.3 only occasionally detected wading birds. Dunlins, common snipes, Eurasian curlews and northern lapwings were recorded during only a few, irregular migratory events (IfAÖ et al. 2020). Based on the current level of knowledge, the vicinity of site O-1.3 is only of low to medium importance for wading bird migrations given the irregular occurrence of protected wader species.

Songbirds

Past investigations in the vicinity of site O-1.3 recorded large numbers of songbirds both during the day and at night, with the latter making up the vast majority. The most frequent songbird species spotted during the day were the Eurasian siskin (*Spinus spinus*), the meadow pipit (*Anthus pratensis*) and the common starling (*Sturnus vulgaris*) (BioConsult SH 2016b, BioConsult SH 2018, BioConsult SH 2019). Nocturnal migrations in the vicinity of the site O-1.-3 based on call recordings were dominated above all by robins (*Erithacus rubecula*), common blackbirds (*Turdus merula*) as well as song thrushes and redwings (*Turdus philomelos*, *Turdus iliacus*) (BioConsult SH 2016b, BioConsult SH 2017b, BioConsult SH 2018). Many species encountered in the vicinity of site O-1.3 have a special protection status. Bramblings, skylarks and starlings are listed as SPEC category 3 (widely distributed species not concentrated in Europe, but with negative population development and unfavourable conservation status in Europe); goldcrests are listed as category 2 (species with global population concentrated in Europe and with negative population development and unfavourable conservation status in Europe) and redwings and meadow pipits as category 1 (European species requiring global protection measures, i.e. globally classed as 'Critically Endangered', 'Endangered', 'Vulnerable', 'Near Threatened' or 'Data Deficient') (BirdLife International 2015).

It is assumed that diurnal migrations of songbirds over the Baltic Sea happen along a wide front. The majority of nocturnal bird migrations across the Baltic Sea are also likely to occur along a wide front (BSH 2019). The surveys of bird migrations in the vicinity of site O-1.3 regularly recorded sightings or acoustic detections of high numbers of individuals or calls. All in all, the songbird species observed tend to belong to those populations of northern Europe which are present in high numbers (Birdlife International 2004, BSH 2019). Given the very high number of individuals which can be expected and the proportion of vulnerable species in bird migrations, the vicinity of site O-1.3 is of average to above-average importance for songbirds migrating at night.

Migratory behaviour

Common cranes

Common cranes are classed as thermal gliders according to the ratio of their weight to the size of the wingspan. Phases with rising flight altitudes in thermal columns are interspaced with gliding phases. This behaviour enables them to fly very energy-efficiently. However, it is not possible to cross the approx. 80 km of the Baltic Sea using gliding flight only. Starting at a height of 1,000 m, common cranes can glide across a distance of up to 16 km (Alerstam 1990). Since marine areas do not experience updraughts, they must cross the majority of the distance using active flapping (initially presumably interspaced with gliding phases). For this, they normally wait for weather conditions with prevailing tailwind (Alerstam & Bauer 1973).

Common cranes largely migrate during the day. A study by Bellebaum et al. (2008) estimates the proportion of nocturnal migrations to be around 10 %. The study showed in relation to the distribution of migratory events that neither autumn nor spring migrations occurred evenly and that instead, mass migrations took place on relatively few days. The cranes used tailwind phases in a targeted way to cross the Baltic Sea. Wind also significantly influenced the cranes' flight altitude. During prevailing headwind, flight altitude was significantly lower than during tailwind or 'neutral' wind conditions (Bellebaum et al. 2008). The investigations for the cluster 'Western Adlergrund' and site O-1.3 also indicate concentrated migratory events of common cranes on individual days (BioConsult SH 2016b, BioConsult SH 2017b, BioConsult SH 2018, BioConsult SH 2019, IfAÖ et al. 2020).

Waterbirds

The important migratory aquatic bird populations (marine ducks, loons, geese and swans) mostly come from Siberia so that their migratory route is predominantly but not exclusively in an east-west direction. Geese, marine ducks, loons and swans are predominantly diurnally migrating species.

In terms of diurnal migrants, three main migratory routes over the western Baltic Sea can be identified for aquatic fowl:

- along the Swedish coast (principal route of most common eiders, barnacle geese and brent geese)
- along the German coast (principle route of most common scoters, many loons and sea swallows) and
- in a north-south direction (swans, grey geese, dabbling ducks, mergansers).

Waterbirds are among the so-called flapping flyers. Flapping flight is the most common flying method during which the birds travel through the air entirely based on muscle power (www.wildlifevogelhilfe.org).

Waders

Adult wading birds coming from their Arctic breeding areas mostly migrate across the Baltic Sea to the Wadden Sea at great height, often also flying over southern Sweden. Younger birds tend to travel in smaller sections along the coast, resting in mudflats en route several times (Kube & Struwe 1994). There is evidence to suggest that in the spring, many shorebirds travel from the Wadden Sea to West Siberia at great heights. Shorebirds prefer tailwind for their migrations (Green 2005). Strong headwind or precipitation can occasionally result in emergency rests or in flight closer to the sea surface in the western Baltic Sea along the Swedish (in case of a SW wind in the autumn) or the German (in case of a NW wind in autumn) coast. Sightings of shorebirds on the open sea are very rare. Telemetric investigations of the Eurasian curlew indicate migrations across the western Baltic Sea along a wide front (Schwemmer et al. 2016).

Waders include both exclusively nocturnal migrants, like common snipes and dunlins, as well as species which travel in equal proportions by day and night, like the Eurasian curlew or the northern lapwing. Call recordings are the main evidence during the night (IfAÖ 2005).

Birds of prey

Birds of prey are predominantly thermal gliders and mostly exclusively diurnal migrants. Thermally gliding birds of prey spiral upwards on land to several 100 m in height and then start their migrations. However, some species also use flapping flight (e.g. Eurasian sparrowhawk, osprey, falcon). While the majority of the diurnally migrant birds of prey of Swedish populations follow the 'migratory bird route' over Falsterbo in the autumn, some also cross the Baltic Sea in a north-south direction (in some cases species-specifically, e.g. the rough-legged buzzard). For example, the migration patterns of Eurasian sparrowhawks who have been ringed in Falsterbo and Ottenby have parallel, staggered breeding sites and overwintering areas: The birds breeding further east presumably also travel along a route further to the east and therefore also need to cross larger expanses of water when flying over the Baltic Sea.

Songbirds

Songbirds include species which migrate predominantly during the day as well as exclusively diurnal migrants. Among the diurnally migrant songbirds are mostly short-distance migrants (especially finches and buntings but also pipits, wagtails, tits and crows). It is assumed that diurnal migrations of songbirds over the Baltic Sea happen along a wide front. The 'migratory bird route' between Fehmarn and Lolland is especially important for them because this is the shortest route between the landmasses in the Baltic Sea. Exclusively nocturnal migrants primarily include typical warblers, leaf warblers, flycatchers, Northern wheatears (*Oenanthe oenanthe*) and European robins (*Erithacus rubecula*) as well as thrushes (BirdLife International 2004). The majority of nocturnal bird migrations across the Baltic Sea also occur along a wide front and in many times the numbers. This takes place in only a few nights with extremely strong migration intensity (Berthold 2000, Hüppop et al. 2019).

Flight altitudes and direction

An investigation of flight altitudes based on vertical radar surveys in the migratory periods during 2014 – 2017 shows that migratory birds in the vicinity of site O-1.3 choose a flight altitude of up to 500 m within the recorded range of up to 1,000 m. This observation applies independently of the migratory period and independently of the time of day or night. The area up to 200 m is the busiest area (BioConsult SH 2019). In an evaluation of monitoring data spanning different projects, Welcker (2019a) identified that migrations during nights with greater bird migratory intensities happen at higher altitudes (more than 400 m). This is also confirmed by the individual survey for the cluster 'Western Adlergrund' (BioConsult SH 2019).

Standardised migration observations with reference to the species provide information on the distribution of migration heights in the lower 200 m in the light phase. These surveys show that during the day, around two thirds of all bird migrations in the wider surrounding area of site O-1.3 take place below 20 m (BioConsult SH 2019). The more detailed explanations of the species-specific flight altitude distributions relate primarily to visual observations or other surveys of the flight altitudes of individual species or species groups in the vicinity of site O-1.3, in order to be able to evaluate the observed flight altitude distribution taking into account the existing cumulative effects, such as already existing wind farm projects. In addition, findings from other studies and secondary literature are used as supporting evidence.

Common cranes

The flight altitudes of the cranes, which were determined based on visual observations at site O-1.3, were preferentially above 200 m in both the sector facing the wind farm and the sector facing away from the wind farm (sector 1: 50 % of all observed cranes at altitudes > 200 m; sector 2: 58% of all observed cranes at altitudes > 200 m). The average flight altitude in the sector facing the wind farm was 239 m, and 259 m in the sector facing away from the wind farm (IfAÖ et al. 2020). Compared to current findings, the investigations for the cluster 'Western Adlergrund' in the years 2014 to 2017 were dominated by the height classes 20 – 200 m, at 77 % (2017) to 98 % (2016) of all observed common cranes. These investigations covered a two-year base survey before the construction of the now erected wind farm project commenced in the area O-1, as well as a two-year construction phase. As early as 2017, the second year of the construction phase, an increased flight altitude for common cranes was apparent in the area above 200 m. That year, 77 % of common cranes used the altitude range 20 – 200 m and 23 % used the height range > 200m (BioConsult SH 2019). In the preceding years, common cranes were only very rarely spotted in this height range (BioConsult SH 2016b, BioConsult SH 2017b, BioConsult SH 2018). This comparison could indicate that common cranes in the area of site O-1.3 are already reacting to the existing wind farms by adapting their flight altitude. The observation from the surveys of site O-1.3 in autumn 2019 that common cranes based on visual observations only flew either above or below the rotor area of the existing wind farm 'Wikinger' supports this assumption (IfAÖ et al. 2020). The present findings indicate a vertical rather than a horizontal evasion in relation to the existing wind farm.

In addition to determining flight altitude based on visual observations, migratory birds were measured with the rangefinder (often at the same time in autumn 2019) in the sectors facing the wind farm and facing away from the wind farm in order to obtain a more precise measurement of flight altitude. Based on the information provided by the experts, the bird sightings recorded as part of the rangefinder surveys are 74 % identical to the sightings during the sector-based migration observations. The remaining 26 % of the total of 5,313 individuals were not recorded during the visual observations. During the rangefinder survey, approx. 877 common cranes were observed. All in all, the flight altitude evaluations based on the rangefinder took into account 12 migratory events, three of which occurred in the sector facing the wind farm. Regarding the estimated risk potential for common cranes from a collision with turbines in scenarios 1 and 2 according to section a), the rangefinder surveys and visual observations provided consistent results. The estimates are based only on migratory events from the sector facing the wind farm (sector 1).

The rotor area defined for scenario 1 (26 – 224 m) affected 38 % of the observed migrating common cranes based on the visual observations and 33 % based on the rangefinder measurements. According to both investigation methods, the area above the assumed rotor blade tip was frequented most often at 50 % (visual observations) and 67 % (rangefinder). In scenario 2, 75 % of the recorded common cranes based on visual observations and 100 % of the common cranes measured with the rangefinder flew at the height of the rotor area (50 – 300 m) (IfAÖ et al 2020).

For both methods, the flight altitudes were highest during prevailing tailwind. According to the visual observations, the average flight altitude during tailwind was 331 m (median: 375 m); based on the rangefinder survey, this was 328 m (median: 304 m). For both investigation methods, crosswind conditions prevailed at average flight altitudes of 251 m (visual observation, median 263 m) and 242 m (rangefinder, median 225 m). Flight altitudes in case of headwind were only determined for 1-2 migratory events, with the crane groups flying only a few up to max. 35 m above the sea surface (IfAÖ et al. 2020).

Waterbirds

The flight altitudes of <u>geese</u> estimated based on the visual observations for site O-1.3 in autumn 2019 determined an average flight altitude for the sector facing the wind farm of 100 m, and of 71 m for the sector facing away from the wind farm. All in all, around 80 % of the geese flew in the height range of 20 – 200 m in the sector facing the wind farm, with 61 % of geese doing so in the sector facing away from the wind farm. An evaluation of the prevailing wind conditions at the time of the migration events showed that the flight altitudes did not vary significantly during crosswind, headwind and tailwind conditions (IfAÖ et al. 2020). Visual observations for the cluster 'Western Adlergrund' from past surveys for geese also identified a preference for the height range 20 – 200 m, with proportions of 36 % (2016) to 63 % (2014) of the observed geese flying in this height class (BioConsult SH 2019). Applied to the turbines in scenarios 1 and 2 (see section a)), the results of the visual observations for site O-1.3 indicate that approx. 80 % of geese were flying within the turbine rotor range in scenario 1 and 76 % did so in scenario 2 (IfAÖ et al. 2020). The precise measurements of the rangefinder surveys in the sector facing the wind farm determined an average flight altitude of 76 m, while the average flight altitude in the sector facing away from the wind farm was 59 m. Based on the rangefinder measurements, a total of 62 % of geese flew within the rotor range in scenario 1, with 48 % doing so in scenario 2 (IfAÖ et al. 2020).

An analysis of all flight altitude distribution data available for the vicinity of site O-1.3 consistently show that marine ducks predominantly use the height range of the bottom 20 m. Investigations for site O-1.3 estimated based on visual observations that the flight altitudes of 85 % of marine ducks in the sector facing the wind farm were below 20 m, with this applying to approx. 95 % of marine ducks in the sector facing away from the wind farm. According to rangefinder measurements, these figures were 68 % in the sector facing the wind farm and 81 % in the sector facing away from the wind farm (IfAÖ et al. 2020). The investigations for the cluster 'Western Adlergrund' also revealed a clear preference for the height range of the bottom 20 m (BioConsult SH 2019). Applied to the turbine scenarios used in the impact assessment, this reveals based on visual observations and the rangefinder measurements that approx. 80 % of marine ducks flew below the rotor range in scenario 1 and 94 % of marine ducks did so in scenario 2 (IfAÖ et al. 2020).

Loons and swans are predominantly diurnal migrants. Low flight altitudes are assumed for loons which only sporadically migrate in the height range of 20 to 200 m (BfN notice).

Waders

There is evidence to suggest that, during favourable weather conditions, waders fly at night as well as during the day at heights averaging 2,000 m (GREEN 2005). However, studies of tracked Eurasian curlews also suggest flight altitudes of between 77 and 235 m over the open sea (SCHWEMMER et al. 2020). In its estimates, the BfN also assumes that waders frequently fly in the range of 20 – 300 m. Their migrations across the Baltic Sea from their resting areas in the Wadden Sea to their breeding sites occurred in a wide front in an easterly direction (SCHWEMMER et al. 2016).

Birds of prey

The evaluation of flight altitudes based on visual observations in the vicinity of site O-1.3 showed that 69 % of the recorded birds of prey flew in the range of up to 20 m (BIOCONSULT SH 2019). The investigations for site O-1.3 also revealed a clear preference for the lower altitude range. In the sector facing the wind farm, approx. 76 % of migratory events occurred at altitudes of up to 20 m. Applied to scenarios 1 and 2, therefore, approx. 76 % of birds of prey flew below the rotor range in scenario 1 and 81 % did so in scenario 2 (IfAÖ et al. 2020). According to the information provided by the BfN, flight altitude of between 20 – 200 m must be assumed for birds of prey.

Songbirds

An evaluation of the flight altitudes of diurnal songbirds in all available investigations in the vicinity of site O-1.3 indicate a significant preference for the height range below 20 m. At 88 % and 89 % the respective migratory events, the lower altitude range of up to 20 m dominated in 2019 both in the sector facing the wind farm and in the sector facing away from the wind farm. Due to the limited physical size of diurnal songbirds, rangefinder measurements could not be used reliably (IfAÖ et al. 2020). The flight altitudes estimated during visual observations for the cluster 'Western Adlergrund' in 2014 through to 2017 also identified songbird sighting proportions of 65 % (2016) to 95 % (2015) in the bottom 20 m (BioConsult SH 2016b, BioConsult SH 2017b, BioConsult SH 2018, BioConsult SH 2019). Applied to the turbine scenarios according to section a), these results from the visual observations of site O-1.3 indicate that approx. 89 % or 94 % of diurnally migrant songbirds were observed below the rotor ranges of scenarios 1 and 2. However, according to the BfN estimate, diurnally migrant songbirds must also be assumed to use the flight altitude range of between 20 – 300 m.

For nocturnal bird migrations which are dominated by songbirds, the investigations for the cluster 'Western Adlergrund' showed that the range of up to 200 m is used most frequently. Generally speaking, the altitude distribution in the recorded range of up to 1,000 m was dominated by flight altitudes of up to 500 m (BioConsult SH 2019). In an evaluation of monitoring data spanning different projects, Welcker (2019a) identified that migrations during nights with greater bird migratory intensities happen at higher altitudes (more than 400 m). This is also confirmed by the individual survey for the cluster 'Western Adlergrund' (BioConsult SH 2019).

Generally, migrating birds fly higher in good weather than in bad. It is also undisputed 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 likely to reach their destination in the best possible weather (BSH 2009).

In addition, among the birds who favoured clear weather conditions for their migration, collisions with offshore wind turbines were less likely as the flight altitudes of most birds are above the range of the rotor blades and the turbines are clearly visible. An evaluation of all existing vertical radar data from bird migration monitoring for offshore wind farm projects showed for projects in the EEZ of the Baltic Sea that the flight altitudes of nocturnal bird migrations in the spring and autumn average at approx. 400 m (Welcker 2019a). By contrast, sudden mist and rain constitute a potential risk situation which can result in poor visibility and lower flight altitudes. One particular problem is the coincidence of bad weather conditions with so-called mass migration events. Based on the information available from various environmental impact studies, these events occur approx. 5 to 10 times a year. On average, two to three of these coincide with poor weather. An analysis of all existing bird migration surveys from the mandatory monitoring of offshore wind farms in the EEZ of the North and Baltic Seas (period under investigation: 2008 – 2016) confirm that during nocturnal bird migrations, 1 % of especially intense bird migrations coincide with extremely bad weather conditions (Welcker 2019b).

In the context of flight altitude, the so-called 'step effect' must be considered. This occurs of turbines of greater dimensions are erected in the immediate vicinity of existing, smaller turbines.

The wind turbines of the wind farms 'Wikinger' and 'Arkona' situated to the south are approx. 59 m or up to 135 m lower than the turbines in scenarios 1 and 2 (see section a)). This creates a step effect where, coming from the south, lower turbines in the south of area O-1 are followed by larger turbines in the north. Depending on the turbine scenario (1 or 2), the visibility of the taller turbines could be limited to the turning rotors. This is particularly true of the smaller turbines in scenario 1. In scenario 2, at a hub height of 175 m, it can be assumed that the massive nacelles will also be visible. This effect particularly occurs in the spring for species coming from the south which encounter site O-1.3 on their route to their northern breeding sites.

Avoidance/attraction

The project at site O-1.3 must be expected to have an attraction or avoidance effect on some species or species groups. These can occur both during the day and at night as well as due to intrinsic reactions to the structures or induced e.g. by lighting at night and/or bad weather. Below are presented the known behaviours of individual species and species groups based on investigations at site O-1.3 and on secondary literature.

Common cranes

Of the 1,609 common cranes spotted in autumn 2019, a total of 1,439 individuals were assigned to directional migrations. The area surveyed by the visual observations was split into a sector facing the wind farm and a sector facing away from the wind farm in order to be able to identify potential avoidance of an existing wind farm in the immediate vicinity of site O-1.3 based on the migratory events recorded in the two sectors and hence potential future behaviour in relation to an offshore wind farm at the site O.1-3. In light of the position of the anchored vessel, it was not possible to capture flight through the wind farm and flight behaviour inside the wind farm. The 1,439 common cranes on a targeted migratory route were distributed across a total of 20 migratory events with an average group size of 72 individuals. A total of 727 individuals flew through the sector facing the wind farm in 8 migratory events, whereas 712 individuals in 12 migratory events travelled through the sector facing away from the wind farm. Accordingly, 51 % of the observed individuals were spotted in the sector facing the wind farm (sector 1) and 49 % in the sector facing away from the wind farm (sector 2). As a result, no avoidance through horizontal circumvention of the wind farm area was apparent (IfAÖ et al. 2020).

During the base surveys of the Danish offshore wind farm 'Kriegers Flak' in 2015, the avoidance rates of common cranes were evaluated at macro, meso and micro level. These surveys were based on the data of behavioural reactions collected in the immediate vicinity of the offshore wind farm 'Baltic 2'. These identified only limited reactions on the part of common cranes to the offshore wind farm 'Baltic 2' as only one of 14 groups approaching the wind farm avoided flying into the first row of turbines (macro avoidance) (Skov et al. 2015).

When the common cranes were in the neighbouring wind farm, they displayed relatively strong horizontal and vertical avoidance (meso avoidance). Of the 20 recorded groups, 16 avoided flying into the rotor area, with seven groups displaying horizontal avoidance and nine groups vertical avoidance. All in all, based on the observations collected as part of the investigations for the base survey 'Kriegers Flak' and additional findings for the common crane, a total avoidance rate of 83 % is estimated (Skov et al. 2015). By way of comparison, based on offshore surveys, large gulls are assumed to have an avoidance rate of 99.8 % (Skov et al 2018).

Waterbirds

In the course of the diurnal migration surveys at site O-1.3 in autumn 2019, a total of 5,190 geese were observed during 138 migration events. In the sector facing the wind farm, 2,145 individuals were spotted in 49 migration events, with 3,045 individuals sighted in 89 migration events in the sector facing away from the wind farm. This means that, across all goose species, significantly more migration events were recorded in the sector facing away from the wind farm, which suggests avoidance of the existing wind farm in the immediate vicinity of site O-1.3. A consideration of the most frequent goose species reveals that the behaviour varied by species. While the avoidance behaviour which dominated across all goose species was also identified in individual observations of greater white-fronted geese and barnacle geese, no statistically significant differences in occurrence were found for greylag geese in the sector facing the wind farm compared to the sector facing away from the wind farm (IfAÖ et al. 2020). In the investigation year 2017 for the cluster 'Western Adlergrund', no statistically significant avoidance effect was identified across all goose species. However, that year, the wind farm near site O-1.3 was still partially under construction (BioConsult SH 2019). The present investigations at site O-1.3 showed that geese also displayed larger-scale avoidance in relation to an existing wind farm in the vicinity of site O-1.3. This behaviour was particularly observed among the strictly protected greater white-fronted geese and barnacle geese (IfAÖ et al. 2020). Other studies also came to the result that the collision risk for geese is reduced due to their pronounced avoidance behaviour (BLEW et al. 2008, LINDEBOOM et al. 2011, FOX&PETERSEN 2019). This was explained with reference to the fact that geese are predominantly diurnal migrants and are therefore able to see and avoid obstacles in time (KAHLERT et al. 2004, DESHOLM & KAHLERT 2005, PETERSEN et al. 2006).

For marine ducks, the evaluations of migratory activities in the respective sectors come to comparable results as for geese. All in all, visual observations for site O-1.3 identified 811 marine ducks during 136 migratory events. Of these, 243 individuals in 44 migratory events were in the sector facing the wind farm, with 568 individuals in 92 migratory events sighted in the sector facing away from the wind farm. As a result, a statistically significant increase in the migratory activities of marine ducks in the sector facing away from the wind farm can be identified across all species. However, an examination of the individual species reveals differences. Where a statistically significant, increased migratory activity in the sector facing away from the wind farm was identified for common scoters and long-tailed ducks, velvet scoters and common eiders displayed no significant difference between the two sectors (IfAÖ et al. 2020). Investigations for the cluster 'Western Adlergrund' in 2017 also observed significantly fewer marine ducks in the sector facing the wind farm ($p \leq 0.001$). This behaviour was most pronounced with common scoters (BioConsult SH 2019). In addition, common scoters also displayed deviations from their expected migration directions during investigations for site O-1.3 which indicate a horizontal avoidance of the wind farm area (IfAÖ et al. 2020).

For loons, in spite of low sample numbers totalling 12 individuals in 10 migratory events, a statistically significant increase in migratory activity was identified in the sector facing away from the wind farm during investigations of site O-1.3 (IfAÖ et al. 2020). Generally speaking, loons (in German marine waters, these are especially red-throated and black-throated loons) are a species group which is known to be particularly sensitive to disruptions and which displays a pronounced avoidance behaviour towards offshore wind farm projects (GARTHE et al. 2019, MENDEL et al. 2019, BIOCONSULT SH 2020).

Given the low numbers of swans sighted, investigations at site O-1.3 did not reach any clear or statistically significant findings regarding the use of the sector facing the wind farm compared to the sector facing away from the wind farm, which would indicate potential avoidance or attraction (IfAÖ et al. 2020). During the investigations for the cluster 'Westerns Adlergrund' in 2017, it was identified that, of the 16 migratory events across the whole year, 63 %

took place in the sector facing away from the wind farm and 37 % in the sector facing the wind farm. However, given the low sample size, this difference was not statistically significant (BioConsult SH 2019). In its evaluations, the BfN also assumes a significant avoidance reaction by swans in relation to offshore wind farms (BfN notice).

Waders

The investigations for site O-1.3 did not reveal any clear findings regarding the use by waders of the sector facing the wind farm compared to the sector facing away from the wind farm (IfAÖ et al. 2020). The day-time investigations for the cluster 'Western Adlergrund' in 2017 also identified increased use of the area facing away from the wind farm, however this was not statistically significant given the low sample size (BioConsult SH 2019). The BfN also assumes that wader species display partial avoidance and offshore wind farm projects are not expected to have an attraction effect (BfN notice).

Birds of prey

An evaluation of migratory activity in the two sectors under investigation based on visual observations at site O-1.3 revealed higher migratory activity at 58 % in the sector facing away from the wind farm compared to the sector facing the wind farm, but this difference was not statistically significant given the low numbers sighted (IfAÖ et al. 2020). During the investigations for the cluster 'Western Adlergrund' in 2017, however, at 67 % significantly more birds of prey were observed in the sector facing the wind farm (BioConsult SH 2019). Regarding birds of prey, findings are available on the attraction effects of offshore structures like wind turbines who actively approach them as resting sites in case of exhaustion, especially during unfavourable migration conditions (Hüppop et al. 2019).

Songbirds

During the visual observations for site O-1.3 in autumn 2019, a total of 1,828 songbirds were observed across 224 migratory events. Of these, 883 individuals in 108 migratory events were in the sector facing the wind farm, with 995 individuals in 116 migratory events sighted in the sector facing away from the wind farm. Even though approx. 52 % of migratory events were registered in the sector facing away from the wind far, the difference between the two sectors was not statistically significant (IfAÖ et al. 2020). Investigations for the cluster 'Western Adlergrund' in 2017 observed significantly more frequent use of the sector facing the wind farm (BioConsult SH 2019). Currently, no verified findings are available on the reaction of diurnally migrant songbird species to offshore wind turbines.

However, it cannot be ruled out that the lighting in fhs installations might have a lure effect, particularly for nocturnal migrants, and that these might fly into the turbines or at least causing glare. Investigations of lightships in Denmark have revealed that light sources are frequently approached by small bird species such as starlings, song thrushes and skylarks during poor visibility (Hansen 1954).

Frequent/regular frequentation O-1.3

The bird migration surveys conducted as part of the investigations for the cluster 'Western Adlergrund' for the years 2014 – 2017 showed that no individual months displayed constantly higher migration intensity during autumn migration or spring migration with the result that it was not possible to narrow down bird migrations to individual months. Comparing the individual years under investigation revealed seasonal as well as interannual differences. Bird migration events of different intensities occurred across all years (BioConsult SH 2016b, BioConsult SH 2017b, BioConsult SH 2018, BioConsult SH 2019).

Conclusion regarding significance

Taking into account the above aspects, the assessment under species protection law comes to the conclusion that a significantly increased risk of killing or injuring common cranes, geese, waders, birds of prey and songbirds pursuant to section 44(1) BNatSchG cannot be excluded with the required certainty. This result is based on the above considerations for the species or species groups.

Common cranes

Based on the results from investigations for the site O.1-3 and additional findings regarding the migratory behaviour of common cranes, it can be assumed in line with the current level of knowledge, that common cranes are highly likely to cross site O-1.3 at the rotor height of the turbines in scenarios 1 and 2 (see section a)). According to the findings on general flight altitude distribution and the information about flight behaviour during prevailing crosswind which resulted in higher numbers of individuals being spotted in the vicinity of site O-1.3 (see chapter 2.9.3.3), it makes sense to assume that the collision potential for the larger turbines in scenario 2 is higher than that of the smaller turbines in scenario 1.

The bird migration study for site O-1.3 commissioned by the BSH involved not just targeted investigations of the migrations of common cranes and other species sensitive to wind turbines, but also collision modelling for the autumn migration period using the stochastic collision risk model (CRM) of McGregor et al. (2018) (IfAÖ et al 2020). However, the experts only recommend using collision risk models for a qualitative comparison of different wind farm scenarios because of the sensitivity of collision risk models to its input parameters, e.g. avoidance rates, flight altitude distribution and migration rates based on vertical radar tracks, and the fact that CRMs have so far not been validated for the offshore area. In addition, the experts also refer to scientific recommendations to further develop CRMs so that in future, the models will be able to take into account different precise survey methods and realistically estimate the probability of collisions based on the recorded reactions of the birds (Cuttat & Skov 2020, IfAÖ et al. 2020). In view of the existing significant uncertainties of the collision risk models, the specific numerical results of the CRM for site O-1.3 are not provided below. Instead, these are only discussed qualitatively and in the context of the findings from the migration surveys of common cranes.

The models for cranes predict that the highest number of victims will be among the species migrating during the day. Based on the estimate of the experts, this result can be explained with reference to the observed flight altitude distribution and the low avoidance rate which is assumed based on the observations for 'Krieger's Flak' by Skov et al. (2015). There were significant differences between the underlying turbine scenarios 1 and 2. Scenario 2 with bigger turbines (total height: 300 m, scenario 1: 224 m) and lower number of turbines (20 turbines, scenario 1: 33 turbines) had significantly lower predicted collision figures than scenario 1. The median numbers of collision victims for common cranes in scenario 2 are approx. 38 % compared to scenario 1. According to the experts, the two scenarios have neither significant impacts on the protected object nor do they endanger the common crane population. The so-called 'Potential Biological Removal' (PBR) value from a study by Skov et al. (2019) is used to measure this evaluation by determining the cumulative bird collision risk for common cranes in 18 wind farms in the Baltic Sea. The PBR value states the extent of additional mortality for which a population must compensate without endangering their continued existence (WADE 1998). SKOV et al. (2019) used the population of 84,000 common cranes above the Arkona Sea as their reference population for the PBR value.

All in all, the general data and findings and, more specifically, crane migrations at site O-1.3, show based on the results of collision risk modelling that common cranes are subject to an increased conflict potential with offshore wind turbines due to their flight behaviour and flight altitude distribution in both scenario 1 and scenario 2. Based on observations at and in the vicinity of site O-1.3 that, during prevailing crosswinds, cranes more frequently drift from their migratory path into this area of the western Baltic Sea, a higher overall occurrence of cranes must be expected at site O-1.3 under certain conditions. In favourable weather conditions for crane migrations, site O-1.3 is only on the margins of the migration corridor between Rügen and Schonen.

Taking into account all findings, a significantly increased risk of killing common cranes in situations of increased common crane occurrence at site O-1.3 and hence a realisation of the killing and injury prohibition at site O-1.3 pursuant to section 44(1)(1) BNatSchG cannot currently be excluded with the required certainty. Accordingly, the suitability approval for site O-1.3 includes a requirement that the project developer must take suitable measures to observe bird migrations in the vicinity of the site and avoid the occurrence of significant collision risk (see 2.).

Waders

Past investigations have only infrequently observed waders in a few migratory events in the vicinity of site O-1.3. Based on these investigations, and given the observed migration of protected species, the vicinity of site O-1.3 is classed as having a low to medium importance for wader migrations. In its statement, the BfN points out that the rarity of the migratory events may also be related to the timing of the past investigations which may have missed the peak of wader migrations. While there is evidence to suggest that waders regularly fly at greater altitudes and outside the survey range and hazard zone of offshore wind farm projects, other findings from telemetric projects suggest that the flight altitude overlaps with the hazard zone of offshore wind farms. At the same time, the BfN assumes that wader species migrating diurnally and nocturnally display partial avoidance and offshore wind farm projects are not expected to have an attraction effect (BfN notice). Findings regarding behaviour in relation to offshore wind farms during bad weather are not currently available. According to the BfN's estimate, a significantly increased risk of killing and injuring waders at site O-1.3 pursuant to section 44(1)(1) BNatSchG cannot be excluded with the required certainty. Since, based on the estimate of the competent specialist federal authority, the realisation of the killing and injury prohibition pursuant to section 44(1)(1) BNatSchG cannot be excluded with the required certainty, the suitability approval for site O-1.3 includes a requirement that the project developer must take suitable measures to observe bird migrations in the vicinity of the site and avoid the occurrence of a significant collision risk (see 6.3.1.1.2.)

