BUNDESAMT FÜR
SEESCHIFFFAHRT
UND
HYDROGRAPHIE

Environmental Report
for the Suitability Assessment of Site N-3.8*

Hamburg, October 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

AC	Alternating Current
TFEU	Treaty on the Functioning of the European Union
AIS	Automatic Identification System (for ships)
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas
AWI	Alfred Wegener Institute for Polar and Marine Research
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
BMUB	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
CTD	Conductivity, Temperature, Depth Sensor
DC	Direct Current
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
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 Seaward of the Limits of German Territorial Sea (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
ÜNB	Transmission Service Operator
UVPG	Environmental Impact Assessment Act
EIA	Environmental Impact Assessment
EIS	Environmental Impact Study
VARS	Visual Automatic Recording System
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 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 N-3.8 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, BSH2109c), upstream of this suitability assessment and later determination, defines areas and sites within these sites 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 9 (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, preceded by the suitability assessment, forms part of a staged planning process for offshore wind energy 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 site examination and suitability assessment and finally 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.

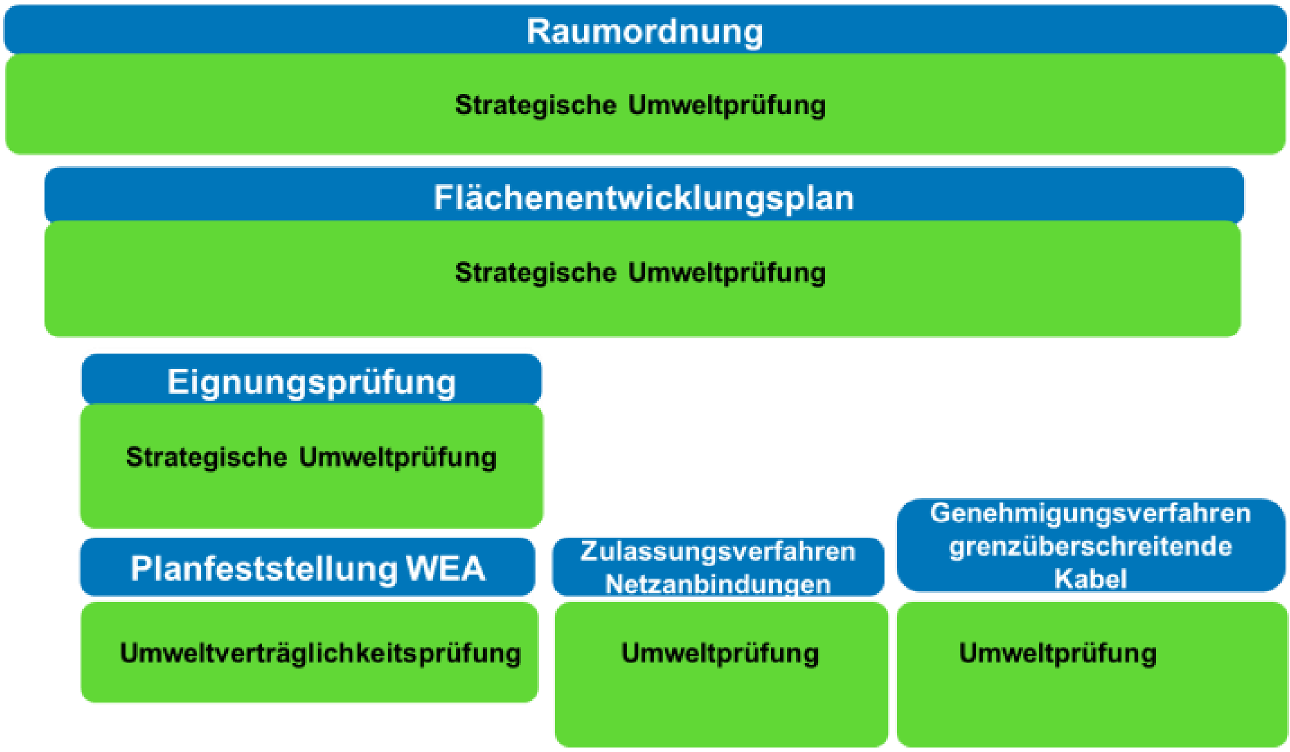


Figure 1: Overview of the environmental assessments to be carried out during each stage of the procedure

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.

In the case of subsequent plans and subsequent approvals of projects for which the plan sets a framework, the environmental assessment pursuant to section 39(3)(3) UVPG is to be limited to additional or other significant environmental impacts and to necessary updates and more detailed investigations.

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.

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

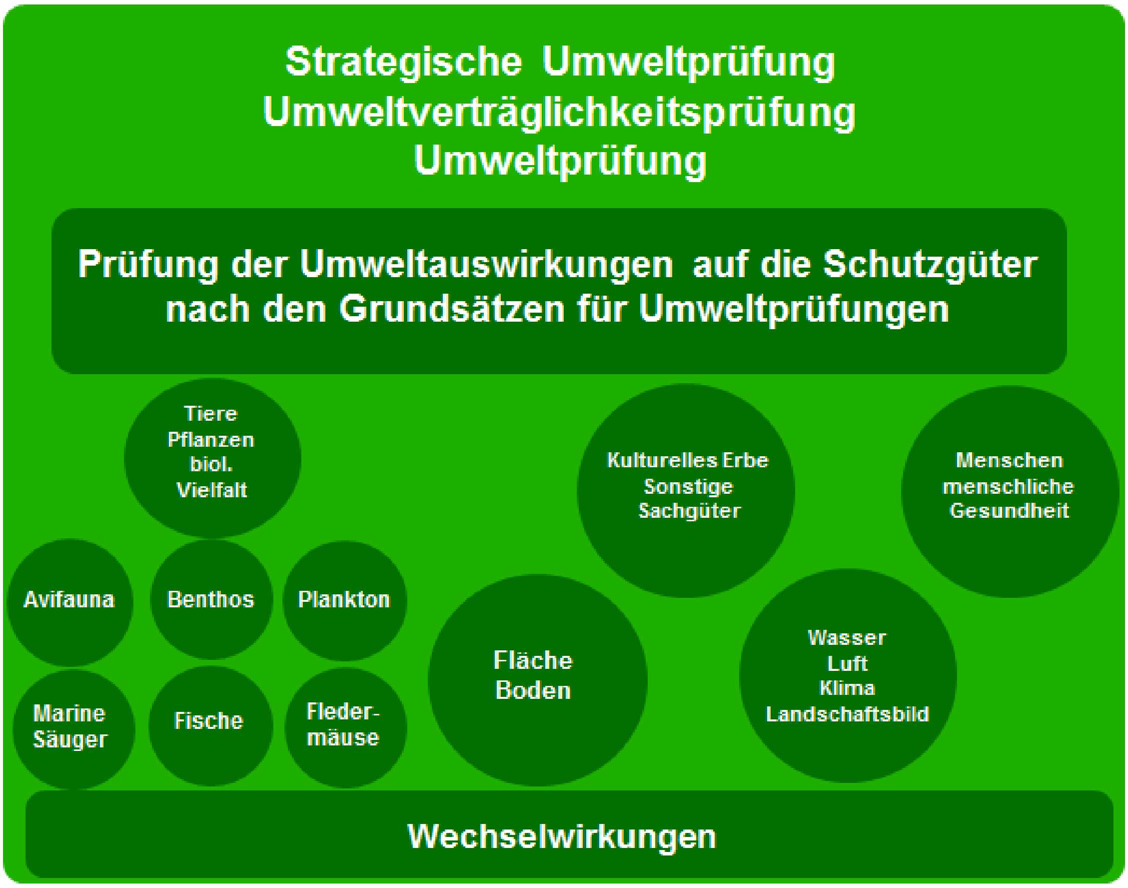


Figure 2: Overview of the protected objects in environmental assessments

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 Investigation 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.

As a basis for the suitability determination, a review is carried out in accordance with section 10(2) WindSeeG as to whether the construction and operation of offshore wind turbines at the site meets the criteria for the inadmissibility of determination of a site in the Site Development Plan in accordance with section 5(3) WindSeeG or, insofar as these can be assessed independently of the later design of the project, the interests relevant to the plan approval in accordance with section 48(4) sentence 1 WindSeeG do not conflict with this.

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 forecasts is based on model parameters in[2] scenarios that are intended to reflect possible realistic developments (see Table 3: Model parameters for consideration of the site).

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, 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

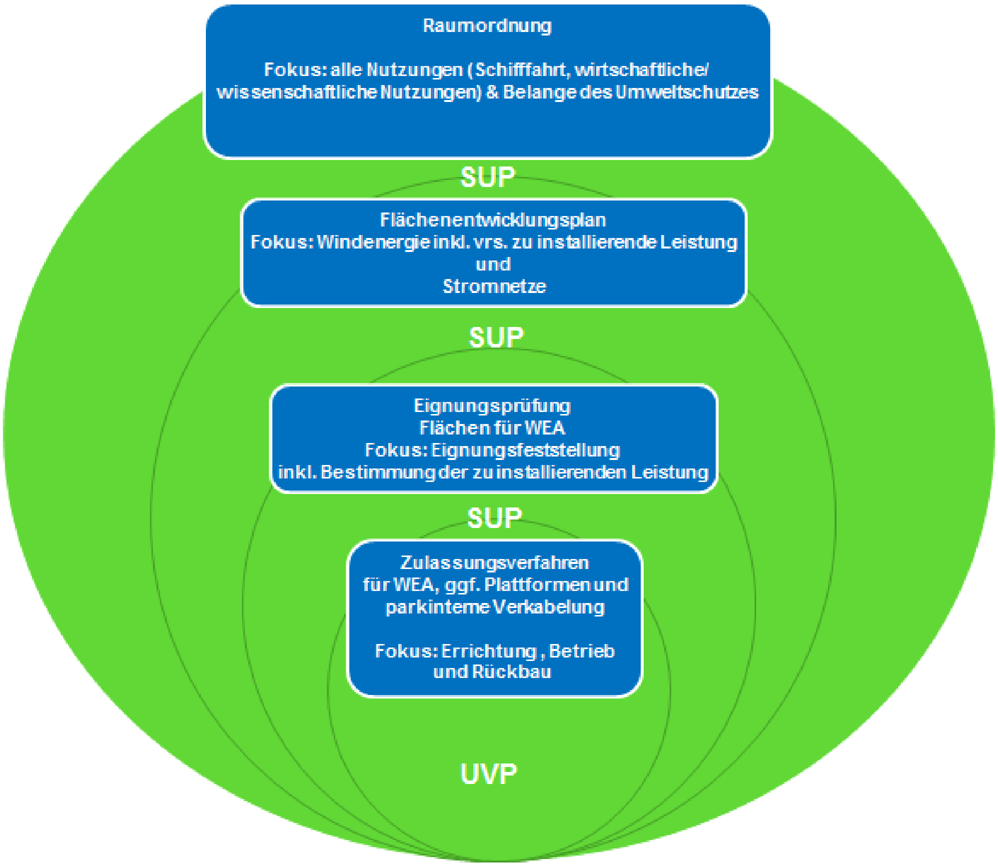


Figure 3: Subject of the planning and approval procedures and focus areas of the environmental assessment

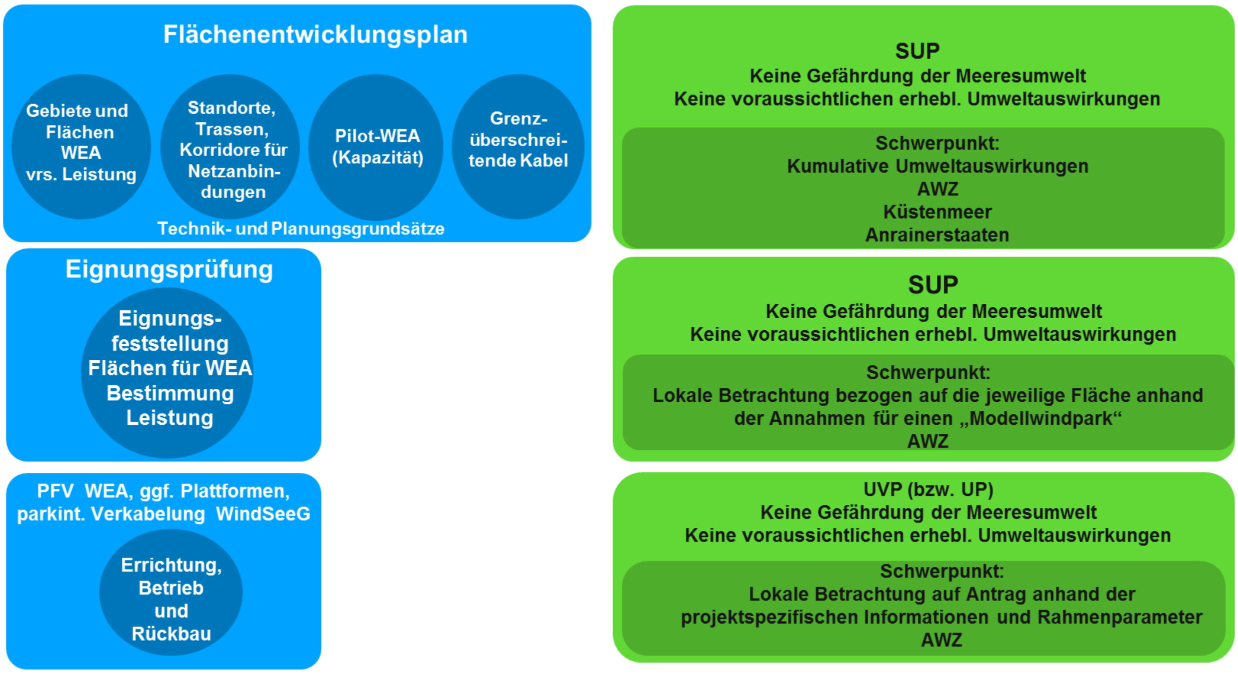


Figure 4: Subject of the planning and approval procedures and focus areas of the environmental assessment

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

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

	Seeks to establish bundles of measures without assessing the environmental impact of the planning in absolute terms.	• 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 connections, cross-border submarine cables)	Serves as an instrument between the FEP and the approval procedure for wind turbines at a specific site.
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 sewage treatment plants and ship's 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

- Trilateral Wadden Sea Cooperation (1978) and Trilateral Monitoring and Assessment Programme of 1997 (TMAP)

The aim of the Trilateral Wadden Sea Cooperation and the Trilateral Monitoring and Assessment Programme of 1997 between Denmark, the Netherlands and Germany is to preserve the diversity of biotope types in the Wadden Sea ecosystem. The principle is to achieve a natural and self-sustaining ecosystem where natural processes can run undisturbed. To this end, a Wadden Sea Plan with common key points was adopted (COMMON WADDEN SEA SECRETARIAT 2010). The objectives of the Wadden Sea Plan – which relate, among other things, to the protected objects of landscape, water, sediment, birds, marine mammals and fish and overlap in essential points with those of the Habitats and Birds Directive, the Water Framework Directive and the Marine Strategy Framework Directive – are taken into account by means of the specifications concerning installation depth with regard to the 2 K criterion and also concerning cable crossings, for example. The impact on nature conservation areas is be assessed and included in the evaluation and consideration of the plan.

- 1992 Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention)

The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) aims to protect the marine environment of the North-East Atlantic from risks arising from anthropogenic pollution from all sources. This requires the use of the best available emission control technology (section 2 paras. 2 and 3 of the OSPAR Convention). The specifications set out requirements for the reduction of emissions from the operation of wind farms, platforms and cables.

- UNECE Convention on Environmental Impact Assessment (EIA) in a Transboundary Context (Espoo 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 suitability assessment underlying the suitability determination, 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 plan 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) establishes the protection of toothed whales, with the exception of the sperm whale *Physeter macrocephalus*, specifically for the North Sea and Baltic Sea. 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 Seals in the Wadden Sea of 1991

The Agreement on the Conservation of Seals in the Wadden Sea of 1991 (see Notice of the Agreement on the Conservation of Seals in the Wadden Sea, of 19 November 1991, Federal Law Gazette II No. 32 p. 1307) aims to establish and maintain a favourable conservation situation for the seal population in the Wadden Sea. It contains rules on the monitoring, removal and protection of habitats. The environmental report examines the likely significant impacts on marine mammals, including seals, and includes them in the assessment and subsequent consideration.

- 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 (EuGH, Kommission./.Vereinigtes Königreich, 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 FFH areas and for projects in their vicinity, the implementation of an FFH impact assessment pursuant to Art. 6(3) of the FFH 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 noxious substances
- 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 suitability assessment which precedes the suitability determination.

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. Specifications are included in the draft suitability determination in order to prevent any adverse effects on 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.

- Conservation area ordinances

Pursuant to section 57 BNatSchG, the existing nature conservation areas and FFH areas in the German EEZ were included in the national area categories and declared nature conservation areas by statutory ordinances of 22 September 2017. This also involved their regrouping to some extent. For example, the Ordinance on the Designation of the 'Sylt Outer Reef – Eastern German Bight' Nature Conservation Area (NSGSylV of 22 September 2017, Federal Law Gazette I p. 3423)·, the Ordinance on the Designation of the 'Borkum Reef Ground' Nature Conservation Area (NSGBRgV of 22 September 2017, Federal Law Gazette I p. 3395) and the Ordinance on the Designation of the 'Dogger Bank' Nature Conservation Area (NSGDgbV of 22 September 2017, Federal Law Gazette I p. 3400) have now established the nature conservation areas 'Sylt Outer Reef – East German Bight', 'Borkum Reef Ground' and 'Dogger Bank'. This does not give rise to any differences in terms of spatial extension. As a result of this, certain species (great skua *(Stercorarius skua*) and pomarine skua (*Stercorarius pomarinus*)) were placed 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

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 decisions of the Climate Cabinet of 20 September 2019 and the Federal Cabinet of 9 October 2019, the share of renewable energies in electricity consumption is now to increase to 65 per cent 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) UVPG, a preliminary assessment of

procedures, etc. also serve to avoid impairments of the conservation areas.

environmental impacts is undertaken in the environmental report. 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, margin note 1.) In the present case, the environmental impacts of the suitability determination for site N-3.8 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 N-3.8, 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 3).

The description and assessment of the environmental status is undertaken according 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:

- Soil/ground
- 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 (HOPPE/BECKMANN/KMENT UVPG, section 40 margin note 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 (KMENT in HOPPE/BECKMANN/KMENT UVPG section 40, marginal note 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.

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

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 1.4.

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 the rarity and vulnerability of migratory birds, the aspects of occurrence assessment and the area's significance for bird migration are also considered.

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, the specific site and its immediate surroundings for marine mammals as a transit area, feeding ground 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.

1.5.6 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	
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

Protected object	Effect	Potential impact	Construction/dismantling	Installation	Operation
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

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

1.5.6.1 Cumulative analysis

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.

The assessment of cumulative impacts derives from a number of legal obligations:

- 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. These determinations are inadmissible in particular if ... 2. they jeopardise **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 4.12.

1.5.6.2 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 4.12.5.

1.5.6.3 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/km² 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.

Table 3: Model parameters for consideration of site N-3.8

	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 [m²]	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 [m²]	approx. 57	approx. 113
Diameter of scour protection [m]	approx. 43	approx. 60
Area of foundation incl. scour protection [m²]	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.

With regard to hub height information, it should be noted that objective 3.5.1 (8) of the North 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.

1.5.6.4 Assumptions regarding other development

The following model assumptions are made with regard to other installations.

Table 4: Parameters for the consideration of other development at site N-3.8

Length of internal cabling (= 0.12 km/MW*) [m²]	45
Voltage level of internal cabling	33 kV
Number of wind turbines – scenario 1	42
Number of wind turbines – scenario 2	25
Number of transformer platforms	**1**
Number of residential platforms	0
Area sealing foundation incl. scour protection [m²] – scenario 1	61,603
Area sealing foundation incl. scour protection [m²] – scenario 2	72,713
Area sealing of the transformer station incl. scour protection [m²]	1,963

* 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.

1.5.6.5 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 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 N-3.8, are to be considered in the sense of the tiering between the planning instruments. These may be procedural alternatives, i.e. the (technical) design of the installations in detail (Peters/Balla/Hesselbarth, UVPG Comment section 40, marginal note 1). 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.

1.6 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 1.6.

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 1.6) 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 area 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. 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. The goal of economical surface usage is already through the determinations made in the FEP (BSH 2019c), which stipulates the spatially structured and space-saving expansion of offshore wind turbines and the necessary offshore connection lines.

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 N-3.8 are the site investigations carried out in this area. 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 2018 (VBW WEIGT GMBH, 2018). The map of sediment distribution in the German North Sea (LAURER et. al, 2014; Project GPDN – Geopotential Deutsche Nordsee) is available as a further data basis.

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 under consideration, N-3.8, is located in the south-western part of the German EEZ in the North Sea, an area with a largely flat seabed relief.

The seabed declines from south to north. The water depths in relation to LAT are between 29 and 33 metres. Small, minor depressions of approx. 10–30 cm occur sporadically; their origin is unknown. In the extreme south of N-3.8 ripples are to be found on the sea floor. Figure 6 shows the bathymetry of the site.

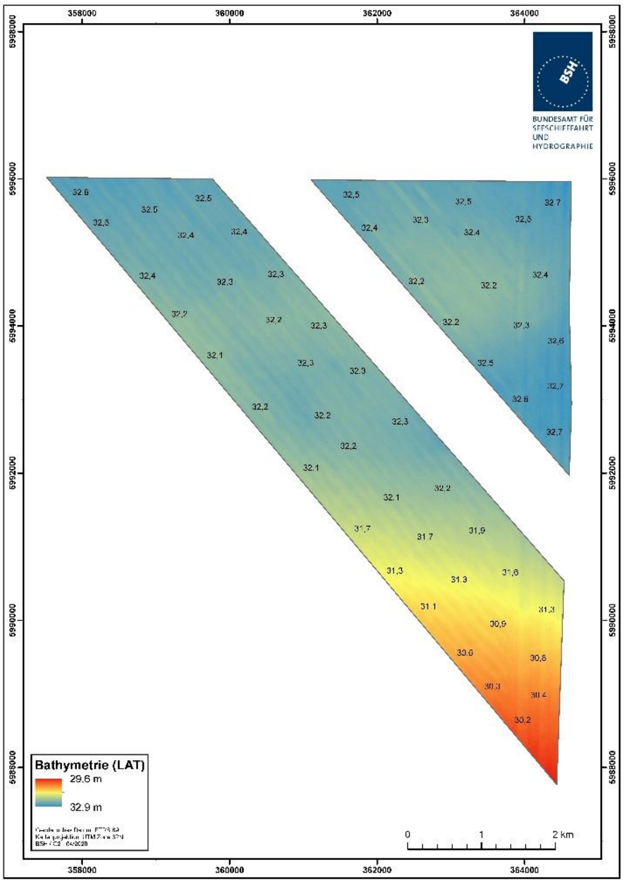


Figure 6: Bathymetry of site N-3.8 related to LAT

2.2.2.2 Sediment distribution on the seabed

The classification of the surface sediments according to LAURER et al. (2014, Figure 2) shows a uniform sediment composition of the seabed surface in area N-3, which consists mainly of fine sands, some with a low proportion of fine grains (5-10%). 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 2018 at site N-3.8 and soil samples were taken. The sediment samples were classified according to DIN 18123 as well as Figge 1981 and Folk 1954/1974. The determination of the grain size index from the grain size distribution of the soil samples taken at site N-3.8 shows fine sands. One sample showed a low silt content of 8.5%. In the backscatter mosaic, no changes in intensities are visible, which would indicate a sediment change.

Sediment mapping was carried out according to the Guidelines for Seabed Mapping (BSH) and shows only fine sand at site N-3.8 ().

Besides this very homogeneous sediment composition, one object was verified at site N-3.8. It was possible to identify this as an anthropogenic object.

The occurrence of marine erratic boulders as defined in the reef mapping instructions of the BfN can be ruled out. Residual or relic sediments or coarse sand and gravel are not to be expected in this area.

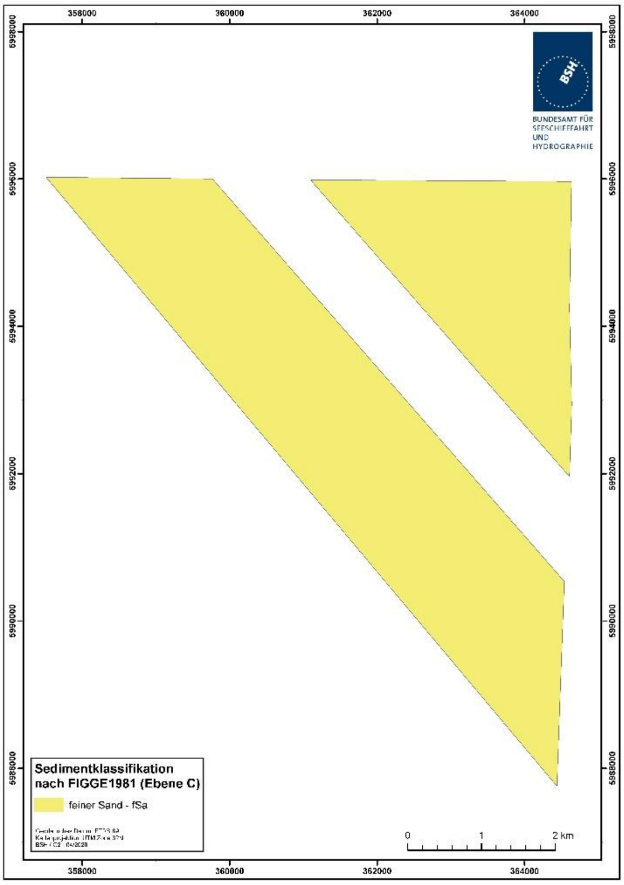


Figure 7: Sediment classification according to the BSH Guidelines for Seabed Mapping

Besides this very homogeneous sediment composition, one object was verified at site N-3.8. It was possible to identify this as an anthropogenic object.

The occurrence of marine erratic boulders as defined in the reef mapping instructions of the BfN can be ruled out. Residual or relic sediments or coarse sand and gravel are not to be expected in this area.

Residual or relic sediments or coarse sand and gravel are not to be expected in this area

2.2.2.3 Geological structure of the near-surface subsoil

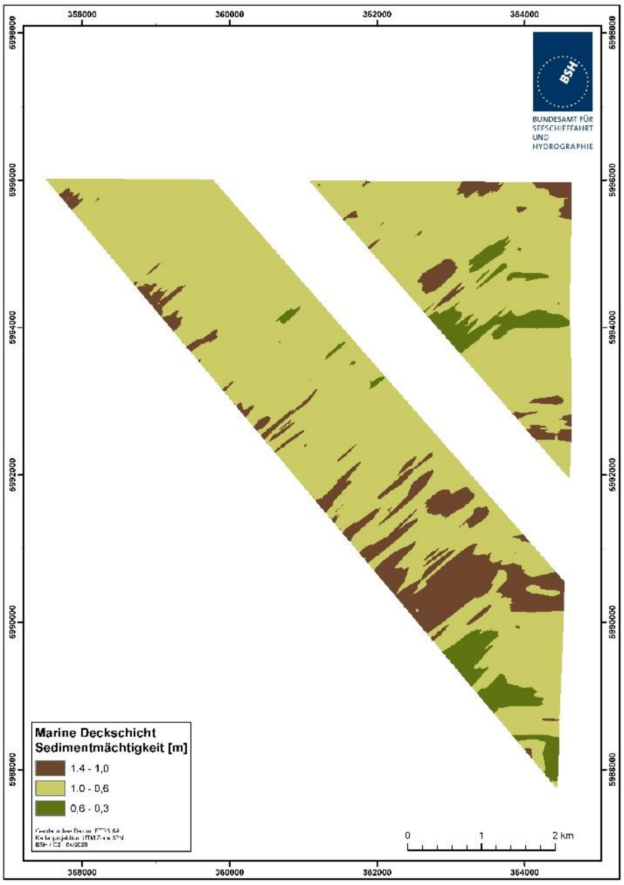
For the description of the seabed surface and the near-surface subsoil of area N-3, grab samples as well as boreholes and their layer descriptions were used, which were compiled, processed and classified according to soil classes for construction purposes (DIN 18196) in the course of various R&D projects (including 'Shelf Geo-Explorer Baugrund', GPDN).

Usually the upper layers consist of sand of loose to medium-dense bedding. Under the loosely bedded surface layer, the sand can also be densely bedded in places. Locally, silts, clays and peat as well as coarse sands with a thickness of a few centimetres up to several decimetres can occur.

This was already described in the environmental report for the FEP 2019 (BSH 2019a).

As part of the site investigation, detailed sediment echo sounding with a profile distance of 75 metres was carried out in 2018 at site N-3.8. These high-resolution investigations confirm the descriptions of area N-3 in the environmental report of the FEP 2019.

At site N-3.8, under a 0.25m to > 2m thick upper sand layer (marine surface layer, fine to medium sand), there are other sands which, due to their composition, impair further signal penetration. For this reason, their base is not visible in the measurement results . At the base of the marine top layer, channel structures and trough-like, uneven depressions filled with sediment are common. Locally, soft sediments occur as channel fillings, which were mapped out separately. Locally, gutter structures of > 10m depth are visible. Occasionally and very irregularly, very strong, internally parallel reflectors appear at the base of the marine top layer, indicating peat deposits. These were also mapped out separately. Figure 8 shows the thickness of the marine surface layer.



2.2.2.4 Figure 8: Thickness of the marine top layer (linear interpolation) at site N-3.8Distribution of pollutants in the sediment

Metals

The seabed is the most important sink for trace metals in the marine ecosystem. However, it can also act regionally as a source of contamination by resuspension of historically deposited, more highly contaminated material. The absolute metal content in the sediment is strongly dominated by the regional grain size distribution. Higher content levels are observed in regions with a high silt content than in sandy regions. The reason is the higher affinity of the fine sediment content to the adsorption of metals. Metals accumulate mainly in the fine-grain fraction.

In particular, the elements copper, cadmium and nickel are found in most regions of the German EEZ at low levels or in the range of background concentrations. All heavy metals show increased levels near the coast, and less pronounced levels along the East Frisian islands than along the North Frisian coast. These very distinct gradients, with elevated levels near the coast and very low levels in the central North Sea, indicate a dominant role of freshwater inflows as a source of metal pollution. In contrast, lead in the central North Sea in particular also shows significantly higher content levels in the fine-grain fraction. These are even higher than the levels measured at stations near the coast. The spatial distribution of the nickel content in the fine-grain fraction of the surface sediment, on the other hand, is only characterised by very weakly pronounced gradients. The spatial structure allows hardly any conclusions to be drawn as to the pollution focal points. Heavy metal pollution in the surface sediments of the EEZ has tended to decrease (Cd, Cu, Hg) or show no clear trend (Ni, Pb, Zn) over the past 30 years.

Organic substances

Most of the organic pollutants are of anthropogenic origin. Some 2,000 mainly industrially produced substances are currently considered to be environmentally relevant (pollutants) because they are toxic or persistent in the environment and/or may accumulate in the food chain (bioaccumulative). Since the properties can vary greatly, their distribution in the marine environment depends on a variety of factors. In addition to discharge sources, discharge quantities and discharge paths (direct via rivers, diffuse via the atmosphere), the physical and chemical properties of the pollutants and the dynamic-thermodynamic state of the ocean are relevant to dispersion, mixing and distribution processes. For these reasons, the various organic pollutants in the sea are distributed unevenly and differently and occur in highly varied concentrations.

On its monitoring trips, the BSH has determined up to 120 different pollutants in seawater, suspended solids and sediments. For most pollutants in the German Bight, the River Elbe is the main source of discharge. For this reason, the Elbe plume off the North Frisian coast generally has the highest concentrations of pollutants, which tend to decrease from the coast to the open sea. The gradients are particularly strong for non-polar substances, as these substances are predominantly adsorbed on Suspended Particulate Matter and are removed from the water phase by sedimentation. Outside the coastal regions rich in Suspended Particulate Matter, concentrations of non-polar pollutants are therefore usually very low. However, many of these substances are also discharged into the sea by atmospheric deposition or have direct sources in the sea (e.g. PAH – polycyclic aromatic hydrocarbons – discharge from the oil and gas industry and shipping), so sources remote from the land must also be taken into account in the distribution of these substances.

According to current knowledge, the observed concentrations of most pollutants in seawater do not pose any immediate threat to the marine ecosystem. One exception is the exposure to tributyltin hydride (TBT), which was formerly used in ship paints and whose concentration near the coast reaches the biological threshold in some instances. Acute oil pollution (shipping, offshore oil production) can also cause extensive damage to seabirds and harbour seals.

Radioactive substances (radionuclides)

For decades, radioactive contamination of the North Sea was determined by discharges from nuclear fuel reprocessing plants. As these discharges are very low today, radioactive contamination of the North Sea does not pose a threat to humans or nature according to current knowledge.

Contaminated sites

Possible occurrences of existing contamination in the EEZ in the North Sea are 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 North Sea is estimated at up to 1.3 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 N-3.8 considered within the scope of the suitability assessment.

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 throughout the North Sea. The fine sands prevailing at site N-3.8 are common throughout the North Sea. The seabed is uniformly flat. For this reason, the aspect of 'rarity and vulnerability' is rated 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.

The sediment composition of the surface sediments at site N-3.8 is very homogeneous. Special morphological forms in this fine sand area are not known. The aspect of 'rarity and vulnerability' is therefore rated as 'low'.

2.2.3.3 Existing cumulative effects

Natural factors

Climate change and sea level rise: The North Sea region has experienced dramatic climate change over the last 11,800 years, with a profound change in the land/sea distribution due to a global sea level rise of 130 m. The sea level of the North Sea has been at its present level for about 2,000 years. The sea level off the German North Sea coast rose by 10 to 20 cm in the 20th century. Storms cause changes on the seabed. All sediment dynamics processes can be traced back to meteorological and climatic processes, which are essentially controlled by the weather in the North Atlantic.

Anthropogenic factors

Fishing: In the North Sea, bottom trawlers use otter trawls and beam trawls for bottom fishing. Otter trawls are mainly used in the northern North Sea and are pulled diagonally across the seabed. By contrast, beam trawls have been used mainly in the southern North Sea since the 1930s. Since the 1960s there has been a sharp increase in beam trawl fishing, which has declined slightly over the last decade due to catch regulations and the decline in fish populations. The runners of beam trawls leave marks that are 30 to 50 cm in width. In particular, their tickler chains or chain nets have a stronger effect on the ground than otter boards. The bottom trawls create specific furrows in the sediment, which can range from a few millimetres to 8 cm deep on boulder clay and sandy soils and up to 30 cm deep in soft silt. The results of the EU TRAPESE project show that at most the upper 10 cm of the seabed are regularly stirred and suspended (PASCHEN et al. 2000).