Birds of prey

Past investigations have only observed few birds of prey in the vicinity of site O-1.3. However, these have been sighted more frequently in the sector facing the wind farm, albeit at flight altitudes of up to 20 m (IfAÖ et al. 2020). Offshore structures, and hence also wind turbines, must be assumed to have an attraction effect on birds of prey which can increase the collision risk for individuals of bird of prey species. According to the BfN's estimate, a significantly increased risk of killing and injuring birds of prey at site O-1.3 pursuant to section 44(1)(1) BNatSchG cannot be excluded with the required certainty. Since, based on the estimate of the competent specialist federal authority, the realisation of the killing and injury prohibition pursuant to section 44(1)(1) BNatSchG cannot be excluded with the required certainty, the suitability approval for site O-1.3 includes a requirement that the project developer must take suitable measures to observe bird migrations in the vicinity of the site and avoid the occurrence of a significant collision risk (see 6.3.1.1.2).

Songbirds

Songbirds include both species which migrate by day and species which migrate by night. Past findings for the vicinity of site O-1.3 show that species which migrate by day more frequently flew through the sector facing the wind farm, but preferred flight altitudes of up to 20 m, thus remaining below the rotors. In its estimates, the BfN assumes that diurnally migrant songbirds frequently use the range between 20 – 300 m which puts them into the hazard zone of the turbines. Moreover, no verified findings are available regarding the migratory behaviour of diurnally migrant songbirds during bad weather conditions. According to the BfN estimate, a significantly increased collision risk of diurnally migrant songbirds at site O-1.3, especially in case of especially high migration intensity and in connection with bad weather conditions, cannot be excluded with the required certainty.

Nocturnal songbird migrations involve many times the numbers of diurnal songbird migrations. Especially where mass migration events and bad weather conditions coincide, this can increase the collision risk for song birds due to the attraction effects of turbine lighting. According to the BfN estimate, a significantly increased risk of killing and injuring nocturnally migrating songbirds generally applies at site O-1.3 due to their preferred use of the height range of up to 200 m at night. Since, based on the estimate of the competent specialist federal authority, the realisation of the killing and injury prohibition pursuant to section 44(1)(1) BNatSchG cannot be excluded with the required certainty, the suitability approval for site O-1.3 includes a requirement that the project developer must take suitable measures to observe bird migrations in the vicinity of the site and avoid the occurrence of a significant collision risk (see 6.3.1.1.2).

Waterbirds

Geese are the most frequent species group recorded in past investigations. All geese species have been shown to display avoidance reactions to offshore wind farms, which are particularly apparent in barnacle and greater white-fronted geese and have been confirmed in further scientific studies. Moreover, geese are diurnally migrant waterbirds so they are able to rest on the water during unfavourable weather and visibility conditions. But geese tend to prefer the flight altitude range of 20 – 300 m and thus the hazard zone of possible wind turbines at site O-1.3. In addition, there are currently no findings available on the extent to which the reactive behaviour of geese is influenced by bad visibility conditions. According to the BfN's estimate, a significantly increased risk of killing geese at site O-1.3 pursuant to section 44(1)(1) BNatSchG cannot be excluded with the required certainty. Since, based on the estimate of the competent specialist federal authority, the realisation of the killing and injury prohibition pursuant to section 44(1)(1) BNatSchG cannot be excluded with the required certainty, the suitability approval for site O-1.3 includes a requirement that the project developer must take suitable measures to observe bird migrations in the vicinity of the site and avoid the occurrence of a significant collision risk (see 6.3.1.1.2).

Marine ducks were the second most frequent species group among waterbirds. Marine ducks are known to display avoidance reactions to offshore wind farms according to investigations for the vicinity of site O-1.3 and based on literature. In addition, it is also assumed for this species group that they will be able to land on water in case of unfavourable migration conditions. Investigations further show that migrating marine ducks primarily fly at altitudes of up to 20 m and hence outside the hazard zone of wind turbines at site O-1.3. Therefore, a significantly increased risk of killing marine ducks at site O-1.3 can be excluded with the required certainty.

Only limited numbers of loons and swans were sighted in past investigations of migrations in the vicinity of site O-1.3. Furthermore, both species groups are known to display avoidance behaviour towards offshore wind turbines. As a result, a realisation of the conditions for killing swans and loons according to section 44(1)(1) BNatSchG is not expected to apply at site O-1.3.

6.3.1.1.2 Avoidance measures recognised by experts

According to section 44 (5)(2) BNatSchG, a violation of the 'prohibition of killing and injury pursuant to clause 1 no. 1 is not deemed to apply if the impairment caused by the intervention or project does not significantly increase the risk of killing and injuring individuals of the affected species and this impairment cannot be avoided by using the required, expert-approved protection measures.' Based on the interpretation of the BVerwG, the conditions for the killing prohibition are also not deemed to have been met if a project does not cause a significantly increased risk of collision-related losses of individuals due to avoidance measures, i.e. if it remains below the risk threshold in a risk area connected with such a project in the natural sphere. It is not necessary to achieve zero risk, with the result that the requirement that the protection measures by themselves should avoid collision with close to 100 % certainty, is too broad (BVerwG, ruling of 28/04/2016 – 9 A 9/15, NVwZ 2016, 1710, recital 141). As a result, a (if applicable, additional) protection measure based on special protection law is only required and imperative if otherwise, the risk for the specially protected species would significantly increase compared to general risk to life.

In this context, GELLERMANN also states in LANDMANN/ ROHMER that this would also be in line with the legal position following the amendment to BNatSchG, 'according to which it is sufficient for the risk of killing and injury to not be increased significantly or if counter-measures are used to lower an increased risk in the individual case below the significance threshold.' By contrast, in its current version, section 44 (5)(2)(1) BNatSchG gives the impression that avoidance effort need to be taken even where the mentioned risk would remain below the significance threshold in the absence of such measures. However, such an interpretation would give rise to problems because section 44 (5)(2)(1) BNatSchG already relates to impairments which cannot be remedied using proportionate methods in application of section 15(1) BNatSchG […]. Therefore, the somewhat unclear wording of section 44(5)(2)(1) BNatSchG is at most seen as a further confirmation of the already considerable avoidance requirement and should presumably be interpreted to mean that a significantly increased risk of killing and injury can only be countered with avoidance measures recognised by experts. Protection measures which are not recognised by experts or whose design is insufficient to meet the requirement from an expert perspective, do not result in an exclusion of the consequence of the prohibition (see Bundestag Printed Document 18/12845, 24; Lütkes NuR 2018, 145 (147)).“ (GELLERMANN, IN:

LANDMANN/ROHMER Umweltrecht, version: 92. edition, February 2020, recital 52)

Therefore, a protection measure is only imperative and required for European bird species for which a significantly increased collision risk cannot be excluded with the required certainty in the absence of this measure. Based on the details under I., the following requirement is included in the suitability approval:

'Section 44 Special provisions to protect avifauna

(1) For the European bird species which migrate across the site and which may be subject to a significantly increased collision risk, the project developer must record, consistently and in a suitable way, at a minimum, their migration rates and migration intensities, their vertical migration distribution and the weather conditions and visibility ranges, both during autumn and spring migrations as part of risk management from the time that the wind turbines are implemented. With reference to cranes, a significantly increased risk of collision due to the wind turbines is to be assumed during events with very high migration intensities over site O-1.3. Monitoring shall be combined with surveillance of the resting places in southern Sweden for autumn migration and in the Rügen-Bock region and on the Darss for spring migration in order to obtain information regarding the start of migration. Particularly for birds of prey, geese and waders as well as songbirds, a significantly increased collision risk with the wind turbines must be assumed during events with very high migration intensities over site O-1.3 which occur:

1. at night, or

2. during the day alongside visibility ranges of less than 500 m.

The wind turbines shall be equipped with suitable devices that enable the real-time recording of migration intensities.

(2) Where it becomes apparent from the surveys according to clause 1 that the collision risk for the bird species listed in clause 1 is significantly increased, the wind turbines must be switch off and turned out of the wind. Shut-off can be forgone insofar as other equally suitable reduction measures are implemented.

(3) A specific concept for monitoring in accordance with clause 1 and for implementing or checking the success of shut-off or other suitable measures in accordance with clause 2 shall be submitted to the planning approval authority by the project developer along with the planning approval application.“

This must be based on the results of the assessment under species protection law, to summarise:

'The requirement serves the avoid the realisation of the prohibition of killing and injury under species protection law pursuant to section 44(1)(1) BNatSchG.

According to section 44(1)(1) in conjunction with section 7(2)(13) BNatSchG, it is illegal to kill or injure European bird species.

When planning and approving public infrastructure and private construction projects, it must be assumed that unavoidable killing or injuries of individuals during operations (e.g. the collision of birds with wind turbines) as socially acceptable risks are not classed as prohibited conditions, section 44 (5)(2) BNatSchG (Bundestag Printed Document 16/5100, S. 11 and 16/12274, p. 70 f.). 'This provision limits the conditions of section 44(1)(1) in concert with the jurisprudence specifically relating to the risks of operations, construction and installation (e.g. in case of collisions between animals and road traffic or wind turbines, clearing of building areas) (BVerwGE 134, 166, recital 42; BVerwG, ruling of 13.05.2009, 9 A 73/07, recital 86;

BVerwG, ruling of 08.01.2014, 9 A 4/13, recital 99) in that the unavoidable loss of individuals as a result of the project does not automatically or always constitute a violation of the killing prohibition. Instead, a violation assumes that the project significantly increases the risk of killing individuals of a specific species. Regarding the definition of the term 'significant', based on the jurisprudence, some rulings equate this term with the term 'considerable' (recitals for section 44 (5)(2) BNatSchG, Bundestag Printed Document 18/11939)

This is only attributed if the risk of occurrence due to the project is significantly increased by special circumstances, such as turbine design, the topographical conditions or species biology and this impairment cannot be avoided by applying the required, expert-approved protection measures.

Section 44 stipulates such a protection measure.

Based on the current level of knowledge, a significantly increased risk for bird species crossing the area of the project cannot be excluded, especially during certain weather conditions:

The Baltic Sea contains a number of migratory routes used by species which are sensitive to wind power or at risk of collisions, especially common cranes, birds of prey, geese and waders as well as songbirds, with the latter also crossing site O-1.3 in larger numbers. According to the result of the assessment under species protection law, common cranes, birds of prey, geese and waders, as well as songbirds in certain situations, are generally subject to an increased risk of colliding with wind turbines, especially during events with very high migration intensities, which could e.g. occur on approx. 5 - 10 % of all days during the principal migration periods whenever migration congestion disperses. If these events take place on unfavourable weather days or on days with poor visibility, the risk of the birds colliding with the wind turbines might increase, e.g. due to attraction effects or difficulties navigating. This risk can be countered using the prescribed measures.'

The rationale behind the individual paragraphs can be found in the recitals for the suitability approval.

6.3.2 Section 44(1)(2) BNatSchG (prohibition of disturbance)

Pursuant to section 44(1)(2) BNatSchG, it is prohibited to significantly disturb wild animals of strictly protected species during the reproduction, rearing, moulting, wintering and migration periods. For this reason, it is necessary to consider possible disturbances to local populations in German waters, particularly in the German EEZ, arising from wind energy use at site O-1.3.

An assessment under species protection law across areas and sites with regard to the ban on disturbance in the sense of a deterioration in the conservation status of local populations of protected species was carried out as part of the SEA for the Site Development Plan (FEP, Environmental Report 2019). The result of the assessment within the framework of the preparation of the FEP (BSH 2019) can be confirmed based on the available data and information for site O-1.3.

Site O-1.3 and its surroundings are home to protected species, as explained above. These include the species listed in Annex I of the Birds Directive whose habitats and biotopes are protected in the nature conservation areas, as well as characteristic species and regularly occurring migratory bird species.

Loons predominantly use the area in which site O-1.3 is situated as a transit area during their migrations and in winter. Based on the current level of knowledge, this site and its surrounding area are located outside the preferred habitats in the Bay of Pomerania. Based on the present findings, the BSH comes to the conclusion that site O-1.3 and its surrounding area is not especially important for the loon population which rests in the German Baltic Sea. In this respect, no disturbance of the local population can be assumed.

Given the relatively limited observed densities of little gulls in the vicinity of O-1.3 and the limited crossover with the timing of the species-specific principal migratory periods, the vicinity of site O-1.3 is assumed to only play a minor role for little gulls. With regard to little gulls, it is not assumed based on current knowledge that a wind farm project at site O-1.3 fulfils the criteria for disturbance in accordance with section 44(1)(2) BNatSchG.

Grebes prefer shallow grounds with water depths of up to 10 m. Owing to the water depths at site O-1.3, this area of the EEZ does not play any special role for grebes. This is confirmed by the limited number of individuals sighted during the marine bird surveys for the cluster 'Western Adlergrund', which also cover the present site O-1.3. Therefore, the conditions for a disruption to the local grebe population cannot be assumed to apply.

Diving marine ducks, such as long-tailed ducks, common scoters and velvet scoters, also prefer the shallow grounds of the Baltic Sea with its greater availability of food sources. Therefore, site O-1.3 and its surrounding area are not considered to be of special importance for them. With regard to diving marine ducks, it is not assumed based on current knowledge that a wind farm project at site O-1.3 fulfils the criteria for disturbance in accordance with section 44(1)(2) BNatSchG.

Common guillemots and razorbills have a large distribution in the wider surrounding area of site O-1.3. Based on the present investigations and the knowledge of their distribution across the whole of the Baltic Sea, the area of O-1.3 cannot be identified as a preferred habitat. As a result, the area surrounding the present site is only assumed to be of medium importance seasonally. Based on the current level of knowledge, a wind farm project at site O-1.3 is not assumed to have any significant impacts for auks, especially common guillemots and razorbills. According to current knowledge, the BSH does no therefore assume that the criteria for disturbance in accordance with section 44(1)(2) BNatSchG are fulfilled.

Most gull species present in the vicinity of site O-1.3 are known to be pronounced followers of ships. In addition, evidence from research projects and wind farm monitoring points to the attraction effect of offshore wind farms. Based on the current level of knowledge, no significant impacts on the populations of the occurring gull species are expected in the form of disruptions caused by an offshore wind farm project at site O-1.3.

In conclusion, the construction and operation of offshore wind turbines and ancillary installations (transformer station, internal cabling of the wind farm) at site O-1.3 is not deemed to meet the criteria of disturbance pursuant to section 44(1)(2) BNatSchG according to current knowledge.

However, at the time of the determination of the suitability of site O-1.3, the technical design of the concrete project in question has not been specified. In this respect, the individual approval procedure requires an update of the verification of fulfilment of disturbance criteria in accordance with section 44(1)(2) BNatSchG.

6.4 Bats

The suitability of site O-1.3 for offshore wind energy use must be assessed in relation to the species protection requirements for bats as outlined in section 44 in conjunction with Art. 12 of the Habitats Directive.

6.4.1 Section 44(1)(1) and (2) BNatSchG

In terms of species protection law, the same considerations apply in principle as those already set out in the assessment of avifauna. In accordance with Art. 12(1)(a) Habitats Directive, all intentional types of catching and killing of individuals taken from nature which belong to a species listed in Annex IV of the Habitats Directive, and therefore all bat species, are prohibited. In terms of collisions with high offshore structures, reference can be made to the guidance on the strict protection system for animal species of Community interest under the Habitats Directive, which, in II.3.6 recital 83, assumes that the killing of bats through collisions with wind turbines is a type of killing which requires constant monitoring according to Section 12 para. 4 Habitats Directive. There are no indications to suggest that additional conditions need to be considered pursuant to SectionArt. 12(1) Habitats Directive.

Even though bat migrations over the Baltic Sea have been documented in various ways, there is still no reliable information available on the migratory species, migration corridors, flight altitudes and migration concentrations. Results so far merely confirm that bats, especially long-distance migrants, migrate over the Baltic Sea. The individual registrations documented so far are technically insufficient to characterise bat migration activity in the vicinity of site O-1.3. There is currently insufficient data to identify significant impacts on bats or raise questions about the suitability of site O-1.3.

In addition, it can be assumed that any negative impacts of wind turbines on bats can be avoided using the same avoidance and mitigation measures as are planned to protect bird migrations.

Experiences and results from research projects or from wind farms already in operation will also be adequately considered in further procedures.

In its statements, the BfN regularly assumes that, based on the current level of knowledge, killing or injury (section 44(1)(1) BNatSchG) of other specially protected species, e.g. bats, by wind farms can be excluded. In addition, according to the BfN's statement, a realisation of the prohibited conditions under species protection law (section 44(1)(2) BNatSchG) for other strictly protected species is not expected based on current knowledge. The BSH concurs with the BfN's opinion.

According to current knowledge, the construction and operation of offshore wind turbines and ancillary installations (transformer station, cabling within the wind farm) at site O-1.3 are not expected to result in either killing and injury of bats in accordance with section 44(1)(1) BNatSchG or according to the ban on significant disturbance under species protection law pursuant to section 44(1)(2) BNatSchG.

7 Impact assessment

7.1 Legal basis

According to section 34 BNatSchG, it is necessary for plans or projects which, individually or in conjunction with other plans or projects, may significantly affect a Natura 2000 area and which do not directly serve the administration of the area, to carry out an assessment of their compatibility with the protection and conservation objectives of the Natura 2000 area. This also applies to projects outside the area which, either individually or in combination with other projects or plans, are likely to have a significant adverse effect on the conservation purpose of the areas. The Natura 2000 network comprises Sites of Community Importance (SCIs) under the Habitats Directive and Special Protection Areas (SPAs) under the Birds Directive. Insofar as these areas have been designated as conservation areas, the assessment refers to their compatibility with the protective purpose of these nature conservation areas, section 34(1)(2) BNatSchG.

The impact assessment has a narrower scope than the other SEAs, as it is limited to assessing compatibility with the conservation objectives specified for the conservation area, i.e. it is territorial in nature.

Within the framework of the present SEA, the compatibility of the development and operation of wind turbines at site O-1.3 with the protection purposes of the individual nature conservation areas is examined separately for each protected object and conservation area.

The impact assessment carried out here for site O-1.3 takes place at a higher level of the suitability assessment and does not replace the assessment at the level of the specific project with knowledge of the concrete project parameters, which is carried out in the context of planning approval procedures. To this extent, further avoidance and mitigation measures are to be expected if they are deemed necessary by the impact assessment within the framework of planning approval procedures in order to rule out any impairment of the conservation objectives of the Natura 2000 areas or the protection purposes of the conservation areas arising from use inside or outside a nature conservation area.

Compatibility within the framework of the suitability assessment has to be examined based on the previous assessments carried out for the nature conservation areas or Habitats Directive areas.

Prior to their designation as protected marine areas pursuant to sections 20(2) and 57 BNatSchG, the nature conservation areas in the EEZ were already covered by European law of 12 November 2017 due to their inclusion in the first updated list of Sites of Community Importance in the Atlantic biogeographic region pursuant to Article 4(2) of the Habitats Directive (Official Journal of the EU, 15 January 2008, L 12/1), so a habitat-related impact assessment was already carried out as part of the Spatial Offshore Grid Plan for the German EEZ in the Baltic Sea (BSH 2017). Most recently, an impact assessment in accordance with section 34(1) BNatSchG was carried out as part of the SEA for the Site Development Plan (BSH, 2019b).

In principle, the construction of artificial installations and structures in nature conservation areas is prohibited. Also pursuant to section 5(3(5)(a) WindSeeG, sites may not be located within a conservation area designated in accordance with section 57 BNatSchG; this has to be reviewed again in the course of the suitability assessment.

However, projects and plans must also be assessed as to their compatibility with the protective purpose of the respective ordinance even if they are located outside the conservation areas as so-called 'surrounding environment projects' (Landmann/Rohmer, section 34 BNatSchG, recital 10.) They are permitted if, in accordance with section 34(2) BNatSchG, they cannot lead to significant impairment of the elements of the nature conservation area relevant to the conservation purpose or meet the requirements in accordance with section 34(3) to (5) BNatSchG. The protection purposes result from the ordinances on conservation areas or other stipulations.

Based on the ordinance of 22.09.2017, the German EEZ of the Baltic Sea contains the designated nature conservation areas 'Bay of Pomerania – Rönnebank' (ordinance establishing the nature conservation area 'Bay of Pomerania – Rönnebank' of 22 September 2017, NSGPBRV, Federal Law Gazette I p. 3415), 'Fehmarnbelt' (ordinance establishing the nature conservation area 'Fehmarnbelt' of 22 September 2017, NSGFmbV, Federal Law Gazette I p. 3405), 'Kadetrinne' (ordinance establishing the nature conservation area 'Kadetrinne' of 22 September 2017, NSGFmbV, Federal Law Gazette I p. 3410, NSGKdrV).

The total area of the three nature conservation areas amounts to 2,472 km², with the nature conservation area 'Bay of Pomerania – Rönnebank' covering an area of 2,092 km², the nature conservation area 'Fehmarnbelt' covering an area of 280 km^2 and the nature conservation area 'Kadetrinne' covering an area of 100 km^2.

Protected objects are the habitat types 'reefs' and 'sandbanks' according to Annex I Habitats Directive, certain fish species (sturgeon, twait shad) and marine mammals (harbour porpoise, harbour seals and grey seals) according to Annex II Habitats Directive and various marine bird species according to Annex I of the Birds Directive (red-throated and black-throated loons, grebes) and regularly occurring migratory bird species (red-necked grebes, yellow-billed loons, long-tailed ducks, common scoters, velvet scoters, common gulls, common guillemots, razorbills, black guillemots).

7.2 Impact assessment with regard to habitat types

The protective purpose of the nature conservation areas Kadetrinne (section (3)(3)(1) NSGKdrV) and im 'Bay of Pomerania – Rönnebank' (section 4(1)(1) NSGPBRV) is to preserve or, where necessary, restore a favourable conservation status of the habitat type 'reef' (EU code 1170). The habitat types 'sandbank' is a protected object in the nature conservations areas 'Bay of Pomerania – Rönnebank' (section 5(1)(1) NSGPBRV) and 'Fehmarnbelt' (section 3(3)(1) NSGFmbV).

Since the shortest distance between site O-1.3 and a nature protection area, in this case the 'Bay of Pomerania – Rönnebank', is at least 8.3 km, construction-related, installation-related and operation-related impacts on the Habitats Directive habitat types 'reef' and 'sandbank' with their characteristic and vulnerable habitats and species can be excluded. The distance of site O-1.3 is far beyond the drift distances discussed in the specialist literature, so no release of turbidity, nutrients and pollutants is to be expected which could impair the nature conservation and Habitats Directive area components relevant to the conservation objectives or the protection purpose.

7.3 Impact assessment with regard to protected species

7.3.1 Protect marine bird species

7.3.1.1 Impact assessment for the use of offshore energy at site O-1.3 to assess compatibility with the nature conservation area 'Bay of Pomerania – Rönnebank'

Site O-1.3 is located near the nature conservation area 'Bay of Pomerania – Rönnebank' designated as such in the ordinance of 22.09.2017 (Federal Law Gazette I, I p. 3415).

According to the section 34(1) BNatSchG and section 9(1)(3) NSGPBRV, it must be determined whether the implementation of the plan would impair the conservation goals of sub-area IV of the nature conservation area.

The impact assessment is carried out in relation to the protective purpose for the area IV pursuant to section 7 NSGPBRV.

According to section 7(1) NSGPBRV, the protective purposes pursued for area IV include the conservation and, if necessary, the restoration of a favourable conservation status

- according to No. 1, of the species occurring in this area and listed in Annex I of the Directive 2009/147/EC, i.e. red-throated loons (*Gavia stellata*), black-throated loons (*Gavia arctica*), horned grebes (*Podiceps auritus*),
- according to No. 2, of the migratory bird species regularly occurring in this area, i.e. red-necked grebes (*Podiceps grisegena*), yellow-billed loons (*Gavia adamsii*), long-tailed ducks (*Clangula hyemalis*), common scoters (*Melanitta nigra*), velvet scoters (*Melanitta fusca*), common gulls (*Larus canus*), common guillemots (*Uria algae*), razorbills (*Alca torda*) and black guillemots (*Cepphus grylle*) and
- according to No. 3, of the function of this area as a feeding ground, overwintering site, moulting ground, transit and resting area for the mentioned species.

Pursuant to section 7(2) NSGPBRV, the protection of the habitats and the survival and reproduction of the bird species listed in clause 1 and of the area in its functions listed in clause 1, particularly require the conservation or, where necessary, the restoration

- according to No. 1, of the qualitative and quantitative populations of the bird species with the aim of achieving a favourable conservation status, taking into account natural population dynamics and the population development of their biogeographical population,
- according to No. 2, of the key foods of the bird species, especially the population densities, age class distributions and prevalence patterns of the organisms serving as food sources for the bird species,
- according to No. 3, of the characteristic features of the area, especially with regard to salinity, absence of ice even in harsh winters as well as geomorphological and hydromorphological characteristics alongside species-specific ecological functions and effects, and
- according to No. 4, of the natural quality of the habitats alongside their species-specific ecological functions, their cohesion and spatial reciprocal relationships as well as unhindered access to adjacent and neighbouring marine areas.

The FEP (2019) defines areas and sites for wind turbines and platforms. As part of the impact assessment for the Site Development Plan, possible effects of the plan were examined. The assessment revealed that the erection and operations of the offshore wind turbines and platforms did not involve any significant negative impacts on marine mammals etc. in area O-1.

The assessment there considers potential impacts from the construction and operations of offshore wind farms at site O-1.3 specifically and in conjunction with other existing wind turbines in the neighbouring offshore wind farms 'Wikinger' and 'Arkona Basin Southeast'.

As outlined above, site O-1.3 is located outside the known, important resting areas of the protected bird species (see chapter 2.8.3). Based on current knowledge, the erection and operations of offshore wind turbines are not expected to lead to a disruption of the resident and migratory marine bird species. Based on current knowledge and the findings of the monitoring for the offshore wind farms 'Wikinger' and 'Arkona Basin Southeast' in the investigation cluster 'Western Adlergrund', an impairment of the protective purposes of the area IV in the nature conservation area 'Bay of Pomerania – Rönnebank' can be excluded with the required certainty.

No significant impacts on bird species are expected from the laying and operations of the internal wind farm cabling at site O-1.3.

7.3.1.2 Result

Based on current knowledge, a significant impairment caused by the plan, either individually or together with other projects, of the protective purposes of the nature conservation area 'Bay of Pomerania – Rönnebank' with regard to the protected bird species can be excluded with certainty.

7.3.2 Protected marine mammals

7.3.2.1 Impact assessment for the use of offshore energy at site O-1.3 to assess compatibility with the nature conservation area 'Bay of Pomerania – Rönnebank'

According to the section 34(1) BNatSchG, it must be determined whether the implementation of the plan would impair the conservation goals or protective purposes of the nature conservation area.

The impacts of the plan are assessed in relation to the protected purpose of the conservation area 'Bay of Pomerania – Rönnebank'. The comprehensive protective purpose according to section 3(1) NSGPbrV is the realisation of the conservation goals of the Natura2000 areas through a permanent conservation of the marine area, the diversity of the habitats, communities and species relevant to these areas and the special individuality of this part of the Baltic Sea characterised by the Odra Bank, the Adlergrund, the Rönnebank and the slopes of the Arkona Basin.

According to section 3(2)(3) NSGPbrV, the conservation or, if necessary, the restoration of the specific ecological values and functions of the area, particularly relates to the populations of the harbour porpoise, grey seal and marine bird species as well as their habitats and natural population dynamics.

Finally, in sections 4(6) NSGPbrV, the ordinance outlines the goals to ensure the survival and reproduction of the marine mammal species listed in section 3(2) NSGPbrV as per Annex II Habitats Directive, i.e. the harbour porpoise and grey seal, and the conservation and restoration of their habitats.

In accordance with section 4(3), the protection of the harbour porpoise in area I particularly requires the conservation and, if necessary, the restoration

- of the natural population densities of this species with the aim of achieving a favourable conservation status, their natural spatial and temporal distribution, their health status and reproductive fitness, taking into account natural population dynamics, their natural genetic diversity within the local area population and opportunities for genetic exchange with populations outside the area,
- of the area as a habitat of the harbour porpoise which is largely free from disruptions and local contaminations,
- of cohesive habitats and the opportunity of the harbour porpoise to migrate within the central Baltic Sea and into the western Baltic Sea and the Belts, and
- of the key foods of the harbour porpoise, especially the natural population densities, age class distributions and prevalence patterns of the organisms serving as food sources for the harbour porpoise.

The same is set out in section 6(3) NSGPbrV for the harbour porpoise in area III of the protected area and in section 5(3) NSGPbrV.

According to section 5(1) NSGPbrV, the protective purpose of area II is to conserve or restore a favourable conservation status of the harbour porpoise and to conserve or restore a favourable conservation status of the grey seal.

In order to exclude significant impacts on marine mammals, strict noise control measures must be implemented. The determination of the suitability of site O-1.3 will include a number of specifications in this regard. In addition, the assessment under species protection law described noise control measures using the latest science and technology whose application excludes significant impacts on harbour porpoises according to current knowledge. Since 2008, the BSH imposes binding thresholds for impulse noise inputs resulting from pile-driving works. The BSH monitors compliance with these thresholds (160 dB sound event level (SEL05) re 1µPa2s and 190 dB re 1µPa at a distance of 750 m). Additional noise control measures, such as coordinating simultaneous pile-driving work, which could also contribute to a reduction of pollution in nature conservation areas, are set out in the impact assessment and adapted to the location-specific and project-specific features, ordered and strictly monitored in the individual BSH approval procedures.

According to current knowledge and the findings from the monitoring for the erection and operations of the offshore wind farms 'Wikinger' and 'Arkona Basin Southeast', an impairment of the protective purposes of area III of the nature conservation area 'Bay of Pomerania – Rönnebank' can be excluded with certainty. In addition, impairments resulting from the realisation of offshore wind energy use at site O-1.3 on the conservation goals of area II 'Adlergrund' and area I 'Western Rönnebank' in the nature conservation area 'Bay of Pomerania – Rönnebank' in relation to marine mammals can also be excluded with certainty.

7.3.2.2 Impact assessment for the use of offshore energy at site O-1.3 to assess compatibility with the protective purposes of the nature conservation areas 'Fehmarnbelt'

The comprehensive protective purpose according to section 3(1) NSGFmbV is the realisation of the conservation goals of the Natura2000 areas through a permanent conservation of the marine area, the diversity of the habitats, communities and species relevant to these areas and the special features of the sandbank, i.e. megaripples.

Protection according to clause 2 comprises

- the conservation and, if necessary, the restoration of the specific ecological values and functions of the area, especially its characteristic morphodynamics and hydrodynamics characterised by the water exchange between the North and Baltic Seas, natural or near-natural marine macrophyte populations and species-rich gravel, coarse sand and shell limestone floors,
- the populations of harbour porpoises, seals including their habitats and natural population dynamics, and
- its function as a link or stepping stone for the ecosystems of the western and central Baltic Sea;

According to section 3(3)(2) NSGFmbV, the pursued protective purposes particularly include the conservation and, if necessary, the restoration of a favourable conservation status of the species harbour porpoise and harbour seal.

The protection of the harbour porpoise and harbour seal according to section 3(5)

NSGFmbV particularly requires the conservation or restoration

- of the natural population densities of this species with the aim of achieving a favourable conservation status, their natural spatial and temporal distribution, their health status and reproductive fitness, taking into account natural population dynamics, their natural genetic diversity within the population and opportunities for genetic exchange with populations outside the area,
- of the area as a food and migration habitat of the harbour porpoise and harbour seal and a procreation and rearing ground for the harbour porpoise, which is as free from disruptions as possible and largely free from local contaminations,
- of cohesive habitats and the opportunity of the harbour porpoise and harbour seal to migrate within the Baltic Sea, especially into the adjacent and neighbouring nature conservation areas in Schleswig-Holstein and Mecklenburg-West Pomerania and to the resting grounds along the Danish coast (especially Rødsand) and the German coast, and
- of the key foods of the harbour porpoise and harbour seal, especially the natural population densities, age class distributions and prevalence patterns of the organisms serving as food sources for the harbour porpoise and harbour seal.

The site O-1.3 is located at a very great distance from the nature conservation area 'Fehmarnbelt'.

An impairment of the conservation goals of the nature conservation area 'Fehmarnbelt' with regard to marine mammals can be excluded with certainty.

7.3.2.3 Impact assessment for the use of offshore energy at site O-1.3 to assess compatibility with the protective purposes of the nature conservation areas 'Kadetrinne'

The comprehensive protective purpose according to section 3(1) NSGKdrV is the realisation of the conservation goals of the Natura2000 areas through a permanent conservation of the marine area, the diversity of the habitats, communities and species relevant to these areas and the special importance of the runnel system in this area for the water exchange between the North and Baltic Seas. Protection comprises

the conservation and, if necessary, the restoration of the specific ecological values and functions of the area, especially its characteristic morphodynamics and hydrodynamics characterised by the water exchange between the North and Baltic Seas, harbour porpoise populations including their habitat and natural population dynamics and its function as a link or stepping stone for the ecosystems of the western and central Baltic Sea.

According to section 3(3)(2) NSGKdrV, the pursued protective purposes include the conservation or restoration of a favourable conservation status of the harbour porpoise. In accordance with section 3(5) NSGKdrV, the protection of the harbour porpoise particularly requires the conservation and, if necessary, the restoration

- of the natural population densities of this species with the aim of achieving a favourable conservation status, their natural spatial and temporal distribution, their health status and reproductive fitness, taking into account natural population dynamics, their natural genetic diversity within the population and opportunities for genetic exchange with populations outside the area,
- of the area as a food and migration habitat and procreation and rearing ground for the harbour porpoise, which is as free from disruptions as possible and largely free from local contaminations,

- of contiguous habitats and the opportunity of the marine mammals to migrate within the central Baltic Sea and into the western Baltic Sea, and
- of the key food organisms of the harbour porpoise, especially their natural population densities, age class distributions and prevalence patterns.

The site O-1.3 is located at a very great distance from the nature conservation area 'Kadetrinne'. In addition, the results of the monitoring for the offshore wind farms 'EnBW Baltic2' confirm that no significant impacts for protected marine mammals are expected.

An impairment of the conservation goals of the nature conservation area 'Kadetrinne' with regard to marine mammals can thus be excluded with certainty.

7.3.3 Other species

According to section 6(1)(2) NSGPBRV, the pursued protective purposes of the nature conservation area 'Bay of Pomerania – Rönnebank' include the conservation and, if necessary, the restoration of a favourable conservation status of the sturgeon *(Acipenser oxyrhinchus)* and the twaite shad (*Alosa fallax*) as species listed in Annex II of the Habitats Directive.

The protection of the mentioned species according to section 6(3) NSGPBRV particularly requires the conservation or, if necessary, the restoration

- of the natural population densities of this species with the aim of achieving a favourable conservation status, their natural spatial and temporal distribution, their health status and reproductive fitness, taking into account natural population dynamics, their natural genetic diversity within the local area population and opportunities for genetic exchange with populations outside the area,
- of cohesive habitats and the opportunity of the mentioned species to migrate within the central Baltic Sea and into the western Baltic Sea and the Belts,
- of a high vitality of individuals and a species-typical age structure of the sturgeon and twaite shad populations as well as the natural food sources required for spatial and temporal prevalence patterns and population densities,
- of the functionality of the area as a migratory corridor and feeding ground for sturgeons.

Since the shortest distance between site O-1.3 and the nature protection area is at least 38 km, construction, installation and operations impacts on these species and their conservation status in the nature conservation area can generally be excluded.

7.4 Natura2000 areas outside the German EEZ

The impact assessment also takes into account long-distance effects of the present plan on the protected areas in the adjacent 12 nautical miles zone and in the adjacent waters of the neighbouring states. This also includes the assessment and consideration of functional relationships between the individual protected areas and the coherence of the protected area network according to section 56(2) BNatSchG because the habitats of some target species (e.g. avifauna, marine mammals) covers several protected areas due to their large cruising radius.

In detail, the following areas are taken into account: the bird protection area 'Western Bay of Pomerania', the Habitats Directive and bird protection area 'Plantagenetgrund', the Habitats Directive area 'Darss Sill', the bird protection area 'West Pomeranian Bodden and Northern Strelasund', and the Habitats Directive area 'Greifswalder Boddenrandschwelle and parts of the Bay of Pomerania' in the coastal waters of Mecklenburg-West Pomerania. The following areas in the adjacent areas of neighbouring states are taken into account: the Habitats Directive areas 'Adler Grund og Rønne Banke' and 'Klinteskov kalk-grund' in Danish waters, the Swedish Habitats Directive area 'Sydvästskånes utsjövatte', the Polish bird protection area 'Zatoka Pomorska' and the Polish Habitats Directive area 'Ostoja na Zatoce Pomorskiej'.

The protection and conservation goals of the Natura2000 areas outside the EEZ were taken from the following documents:

• Bird protection area 'Western Bay of Pomerania' (coastal waters M-V, DE1649 401): EUNIS factsheet (https://eunis.eea.europa.eu/sites/DE1649401)

• Habitats Directive and bird protection area 'Plantagenetgrund' (coastal waters M-V, DE 1343 301/ DE 1343 401): Habitat Directive area https://www.lung.mv-regierung.de/dateien/de_1343_301.pdf, bird protection area https://eunis.eea.europa.eu/sites/DE1343401

• Habitats Directive area 'Darss Sill' (coastal waters M-V, DE 1540 302): https://www.lung.mv-regierung.de/dateien/de_1540_302.pdf

• Bird protection area 'Western Pomeranian Bodden and Northern Strelasund“ (coastal waters M-V, DE 1542 401): EUNIS factsheet (https://eunis.eea.europa.eu/sites/DE1542401.

- Habitats Directive area 'Greifswalder Boddenrandschwelle and parts of the Bay of Pomerania' (coastal waters M-V, DE 1749-302): EUNIS factsheet (http://eunis.eea.europa.eu/sites/DE1749302)
- Danish Habitats Directive area 'Adler Grund og Rønne Banke' (DK 00VA 261): EUNIS factsheet (http://eunis.eea.europa.eu/sites/DK00VA261)
- Danish Habitats Directive area 'Klinteskov kalkgrund' (DK 00VA 306): EUNIS factsheet (http://eunis.eea.europa.eu/sites/DK00VA306)
- Swedish Habitats Directive area 'Sydvästskånes utsjövatte' (SE 0430187): EUNIS factsheet (https://eunis.eea.europa.eu/sites/SE0430187)
- Polish bird protection area 'Zatoka Pomorska' (PLB 990003): EUNIS factsheet (http://eunis.eea.europa.eu/sites/PLB990003)
- Polish Habitats Directive area 'Ostoja na Zatoce Pomorskiej' (PLH 990002): EUNIS factsheet (https://eunis.eea.europa.eu/sites/PLH990002).

In addition, the EU member states will take the necessary measures inside and outside protected areas according to Art. 12 Habitats Directive for species in Annex IV of the Habitats Directive, in order to introduce a strict protection system for the mentioned animal species in their natural distribution area. According to the Habitats Directive, this includes all cetaceans. The Habitats Directive areas are intended to preserve parts of their feeding grounds.

The present impact assessment investigates the impacts of the plan within the EEZ and the potential long-distance effects on the protected areas in the adjacent regions. Site O-1.3 is located at a sufficient distance from the protected areas in coastal waters so that no significant impacts on these protected areas are expected.

The results of the impact assessment for the present plan in relation to the protected marine mammals and protected bird species regarding compatibility with the conservation goals of the nature conservation area 'Bay of Pomerania – Rönnebank' apply accordingly to the nearest nature conservation area 'Greifswalder Boddenrandschwelle and parts of the Bay of Pomerania' in German coastal waters and the Habitats Directive area 'Adler Grund og Rønne Banke' in the Danish EEZ as well as the Habitats Directive area 'Ostoja na Zatoce Pomorskiej' in the Polish EEZ.

In conclusion, the present plan, either individually or together with other plans and projects, is not expected to impair the conservation and restoration goals of the above protected areas.

7.5 Results of the impact assessment

To conclude, a significant impairment of the protective purposes of the assessed nature conservation areas through the implementation of the plan, taking into account the avoidance and mitigation measures, can be excluded with the required certainty.

Based on the current level of knowledge, even if the plan is considered cumulatively together with existing projects, significant impairments of the Habitats Directive habitats 'reefs' and 'sandbanks which are slightly covered by sea water all the time', of the species 'harbour porpoise', 'grey seal' and 'harbour seal' and of the protected seabirds for the assessed nature conservation areas can also be excluded.

8 Overall plan evaluation

In summary, no significant impacts on the marine environment are expected from the erection and operation of offshore wind turbines, including the necessary installations. Significant impacts from the implementation of the plan can be avoided through strict compliance of the avoidance and mitigation measures, especially to reduce noise during the construction phase, prevent light emissions during construction and operations and avoid pollutant emissions.

The laying of the wind farm's internal cabling can be made as environmentally friendly as possible, for example by choosing a laying method that is as low-impact as possible. The requirement to meet the 2 K criterion is intended to ensure that significant negative impacts of cable heating on benthic communities are avoided. In addition, the avoidance of crossings between submarine cable systems as far as possible serves to avoid negative impacts on the marine environment, in particular on the protected objects of soil and benthos. Based on the above descriptions and evaluations, and on the current level of knowledge, it must also be recorded conclusively for the SEA that no significant impacts on the marine environment are expected within the investigated area from reciprocal effects resulting from the realisation of a project at site O-1.3. The potential impacts are often limited in space and mostly short-term, as they are limited to the construction phase.

There is insufficient scientific knowledge and uniform assessment methods for the cumulative assessment of the impacts on individual protected objects such as bat migration . Therefore, these impacts cannot be conclusively assessed within the framework of the present SEA or are subject to uncertainty and require more detailed examination.

9 Measures to prevent, reduce and compensate significant negative impacts on the marine environment

Pursuant to section 40(2) UVPG, the environmental report contains a description of the measures planned to prevent, reduce and, as far as possible, offset any significant adverse environmental impacts resulting from the implementation of the plan. While some avoidance, mitigation and compensation measures can already be implemented at the planning level, others only come into effect during the actual implementation phase

With regard to planning avoidance and mitigation measures, the FEP already sets out spatial and textual determinations which, in accordance with the environmental protection objectives set out there, serve to avoid or reduce significant negative impacts of the implementation of the FEP on the marine environment. The determinations of the FEP are taken into account within the scope of the suitability assessment. Concrete reference to the site also allows the measures here to be specified more extensively or additional measures to be specified. In the subsequent planning approval procedure, project-specific or site-specific measures are then added which relate to the concrete planning of the project.

Within the framework of the suitability assessment, measures in accordance with section 12(5)(2) Wind-SeeG may be included in the statutory ordinance for determining the suitability of the site as requirements for the subsequent project if the construction and operation of wind turbines at the site would otherwise be likely to impair the criteria and interests in accordance with section 10(2) WindSeeG.

The assessment of the suitability of the site with regard to a threat to the marine environment is based, among other things, on data from the baseline survey according to StUK.

In order to be able to take suitable measures to avoid collisions between migratory birds and wind turbines, in addition to the StUK requirements, the autumn and spring migrations must also be recorded. A concept of how suitable measures will be designed and implemented and how their success monitored must be submitted to the planning approval authority together with the planning approval application. The planning approval authority will order concrete, project-specific measures to sufficiently reduce bird collision risk. Where necessary, this can include switching off individual or all wind turbines for a time.

Measures must be taken to prevent risks to the marine environment from noise emissions, particularly during the construction of installations. These are intended to ensure that the work is carried out as quietly and briefly as possible, while complying with limits for sound pressure (SEL_{05}) and the peak sound pressure level. This principle, in particular compliance with maximum levels of 160 dB for the Sound Exposure Level (SEL_{05}) and 190 dB for the peak level at a distance of 750 m from the point of emission, can be established in the determination of suitability even without knowledge of the specific types of installations. When the types of installations and foundations to be used are known, the planning approval authority will subsequently issue specifications concerning, for example, maximum permissible time periods.

Project developers of offshore wind farm projects to be completed in parallel must coordinate their respective pile driving activities to avoid disturbances within the meaning of section 44(1)(2) BNatschG.

With the planning documents, the project developer must submit a concept for the planned measures for real compensation of unavoidable impairments in order to provide the planning approval authority with the necessary basis pursuant to section 15 BNatSchG to be able to decide on the admissibility of the notified impairment.

The necessary submarine cable systems must be designed and laid in such a way that the adverse effects on the marine environment caused by cable-induced sediment warming are reduced as far as possible. It must be ensured and demonstrated in the planning approval procedure that the sediment above the cable system at a depth of 20 cm below the seabed surface is not heated by more than two degrees (Kelvin). When the specific parameters are known, the planning approval authority subsequently orders the minimum covering to be created – possibly differentiated according to subsections. The procedure for laying submarine cable systems must be chosen in such a way that the minimum covering required is achieved with the least possible environmental impact.

In order to ensure that pollution of the marine environment is not a cause for concern, measures must be taken during the planning and implementation of installations to avoid or reduce material emissions during construction and operation. These must ensure that no emissions of pollutants, noise and light which are avoidable according to the state of the art enter the marine environment. Insofar as corresponding emissions are required and unavoidable due to the safety requirements of shipping and aviation, it must be ensured that these cause the minimum possible impairments. The least possible impairment has to be ensured, e.g. by the choice of the operating materials used, the structural safety systems, suitable monitoring measures as well as organisational and technical precautionary measures. This applies in particular to the areas of operating material change, refuelling, corrosion protection, waste water, drainage water, the diesel generators used and scour and cable protection.

10 Alternatives examined

Pursuant to Art. 5(1)(1) of the SEA Directive in combination with the criteria in Annex I of the SEA Directive and section 40(2)(8) UVPG, the environmental report contains a brief description of the reasons for the choice of the reasonable alternatives examined.

In principle, different types of alternatives are considered, in particular strategic, spatial or technical alternatives. The prerequisite is always that they are reasonable and given serious consideration. As such, it is not necessary to examine every conceivable alternative. However, it is no longer sufficient to identify, describe and evaluate only those alternatives that 'seriously present themselves' or even 'appear inevitable'. The obligation to investigate therefore extends to all alternatives that are 'not obviously (...) remote' (LANDMANN & ROHMER 2018). The assessment of alternatives does not explicitly require the development and assessment of particularly environmentally-friendly alternatives. Rather, the 'reasonable' alternatives in the above sense are to be presented in a comparative manner with regard to their environmental impacts, thereby clarifying the consideration of environmental concerns when deciding on the alternative to be pursued further (BALLA ET AL. 2009).

At the same time, the effort required to identify and assess the alternatives under consideration must be reasonable. Here, the following applies: the greater the anticipated environmental impacts and therefore the need for planning conflict management, the more extensive or detailed investigations are required.

Annex 4(2) UVPG gives examples of the examination of alternatives with regard to the design, technology, location, size and scope of the project, but explicitly refers only to projects. According to (HOPPE 2018), plan-related and programme-related alternative assessment is likely to be reduced to concept alternatives and site-related alternatives and not be concerned with installation-specific alternatives except in rare, exceptional cases. At the same time, according to Hoppe, attention has to be paid to whether alternative plan or programme concepts were already dealt with at a higher planning level in the sense of the synergy effects of tiering within the meaning of section 39(3) UVPG.

Within the framework of the upstream SEA on FEP 2019 (BSH 2019b), alternatives are already being examined. At this planning level these are mainly the conceptual/strategic design, the spatial location and technical alternatives.

The main focus of this assessment for the FEP is the consideration of alternatives for designating the sites required to meet the statutory expansion target for offshore wind energy: the sites are compared and defined based on nature conservation criteria. The site designated in the FEP represents the planning area for the suitability assessment following designation in the FEP. The scope of the later project is therefore already largely determined in the FEP, above all by the designation of the site and the capacity that is likely to be installed at the site.

This designation of sites for offshore wind energy in turn forms the starting point for the FEP's further determinations regarding the required grid connection systems. At the level of the suitability assessment in question, it is therefore neither necessary nor reasonable to examine alternative sites to the present planning area, the site designated by the FEP. Such an assessment would inevitably run counter to the FEP 'structure' consisting of the wind farm procedures and grid connections in operation or in concrete planning, and the synchronised designations of the FEP for wind energy sites and grid connection systems which build on these.

The assessment of alternative site locations would therefore not be suited to achieving the plan's objective of establishing the suitability assessment for the site under review in the order specified in the FEP for the invitation to tender (section 9(1)(1)(2) WindSeeG). The waiver of the assessment of spatial alternatives also corresponds to the 'synergy effects of tiering' as laid down in section 39(3) UVPG, which can significantly reduce the assessment of alternatives (HOPPE 2018). The assessment of alternatives within the framework of the SEA for the FEP procedure (published on 28.06.2019) appears sufficiently up-to-date and detailed for this purpose.

As part of the suitability assessment, therefore, only alternatives that relate specifically to the site under review according to the FEP determinations, in this case O-1.3, are to be considered in the sense of the tiering between the planning instruments. These can mainly be process alternatives, i.e. the (technical) design of the installations in detail (BALLA et al. 2009).

At the same time, the exact design of the installations to be erected on the site is not yet known at the time of the suitability assessment. Therefore, the examination of alternatives with regard to the concrete design of the subsequent project can only take place in the subsequent planning approval procedure. At this point, therefore, only those alternatives that relate to the respective site and can already be carried out without detailed knowledge of the concrete construction project are to be examined. Here, the issue is 'not alternatives for the entire plan, but variants for individual planning determinations or the type of implementation in question' (HOPPE 2018).

These must be distinguished from measures to prevent and reduce and offset significant adverse impacts of the plan on the marine environment. Only 're-planning measures which leads to a substantial change in the planning concept and thus to a new plan version (...) is the subject of the assessment of alternatives' (BALLA et al. 2009). The 're-planning measures' which do not lead to new plan variants is presented as measures for prevention and reduction in Chapter 0.

The remaining conceivable alternatives which have not already been conclusively dealt with in the FEP and which are not simply measures and are conceivable at the abstract level without knowledge of the specific project, therefore appear limited. As described, they are limited to process alternatives, i.e. the (technical) design of the installations in detail.

In view of this, the use of different installation concepts that differ in terms of their physical parameters appears to be an alternative that could be seriously considered. Due to the expected number of structures to be erected at the site and their effects on the marine environment, the variation of the installation parameters appears to be of particular importance with regard to wind turbines. In order to achieve the capacity of 300 MW at site O-1.3 as determined within the framework of the suitability assessment (section 12(4) WindSeeG) and to be determined by statutory ordinance (section 12(5)(1) WindSeeG), the project developer may use various turbines available on the market at the time of project planning. Based on 'comprehensive information gathering', the implementation of the project can be assessed based on model parameters for opposing concepts: on the one hand for implementation with small turbines with a correspondingly relatively low generation capacity and therefore in larger number or, on the other hand using large, powerful turbines and therefore a small number; see Chapter 1.5.5.4.

It also seems conceivable that alternatives could be considered with regard to the foundation of the buildings (wind turbine and transformer platform) even without knowledge of the specific project; see Chapter 10.2. Due to the fundamental design and environmental impacts of the choice of foundation type, the comparison of foundation options constitutes an alternative, not a mere measure to reduce or avoid marine environmental impacts. By contrast, the further technical design of the turbines such as the design of scour protection or corrosion protection are considered to be measures to avoid, reduce or compensate for environmental impacts and are described accordingly in Chapter 0.

A zero variant should only be considered in the context of the alternative assessment if it is 'reasonable', i.e. if it takes into account the objectives and geographical scope. In the present case, this zero option would mean that the area is not suitable for an invitation to tender. This presupposes that the impairment of the relevant criteria and issues are also a cause for concern if the suitability determination includes specifications for the subsequent project. This is not the case for site O-1.3, as corresponding impairments can be ruled out by specifications. The zero variant is therefore not a reasonable alternative and does not need to be assessed, as it would not be 'in line with the planning objectives' (HOPPE 2018).

The expected developments in the status of the environment in the event of non-implementation of the plan, i.e. without wind energy turbines being erected and operated at the site at sea, are described as a benchmark for the assessment of environmental impacts in Chapter 3.

The consideration of alternatives with regard to the wind farm's internal cabling does not appear to be appropriate, since there are no reasonable alternatives with regard to their technical design (largely standardised transmission voltages and cable systems) or laying (laying on the seabed is ruled out due to the lack of protection of the cable).

10.1 Turbine concept

Wind turbines with different parameters can be used in the implementation of the project. For the purpose of comparing alternatives and evaluating them, it seems to make sense to evaluate model wind farm plans that show the range of available or future wind turbines.

Corresponding model scenarios have already been introduced in (BSH 2019c). These two scenarios are also used in the present assessment, described in Chapter 1.5.5.4 and applied to site O-1.3.

The two alternative scenarios differ in particular with regard to the number of installations to be built to achieve the capacity to be installed (scenario 1 with 34 as compared to scenario 2 with 20 installations) as well as hub height and rotor diameter, from which the total height of the individual wind turbines is derived (about 225 m vs. 300 m).

The evaluation of these alternatives or scenarios is carried out in relation to the individual protected object in Chapter 4.

As a result, neither of the two scenarios can be considered clearly preferable due to their lower environmental impact. Rather, the assessment differs depending on the protected object. Scenario 2, for example, is more advantageous with regard to the protected objects of soil and benthos, since the smaller number of wind turbines and the scour protection associated with each installation means that scour protection is integrated in the form of exogenous hard substrate. For avifauna, on the other hand, the lower turbines of scenario 1 are expected to lead to slightly lower impairment.

10.2 Foundation

As described in Chapter 1.5.5.4, the foundation of the wind turbines and the transformer platform by means of pile foundations (monopile for the offshore wind turbines and jacket for the transformer station) is assumed for the present assessment. In principle, the use of other types of foundations is conceivable. In individual cases or for test purposes, other variants have already been implemented or planned in the German EEZ.

Conceivable alternatives for site O-1.3 would be turbine foundations using drilled piles or gravity foundations. By contrast, suction buckets or vibropiles would not be suitable for the site because these can only be used on sandy subsoil suitable for sluicing.

Only very limited information is available for the mentioned suitable foundation types. In particular, there is insufficient knowledge from monitoring comparable offshore installations. Based on current knowledge with regard to the concrete parameters and in particular with regard to the impacts on the various protected objects during construction and operation, the environmental impacts of these foundation types cannot be determined, described or evaluated. It is therefore not possible to consider these alternatives in detail because the necessary information cannot be determined with reasonable effort.]

Furthermore, the above-mentioned foundation variants are each suitable for different soil types and water depths, so the respective conditions of the site would also have to be taken into account when choosing the foundation. However, the evaluation of the soil with regard to its subsoil properties is not carried out within the scope of the suitability assessment; at best, the site investigation may reveal soil characteristics that are not suited or less suited to certain foundation technologies (DEUTSCHER BUNDESTAG 2016).

In order to assess whether one of the above-mentioned foundation methods is suitable for the specific site, other investigations would be necessary; these would have to be determined and evaluated on a case-by-case basis.

11 Planned measures to monitor the impact of the plan on the environment

The potential significant effects on the environment resulting from the implementation of the plan must be monitored pursuant to section 45 UVPG. This is to enable the early identification of unforeseen negative impacts and appropriate remedial actions to be implemented.

Accordingly, section 40(2)(9) UVPG requires the environmental report to specify the measures envisaged for monitoring the significant effects of the implementation of the plan on the environment. Monitoring is the responsibility of the BSH, since it is the competent authority for the SEA (see section 45(2) UVPG). As intended in section 45(5) UVPG, existing monitoring mechanisms can be used to avoid duplication of monitoring work.

With regard to the monitoring measures envisaged, it should be noted that the actual monitoring of the potential impact on the marine environment can only start when the plan is implemented, i.e. when the project is carried out at site O-1.3. However, the natural evolution of the marine environment, including climate change, must not be ignored when assessing the results of monitoring activities. Nonetheless, no general research may be carried out within the framework of monitoring. For this reason, project-related monitoring of the project's impacts on the area and its surroundings is of particular importance.

The essential task of monitoring this plan in interaction with the FEP and the individual planning approval procedures is to combine and evaluate the results from different phases of monitoring. The assessment also covers unforeseen significant impacts of implementing the plan on the marine environment as well as the review of the forecasts in the environmental report. Chapter 10 of the environmental report for the 2019 Site Development Plan for the German Baltic Sea (especially chapter 10.1 on the potential impacts of the areas and sites for offshore wind turbines) describes the planned procedure, measures to monitor the potential impacts of the plan and the required data (BSH-2019b).

In order to verify the forecasts of the present environmental report and the subsequent EIA within the framework of the planning approval and to enable any necessary adjustments to be made, construction and operation monitoring must be carried out with regard to the individual protected objects and possible hazards, such as collisions of migratory birds with the wind turbines. This is to be carried out according to the specifications of the StUK.

12 Non-technical summary

12.1 Subject and reason

According to section 12(4) in combination with section 10(2) WindSeeG, the BSH assesses the suitability of a site for the construction and operation of offshore wind turbines as a basis for the separate determination of suitability based on statutory ordinance issued by the BNetzA. The suitability assessment is to include an environmental assessment within the meaning of the Environmental Impact Assessment Act in the version of the announcement of 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) (Environmental Impact Assessment Act – UVPG), the so-called Strategic Environmental Assessment (SEA). The main document of the Strategic Environmental Assessment is this environmental report. It identifies, describes and assesses the likely significant environmental effects that the implementation of the plan, i.e. the construction and operation of an offshore wind farm at site O-1.3, will have on the environment and possible alternative planning options, taking into account the essential purposes of the plan.

The determination of suitability forms part of a planning cascade. It is preceded by the spatial offshore grid plans in the area of regional planning as a rough overall plan for all uses in the German EEZ and the FEP as an important control instrument for the orderly expansion of offshore wind energy. On the basis of the FEP, which designates areas and sites as well as locations, routes and route corridors for network connections, the sites are pre-examined by the BSH and assessed for their suitability.

If the impact assessment comes back with a positive result, the statutory ordinance is issued. This contains a general approval of suitability and of the capacity to be installed as well as specifications for the project at the given site if otherwise, the site would not be suitable due to the impacts on the marine environment and other matters to be examined.

The suitability determination in connection with the underlying suitability assessment has the character of a spatial offshore grid plan and as such forms the basis for the subsequent planning approval. If the suitability of a site is determined for the use of offshore wind energy, the site is put out to tender and the prevailing bidder may submit an application for approval (planning approval or plan authorisation) for the construction and operation of wind turbines on the site.

The SEA for the site in question is related to the environmental assessments of the upstream and downstream planning levels. Whereas in the upstream strategic environmental assessments of Maritime Spatial Planning and the FEP, the depth of the assessment of presumably significant environmental impacts was characterised by a wider scope of investigation and, in principle, a lower depth of investigation, and the focus of the assessment was on the evaluation of cumulative impacts and the examination of spatial alternatives, the SEA for the suitability assessment examines the impacts on the marine environment caused by an offshore wind farm project at the specific site. In addition, the results of the state site investigation are to be used for the suitability assessment, which means that the depth of the assessment is greater than in the previous plans.

The suitability assessment as well as the implementation of the SEA as a basis for the determination by statutory ordinance are carried out with due regard to the objectives of environmental protection. These provide information on the environmental status that is to be achieved in the future (environmental quality objectives). The objectives of environmental protection can be derived from an overall view of the international, EU and national conventions or regulations on the basis of which the Federal Republic of Germany has committed itself to certain principles and undertaken to achieve objectives.

12.2 Strategic Environmental Assessment methodology

In the present environmental report, the methodology of the SEA of the Spatial Offshore Grid Plan (BFO) and the FEP is taken as a basis, built on and further developed with regard to the determinations made in the suitability assessment.

The main purpose of this SEA is to identify, describe and assess whether the construction and operation of an offshore wind farm at the site can have a significant impact on the protected objects concerned. Where impacts were to be expected, it would further be assessed whether these could be offset by specifications and whether these specifications would not in themselves constitute a significant impairment. Although some of these specifications serve, among other things, to reduce environmental impacts, they may in turn result in impacts themselves, so an evaluation is required.

The assessment of likely significant environmental effects includes secondary, cumulative, synergistic, short, medium and long-term, permanent and temporary, positive and negative impacts on the protected object. The basis for assessing potential impacts is a detailed description and assessment of the environmental status. The SEA is carried out based on the results of the SUP-FEP North Sea (BSH 2019) for the following protected objects:

- Soil/ground
- Water
- Benthos
- Biotope types
- Fish
- Marine mammals
- Avifauna
- Bats
- Air
- Biological diversity
- Climate
- Landscape
- Cultural heritage and other tangible assets
- Human beings, in particular human health
- Interactions between protected objects

The description and assessment of the probable significant environmental impacts is carried out in relation to the protected area. All plan elements that could potentially have significant environmental impacts are examined.

The effects of construction and dismantling as well as those relating to the installations themselves and their operation. In addition, impacts that may arise in the course of maintenance and repair work are taken into account. This is followed by a presentation of potential interactions, a consideration of potential cumulative impacts and potential transboundary impacts.

An assessment of the impacts is carried out based on the status description and status assessment, and the function and significance of the respective area for the individual protected objects. The prognosis is based on the criteria of intensity, range and duration of the effects.

Within the framework of the impact forecast, certain parameters are assumed for the SEA with regard to the protected objects. In order to illustrate the range of possible (realistic) developments, the assessment is essentially based on two scenarios. Scenario 1 assumes a large number of small installations, scenario 2 a small number of large installations, each with different parameters, such as the number of turbines, hub height, height of the lower rotor tip, rotor diameter, overall height, diameter of foundation types and scour protection. The range covered in this way enables the most comprehensive possible description and assessment of the current state of planning with regard to the protected objects.

12.3 Assessment in relation to the individual protected objects

12.3.1 Soil/ground

The surface sediments at site O-1.3 show a homogeneous sediment composition and a structureless seabed. This is typical basin sediment as can be found in this or a similar form in nearly all basins of the Baltic Sea.

Wind turbines have a locally limited environmental impact with regard to soil as a protected object. The sediment is only permanently affected in the immediate vicinity by the insertion of foundation elements and the resulting space usage.

As a result of the construction of wind turbines, sediments are briefly stirred up and turbidity plumes are formed. The extent of resuspension depends mainly on the fine grain content of the soil. In the areas with a lower proportion of fine grains, most of the released sediment will settle relatively quickly directly in the area of the intervention or in its immediate vicinity. The suspension content decreases to natural background levels due to dilution effects and sedimentation of the stirred up sediment particles. However, the impairments to be expected in areas with a higher proportion of fine grain and the associated increased turbidity remain limited to a small area due to the limited current near the ground.

From an operation-related perspective, the interaction of foundation and hydrodynamics in the immediate vicinity of the installation may lead to a permanent turbulence and rearrangement of sediments. Based on previous experience in the North Sea, current-related permanent sediment shift can only be expected in the immediate vicinity of the wind turbines. Such experience is currently not available for the Baltic Sea. However, given the low near-soil current speeds in the area of the turbines, only local scouring is expected. Due to the predicted spatially limited extent of scouring, no significant substrate changes are to be expected.

When laying the wind farm's internal cabling, the turbidity of the water column increases due to sediment turbulence. The extent of the resuspension depends mainly on the laying method and the fine grain content of the soil. In the areas with a lower proportion of fine grains, most of the released sediment will settle relatively quickly directly at the construction site or in its immediate vicinity. The suspension content decreases to natural background levels due to dilution effects and sedimentation of the stirred up sediment particles. The expected adverse effects of increased turbidity remain locally limited within a small area.

In areas with softer sediments and correspondingly higher small particle contents, the released sediment is likely to settle a lot more slowly. Since near-ground currents are relatively low, however, it can be assumed that the turbidity plumes occurring in this area will also have a predominantly local effect and that the sediment will settle relatively nearby. A substantial change in the sediment composition is not expected.

In the short term, pollutants and nutrients can be released from the sediment into the bottom water. The possible release of pollutants from the sandy sediment is negligible due to the low fine-grain content (silt and clay) and low heavy metal concentrations. In the area of soft, silty and clayey marine floors, this can lead to a significant release of pollutants from the sediment into the soil waters. The pollutants normally attach themselves to sinking particles which, given the low currents in the Baltic Sea basin, rarely drift across larger distances and tend to remain in their original environment. In the medium term, this remobilised material again settles in the muddy basin.

Impacts 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 the small size of the area.

12.3.2 Water

The Baltic Sea is an intracontinental sea. The Baltic Sea is linked to the Kattegat via the Little Belt, the Great Belt and the Øresund. This provides a link to the North Sea and the Atlantic via the Skagerrak. The water circulation of the Baltic Sea is characterised by the inflow of freshwater from rivers and the exchange of water masses with the North Sea. Given the low water depths of the straits, only a small amount of water is exchanged with the North Sea, resulting in the low salt content of the Baltic Sea (brackish sea).

Given the morphological features of the Baltic Sea, an – in part quite pronounced – vertical salinity and temperature layering can form which cannot be broken open by the predominantly wind-driven water currents and minimal tides (< 10 cm).

Impacts on the water body can occur during the construction phase of the wind turbines and the cabling within the wind farm through sediment resuspension, pollutant discharge and the formation of turbidity plumes. From an operation-related perspective, an increase in turbidity due to scouring around the foundations cannot be ruled out. Based on current knowledge, substance emissions are not expected to cause any significant impacts on the protected object 'water'. Generally speaking, substance emissions into the body of water must be largely avoided. Therefore, the specific approval procedure must consider e.g. substance emissions in detail. All relevant emissions routes must be presented in an emissions study and all technical alternatives, including avoidance and mitigation measures, must be reviewed. Taking into account the technical environment documents to be submitted as part of individual approval procedure, the results of the emissions study must be comprehensively evaluated in relation to the potential impacts on possibly affected protected objects.