Submarine cables (telecommunications, power transmission): When cables are laid in the seabed, the water column becomes turbid as a result of sediment turbulence, but this is distributed over a larger area due to the influence of tidal currents. The suspension content decreases to natural background levels due to dilution effects and sedimentation of the stirred up sediment particles. As a rule, sediment dynamics processes lead to a complete levelling of the laying tracks, especially after periods of bad weather. In the area of cable crossings, stone fills are applied; these represent a locally limited hard substrate that is exogenous to the location.

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.

The extent of anthropogenic cumulative effects of the sediments and the morphological inventory of forms is key to the assessment of the aspect of 'existing cumulative effects'. With regard to the pollution load, it can generally be stated that the sediment in the site under consideration is only slightly contaminated by metals and organic pollutants. Due to the trawling and beam trawling activities that take place at site N-3.8 the protected object of soil/ground is assigned medium importance with regard to the criterion of 'existing cumulative effects' at site N-3.8. Although the above-mentioned instances of existing cumulative effects are present, they do not result in a loss of ecological function.

2.3 Water

The North Sea is a relatively shallow shelf sea with a wide opening to the North Atlantic Ocean in the north. The oceanic climate of the North Sea – characterised by salinity and temperature – is largely determined by this northern opening to the Atlantic Ocean. In the southwest, the Atlantic Ocean has less influence on the North Sea due to the shallow English Channel and the narrow Dover Strait. The Baltic Sea is connected to the Kattegat/Skagerrak and the North Sea by the Great Belt, the Little Belt and the Sound.

2.3.1 Data situation

In addition to data and information drawn from the literature, the status description and assessment of water as a protected object is based primarily on the evaluation of various long-term measurement series carried out by the BSH, some of which run over several decades, and on BSH monitoring trips.

2.3.2 Status description

2.3.2.1 Nutrients

Nutrients such as phosphate and inorganic nitrogen compounds (nitrate, nitrite, ammonium) and silicate are essential for marine life. 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 still persists (MEL and BMU 2020). As a result, there may be an increased occurrence of algal blooms (phytoplankton and green algae), reduced visibility depths, a decline in seagrass beds, shifts in the species spectrum and oxygen deficiency situations near the seabed (BMU 2018A).

Nutrient concentrations in the German Bight show a typical annual cycle, with high concentrations in winter and low concentrations in the summer months. All nutrients show similar distribution structures with a gradual decrease in concentration from the river estuary via the coastal area towards the open sea(BMU 2018a).

2.3.2.2 Pollutants

Organic pollutants and metals reach the North 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 also accumulate in sediments and in marine organisms.

The highest concentrations of organic pollutants are generally measured in the Elbe plume off the North Frisian coast, which essentially decreases towards the open sea. The gradients are particularly strong for non-polar substances, as these substances are predominantly adsorbed on Suspended Particulate Matter and are removed from the water phase by sedimentation. Outside the coastal regions rich in Suspended Particulate Matter, concentrations of non-polar pollutants are therefore usually very low. Water pollution from petroleum hydrocarbons is low, but in isolated cases acute oil spills from shipping can be detected based on visible oil films. In recent years, new analytical methods have been used to detect a large number of 'new' pollutants (contaminants of emerging concern) with polar properties in the environment (BMU 2018a). Many of these substances (e.g. perfluorinated and polyfluorinated alkyl compounds, as well as some pesticides) occur in much higher concentrations than the classic pollutants.

Metals occur 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. The content levels of mercury, cadmium, copper and zinc generally decrease from the coast to the open sea. Due to the natural background concentration of lead in sediments of the open North Sea, similarly high concentrations of lead are to be found in the water phase in the open sea as on the coast (BMU 2018A). Similar to the nutrients, some metals (e.g. zinc, cadmium) also show seasonally periodic variations in concentration in the dissolved fraction. This seasonal profile corresponds roughly to the biological growth and remineralisation cycle.

2.3.2.3 Currents

The currents in the North Sea consist of a superimposition of the half-day tidal currents with the wind-driven and density-driven currents. In general, the North Sea is characterised by large-scale, cyclonic, i.e. counter-clockwise, circulation with a strong inflow of Atlantic water at the north-western edge and an outflow into the Atlantic Ocean via the Norwegian Trench. The strength of the North Sea circulation depends on the prevailing air pressure distribution over the North Atlantic, which is parameterised by the North Atlantic Oscillation Index (NAO),

the standardised air pressure difference between Iceland and the Azores.

Based on an analysis of all current measurements carried out by the BSH and the German Hydrographic Institute (DHI) between 1957 and 2001 (KLEIN 2002), the mean current velocity (scalar mean including tidal current) and residual current velocities (vector mean) were determined for various areas of the German Bight near the surface (3 – 12 m water depth) and near the bottom (0 – 5 m distance to the bottom) (Table 5). All time series with a length of at least 10 days and a water depth of more than 10 m were considered in this analysis. The aim of the analysis was to estimate the conditions in the open sea. The mean values are shown in Table 5. The tidal currents were determined by reference to the Heligoland level, i.e. the measured currents are related to the tidal range and flood times observed there (KLEIN & MITTELSTAEDT 2001).

Table 5: Average current velocities, residual and tidal currents in the German Bight

	Surface proximity (3 – 12 m)	**Seabed proximity (0 – 5 m distance to the seabed)**
Average amount	25 – 56 cm/s	16 – 42 cm/s
Vector means (residual current)	1 – 6 cm/s	1 – 3 cm/s
Tidal current	36 – 86 cm/s	26 – 73 cm/s

Figure 9 shows the current conditions in the near-surface layer (3 – 12 m measuring depth) for various areas in the German Bight. Here, the values in area GB3 correspond to the (geological) sub-area 'Borkum and Norderney Reef Ground', GB2 corresponds to the sub-area 'Northern Heligoland' and GB1 corresponds to the sub-area 'Elbe Glacial Valley and Western Plains'.

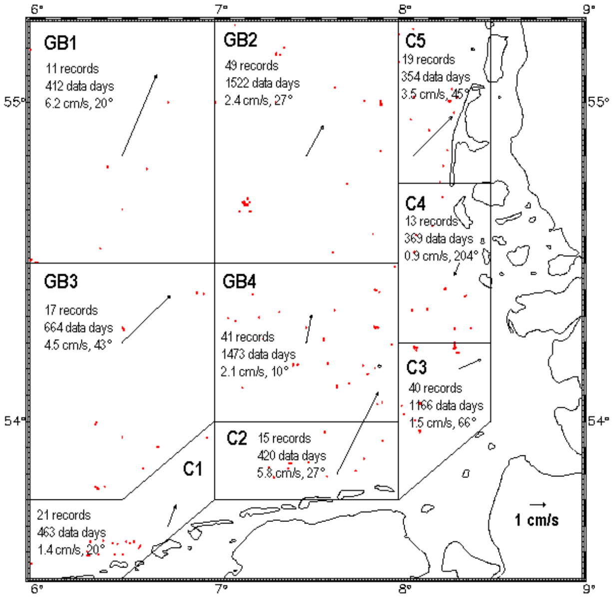


Figure 9: Vector means of the current in the near-surface layer (measuring depth 3 to 12 m). The measuring positions are marked with a red dot (BSH 2002)

2.3.2.4 Sea heave

In connection with sea heave a distinction is drawn between waves generated by the local wind – the so-called 'wind sea' – and swell. Swell consists of waves that have left their area of origin and enter the sea area under consideration. The swell entering the southern North Sea is generated by storms in the North Atlantic or the northern North Sea. The swell has a longer period than the 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. For example, the length of the wind sweep in the German Bight is much shorter in the case of east and south winds than with north and west winds. The wind sea is measured by the significant or characteristic wave height, i.e. the mean wave height of the upper third of the wave height distribution.

During the climatological seasonal cycle (1950-1986), the highest wind speeds in the inner German Bight occur in November at about 9 m/s and then drop to 7 m/s by February. In March, the speed reaches a local maximum of 8 m/s, then drops rapidly and remains at a flat level of about 6 m/s between May and August, before rising just as rapidly from mid-August to the maximum in late autumn (BSH, 1994). This annual cycle, based on monthly averages, is transferable to the height of the sea heave. For the inner German Bight, the directional distribution of the sea heave of the unmanned lightship UFS German Bight (formerly UFS Deutsche Bucht) shows – analogous to the distribution of wind direction – a distribution with one maximum in the case of sea heave from west-southwest and a second maximum from east-southeast (LOEWE et al. 2003).

2.3.2.5 Temperature, salinity and seasonal stratification

Water temperature and salinity in the German EEZ are determined by large-scale atmospheric and oceanographic circulation patterns, freshwater input from the Weser and Elbe rivers and energy exchange with the atmosphere. The latter applies in particular to the sea surface temperature (LOEWE et al. 2003). The seasonal minimum temperature in the German Bight usually occurs at the end of February/beginning of March, seasonal warming starts between the end of March and the beginning of May, and the temperature maximum is reached in August. Based on spatial mean temperatures for the German Bight, SCHMELZER et al. (2015) have established extreme levels for the period 1968-2015 of 3.5°C in February and 17.8°C in August. This corresponds to an average amplitude of 14.3 K, with the annual difference between maximum and minimum varying between 10 and 20 K. With the onset of seasonal warming and increased irradiation, thermal stratification sets in between the end of March and the beginning of May in the north-western German Bight at water depths of over 25-30 m. With pronounced stratification, vertical gradients of up to 3 K/m are measured in the temperature jump layer (thermocline) between the warm top layer and the colder bottom layer; the temperature difference between the layers can be up to 10 K (LOEWE et al. 2013). Shallower areas are generally mixed, even in summer, due to turbulent tidal currents and wind-induced turbulence. With the onset of the first autumn storms, the German Bight is again thermally mixed vertically.

The time series of the annual mean spatial temperatures of the entire North Sea based on the temperature charts published weekly by the BSH since 1968 show that the development of the SST is not characterised by a linear trend, but by regime changes between warmer and colder phases (see also Fig. 3-28, BSH 2005). The extreme warming regime of the first decade of the new millennium, in which the annual mean of the North Sea SST fluctuated around an average level of 10.8°C, ended with the cold winter of 2010 (Figure 10). After four significantly cooler years, the North Sea SST 2014 reached its highest annual mean to date of 11.4°C.

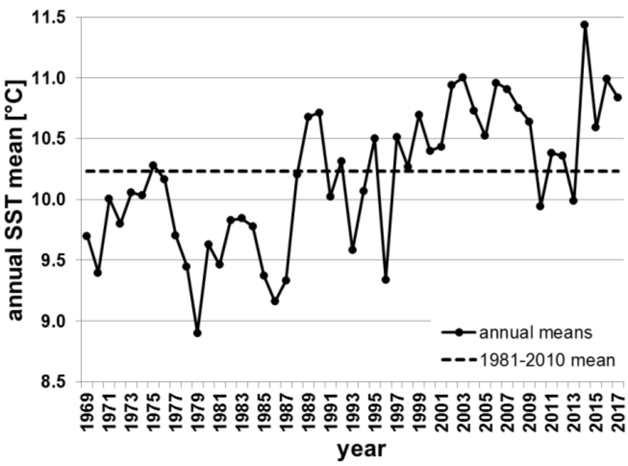


Figure 10: Annual mean of the North Sea surface temperature for the years 1969-2017

Regarding climate-related changes, QUANTE et al. (2016) expect an increase in the SST of 1-3 K by the end of the century. Here the different projections arrive at consistent results despite considerable differences in the model simulations with regard to set-up, influence of the global climate model and bias corrections, etc. (KLEIN et al. 2018).

In contrast to the temperature, the salinity does not have a clearly pronounced annual cycle. Stable salinity stratification occurs in the North Sea in the estuaries of the major rivers and in the area of the Baltic outflow. Due to tidal turbulence, the fresh water discharge of the major rivers within the estuaries mixes with the coastal water at shallow depths, but at greater depths it stratifies over the North Sea water in the German Bight. The intensity of stratification varies depending on the annual course of river discharges, which in turn exhibit considerable inter-annual variability, e.g. due to high meltwater run-off in spring after heavy snow winters. For example, the salinity at Heligoland Reede is negatively correlated with the discharge volumes of the Elbe, which shows that fresh water discharges cause a significantly reduced near-surface salinity near the coast (LOEWE et al. 2013), with the Elbe having the greatest influence on the salinity of the German Bight with a discharge of 21.9 km³/year.

Salinity measurements of Heligoland Reede have been available since 1873, and also the data at the positions of the former lightships since around 1980, the latter subsequently being replaced at least in part by automated measuring systems. The shifts in lightship positions and methodological problems, also in the measurements at Heligoland, led to interruptions and uncertainties in the extended time series and made reliable trend estimates more difficult (HEYEN & DIPPNER 1998). There is no long-term trend in the annual average surface salinity of Heligoland for the years 1950-2014. This also applies to the annual discharge rates of the Elbe. The projections of the future development of salinity in the German EEZ currently still vary considerably with regard to temporal development and spatial patterns, with more recent projections indicating a decrease in salinity between 0.2 and 0.7 PSUs by the end of the century (KLEIN et al . 2018).

2.3.2.6 Ice conditions

In the open German Bight, the heat reserve of the relatively salty North Sea water in early winter is often so large that ice can only form very rarely. The open sea area off the North and East Frisian Islands is ice-free in two thirds of all winters. On average over many years, the ice edge extends to just behind the islands and into the outer estuaries of the Elbe and Weser. In normal winters, ice occurs in the protected inner fairways in the North Frisian Wadden area on 17 to 23 days, in the open fairways – similar to the East Frisian Wadden area – only on 2 to 5 days.

By contrast, in ice-rich and very ice-rich winters, ice occurs in the protected inner fairways in the North Frisian Wadden area on an average of 54 to 64 days, in the open fairways – similar to the East Frisian Wadden area – only on 31 to 42 days. In the inner tidal flats, mainly solid ice forms. In the outer tidal flats, mainly floe ice and ice slurry form, which are kept in motion by wind and tidal action. Further information can be found in the Climatological Ice Atlas 1991-2010 for the German Bight (SCHMELZER et al. 2015).

2.3.2.7 Fronts

Fronts in the sea are high-energy mesoscale structures (of the order of a few tens of kilometres to a few hundred kilometres) which have a major impact on the local movement dynamics of the water, on biology and ecology and – due to their ability to transport CO_2 to greater depths – also on the climate. In the coastal areas of the North Sea, especially off the German, Dutch and English coasts, the so-called river plume fronts with strong horizontal salinity and Suspended Particulate Matter gradients are located between the freshwater discharge area of the major continental rivers and the continental territorial sea of the North Sea. These fronts are not static structures but consist of a system of smaller fronts and vortices with typical spatial scales between 5 and 20 km. This system is subject to a large temporal variability with time scales of between 1 and about 10 days. Frontal structures continuously disperse and form depending on the meteorological conditions, the discharge rates of the Elbe and Weser rivers and the circulation conditions in the German Bight. Only in extremely calm weather conditions can discrete frontal structures be observed over long periods of time. Approximately in the area of the 30 m depth line, during the period of seasonal stratification (approx. from the end of March to September), the tidal mixing fronts are located which mark the transition area between the thermally stratified deep water of the open North Sea and the shallower, vertically mixed area due to wind and tidal friction. Due to their dependence on topography, these fronts are relatively stationary (OTTO et al. 1990). KIRCHES et al. (2013a-c) analysed satellite-based remote sensing data from 1990 – 2011 and established a climatology for SST, chlorophyll, yellow and Suspended Particulate Matter fronts in the North Sea. This shows that fronts occur all year round in the North Sea, with the strength of the spatial gradient generally increasing towards the coast.

Fronts are characterised by significantly increased biological activity; and adjacent areas play a key role in the marine ecosystem. They influence ecosystem components at all stages, either directly or as a cascading process through the food chain (ICES 2006). Vertical transports on fronts bring nutrients into the euphotic zone, thereby increasing biological productivity. The increased biological activity on fronts due to the high availability and effective use of nutrients results in increased binding of atmospheric CO_2 and transport to deeper layers. The discharge of these CO_2-enriched water masses into the open ocean is known as 'shelf sea pumping' and is an essential process for absorption of atmospheric CO_2 by the world ocean. Large parts of the North Sea are a CO_2 sink throughout the year, with the exception of the southern areas in the summer months. The North Sea exports more than 90% of the CO_2 absorbed from the atmosphere to the North Atlantic.

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 Suspended Particulate Matter content is greatly dependent on the season. The highest values occur during plankton blooms in early summer. In stormy weather conditions and the resulting 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 swell has the greatest impact. When hurricanes cause damage on passing through the German Bight, increases in the Suspended Particulate Matter content of up to ten times the normal values are easily possible. It is not possible to take water samples in extreme storm conditions: estimates are therefore derived from the records of anchored turbidity measuring instruments. A pronounced half-day tidal signal is always found if the temporal variability of the Suspended Particulate Matter content at a fixed position is considered. Ebb and flow currents transport the water in the German Bight about 10 nautical miles away from or towards the coast on average (Table 5). Accordingly, the high Suspended Particulate Matter (SPM) content near the coast is also transported 'back and forth' and causes strong local fluctuations. Further variabilities in the SPM are caused by material transport (advection) from rivers such as the Elbe and Weser and from the southeast coast of England.

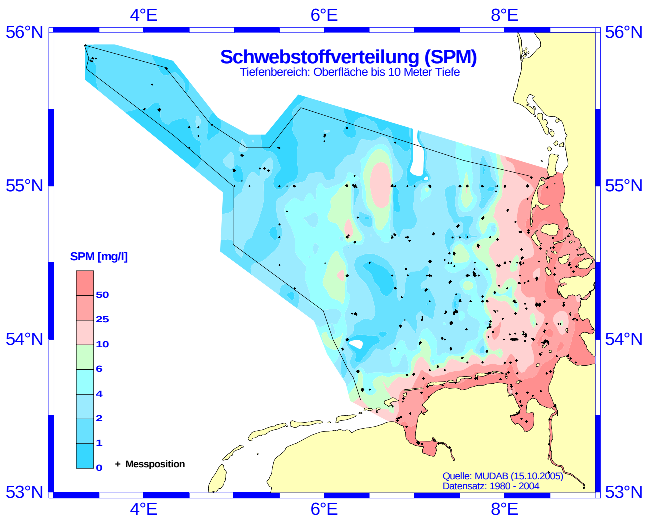


Figure 11: Mean Suspended Particulate Matter distribution (SPM) for the German North Sea.

Figure 11 shows the mean Suspended Particulate Matter distribution for the German Bight. This presentation is based on all SPM values in the MUDAB marine environment database as of 15 October 2005. The data set was reduced to the range 'Surface to 10-metre depth' and values ≤ 150 mg/l. The underlying measured values were only obtained in weather conditions in which research vessels are still able to work. Difficult weather conditions are therefore not reflected in the mean values shown here. Figure 11 shows mean values of around 50 mg/l and extreme values >150 mg/l which were measured in the mudflats landward of the East and North Frisian Islands and in the large river estuaries. Further seawards, the values quickly decrease to a range between 1 and 4 mg/l. Slightly east of 6° E, there is an area with an increased Suspended Particulate Matter content. The lowest mean SPM values of around 1.5 mg/l are found on the north-western fringes of the EEZ and above the sandy areas between the Borkum Reef Ground and the Elbe Glacial Valley.

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 of the individual parameters, which in turn are largely influenced and controlled by large-scale processes at work in the North Atlantic.

2.3.3.2 Nutrients

Thanks to measures such as advanced wastewater treatment technologies and the introduction of phosphate-free detergents, nutrient discharge into the North Sea has been reduced by around 50% since 1983, while phosphorus discharge has been reduced by as much as around 65% (BMEL and BMU 2020). Nevertheless, according to the MSFD Assessment 2018 (BMU 2018), 55% of German North Sea waters are still considered to be eutrophicated. As such, eutrophication remains one of the greatest ecological problems facing the marine environment of the German North Sea waters. Enrichment with nutrients and organic material via direct discharge, rivers and air leads to undesirable biological effects such as the mass development of algae or an altered species spectrum as well as other effects such as oxygen deficiencies (OSPAR 2017).

2.3.3.3 Pollutants

Organic pollutants continue to be detected in the North Sea at elevated concentrations (BMU 2018a). Many persistent, bioaccumulative and toxic substances are still found in significant concentrations in the marine environment decades after being banned. However, according to current knowledge, the observed concentrations of most pollutants in seawater do not pose an immediate threat to the marine ecosystem. For the majority of pollutants a decreasing trend can be observed (OSPAR 2017). One exception is exposure to perfluorooctane sulphonic acid PFOS, whose concentration near the coast sometimes exceeds the toxicological limits (BMU 2018a). Furthermore, seabirds and harbour seals can be harmed by oil films floating on the surface of the water as a result of acute oil spills. According to current knowledge, the above-mentioned metal pollution of seawater does not pose any direct threat to the marine ecosystem.

The entrainment of pollutants has a negative impact on the performance of the marine ecosystem of the North Sea and can significantly impair it. The constant renewal of water dilutes the pollutant concentrations, resulting in a corresponding average sensitivity to the impacts mentioned above. Nonetheless, prolonged and excessive exposure can cause significant damage to the North Sea ecosystem.

2.3.4 Conclusion

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.

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

The existing cumulative effects of the protected object of water is rated as 'high'.

2.4 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.

2.4.1 Data situation

The data basis for the status description and assessment of macrozoobenthos in the EEZ in the North Sea is described in the environmental report for the FEP 2019 (BSH 2019a).

Current macrobenthos data for site N-3.8 are available from the first year of the baseline survey, which was carried out 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.

2.4.2 Status description

As part of the offshore site investigation of site N-3.8, 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. Since the autumn sampling was carried out right at the beginning of the StUK4 period (15.08. – 15.11), numerous juvenile individuals were included in the samples.

2.4.2.1 Infauna

At site N-3.8, a total of 197 taxa of infauna were identified, during the 1st year under investigation, 128 of which were identified by species. A total of 174 taxa were identified in autumn 2018, while 133 taxa were detected in spring 2019 . Per station, a significantly higher average number of taxa were detected in autumn (74 taxa) than in spring (50 taxa).

Species occurring regularly in both spring and autumn were the hydropolyp *Lovenella clausa,* the amphipod *Bathyporeia tenuipes,* the molluscs *Fabulina fabula, Nucula nitidosa* and *Phaxas pellucidus,* the nemertean species in the Lineidae family and the nemertean species *Tubulanus polymorphus,* unidentifiable representatives of the genus Phoronis, and the polychaetes *Chaetozone christiei, Magelona filiformis, Magelona johnstoni, Scoloplos armiger* and *Spiophanes bombyx.*

The mean total abundance was significantly higher in autumn 2018 (6,080 per m²) than in spring (831 per m²). No eudominant species appeared in either autumn or spring. In autumn 2018, juvenile sea urchins (Echinocardium sp.; 13.6 %) were most abundant, followed by the bivalve mollusc *Phaxas pellucidus* (12.1 %) and the polychaetes *Spiophanes bombyx* (9.6 %), *Owenia fusiformis* agg. (7.1%) and *Magelona johnstoni* (5.3%). In spring 2019, *Magelona johnstoni* (25.1%) was the only dominant main species, followed by the subdominant molluscs *Fabulina fabula* (5.2%), *Nucula nitidosa* (8.5%) and *Tellimya ferruginosa* (5.2%). The main species were found at all stations at the time the study was carried out.

The mean diversity was significantly higher in autumn, with a value of 4.53, than in spring, with a value of 4.33. In spring, the mean evenness was significantly higher than in autumn (0.74) with a value of 0.79.

With regard to the average total biomass, no significant difference was found between autumn (311 g/m²) and spring (347 g/m²). In both seasons, *Echinocardium cordatum* was the only eudominant main species in terms of biomass (70.0% in autumn, 84.2% in spring). In autumn, juvenile sea urchins (5.6%) and the bivalve mollusc *Mactra stultorum* (4.1%) were also dominant in terms of biomass.

The macrozoobenthos in the area can be described as a transitional community between the *Tellina fabula* and *Nucula nitidosa* communities according to Rachor & Nehmer (2003) and Pehlke (2005). The *Tellina fabula* community prefers the fine sandy areas of the 20 to 30-metre depth line, but also populates medium sandy areas (RACHOR &NEHMER 2003). The characteristic species here are the eponymous bivalve mollusc *Fabulina fabula* (formerly *Tellina fabula*), the Polychaeta *Goniada maculata* and *Magelona johnstoni*, and the amphipods *Bathyporeia guilliamsoniana* and *Urothoe poseidonis*. The silt area of the inner German Bight, which is largely bounded by the 30-metre depth line, is colonised by the *Nucula nitidosa* community (ACHOR & EHMER 2003). *Nucula nitidosa, Abra alba* and *Scalibregma inflatum* were determined as characteristic species.

In autumn 2018 as well as in spring 2019 almost all the above-mentioned characteristic species were found at site N-3.8. The characteristic species *Magelona johnstoni* and *Fabulina fabula* of the *Tellina fabula* community were recorded at each station. *Magelona johnstoni* and the characteristic species *Spiophanes bombyx* were dominant main species with respect to abundance in autumn and spring. In spring, *Fabulina fabula* was also the dominant main species. In autumn 2018, all characteristic species of the *Nucula nitidosa* community were detected, while *Scalibregma inflatum* was absent in spring.

The community values determined at site N-3.8 for abundance, biomass, diversity, evenness and taxa of the infauna fit well into the results described by DANNHEIM et al. (2014) for the Dogger Bank/*Tellina fabula* community and the geo-cluster 'EF/NF Coast'.

2.4.2.2 Epifauna

At site N-3.8, a total of 65 taxa of epifauna were recorded in autumn 2018 and spring 2019, 52 of which it was possible to determine at species level. During both research campaigns, the hermit crab *Pagurus bernhardus* and the echinoderms *Asterias rubens, Astropecten irregularis* and *Ophiura ophiura* were recorded at each station. With regard to the mean taxa number per station, no significant difference was found between autumn (18 taxa) and spring (21 taxa).

At 0.50 ind./m² in spring 2019, the average total number was significantly higher than in autumn 2018 (0.21 ind./m²). During both study campaigns the starfish *Asterias rubens* was the eudominant main species (55.8% and 61.8%). The brittle star *Ophiura ophiura* was classified as the dominant main species in autumn (18.5%) and spring (24.7%). The sea star *Astropecten irregularis* was also the dominant main species in spring (13.6%). In autumn, the crustaceans *Liocarcinus holsatus* (5.8%) and *Pagurus* *bernhardus* (4.0%) and the sea star *Astropecten irregularis* (7.2%) were sub-dominant main species.

The mean diversity of epifauna did not differ significantly between autumn 2018 (1.73) and spring (1.70). Similarly, no significant difference was found for mean evenness between autumn (0.60) and spring (0.55).

The average biomass was significantly higher in spring 2019 (3.54 g/m²) than in autumn (2.32 g/m²). The starfish *Asterias rubens* was eudominant in both autumn and spring (67.1% – 74.4%). In autumn, the main species were also the edible crab (*Cancer pagurus*; 11.9%), the swimming crab *Liocarcinus holsatu*s (4.2%), the sea star *Astropecten irregularis* (5.3%) and the brittle star *Ophiura ophiura* (4.4%). The edible crab was detected at only three stations in autumn. In spring, *Astropecten irregularis* (12.1%) and *Ophiura ophiura* (8.0%) were other main species.

The values determined at site N-3.8 for abundance, biomass, diversity, evenness and the taxa number of the epifauna fit well into the results described by DANNHEIM et al (2014) for the communities 'Coast II' and 'Transition I' and the geo-cluster 'SW-E GB'.

2.4.2.3 Red List species

Of the total of 229 taxa of infauna and epifauna recorded at site N-3.8 in autumn 2018 and spring 2019, it was possible to determine 153 taxa at species level. A total of 24 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 15.7% of the total number of species.

No species were recorded as extinct (RL category 0) or critically endangered (RL category 1). The bivalve mollusc *Ensis ensis* and the polychaete species *Sabellaria spinulosa* are classified as endangered (RL Category 2). Both species were recorded in small abundances or as individual finds, *Ensis ensis* exclusively in spring 2019 and *Sabellaria spinulosa* only in autumn 2018. Among the species classified as vulnerable (RL Category 3), dead man's fingers (*Alcyonium digitatum*), the amphipod *Ampelisca typica*, the bivalve mollusc *Ensis magnus*, the sea anemone *Sagartiogeton undatus* and the polychaete species *Sigalion mathildae* were recorded. The latter two species were recorded on both occasions. *Alcyonium digitatum* was found only in spring and *Ampelisca typica* and *Ensis magnus* were recorded only in autumn. With the exception of *Sigalion mathildae*, recorded with a 90% presence at the site, all other species classified as endangered were detected with low presence and low abundance. A further ten species were identified as being at a not-evaluated risk (RL category NE). The amphipod *Apherusa clevei* and the bryozoan *Celleporella hyalina* are considered to be extremely rare.

On the whole, it can be stated that none of the macrozoobenthos species found at site N-3.8 have a protection status under BArtSchV or are listed in Annexes II and IV of the Habitats Directive.

2.4.3 Status assessment

The benthos of the EEZ in the North 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. The results of the investigations carried out between 2002 and 2019 at site N-3.8 and in its immediate surroundings confirm a strong natural variability of benthic communities.

2.4.3.1 Rarity and vulnerability

The number of rare or vulnerable species is taken into account. The rareness/vulnerability of the population can be assessed based on the identified Red List species.

At site N-3.8, 24 species were recorded from the Red List according to RACHOR et al. (2013). No species considered lost (RL Category 0, threatened with extinction (RL Category 1) or critically endangered (RL Category 2) were detected at site N-3.8. Species of the endangered and vulnerable categories (RL Categories 2 and 3) were found in small abundances and mostly in low numbers. Based on the Red List species found and their abundance, the benthic communities at site N-3.8 are assigned medium importance with regard to the criterion of rarity and vulnerability. This confirms the assessment arrived at in the environmental report of the FEP 2019 (BSH 2019), according to which the benthic biotic communities found in area N-3 are neither rare nor endangered.

2.4.3.2 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 benthic coenosis detected at site N-3.8 can be described as a transitional community of *Tellina fabula* and *Nucula nitidosa* communities according to Rachor & Nehmer (2003). Almost all typical representatives of this community were detected in the first year of the site investigations. Of the approximately 750 species recorded in the German EEZ, 229 taxa of epifauna and infauna (153 taxa determined at species level) were recorded at site N-3.8. Three neozoa (*Austrominius modestus, Crepidula fornicata, Jassa marmorata*) were detected in autumn 2018. On the basis of these results, the benthic zone of site N-3.8 is assigned medium importance with regard to the criterion of diversity and uniqueness. This confirms the assessment arrived at in the environmental report of the FEP 2019 (BSH 2019), according to which a stable transitional form occurs in the area around site N-3.8 between the *Tellina fabula* community and the *Nucula nitidosa* community, with average biodiversity.

2.4.3.3 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.

Due to the trawling and beam trawling taking place at site N-3.8, it can be assumed that the dominant structures found, especially within the epibenthic community, are the result of anthropogenic influence. According to PEDERSEN et al. (2009), fishing with small and large beam trawls is particularly common in the area in question. Although fishing in the North Sea has declined since the early 2000s due to EU regulations (ICES, 2018a), it continues to have a major impact on benthic communities in this part of the North Sea. Since the 1980s, nutrient discharge into the North Sea has been reduced by 50% (BSH, 2019). Large sections of the German EEZ in the North Sea were classified as eutrophic between 2006 and 2014 (BROCKMANN et al., 2017). Despite this information, however, there is still a lack of suitable measuring and detection methods to quantify the effects of eutrophication. Long-lived bivalve mollusc species such as *Mya arenaria* and *Arctica islandica* were not found at site N-3.8 during the investigations in autumn 2018 and spring 2019.

With regard to the criterion of 'existing cumulative effects', the benthic zone at site N-3.8 is assigned medium importance.

2.4.3.4 Importance of site N-3.8 for benthos

The individual criteria classified as 'medium' in each case result in an average overall rating for the benthic zone of site N-3.8. This assessment confirms the low to medium overall assessment of the environmental report of the FEP 2019 (BSH 2019) for sites within area N-3.

2.5 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 – fishing and climate change (HOLLOWED et al. 2013, HEESSEN et al. 2015) – interact with each other and their relative impact can hardly be distinguished (DAAN et al. 1990, VAN BEUSEKOM et al. 2018).

2.5.1 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 basis for the status assessment of the protected object (demersal) fish is provided by current studies in fish biology from the offshore site investigation of site N-3.8 carried out in autumn 2018 and spring 2019, together with current results from environmental impact studies relating to individual projects and cluster studies in close proximity to N-3.8 (N-3.7: expert opinion IfAÖ 2018, 2019; Gode Wind 01: expert opinion IfAÖ 2016, 2018; Gode Wind 02: expert opinion IfAÖ 2016, 2018, Gode Wind 03: EIA report IfAÖ 2009 – 2011). In addition, the environmental report for the Site Development Plan for the German North Sea (BSH 2019a) is used as a basis. The following is an assessment focusing specifically on site N-3.8. It also looks at the North of Borkum area, which includes project site N-3.8, reference site N-3.8 and the above-mentioned neighbouring projects.

2.5.2 Status description

In order to be able to narrow down possible impacts of offshore wind farms on fish, it is advisable to first differentiate the species according to their way of life and life cycle. Furthermore, knowledge of nutrition, reproduction and habitat use can provide key information about the importance of an area or a site for fish.

2.5.2.1 Way of life

At almost 60%, demersal species account for the largest share of the North Sea fish community, followed by pelagic (20%) and benthopelagic (15%) species, which are mainly found close to the seabed. Only about 5% cannot be assigned to any of these three ways of life due to a close habitat link (www.fishbase.org). This categorisation applies to the adult stages of the fish. However, the individual developmental stages of the species often differ more in form and behaviour than the same stages of different species.

Most of the fish species found in the North Sea complete their entire life cycle from egg to adult fish ready to spawn in the North Sea and are therefore referred to as permanent residents, such as herring *Clupea harengus*, plaice *Pleuronectes platessa* and whiting *Merlangius merlangus* (LOZAN 1990). Other marine species such as tub gurnard and grey gurnard (*Chelidonichthys lucernus* and *Eutrigla gurnardus*) appear as 'summer visitors' in the North Sea, mainly in summer, but without clear signs of reproduction, while the so-called 'strays' appear irregularly in the North Sea, regardless of the season, and usually only as single specimens, including bream mackerel *Brama brama* and halibut *Hippoglossus hippoglossus*.