12.3.3 Biotope types

Possible impacts of wind turbines and internal wind farm cabling on the protected object 'biotope types' can result from a direct use of the protected biotopes, possible coverage by sedimentation from material released during construction as well as from potential changes to the habitat. The standard surveys did not reveal indicators of legally protected biotopes. However, further evaluations going beyond the BfN mapping guidelines detected prominent objects that must be taken into account when planning the routes and locations. If, contrary to the results of the previous video surveys, marine boulders or stone fields are found, these would have to be taken into account in the planning in accordance with § 35 1st WindSeeV and buffered in accordance with the specifications of the mapping guidelines and the area would have to be excluded from construction. The standard surveys did not reveal indicators of legally protected biotopes. However, further evaluations going beyond the BfN mapping guidelines detected prominent objects that must be taken into account when planning the routes and locations. If, contrary to the results of the previous video surveys, marine boulders or stone fields are found, these would have to be taken into account in the planning in accordance with § 35 1st WindSeeV and buffered in accordance with the specifications of the

mapping guidelines and the area would have to be excluded from construction.

Given the predominant sediment types in the areas in which protected biotope types occur, impairments of biotope types not subject to section 30 BNatSchG as a result of being covered are likely to be small-scale because the released sediment is quickly re-deposited. In light of the prevailing low near-ground currents, turbidity plumes which significantly exceed the natural maxima of suspended sediments are only expected up to a distance of approx. 500 m, even in areas with soft sediments. The released material remains in the water column for long enough to spread over a large area so that traceable masses of deposited material are not expected given the comparatively low volumes. Simulations show that the released sediment has been re-deposited after max. 12 hours. Therefore, based on current knowledge, impairments will normally remain small-scale and temporary.

Permanent habitat changes are limited to the immediate area of the foundations and of rock fillings which are required when laying cables on the sea floor and for cable crossings. The stone fills constitute a permanent, exogenous hard substrate. This provides new habitats for benthic organisms and can lead to a change in the species composition. These small areas are not expected to have any significant impacts on the protected biotope types. In addition, the risk of negative impacts on the benthic soft soil community by non-native species is low, as recruitment of the species is very likely to take place from natural hard substrate habitats.

12.3.4 Benthos

The number of species present at site O-1.3 must be classed as average. The benthos communities are also typical for the EEZ of the Baltic Sea and largely display no special features. Based on recent investigations, the macrozoobenthos at site O-1.3 must also be classed as average based on the number of red list species which have been shown to occur. The species inventory found and the number of Red List species indicate an average importance of site O-1.3 for benthic organisms.

The deep foundations of wind turbines are a short-term, small-scale disruption to the sea floor, create sediment swirls and lead to the formation of turbidity plumes. The resuspension of sediment and the subsequent sedimentation can impair or harm the benthos in the immediate vicinity of the foundations for the duration of construction activities. However, these impairments are expected to only have small-scale effects and be limited in time. Depending on the installation, changes in species composition may occur due to local area sealing and the insertion of hard substrates in the immediate vicinity of the structures. Since the settlement of artificial hard substrates involves an accumulation of organic material, local anoxia can occur as a result of biological decomposition processes.

The laying of internal wind farm cabling is also only expected to lead to small-scale disruptions to the benthos as a result of sediment swirls and turbidity plumes in the area of the cable routes. Potential impacts on the benthos depends on the laying method used and on the geological and hydrographic conditions. With comparatively low-impact laying by means of the burying method, only minor disturbances of the benthos in the area of the cable route are to be expected. Local sediment shifts turbidity plumes are to be expected during the laying of the internal cabling. In more cohesive soils, the cable systems are milled into the ground or laid using a heavy plough. This method also involves significant disruptions to the sediment and benthos faun as well as sediment swirls.

In areas containing a low proportion of fine grain, most of the released sediment will settle relatively quickly in the immediate vicinity of the cable route. In areas with soft sediments and correspondingly high fine grain content, the near-ground disruptions are relatively low so that only temporary, local effects are expected for these areas. In the short term, pollutants and nutrients can be released from the sediment into the bottom water. The pollutants normally attach themselves to sinking particles which, given the low currents in the Baltic Sea basin, rarely drift across larger distances and tend to remain in their original environment. In the medium term, this remobilised material again settles in the muddy basin.

Where rock filling is needed for cable crossings or locally when laying cable sections on the sea floor, benthic habitats will be covered. The resulting habitat loss is permanent but limited to a small area. An exogenous hard substrate is created, which can cause changes in the species composition on a small scale.

From an operation-related perspective, a warming of the uppermost sediment layer of the seabed can occur directly above the cable system which can result in impairments of the benthic communities.

Based on current knowledge, if the 2 K criterion is observed, internal wind farm cabling is not expected to have any significant impacts on the protected object 'benthos'. Only very small-scale areas outside the protected areas will be used. Given the usually fast regenerative capacity of the populations of benthos organisms in the German Baltic Sea, their short generation cycles and their large-scale distribution, rapid recolonisation is highly likely.

12.3.5 Fish

A total of 20 species of the protected object 'fish' have been recorded at site O-1.3. The fish community in the area of site 'O-1.3' has a species composition which is typical for the Arkona Sea. It is dominated by cod, flounder and plaice. According to current knowledge, the site is not a preferred habitat for any of the protected fish species. As a result, the fish population in the planning area of site O-1.3 is not of outstanding ecological significance as compared to neighbouring marine areas. According to current knowledge, the planned construction of a wind farm and the associated transformer platform and internal wind farm cabling is not expected to significantly impair the protected object of fish. The impact of the construction of the wind farm on the fish fauna is limited in space and time. During the construction phase of the wind turbines and the laying of the submarine cables, the fish fauna may be temporarily impaired in small areas by sediment turbulence and the formation of turbidity plumes. Due to the prevailing sediment and current conditions, the turbidity of the water is expected to decrease rapidly. Moreover, fish fauna is adapted to natural sediment swirls. Furthermore, during the construction phase, noise and vibrations may cause fish to temporarily escape. Noise emissions are minimised by means of reduction measures such as aversion and bubble curtains. Further local impacts on fish fauna may result from the additional hard substrates inserted due to habitat alteration. The fish community will lose part of their habitat through the installation of the wind farm. Benthic invertebrates settle on the added structures and provide food for the fish. In addition, the fish community might benefit from the freedom from fishing and accumulate at site O-1.3 as a retreat area. Irrespective of the wind farm scenario, the installation of a wind farm does not have any significant adverse effects on the fish fauna. In the long term, the first scenario might offer an advantage to the fish community due to the lower level of space usage and the larger number of wind turbines.

12.3.6 Marine mammals

Like the entire western Baltic Sea, site O-1.3 in the EEZ in the Baltic Sea forms part of the habitat of the porpoises. Based on the current level of knowledge, harbour porpoises use this area and its surrounding areas as transit areas. There are currently no indications that site O-1.3 has any particular function as a feeding ground or rearing area for porpoises. Harbour seals and grey seals only use site O-1.3 and its surrounding area as a transit area. Based on the findings of the monitoring conducted for the Natura2000 areas and the investigations for offshore wind farms, a medium to seasonally high importance of site O-1.3 for harbour porpoises can be deduced. The seasonally high importance of the site results from its possible use by individually of the separate and endangered Baltic Sea population of the harbour porpoise during the winter months. This site does not play any special role for harbour seals and grey seals.

Hazards to marine mammals can result from noise emissions during the installation of the foundations of offshore wind turbines and transformer stations. Without the use of noise-reducing measures, significant disturbance to marine mammals during pile driving cannot be ruled out. The pile driving will therefore only be permitted in the specific approval procedure if effective noise reduction measures are applied. The draft suitability approval will contain specifications in this regard.

In accordance with the requirements of the plan, the foundations may only be installed if strict noise reduction measures are observed. In the concrete approval procedure, extensive noise reduction measures and monitoring measures will be ordered to comply with applicable noise control limits (sound exposure level – SEL) of 160 dB re 1µPa and peak levels of 190 dB re 1µPa at a distance of 750 m around the pile driving or placement site). Suitable measures must be taken to ensure that no marine mammals are present in the vicinity of the pile driving site. According to current knowledge, significant impacts on marine mammals from the operation of offshore wind turbines can be ruled out.

The fact that the erection of offshore wind turbines is not permitted in Natura2000 areas contributes to a reduced risk to harbour porpoises in important feeding and rearing grounds. Based on current knowledge, the erection and operation of turbines is not expected to cause significant adverse impacts on marine mammals. The laying and operation of marine cable systems are also no expected to cause significant impacts on marine mammals.

12.3.7 Seabirds and resting birds

All findings to date indicate that site O-1.3 is of medium importance for seabirds and resting birds. All in all, site O-1.3 and its environment reveal an average seabird population and also an average population of species that are endangered and require protection. This area of the EEZ does not form part of the principal resting, feeding and overwintering habitats of the species listed in Annex I of the Birds Directive or of the species requiring special protection from the nature conservation area 'Bay of Pomerania – Rönnebank'. The environment of site O-1.3 is not important for breeding birds due to its distance from the coast. Given its water depth, it is also not an important feeding ground for diving marine ducks.

During the construction phase, only local impacts lasting a limited time are expected. Due to the high mobility of the birds, significant impacts can be ruled out with the necessary certainty.

During the operations phase, erected wind turbines can constitute an obstacle in the air or result in the wind farm area being avoided by specific species. The surrounding area of site O-1.3 is not one of the important feeding or resting habitats for the identified seabirds species in the Baltic Sea. The preferred areas of seabirds are located further south in the Bay of Pomerania or to the east of site O-1.3. Given that the site is only of medium importance for the protected object 'seabirds and resting birds', significant impacts during the operations phase of a wind farm at site O-1.3 can be excluded with the required certainty.

12.3.8 Migratory birds

All in all, site O-1.3 and its surrounding area are of medium to, at times, high importance for bird migrations both concerning specific species and species groups and under certain migration conditions.

The potential impact of an offshore wind farm at site O-1.3 in the operational phase may be that it will create a barrier to migrating birds or pose a risk of collision. In past investigations, some species or species groups have been observed to display large-scale avoidance behaviour or generally low flight altitudes below the rotor range so that significant impacts on these species can be excluded with the required certainty. Based on the current level of knowledge, cranes are at increased risk of collision with the wind turbines in scenarios 1 and 2 due to their flight behaviour and the observed flight altitude distribution. Taking into account the present findings regarding cranes, suitable measures to reduce collision risk must be taken in order to closely observe migratory events and in this way identify situations involving increased migratory events in good time and be able to take effective measures to reduce the collision risk for cranes in these situations.

Based on current knowledge, no significant impacts on migratory birds are expected during the construction phase as a result of temporary installation work. Scaring effects resulting from construction work are local and do not go beyond the disruptions normally connected with slow shipping movement, however. The laying and operations of internal wind farm cabling are also not expected to have significant impacts.

12.3.9 Bats

Even though bat migrations over the Baltic Sea have been documented in various ways, there is still no reliable information available on the migratory species, migration corridors, flight altitudes and migration concentrations. Results so far merely confirm that bats, especially long-distance migrants, fly over the Baltic Sea. Since only individual occurrences have been detected, there is currently an insufficient basis for describing and evaluating potential bat activities in the vicinity of site O-1.3 .

To date, no verifiable findings exist for bat migrations and the potential impacts of offshore structures, specifically wind turbines, on bats. There is currently insufficient data to identify significant impacts on bats or raise questions about the suitability of site O-1.3. In addition, it can be assumed that any negative impacts on bats can be avoided using the same avoidance and mitigation measures as are used to protect bird migrations.

A consideration of the cumulative impacts is currently not possible due to the lack of sufficient verifiable data.

12.3.10 Air

The construction and operation of wind turbines and the laying of internal wind farm cabling do not have any measurable impacts on air quality.

12.3.11 Biological diversity

Biodiversity means the variability between habitats and habitat communities, the variability between species and the genetic variability within species (Section 2 Convention on Biological Diversity 1992). Public focus is on the diversity of species.

Regarding the current status of biological diversity in the Baltic Sea, countless evidence points to the changes to biodiversity and species communities 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. Red lists of endangered animal and plant species have an important monitoring and warning function in this context, as they show the status of the populations of species and biotopes in a region. Potential impacts on biodiversity are presented in the environmental report in relation to the individual protected objects. To summarise, based on current knowledge, site O-1.3 is not expected to have any significant impacts on biodiversity.

12.3.12 Climate

Negative impacts on the climate from the construction and operation of wind turbines and the internal cabling of the wind farm are not expected, as there are no measurable climate-related emissions during construction or operation.

12.3.13 Landscape

The realisation of offshore wind farms has an impact on the landscape, as it is altered by the erection of vertical structures and safety lighting. The extent of these visual impairments of the landscape due to the planned offshore installations depends very much on the respective visibility conditions.

Given the large distance to the nearest coast (> 30 km), the development of the landscape will not be influenced significantly by the implementation of the construction project at site O-1.3, not least because the present site is situated to the north of two existing offshore wind farms.

12.3.14 Cultural heritage and other material assets

There are no indications of possible material assets or cultural heritage (e.g. wrecks or settlement remains) in the area around site O-1.3. Under this condition, no significant impacts on the protected object of cultural heritage and other material assets are to be expected at site O-1.3.

12.3.15 Protected object 'humans including human health'

On the whole, site O-1.3 is of low importance for human health and well-being. Humans are not directly impacted by the plan. It is occasionally used directly for recreation and leisure by pleasure craft and tourist vessels. A special significance of site O-1.3 for human health and well-being cannot be deduced.

12.3.16 Interactions/cumulative impacts

In general, impacts on a protected object lead to various consequences and interactions between the protected objects. The essential interdependence of the biotic protected objects is based on food chains. Possible interdependencies during the construction phase result from sediment rearrangements and turbidity plumes as well as noise emissions. However, these interactions occur only very briefly and are limited to a few days or weeks.

Installation-related interactions, e.g. through the insertion of hard substrate, are permanent but only to be expected on local basis. This could lead to a small-scale change in the food supply. Furthermore, site O-1.3 is not of special importance as a feeding ground for the protected objects on the higher ranks of the food web.

Due to the variability of the habitat, interactions can only be described in a very imprecise manner overall. In principle, it can be stated that, according to current knowledge, no interactions are discernible which could result in a threat to the marine environment.

Cumulative impacts arise from the interaction between various independent individual effects, which either add up as a result of their interaction (cumulative impacts) or reinforce each other, thereby producing more than the sum of their individual effects (synergetic effects). Both cumulative impacts and synergistic effects can be caused by coincidence in time and space of the impacts of the same or different projects.

12.3.16.1 Soil, benthos and biotope types

A substantial proportion of the environmental impacts caused by the development of the site, construction of the transformer platform and the wind farm's internal submarine cable systems on the soil, benthos and biotopes will take place exclusively during the construction period (formation of turbidity plumes, sediment shift, etc.) and in a spatially narrowly defined area. Possible cumulative impacts on the seabed, which could also have a direct impact on benthos and specially protected biotopes, result from the permanent direct space usage by the foundations of the wind turbines and platforms, and from the cable systems laid. The individual impacts are essentially limited to a small area and are local in nature.

A rough calculation based on the model wind farm scenarios is carried out to estimate the direct use of the site. The calculated space usage is based on ecological aspects, i.e. the calculation is based on the direct ecological loss of function or the possible structural change in the area caused by the installation of foundations and cable systems. However, in the area of the cable trench, the impairment of the sediment and benthos organisms is likely to be largely temporary. In the case of crossing particularly sensitive biotope types such as reefs or species-rich gravel, coarse sand and shell layers, permanent impairment would have to be assumed.

Based on the allocated capacity of 300 MW for site O-1.3 and an assumed capacity per installation of 9 MW (model wind farm scenario 1) or 15 MW (model wind farm scenario 2), the calculated number of installations for the area is between 34 (scenario 1) and 20 (scenario 2).

If we use the model wind farm parameters as a basis, and include the assumed scour protection, this results in a sealed area of the size of 48,280 m² (scenario 1) or 56,600 m² (scenario 2). Compared to the total area of site O-1.3 of approx. 25 km², the model wind farm scenarios result in calculated area sealing of between 0.19% (scenario 1) and 0.23% (scenario 2).

The functional loss caused by internal wind farm cabling is calculated based on the assigned capacity and assuming a cable trench with a 1 m width. On the basis of this conservative estimate, site O-1.3 is temporarily impaired by approx. 36 km of cabling within the wind farm, which corresponds to a temporary space usage of 0.14% of the total area of O-1.3.

Even the sum of area sealing and temporary space usage results in a conservatively estimated impairment in the order of magnitude of well below 1% of the total area of site O-1.3. Therefore, according to current knowledge, no significant, including cumulative, impacts are expected which could endanger the marine environment in relation to the sea floor and benthos.

12.3.16.2 Marine mammals

Cumulative impacts on marine mammals, in particular harbour porpoises, may occur mainly due to noise exposure during the pile driving work for the foundations. For example, these protected objects could be significantly impaired if situations occur where pile-driving takes place simultaneously at different sites in the EEZ, not leaving enough space to evade the noise and withdraw. So far, insufficient experience is available regarding temporal and spatial overlaps during the propagation of pile-driving noise.

However, the illustrations for the plan indicate that the individual offshore wind farms and network connection systems will be built in steps, meaning progressively over the coming years rather than simultaneously.

12.3.16.3 Marine birds

Vertical structures like platforms or offshore wind turbines can have different impacts on resting birds, such as habitat loss, increased collision risk or a disruptive or barrier effect. For resting birds, habitat loss through the realisation of several structures can be particularly important.

For resting birds, habitat loss due to cumulative impacts of several structures or offshore wind farms can be particularly significant. In order to assess the significance of cumulative impacts on seabirds, any effects must be assessed on a species-specific basis. In particular, species listed in Annex I of the Birds Directive, species in sub-area IV of the nature conservation area 'Bay of Pomerania' – Rönnebank' and species for which avoidance behaviour towards structures has already been established must be considered with regard to cumulative impacts. For the vicinity of site O-1.3, chapter 4.13.4 more closely examined the species groups loons, marine ducks and auks.

Based on the present findings for the project and the distribution of those marine bird species for which avoidance behaviour in relation to offshore wind farms has been documented in research and monitoring, the BSH comes to the conclusion that site O-1.3 and its surrounding area are only of subordinate importance for the marine bird populations under investigation in the German Baltic Sea regions. The present site and the neighbouring, already realised wind farm projects are located outside the main distribution areas of the Bay of Pomerania and only on the margins of larger-scale resting areas. Owing to the fact that an offshore wind farm has already been erected at the site N-3.7, cumulative impacts with already realised projects in the immediate vicinity of site O-1.3 as well as further activities relating to the construction of a wind farm, can be excluded with the required certainty.

12.3.16.4 Migratory birds

The risk potential for bird migrations not only results from the impacts of the individual project due to collisions or the negative effects of forced changes to the flight routes, but also applies cumulatively in conjunction with other approved or already erected wind farm projects in the vicinity of site O-1.3. An assessment of the potential cumulative impacts of already realised or future wind farms on the sites identified on the Site Development Plan (SDP) was already carried out as part of the SEA for the SDP (BSH 2019b).

The wind turbines of the wind farms 'Wikinger' and 'Arkona' situated to the south are approx. 59 m or up to 135 m lower than the turbines in scenarios 1 and 2. This creates a step effect where, coming from the south, lower turbines in the south of area O-1 are followed by larger turbines in the north. Depending on the turbine scenario (1 or 2), the visibility of the taller turbines could be limited to the turning rotors. This is particularly true of the smaller turbines in scenario 1. In scenario 2, at a hub height of 175 m, it can be assumed that the massive nacelles will also be visible.

The collision risk for the majority of the diurnally migrating species is generally considered to be low as these use visual orientation. In addition, waterbirds migrating during the day are generally able to land on water and continue their flight at a later time. Moreover, some species groups tend to prefer lower flight altitudes of up to 20 m or display large-scale avoidance behaviour (chapter 4.8.1). During nocturnal songbird migrations, sudden mist and rain combined with especially intense migratory activity (so-called mass migrations) can constitute a potential risk situation. At up to 100 km, the migratory route across the Baltic Sea is relatively short. If we take the air speed of the especially numerous thrush species participating in nocturnal migrations as a basis (between 35 and 50 km/h depending on the species) (BRUDERER & BOLDT 2001), these gives us migration times over the Baltic Sea of approx. two to three hours. In light of these short migration times, the probability of unfavourable weather situations coinciding with so-called mass migration events is considered to be low. Findings from the monitoring of offshore wind farms confirm this assumption (chapter 4.8.1).

Based on the current level of knowledge, cranes are at increased risk of collision with the wind turbines in scenarios 1 and 2 due to their flight behaviour and the observed flight altitude distribution. Initial findings indicate that cranes appear to react to the smaller wind turbines already in place in the area O-1 by adjusting their flight altitude (chapter 3.1.1). During spring migrations, the described step effect could occur on the way from Rügen to Schonen, while in the autumn, cranes would encounter the larger turbines in scenarios 1 and 2 first. Taking into account the present findings, suitable measures for cranes must be taken at site O-1.3 in order to closely observe migratory events and in this way identify situations involving increased migratory events in good time and be able to take effective measures to reduce the collision risk for cranes in these situations. Based on the current level of knowledge, these measures also contribute to reducing the cumulative collision risk in the area O-1. To summarise, if this requirement is implemented, the plan is not expected to result in any significant cumulative impacts.

A more detailed cumulative analysis in relation to the barrier effects was already implemented as part of the SEA for the Site Development Plan (BSH 2019b). Where the birds travel around the projects examined cumulatively, this is not currently expected to have any significant negative effects on the further development of the populations owing to the generally high flight capacity of the migratory species. Based on the current level of knowledge, this also applies to a cumulative analysis.

In this context, it must be taken into account that present scientific and technological findings are incomplete, particularly regarding species-specific migratory behaviour during unfavourable weather conditions (rain, mist).

To summarise, significant cumulative effects of a wind farm at site O-1.3 on bird migrations in the area O-1 can nevertheless be excluded with the required certainty, so long as the monitoring requirement is implemented to reduce the collision risk for cranes with the taller turbines in scenarios 1 and 2 and effective measures to reduce collision risk are taken.

12.4 Transboundary effects

Based on current knowledge, no significant impacts of site O-1.3 are expected on the areas of the neighbouring countries bordering onto the German EEZ of the Baltic Sea.

Transboundary environmental impacts are defined pursuant to section 2(3) UVPG as environmental impacts in another country.

Whether the development of site O-1.3 may have an impact on the environment in neighbouring countries and whether this impact is also to be classified as significant depends on the circumstances of the individual case. The site O-1.3 is immediately on the border of the Danish EEZ surrounding the island of Bornholm at a distance of 500 m. The Danish islands surrounded by the Danish EEZ and situated to the west of site O-1.3 are at a distance of at least 54 km. The distance to Swedish waters is approx. 4 km.

According to the assumptions in an agreement on implementing transboundary participation between German and the Netherlands, which distinguishes between projects located up to 5 km from the border and those at a greater distance, impacts are more likely in the event of greater proximity.

The Polish EEZ is at a distance of at least 50 km. For this reason, local impacts on Polish waters with regard to benthos, soil or biotopes neighbouring states due to turbidity plumes and area sealing, for example, or effects on marine mammals and fish due to noise or impacts on the landscape, and therefore on tourism, are generally not to be expected.

Also, no significant transboundary impacts on the Danish and Swedish EEZ are expected. In this case, given the comparable species occurrence, the evaluation for the individual projected objects in chapters 4.1 to 4.12 can be applied.

On the one hand, the stipulated mitigation measures, such as noise reduction, are also effective across borders. On the other hand, certain project-related impacts are only short-term and across a small area, and accordingly not significant.

Likewise, there is no anticipation of extensive transboundary effects.

According to the Guide on the Practical Implementation of the Espoo Convention, prepared by the Netherlands, Sweden and Finland in 2003, projects that could have an extensive impact in a transboundary context would be those that cause air or water pollution, projects that pose a potential threat to migratory species and projects related to climate change. Possible significant transboundary effects could be expected for the highly mobile protected objects of fish, marine mammals, seabirds and resting birds, migratory birds and bats if the (local) effects of the project were to have a significant impact on the respective population/migratory species.

At most, potential significant transboundary effects for the highly mobile biological protected objects 'fish', 'marine mammals', 'seabirds and resting birds' as well as 'migratory birds and bats' could occur cumulatively in the area of the German Baltic Sea.

For the protected object 'fish', the SEA comes to the conclusion that, based on the current level of knowledge, the implementation of the plan is not expected to have any significant effects on the protected object because the area does not play any special role for fish fauna and, on the other hand, any notable foreseeable effects would be small-scale and temporary. This also rules out transboundary effects.

The same holds true for the protected objects 'marine mammals' and 'seabirds and resting birds'. These predominantly use this site as a transit area. No significant habitat loss for strictly protected marine and resident bird species is expected. Based on the current level of knowledge and taking into account the measures to minimise impacts and limit damage, significant transboundary effects can be excluded. The suitability approval only permits the foundations of wind turbines and platforms to be installed if effective noise reduction measures are used and noise-intensive construction work is coordinated with any adjacent projects. In light of the special risk to the separate Baltic Sea population of the harbour porpoise, close monitoring measures must be implemented during execution and, if applicable, the noise reduction measures must be adjusted or further requirements regarding the coordination of construction work must be applied in order to exclude any cumulative impacts.

The wind turbines erected on site O-1.3 could create a barrier and constitute a collision risk for migratory birds. This collision risk must be reduced in general and for nocturnal migrations of smaller birds in particular, by taking measures to reduce the attraction effects of lighting. Moreover, due to the higher size of the wind turbines at site O-1.3, additional measures for cranes are required in order to closely observe migratory events and in this way identify situations involving increased migratory events in good time and be able to take effective measures to reduce the collision risk for cranes in these situations. As concerns the barrier effect, the total length of the migratory routes taken by the different migrating species and the relatively short migratory section across the

Baltic Sea mean that significant transboundary effects can be excluded with the required certainty.

For bat migrations, it is also not possible to give a cumulative estimate of the endangerment risk at the present time because insufficient findings are available to date on bat migratory routes, flight altitudes and flight intensities. It can generally be assumed that the mitigation and minimisation measures taken will prevent any significant transboundary effects of the plan in the same way as for bird migrations.

12.5 Assessment under species protection law

The environmental report contains an assessment under species protection law pursuant to section 44(1) BNatSchG. This comes to the conclusion that, based on current knowledge, if avoidance and reduction measures are strictly observed, a wind farm on site O-1.3 would not involve any significant negative impacts which would trigger the prohibited conditions under species protection law. The present assessment is carried out at the level of verification of the basic suitability of site O-1.3 for the generation of electricity from wind energy. At this point in time, the technical design of the specific project has not been defined. As a result, the later individual approval procedure must update the assessment under species protection law, taking into account the specific project parameters.

12.6 Impact assessment

As part of the present SIA, the compatibility of the plan with the protective purposes of the nature conservation areas pursuant to sections 34 and 36 BNatSchG was reviewed. The German EEZ of the Baltic Sea contains the nature conservation areas 'Bay of Pomerania – Rönnebank', 'Fehmarnbelt' and 'Kadetrinne' designated by the statutory ordinance of 22.09.2017.

The impact assessment in relation to the protected habitat types and protected species showed that, if measures are taken as ordered in the individual procedure as part of the planning approval procedure, significant impacts on the protective purposes can be excluded with the required certainty. The present assessment is carried out at the level of verification of the basic suitability of site O-1.3 for the generation of electricity from wind energy. At this point in time, the technical design of the specific project has not been defined. As a result, the later individual approval procedure must update the impact assessment, taking into account the specific project parameters.

12.7 Planned measures to prevent, reduce and compensate significant negative impacts on the marine environment

Pursuant to section 40(2) UVPG and the requirements of the SEA Directive, a description is to be provided of the measures planned to prevent, reduce and, as far as possible, compensate any significant adverse environmental impacts resulting from the implementation of the plan. While some avoidance, mitigation and compensation measures can already be implemented at planning level, others only come into effect during the actual implementation phase.

With regard to planning avoidance and mitigation measures, the FEP already sets out spatial and textual determinations which, in accordance with the environmental protection objectives set out there, serve to avoid or reduce significant negative impacts of the implementation of the FEP on the marine environment. The determinations of the FEP are taken into account within the scope of the suitability assessment. Concrete reference to the site also allows the measures here to be specified in more concrete terms or additional measures to be specified by means of a statutory ordinance for suitability determination. In the subsequent planning approval procedure, project-specific or site-specific measures are then added which relate to the concrete planning of the project.

Within the framework of the suitability assessment, measures in accordance with section 12(5)(2) Wind-SeeG may be included in the statutory ordinance for determining the suitability of the site as requirements for the subsequent project if the construction and operation of wind turbines at the site would otherwise be likely to impair the criteria and interests in accordance with section 10(2) WindSeeG.

Measures must be implemented specifically to avoid risks to the marine environment due to noise emissions, , for example, in particular during the construction of the installations in order to comply with limits for sound pressure and peak sound pressure levels and to carry out the work as quietly and briefly as possible. In order to avoid pollution of the marine environment, emissions must be avoided and unavoidable emissions reduced.

12.8 Examination of alternatives

Pursuant to Art. 5(1)(1) of the SEA Directive in combination with the criteria in Annex I of the SEA Directive and Art. 40(2)(8) UVPG, the environmental report contains a brief description of the reasons for the choice of the reasonable alternatives examined.

In principle, different types of alternatives are considered, in particular strategic, spatial or technical alternatives. The prerequisite is always that they are reasonable and given serious consideration.

Alternatives are already being analysed in the context of the preceding SEA for the 2019 SDP (BSH 2019b). At this planning level these are mainly the conceptual/strategic design, the spatial location and technical alternatives.

As part of the suitability assessment, therefore, only alternatives that relate specifically to the site under review according to the FEP determinations, in this case O-1.3, are to be considered in the sense of the tiering between the planning instruments. These can particularly be process alternatives, i.e. the (technical) design of the installations in detail (BALLA et al. 2009). At the same time, the exact design of the installations to be erected on the site is not yet known at the time of the suitability assessment. Therefore, the examination of alternatives with regard to the concrete design of the subsequent project can only take place in the subsequent planning approval procedure. At this point, therefore, only those alternatives that relate to the respective site and can already be carried out without detailed knowledge of the concrete construction project are to be examined. The implementation of the project with different installation concepts based on exemplary scenarios is possible. The two alternative scenarios differ particularly in relation to the number of turbines to be erected to achieve the capacity to be installed (scenario 1 ## compared to scenario 2 ##) and to the hub height and rotor diameter which determine the total height of the individual wind turbines (approx. 225 m compared to approx. 300 m). As a result, neither of the two scenarios can be considered clearly preferable due to their lower environmental impact. Rather, the assessment differs depending on the protected object. Scenario 2, for example, is more advantageous with regard to the protected objects of soil and benthos, since the smaller number of wind turbines and the scour protection associated with each turbine means that scour protection is inserted in the form of exogenous hard substrate. For avifauna, on the other hand, the lower turbines of scenario 1 are expected to result in slightly less impairment.

Another alternative is to assess the use of different types of foundations. As conceivable alternatives for rammed pile turbine foundations in the German EEZ of the Baltic Sea, drilled piles or gravity foundations are discussed.

The information available for the types of foundation mentioned above is very limited. In particular, there is insufficient knowledge from monitoring comparable offshore installations. Based on the present level of knowledge of the specific parameters and particularly the impacts on the different protected objects during construction and operations, it is not possible to determine, describe and assess the environmental impacts of these foundation types.

It is therefore not possible to consider these alternatives in detail because the necessary information cannot be determined with reasonable effort.

12.9 Planned measures to monitor the impacts of implementing the plan on the environment

The potential significant impacts on the environment resulting from the implementation of the plan must be monitored pursuant to section 45 UVPG. This is to enable the early identification of unforeseen negative impacts and the implementation of appropriate remedial actions.

Accordingly, section 40(2)(9) UVPG requires the environmental report to specify the measures envisaged for monitoring the significant impacts of implementing the plan on the environment. Monitoring is the responsibility of the BSH, since it is the competent authority for the SEA (see section 45(2) UVPG). As intended in section 45(5) UVPG, existing monitoring mechanisms can be used to avoid duplication of monitoring work.

With regard to the monitoring measures envisaged, it should be noted that the actual monitoring of the potential impacts on the marine environment can only start when the plan is implemented, i.e. when the project is carried out at site O-1.3. Nonetheless, no general research may be carried out within the framework of monitoring. For this reason, project-related monitoring of the project's impacts on the area and its surroundings is of particular importance.

The essential task of monitoring this suitability determination in interaction with the FEP and the individual planning approval procedures is to combine and evaluate the results from different phases of monitoring. The assessment also covers unforeseen significant impacts of implementing the plan on the marine environment as well as the review of the forecasts in the environmental report. Chapter 10 of the environmental report for the 2019 Site Development Plan for the German Baltic Sea (especially chapter 10.1 on the potential impacts of the areas and sites for offshore wind turbines) describes the planned procedure, measures to monitor the potential impacts of the plan and the required data (BSH-2019b).

13 Bibliography

ABT K (2005) Gibt es bei Schweinswalen "Invasionsjahre"? - Strandfunde als Index für Bestandsveränderungen. Seevögel 26 (4): 14–19.

AHLÉN I (1997) Migratory behaviour of bats at south Swedish coasts. International Journal of Mammal Biology 62: 375–380.

AHLÉN I (2002) Wind turbines and bats – a pilot study. Final Report to the Swedish National Energy Administration, 5 pages.

AHLÉN I, BACH L, GUSTAFSON T, ERIKSSON A & PETTERSON J (2005) Bat casualty risks at offshore wind power turbines (Schwedisch). Slutrapport fran förstudien 2005 (project no. 22316-1)

AHLÉN I, BAGGØE H & BACH L (2009) Behaviour of Scandinavian bats during migration and foraging at sea. Journal of Mammalogy 90 (6): 1318–1323.

ALERSTAM T & BAUER CA (1973) A radar study of the spring migration of the Crane (*Grus grus*) over the southern Baltic area. Vogelwarte 27: 1–16.

ALERSTAM T & ULFSTRAND S (1972) Radar and field observations of bird migration in South Sweden, Autumn 1971. Ornis Scandavica 3: 99–139.

ALERSTAM T (1975) Crane *Grus grus* migration over sea and land. *Ibis* 117: 489–495.

ALERSTAM T (1990) Bird migration. Cambridge University Press, Cambridge, 420 pages.

ALERSTAM T, BAUER CA & ROOS G (1974) Spring migration of eiders *Somateria mollissima* in southern Scandinavia. Ibis 116: 194–210.

ALHEIT J, MÖLLMANN C, DUTZ J, KORNILOVS G, LOWE P, MOHRHOLZ V & WASMUND N (2005) Synchronous ecological regime shifts in the central Baltic and the North Sea in the late 1980s. ICES Journal of Marine Science 62: 1205−1215.

ALMQVIST G, STRANDMARK AK & APPELBERG M (2010) Has the invasive round goby caused new links in Baltic food webs? Environmental Biology of Fishes 89: 79–93.

ANDERSIN A-B, LASSIG J, PARKKONEN L & SANDLER H (1978) The decline of macrofauna in the deeper parts of the Baltic proper and the Golf of Finland. Kieler Meeresforschungen, Sonderheft 4: 23–52.

ANDRULEWICZ E, NAPIERSKA D & OTEMBRA Z (2003) The environmental effects of the installation and functioning of the submarine SwePol Link HVDC transmission line: a case study of the Polish marine area of the Baltic Sea. Journal of Sea Research 49, 337−345.

ARMONIES W & ASMUS H (2002) Fachgutachten Makrozoobenthos im Rahmen der UVS und FFH-VP für den Offshore-Bürgerwindpark "Butendiek" westlich von Sylt. For the OSB-Offshore Bürgerwindpark "Butendiek" GmbH und Co. KG.

ARMONIES W (1999) Drifting benthos and long-term research: why community monitoring must cover a wide spatial scale. Senckenbergiana Maritima 29: 13−18.

ARMONIES W (2000) What an introduced species can tell us about the spatial extension of benthic populations. Marine Ecology Progress Series 209: 289−294.

ARMONIES W, HERRE E & STURM M (2001) Effects of the severe winter 1995/96 on the benthic macrofauna of the Wadden Sea and the coastal North Sea near the island of Sylt. Helgoland Marine Research 55: 170−175.

ARNTZ WE & RUMOHR H (1986) Fluctuations of Benthic Macrofauna during Succession and in an Established Community. Meeresforschung 31: 97−114.

ARNTZ WE & WEBER W (1970) *Cyprina islandica* L. (Molluska, Bivalvia) als Nahrung für Dorsch und Kliesche in der Kieler Bucht. Reports of the German Scientific Commission for Marine Research 21: 193−209.

ARNTZ WE (1970) Das Makrobenthos der Kieler Bucht im Jahre 1968 und seine Ausnutzung durch die Kliesche (*Limanda limanda* L.). Dissertation Universität Kiel. 167 pages.

ARNTZ WE (1971) Biomasse und Produktion des Makrobenthos in den tieferen Teilen der Kieler Bucht im Jahr 1968. Kiel Marine Research 27: 36−72.

ARNTZ WE (1978) Zielsetzung und Probleme struktureller Benthosuntersuchungen in der Marinen Ökosystemforschung. Verhandlungen der Gesellschaft für Ökologie: 35−51.

ARNTZ WE, BRUNSWIG D & SARNTHEIN M (1976) Zonierung von Mollusken und Schill im Rinnensystem der Kieler Bucht (Westliche Ostsee). Senckenbergiana maritima 8: 189−269.

ASCOBANS (2003) Proceedings of the 4th meeting of the parties to ASCOBANS - Esbjerg, Denmark, 19-22 August 2003. ASCOBANS, Bonn, Germany, 121 pages.

ASCOBANS (2010) ASCOBANS recovery plan for Baltic Harbour porpoises Jastarnia plan (2009 revision). In: report of the 6th meeting of the parties to ASCOBANS, ASCOBANS, Bonn, Germany, Seite 24−49.

ASCOBANS (2012) ASCOBANS conservation plan for the Harbour porpoise population in the western Baltic, the Belt Sea and the Kattegat.

ASFERG T (2002) Vildtudbyttet i Danmark i jagtsæsonen 2000/2001. Faglig rapport fra DMU nr.393, 35 pages.

AVITEC RESEARCH GBR (2017) "Cluster Nördlich Borkum" StUK-Monitoring des Jahres 2016. Unpublished expert opinion for UMBO GmbH. Osterholz-Scharmbeck, September 2017.

BACH L & MEYER-CORDS C (2005) Lebensraumkorridore für Fledermäuse (draft). 7 pages.

BAERENS C & HUPFER P (1999) Extremwasserstände and der deutschen Ostseeküste nach Beobachtungen und in einem Treibhausgasszenario. Die Küste 61: 47-72

BAERWALD EF, D'AMOURS GH, KLUG BJ & BARCLAY RMR (2008) Barotrauma is a significant cause of bat fatalities at wind turbines. Current Biology 18:695–696.

BAIRLEIN F & HÜPPOP O (2004) Migratory Fuelling and Global Climate change. Advances in Ecology Research 35: 33−47.

BAIRLEIN F & WINKEL W (2001) Birds and climate change. In: LOZAN JL, GRAßL H, HUPFER P (Ed.) Climate of the 21st Century: Changes and Risks: 278−282.

BALLA S, WULFERT K, PETERS HJ (2009) Leitfaden zur Strategischen Umweltprüfung (SUP). *Texte 08/09*. Dessau-Roßlau, Saxony-Anhalt, Germany: Federal Environment Agency.

BANZHAF W (1936) Der Herbstvogelzug über der Greifswalder Oie in den Jahren 1931-1934 nach Arten, Alter und Geschlecht. Dohrniana 15: 60−115.

BARZ K & ZIMMERMANN C (Ed.) Fischbestände online. Thünen-Institut für Ostseefischerei. Published electronically at www.fischbestaende-online.de, Accessed on 12.03.2018.

BEAUGRAND G & REID PC (2003) Long-term changes in phytoplankton, zooplankton and salmon related to climate. Global Change Biology 9: 1−17.

BEAUGRAND G (2004) The North Sea regime shift: evidence, causes, mechanisms and consequences. Progress in Oceanography 60: 201−222.

BEAUGRAND G (2009) Decadal changes in climate and ecosystems in the North Atlantic Ocean and adjacent seas. Deep Sea Research II 56: 656–673.

BEAUGRAND G, BRANDER KM, LINDLEY JA, SOUISSI S & REID PC (2003) Plankton effect on cod recruitment in the North Sea. Nature 426: 661–663.

BELLEBAUM J, BOCK C, GARTHE S, KUBE J, SCHILZ M & SONNTAG N (2010) Vorkommen des Gelbschnabeltauchers *Gavia adamsii* in der deutschen Ostsee. Vogelwelt 131: 179–184.

BELLEBAUM J, DIEDERICHS A, KUBE J, SCHULZ A & NEHLS G (2006) Flucht- und Meidedistanzen überwinternder Seetaucher und Meeresenten gegenüber Schiffen auf See. Ornithologischer Rundbrief Mecklenburg-Vorpommern, Tagungsband. 5. Deutsches See- und Küstenkolloquium: 86–90.

BELLEBAUM J, GRIEGER C, KLEIN R, KÖPPEN U, KUBE J, NEUMANN R, SCHULZ A, SORDYL H & WENDELN H (2008): Ermittlung artbezogener Erheblichkeitsschwellen von Zugvögeln für das Seegebiet der südwestlichen Ostsee bezüglich der Gefährdung des Vogelzuges im Zusammenhang mit dem Kollisionsrisiko an Windenergieanlagen. Final report. BMU research project (FKZ 0329948). Neu Broderstorf.

BELLEBAUM J, KUBE J, SCHULZ A, SKOV H & WENDELN H (2014) Decline of Long-tailed Duck *Clangula hyemalis* numbers in the Pomeranian Bay revealed by two different survey methods. Ornis Fennica 9: 129 – 137

BENKE H, BRÄGER S, DÄHNE M, GALLUS A, HANSEN S, HONNEF CG, JABBUSCH M, KÖBLITZ JK, KRÜGEL K, LIEBSCHNER A, NARBERHAUS I, VERFUß UK (2014) Baltic Sea Harbour Porpoise populations: status and conservation needs derived from recent survey results. Marine Ecology Progress Series 495: 275–290.

BERNDT RK & BUSCHE G (1991) Vogelwelt Schleswig-Holsteins. Vol. 3, Entenvögel I (Höckerschwan-Löffelente). Wachholtz Verlag, Neumünster.

BERTHOLD P (2000) Vogelzug - Eine aktuelle Gesamtübersicht, Wissenschaftliche Buchgesellschaft, Darmstadt, 280 pages.

BELLMANN M. A., BRINKMANN J., MAY A., WENDT T., GERLACH S. & REMMERS P. (2020) Underwater noise during the impulse pile-driving procedure: Influencing factors on pile-driving noise and technical possibilities to comply with noise mitigation values. Supported by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit (BMU)), FKZ UM16 881500. Commissioned and managed by the Federal Maritime and Hydrographic Agency (Bundesamt für Seeschifffahrt und Hydrographie (BSH)), Order No. 10036866. Edited by the itap GmbH.BETKE (2012) Messungen von Unterwasserschall beim Betrieb der Windenergieanlagen im Offshore-Windpark alpha ventus.

BEUKEMA JJ (1992) Expected changes in the Wadden Sea benthos in a warmer world: lessons from periods with mild winters. Netherlands Journal of Sea Research 30: 73−79.

BEUSEKOM JEE VAN, THIEL R, BOBSIEN I. BOERSMA M, BUSCHBAUM C, DÄNHARDT A, DARR A, FRIEDLAND R, KLOPPMANN MHF, KRÖNCKE I, RICK J & WETZEL M (2018) Aquatische Ökosysteme: Nordsee, Wattenmeer, Elbeästuar und Ostsee. In: VON STORCH H, MEINKE I & CLAUßEN M (Ed.) Hamburger Klimabericht – Wissen über Klima, Klimawandel und Auswirkungen in Hamburg und Norddeutschland. Springer Spektrum, Berlin, Heidelberg.

BEZZEL E & PRINZINGER R (1990) Ornithologie. UTB Stuttgart. 552 pages.

BFN, FEDERAL AGENCY FOR NATURE CONSERVATION (2006) Naturschutzfachlicher Planungsbeitrag des Bundesamtes für Naturschutz zur Aufstellung von Zielen und Grundsätzen der Raumordnung für die deutsche Ausschließliche Wirtschaftszone der Nord- und Ostsee, February 2006.

BFN, FEDERAL AGENCY FOR NATURE CONSERVATION (2012a) Marine biotope type "Seegraswiesen und sonstige marine Makrophytenbestände". (http://www.bfn.de/habitatmare/de/marine-biotoptypen.php, Stand: 14.05.2013).

BFN, FEDERAL AGENCY FOR NATURE CONSERVATION (2012b) Mapping instruction "Artenreiche Kies-, Grobsand- und Schillgründe im Küsten- und Meeresbereich". (http://www.bfn.de/habitatmare/de/downloads/marine-biotope/Biotoptyp-Kies-Sand -Schillgruende.pdf, as at: 14/05/2013)

BFN, FEDERAL AGENCY FOR NATURE CONSERVATION (2018) BfN mapping instruction for "reefs" in the German Exclusive Economic Zone (AWZ). Protected biotope type according to Section 30 para. 2 S. 1 No. 6 BNatSchG, FFH – Annex I – Habitat type (Code 1170). 70 pages.

BIJKERK R (1988) Ontsnappen of begraven blijven. De effecten op bodemdieren van een verhoogte sedimentatie als gevolg van baggerwerkzaamheden. Literatuuronderzoek – NIOZ Rapport 2005−6,18 pages.

BIOCONSULT SH (2016a) Environmental monitoring in the cluster "Western Adlergrund". Fachgutachten Rastvögel. 1. Untersuchungsjahr März 2014 – Februar 2015. Unpublished expert opinion for Iberdrola Renovables Offshore Deutschland GmbH und E.ON Climate & Renewables GmbH, Husum, February 2016.

BIOCONSULT SH (2016b) Environmental monitoring in the cluster "Western Adlergrund". Fachgutachten Zugvögel. 1. Untersuchungsjahr März 2014 – November 2014. Unpublished expert opinion for Iberdrola Renovables Offshore Deutschland GmbH und E.ON Climate & Renewables GmbH, Husum, January 2016.

BIOCONSULT SH (2017a) Environmental monitoring in the cluster "Western Adlergrund". Fachgutachten Rastvögel. 2. Untersuchungsjahr März 2015 – Februar 2016. Unpublished expert opinion for Iberdrola Renovables Offshore Deutschland GmbH und E.ON Climate & Renewables GmbH, Husum, November 2017.

BioConsult SH (2017b) Environmental monitoring in the cluster "Western Adlergrund". Fachgutachten Zugvögel. 2. Untersuchungsjahr März 2015 – November 2015. Unpublished expert opinion for Iberdrola Renovables Offshore Deutschland GmbH and E.ON Climate & Renewables GmbH, Husum, November 2017.

BioConsult SH (2017c) Environmental monitoring in the cluster "Western Adlergrund". Fachgutachten Fledermäuse. Zu den Untersuchungsjahren 2014 & 2015. Version 2.0. Husum.

BioConsult SH (2018) Environmental monitoring in the cluster "Western Adlergrund". Fachgutachten Zugvögel. 2. Untersuchungsjahr März 2016 – November 2016. Unpublished expert opinion for Iberdrola Renovables Offshore Deutschland GmbH and E.ON Climate & Renewables GmbH, Husum, November 2018.

BioConsult SH & Co KG (2019a) Environmental monitoring in the cluster "Western Adlergrund" Non-technical summary of the 4th year of the cluster investigation March 2017 to February 2018, on behalf of Iberdrola Renovables Offshore Deutschland GmbH and der AWE Arkona-Windpark Entwicklungsgesellschaft-mbH, 163 pages.

BioConsult SH & Co. KG (2019b) Environmental monitoring in the cluster "Western Adlergrund". Fachgutachten Zugvögel. 2. Untersuchungsjahr März 2017 – November 2017. Unpublished expert opinion for Iberdrola Renovables Offshore Deutschland GmbH and E.ON Climate & Renewables GmbH, Husum, July 2019.

BioConsult Sh & Co.KG, IBL Umweltplanung &IFAÖ GmbH (2020) Divers (Gavia spp.) in the German North Sea: Changes in Abundances and Effects of Offshore Wind Farms. Prepared for Bundesverband der Windparkbetreiber Offshore e.V.

BirdLife International (2004a) Birds in Europe: population estimates, trends and conservation status. BirdLife Conservation Studies No.12, Cambridge.

BirdLife International (2004b) Birds in the European Union: a status assessment. Wageningen, the Netherlands, BirdLife International.

BirdLife International (2015) European Red List of Birds. Luxembourg: Office for Official Publication of the European Communities.

BirdLife International (2017) European birds of conservation concern: populations, trends and national responsibilities. Cambridge, UK.

Bleil M, Oeberst R & Urrutia P (2009) Seasonal maturity development of Baltic cod in different spawning areas: importance of the Arkona Sea for the summer spawning stock. Journal of Applied Ichthyology 25 (1): 10-17.

Blew J, Diederichs A, Grünkorn T, Hoffmann M & Nehls G (2006) Investigations of the bird collision risk and the responses of harbour porpoises in the offshore wind farms Horns Rev, North Sea, and Nysted, Baltic Sea, in Denmark. Status Report 2005 for the BMU R+D projects FKZ 0329963 and FKZ 0329963A.

Blew J, Hoffmann M, Nehls G & Hennig V (2008): Investigations of the bird collision risk and the responses of harbour porpoises in the offshore wind farms Horns Rev, North Sea, and Nysted, Baltic Sea, in Denmark. Part I: Birds. – Final Report 2008. Funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (FKZ 0329963 + FKZ 0329963A), 133 pp.

BMU (2018) Zustand der deutschen Ostseegewässer 2018. Aktualisierung der Anfangsbewertung nach § 45c, der Beschreibung des guten Zustands der Meeresgewässer nach § 45d und der Festlegung von Zielen nach § 45e des Wasserhaushaltsgesetzes zur Umsetzung der Meeresstrategie-Rahmenrichtlinie. Bonn, 194 pages.

BMU, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2012) (Ed.) Umsetzung der Meeresstrategie-Rahmenrichtlinie. RICHTLINIE 2008/56/EG zur Schaffung eines Ordnungsrahmens für Maßnahmen der Gemeinschaft im Bereich der Meeresumwelt (Meeresstrategie-Rahmenrichtlinie). Festlegung von Umweltzielen für die deutsche Nordsee nach Artikel 10 Meeresstrategie-Rahmenrichtlinie, Bonn.

BMU, Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (2013) Konzept für den Schutz der Schweinswale vor Schallbelastungen bei der Errichtung von Offshore-Windparks in der deutschen Nordsee (Schallschutzkonzept).

BMU, Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (2018a): Umsetzung der Meeresstrategie-Rahmenrichtlinie. Richtlinie 2008/56/EG zur Schaffung eines

Ordnungsrahmens für Maßnahmen der Gemeinschaft im Bereich der Meeresumwelt (Meeresstrategie-Rahmenrichtlinie). Zustand der deutschen Nordseegewässer – Bericht gemäß § 45j i.V.m. §§ 45c, 45d und 45e des Wasserhaushaltsgesetzes.

BMU, BUNDESMINISTERIUM FÜR UMWELT, NATURSCHUTZ UND REAKTORSICHERHEIT (2018B): Umsetzung der Meeresstrategie-Rahmenrichtlinie. Richtlinie 2008/56/EG zur Schaffung eines Ordnungsrahmens für Maßnahmen der Gemeinschaft im Bereich der Meeresumwelt (Meeresstrategie-Rahmenrichtlinie). Zustand der deutschen Ostseegewässer – Bericht gemäß § 45j i.V.m. §§ 45c, 45d und 45e des Wasserhaushaltsgesetzes.

BMEL, BUNDESMINISTERIUM FÜR ERNÄHRUNG UND LANDWIRTSCHAFT UND BMU, BUNDESMINISTERIUM FÜR UMWELT, NATURSCHUTZ UND REAKTORSICHERHEIT (2020): Nitratbericht 2020

BOBSIEN IC & BRENDELBERGER H (2006) Comparison of an enclosure drop trap and a visual diving census technique to estimate fish populations in eelgrass habitats. Limnology and Oceanography: Methods 4(5): 130–141.

BOCHERT R & ZETTLER ML (2004) Long-term exposure of several marine benthic animals to static magnetic fields. Bioelectromagnetics 25:498−502.

BOHNSACK JA & DL SUTHERLAND (1985) Artificial reef research: a review with recommendations for future priorities. Bulletin of Marine Science 37 (1):11–39.

BOSSELMANN A (1989) Entwicklung benthischer Tiergemeinschaften im Sublitoral der Deutschen Bucht. Dissertation University Bremen, 200 pages.

BOYE P, DIETZ M & WEBER M (1999) Fledermäuse und Federmausschutz in Deutschland. – Bundesforschungsanstalt für Naturschutz und Landschaftsökologie.

BRANDT M, DRAGON AC, DIEDERICHS A, SCHUBERT A, KOSAREV V, NEHLS G, WAHL V, MICHALIK A, BRAASCH A, HINZ C, KETZER C, TODESKINO D, GAUGER M, LACZNY M & PIPER W (2016) Effects of offshore pile driving on Harbour porpoise abundance in the German Bight. Study prepared for Offshore Forum Windenergie. Husum, June 2016, 246 pages.

BRANDT MJ, BETKE K, DIEDERICHS A & NEHLS G (2012) Effects of Offshore Pile Driving on Harbour Porpoises *Phocoena phocoena*. In: POPPER AN & HAWKINS A (2012) The Effect of Noise on aquatic life. Advances in Experimental Medicine and Biology 730, Springer Science & Business.

BREY T (1984) Gemeinschaftsstrukturen, Abundanz, Biomasse und Produktion des Makrobenthos sandiger Böden der Kieler Bucht in 5-15 m Wassertiefe. Berichte aus dem Institut für Meereskunde an der Christian-Albrechts-Universität Kiel Nr. 186: 248 pages.

BRUDERER & BOLDT (2001) Flight characteristics of birds: I. Radar measurements of speeds. Ibis 143: 178-204.

BSH, BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE (2009) Umweltbericht zum Raumordnungsplan für die deutsche ausschließliche Wirtschaftszone (AWZ) in der Nordsee. Federal Maritime and Hydrographic Agency, 537 pages.

BSH, BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE (2012) Klimatologischer Eisatlas für die westliche und südliche Ostsee.

BSH, BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE (2013) Standard Untersuchung der Auswirkungen von Offshore-Windenergieanlagen auf die Meeresumwelt (StUK4). 86 pages.

BSH, BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE (2017) Bundesfachplan Offshore für die deutsche ausschließliche Wirtschaftszone der Nordsee 2016/2017 und Umweltbericht. Hamburg/ Rostock, 130 & 206 pages.

BSH, BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE (2019) Umweltbericht zum Flächenentwicklungsplan 2019 für die deutsche Ostsee. Bundesamt für Seeschifffahrt und Hydrographie, BSH-Nummer 7608, Hamburg, 28. Juni 2019.

BSH, BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE (2019a) Umweltbericht Nordsee zum Flächenentwicklungsplan. Hamburg/ Rostock.

BSH, BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE (2019b) Umweltbericht Ostsee zum Flächenentwicklungsplan. Hamburg/ Rostock.

BSH, Bundesamt für Seeschifffahrt und Hydrographie (2019c) Flächenentwicklungsplan 2019 für die deutsche Nord- und Ostsee. Hamburg/ Rostock.

BSH, Bundesamt für Seeschifffahrt und Hydrographie / IOW, Institut f. Ostseeforschung Warnemünde (2012) Digitaler Kartensatz zur Sedimentverteilung für das deutsche Ostseegebiet.

Burchard H & Lass HU (2004) Einschätzung einiger Risiken durch Offshore-Windkraftanlagen im Bereich Kriegers Flak und Adlergrund auf das marine Ökosystem der Ostsee. Schreiben des IOW an das BSH vom 2.1.2004.

Burchard H, Lass HU, Mohrholz V, Umlauf L, Sellschopp J, Fiekas V, Bolding K & Arneborg L (2005) Dynamics of medium-intensity dens water plumes in the ArkonaBasin, Western Baltic Sea. Ocean Dynamics, 55, 391-402 (DOI: 10.1007/s10236-005-0025-2).

Burchard, H., A. Leder, M. Markofsky, R. Hofmeister, F. Hüttmann, H. U. Lass, J.-E. Melskotte, P. Menzel, V. Mohrholz, H. Rennau, S. Schimmels, A. Szewczyk, and L. Umlauf (2010): Quantification of Water Mass Transformations in the Arkona Sea – Impact of Offshore Wind Farms - QuantAS-Off. Final Report. Leibniz Institute for Baltic Sea Research Warnemünde. Rostock, Germany, 2010.

Burger C, Schubert A, Heinänen S, Dorsch M, Kleinshcmidt B, Žydelis, Morkūnas, Quillfeldt P & Nehls G (2019) A novel approach for assessing effects of ship traffic on distributions and movements of seabirds. Journal of Environmental Management 251

Camphuysen CJ & Garthe S (2000) Seabirds and commercial fisheries: population trends of piscivorous seabirds explained? In: The Effects of Fishing on Non-target Species and Habitats (Kaiser MJ & Groot de SJ, Hrsg), Seite 163−184. Blackwell Science, Oxford.

Camphuysen CJ (2005) The return of the Harbour porpoise in Dutch coastal waters. Lutra 47: 135−144.

Cederwall H & Elmgren R (1980) Biomass increase of benthic macrofauna demonstrates eutrophication of the Baltic Sea. In Proceedings of the 6th Symposium of the Baltic Marine Biologists: relationship and exchange between the pelagic and benthic biota.

Chakrabari, S.K. (1987): Hydrodynamics of Offshore Structures. Computational Mechanics, 1987, 440 S.

Couperus AS, Winter HV, van Keeken OA, van Kooten T, Tribuhl SV & Burggraaf D (2010) Use of high resolution sonar for near-turbine fish observations (didson)-we@ sea 2007-002 IMARES Report No. C0138/10, Wageningen, 29 pages.

Crick HQP (2004) The impact of climate change on birds. Ibis 146 (Supplement1): 48−56.

Cushing DH (1990) Plankton Production and Year-class Strength in Fish Populations: an Update of the Match/Mismatch Hypothesis. Advances in Marine Biology 26: 249–293.

Cuttat F & Skov H (2020) SEANSE. Cumulative collision risk for seabirds. – DHI Report. Im Aufrag des Bundesamtes für Seeschiffahrt und Hydrographie, Hamburg.

Daan N, Bromley PJ, Hislop JRG & Nielsen NA (1990) Ecology of North Sea fish. Netherlands Journal of Sea Research 26 (2−4): 343–386.

Dagys M & Žydelis R (2002). Bird bycatch in fishing nets in Lithuanian coastal waters in wintering season 2001–2002. Acta Zoologica Lituanica 12(3): 276−282.

Dänhardt A & Becker PH (2011) Herring and sprat abundance indices predict chick growth and reproductive performance of Common Terns breeding in the Wadden Sea. Ecosystems 14: 791–803.

Davis N, van Blaricom G & Dayton PK (1982) Man-made structures: effects on adjacent benthic communities. Marine Biology 70: 295−303.

De Backer A, Debusschere E, Ranson J & Hostens K (2017) Swim bladder barotrauma in Atlantic cod when in situ exposed to pile driving. In: Degraer S, Brabant R, Rumes B & Vigin L (Ed.) (2017) Environmental impacts of offshore wind farms in the Belgian part of the North Sea: A continued move towards integration and quantification. Brussels: Royal Belgian Institute of Natural Sciences, OD Natural Environment, Marine Ecology and Management Section.

Desholm M & Kahlert J (2005) Avian collision risk at an offshore wind farm. Biology Letters, published online: Doi:10.1098/rsbl.2005.0336.

DESHOLM M (2005) TADS investigations of avian collision risk at Nysted off shore wind farm, autumn 2004. Report from NERI, 27 pages.

DESHOLM M, CHRISTENSEN TK, SCHEIFFARTH G, HARIO M, ANDERSSON Å, ENS B, CAMPHUYSEN CJ, NILSSON L, WALTHO CM, LORENTSEN S-H, KURESOO A, KATS RKH, FLEET DM & FOX AD (2002) Status of the Baltic/Wadden Sea population of the Common Eider *Somateria m. mollissima*. Wildfowl 53: 167−203.

DESHOLM M, FOX AD, BEASLEY PDL, & KAHLERT J (2006). Remote techniques for counting and estimating the number of bird–wind turbine collisions at sea: a review. Ibis 148: 76−89.

Deutscher Bundestag (2016) Gesetzentwurf der Fraktionen der CDU/CSU und SPD. Entwurf eines Gesetzes zur Einführung von Ausschreibungen für Strom aus erneuerbaren Energien und zu weiteren Änderungen des Rechts der erneuerbaren Energien (Erneuerbare-Energien-Gesetz – EEG 2016). Drucksache 18/8860.

DICKEY-COLLAS M, HEESSEN H & ELLIS J (2015) 20. Shads, herring, pilchard, sprat (Clupeidae) In: Heessen H, Daan N, Ellis JR (Ed.) Fish atlas of the Celtic Sea, North Sea, and Baltic Sea: based on international research-vessel surveys. Academic Publishers, Wageningen, pages 139−151.

DIEDERICHS A, NEHLS G & PETERSEN IK (2002) Flugzeugzählungen zur großflächigen Erfassung von Seevögeln und marinen Säugern als Grundlage für Umweltverträglichkeitsstudien im Offshorebereich. Seevögel 23: 38-46.

DIERSCHKE V, EXO KM, MENDEL B & GARTHE S (2012) Gefährdung von Sterntaucher *Gavia stellata* und Prachttaucher *G. arctica* in Brut-, Zug- und Überwinterungsgebieten – eine Übersicht mit Schwerpunkt auf den deutschen Meeresgebieten. Vogelwelt 133: 163-194.

DIERSCHKE V, HÜPPOP O & GARTHE S (2003) Populationsbiologische Schwellen der Unzulässigkeit für Beeinträchtigungen der Meeresumwelt am Beispiel der in der deutschen Nord- und Ostsee vorkommenden Vogelarten. Seevögel 24: 61−72.

DIETZ R, TEILMANN J, DAMSGAARD O & HENRIKSEN N (2003) Movements of seals from Rødsand seal sanctuary monitored by satellite telemetry. NERI Technical Report. 429. National Environmental Research Institute. Roskilde, Denmark. 44 pages.

DNV GL (2010), Cathodic Protection Design, Recommended Practice DNV-RP-B401

DURANT JM, HJERMANN DØ, OTTERSEN G & STENSETH NC (2007) Climate and the match or mismatch between predator requirements and resource availability. Climate Research 33: 271–283.

DURINCK J, SKOV H, JENSEN FP & PIHL S (1994) Important marine areas for wintering birds in the Baltic Sea. Ornis Consult Copenhagen.

EDWARDS M & RICHARDSON AJ (2004) The impact of climate change on the phenology of the plankton community and trophic mismatch. Nature 430: 881-884.

EHRICH S & STRANSKY C (1999) Fishing effects in northeast Atlantic shelf seas: patterns in fishing effort, diversity and community structure. VI. Gale effects on vertical distribution and structure of a fish assemblage in the North Sea. Fisheries Research 40: 185−193.

EHRICH S, ADLERSTEIN S, BROCKMANN U, FLOETER JU, GARTHE S, HINZ H, KRÖNCKE I, NEUMANN H, REISS H, SELL AF, STEIN M, STELZENMÜLLER V, STRANSKY C, TEMMING A, WEGNER G & ZAUKE GP (2007) 20 years of the German Small-scale Bottom Trawl Survey (GSBTS): a review. Senckenbergiana Maritima 37: 13–82.

EHRICH S, ADLERSTEIN S, GÖTZ S, MERGARDT N & TEMMING A (1998) Variation in meso-scale fish distribution in the North Sea. ICES C.M. 1998/J, S.25 ff.

EHRICH S, KLOPPMANN MHF, SELL AF & BÖTTCHER U (2006) Distribution and Assemblages of Fish Species in the German Waters of North and Baltic Seas and Potential Impact of Wind Parks. In: KÖLLER W, KÖPPEL J & PETERS W (Ed.) Offshore Wind Energy. Research on Environmental Impacts. 372 pages.

EKLÖF J (2003) Vision in echolocating bats. Doctoral thesis, Zoology Department University of Göteborg, Sweden.

ELLESTRÖM O (2002) Sjöfågelsträcket i östra Skåne. In: Arinder M & Erterius D (2002): Fåglar i Skåne 2001. Anser supplement nr 46: 99–105.

ELLIOTT M, WHITFIELD AK, POTTER IC, BLABER SJ, CYRUS DP, NORDLIE FG, & HARRISON TD (2007) The guild approach to categorizing estuarine fish assemblages: a global review. Fish and Fisheries 8(3): 241–268.

Elmer K-H, Betke K & Neumann T (2007) Standardverfahren zur Ermittlung und Bewertung der Belastung der Meeresumwelt durch die Schallimmission von Offshore-Windenergieanlagen. "Schall II", Leibniz University Hanover.

Emeis K-C, Struck U, Leipe T, Pollehne F, Kunzendorf H & Christiansen C (2000) Changes in the C, N, P burial rates in some Baltic Sea sediments over the last 150 years – relevance to P regeneration rates and the phosphorus cycle. Marine Geology 167: 43–59.

EMEP (2016) European monitoring and evaluation programme. Unpublished modelling results on the projected effect of Baltic Sea and North Sea NECA designations to deposition of nitrogen to the Baltic Sea area. Available at the HELCOM Secretariat.