The life cycle of diadromous species includes sea and freshwater, either with marine spawning grounds and limnic growth areas (catadromous, e.g. eel *Anguilla anguilla*) or vice versa (anadromous, e.g. smelt *Osmerus eperlanus*, twait shad *Alosa fallax* and salmon *Salmo salar*).

Finally, fish can be assigned to functional guilds based on diet, reproduction and habitat use. Unlike taxonomic classification, these make it easier to describe the functions of fish in the ecosystem (Elliott et al. 2007).

2.5.2.2 Spatial and temporal distribution

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. Hydrographic and climatic factors such as sea heave, tides and wind-induced currents, as well as the large-scale circulation of the North Sea, have an impact over a large area. 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. 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 influence 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).

2.5.2.3 Characterisation of the fish community

KLOPPMANN et al. (2003) identified a total of 39 fish species in a one-off survey to record FFH Annex II fish species in the German EEZ in the areas of Borkum Reef Ground, Amrum Outer Ground, Eastern Slope of Elbe Glacial Valley and Dogger Bank in May 2002. This study identified a gradual change in the species composition of fish communities from coastal to offshore areas due to hydrographic conditions. These changes were confirmed by Dannheim et al. (2014a), who were able to identify four geographically distinct fish communities in the German EEZ based on catch figures adjusted for input: the largest was the Central Community (ZG), which was distinguished in the north from the two 'Duck's Bill' communities (ES I and ES II) and along the coast from a Coastal Community (KG). These four fish communities essentially exhibited a similar species composition, but with different species-specific abundances. Common dab *Limanda limanda* dominated in general and occurred very regularly, while the offshore community ES II was dominated by plaice and American plaice *Hippoglossoides platessoides* dominated. Plaice were also regularly found in the central transitional community. Dragonets *Callionymus spec.*, solenette *Buglossidium luteum* and hooknose *Agonus cataphractus* were characteristic for the coastal community of demersal fish. Solenette and common dragonet were also regularly found in the central transitional community. The species composition and distribution of demersal fish showed gradual changes from off-shore to the central community to the near-shore areas.

According to this classification (Dannheim et al. 2014a), site N-3.8 lies at the transition between the central and coastal communities.

2.5.3 Status assessment

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

- rarity and vulnerability,
- diversity and uniqueness and
- existing cumulative effects.

These three criteria are defined below and applied to site N-3.8.

2.5.3.1 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
NE: Not evaluated
R: Extremely rare
NT: Near-threatened
DD: 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.

At site N-3.8, a total of 31 species from 20 families were recorded during the preliminary survey in autumn 2018 and spring 2019. According to THIEL et al (2013), no species is considered extinct, lost (0) or threatened with extinction (1). None of the species identified at site N-3.8 are assumed to be endangered (2) or vulnerable (3). Only for the snake pipefish *Entelurus aequoreus* is the threat deemed to be not evaluated (NE). Thus, the snake pipefish *Entelurus aequoreus* remains the only species that falls into an acute endangerment category. Extremely rare species (R) were not detected. Three near-threatened (NT) species were recorded: sole *Solea solea*, turbot *Scophthalmus maximus* and cod *Gadus morhua*. For the lesser sand eel *Ammodytes marinus*, the great sand eel *Hyperoplus lanceolatus*, and the sand goby *Pomatoschistus minutus*, the data is considered deficient for an assessment (DD). Of the 31 species recorded during the preliminary survey in site N-3.8, 24 are considered to be of least concern (*).

In the surrounding sea area North of Borkum, a total of 49 species were recorded in the course of the environmental impact investigations (see 2.6.1). In addition to the fish species identified, site N-3.8 may potentially contain other species adapted to local geological and hydrographic conditions. In this section, the species that have not yet been identified at project site N-3.8 but in adjacent areas (Table 6) are presented in addition. According to THIEL et al (2013), the thornback ray *Raja clavata* recorded in the area is threatened with extinction (1). The European eel *Anguilla anguilla* and the greater weever *Trachinus draco* are considered to be endangered (2). The thorny skate *Amblyraja radiata* and the poor cod *Trisopterus minutus* are both considered to be at risk (3). The greater pipefish *Syngnathus acus* and the sea lamprey *Petromyzon marinus* are considered to be a not evaluated threat (NE). The sea lamprey *Petromyzon marinus* is also listed in Annex II of the Habitats Directive (THIEL & WINKLER 2007). Three species are near-threatened: the Atlantic mackerel *Scomber scombrus*, the whiting-pout *Trisopterus luscus* and the twait shad *Alosa fallax*. The latter, like the sea lamprey, is given special protection under the Habitats Directive and is listed as near-threatened (NT). For the spotted dragonet *Callionymus maculatus*, the reticulated dragonet *Callionymus reticulatus*, Lozano's goby *Pomatoschistus lozanoi*, the tadpole fish *Raniceps raninus* and the longspined bullhead *Taurulus bubalis*, the data is considered deficient for an evaluation (DD). In total, 26 of the 49 fish species covered are considered to be of least concern (*).

In the Red List of marine fish, 27.1% of the species assessed are assigned to a risk category (0, 1, 2, 3, G or R), 6.5% have near-threatened status, and for 22.4% no assessment is possible due to lack of data. All in all, 43.9% of the species are considered to be of least concern (THIEL et al. 2013,

Table 6). Of the fish species detected during the site investigation at site N-3.8, 3.2 % have a not evaluated endangerment status (NE). 9.7% of species have near-threatened status. For a further 9.7% of the identified species, no endangerment can be identified due to the insufficient data available (DD). The largest proportion (77.4%) is made up of least-concern species.

If the entire area North of Borkum is considered, the number of species with an endangered status increases (1, 2, 3: 10.2%, G: 6.1%). 12.2% of the registered fish species North of Borkum have near-threatened status, while for 18.4% the data available is insufficient for an assessment. On the whole, as at site N-3.8, more than half of all recorded species are classified as being of least concern (53.1%).

No extinct or lost species (0) were recorded at site N-3.8, nor in the surrounding sea area North of Borkum. The relative proportions of critically endangered (1) and endangered (2) species are significantly lower than in the North Sea as a whole (represented by the Red List and Total Species List). As such, site N-3.8 has a below-average significance for species in endangerment categories 0-2. For vulnerable species (3), however, the area is of above-average importance relative to the North Sea. The proportion of fish species whose endangerment is not evaluated (NE) is higher than in the North Sea. For extremely rare species (R), site N-3.8 is of below-average importance, while the relative proportion of category V species is significantly higher than in the North Sea. The highest proportion of recorded fish species that can be found at site N-3.8 is of least concern (*). The proportion of species that could not be assessed due to deficient data (DD) at site N-3.8 and in the area North of Borkum was below the proportion of the respective category in the Red List. Species in the threat categories (1, 2, 3 and NE) were recorded as individual specimens at site N-3.8. The FFH species twait shad *Alosa fallax* has been identified as a pelagic migratory species on several occasions using a bottom trawl. Therefore its presence at site N-3.8 is likely. However, its distribution is concentrated in the estuaries of rivers, so regular occurrence at site N-3.8 is not to be expected. Since the sea lamprey *Petromyzon marinus* lives parasitically on the body tissue of large fish and mammals in the North Sea and there is no quantitatively suitable method of detection, it is not possible to issue a statement as to its occurrence based on individual detection. Species in categories G, V and D occurred in small numbers in relation to the overall density of individuals and are not typical representatives of the fish fauna.

In the overall assessment, the fish fauna at site N-3.8 is rated as average in terms of the criterion of rarity and vulnerability.

Table 6: Absolute number of species and relative proportion of the Red List Categories of fish detected during the offshore site investigation at site N-3.8, while environmental impact assessments (EIA) were carried out in the North of Borkum sea area and throughout the entire German North Sea (Red List and Total Species List, THIEL et al. 2013).

Red List Category	**OSI N-3.8**		**EIA area North of Borkum**		**German North Sea (THIEL et al. 2013)**	
	Absolute species number	Relative share [%]	Absolute species number	Relative share [%]	Absolute species number	Relative share [%]
0: Extinct or lost	0	0	0	0	3	2.8
1: Threatened with extinction	0	0	1	2.0	8	7.5
2: Critically endangered	0	0	2	4.1	7	6.5
3: Endangered	0	0	2	4.1	2	1.9
G: Not evaluated	1	3.2	3	6.1	5	4.7
R: Extremely rare	0	0	0	0	4	3.7
V: Near-threatened status	3	9.7	6	12.2	7	6.5
D: Insufficient data	3	9.7	9	18.4	24	22.4
***:** Of least concern	24	77.4	26	53.1	47	43.9
Total number of species	31		49		107	

2.5.3.2 Diversity and uniqueness

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 uniqueness are compared and assessed below between the entire North Sea and N-3.8 and the sea area North of Borkum.

Over 200 species of fish have been recorded in the North Sea to date (YANG 1982, DAAN 1990: 224, LOZAN 1990: > 200, FRICKE et al. 1994, 1995, 1996: 216, WWW.FISHBASE.ORG: 209; status: 24.02.2017), whereby in most cases these were rare instances of individuals being detected. Less than half of them reproduce regularly in the German EEZ or are found as larvae, young or adult specimens. According to these criteria, only 107 species are considered established in the North Sea (THIEL et al. 2013). The International Bottom Trawl Survey (IBTS) detected 99 species of fish throughout the North Sea between 2014 and 2018. A total of 56 species have been identified in the German EEZ (BSH 2019, bibliography FEP). The fish community of sandy seabeds in the southern North Sea is characterised by the species common dab *Limanda limanda*, plaice *Pleuronectes platessa*, solenette *Buglossidium luteum*, Mediterranean scaldfish *Arnoglossus laterna*, whiting *Merlangius merlangus*, sand goby *Pomatoschistus minutus*, common dragonet *Callionymus lyra*, hooknose *Agonus* *cataphractus* and lesser sand eel *Ammodytes marinus* (DAAN et al. 1990, REISS et al 2010).

A total of 31 species were recorded at site N-3.8, including all typical flat and round fish species. The species common dab *Limanda limanda,* solenette *Buglossidium luteum*, plaice *Pleuronectes platessa* and Mediterranean scaldfish *Arnoglossus laterna* constituted the characteristic species, accounting for > 90% of total individual density. In addition, the species whiting *Merlangius merlangus*, sand goby *Pomatoschistus minutus*, hooknose *Agonus cataphractus* and sole *Solea solea* were typical representatives of the fish fauna at N-3.8. Although the bottom trawls used are not suitable for capturing pelagic fish, species such as herring *Clupea harengus* and sprat *Sprattus sprattus* were quantitatively identified.

The diversity and specificity of the fish community in the North of Borkum sea area largely correspond to that at site N-3.8. Species composition differs between the areas with regard to individual, rare species, which is due to the larger sample size. With regard to the occurrence of habitat-typical species, biodiversity and dominance conditions, site N-3.8 and the North of Borkum sea area are consistent.

Species of the central fish community (DANNHEIM et al. 2014a) account for the largest proportion in their biodiversity. Individual species of the coastal community diversify the fish fauna at site N-3.8. As a result, the diversity and uniqueness in site N-3.8 are characterised by a typical species and dominant structure of fish fauna and can be considered average.

Table 7: TABLE List of all fish species identified at project site N-3.8 and the surrounding sea area North of Borkum with their Red List status in the North Sea Region (RLS) according to Thiel et al. 2013 and their way of life (LW; p=pelagic, d=demersal)

Fish species	Common name	LW	RLS	N-3.8	North of Borkum
Agonus cataphractus	Hooknose	d	*	X	X
Alosa fallax	Twait shad	p	V		X
Amblyraja radiata	Thorny skate	d	3		X
Ammodytes marinus	Lesser sand eel	d	D	X	X
Anguilla anguilla	European eel	d	2		X
Arnoglossus laterna	Mediterranean scaldfish	d	*	X	X
Belone belone	Garfish	p	*	X	X
Buglossidium luteum	Solenette	d	*	X	X
Callionymus lyra	Common dragonet	d	*	X	X
Callionymus maculatus	Spotted dragonet	d	D		X
Callionymus reticulatus	Reticulated dragonet	d	D		X
Chelidonichthys lucerna	Tub gurnard	d	*	X	X
Ciliata mustela	Fivebeard rockling	d	*	X	X

Clupea harengus	Atlantic herring	p	*	X	X
Cyclopterus lumpus	Lumpfish	d	*	X	X
Echiichthys vipera	Lesser weever	d	*		X
Enchelyopus cimbrius	Fourbeard rockling	d	*	X	X
Entelurus aequoreus	Snake pipefish	d	G	X	X
Eutrigla gurnardus	Grey gurnard	d	*	X	X
Gadus morhua	Atlantic cod	d	V	X	X
Gasterosteus aculeatus	Three-spined stickleback	d	*	X	X
Hyperoplus lanceolatus	Great sand eel	d	D	X	X
Limanda limanda	Common dab	d	*	X	X
Merlangius merlangus	Whiting	d	*	X	X
Microstomus kitt	Lemon sole	d	*	X	X
Mullus surmuletus	Striped red mullet	d	*	X	X
Myoxocephalus scorpius	Shorthorn sculpin	d	*	X	X
Petromyzon marinus	Sea lamprey		G		X
Pholis gunnellus	Rock gunnel	d	*	X	X
Platichthys flesus	European flounder	d	*	X	X
Pleuronectes platessa	European plaice	d	*	X	X
Pomatoschistus lozanoi	Lozano's goby	d	D		X
Pomatoschistus minutus	Sand goby	d	D	X	X
Pomatoschistus pictus	Painted goby	d	D		X
Raja clavata	Thornback ray	d	1		X
Raniceps raninus	Tadpole fish	d	D		X
Scomber scombrus	Atlantic mackerel	p	V		X
Scophthalmus maximus	Turbot	d	V	X	X
Scophthalmus rhombus	Brill	d	*	X	X
Scyliorhinus canicula	Small-spotted catshark	d	*		X
Solea solea	Common sole	d	V	X	X
Sprattus sprattus	Sprat	p	*	X	X
Syngnathus acus	Greater pipefish	d	G		X
Syngnathus rostellatus	Lesser pipefish	d	*	X	X
Taurulus bubalis	Longspined bullhead	d	D		X

Trachinus draco	Greater weever	d	2		X
Trachurus trachurus	Atlantic horse mackerel	p	*	X	X
Trisopterus luscus	Whiting-pout	d	V		X
Trisopterus minutus	Poor cod	d	3		X
Total number of species				31	49

2.5.3.3 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. Fish are also subject to other direct or indirect human influences such as shipping traffic, pollutants and sand and gravel extraction. However, it is difficult to establish evidence of these indirect influences and their effects on the fish fauna. In principle, 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 is 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. There is no assessment of populations within a smaller area, such as the German Bight. Consequently, the assessment of this criterion cannot be carried out at the area level but only for the entire North Sea.

Of the 107 species considered as established in the North Sea, 21 are fished commercially (Thiel et al. 2013). The assessment of naturalness is based on the 'Fisheries overview – Greater North Sea Ecoregion' published by the International Council for the Exploration of the Sea (ICES 2018a). 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, endangered or threatened species, including reptiles, birds and mammals in addition to fish (ICES 2017c). Some 6600 fishing vessels from 9 nations fish in the North Sea. The largest quantities were landed in the early 1970s, and catches have declined since then. However, a reduction in fishing has only been observed since 2003.

The intensity of bottom-contact fishing is concentrated in the southern North Sea and is also by far the predominant form of fishing in the German EEZ (ICES 2018a). Flatfish fishing in the German EEZ targets plaice and sole, using not only heavy bottom tackle but also relatively small meshes, as a result of which by-catch rates of small fish and other marine organisms can be very high.

Commercial fishing and the size of spawning populations are assessed against Maximum Sustainable Yield (MSY), taking into account the precautionary approach. A total of 119 populations were considered in terms of fishing intensity, 43 of which are subject to scientific assessment (Figure 12; ICES 2018a). Of the 43 populations evaluated, 25 are managed sustainably. 38 of the 119 populations were assessed in terms of their reproductive capacity (spawning biomass), with 29 populations being able to use their full reproductive capacity (Figure 12).

The biomass share of the total catch (5,350,000 t in 2017) which is managed with excessive fishing intensity outweighs the share of sustainably caught and unevaluated fish populations in the North Sea (). Fish from populations whose reproductive capacity is above the reference level account for the majority of the biomass in the catch (3,709,000 t, Figure 12).

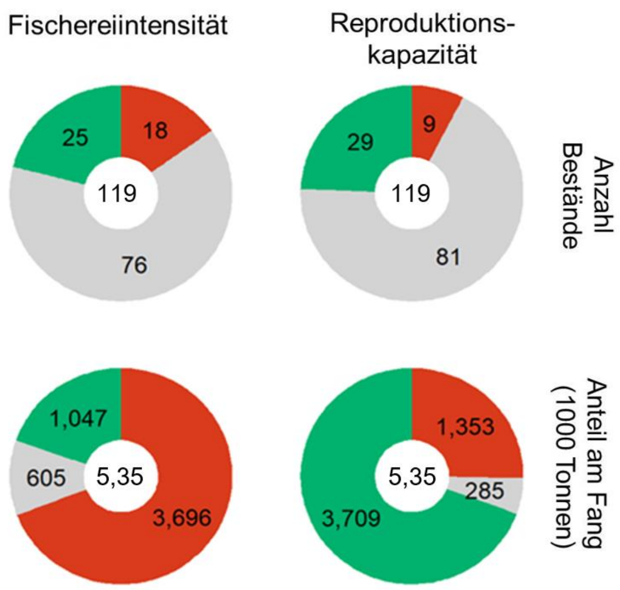


Figure 12: Fishing intensity and reproductive capacity of 119 fish populations in the North Sea, which together accounted for more than 5,350,000 tonnes caught in 2018. Number of populations (top) and biomass share of the catch (bottom). Reference level of fishing intensity: sustainable long-term yield (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 according to ICES (2018a).

Overall fishing mortality of demersal and pelagic fish has decreased significantly since the late 1990s and for most of these populations, spawning biomass has been on the increase since 2000 and is now above or close to individually defined reference levels. Nevertheless, fishing mortality rates for many populations are also higher than the reference levels set, e.g. for cod *Gadus morhua*, whiting *Merlangius merlangus* and mackerel *Scomber scombrus*. Moreover, for the vast majority of the populations exploited, no reference levels have been defined, which makes it impossible to carry out scientific population assessments.

In addition to fishing, eutrophication is one of the greatest ecological problems confronting the marine environment in the North Sea (BMU 2018). Despite reduced nutrient discharge and lower nutrient concentrations, the southern North Sea was subject to high eutrophication in the 2006 – 2014 period. Nitrates and phosphates are mainly introduced via rivers, which leads to a pronounced gradient of nutrient concentration from the coast to the open sea (BROCKMANN ET AL. 2017. Significant direct effects of eutrophication are increased chlorophyll-a concentrations, reduced visibility depths, local decline in seagrass areas and vegetation density with associated mass reproduction of green algae and increased cell numbers of disturbing phytoplankton species (especially Phaeocystis). Above all, the seagrass beds of the Wadden Sea play an important role in protecting the fish spawn and provide a protection and feeding area between the stalks for numerous young fish, such as the common goby *Pomatoschistus microps* (AWI 2019). With the increasing decline of seagrass beds due to eutrophication, there are fewer retreat areas and 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. Furthermore, the altered species composition of benthic organisms can also affect the biodiversity of the fish community, especially that of food specialists.

Due to the fact that, despite these anthropogenic factors, ICES reports that the abundance of fish species in the North Sea has not decreased for

40 years (number of species per 300 hauls; catch data from the International Bottom Trawl Survey, IBTS), and that the commercially exploited populations are also subject to strong natural fluctuations, the fish fauna has been assessed as average with regard to the level of existing cumulative effects in the German EEZ. This assessment is supported by a summary of fishery indicators and the ecosystem effects of bottom-contact fishing (WATLING & NORSE 1998, HIDDINK et al. 2006).

2.5.3.4 Importance of site N-3.8 for fish

The overriding criterion for the significance of site N-3.8 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. Site N-3.8 could serve as a spawning and nursery habitat for several species. Site investigations of the project site and reference area mainly recorded juvenile stages of the characteristic species common dab *Limanda limanda*, plaice *Pleuronectes platessa* and striped red mullet *Mullus surmuletus* . For these species, site N-3.8 could also be important as a nursery and feeding ground. In addition, current investigations indicate that the species Mediterranean scaldfish *Arnoglossus laterna* and solenette *Buglossidium luteum* potentially use the area as a spawning habitat. To date, however, no specific spawning sites for these two species have been identified (HEESSEN et al. 2015). The five affected characteristic species occur throughout the German Bight. They are food generalists and r-strategists with extremely high reproductive capacities. Accordingly, localised site N-3.8 is assigned average importance as a habitat.

2.6 Marine mammals

Three species of marine mammals regularly occur in the German EEZ in the North Sea: the harbour porpoise *(Phocoena phocoena*), the grey seal *(Halichoerus grypus*) and the harbour seal *(Phoca vitulina*). All three species are characterised by a high degree of mobility. Migration, especially in search of food, is not limited to the EEZ, but also includes the territorial sea and large areas of the North Sea across national 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. Due to the high mobility of marine mammals and the use of very extensive areas, it is necessary to consider their occurrence not only in the German EEZ but in the whole area of the southern North Sea.

Occasionally, other marine mammals are also observed in the German EEZ in the North Sea, such as the white-sided dolphin *(Lagenorhynchus acutus*), the white-beaked dolphin *(Lagenorhynchus albirostris*), the common bottlenose dolphin *(Tursiops truncatus*) and the common minke whale *(Balaenoptera acutorostrata*).

Marine mammals are among the TOP predators in the marine food chains. 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 consumers at the top of the marine food chain, marine mammals also influence the occurrence of food organisms.

2.6.1 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.

Harbour porpoises are present all year round in the German EEZ in the North Sea, but their abundance and spatial distribution vary depending on the season.

The most important large-scale studies mainly include the three so-called SCANS (Small Cetacean Abundance in the North Sea and adjacent waters) studies, which cover the entire North Sea, Skagerrak, Kattegat, Western Baltic/Belt Sea, Celtic Sea and other parts of the North East Atlantic.

The German waters are currently among those areas of the North Sea which have been systematically and very intensively investigated for the presence of marine mammals since 2000. Most of the data is provided by the StUK4 studies (BSH, 2013), which are carried out as part of environmental impact studies as well as for construction and operational monitoring of offshore wind farms. Since 2009, a monitoring network consisting of more than 20 stations has been operated in the German EEZ in the North Sea for the acoustic recording of harbour porpoise habitat use by means of so-called C-PODs on behalf of wind farm operators. The network of stations provides the most comprehensive and valuable data on harbour porpoise habitat use in the areas of the German EEZ in the North Sea to date. Acoustic data from C-PODs are also collected in the context of construction and operational monitoring of individual projects.

Since the changeover of survey methods as of StUK4 (BSH, 2013) in 2013 from observer-based recording from aircraft to digital recording by means of video technology or photography, large clusters are being investigated in connection with the monitoring of offshore wind farms. These so-called cluster studies cover a large part of the German EEZ, in particular valuable harbour porpoise habitats and all areas where there is offshore wind energy use.

In addition, since 2008, regular surveys for monitoring Natura 2000 areas have been carried out on behalf of the BfN (monitoring reports on behalf of the BfN 2008, 2009, 2011, 2012, 2013, 2016). Data are also collected in the context of research projects that investigate specific issues.

The current findings refer to different spatial dimensions:

- The whole North Sea and adjacent waters: large-scale surveys under SCANS I, II and III from 1994, 2005 and 2016,
- Natura 2000 areas in the German EEZ: monitoring commissioned by the BfN since 2008 and continuously,
- Parts of the German EEZ and the territorial sea: research projects with different focal points (including MINOS, MINOSplus (2002 – 2006), StUKplus (2008 – 2012), underwater clusters (commissioned by the BfN).
- Investigations for the fulfilment of the requirements of the UVPG as part of licensing and planning approval procedures carried out by the BSH, in connection with the monitoring of the construction and operation phase of offshore wind farms since 2001 and on an ongoing basis. During the baseline surveys from 2001 to 2013, mostly specific areas with planned offshore wind farms were investigated with high temporal resolution. Since 2014, these areas have been enlarged and adapted in such a way that up-to-date data with high

temporal resolution are available for large areas of the German EEZ.

The BSH has current findings on the occurrence of marine mammals from the vicinity of site N-3.8 from the monitoring of offshore projects in areas N-1, N-2 and N-3 (study cluster North of Borkum 2013 – 2019). The results of cluster studies of offshore wind farms provide extensive spatially and temporally high-resolution data on the occurrence of marine mammals.

Gaps in knowledge currently still exist in research into the biological relevance of the impacts of offshore wind farms on marine mammals in the German EEZ and in particular on the key species of the harbour porpoise. There is also a continuing need for monitoring and knowledge generation to assess interactions and possible cumulative impacts.

2.6.2 Spatial distribution and temporal variability

The high mobility of marine mammals, depending on specific conditions in the marine environment, results in the high spatial and temporal variability of their occurrence. In addition to natural variability, climate-induced changes in the marine ecosystem and anthropogenic uses also influence the occurrence of marine mammals. Both the distribution and abundance of the animals vary with the seasons. In order to be able to draw conclusions about seasonal distribution patterns and the use of areas and sites, the effects of seasonal and interannual variability and the influences of anthropogenic uses, large-scale long-term studies in the German EEZ are particularly necessary.

2.6.2.1 Harbour porpoises

The harbour porpoise *(Phocoena phocoena*) 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 North Sea. The distribution of the harbour porpoise is limited to continental shelf seas due to their hunting and diving behaviour (Read 1999). The animals are extremely agile and can cover long distances in a short time. Satellite telemetry has shown that harbour porpoises can travel up to 58 km in one day. Marked animals exhibited a high degree of individual variation in movement patterns. with migration periods of several hours to several days between the individually selected resting places (Read & Westgate 1997).

In the North Sea, the harbour porpoise is the most widespread species of cetacean. In general, harbour porpoises occurring in German and neighbouring waters of the southern North Sea are assigned to a single population (ASCOBANS 2005).

The best overview of the occurrence of the harbour porpoise throughout the North Sea is provided by the large-scale surveys of small cetaceans in northern European waters in 1994, 2005 and 2016, which were carried out as part of the SCANS surveys (Hammond et al. 2002, Hammond & Macleod 2006, Hammond et al. 2017). The large-scale SCANS surveys allow the estimation of the population size and the population trends in the whole area of the North Sea, which is part of the habitat of highly mobile animals, without the need for detailed mapping of marine mammals in sub-areas (seasonal, regional, small-scale). The abundance of harbour porpoises in the North Sea in 1994 was estimated at 341,366 animals based on the SCANS I survey. In 2005, the SCANS II survey covered a larger area and as a result a larger number of animals was estimated at 385,617. However, the abundance calculated for an area of the same size as in 1994 was about 335,000 animals. The most recent survey, carried out in 2016, showed an average abundance of 345,373 (minimum abundance 246,526, maximum abundance 495,752) animals in the North Sea. As part of the statistical analysis of the data from SCANS-III, the data from SCANS

I and II were recalculated. The data from SCANS I, II and III show no decreasing trend in the abundance of harbour porpoises between 1994, 2005 and 2016 (HAMMOND et al., 2017). However, the regional distribution in 2005 and 2016 differs from the distribution in 1994 in that more animals were counted in the southwest than in the northwest in 2005 (LIFE04NAT/GB/000245, Final Report, 2006), and in 2016 high occurrences were recorded throughout the English Channel. The results of the latest SCANS study (SCANS III) can be summarised as follows: the calculated abundance of harbour porpoises in the North Sea in 2016 is 345,000 (CV = 0.18) animals and is therefore comparable to the abundance in 2005, at 355,000, and in 1994, at 289,000 (CV = 0.14) animals. However, a further shift of populations towards the south-east coast of the UK and the English Channel was identified in 2016. This shift will lead to a decline in populations in German waters of the North Sea (HAMMOND et al. 2017). Statistical modelling of the results from SCANS III is still pending.

The abundance calculated in SCANS I, II and III is also comparable to the statistical value of 361,000 (CV 0.20) from the modelling of the data from 2005 up to and including 2013, which was performed as part of a study (GILLES et al. 2016). The study by GILLES et al. (2016) provides a very good overview of the seasonal distribution patterns of harbour porpoises in the North Sea. Data from the UK, Belgium, the Netherlands, Germany and Denmark from 2005 up to and including 2013 were considered collectively in the study. Data from large-scale and cross-border visual surveys, such as those performed in the SCANS II and Dogger Bank projects, and extensive data from smaller-scale national surveys (monitoring, EIS) were validated and seasonal, habitat-related distribution patterns were predicted (GILLES et al. 2016). It was possible to verify and confirm the results of the habitat modelling during the study using data from acoustic surveys. This study is one of the first to take into account the availability of food, in particular sand eels, in addition to dynamic hydrographic variables such as surface temperature, salinity and chlorophyll. Food availability was modelled by removing the animals to known sand eel habitats in the North Sea. Habitat modelling has shown significantly high densities, especially for spring and summer, in the area west of Dogger Bank. The study concludes that the distribution patterns of harbour porpoise in the North Sea indicate the high spatial and temporal variability of hydrographic conditions, the formation of fronts and the associated food availability.

Occurrence of the harbour porpoise in the German North Sea

Site N-3.8 of area N-3 (FEP, 2018) is located in the southern part of the German EEZ and is part of the North Sea harbour porpoise habitat. In the summer months especially, the area of the territorial sea and the German EEZ off the North Frisian islands, especially north of Amrum and near the Danish border, is subject to intense use by harbour porpoises (SIEBERT et al. 2006). In addition, the presence of calves is always confirmed here during the summer months.

The large-scale studies on the distribution and abundance of harbour porpoises and other marine mammals carried out as part of the MINOS and MINOSplus projects from 2002 to 2006 (SCHEIDAT et al. 2004, GILLES et al. 2006) provide an overview of the German waters of the North Sea. Based on the results of the MINOS surveys (SCHEIDAT et al. 2004), the abundance of harbour porpoises in German waters of the North Sea was estimated at 34,381 individuals in 2002 and 39,115 in 2003. In addition to the pronounced temporal variability, a strong spatial variability was also observed. The seasonal evaluation of the data has shown that up to 51,551 animals may have been temporarily present in the German EEZ in the North Sea, e.g. in May/June 2006 (GILLES et al. 2006). Since 2008, the abundance of harbour porpoise has been determined in connection with the monitoring of Natura 2000 areas. Although abundance varies between years, it remains high, especially in the summer and spring. In May 2012, 68,739 animals were recorded – the highest abundance recorded in the German North Sea to date (GILLES et al. 2012)

A recent evaluation of the data from the monitoring of Natura 2000 areas and from research projects has confirmed the indications from the SCANS III study, showing that the population of harbour porpoise in the German EEZ in the North Sea has changed in recent years. The changes in the population are more pronounced in the area of the nature conservation area 'Sylt Outer Reef – Eastern German Bight' than in the southern part of the German EEZ (Gilles A. et al., 2019).

Occurrence in nature conservation areas

Based on the results of the MINOS and EMSON1 surveys, three areas of particular importance for harbour porpoises were defined in the German EEZ. These have been notified to the EU as offshore conservation areas under the Habitats Directive and were recognised by the EU as Sites of Community Importance (SCIs) in November 2007: Dogger Bank (DE 1003-301), Borkum Reef Ground (DE 2104-301) and especially Sylt Outer Reef (DE 1209-301). Since 2017, the three FFH areas in the German EEZ in the North Sea have been granted nature conservation status:

- Ordinance on the Designation of the 'Borkum Reef Ground' Nature Conservation Area (NSGBRgV), Federal Law Gazette I, I p. 3395 of 22.09.2017,
- Ordinance on the Designation of the 'Dogger Bank' Nature Conservation Area (NSGDgbV), Federal Law Gazette I, I p. 3400 of 22 September 2017,
- Ordinance on the Designation of the 'Sylt Outer Reef – Eastern German Bight' Nature Conservation Area (NSGSylV), Federal Law Gazette I, I p. 3423 of 22 September 2017.

The nature conservation area 'Sylt Outer Reef – Eastern German Bight' is the main distribution area for harbour porpoises in the EEZ. The highest densities are often found here in the summer months. The nature conservation area 'Sylt Outer Reef – Eastern German Bight' has the function of a breeding area. In the period from 1 May to the end of August, high calf percentages are recorded in the area of the conservation area 'Sylt Outer Reef – Eastern German Bight'.

The nature conservation area 'Borkum Reef Ground' is of great importance for harbour porpoises in spring and to some extent in the early months of summer.

Results from the monitoring of Natura 2000 areas as well as from the monitoring of offshore wind farms show a high occurrence of harbour porpoise in the conservation areas up until 2013, especially in the area of Sylt Outer Reef (Gilles et al., 2013). However, current findings from the monitoring of Natura 2000 areas show a change in the populations in the German EEZ, which particularly affects the nature conservation area 'Sylt Outer Reef – Eastern German Bight' (Gilles et al. 2019).

Based on the findings, the BMU has highlighted the importance of the 'Sylt Outer Reef – Eastern German Bight' nature conservation area in its noise control concept for harbour porpoise and defined a main concentration area for harbour porpoise in the summer months (BMU 2013).

Occurrence at site N-3.8

Information on the occurrence of marine mammals in area N-3, in which site N-3.8 is located, is provided for the period from 2008 up to and including 2012 by the studies carried out during the third year of study, as well as construction and operational monitoring for the 'alpha ventus' test site and the accompanying ecological research in connection with the 'StUKplus' project. For this purpose, extensive airborne and shipborne surveys of marine mammals according to StUK were carried out in the entire area of the German EEZ between the traffic separation schemes TGB and GBWA, in which site N-3.8 is also located. Along with the visual surveys, acoustic surveys of harbour porpoises using acoustic underwater detectors were also carried out as part of the studies (Rose et al. 2014, Gilles et al. 2014). These studies covered all three areas N-1, N-2 and N-3. The highest densities were always found to the west of areas N-2 and N-3 in the nature conservation area 'Borkum Reef Ground'. The highest density of 2.58 ind./km^2 in the above-mentioned studies was found in summer 2010.

Since 2013 and on an ongoing basis, large-scale so-called cluster studies have been carried out in accordance with the BSH standard for investigating the impact of offshore wind turbines on the marine environment (StUK4) in the area north of the East Frisian islands. The entire region of areas N-1, N-2 and N-3, including site N-3.8, is part of the large assessment area of the 'North of Borkum' cluster in which nine wind farms were erected between 2009 and 2018, six of which are already in regular operation. This provides up-to-date data on the occurrence of marine mammals as well as possible effects during the construction and operation phases of the wind farms already implemented in the entire area North of Borkum.