Erdmann F, Bellebaum J, Kube J & Schulz A (2005) Verluste von See- und Wasservögeln durch die Fischerei unter besonderer Berücksichtigung der international bedeutsamen Rast-, Mauser- und Überwinterungsgebiete in den Küstengewässern Mecklenburg-Vorpommerns. In: Landesamt für Umwelt, Naturschutz und Geologie Mecklenburg-Vorpommern, Güstrow, Germany, Seite 1–129.

Erni B, Liechti F, Underhill LG & Bruderer B (2002) Wind and rain govern the intensity of nocturnal bird migration in central Europe – a log-linear regression analysis. Ardea 90: 155–166.

European Environment Agency (2015) State of the Europe's seas. EEA Report No 2/2015. European Environment Agency. Publications Office of the European Union, Luxembourg (Webseite der European Environment Agency).

Evans PG, Weir CR & Nice HE (1996) Temporal and spatial distribution of harbour porpoises in Shetland waters, 1990–95. European Research on Cetaceans 10: 234–237.

Evans, P. (2020) European Whales, Dolphins, and Porpoises: Marine Mammal Conservation in Practice, Academic Press, ISBN: 978-0-12-819053-1

Fauchald P (2010) Predator-prey reversal: a possible mechanism for ecosystem hysteresis in the North Sea. Ecology 91: 2191–2197.

Fennel W & Seifert T (2008) Oceanographic processes in the Baltic Sea. Die Küste 74: 77–91.

Finck P, Heinze S, Raths U, Riecken U & Ssymank A (2017) Rote Liste der gefährdeten Biotoptypen Deutschlands: dritte fortgeschriebene Fassung 2017. Naturschutz und Biologische Vielfalt 156.

Fließbach KL, Borkenhagen K, Guse N, Markones N, Schwemmer P & Garthe S (2019) A Ship Traffic Disturbance Vulnerability Index for Northwest European Seabirds as a Tool for Marine Spatial Planning. Frontiers in Marine Science 6: 192.

Floeter J, van Beusekom JEE, Auch D, Callies U, Carpenter J, Dudeck T, Eberle S, Eckhardt A, Gloe D, Hänselmann K, Hufnagl M, Janßen S, Lenhart H, Möller KO, North RP, Pohlmann T, Riethmüller R, Schulz S, Spreizenbarth S, Temming A, Walter B, Zielinski O & Möllmann C (2017) Pelagic effects of offshore wind farm foundations in the stratified North Sea. Progress in Oceanography 156: 154–173.

Flyckt G, Hellquist A, Holmgren T, Holmqvist N, Larsson H, Strandberg R, Svanberg T, Söderberg P & Österblad P (2003) Fågelrapport 2002. In: SkOF. Fåglar I Skåne: 97–192.

Fox AD & Petersen IK (2019) Offshore wind farms and their effects on birds. Dansk Orn. Foren. Tidsskr 113: 86 – 101.

Franco A, Elliott M, Franzoi P & Torricelli P (2008) Life strategies of fishes in European estuaries: the functional guild approach. Marine Ecology Progress Series 354: 219–228.

Fransson T & Pettersson J (2001) Svensk ringmärkningsatlas. Vol. 1. Stockholm.

Freyhof J (2009) Rote Liste der im Süßwasser reproduzierenden Neunaugen und Fische (Cyclostomata & Pisces). In: Haupt H, Ludwig G, Gruttke H, Binot-Hafke M, Otto C & Pauly A (Red.) Rote Liste gefährdeter Tiere, Pflanzen und Pilze Deutschlands, Band 1: Wirbeltiere. Naturschutz und Biologische Vielfalt 70 (1): 291–316.

Fricke R, Rechlin O, Winkler H, Bast H-D & Hahlbeck E (1996) Rote Liste und Artenliste der Rundmäuler und Meeresfische des deutschen Meeres- und Küstenbereichs der Ostsee. *In*: Nordheim H von & Merck T (Ed.) Rote Listen und Artenlisten der Tiere und Pflanzen des deutschen

Meeres- und Küstenbereichs der Ostsee. Landwirtschaftsverlag Münster, Schriftenreihe für Landschaftspflege und Naturschutz 48: 83–90.

FROESE R & PAULY D (HRSG) (2000) FishBase 2000: concepts, design and data sources. ICLARM, Los Baños, Laguna, Philippines. 344 pages. www.fishbase.org, Accessed on 14.03.2018.

GALATIUS A, KINZE CC & TEILMANN J (2012) Population structure of harbour porpoises in the Baltic region: Evidence of separation based on geometric morphometric comparisons. Journal of the Marine Biological Association of the United Kingdom.

GALLUS A, DÄHNE M & BENKE H (2010) Monitoringbericht 2009-2010. Marine Säugetiere und Seevögel in der deutschen AWZ von Nord- und Ostsee. Teilbericht Marine Säugetiere. Akustische Erfassung von Schweinswalen in der Ostsee. FTZ Westküste & Deutsches Meeresmuseum Stralsund. Im Auftrag des Bundesamtes für Naturschutz (BfN): Seite 35–56.

GALLUS A, KRÜGEL K & BENKE H (2015) Akustisches Monitoring von Schweinswalen in der Ostsee, Teil B in Monitoring von marinen Säugetieren 2014 in der deutschen Nord- Und Ostsee im Auftrag des BfN.

GARTHE S & HÜPPOP O (2004) Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index, Journal of Applied Ecology 41: 724-734.

GARTHE S (2000) Mögliche Auswirkungen von Offshore-Windenergieanlagen auf See- und Wasservögel der deutschen Nord- und Ostsee. In: Merck T & von Nordheim H (Hrsg) Technische Eingriffe in marine Lebensräume. Workshop des Bundesamtes für Naturschutz, Internationale Naturschutzakademie Insel Vilm, 27–29 Oktober 1999: BfN-Skripten 29: 113–119. Bonn/ Bad Godesberg.

GARTHE S, DIERSCHKE V, WEICHLER T & SCHWEMMER P (2004) Rastvogelvorkommen und Offshore-Windkraftnutzung: Analyse des Konfliktpotenzials für die deutsche Nord- und Ostsee. Abschlussbericht des Teilprojektes 5 im Rahmen des Verbundvorhabens "Marine Warmblüter in Nord- und Ostsee: Grundlagen zur Bewertung von Windkraftanlagen im Offshorebereich (MINOS)". Forschungs- u.Technologiezentrum Westküste, Universität Kiel, Büsum.

GARTHE S, HÜPPOP O & WEICHLER T (2002) Anleitung zur Erfassung von Seevögeln auf See von Schiffen. Seevögel 23 (2): 47−55.

GARTHE S, SCHWEMMER H, MÜLLER S, PESCHKO V, MARKONES N & MERCKER M (2018) Seetaucher in der Deutschen Bucht: Verbreitung, Bestände und Effekte von Windparks. Report for the Federal Maritime and Hydrographic Agency and the Federal Agency for Nature Conservation. Published at: http://www.ftz.uni-kiel.de/de/forschungsabteilungen/ecolab-oekologie-mariner-tiere/laufende-projekte/offshore-windenergie/Seetaucher_Windparkeffekte_Ergebnisse_FTZ_BIONUM.pdf

GARTHE S, ULLRICH N, WEICHLER T, DIERSCHKE V, KUBETZKI U, KOTZERKA J, KRÜGER T, SONNTAG N & HELBIG AJ (2003) See- und Wasservögel der deutschen Ostsee. Verbreitung, Gefährdung und Schutz. Landwirtschaftsverlag, Münster-Hiltrup. 170 pages.

GASSNER E, WINKELBRAND A & BERNOTAT D (2005) UVP – Rechtliche und fachliche Anleitung für die Umweltverträglichkeitsprüfung. 476 pages.

GERLACH SA (2000) Checkliste der Fauna der Kieler Bucht und eine Bibliographie zur Biologie und Ökologie der Kieler Bucht. In: Bundesanstalt für Gewässerkunde (Hrsg) Die Biodiversität in der deutschen Nord- und Ostsee, Band 1. Bericht BfG-1247, Koblenz. 376 pages.

GESSNER J, DEBUS L, FILIPIAK J, SPRATTE S, SKORA K & ARNDT GM (2000) Development of sturgeon catches in German and adjacent waters since 1980. J.ournal of Applied Ichthyology 15: 136−141.

GILL AB, GLOYNE-PHILLIPS I, NEAL KJ & KIMBER JA (2005) The potential effects of electromagnetic fields generated by sub-sea power cables associated with offshore wind farm developments on electrically and magnetically sensitive marine organisms – a review. Report to Collaborative Offshore Wind Research into the Environment (COWRIE) group, Crown Estates.

GILLES A & SIEBERT U (2009) Erprobung eines Bund-Länder-Fachvorschlags für das Deutsche Meeresmonitoring von Seevögeln und Schweinswalen als Grundlage für die Erfüllung der Natura2000-Berichtspflichten mit einem Schwerpunkt in der deutschen AWZ der Nord- und Ostsee (FFHBerichtsperiode 2007-2012), Teilbericht Schweinswale.

GILLES A, HERR H, LEHNERT K, SCHEIDAT M & SIEBERT U (2008) Harbour porpoises – abundance estimates and seasonal distribution patterns. In: Wollny-Goerke K & Eskildesen K (Hrsg): Marine mammals and seabirds in front of offshore wind energy. MINOS-marine blooded animals in North and Baltic Seas. Teubner Verlag, Wiesbaden.

GILLES A, HERR H, LEHNERT K, SCHEIDAT M, KASCHNER K, SUNDERMEYER J, WESTERBERG U & SIEBERT U (2007) MINOS+ Final report sub-project 2 – "Erfassung der Dichte und Verteilungsmuster von Schweinswalen (*Phocoena phocoena*) in der deutschen Nord- und Ostsee".

GILLES A, PESCHKO V, SIEBERT U, GALLUS A, HANSEN S, KRÜGEL K, DÄHNE M & BENKE H (2011) Monitoringbericht 2010-2011. Marine Säugetiere und Seevögel in der deutschen AWZ von Nord- und Ostsee. Stiftung Tierärztliche Hochschule Hannover, Institut für Terrestrische und Aquatische Wildtierforschung (ITAW) & Deutsches Meeresmuseum Stralsund. Im Auftrag des Bundesamtes für Naturschutz (BfN).

GILLES A, SCHEIDAT M & SIEBERT U (2004) Erfassung von Meeressäugetieren und Seevögeln in der deutschen AWZ von Nord- und Ostsee (EMSON) - Teilvorhaben: Erfassung von Meeressäugetieren -. internal report 09/2004 for the Federal Agency for Nature Conservation, Vilm. FKZ: 802 85 260.

GILLESPIE D, BROWN S, LEWIS T, MATTHEWS J, MCLANAGHAN R & MOSCROP A (2003) Relative abundance of harbour porpoises (*Phocoena phocoena*) in the Baltic from acoustic and visual surveys. Annual Meeting of the European Cetacean Society, Tenerife, Spain.

GJOSAETER J, LEKVE K, STENSETH NC, LEINAAS HP, CHRISTIE H, DAHL E, DANIELSEN D, EDVARDSEN B, OLSGARD F, OUG E & PAASCHE E (2000) A long term perpspective on the Chrysochromulina bloom on the Norwegian Skagerrak coast 1988: a catastrophe or an innocent incident? Marine Ecology Progress Series 207: 201−218.

GLOCKZIN M & ZETTLER ML (2008) Spatial macrozoobenthic distribution patterns and responsible major environmental factors - a case study from the Pomeranian Bay (southern Baltic Sea), Journal of Sea Research 59 (3): 144−161.

GOGINA M, NYGARD H, BLOMQVIST M, DAUNYS D, JOSEFSON AB, KOTTA J, MAXIMOV A, WARZOCHA J, YERMAKOV V, GRÄWE U & ZETTLER ML (2016) The Baltic Sea scale inventory of benthic faunal communities. ICES Journal of Marine Science 73(4): 1196−1213.

GOSSELCK F & GEORGI F (1984) Benthic recolonization of the Lübeck Bight (Western Baltic) in 1980/1981. Limnologica 15: 407−414.

GOSSELCK F (1992) Zwischen Artenreichtum und Tod. Die Tiere des Meeresbodens der Lübecker Bucht als Maßstab ihrer Umwelt. Ber. Ver. Natur Heimat Kulturhist. Mus. Lübeck 23/24: 41−61.

GOSSELCK F, ARLT G, BICH A, BÖNSCH R, KUBE J, SCHROEREN V & VOSS J (1996) Rote Liste und Artenliste der benthischen wirbellosen Tiere des deutschen Meeres- und Küstenbereichs der Ostsee.In: Nordheim H von & Merck T (Hrsg) (1996): Rote Listen und Artenlisten der Tiere und Pflanzen des deutschen Meeres- und Küstenbereichs der Ostsee. – Schriftenreihe für Landschaftspflege und Naturschutz 48: 41−51.

GOSSELCK F, DOERSCHEL F & DOERSCHEL T (1987) Further developments of macrozoobenthos in Lübeck Bay, following recolonisation in 1980/81. Internationale Revue der gesamten Hydrobiologie 72: 631−638.

GRAHAM KR & SEBENS KP (1996) The distribution of marine invertebrate larvae near vertical surfaces in the rocky subtidal zone. Ecology 77:933−949.

GREEN M & ALERSTAM T (2000) Flight speeds and climb rates of Brent Geese: mass-dependent differences between spring and autumn migration. Journal of Avian Biology 31: 215−225.

GREEN M (2005) Flying with the wind – spring migration of Arctic breeding waders and geese over South Sweden. Ardea 92: 145−160.

GRENMYR U (2003) Kungsfågelns svåra år. *Vår Fågelvärld* 1: 6−10.

GRÖGER JP, KRUSE GH & ROHLF N (2010) Slave to the rhythm: how large-scale climate cycles trigger herring (*Clupea harengus*) regeneration in the North Sea. ICES Journal of Marine Science 67(3): 454–465.

GROVE RS, CH SONU & M NAKAMURA (1989) Recent Japanese trends in fishing reef design and planning. Bulletin of Marine Science 44: 984-996.

GUILLEMETTE M, LARSEN JK & CLAUSAGER I (1999) Assessing the impact of the Tunø Knob wind park on sea ducks: the influence of food resources.

Department of Coastal Zone Ecology. Neri Technical Report No 263.

GUTIERREZ M, SWARTZMAN G, BERTRAND A & BERTRAND S (2007) Anchovy (*Engraulis ringens*) and sardine (*Sardinops sagax*) spatial dynamics and aggregation patterns in the Humboldt Current ecosystem, Peru, from 1983–2003. Fisheries Oceanography 16(2): 155–168.

HAGMEIER A (1925) Vorläufiger Bericht über die vorbereitenden Untersuchungen der Bodenfauna der Deutschen Bucht mit dem Petersen-Bodengreifer. – Berichte der Deutschen Wissenschaftlichen Kommission Meeresforschung, Band 1: 247−272.

HANSEN L (1954) Birds killed at lights in Denmark 1886–1939. Videnskabelige meddelelser, Dansk Naturhistorisk Forening I København, 116, 269−368.

HARDEN JONES FR (1968) Fish migration. Edward Arnold, London.

HARDER K & SCHULZE G (1997) Robben und Wale in der Wismar Bucht. Meer und Museum, Stralsund.

HARDER K & SCHULZE G (2001) Meeressäugetiere in der Darß-Zingster Boddenkette. Meer und Museum 16: 112–114.

HARDER K (1996) Zur Situation der Robbenbestände. In: J. L. Lozan et al. (Ed.): Warnsignale aus der Ostsee. Blackwell. Berlin. p. 236–242.

HASLØV & KJÆRSGAARD (2000): Vindmøller syd for Rødsand ved Lolland – vurderinger af de visuelle påvirkninger. SEAS Distribution A.m.b.A. Teil der Hintergrunduntersuchungen zur Umweltverträglichkeitsuntersuchung.

HAUPT H, LUDWIG G, GRUTTKE H, BINOT-HAFKE M, OTTO C & PAULY A (2009) Rote Liste gefährdeter Tiere, Pflanzen und Pilze Deutschlands. Band 1: Wirbeltiere. BfN, Bonn.

HAYS CG, RICHARDSON AJ & ROBINSON C (2005) Climate change and marine plankton. Trends in Ecology and Evolution, Review 20: 337−344.

HEATH MF & EVANS MI (2000) Important Bird Areas in Europe, Priority Sites for Conservation, Vol 1: Northern Europe, BirdLife International, Cambridge.

HEATH MF, BORGGREVE C & PEET N (2000) European bird populations: estimates and trends. Cambridge, UK: BirdLife International, BirdLife Conservation Series No. 10.

HEESSEN HJL, DAAN N & ELLIS JR (2015) Fish atlas of the Celtic Sea, North Sea, and Baltic Sea: based on international research-vessel surveys. Academic Publishers, Wageningen.

HELCOM (2004) Phytoplankton biomass and species succession in the Gulf of Finland, Northern Baltic Proper and Arkona Basin in 2004. Indicators 2004, HELCOM.

HELCOM (2006) Development of tools for assessment of eutrophication in the Baltic Sea. Baltic Sea Environm. Proc. No. 104.

HELCOM (2009) Eutrophication in the Baltic Sea – An integrated thematic assessment of the effects of nutrient enrichment and eutrophication in the Baltic Sea region. Helsinki Commission. Balt. Sea Environ. Proc. No.115B.

HELCOM (2013a) Red List of Baltic Sea underwater biotopes, habitats and biotope complexes. Baltic Sea Environment Proceedings No. 138.

HELCOM (2013b) HELCOM Red List of Baltic Sea species in danger of becoming extinct. Baltic Sea Environment Proceedings No. 140.

HELCOM (2013c) Red List Species, Species information Sheet Mammals – Harbour Porpoise, IUCN, 2016-2. *Phocoena phocoena* (Baltic Sea Population).

HELCOM (2018): State of the Baltic Sea – Second HELCOM holistic assessment 2011-2016. Baltic Sea Environment Proceedings 155.

HERRMANN C & KRAUSE JC (2000) Ökologische Auswirkungen der marinen Sand- und Kiesgewinnung. In: H. von Nordheim und D. Boedeker. Umweltvorsorge bei der marinen Sand- und Kiesgewinnung. BLANO-Workshop 1998. BfN-Skripten 23. Federal Agency for Nature Conservation (Ed.). Bonn Bad Godesberg, 2000. 20−33.

HIBY L & LOVELL P (1996) Baltic/North Sea aerial surveys. 11 pages.

HIDDINK JG, JENNINGS S, KAISER MJ, QUEIRÓS AM, DUPLISEA DE & PIET GJ (2006) Cumulative impacts of seabed trawl disturbance on benthic biomass, production, and species richness in different habitats.

Canadian Journal of Fisheries and Aquatic Sciences 63(4): 721−736.

HISLOP J, BERGSTAD OA, JAKOBSEN T, SPARHOLT H, BLASDALE T, WRIGHT P, KLOPPMANN MHF, HILLGRUBER N & HEESSEN H (2015) 32. Cod fishes (Gadidae). In: HEESSEN H, DAAN N, ELLIS JR (Hrsg) Fish atlas of the Celtic Sea, North Sea, and Baltic Sea: based on international research-vessel surveys. Academic Publishers, Wageningen, Seite 186–194.

HOFFMANS G.J.C.M., VERHEIJ H.J. (1997): Scour Manual, CRC Press, 224 S.HOLLAND RA & WIKELSKI M (2009) Studying the migratory behavior of individual bats: current techniques and future directions. Journal of Mammalogy 90(6): 1324-1329.

HOLLOWED AB, BARANGE M, BEAMISH RJ, BRANDER K, COCHRANE K, DRINKWATER K, FOREMAN MGG, HARE JA, HOLT J, ITO S, KIM S, KING JR, LOENG H, MACKENZIE BR, MUETER FJ, OKEY TA, PECK MA, RADCHENKO VI, RICE JC, SCHIRRIPA MJ, YATSU A & YAMANAKA Y (2013) Projected impacts of climate change on marine fish and fisheries. ICES Journal of Marine Science 70:1023–1037.

HOPPE W, BECKMANN M, KMENT M (2018) Gesetz über die Umweltverträglichkeitsprüfung (UVPG). Umwelt-Rechtsbehelfsgesetz (UmwRG). Commentary, 5th edition.

HORCH P & KELLER V (2005) Windkraftanlagen und Vögel − ein Konflikt? Eine Literaturrecherche. Schweizerische Vogelwarte, Sempach.

HOUDE ED (1987) Fish early life dynamics and recruitment variability. American Fisheries Society Symposium 2: 17–29.

HOUDE ED (2008) Emerging from Hjort's Shadow. Journal of Northwest Atlantic Fishery Science 41: 53–70.

HÜPPOP O, MICHALIK B, BACH L, HILL R, PELLETIER SK (2019b) Migratory birds and bats. In: PERROW, M. R. (Ed.): Wildlife and Wind Farms, Conflicts and Solutions, Vol. 3, Offshore: Potential Effects: S. 142-173. Pelagic Publishing, Exeter.

HÜPPOP K & HÜPPOP O (2002) Atlas zur Vogelberingung auf Helgoland. Teil 1: Zeitliche und regionale Veränderungen der Wiederfundraten und Todesursachen auf Helgoland beringter Vögel (1909 bis 1998). Die Vogelwarte 41: 161−180.

HÜPPOP O & HÜPPOP K (2003) North Atlantic Oscillation and timing of spring migration in birds. Proceedings of the Royal Society of London B 270: 233−240.

HÜPPOP O, BALLASUS H, FIEßER F, REBKE M & STOLZENBACH F (2005b) AWZ-Vorhaben: Analyse und Bewertungsmethoden von kumulativen Auswirkungen von Offshore-WKA auf den Vogelzug"; FKZ 804 85 004, final report

HÜPPOP O, DIERSCHKE J, EXO K-M, FREDRICH E & HILL R (2006) Bird migration studies and potential collision risk with offshore wind turbines. Ibis 148: 90−109.

HÜPPOP O, DIERSCHKE J, EXO K-M, FREDRICH E. & HILL R (2005a) AP1 Auswirkungen auf den Vogelzug. In: OREJAS C, JOSCHKO T, SCHRÖDER A, DIERSCHKE J, EXO K-M, FREDRICH E, HILL R, HÜPPOP O, POLLEHNE F, ZETTLER ML, BOCHERT R (Hrsg) Ökologische Begleitforschung zur Windenergienutzung im Offshore-Bereich auf Forschungsplattformen in der Nord- und Ostsee (BeoFINO) - Endbericht Juni 2005, Bremerhaven: Seite 7−160.

HÜPPOP O, HILL R, HÜPPOP K & JACHMANN F (2009) Auswirkungen auf den Vogelzug. Begleitforschung im Offshore-Bereich auf Forschungsplattformen in der Nordsee (FINOBIRD), Abschlussbericht.

HUTTERER R, IVANOVA T, MEYER-CORDS C & RODRIGUES L (2005) Bat Migrations in Europe. - Naturschutz und Biologische Vielfalt 28, 180 pages.

HYDER K, WELTERSBACH MS, ARMSTRONG M, FERTER K, TOWNHILL B, AHVONEN A, ARLINGHAUS R, BAIKOV A, BELLANGER M, BIRZAKS J, BORCH T, CAMBIE G, DE GRAAF M, DIOGO HMC, DZIEMIAN L, GORDOA A, GRZEBIELEC R, HARTILL B, KAGERVALL A, KAPIRIS K, KARLSSON M, RING KLEIVEN A, LEJK AM, LEVREL H, LOVELL S, LYLE J, MOILANEN P, MONKMAN G, MORALES-NIN B, MUGERZA E, MARTINEZ R, O'REILLY P, OLESEN HJ, PAPADOPOULOS A, PITA P, RADFORD Z, RADTKE K, ROCHE W, ROCKLIN D, RUIZ J, SCOUGAL C, SILVESTRI R, SKOV C, STEINBACK S, SUNDELÖF A, SVAGZDYS A, TURNBULL D, VAN DER HAMMEN T, VAN VOORHEES D, VAN WINSEN F, VERLEYE T, VEIGA P, VØLSTAD J-H, ZARAUZ L, ZOLUBAS T, & STREHLOW HV (2017) Recreational sea fishing in Europe in a global context—Participation rates, fishing effort, expenditure, and implications for monitoring and assessment. Fish and Fisheries 19: 225–243.

IBL UMWELTPLANUNG GMBH, BIOCONSULT SH GMBH & CO KG, IFAÖ INSTITUTE FOR APPLIED ECOSYSTEM RESEARCH GMBH (2017) Cluster "Northern Helgoland" Annual report 2017. Ergebnisse der ökologischen Untersuchungen für das Schutzgut Rastvögel. Unveröffentl. Gutachten i.A. der E.ON Climate & Renewables GmbH, innogy SE und WindMW GmbH, Oldenburg, Juni 2018.

IBL Umweltplanung GmbH, BioConsult SH GmbH & Co KG, IfAÖ Institute for Applied Ecosystem Research GmbH (2017) Cluster "Northern Helgoland" Annual report 2017. Ergebnisse der ökologischen Untersuchungen für das Schutzgut Rastvögel. Unveröffentl. Gutachten i. A. der E.ON Climate & Renewables GmbH, innogy SE und WindMW GmbH, Oldenburg, Juni 2018.

ICES (2019) Baltic Sea Ecoregion – Ecosystem overview. https://www.ices.dk/community/advisory-process/Pages/Ecosystem-overviews.aspx.

ICES, Internationaler Rat für Meeresforschung (1992) Effects of Extraction of Marine Sediments on Fisheries. ICES Cooperative Reserach Report No. 182, Kopenhagen.

ICES, Internationaler Rat für Meeresforschung (2017a) Fisheries overview – Baltic Sea Ecoregion. 24 pages, DOI: 10.17895/ices.pub.4389.

ICES, Internationaler Rat für Meeresforschung (2017b) Report of the Working Group on Bycatch of Protected Species (WGBYC), 12–15 June 2017, Woods Hole, Massachusetts, USA. ICES CM 2017/ACOM: 24, 82 pages.

ICES, Internationaler Rat für Meeresforschung (2019) Fisheries overview – Baltic Sea Ecoregion. 29 pages, ICES Advice 2019 – https://doi.org/10.17895/ices.pub.XXXX.

ICES, Internationaler Rat für Meeresforschung Database of Trawl Surveys (DATRAS), Extraction date 12 March 2018. International Bottom Trawl Survey (IBTS) data 2016−2018; http://datras.ices.dk. ICES, Copenhagen.

ICES, Internationaler Rat für Meeresforschung WGEXT (1998) Cooperative Research Report, Final Draft, April 24, 1998.

ICES, Internationaler Rat für Meeresforschung WGEXT (2004) Report of the Study Group to Review Ecological Quality Objectives for Eutrophication. ICES Advisory Committee on Ecosystems. ICES CM 2004/ACE: 04 Ref. ACME, C, E.

IFAF, Institut für angewandte Forschung GmbH (2004) Fachgutachten Fischbiologische Beschreibung & Bewertung des Projektes "Hochsee Windpark Nordsee" der EOS Offshore AG. 30.08.2004.

IfAÖ (2013) Offshore-Windpark "Windanker" - Fachgutachten Fische. 1. und 2. Jahr der Basisaufnahme. Betrachtungszeitraum: Herbst 2011 bis Frühjahr 2013. Juli 2013. Institute for Applied Ecosystem Research GmbH, Neu Broderstorf, 75 pages.

IfAÖ (2019) Fachgutachten Fische zum Offshore-Windparkprojekt "Baltic Eagle". Basisaufnahme nach StUK 4 im Herbst 2018, Fachgutachten im Auftrag der Iberdrola Baltic Eagle GmbH, 56 pages.

IfAÖ (2019) Untersuchungen der Schutzgüter Benthos, Biotoptypen und Fische im Bereich der Fläche "O-1.3". Zwischenbericht über das 1. Jahr der Flächenvoruntersuchung. Bericht Version 3 vom 04.12.2019.

IfAÖ (2020) Validierung von Verdachtsflächen mit potenziell gesetzlich geschützten Biotoptypen im Bereich der Fläche "O-1.3". Ergebnisbericht 2020. Bericht Version 2 vom 28.07.2020.

IfAÖ GmbH & BioConsult SH & Co.KG (2018) Environmental monitoring in the cluster "Western Adlergrund". Fachgutachten Rastvögel. 3. Untersuchungsjahr März 2016 – Februar 2017. Unpublished expert opinion for Iberdrola Renovables Offshore Deutschland GmbH and E.ON Climate & Renewables GmbH, Husum, October 2018.

IfAÖ GmbH & BioConsult SH & Co.KG (2019) Environmental monitoring in the cluster "Western Adlergrund". Fachgutachten Rastvögel. 2. Untersuchungsjahr März 2017 – Februar 2018. Unpublished expert opinion for Iberdrola Renovables Offshore Deutschland GmbH und E.ON Climate & Renewables GmbH, Husum, February 2019.

IfAÖ GmbH, DHI A/S & Avitec Research GbR (2020) Vogelzug über der deutschen AWZ der Ostsee Methodenkombination zur Einschätzung des Meideverhaltens und Kollisionsrisikos windkraftsensibler Arten mit Offshore-Windenergieanlagen, im Auftrag des Bundesamtes für Seeschifffahrt und Hydrographie, Stand: Entwurf vom 10.März 2020.

IfAÖ Institute for Applied Ecosystem Research GmbH (2005a) Gutachtlicher Vorschlag zur Identifizierung, Abgrenzung und Beschreibung sowie vorläufigen Bewertung der zahlen- und flächenmäßig geeignetsten Gebiete zur Umsetzung der Richtlinie 79/409/EWG in den äußeren Küstengewässern Mecklenburg-Vorpommerns. Unpublished expert opinion for LUNG M-V, Broderstorf.

IFAÖ INSTITUTE FOR APPLIED ECOSYSTEM RESEARCH GMBH (2005b) BENTHOS – Bestandsaufnahme und Monitoring benthischer Lebensgemeinschaften des Sublitorals vor der Außenküste Mecklenburg-Vorpommerns – Teilvorhaben "Monitoring Makrozoobenthos", report for 2004. Unpublished expert opinion of the Institut für Angewandte Ökologie on behalf of LUNG M-V, 192 S. (cited in SORDYL et al., 2010).

IFAÖ INSTITUTE FOR APPLIED ECOSYSTEM RESEARCH GMBH (2009) Wirkungen durch erhöhte Trübungen, Resuspension und Sedimentation bei submarinen Baggerungen, Pflug-Trenchen sowie Verklappungen. Literaturstudie. Anhang 8 der Umweltverträglichkeitsstudie zur Nord Stream Pipeline.

IFAÖ INSTITUTE FOR APPLIED ECOSYSTEM RESEARCH GMBH (2013) Export opinion "Benthos" for the offshore wind farm "Windanker". Bericht über die Basisaufnahme. Betrachtungszeitraum Herbst 2011 / Frühjahr 2012 / Herbst 2012 / Frühjahr 2013. Unpublished expert opinion for Iberdrola Renovables Deutschland GmbH. 108 pages.

IFAÖ INSTITUTE FOR APPLIED ECOSYSTEM RESEARCH GMBH (2015) Spezielle biotopschutzrechtliche Prüfung (BRP) für das 1. und 2. Untersuchungsjahr der Basisaufnahme zum Bau und Betrieb des Offshore-Windparks "Windanker". Unpublished expert opinion for Iberdrola Renovables Deutschland GmbH. Stand 27.11.2015. 15 pages.

IFAÖ INSTITUTE FOR APPLIED ECOSYSTEM RESEARCH GMBH (2015a) Export opinion "Benthos" for the offshore wind farm project "EnBW Baltic 2". Baubegleitendes Monitoring. Betrachtungszeitraum: Herbst 2014.

IFAÖ INSTITUTE FOR APPLIED ECOSYSTEM RESEARCH GMBH (2016) Umweltverträglichkeitsstudie (UVS) für das 1. und 2. Untersuchungsjahr der Basisaufnahme zum Bau und Betrieb des Offshore-Windparks "Windanker". Unpublished expert opinion for Iberdrola Renovables Deutschland GmbH. Stand 27.11.2015. 650 pages.

IFAÖ INSTITUTE FOR APPLIED ECOSYSTEM RESEARCH GMBH (2019) Untersuchungen der Schutzgüter Benthos, Biotoptypen und Fische im Bereich der Fläche "O-1.3" – Zwischenbericht über das 1. Jahr der Flächenvoruntersuchung. Unveröffentliches Gutachten im Auftrag des Bundesamtes für Seeschifffahrt und Hydrographie.

IFAÖ (2020) Validierung von Verdachtsflächen mit potenziell gesetzlich geschützten Biotoptypen im Bereich der Fläche "O-1.3". Ergebnisbericht 2020. Unveröffentliches Gutachten im Auftrag des Bundesamtes für Seeschifffahrt und Hydrographie.

IPCC, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (2001) Third Assessment Report. Climate Change 2001.

IPCC, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (2007) Fourth Assessment Report. Climate Change 2007.

IUCN (2008) Cetacean update of the 2008 IUCN Red List of Threatened Species.