The results of all studies for the 'North of Borkum' cluster and areas N-1, N-2 and N-3 show that harbour porpoises occur in varying numbers in this part of the German EEZ throughout the year. The highest densities were always determined in spring and the first months of summer. In connection with the “North of Borkum” cluster studies, the highest density of harbour porpoise was also found in the summer months, at 2.9 individuals per km^2 up to 2013. The area North of Borkum – and therefore also site N-3.8 – is crossed by mother-calf pairs during the summer months.

The results of the “North of Borkum” cluster studies show a change in the occurrence of harbour porpoise since 2014, with a tendency towards lower densities (Krumpel *et al.*, 2017, Krumpel *et al.*, 2018, Krumpel *et al.*, 2019). The majority of the cluster study results obtained north of the traffic separation schemes, north of Heligoland and north of Amrum Bank also indicate a trend towards lower harbour porpoise densities since 2013. The results of the 'North of Borkum' cluster studies thus fit into the overall picture of changes in the occurrence of harbour porpoise in the German EEZ in the North Sea and in the southern North Sea. Compared to the occurrence of harbour porpoise in other areas of the German EEZ in the North Sea, however, the changes are smallest in the area North of Borkum. The entire area North of Borkum with the nature conservation area 'Borkum Reef Ground' and the three areas for offshore wind energy use N-1, N-2 and N-3 also show a relatively high and stable occurrence of harbour porpoise in the years 2013 to 2018.

The data from the acoustic survey of harbour porpoise in the 'North of Borkum' cluster studies also show continuous use of the area by harbour porpoises, which is also more intensive in spring and summer. The results from visual and acoustic surveys of the cluster studies also confirm a higher abundance and use by harbour porpoises in the western part of the assessment area, in particular the FFH area 'Borkum Reef Ground'. The abundance of harbour porpoise and habitat use decreases in the area North of Borkum towards the east, with occasional high densities in various sub-areas. Distribution patterns seem to be related to food availability

(Krumpel et al., 2017, Krumpel et al., 2018, Krumpel et al., 2019, Gilles et al., 2019)

As part of the large-scale survey carried out in 2016, SCANS III showed a further shift of the population from the south-eastern area of the North Sea more towards the south-western area in the direction of the English Channel (Hammond et al., 2017). An initial evaluation of research data and data from the national monitoring of nature conservation areas also indicates a shift in the population, and the authors consider several factors as possible reasons for the observed change (Gilles et al., 2019).

2.6.2.2 Harbour seals and grey seals

The harbour seal is the most widespread seal species in the North Atlantic and is found along the coastal regions throughout the entire North Sea. Throughout the Wadden Sea, regular aerial surveys are carried out at the peak of the moulting period in August. In 2005, 14,275 seals were counted in the entire Wadden Sea (ABT et al. 2005). As there are some animals in the water that are not counted, this reflects the minimum population.

Suitable undisturbed resting areas are crucial for the presence of seals. In the German North Sea, sandbanks are mainly used as resting places (Schwarz & Heidemann, 1994). Telemetric studies show that adult seals in particular rarely move more than 50 km away from their original resting areas (TOLLIT et al. 1998). On food excursions, the radius of action is usually about 50 to 70 km from the resting places to the hunting areas (z. B. THOMPSON & MILLER 1990), although in the Wadden Sea area this can also be as much as 100 km (ORTHMANN 2000).

Surveys of grey seals during the moulting period have so far only been carried out occasionally in the German North Sea. In 2005, 303 animals were counted in Schleswig-Holstein during the moulting period. 100 animals are estimated for Lower Saxony (AK SEEHUNDE 2005). These figures only provide a snapshot.

Strong seasonal fluctuations are reported (ABT et al. 2002, ABT 2004). The figures observed in German waters have to be seen in a wider geographical context, as grey seals can migrate, sometimes over very long distances, between different resting places throughout the North Sea region (MCCONNELL et al. 1999). The grey seals observed in the territorial sea at their resting places probably have their feeding grounds at least partly in the EEZ.

The 'North of Borkum' cluster studies show that grey seals and harbour seals use the entire area in small numbers and irregularly. A comparison of the monthly densities from 2018 with those of previous years (2014-2017) shows that densities in individual months can fluctuate strongly from year to year (Krumpel et al., 2019).

Site N-3.8 is also used by seals in small numbers and on an irregular basis.

2.6.3 Status assessment of marine mammals

The good data basis which has been built up since 2002 to the present allows a sound assessment of the importance and status of the area around site N-3.8 as a habitat for marine mammals.

2.6.3.1 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 an Annex IV species, it enjoys strict general species protection in accordance with Articles 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).

The grey seal and harbour seal are also listed in Annex II of the Habitats Directive. In the Red List, the grey seal is also classified in endangerment category 2. The harbour seal is classified in protection category 3 (vulnerable).

The protection purposes of the nature conservation areas in the German EEZ in the North Sea include the maintenance and restoration to a favourable conservation status of the species listed in Annex II of the Habitats Directive, in particular the harbour porpoise, grey seal and harbour seal, and the conservation of their habitats (Ordinance on the Designation of the 'Borkum Reef Ground' Nature Conservation Area – NSGBRgV, 2017. Federal Law Gazette, Part I, No. 63, 3395).

The conservation of habitats of importance to harbour porpoises is also one of the formulated conservation objectives of the 'Lower Saxony Wadden Sea National Park' (EU code DE 2306-301) in the territorial sea.

2.6.3.2 Assessment of occurrence

The population of harbour porpoises in the North Sea has decreased over the past few centuries. The situation of the harbour porpoise generally worsened in earlier periods. In the North Sea, the population has been declining mainly due to by-catch, pollution, noise, over-fishing and food restrictions (ASCOBANS 2005). However, there is a lack of concrete data to calculate a trend or forecast trend developments. The best overview of the distribution of harbour porpoises in the North Sea is to be found in the 'Atlas of the Cetacean Distribution in North-West European Waters' (REID et al. 2003). However, when calculating abundance or population based on aerial surveys or even inspections, the authors point out that the occasional sighting of a large accumulation (group) of animals within an area recorded in a short period of time can lead to the assumption of unrealistically high relative densities (REID et al. 2003). The detection of distribution patterns or the calculation of herds is made more difficult by the high level of mobility exhibited by the animals in particular.

The population of harbour porpoises throughout the North Sea has not changed significantly since 1994, and no significant differences were found between the data from SCANS I, II and III (HAMMOND & MACLEOD 2006, HAMMOND et al. 2017).

The statistical evaluation of data from the large-scale surveys carried out as part of research projects and, since 2008, as part of the monitoring of Natura 2000 areas on behalf of the Federal Agency for Nature Conservation (BfN) indicates a significant increase in harbour porpoise densities in the southern German North Sea for the years 2002 to 2012. In the area of the nature conservation area 'Sylt Outer Reef – Eastern German Bight', too, the trend analysis indicated stable populations in summer between 2002 and 2012 (GILLES et al. 2013). However, a current analysis of the populations up to and including 2018 has identified changes that affect the area of the Sylt Outer Reef in particular (Gilles et al. 2019).

In general, there is still a north-south density gradient of harbour porpoise occurrence from the North Frisian to the East Frisian area.

2.6.3.3 Importance of site N-3.8 for marine mammals

According to current knowledge, it can be assumed that the German EEZ is used by harbour porpoises for crossing and resting, and also as a food and area-specific breeding ground. Based on the information available, it can be concluded that the EEZ is of medium to high importance for harbour porpoises. Habitat use varies in different areas of the EEZ. Marine mammals, which of course include the harbour porpoise, are highly mobile species that variably use wide areas in search of food depending on hydrographic conditions and food supply. As such, it is of little use to consider the significance of individual sites, such as the site under planning consideration or individual wind farm areas. In the following, the importance of areas belonging to a natural unit and additionally covered by intensely project-related studies is assessed separately.

According to current knowledge, site N-3.8 is of medium to high importance – seasonally in spring – for harbour porpoises.

Studies carried out in connection with the monitoring of the Natura 2000 areas as well as the 'North of Borkum' cluster studies always confirm a significantly higher occurrence in the conservation area 'Borkum Reef Ground', with decreasing densities in an easterly direction, where site N-3.8 is also located.

- Site N-3.8 is used by harbour porpoises all year round for crossing and resting, and probably also as a feeding ground.
- The use of the area by harbour porpoises is much higher in spring, however.
- The use of the area by harbour porpoises in summer is usually average compared with the use of the waters west of Sylt.
- Sightings of calves in area N-3 are rather sporadic and irregular: for this reason, it is highly likely that use as a rearing area can be ruled out.
- There is no evidence of a continuous, special function of area N-3 and therefore of site N-3.8 for harbour porpoises.

For grey seals and harbour seals, area N-3 and site N-3.8 have low to medium (in southern parts) importance.

2.6.3.4 Existing cumulative effects

The existing cumulative effects on the North Sea harbour porpoise population assume a wide range of anthropogenic activities, changes in the marine ecosystem and diseases in addition to climate change.

The existing cumulative effects on marine mammals result from fishing, attacks by Delphinoidea, physiological effects on reproduction, diseases possibly related to high levels of pollution and underwater noise. The main threats to harbour porpoise populations in the North Sea come from fishing, namely as a result of by-catch in bottom trawls and gillnetting and bottom trawling, depletion of prey fish populations through over-fishing and consequent reduction in food availability. An analysis of dead bodies and strandings from 1991 to 2010 from the British Isles identifies the causes as follows: 23% infectious diseases, 19% attacks by dolphins, 17% by-catch, 15% starvation and 4% were stranded alive (Evans, P.G.H. (ed.), 2020. European Whales, Dolphins and Porpoises. Marine Mammal Conservation in Practice. Academic Press).

Current anthropogenic uses in the vicinity of site N-3.8 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.

2.7 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 (guillemot, razorbill). Terns and gulls, on the other hand, are more common near the coast than seabirds.

2.7.1 Data situation

The BSH has a comprehensive data basis available for the suitability assessment of site N-3.8 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 an offshore wind farm according to the standard investigation concept (StUK 4). Since 2013, seabird and resting bird occurrence for the areas N-1, N-2 and N-3 has been studied on a large scale by means of ship-based and airborne (digital) surveys for the 'North of Borkum' research cluster (UMBO). The findings from the monitoring are therefore also suitable for the description and assessment of seabirds and resting birds in the vicinity of site N-3.8 (IFAÖ et al. 2015a, IFAÖ et al. 2015b, IFAÖ et al. 2016, IFAÖ et al. 2017, IFAÖ et al. 2018, IFAÖ et al. 2019).

In addition, further surveys were carried out at the 'alpha ventus' test site and in a large-scale reference area between 2009 and 2013 as part of the StUKplus research project 'TESTBIRD' which focused on possible behavioural reactions of seabirds to wind turbines (MENDEL et al. 2015).

Important information on the large-scale occurrence of seabirds in the German EEZ in the North Sea is provided by the surveys of Natura 2000 areas 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.

2.7.2 Spatial distribution, temporal variability and abundance of seabirds and resting birds in the German North Sea

Seabirds are highly mobile and are therefore able to search large areas during their hunt for food and track species-specific prey organisms such as fish over long distances. The high level of mobility – depending on specific marine environment conditions – results in the high spatial and temporal variability of seabird occurrence. The birds' distribution and abundance vary throughout the seasons.

The distribution of seabirds in the German Bight is determined in particular by the distance from the coast or breeding grounds, hydrographic conditions, water depth, the ground conditions and the food supply. The occurrence of seabirds is also influenced by severe natural events (e.g. storms) and anthropogenic factors such as nutrient and pollutant discharge, shipping and fishing. As consumers in the upper part of the food chain, seabirds feed on fish, macrozooplankton and benthic organisms, depending on the species. As such, they are directly dependent on the occurrence and quality of benthos, zooplankton and fish.

As a number of studies show, some areas of the German territorial sea and parts of the EEZ in the North Sea are of great importance not only nationally but also internationally for seabirds and waterfowl and were identified very early on as areas of special importance for seabirds, so-called 'Important Bird Areas – IBA' (SKOV et al. 1995, HEATH & EVANS 2000). Particular mention should be made here of sub-area II of the nature conservation area 'Sylt Outer Reef – Eastern German Bight', which was designated by the ordinance of 22 September 2017 and already established as a Special Protection Area (SPA) by the ordinance of 15 September 2005 pursuant to the Birds Directive 79/409/EEC.

With regard to the species group of divers, an overall analysis and evaluation of existing data sets identified a main concentration area in spring in the German Bight, west of Sylt. The delineation of the main concentration area was chosen to include all important and known regular occurrences (BMU 2009).

There are 19 species of seabirds in the German EEZ in the North Sea that are regularly recorded as resting birds in larger populations. Table 8 in the following contains population estimates for the most important seabird species in the EEZ and the entire German North Sea in the most important seasons. Detailed descriptions of the seasonal and spatial occurrence of the most common species of seabirds and resting birds, as well as species of particular importance for the 'Sylt Outer Reef – Eastern German Bight' nature conservation area in the EEZ in the North Sea, are to be found in the relevant chapters of the Environmental Report on the Site Development Plan 2019 for the German North Sea (BSH 2019a).

Table 8: Populations of the most important resting bird species in the German North Sea and EEZ in the most frequented seasons according to MENDEL et al. (2008). Spring populations of red-throated divers according to SCHWEMMER et al (2019), spring populations of black-throated divers according to GARTHE et al (2015)

Common name *(scientific name*)	**Season**	**Population German North Sea**	**Population German EEZ**
Red-throated diver *(Gavia stellata)*	Winter	3,600	1,900
	Spring	22,000	16,500
Black-throated diver (*Gavia arctica*)	Winter	300	170
	Spring	1,600	1,200
Gannet *(Morus bassanus*)	Summer	1,400	1,200
Great black-backed gull *(Larus marinus*)	Winter	15,500	9,000
	Autumn	16,500	9,500
Lesser black-backed gull *(Larus fuscus*)	Summer	76,000	29,000
	Autumn	33,000	14,500
Common gull *(Larus canus*)	Winter	50,000	10,000
Little gull *(Hydrocoloeus minutus*)	Winter	1,100	450
Black-legged kittiwake *(Rissa tridactyla)*	Winter	14,000	11,000
	Summer	20,000	8,500
Sandwich tern *(Thalasseus sandvicensis*)	Summer	21,000	130
	Autumn	3,500	110
Common tern *(Sterna hirundo*)	Summer	19,500	0
	Autumn	5,800	800
Arctic tern *(Sterna paradisaea*)	Summer	15,500	210
	Autumn	3,100	1,700
Razorbill *(Alca torda*)	Winter	7,500	4,500
	Spring	850	800
Common guillemot (*Uria aalge*)	Winter	33,000	27,000
	Spring	18,500	15,500

2.7.3 Occurrence of seabirds and resting birds in the vicinity of site N-3.8

The extensive studies of seabirds as part of environmental impact studies and during the construction or operation phases of offshore wind farms in the 'North of Borkum' study cluster unanimously show that a seabird community is present in the area surrounding site N-3.8, as is to be expected for the prevailing water depths and hydrographic conditions, the distance from the coast and site-specific influences.

The seabird population is dominated by seagulls, which are present all year round in the around site N-3.8. Among the most common species of the past study years were the lesser black-backed gull *(Larus fuscus*) and the black-legged kittiwake *(Rissa tridactyla*).

Lesser black-backed gulls occur widely in the vicinity of site N-3.8, but the strength of their presence varies seasonally. In the study years 2013 – 2018, the highest densities were found in the summer months, when the species occurs throughout the assessment areas of the 'North of Borkum' cluster. The maximum densities determined to date were 5.95 ind./km^2 in July 2017 according to marine transect studies and 3.86 ind./km^2 in July 2016 according to airborne transect studies. The spatial distribution of the lesser black-backed gull, a prominent ship follower, is often influenced by fishing activity so this does not reveal a specific distribution pattern. In recent years, the main distribution areas have therefore been in the northern, southern or eastern part of the assessment area and thus occasionally in the immediate vicinity of site N-3.8. Lesser black-backed gulls are also regularly sighted at wind farms (IFAÖ et al. 2018, IFAÖ et al. 2019, BIOCONSULT SH et al. 2015).

The black-legged kittiwake is the second most common gull species in the assessment areas of the 'North of Borkum' cluster according to both study methods. In the study years 2013 – 2018, the highest densities were found in April, in addition to increased densities in the winter months. According to both ship and digital flight transect surveys, the highest densities to date were determined in April 2016 at 0.77 ind./km^2 and 1.38 ind./km^2 respectively (IfAÖ et al. 2019). When seasonal densities are considered, the highest seasonal densities have so far been found in winter in the majority of the study years, for example in winter 2017/2018 at 0.73 ind./km^2. Spatial occurrence extends incompletely over the entire assessment areas of the 'North of Borkum' cluster, but in recent years a tendency towards higher occurrences in the west of the assessment areas and thus not in the immediate vicinity of site N-3.8 has become apparent (IfAÖ et al. 2018, IfAÖ et al. 2019).