IWC – INTERNATIONAL WHALING COMMISSION (2000) Report of the Scientific Committee, Annex O. Report of the IWC-ASCOBANS working group on harbour porpoises. Journal of Cetacean Research and Management 2 (Suppl.): 297–304.

JANSSEN F, SCHRUM C & BACKHAUS JO (1999) A Climatological Data Set of Temperature and Salinity for the Baltic Sea and the North Sea, German Journal of Hydrography (Supplement 9), 245 pages.

JENSEN J & MÜLLER-NAVARRA SH (2008) Storm surges on the German Coast. Die Küste 74: 92–124.

JOHNSON G (2004) A review of bat impacts at wind farms in the US. Proceedings of the Wind Energy and Birds / Bats Workshop: Understanding and Resolving Bird and Bat Impacts, Washington D.C., Sept. 2004.

KAHLERT J, PETERSEN IK, FOX AD, DESHOLM M & CLAUSAGER I (2004) Investigations of birds during construction and operation of Nysted offshore wind farm at Rødsand-Annual status report 2003: Report request. Commissioned by Energi E2 A/S.

KARLSON AML, ALMQVIST G, SKORA KE & APPELBERG M (2007) Indications of competition between non-indigenous round goby and native flounder in the Baltic Sea. ICES Journal of Marine Science 64: 479–486.

KARLSSON L (1992) Falsterbo ur fågelperspektiv. Anser, supplement 32.

KARLSSON O & HELANDER B (2005) Development of the Swedish Baltic grey seal stock 1990-2004. Abstract. Symposium on the biology and management of seals in the Baltic Area. 15-18 February 2005, Helsinki, Finland, 21 pages.

KASCHNER K (2001) Harbour porpoises in the North Sea and Baltic - bycatch and current status. Report for the Umweltstiftung WWF - Deutschland; 82 pages.

KASCHNER K (2003) Review of small cetacean bycatch in the ASCOBANS area and adjacent waters–current status and suggested future actions. Report to ASCOBANS, 122 pages.

KETTEN DR (2002) Marine mammal auditory systems: a summary of audiometric and anatomical data and implications for underwater acoustic impacts. Polarforschung, 72 (2/3): 79–92.

KING M (2013) Fisheries Biology, assessment and management. John Wiley & Sons.

KINZE CC (1990) Chapter 6: The behaviour of freeranging harbour porpoises (Phocoena phocoena) in inner Danish waters. PhD. University of Copenhagen. 39 pp.

KLOPPMANN MHF, BÖTTCHER, U, DAMM U, EHRICH S, MIESKE B, SCHULTZ N & ZUMHOLZ K (2003) Erfassung von FFH-Anhang-II-Fischarten in der deutschen AWZ der Nord- und Ostsee. Studie im Auftrag des BfN, Bundesforschungsanstalt für Fischerei. Final report, Hamburg, 82 pages.

KNUST R, DAHLHOFF P, GABRIEL J, HEUERS J, HÜPPOP O & WENDELN H (2003) Investigation to avoid and reduce possible impacts of wind energy parks on the marine environment in the offshore areas of North and Baltic Sea. Final report; Untersuchungen zur Vermeidung und Verminderung von Belastungen der Meeresumwelt durch Offshore-Windenergieanlagen im kuestenfernen Bereich der Nord-und Ostsee-Offshore WEA. Final report.

KNUST R, DALHOFF P, GABRIEL J, HEUERS J, HÜPPOP O & WENDELN H (2003) Untersuchungen zur Vermeidung und Verminderung von Belastungen der Meeresumwelt durch Offshore-Windenergieanlagen im küstenfernen Bereich der Nord- und Ostsee ("offshore WEA"). Final report of the research and development project no. 200 97 106 of the Federal Environment Agency, 454 pages with annexes.

KOCK M (2001) Untersuchungen des Makrozoobenthos im Fehmarnbelt, einem hydrographisch besonders instabilen Übergangsbereich zwischen zentraler und westlicher Ostsee. Dissertation zur Erlangung des Doktorgrades der Mathematisch-Naturwissenschaftlichen Fakultät der Christian-Albrechts-Universität zu Kiel. 103 S. und Anhang.

KÖLMEL R (1979) The annual cycle of macrozoobenthos: its community structures under the influence of oxygen deficiency in the Western Baltic. In Cyclic phenomena in marine plants and animals, Seite 19–28. Pergamon.

KOOP B (2005) Engpass im europäischen Vogelzug. Feste Fehmarnbelt-Querung. Betrifft: Natur 1:10−11.

KOSCHINSKI S (2002) Ship collisions with whales. Information document presented at the eleventh meeting of the CMS scientific council. 14-17 September 2002, Bonn/Germany. UNEP/ScC11/Inf.7. 19 pages.

KÖSTER FW, MÖLLMANN C, HINRICHSEN HH, WIELAND K, TOMKIEWICZ J, KRAUS G, VOSS R, MAKARCHOUK A, MACKENZIE BR, ST. JOHN MA, SCHNACK D, ROHLF N, LINKOWSKI T, BEYER JE (2005). Baltic cod recruitment–the impact of climate variability on key processes. ICES Journal of marine science 62(7): 1408−1425.

KRÄGEFSKY S (2014) Effects of the alpha ventus offshore test site on pelagic fish. In: BEIERSDORF A, RADECKE A (Hrsg) Ecological research at the offshore windfarm alpha ventus − challenges, results and perspectives. Federal Maritime and Hydrographic Agency (BSH), Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). Springer Spektrum, 201 pages.

KRAMARSKA R (1998) Origin and Development of the Odra Bank in the Light of the Geologic Structure and Radiocarbon Dating. *Geological Quarterly*, 42, 277−288.

KRÖNCKE I (1995) Long-term changes in North Sea benthos. Senckenbergiana maritima 26 (1/2): 73−80.

KROST P, BERNHARD M, WERNER W & HUKRIEDE W (1990) Otter Trawl Tracks in Kiel Bay (Western Baltic) Mapped by Side-Scan Sonar. Meeresforschung 32: 344−353.

KRÜGER T & GARTHE S (2001) Flight altitude of coastal birds in relation to wind direction and speed, Atlantic Seabirds 3: 203−216.

KUBE J & STRUWE B (1994) Die Ergebnisse der Limikolenzählungen an der südwestlichen Ostseeküste 1991.

KUBETZKI U, GARTHE S & HÜPPOP O (1999) The diet of common gulls Larus canus breeding on the German North Sea Coast. Atlantic Seabirds 1: 57−70.

KÜHLMORGEN-HILLE G (1963) Quantitative Untersuchungen der Bodenfauna in der Kieler Bucht und ihrer jahreszeitlichen Veränderungen. Kiel Marine Research 19: 42−103.

KÜHLMORGEN-HILLE G (1965) Qualitative und quantitative Veränderungen der Bodenfauna der Kieler Bucht in den Jahren 1953-1965. Kiel Marine Research 21: 167−191.

KULLINCK U & MARHOLD S (1999) Abschätzung direkter und indirekter biologischer Wirkungen der elektrischen und magnetischen Felder des Eurokabels/ Viking Cable HGÜ-Bipols auf Lebewesen der Nordsee und des Wattenmeeres. Studie im Auftrag von Eurokabel/Viking Cable: 99 pages.

KUNC H, MCLAUGHLIN K & R SCHMIDT (2016) Aquatic noise pollution: implications for individuals, populations, and ecosystems. Proc. Royal Soc. B: Biological Sciences 283:20160839. DOI: 10.1098/rspb.2016.0839.

KVITTEK R & BRETZ C (2005) Shorebird foraging behaviour, diet and abundance vary with harmful algal bloom toxin concentrations in invertebrate prey. Marine Ecology Progress Series 293: 303−309.

LAMBRECHT, H. & J. TRAUTNER (2007). Fachinformationssystem und Fachkonventionen zur Bestimmung der Erheblichkeit im Rahmen der FFH-VP. Endbericht zum Teil Fachkonventionen. Hannover, Filderstadt: 239 pages.

LANDMANN R VON & ROHMER G (2018) Umweltrecht Band I − Kommentar zum UVPG. München: C.H. Beck.

LANGE W, MITTELSTAEDT E & KLEIN H (1991) Strömungsdaten aus der westlichen Ostsee. Deutsche Hydrographische Zeitschrift, Series B, No. 24, 129 pages.

LASS HU (2003) Über mögliche Auswirkungen von Windparks auf den Wasseraustausch zwischen Nord- und Ostsee. In: Meeresumwelt-Symposium 2002. Ed.: Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit und Bundesamt für Seeschifffahrt und Hydrographie. Seite 121−130.

LAUSTEN M & LYNGS P (2004) Trækfugle på Christiansø 1976-2001. Christiansø Naturvidenskabelige Feltstation.

LEDER A (2003) Gutachterliche Stellungnahme zur Thematik: Beeinflussung der Wasserströmung durch einen Offshore-Windpark im Arkonabecken Südost. Institut für Maritime Systeme und Strömungstechnik, Universität Rostock.

LEMKE W (1998) Sedimentation und paläogeographische Entwicklung im westlichen Ostseeraum (Mecklenburger Bucht bis Arkona-Becken) vom Ende der Weichselvereisung bis zur Litorinatransgression. Meereswissenschaftliche Berichte, Warnemünde, 31, 156 S. mit Anhang.

LEONHARD SB, STENBERG C & STØTTRUP J (2011) Effect of the Horns Rev 1 Offshore Wind Farm on Fish Communities Follow-up Seven Years after Construction DTU Aqua Report No 246-2011 ISBN 978-87-7481-142-8 ISSN 1395−8216.

LIECHTI F & BRUDERER B (1998) The relevance of wind for optimal migratory theory. Journal of Avian Biology 29: 561−568.

LIECHTI F, KLAASEN M & BRUDERER B (2000) Predicting migratory flight altitudes by physiological migration models. The Auk 117: 205−214.

LINDEBOOM HJ, KOUWENHOVEN HJ, BERGMAN MJN, BOUMA S, BRASSEUR S, DAAN R, FIJN RC, DE HAAN D, DIRKSEN S, VAN HAL R, HILLE RIS LAMBERS R, TER HOFSTEDE R, KRIJGSVELD KL, LEOPOLD M & SCHEIDAT M (2011): SHORT-TERM ECOLOGICAL EFFECTS OF AN OFFSHORE WIND FARM IN THE DUTCH COASTAL ZONE; A COMPILATION. – ENVIRON. RES. LETT. 6: 1-13.

LUCKE K, LEPPER PA, BLANCHET M-A & SIEBERT U (2007a) Testing the auditory tolerance of harbour porpoise hearing for impulsive sounds. Posterpräsentation auf der internationalen Fachkonferenz: "Effects of Noise on Aquatic Life", Nyborg 2007.

LUCKE K, LEPPER PA, HOEVE B, EVERAARTS E, VAN ELK N & SIEBERT U (2007b) Perception of lowfrequency acoustic signals by a harbour porpoise in the presence of simulated offshore wind turbine noise. Aquatic mammals, 33: 55−68.

LUCKE K, LEPPER PA, BLANCHET M-A & SIEBERT U (2009) Temporary shift in masked hearing thresholds in a harbor porpoise (*Phocoena phocoena*) after exposure to seismic airgun stimuli. Journal of the Acoustic Society of America 125(6): 4060−4070.

LUCKE. K, SUNDERMEYER J & SIEBERT U (2006) MINOSplus Status Seminar, Stralsund, Sept. 2006, Präsentation.

LUDWIG A, DEBUS L, LIECKEFELD D, WIRING I, BENECKE N, JENCKENS I, WILLIOT P, WALDEMANN JR & PITRA C (2002) When the American sea sturgeon swam east. Nature 419: 447−448.

LYNAM CP, HAY SJ & BRIERLEY AS (2004) Interannual variability in abundance of North Sea jellyfish and links to the North Atlantic Oscillation. Limnology and Oceanography 49: 637−643.

MADSEN PT, WAHLBERG M, TOUGAARD J, LUCKE K & TYACK P (2006) Wind turbine underwater noise and marine mammals: implications of current knowledge and data needs, Marine Ecology Progress Series 309: 279−295.

MAKSIMOV Y (2004) The "revival" of the twaite shad (*Alosa fallax*, Lacepede 1803) population in the Curonian Lagoon. Bulletin of the Sea Fisheries Institute 1 (161): 61−62.

MARHOLD S & KULLNICK U (2000) Direkte oder indirekte biologische Wirkungen durch magnetische und/ oder elektrische Felder im marinen (aquatischen) Lebensraum. Überblick über den derzeitigen Erkenntnisstand. Teil II: Orientierung, Navigation, Migration. In: BfN-Skripten 29:19−30.

MARILIM (2016) Environmental monitoring in the cluster "Western Adlergrund". Fachgutachten Benthos, 1. Untersuchungsjahr März 2014 bis Februar 2015, 147 pages.

MARKONES N & GARTHE S (2009) Erprobung eines Bund/Länder-Fachvorschlags für das Deutsche Meeresmonitoring von Seevögeln und Schweinswalen als Grundlage für die Erfüllung der Natura2000-Berichtspflichten mit einem Schwerpunkt in der deutschen AWZ von Nord- und Ostsee FFH-Berichtsperiode 2007-2012). Teilvorhaben Seevögel, FTZ Büsum. Im Auftrag des Bundesamts für Naturschutz (BfN)

MARKONES N & GARTHE S (2011) Marine Säugetiere und Seevögel in der deutschen AWZ von Nord- und Ostsee. Teilbericht Seevögel. Monitoring 2010/2011 – Endbericht, FTZ Büsum. Im Auftrag des Bundesamts für Naturschutz (BfN).

MARKONES N, GUSE N, BORKENHAGEN K, SCHWEMMER H & GARTHE S (2014) Seevogel-Monitoring 2012/2013 in der deutschen AWZ von Nord- und Ostsee. Im Auftrag des Bundesamts für Naturschutz (BfN).

MARKONES N, GUSE N, BORKENHAGEN K, SCHWEMMER H & GARTHE S (2015) Seevogel-Monitoring 2014 in der deutschen AWZ von Nord- und Ostsee. Im Auftrag des Bundesamts für Naturschutz (BfN).

MARKONES N, SCHWEMMER H & GARTHE S (2013) Seevogel-Monitoring 2011/2012 in der deutschen AWZ von Nord- und Ostsee. Im Auftrag des Bundesamts für Naturschutz (BfN).

MCGREGOR RM, KING S, DONOVAN CR, CANECO B & WEBB A (2018): A Stochastic Collision Risk Model for Seabirds in Flight. – Report by Marine Scotland Science, 59 pp.

MEIER HEM, BROMAN B & KJELLSTRÖM E (2004) Simulated sea levels in past and future Climates of the Baltic Sea. Climate Research 27: 59–75.

MEINIG H, BOYE P & HUTTERER R (2008) Rote Liste und Gesamtartenliste der Säugetiere (Mammalia) Deutschlands. In: HAUPT H, LUDWIG G, GRUTTKE H, BINOT-HAFKE M, OTTO C & PAULY A (Hrsg) (2009) Rote Liste gefährdeter Tiere, Pflanzen und Pilze Deutschlands, Band 1: Wirbeltiere. Naturschutz und Biologische Vielfalt 70 (1): 115–153.

MEISSNER K, BOCKHOLD J & SORDYL H (2007) Problem Kabelwärme? – Vorstellung der Ergebnisse von Feldmessungen der Meeresbodentemperatur im Bereich der elektrischen Kabel im dänischen Offshore-Windpark Nysted Havmøllepark. Vortrag auf dem Meeresumweltsymposium 2006, CHH Hamburg.

MENDEL B, SCHWEMMER P, PESCHKO V, MÜLLER S, SCHWEMMER H, MERCKER M & GARTHE S (2019) Operational offshore wind farms and associated ship traffic cause profound changes in distribution patterns of Loons (Gavia spp.). Journal of environmental management 231: 429-438.

MENDEL B, SONNTAG N, SOMMERFELD J, KOTZERKA J, MÜLLER S, SCHWEMMER H, SCHWEMMER P & GARTHE S (2015) Untersuchungen zu möglichem Habitatverlust und möglichen Verhaltensänderungen bei Seevögeln im Offshore-Windenergie-Testfeld

(TESTBIRD). Schlussbericht zum Projekt Ökologische Begleitforschung am Offshore-Testfeldvorhaben alpha ventus zur Evaluierung des Standarduntersuchungskonzeptes des BSH (StUKplus). BMU Förderkennzeichen 0327689A/FTZ3. 166 pages.

MENDEL B, SONNTAG N, WAHL J, SCHWEMMER P, DRIES H, GUSE N, MÜLLER S & GARTHE S (2008) Artensteckbriefe von See- und Wasservögeln der deutschen Nord- und Ostsee. Verbreitung, Ökologie und Empfindlichkeiten gegenüber Eingriffen in ihren marinen Lebensraum. - Naturschutz und Biologische Vielfalt 28, Vol. 59, 437 pages.

METHRATTA ET & DARDICK WR (2019) Meta-Analysis of Finfish Abundance at Offshore Wind Farms. Reviews in Fisheries Science & Aquaculture 27(2): 242-260.

MEYERLE R & WINTER C (2002) Hydrografische Untersuchungen zum Offshore-Windpark SKY 2000. Im Auftrag der 1. SHOW VG.

MIELKE L, SCHUBERT A, HÖSCHLE C & BRANDT M (2017) Umweltmonitoring im Cluster "Westlich Austerngrund", Fachgutachten Meeressäuger, 2. Untersuchungsjahr, März 2015 bis Februar 2016.

MIESKE B (2003) Bericht über die 510. Reise des FFK "Solea" vom 13.06 bis 28.06.2003. Bundesforschungsanstalt für Fischerei (BfA). Website 6 pages.

MIESKE B (2006) Bericht über die 558. Reise des FFS "Solea" vom 12.06 bis 23.06.2006. Untersuchungen zur demersalen Fischfauna in den für Naturschutz bedeutsamen Gebieten vor der deutschen Ostseeküste mittels Grundschernetz. Bundesforschungsanstalt für Fischerei (BfA). Website 13 pages.

MINISTRY OF ENVIRONMENTAL PROTECTION AND REGIONAL DEVELOPMENT OF THE REPUBLIC OF LATVIA (2014) Agreement on the Conservation of bats in Europe - Report on the implementation of the agreement in Latvia 2010-2014. Inf. EUROBATS.MoP7.24.

MINISTRY OF THE ENVIRONMENT, FINLAND (2014) Agreement on the conservation of bats in Europe – National implementation report of Finland. Inf.EUROBATS.MoP7.17.

MINISTRY OF THE ENVIRONMENT, POLAND (2014) Agreement on the conservation of populations of European bats (EUROBATS) – National report on the implementation of the Agreement's resolutions prepared for 7th meeting of the parties in Brussels from 15th to 17th September 2014. Inf. EUROBATS.MoP7.34.

MITTENDORF, K, ZIELKE, W. (2002): Untersuchung der Wirkung von Offshore-Winenergie-Parks auf die Meersstroemung, Hanover 2002. (https://www.gigawind.de/f2002.html)

MÖBIUS K & HEINCKE F (1883) Die Fische der Ostsee. Kiel: 206 pages.

MÖBIUS K (1873) Die wirbellosen Tiere der Ostsee. Jahresbericht der Commission zur wissenschaftlichen Untersuchung der deutschen Meere in Kiel für das Jahr 1871, 1: 97–144.

MOHRHOLZ V, NAUMANN M, NAUSCH G, KRÜGER S, GRÄWE U (2015) Fresh oxygen for the Baltic Sea – An exceptional saline inflow after a decade of stagnation. – Journal of Marine Systems 148 152–166, doi: 10.1016/j.jmarsys.2015.03.005.

MÖLLMANN C, DIEKMANN R, MÜLLER-KARULIS B, KORNILOVS G, PLIKSHS M & AXE P (2009) Reorganization of a large marine ecosystem due to atmospheric and anthropogenic pressure: a discontinuous regime shift in the central Baltic Sea. Global Change Biology 15: 1377–1393.

MORA C, TITTENSOR DP, ADL S, SIMPSON AGB, WORM B (2011) How Many Species Are There on Earth and in the Ocean? PLoS Biol 9(8): e1001127.doi:10.1371/journal.pbio.1001127.

MOYLE PB & CECH JJ (2000) Fishes. An Introduction to Ichthyology. 4th Ed., Prentice Hall: 1-612.

MÜLLER HH (1981) Vogelschlag in einer starken Zugnacht auf der Offshore-Forschungsplattform "Nordsee" im Oktober 1979. Seevögel 2: 33−37

MUNK P, FOX CJ, BOLLE LJ, VAN DAMME CJ, FOSSUM P & KRAUS G (2009) Spawning of North Sea fishes linked to hydrographic features. Fisheries Oceanography 18(6): 458–469

NAUSCH G, NAUMANN M, UMLAUF L, MOHRHOLZ V, SIEGEL H (2016) Hydrographic-hydrochemical assessment of the Baltic Sea 2015. – Meereswissenschaftliche Berichte, Warnemünde, 101, in prep, doi: 10.12754/msr-2016-0101.

NAUTIK NORD & VBW (2012) OWP Windanker: Geological Prereport. 17.01.2012. Nautik Nord GmbH, Vermessungsbüro Weigt, Pohnsdorf.

NEHLS HW & ZÖLLICK Z (1990) The moult migration of the Common Scoter (*Melanitta nigra*) off the coast of the GDR. Baltic Birds 5 (Proceedings) Vol. 2: 36-46.

NELLEN W & THIEL R (1995) Fische. In: RHEINHEIMER G (Ed.) Meereskunde der Ostsee. 2nd edition. Springer-Verlag, Berlin, Heidelberg: 189−196.

NEWTON, I (2008). The Migration Ecology of Birds. NEWTON, I (2010) Bird migration.

NISSLING A, KRYVI H, & VALLIN L (1994) Variation in egg buoyancy of Baltic cod *Gadus morhua* and its implications for egg survival in prevailing conditions in the Baltic Sea. Marine Ecology Progress Series 110: 67–74.

NORD STREAM (2014) Results of Environmental and Socio-economic Monitoring 2013, Document-No. GPE-PER-MON-100-080400EN.

NORD STREAM 2 (2017) Umweltverträglichkeitsstudie (UVS) für den Bereich von der seeseitigen Grenze der deutschen ausschließlichen Wirtschaftszone (AWZ) bis zur Anlandung.

NORDHEIM H VON & MERCK T (1995). Rote Listen der Biotoptypen, Tier-und Pflanzenarten des deutschen Wattenmeer-und Nordseebereichs. Schriftenreihe für Landschaftspflege und Naturschutz 44, 138 pages.

ÖBERG J (2016) Cyanobacteria blooms in the Baltic Sea. 2016: HELCOM Baltic Sea Environment Fact Sheets 2016. Online. [Date Viewed], http://helcom.fi/baltic-sea-trends/environment-factsheets/ eutrophication/cyanobacterial-blooms-in-the-baltic-sea/

OEBERST R, KLENZ B, GRÖHSLER T, DICKEY-COLLAS M, NASH RDM & ZIMMERMANN C (2009). When is year-class strength determined in western Baltic herring? ICES Journal of Marine Science, 66(8), 1667–1672.

OECOS GMBH (2012) Umweltverträglichkeitsstudie zum Offshore-Windpark Baltic Eagle, September 2012, Hamburg.

OECOS GMBH (2015) Abschlussbericht nach Beendigung des zweiten Jahresganges der ökologischen Untersuchungen zum Offshore-Windpark Baltic Eagle – Aktualisierte Umweltverträglichkeitsstudie-Hamburg, März 2015.

OGAWA Y, S TAKEUCHI & A HATTORI (1977) An estimate for the optimum size of artificial reef. Bulletin of the Japanese Society of Fisheries Oceanography 30:39–45.

ÖHMAN MC, SIGRAY P & WESTERBERG H (2007). Offshore windmills and the effects of electromagnetic fields on fish. AMBIO: A journal of the Human Environment, 36(8), 630−633.

ÖSTERBLOM H, HANSSON S, LARSSON U, HJERNE O, WULFF F, ELMGREN R & FOLKE C (2007) Human-induced trophic cascades and ecological regime shifts in the Baltic Sea. Ecosystems 10 (6): 877–889.

ÖSTERBLOM H, OLSSON O, BLENCKNER T & FURNESS RW (2008) Junk-food in marine ecosystems. Oikos 117(7): 967−977.OJAVEER H (2006) The round goby *Neogobius melanostomus* is colonizing the NE Baltic Sea. Aquatic Invasions 1: 44–45. OSPAR commission (2010) Assessment of the environmental impacts of cables.

OSPAR (2017). Intermediate Assessment 2017. Available at:https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017.

PAINTING SJ, DEVLIN MJ, ROGERS SI, MILLS DK, PARKER ER & REES HL (2005) Assessing the suitability of OSPAR EcoQOs for eutrophication vs ICES criteria for England and Wales. Marine pollution bulletin 50(12): 1569–1584.

PANOV VE, KRYLOV PI & RICCARDI N (2004) Role of diapause in dispersal and invasion success by aquatic invertebrates. Journal of Limnology 63: 56–69.

PERRY AL, LOW PJ, ELLIS JR & REYNOLDS JD (2005) Climate change and distribution shifts in marine fishes. Science 308: 1912–1915.

PETERSEN CGJ (1918) The sea bottom and its production of fish-food. A survey of work done in connection with the valuation of the Danish waters from 1883-1917. Reports of the Danish Biological Station 25.

PETERSEN IK, CHRISTENSEN TK., KAHLERT J, DESHOLM M. & FOX AD (2006): Final results of bird studies at the offshore wind farms at Nysted and Horns Rev, Denmark. Report request. Commissioned by DONG Energy and Vattenfall A/S. – NERI, National Environmental Research Institute, 166 pp.

PETERSONS G (2004) Seasonal migrations of north-eastern populations of Nathusius' bat *Pipistrellus nathusii* (Chiroptera). Myotis 41(42): 29–56.

PETTERSSON J (2005) The Impact of Offshore Wind Farms on Bird Life in Southern Kalmar Sound, Sweden– A final report based on studies 1999 –2003. At the request of the Swedish Energy Agency. A reference group collaboration with its principal centre at The Department of Animal Ecology, Lund University. 125 pages.

PFEIFER G (1974) Schleswig-Holstein als Schlüsselpunkt des Vogelzuges zwischen Nord und Süd, Ost und West. Schmidt GAJ & Brehm K: Vogelleben zwischen Nord-und Ostsee, Neumünster.

PGU, PLANUNGSGEMEINSCHAFT UMWELTPLANUNG OFFSHORE WINDPARK (2012a) Konverterstation und Netzanbindungen im Cluster DolWin. Projekt DolWin1. Genehmigungsantrag. Gefährdung der Meeresumwelt / Natura2000-Gebietsschutz / Artenschutz / Biotopschutz/ Landschaftspflegerischer Begleitplan (Eingriffsregelung) / Untersuchungen.

PGU, PLANUNGSGEMEINSCHAFT UMWELTPLANUNG OFFSHORE WINDPARK (2012b) Konverterstationen und Netzanbindungen im Cluster DolWin. Projekt DolWin 2. Planfeststellungsantrag. Gefährdung der Meeresumwelt / Natura2000-Gebietsschutz / Artenschutz / Biotopschutz/ Landschaftspflegerischer Begleitplan (Eingriffsregelung) / Untersuchungen. Umweltfachliche Stellungnahme, August 2012.

PGU, PLANUNGSGEMEINSCHAFT UMWELTPLANUNG OFFSHORE WINDPARK (2013) HVAC- Netzanbindung OWP Butendiek. Umweltfachliche Stellungnahme: Gefährdung der Meeresumwelt / Natura 2000-Gebietsschutz / Artenschutz.

POLOVINA JJ & I SAKI (1989) Impacts of artificial reefs on fishery production in Shimamaki, Japan. Bulletin of Marine Science 44:997–1003.

POPPER AN & HAWKINS AD (2019) An overview of fish bioacoustics and the impacts of anthropogenic sounds on fishes. Journal of fish biology 94(5): 692–713.

POPPER AN, HAWKINS AD, FAY RR, MANN D, BARTOL S, CARLSON T, COOMBS S, ELLISON WT, GENTRY R, HALVORSEN MB, LOKKEBORG S, ROGERS P, SOUTHALL BL, ZEDDIES DG & TAVOLGA WN (2014) ASA S3 s−1C1. 4 TR-2014 sound exposure guidelines for fishes and sea turtles: A technical report prepared by ANSI-accredited standards committee S3 s−1C1 and registered with ANSI. New York, NY: Springer. 10.1007/978-3-319-06659-2, 76 pages.

POSTEL L (2005) Zooplankton: BLMP-Bericht, Meeresumwelt 1999-2002, Bund-Länder Messprogramm für die Meeresumwelt von Nord- und Ostsee, S. 237–243.

POTTER IC, TWEEDLEY JR, ELLIOTT M & WHITFIELD AK (2015) The ways in which fish use estuaries: a refinement and expansion of the guild approach. Fish and Fisheries 16(2): 230–239.

PRANGE H (2005) The status of the Common crane (*Grus grus*) in Europe-breeding, resting, migration, wintering, and protection.

PRENA J, GOSSELCK F, SCHROEREN V & VOSS J (1997) Periodic and episodic benthos recruitment in southwest Mecklenburg Bay (western Baltic Sea). Helgoländer Meeresuntersuchungen 51: 1–21.

RACHOR E (1990) Veränderungen der Bodenfauna. In: LOZAN JL, LENZ W, RACHOR E, WATERMANN B & VON WESTERNHAGEN H (Hrsg): Warnsignale aus der Nordsee. Paul Parey 385 pages.

RACHOR E, ARLT G, BICK A, BÖNSCH R, GOSSELCK F, HARMS J, HEIBER W, KRÖNCKE I, KUBE J, MICHAELIS H, REISE K, SCHROEREN V, VAN BERNEM K-H & VOSS J (1998) Rote Liste der bodenlebenden wirbellosen Meerestiere. – In: BINOT M, BLESS R, BOYE P, GRUTTKE H & PRETSCHER P (Bearb.), 1998: Rote Liste gefährdeter Tiere Deutschlands. - Schr.-R. Landschaftspfl. Natursch. 55: 290–300.

RACHOR E, BÖNSCH R, BOOS K, GOSSELCK F, GROTJAHN M, GÜNTHER C-P, GUSKY M, GUTOW L, HEIBER W, JANTSCHIK P, KRIEG H-J, KRONE R, NEHMER P, REICHERT K, REISS H, SCHRÖDER A, WITT J & ZETTLER ML (2013) Rote Liste und Artenlisten der bodenlebenden wirbellosen Meerestiere. In: BfN (Ed.) (2013) Rote Liste gefährdeter Tiere, Pflanzen und Pilze Deutschlands. Vol. 2: Meeresorganismen, Bonn.

RAUTENBERG W (1956) Über den Verlauf des Vogelzuges im Raum von Rügen, Beiträge zur Vogelkunde 6: 257–267.

READ AJ (1999) Handbook of marine mammals. Academic Press.

REBKE M, DIERSCHKE V, WEINER CN, AUMÜLLER R, HILL K & HILL R (2019) Attraction of nocturnally migrating birds to artificial light: The influence of colour, intensity and blinking mode under different cloud cover conditions.

REESE, A., VOIGT, N., ZIMMERMANN, T., IRRGEHER, J., & PRÖFROCK, D. (2020): Characterization of alloying components in galvanic anodes as potential environmental tracers for heavy metal emissions from offshore wind structures. Chemosphere (257) 127182, doi:10.1016/j.chemosphere.2020.127182.

REID PC, LANCELOT C, GIESKES WWC, HAGMEIER E & WEICHART G (1990) Phytoplankton of the North Sea and its dynamics: a review. Netherlands Journal of Sea Research, 26(2-4): 295–331.

REIJNDERS PJH (1992) Harbour porpoises *Phocoena phocoena* in the North Sea: numerical responses to changes in environmental conditions. Netherlands Journal of Aquatic Ecology 26: 75–85.

REMANE A (1934) Die Brackwasserfauna. Zoolischer Anzeiger (Suppl) 7: 34–74.

REMANE A (1955) Die Brackwasser-Submergenz und die Umkomposition der Coenosen in Belt-und Ostsee, Kieler Meeresforschung.

REMANE A (1958) Ökologie des Brackwassers. In: REMANE A & SCHLIEPER C (Hrsg) Die Biologie des Brackwassers. Schweizerbart´sche Verlagsbuchhandlung, Stuttgart, 1–216.

REMMERT H (1968) Über die Besiedlung des Brackwasserbeckens der Ostsee durch Meerestiere unterschiedlicher ökologischer Herkunft, Oecologia 1: 296–303.

REPECKA R (1999) Biology and resources of the main commercial fish species in the Lithuanian part of the Curonian Lagoon. Proceedings of Symposium on Freshwater Fish and the Herring (*Clupea harengus*) Populations in the Coastal Lagoons – Environment and Fisheries. Sea Fisheries Institute, Gdynia (Poland): 185–195.

REPECKA R (2003) Changes in the biological indices and abundance of salmon, sea trout, smelt, vimba and twaite shad in the coastal zone of the Baltic Sea and the Curonian Lagoon at the beginning of spawning migration. Acta Zoologica Lituania 13 (2): 195–216.

REUBENS JT, DEGRAER S, & VINCX M (2011) Aggregation and feeding behaviour of pouting (Trisopterus luscus) at wind turbines in the Belgian part of the North Sea. Fisheries Research, 108(1): 223–227.

RHEINHEIMER G (Hrsg) (1996) Meereskunde der Ostsee. Springer Heidelberg, 338 pages.

RICHARDSON JW (2002) Marine mammals versus seismic and other acoustic surveys: Introduction to the noise issue. Polarforschung, 72 (2/3): 63–67.

ROBINSON RA, LEARMONTH JA, HUTSON AM, MACLEOD CD, SPARKS TH, LEECH DI, PIERCE GJ, REHFISCH MM & CRICK HQP (Hrsg), 2005: Climate changes and migratory species. BTO Research Report 414, 312 pages.

ROSE, A., M. J. BRANDT, R. VILELA, A. DIEDERICHS, A. SCHUBERT, V. KOSAREV, G. NEHLS, M. VOLKENANDT, V. WAHL, A. MICHALIK, H. WENDELN, A. FREUND, C. KETZER, B. LIMMER, M. LACZNY, W. PIPER EFFECTS OF NOISE-MITIGATED OFFSHORE PILE DRIVING ON HARBOUR PORPOISE ABUNDANCE IN THE GERMAN BIGHT 2014-2016 (GESCHA 2) – (2019), PREPARED FOR ARBEITSGEMEINSCHAFT OFFSHOREWIND E.V., HTTPS://WWW.BWO-OFFSHOREWIND.DE/EN/GESCHA-2-STUDY/

RUBSCH S & KOCK KH (2004) German part-time fishermen in the Baltic Sea and their by-catch of harbour porpoise. ASCOBANS information document. ac11-doc10. ASCOBANS. Bonn, Germany. 12 pages.

RUMOHR H (1995) 6.3.2 Zoobenthos. In: RHEINHEIMER G (Ed.): Meereskunde der Ostsee. 2nd edition. – Berlin; Heidelberg; Mailand; Paris; Tokyo: Springer Verlag, 1995. 173–181.

RUMOHR H (1996) Veränderungen des Lebens am Meeresboden. In: LOZAN JL, LAMPE R, MATTHÄUS W, RACHOR E, RUMOHR H & VON WESTERNHAGEN H (Hrsg) Warnsignale aus der Ostsee. Paul Parey, 385 pages.

RUMOHR H (2003) Am Boden zerstört. Auswirkungen der Fischerei auf Lebewesen am Meeresboden des Nordost-Atlantiks. WWF Deutschland, 26 pages.

SAGER G & M BERNER (1989) Investigations of growth in length and weight of three flatfish species in the Baltic. Rapports et Proces-Verbaux des Reunions-Conseil International pour l'Exploration de la Mer 190:105–108.

SAMBAH (2014) Heard but not seen: Sea-scale passive acoustic survey reveals a remnant Baltic Sea Harbour Porpoise population that needs urgent protection. Non-technical report. Static Acoustic

Monitoring of the Baltic Harbour Porpoise. LIFE 08 NAT/S/000261, SAMBAH.

SAMBAH (2016) Potential breeding area revealed for the endangered Baltic Sea Harbour Porpoise. Press Release on 10th Dec 2014 from the SAMBAH project. LIFE 08 NAT/S/000261, SAMBAH.

SAPOTA MR & SKORA KE (2005) Spread of alien (non-indigenous) fish species *Neogobius melanostomus* in the Gulf of Gdánsk (south Baltic). Biological Invasions 7: 157–164.

SCHEIDAT M, GILLES A & SIEBERT U (2004) Erfassung der Dichte und Verteilungsmuster von Schweinswalen (*Phocoena phocoena*) in der deutschen Nord- und Ostsee. MINOS - Teilprojekt 2, Abschlussbericht, Seite 77–114.

SCHEIDAT M, GILLES A, KOCK KH & SIEBERT U (2008) Harbour porpoise (*Phocoena phocoena*) abundance in the southwestern Baltic Sea. Endangered Species Research 5: 215–223.

SCHEIDAT M, TOUGAARD J, BRASSEUR S, CARSTENSEN J, VAN POLANEN-PETEL T, TEILMANN J & REIJNDERS P (2011) Harbour porpoises (*Phocoena phocoena*) and wind farms: a case study in the Dutch North Sea. Environmental Research Letters 6.

SCHIELE KS, DARR A, ZETTLER ML, FRIEDLAND R, TAUBER F, VON WEBER M & VOSS J (2015) Biotope map of the German Baltic Sea. Marine Pollution Bulletin 96(1–2): 127–135.

SCHIRMEISTER B (2003) Verluste von Wasservögeln in Stellnetzen der Küstenfischerei – das Beispiel der Insel Usedom. Meer und Museum, 17, 160–166.

SCHOMERUS T, RUNGE K, NEHLS G, BUSSE J, NOMMEL J & POSZIG D (2006) Strategische Umweltprüfung für die Offshore-Windenergienutzung. Grundlagen ökologischer Planung beim Ausbau der Offshore-Windenergie in der deutschen Ausschließlichen Wirtschaftszone. Schriftenreihe Umweltrecht in Forschung und Praxis, Band 28, Verlag Dr. Kovac, Hamburg 2006. 551 pages.

SCHRÖDER A, GUTOW L, JOSCHKO T, KRONE R, GUSKY M, PASTER M & POTTHOFF M (2013) Benthosökologische Auswirkungen von Offshore-Windeneregieparks in der Nordsee (BeoFINO II). Abschlussbericht zum Teilprojekt B "Benthosökologische Auswirkungen von Offshore-Windenergie-parks in Nord und Ostsee. Prozesse im Nahbereich der Piles". BMU Förderkennzeichen 0329974B. hdl:10013/epic.40661.d001.

SCHUCHARDT B (2010) Marine Landschaftstypen der deutschen Nord- und Ostsee. F&E-Vorhaben im Auftrag des Bundesamtes für Naturschutz (BfN). 58 S. + Anhänge.

SCHULZ S (1968) Rückgang des Benthos in der Lübecker Bucht. Monatsbericht. Dt. akad. Wissensch. Berlin 10: 748–754.

SCHULZ S (1969a) Benthos und Sediment in der Mecklenburger Bucht. Beiträge zur Meereskunde 24/25: 15–55.

SCHULZ S (1969b) Das Makrobenthos der südlichen Beltsee (Mecklenburger Bucht und angrenzende Seegebiete). Beiträge zur Meereskunde 25: 21–46.

SCHULZE G (1996) Die Schweinswale. Westarp Wissenschaften. Magdeburg. 191 pages.

SCHULZ-OHLBERG J, LEMKE W & TAUBER F(2002) Tracing Dumped Chemical Munitions in Pomeranian Bay (Baltic Sea) at Former Transport Routes to the Dumping Areas off Bornholm Island. In: MISSIAEN T & HENRIET J-P (Hrsg) Chemical Munition Dump Sites in Coastal Environments. Belgian Ministry of Social Affairs, Public Health and Environment, 43–51.

SCHWARZ J, HARDER K, VON NORDHEIM H & DINTER W (2003) Wiederansiedlung der Ostseekegelrobbe (*Halichoerus grypus balticus*) an der deutschen Ostseeküste. Angewandte Landschaftsökologie 54. 1–206.

SCHWEMMER P (2020) Vortrag zum Projjekt BIRDMOVE beim Fachgespräch zum Vogelzug am 21.02.2020 im BSH Hamburg.

SCHWEMMER P, ENNERS L, GARTHE S (2016) Migration routes of Eurasian Curlews (*Numenius aquata*) resting in der eastern Wadden Sea based on GPS telemetry. J Ornithol 157: 901 – 905-

SCHWEMMER P, MENDEL B, SONNTAG N, DIERSCHKE V & GARTHE S (2011) Effects of ship traffic on seabirds in offshore waters: Implications for marine conservation and spatial planning. Ecological Applications 21/5: 1851–1860. DOI: 10.2307/23023122.

SEEBENS A, FUß A, ALLGEYER P, POMMERANZ H, MÄHLER M, MATTHES H, GÖTTSCHE M, GÖTTSCHE M, BACH L & PAATSCH C (2013) Fledermauszug im Bereich der deutschen Ostseeküste. Unveröff. Gutachten im Auftrag des Bundesamtes für Seeschifffahrt und Hydrographie.

SERIGSTAD B (1987) Oxygen uptake of developing fish eggs and larvae. Sarsia 72(3-4): 369–371.

SGFEN (2001) Incidental catches of small cetaceans. Report of the meeting of the subgroup on fishery and the environment (SGFEN) of the Scientific, Technical and Economic Committee for fisheries (STECF), Brussels, 10- 14 December 2001. SEC (2002) 376. 83 pages.

SHUMWAY SE, ALLEN SM & BOERSMA PD (2003) Marine birds and harmful algal blooms: sporadic victims or under-reported events? Harmful Algae 2(1): 1–17.

SIEBERT U, GILLES A, LUCKE K, LUDWIG M, BENKE H, KOCK KH & SCHEIDAT M (2006). A decade of harbour porpoise occurrence in German waters—analyses of aerial surveys, incidental sightings and strandings. Journal of Sea Research 56(1): 65–80.

SIEGEL H, GERTH M & MUTZKE A (1999) Dynamics of the Oder river plume in the Southern Baltic Sea: saltellite data and numerical modelling. Continental Shelf Research 19: 1143–1159.

SKIBA R (2003) Europäische Fledermäuse: Kennzeichen, Echoortung und Detektoranwendung. Westarp Wissenschaften-Verlags GmbH, Hohenwarsleben.

SKORA ME (2003) Charakterytyka populacji parposza *Alosa fallax fallax* (Lacépède, 1803) z rejonu Zatoki Gdanskiej. Magisterwork, Uniwersytet Gdanski: 85 pages.

SKOV H, CHRISTENSEN KD, JACOBSEN EM, MEISSNER J & DURINCK J (1998) Birds and marine mammals. Baseline investigation. Fehmarn Belt Feasibility Study coast-to-coast investigations of environmental impact. Technical note, phase 2. COWI-Lahmeyer. Report-no. 27774C-E-N-11-1.

SKOV H, DESHOLM M, HEINÄNEN S, JOHANSEN TW & THERKILDSEN OR (2015): Birds and bats at Kriegers Flak. Baseline investigations and impact assessment for establishment of an offshore wind farm. – Aarhus University & DHI.

SKOV H, DURINCK J, LEOPOLD MF & TASKER ML (1995) Important bird areas for seabirds in the North Sea including the Channel and the Kattegat. BirdLife International, Cambridge.

SKOV H, HEINÄNEN S, NORMAN T, WARD RM, MÉNDEZ-ROLDÁN S & ELLIS I (2018) ORJIP Bird Collision and Avoidance Study. Final report – April 2018. The Carbon Trust. United Kingdom. 247 pages.

SKOV H, HEINÄNEN S, ŽYDELIS R, BELLEBAUM J, BZOMA S, DAGYS M, DURINCK J, GARTHE S, GRISHANOV G, HARIO M, KIECKBUSCH JJ, KUBE J, KURESOO A, LARSSON K, LUIGUJÕE L, MEISSNER W, NEHLS HW, NILSSON L, PETERSEN IK, MIKKOLA ROOS M, PIHL S, SONNTAG N, STOCK A, STIPNIECE A & WAHL J (2011) Waterbird populations and pressures in the Baltic Sea. – TemaNord 550.

SMOLCZYK U (2001) Grundbau Taschenbuch Teil 2, Geotechnische Verfahren: Anhaltswerte zur Wärmeleitfähigkeit wassergesättigter Böden. Ernst & Sohn-Verlag, Berlin.

SOLDAL AV, O BRONSTAD, O-B HUMBORSTAD, T JORGENSEN, S LOKKEBORG & I SVELLINGEN (1998) Oil production structures in the North Sea as fish aggregating devices. ICES C.M. 1998/ U 11:1-12.

SOMMER A (2005) Vom Untersuchungsrahmen zur Erfolgskontrolle. Inhaltliche Anforderungen und Vorschläge für die Praxis von Strategischen Umweltprüfungen, Wien.

SOMMER U, ABERLE N, ENGEL A, HANSEN T, LENGFELLNER K, SANDOW M, WOHLERS J, ZÖLLNER E & RIEBESELL U (2007) An indoor mesocosm system to study the effect of climate change on the late winter and spring succession of Baltic Sea phyto-and zooplankton. Oecologia 150(4), 655–667.

SONNTAG N (2010). Investigating a seabird hotspot: factors influencing the distribution of birds in the southern Baltic Sea (Doctoral dissertation, Christian-Albrechts Universität Kiel).

SONNTAG N, MENDEL B & GARTHE S (2006) Die Verbreitung von See- und Wasservögeln in der deutschen Ostsee im Jahresverlauf. Vogelwarte 44: 81–122.

SORDYL H, GOSSELCK F, SHAQIRI A & FÜRST R (2010) Einige Aspekte Zu Makrozoobenthischen Lebensräumen Und Raumordnerischen Sachverhalten In Marinen Gebieten Der Deutschen Ostsee. In: KANNEN A ET AL. (Hrsg) Forschung Für Ein Integriertes Küstenzonenmanagement: Fallbeispiele Odermündung Und Offshore-Windkraft In Der Nordsee. Coastline Reports 15 (2010), Seite 185–196.

SOUTHALL BL, BOWLES AE, ELLISON WT, FINNERAN JJ, GENTRY RL, GREENE CR JR., KASTAK D, KETTEN DR, MILLER JH, NACHTIGALL PE, RICHARDSON WJ, THOMAS

JA & Tyack PL (2007) Marine mammal noise exposure criteria: Initial scientific recommendations. Aquatic Mammals 33: 411–521.

Southall Brandon L., James J. Finneran, Colleen Reichmuth, Paul E. Nachtigall, Darlene R. Ketten, Ann E. Bowles, William T. Ellison, Douglas P. Nowacek, and Peter L. Tyack (2019). Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. Vol. 45, 2.

Stanley DR & CA Wilson (1997) Seasonal and spatial variation in the abundance and size distribution of fishes associated with a petroleum platform in the northern Gulf of Mexico. Canadian Journal of Fisheries and Aquatic Science 54:1166-1176.

Stenberg C, M van Deurs, JG Støttrup, H Mosegaard, T Grome, GE Dinesen, A Christensen, H Jensen, M Kaspersen, CW Berg, SB Leonhard, H Skov, J Pedersen, C Hvidt & M Klaustrup (2011) Effect of the Horns Rev 1 Offshore Wind Farm on Fish Communities. Follow-up Seven Years after Construction: Follow-up Seven Years after Construction. In: SB Leonhard, C Stenberg & JG Støttrup. DTU Aqua Report. National Institute of Aquatic Ressources, Technical University of Denmark (DTU Aqua), Charlottenlund, Danmark, 99.

Sumer, B.M., Fredsoe, J. (2002): The Mechanics Of Scour In The Marine Environment. World Scientific, 536 S.

Sutton M.A., Bleeker A., Howard C.M., Bekunda M., Grizzetti B., de Vries W., van Grinsven H.J.M., Abrol Y.P., Adhya T.K., Billen G.,. Davidson E.A, Datta A., Diaz R., Erisman J.W., Liu X.J., Oenema O., Palm C., Raghuram N., Reis S., Scholz R.W., Sims T., Westhoek H. & Zhang F.S., with contributions from Ayyappan S., Bouwman A.F., Bustamante M., Fowler D., Galloway J.N., Gavito M.E., Garnier J., Greenwood S., Hellums D.T., Holland M., Hoysall C., Jaramillo V.J., Klimont Z., Ometto J.P., Pathak H., Plocq Fichelet V., Powlson D., Ramakrishna K., Roy A., Sanders K., Sharma C., Singh B., Singh U., Yan X.Y. & Zhang Y. (2013) Our Nutrient World: The challenge to produce more food and energy with less pollution. Global Overview of Nutrient Management. Centre for Ecology and Hydrology, Edinburgh on behalf of the Global Partnership on Nutrient Management and the International Nitrogen Initiative.

Swedish Environmental Protection Agency (2006) Agreement on the conservation of bats in Europe – National implementation report from Sweden 2006. Inf. EUROBATS.MoP5.40.

Tardent P (1993) Meeresbiologie. Eine Einführung. 2nd newly revised and extended edition. Georg Thieme Verlag, Stuttgart, New York, 305 pages.

Tauber F (2012) Meeresbodensedimente in der deutschen Ostsee. Bundesamt für Seeschifffahrt und Hydrographie, Hamburg.

Teilmann J & Heide-Jorgensen MP (2001) Sæler i Østersøen, Kattegatt og Limfjorden 2000. - In: Laursen K (Ed.) Overvågning af fugle, sæler og planter 1999-2000, med resultater fra feltstationerne. Faglig rapport fra DMU nr. 350: 1–103.

Teilmann J, Sveegaard S & Dietz R (2011) Status of a harbour population - evidence for population separation and declining abundance. In: Sveegaard, S., 2010: Spatial and temporal distribution of harbour porpoises in relation to their prey. PhD Thesis.

Teilmann J, Tougaard J & Carstensen J (2004) Effects of the Nysted Offshore windfarm construction on harbour porpoises- comparisons with Horns Reef. Workshop on Offshore Wind Farms and the Environment, 21–22 Sept. 2004, Billund, DK, Presentation.

Thamm R, Schernewski G, Wasmund N & Neumann T (2004) Spatial phytoplankton pattern in the Baltic Sea, Coastline Reports, 4. 85–109.

Thiel R & Winkler HM (2007) Erfassung von FFH-Anhang II-Fischarten in der deutschen AWZ der Nord- und Ostsee (ANFIOS). Endbericht über das F&E-Vorhaben, FKZ: 803 85 220.

Thiel R & Winkler HM (2007) Erfassung von FFH-Anhang II-Fischarten in der deutschen AWZ der Nord- und Ostsee (ANFIOS). Endbericht über das F&E-Vorhaben, FKZ: 803 85 220.

Thiel R, Riel P, Neumann R, Winkler HM, Böttcher U & Gröhsler T (2007) Return of twaite shad *Alosa fallax* (Lacépède, 1803) to the Southern Baltic Sea and the transitional area between the Baltic and North Seas. Hydrobiologia 602(1): 161–177.

Thiel R, Winkler H, Böttcher U, Dänhardt A, Fricke R, George M, Kloppmann M, Schaarschmidt T, Ubl C, & Vorberg, R (2013) Rote Liste und Gesamtartenliste der etablierten Fische und Neunaugen (Elasmobranchii, Actinopterygii & Petromyzontida) der marinen Gewässer

Deutschlands. Naturschutz und Biologische Vielfalt 70 (2): 11–76.

THIEL R, WINKLER HM & URHO L (1996) Zur Veränderung der Fischfauna. In: LOZÁN JL, LAMPE R, MATTHÄUS W, RACHOR E, RUMOHR H & VON WESTERNHAGEN H (Hrsg) Warnsignale aus der Ostsee, Verlag Paul Parey, Berlin: 181–188.

THIELE R (2005) A review of 30 years FWG transmission loss measurements in the Baltic. Proceedings of the International Conference "Underwater Acoustic Measurements: Technologies & Results" Heraklion, Crete, Greece, 2005.

THORSON G (1957) Bottom communities (sublittoral or shallow shelf). Treatise on Marine Ecology and Palaeoecology Vol I, Ecology, ed. J.W. Hedgpeth. Memoirs of the Geological Society of America 67: 461–534.

TISCHLER W (1993) Einführung in die Ökologie. (4. Aufl.) Fischer Stuttgart.

TOLLIT DJ, BLACK AD THOMPSON PM, MACKAY A, CORPE HM, WILSON B, VAN PARIJS SM, GRELLIER K & PARLANE S (1998) Variations in harbour seal *Phoca vitulina* diet and dive-depths in relation to foraging habitat. Journal of Zoology 244: 209–222.

TRESS J, TRESS C, SCHORCHT W, BIEDERMANN M, KOCH R & IFFERT D (2004) Mitteilungen zum Wanderverhalten der Wasserfledermaus (*Myotis daubentonii*) und der Rauhhautfledermaus (*Pipistrellus nathusii*) aus Mecklenburg. – Nyctalus (N. F.) 9: 236−248.

UBA (2004) Studie zur Ermittlung von Hintergrundwerten bzw. der natürlichen Variabilität von chemischen und biologischen Messgrößen im Meeresmonitoring; UBA Texte 38/04; ISSN 0722-186X; Seite 45–46.

VALDEMARSEN JW (1979) Behavioural aspects of fish in relation to oil platforms in the North Sea. ICES Council Meeting1979/B: 27.

VAN BEUSEKOM JEE, THIEL R, BOBSIEN I, BOERSMA M, BUSCHBAUM C, DÄNHARDT A, ... & RICK J (2018). Aquatische Ökosysteme: Nordsee, Wattenmeer, Elbeästuar und Ostsee. In Hamburger Klimabericht–Wissen über Klima, Klimawandel und Auswirkungen in Hamburg und Norddeutschland (pp. 89-107). Springer Spektrum, Berlin, Heidelberg.

VARANASI U (1989) Metabolism of polycyclic aromatic hydrocarbons in the aquatic environment. CRC Press Inc. Boca Raton. Florida.

VAUK G & PRÜTER J (1987) Möwen. Niederelbe-Verlag, Otterndorf.

VBW WEIGT GMBH ((2020a) Hydrographic Survey O-01-03 Final report for the Federal Maritime and Hydrographic Agency.

VBW WEIGT GMBH ((2020B) Hydrographic survey O-01-03 - Object mapping, Report on behalf of the Federal Maritime and Hydrographic Agency.

VELASCO F, HEESSEN HJL, RIJNSDORP A & DE BOOIS I (2015) 73. Flatfishes (Pleuronectidae). In: HEESSEN H, DAAN N, ELLIS JR (Hrsg) Fish atlas of the Celtic Sea, North Sea, and Baltic Sea: based on international research-vessel surveys. Academic Publishers, Wageningen, Seite 429–446.

VERFUSS UK, JABBUSCH M, DAEHNE M & BEHNKE H (2004) Untersuchung der Raumnutzung durch Schweinswale in der Nord- und Ostsee mit Hilfe akustischer Methoden (PODs). Endbericht MINOS, Teilprojekt 3.

VON NORDHEIM H & MERCK T (1995): Rote Liste der Biotoptypen, Tier- und Pflanzenarten des deutschen Wattenmeer- und Nordseebereichs. - Federal Agency for Nature Conservation (BfN) (Ed.), Bonn-Bad Godesberg, 139 pages.

VON WESTERNHAGEN H & DETHLEFSEN V (2003) Änderungen der Artenzusammensetzung in Lebensgemeinschaften der Nordsee. In LOZÁN JL, RACHOR E, REISE K, SÜNDERMANN J & VON WESTERNHAGEN H (Hrsg) Warnsignale aus Nordsee & Wattenmeer. Eine aktuelle Umweltbilanz. Wissenschaftliche Auswertungen, Hamburg 2003. 161−168.

VON WESTERNHAGEN H., DETHLEFSEN V. (2003). Änderung der Artenzusammensetzung in Lebensgemeinschaften der Nordsee = Changes in species composition of North Sea communities, in: Lozán, J.L. et al. (Ed.) Warnsignale aus Nordsee & Wattenmeer: eine aktuelle Umweltbilanz. pp. 161-168.

WADE PR (1998) Calculating limits tot he allowable human-caused mortality of cetaceans and pinnipeds. Marine Mammal Science 14(1): 1-37.

WALTER G, MATTHES H & JOOST M (2005) Fledermauszug über Nord- und Ostsee. Natur und Landschaft 41: 12–21.

WASMUND N (1997) Occurence of cyanobacterial blooms in the Baltic Sea in relation to environmental conditions. Internationale Revue der gesamten Hydrobiologie 82: 169–184.

WASMUND N (2012) Faktenblatt zur Auswirkung der Eutrophierung auf das Phytoplankton der zentralen Ostsee.

WASMUND N, DUTZ J, POLLEHNE F, SIEGEL H, ZETTLER ML (2016a) Biological Assessment of the Baltic Sea 2015. Meereswissenschaftliche Berichte Warnemünde 102 DOI: 10.12754/msr-2016-0102.

WASMUND N, BUSCH S, GÖBEL J, GROMISZ S, HÖGLANDER H, JAANUS A, JOHANSEN M, JURGENSONE I, KARLSSON C, KOWNACKA J, KRAŚNIEWSKI W, LEHTINEN S, OLENINA I & WEBER MV (2016b) Cyanobacteria biomass: information from the Phytoplankton Expert Group (PEG). HELCOM Baltic Sea Environment Fact Sheet. HELCOM http://helcom.fi/baltic-sea-trends/environment-factsheets/ eutrophication/cyanobacteria-biomass.

WASMUND N, DUTZ J, POLLEHNE F, SIEGEL H, ZETTLER ML (2016a) Biological Assessment of the Baltic Sea 2015. Meereswissenschaftliche Berichte Warnemünde 102 DOI: 10.12754/msr-2016-0102.

WASMUND N, DUTZ J, POLLEHNE F, SIEGEL H, ZETTLER ML (2017) Biological Assessment of the Baltic Sea 2016. Meereswissenschaftliche Berichte Warnemünde 105 DOI: 10.12754/msr-2017-0105.

WASMUND N, NAUSCH G, POSTEL L, WITEK Z, ZALEWSKI M, GROMISZ S, LYSIAK-PASTUSZAK E, OLENINA I, KAVOLYTE R, JASINSKAITE A, MÜLLER-KARULIS B, IKAUNIECE A, ANDRUSHAITIS A, OJAVEER H, KALLSTE K & JAANUS A (2000) Trophic status of coastal and open areas of the south-eastern Baltic Sea based on nutrient phytoplankton data from 1993-1997, Mar. Sci. Reports IOW, No. 38, 83 pages.

WASMUND N, POLLEHNE F, POSTEL L, SIEGEL H & ZETTLER ML (2004) Biologische Zustandseinschätzung der Ostsee im Jahre 2003. Meereswissenschaftliche Berichte Warnemünde, 60, 94 pages.

WASMUND N, POLLEHNE F, POSTEL L, SIEGEL H & ZETTLER ML (2005) Biologische Zustandseinschätzung der Ostsee im Jahre 2004, Marine Science Reports IOW No.64, 78 pages.

WASMUND N, POSTEL L & ZETTLER ML (2012) Biologische Bedingungen in der deutschen AWZ der Ostsee im Jahre 2011.

WATLING L & NORSE EA (1998). Disturbance of the seabed by mobile fishing gear: a comparison to forest clearcutting. Conservation Biology 12(6): 1180−1197.

WEIGELT M (1985) Auswirkungen des Sauerstoffmangels 1981 auf Makrozoobenthos und Bodenfische in der Kieler Bucht. Berichte aus Institut für Meereskunde an der Christian-Albrechts-Universität Kiel 138: 122 pages.

WEIGELT M (1987) Auswirkungen von Sauerstoffmangel auf die Bodenfauna der Kieler Bucht. Berichte aus dem Institut für Meereskunde Kiel, 176: 1–297.

WEILGART L (2018) The impact of ocean noise pollution on fish and invertebrates. Report for OceanCare, Switzerland. 36 pages, https://www. oceancare. org/wp-content/uploads/2017/10/OceanNoise_FishInvertebrates_May2018. pdf .

WELCKER J (2019a) Patterns of nocturnal bird migration in the German North and Baltic Seas. Technical report. BioConsult SH, Husum. 70 pp (in Vorbereitung).

WELCKER J (2019b) Weather-dependence of nocturnal bird migration and cumulative collision risk at offshore wind farms in the German North and Baltic Seas. Technical report. BioConsult SH, Husum. 70 pp (in Vorbereitung).

WENDELN H & KUBE J (2005) Zugplanbeobachtungen in der westlichen Ostsee: die Bedeutung des "Darßer Ortes" für den sichtbaren Vogelzug. 137. Jahresversammlung der DO-G, 29. September bis 4. Oktober 2004 in Kiel. Abstract. Vogelwarte 43: 77.

WENDELN H, BELLEBAUM J, KUBE J, LIECHTI F & STARK H (2008) Zugverhalten von Kranichen (*Grus grus*) über der Ostsee. Vogelwarte 46: 359–360.

WERNER F, HOFFMANN G, BERNHARD M, MILKERT D & VKGREN K (1990) Sedimentologische Auswirkungen der Grundfischerei in der Kieler Bucht (Westliche Ostsee). Meyniana 42: 123–151.

WETLANDS INTERNATIONAL (2012) Waterbird Population Estimates – Fifth edition. Wetlands International, Wageningen, The Netherlands.

WILTSHIRE KH & MANLY BF (2004) The warming trend at Helgoland Roads, North Sea: phytoplankton response. Helgoland marine research 58(4): 269.

WINKLER HM & SCHRÖDER H (2003) Die Fische der Ostsee, Bodden und Haffe. In: Fische und Fischerei in Ost- und Nordsee. Meer und Museum, Vol. 17. Publication by the German Marine Museum.

WINKLER HM & SCHRÖDER H (2003) Die Fische der Ostsee, Bodden und Haffe. In: Fische und Fischerei in Ost- und Nordsee. Meer und Museum, Vol. 17. Publication by the German Marine Museum.

WINKLER HM (1991) Changes of structure and stock in exploited fish communities in estuaries of the southern Baltic coast (Mecklenburg-Vorpommern, Germany). Internationale Revue der gesamten Hydrobiologie 76: 413−422.

WINKLER HM (2006) Die Fischfauna der südlichen Ostsee. Meeresangler-Magazin 16: 17–18.

WINKLER HM, SKORA K, REPECKA R, PLIKSH M, NEELO A, URHO L, GUSHIN A & JESPERSEN H (2000) Checklist and status of fish species in the Baltic Sea. ICES, CM 2000/Mini 11: 1–14.

WINKLER HM, WATERSTRAAT A & HAMANN N (2002) Rote Liste der Rundmäuler, Süßwasser- und Wanderfische Mecklenburg-Vorpommerns, kommentiert, Stand 2002. Umweltministerium Mecklenburg-Vorpommern.

WOLFSON A, VAN BLARICOM G, DAVIS N & LEWBEL GS (1979) The marine life of an offshore oil platform. Marine Ecology Progress Series 1: 81–89.

WOODS P, VILCHEK B & WRIGHTSON B (2001) Pile installation demonstration project (PIDP), Construction report: Marine Mammal Impact Assessment; Impact on Fish.

WOOTTON RJ (2012) Ecology of teleost fishes. Springer Science & Business Media.

ZEHNDER S, ÅKESSON S, LIECHTI F & BRUDERER B (2001) Nocturnal autumn bird migration at Falsterbo, South Sweden. Journal of Avian Biology 32: 239–248.

ZETTLER M, BÖNSCH R & GOSSELCK F (2001) Distribution, abundance, and some population characteristics of the Ocean Quahog, Arctica islandica (Linnaeus, 1767), in the Mecklenburg Bight (Baltic Sea). Journal of Shellfish Research 20 (2):161–169.

ZETTLER ML, BÖNSCH R & GOSSELCK F (2000) Verbreitung des Makrozoobenthos in der Mecklenburger Bucht (südliche Ostsee) – rezent und im historischen Vergleich. Institut für Ostseeforschung Warnemünde. Meereswissenschaftliche Berichte No. 42: 144 pages.

ZETTLER ML, KARLSSON A, KONTULA T, GRUSZKA P, LAINE AO, HERKÜL K, SCHIELE KS, MAXIMOV A & HALDIN J (2014) Biodiversity gradient in the Baltic Sea: a comprehensive inventory of macrozoobenthos data. Helgoland Marine Research 68(1): 49–57.

ZETTLER ML, RÖHNER M, FRANKOWSKI J, BECHER H & GLOCKZIN I (2003) F+E-Vorhaben, FKZ: 802 85 210, Benthologische Arbeiten zur ökologischen Bewertung von Windenergie- Anlagen-Eignungsgebieten in der Ostsee. Endbericht für die Areale Kriegers Flak (KF) und Westlicher Adlergrund (WAG), Federal Agency for Nature Conservation, 54 pages.

ZIELKE, W., SCHAUMANN, P. GERASCH, W. RICHWIEN, W. MITTENDORF, K. KLEINEIDAM, P. UHL, A. (2001): Bau und Umwelttechnische Aspekte von Offshore-Windenergieanlagen, Journal: Forschungszentrum Küste Kolloquium, Hanover 2001.

ZYDELIS R & DAGYS M (1997) Winter period ornithological impact assessment of oil related activities and sea transportation in Lithuanian inshore waters of the Baltic Sea and in Kursiu Lagoon. Acta Zool. Lituanica, Ornithologia 6: 45–65.

ZYDELIS R, BELLEBAUM J, ÖSTERBLOM H, VETEMAA M, SCHIRMEISTER B, STIPNIECE A, DAGYS M, VAN EERDEN M & GARTHE S (2009) Bycatch in gillnet fisheries – An overlooked threat to waterbird populations. Biological Conservation 142 (2009) 1269–1281.