The common gull *(Larus canus*), herring gull *(Larus argentatus*) and great black-backed gull *(Larus marinus*) occur all year round, but only sporadically in the areas under investigation in the 'North of Borkum' cluster. The highest monthly densities for all three species were determined during the winter months. For the common gull, the maximum density was unusually high at 2.06 ind./km^2 according to a marine transect survey in December 2018. In the previous study years, maximum monthly densities of 0.42 ind./km^2 were determined. For all three species, the highest densities according to flight transect studies were in November 2014 and amounted to 1.44 ind./km^2 for the common gull, 1.26 ind./km^2 for the European herring gull and 0.17 ind./km^2 for great black-backed gull (IfAÖ et al. 2019). The spatial distributions of all three species in the assessment areas of the 'North of Borkum' cluster did not show any focal points in the previous studies (IfAÖ et al. 2018, IfAÖ et al. 2019). A preference for the immediate vicinity of site N-3.8 is therefore not discernible.

The little gull *(Hydrocoloeus minutus*) is found in the German Bight mainly as migratory bird during its return to breeding grounds in Eastern Europe from the end of March, and on its way to wintering grounds in Western Europe from the end of September (MENDEL et al. 2008). Accordingly, the highest monthly densities in previous years were also observed in the spring months, mainly in April. The highest monthly densities determined so far were 1.20 ind./km^2 in April 2017 according to ship transect surveys and 1.92 ind./km^2 according to digital flight transect surveys (IfAÖ et al. 2019). The spatial distribution in the assessment area has not yet revealed any focal occurrences.

Sea divers can be found in the German Bight from autumn to spring. In summer they are usually completely absent. Due to the similarity between the red-throated diver *(Gavia stellata*) and the black-throated diver *(Gavia arctica)*, the two species are often referred to generically as divers in the following. From the proportion of individuals actually determined at species level, however, a dominant frequency of the red-throated diver can be identified, often at over 90% compared to the black-throated diver (Mendel et al. 2008). In previous studies of the “North of Borkum” cluster (2013–2018), the highest mean seasonal densities occurred at 0.13–0.16 ind./km^2 according to both ship and air transect surveys in spring (IfAÖ et al. 2015a, IfAÖ et al. 2015b, IfAÖ et al. 2018, IfAÖ et al. 2019).

The highest monthly densities according to air and ship transect surveys were determined in all previous survey years for the 'North of Borkum' cluster in the month of April and mostly amounted to 0.20 – 0.46 ind./km^2 (IFAÖ et al. 2015a, IFAÖ et al. 2015b, IFAÖ et al. 2018, IfAÖ et al. 2019). Exceptions were the flight transect surveys in February 2017 with a maximum monthly density of 0.36 ind./km^2. It should be noted that the large-scale digital flight investigation area also covers coastal areas within the 12 nautical mile zone, so the near-coastal occurrence of divers that builds up in winter is recorded here, too (IfAÖ et al. 2018). No clear distribution priorities were identified in previous surveys. However, in the species-specific period of spring there was a tendency towards the western part of the 'North of Borkum' assessment area, as well as to the south near the coast. The immediate vicinity of site N-3.8 does not seem to be of particular importance for divers according to the studies of the 'North of Borkum' cluster (IFAÖ et al. 2015a, IFAÖ et al. 2015b, IFAÖ et al. 2018, IfAÖ et al. 2019).

Terns occur in the vicinity of site N-3.8 mainly during their migration home in spring. In summer, their occurrence is concentrated in coastal areas near the breeding colonies in the Wadden Sea. While terns can be observed sporadically on their migration in the offshore area in autumn, they are usually not seen at all in the entire German North Sea in winter (Mendel et al. 2008). In previous studies, the highest monthly densities, and therefore also the highest mean seasonal densities, of the sandwich tern (*Thalasseus sandvicensis*) have always been found in spring, during the period of return to the breeding areas. In past study years, the highest monthly density was 0.40 ind./km^2 according to ship transect surveys in April 2017. According to flight transect detection, the highest monthly density to date was determined in May 2018 at 0.73 ind./km^2 (IfAÖ et al. 2019).
For the common and Arctic tern *(Sterna hirundo, Sterna paradisaea*), which are often difficult to distinguish and therefore often recorded together, the highest monthly densities to date were 0.28 ind./km^2 in May 2017 (ship transect survey) and 0.97 ind./km^2 in April 2014 (flight transect survey). CLEAR DISTRIBUTION PRIORITIES, ESPECIALLY IN THE IMMEDIATE VICINITY OF SITE N-3.8, WERE NOT IDENTIFIED IN PREVIOUS SURVEYS (IfAÖ et al. 2015a, IFAÖ et al. 2015b, IFAÖ et al. 2018, IFAÖ et al. 2019).

According to the previous seabird and resting bird surveys in the 'North of Borkum' study cluster, the species group of auks is the second most common seabird group. Guillemots *(Uria algae*) and razorbills *(Alca torda*) were particularly prominent. Due to the relative similarity between the two species from increasing distance as mentioned above as well as their strongly overlapping habitat requirements and feeding areas, a relatively large proportion of auks is frequently not determined at species level. Data evaluation is therefore often carried out for both types together. Based on the individuals actually determined at species level, however, the dominance of the guillemot in this group is apparent. In previous studies, common guillemots were the second most common species in the 'North of Borkum' study cluster after lesser black-backed gulls. In the 2017 and 2018 study years, the highest monthly densities for guillemots according to ship surveys were 5.35 ind./km^2 (January 2017) and 3.16 ind./km^2 (May 2018) respectively, and 1.15 ind./km^2 (February 2017) and 1.72 ind./km^2 (April 2018) according to flight surveys.

For guillemots, the highest densities according to ship surveys were 1.60 ind./km^2 (April 2017) and 2.16 ind./km^2 (January 2018) and 0.83 ind./km^2 (November 2017) and 2.20 ind./km^2 (February 2018) according to flight surveys. The highest densities were thus in winter and spring/early summer (IfAÖ et al. 2018, IfAÖ et al. 2019). These results fit in well with the findings of previous years (IFAÖ et al. 2017, IFAÖ et al. 2016). The spatial distribution of both species has so far shown a large-scale occurrence in the assessment areas of the 'North of Borkum' cluster, but the years 2017 and 2018 in particular show a slight tendency towards the western parts of the cluster. This means it was not possible to identify a focal distribution in the immediate vicinity of site N-3.8 (IFAÖ et al. 2018, IFAÖ et al. 2019).

The northern gannet *(Sula bassana*) is found all year round in the assessment area and in the entire German Bight. The highest monthly densities to date were determined in April 2018 at 1.85 ind./km^2 (ship surveys) and April 2016 at 0.55 ind./km^2 (flight surveys). Interannual differences are not unusual for a highly mobile species such as the northern gannet. Up to now, the main areas of distribution in spring, which shows a high level of occurrence, were mostly in the western part of the 'North of Borkum' cluster (IFAÖ et al. 2019, IFAÖ et al. 2018, IFAÖ et al. 2017). In the other seasons, northern gannets exhibit large though patchy distribution. Studies to date do not indicate a preference for the immediate surroundings of site N-3.8.

The fulmar *(Fulmarus glacialis*) is a typical species of ocean bird. Its distribution depends very much on the hydrographic characteristics of the North Sea water and is therefore mainly concentrated in areas beyond the 30-metre depth line (Mendel et al. 2008, Camphuysen & Garthe 1997). Surveys carried out in past years have therefore only observed isolated individual fulmars in the assessment area. It was not possible to identify either a temporal or spatial focus (IFAÖ et al. 2019, IFAÖ et al. 2018, IFAÖ et al. 2017).

Due to the water depth of 23 – 29 m, sea ducks only occur sporadically as resting birds in this area of the German Bight. Their distribution is concentrated in near-coastal or shallower offshore areas (MENDEL et al. 2008). This can be clearly seen in the densities determined for the common scoter *(Melanitta nigra*) on the basis of ship transect surveys compared to the densities on the basis of flight transect surveys, whose area extends into the territorial sea. The highest monthly density to date according to a ship transect survey was determined in July 2017 at 0.33 ind./km^2. By contrast, the highest monthly density to date according to flight transect surveys was 9.94 ind./km^2 in March 2017 (IfAÖ et al. 2019). Frequent occurrence of scoters is concentrated in the shallower coastal areas of the flight assessment area south of site N-3.8. Distribution in the deeper areas around site N-3.8 has not yet been detected for diving sea ducks, and the common scoter in particular (IFAÖ et al. 2019, IFAÖ et al. 2018, IFAÖ et al. 2017).

Skuas, especially the species pomarine jaeger *(Stercorarius pomarinus*) and great skua (*Stercorarius skua*), were only seldom sighted in the assessment areas in past study years (2013 – 2018). According to marine transect surveys, 7 (2015, 2016, 2018) up to a maximum of 17 (2013) great skuas, pomarine jaegers and indefinite skuas have been sighted annually. According to flight transect studies, there were two (2013, 2015, 2016, 2018) to 12 individuals of the mentioned species or undefined group of species (IFAÖ et al. 2015a, IFAÖ et al. 2015b, IFAÖ et al. 2016, IFAÖ et al. 2017, IFAÖ et al. 2018, IfAÖ et al. 2019).

2.7.4 Status assessment of the protected object of seabirds and resting birds

The large amount of research work carried out in recent years allows a sound assessment of the importance and condition of the area around site N-3.8 as a habitat for seabirds.

2.7.4.1 Protection status

Of the seabird species regularly observed in the vicinity of site N-3.7, albeit sometimes at low densities, the red-throated diver, black-throated diver, little gull and the three species of terns – the sandwich tern, common tern and Arctic tern – are listed in Annex I of the EU Birds Directive. The red-throated and black-throated diver and the little gull are also assigned to SPEC Category 3 (not limited to Europe but with negative population development and unfavourable conservation status). The common gull and sandwich tern are considered to be 'concentrated in Europe with negative population development and unfavourable conservation status' (SPEC Category 2). The fulmar is considered 'endangered' (EN) according to the pan-European endangered status (EUR threat status). The black-legged kittiwake is considered 'vulnerable' (VU) according to the current pan-European endangered status, while the little gull, great black-backed Kittiwake, guillemot and razorbill are classified as ''near-threatened' (NT) (BirdLife International 2015). The endangered status in the 27 EU member states (EU27 threat status) is considered 'endangered' (EN) for the black-legged kittiwake and for the fulmar and European herring gull as 'vulnerable' (VU) (BirdLife International 2015). For the assessment aspect of protected status, the seabird community found in the vicinity of site N-3.8 is therefore of medium to high importance.

2.7.4.2 Assessment of the occurrence of resting birds and seabirds

In the wider surroundings of site N-3.8, seagulls dominate the seabird population, as described in Chapter 2.8.3. Lesser black-backed gulls and kittiwakes are the most frequently observed species. Species listed in Annex I of the Birds Directive such as divers, terns and little gulls, only use site N-3.8 as a feeding ground to an average extent and predominantly during migration periods. This area is not among their valuable resting habitats or preferred places to stay in the German Bight. The main resting area for divers in the German Bight is west of Sylt.

Due to a water depth of 23 – 29 m, food-diving species such as sea ducks only occur sporadically at site N-3.7. Furthermore, distinct species of ocean birds such as the fulmar prefer greater depths of between 40 – 50 m, which is why only isolated observations of these birds have been made in this area. For the species breeding on Heligoland – northern gannets, guillemots and razorbills – site N-3.8 at a distance of < 40 km from the island – is outside their range of action during the breeding season. Outside the breeding season, gannets were only observed sporadically, whereas guillemots were among the three most common species of seabird to be identified.

According to current knowledge, the occurrence of seabirds and resting birds at site N-3.8 and its surroundings can be considered average.

2.7.4.3 Evaluation of spatial units

Typical seabird species of the EEZ in the North Sea have been identified in the vicinity of site N-3.8 (BSH 2019a), but often only at lower densities. This is mainly due to the fact that the area characteristics do not correspond to the species-specific preferences of some seabird species. Seabird species such as fulmars and northern gannets are only observed occasionally during migration periods. For breeding birds, the surroundings of site N-3.8 are of no particular importance due to the distance from the breeding colonies on the coasts or on Heligoland. Site N-3.8 is also located at a distance of over 40 km from the bird sanctuary 'Eastern German Bight' (sub-area II of the nature conservation area 'Sylt Outer Reef – Eastern German Bight'). On the whole, the function of site N-3.8 and its surroundings is rated as medium.

2.7.4.4 Existing cumulative effects

Site N-3.8 lies between the two traffic separation routes Terschelling German Bight and German Bight Western Approach. Due to its proximity to the two busy shipping routes, the area around site N-3.8 is affected by increased traffic volume in terms of existing cumulative effects. In addition, extensive fishing in the North Sea affects the availability of food resources, damages the seabed through bottom trawling and poses a direct threat through the deployment of gillnets, in which seabird species diving for food get caught and die. The pressures from shipping and fishing in the vicinity of site N-3.8 are of medium to high intensity for seabirds on a species-specific basis. In addition, several wind farm projects have already been implemented in the direct and indirect vicinity of site N-3.8. As part of the marine ecosystem, seabirds are also exposed to threats. Changes in the ecosystem may involve threats to seabird populations. The following factors can cause changes in the marine ecosystem and thus also in seabirds:

Climate changes:

Changes in water temperature are accompanied by changes in water circulation, plankton distribution and the composition of the fish fauna, among other things. Plankton and fish fauna provide the seabirds with food. However, due to the uncertainty regarding the effects of climate change on individual ecosystem components, it is virtually impossible to predict the effects of climate change on 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 N-3.8. 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. Fishing discards provide additional food sources for some seabird species. The resulting trend towards more birds (lesser black-backed gull, European herring gull and common gull) has been established by targeted surveys (GARTHE et al. 2006).

Shipping:

Shipping has a deterrence effect on species sensitive to disturbance, such as divers (MENDEL et al. 2019, FLIESSBACH et al. 2019, BURGER et al. 2019) and also includes the risk of oil spills.

Technical structures (offshore wind turbines, platforms):

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 supply trips. There is also a risk of collision with such structures.

In addition, seabirds may be threatened by eutrophication, accumulation of pollutants in the marine food chains and waste floating in the water such as parts of fishing nets and plastic parts. Epidemics of viral or bacterial origin also pose a threat to populations of resting birds and seabirds.

Due to the influences described, the existing cumulative effects at site N-3.8 and its surroundings are to be rated as 'medium'.

2.7.4.5 Conclusion

According to current knowledge, the surroundings of site N-3.8 are of medium importance for resting and foraging seabirds.

2.8 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. As bird migration takes place annually, it is also called annual migration and is spread all over the world. 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. It is possible to distinguish between long-distance and short-distance migrators by the distance covered and physiological criteria.

2.8.1 Data situation

The BSH has a comprehensive data basis available for the suitability assessment of site N-3.8 with regard to the protected object of 'migratory 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). Under the monitoring programme, bird migration for areas N-1, N-2 and N-3 has been studied by the FINO 1 research platform since 2013 by means of radar surveys, visual observations and night migration sound tracking for the 'North of Borkum' (UMBO) study cluster. The findings from the monitoring are therefore also suitable for the description and assessment of bird migration in the vicinity of site N-3.8 (AVITEC RESEARCH GBR 2015a, AVITEC RESEARCH GBR 2015b, AVITEC RESEARCH GbR 2016, AVITEC RESEARCH GBR 2017, AVITEC RESEARCH GBR 2018).

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 detection can provide reliable information on migratory activity but does not allow species-specific detection, does not determine the number of animals and only detects migratory activity up to an altitude of 1,000 m, at most 1,500 m.

In the period prior to 2013, extensive research projects and further investigations such as environmental impact assessments were carried out which provide a comprehensive basis for describing bird migration prior to the expansion of offshore wind energy in the North of Borkum area (e.g. OREJAS et al. 2005, HÜPPOP et al. 2009).

For the classification of bird migration at site N-3.8 as a proportion of total bird migration, long-term data series from various offshore and coastal locations are also available (MÜLLER 1981, DIERSCHKE 2001, HÜPPOP & HÜPPOP 2002, HÜPPOP & HÜPPOP 2004, HÜPPOP et al. 2004, HÜPPOP et al. 2005).

The present data basis provides a sufficient foundation for the suitability assessment of site N-3.8. 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.

2.8.2 Bird migration over the German Bight – spatial distribution and temporal variability of migratory birds

According to current estimates, several 10-100 million birds migrate across the German Bight every year (EXO et al. 2003, HÜPPOP et al. 2005). The biggest share of these are songbirds, most of which cross the North Sea at night (HÜPPOP et al. 2005, HÜPPOP et al. 2006). The bulk of these birds come from Norway, Sweden and Denmark. For waterfowl and waders, however, the breeding grounds extend far north-east into the Palearctic ecozone and in the north and north-west to Svalbard, Iceland and Greenland.

The German Bight is located on the migration route of numerous bird species. Between 1990 and 2003, for example, between 226 and 257 (on average 242) species per year were recorded on Heligoland (according to DIERSCHKE et al. 1991-2004, cited in OREJAS et al. 2005). Other species that migrate at night but rarely emit calls or do not do so at all, such as the pied flycatcher (HÜPPOP et al. 2005), should also be included. If rarities are taken into account, a total of more than 425 migratory bird species have been recorded on Heligoland over the course of several years (HÜPPOP et al. 2006). At greater distances from the coast, the average migration intensity and possibly the number of migrating species appear to decrease (DIERSCHKE 2001).

According to current knowledge, migratory bird activity can generally be roughly divided into two phenomena: broad-fronted migration and migration along migratory routes. It is well known that most migratory bird species fly over at least large parts of their transit areas on a broad front.

According Knust et al. (2003), this also applies to the North Sea and the Baltic Sea. In particular, species that migrate at night – which cannot be guided by geographical structures due to the darkness – migrate across the sea on a broad front.

Broad-fronted migration is typical of the night migration of songbirds and also of the day migration of songbirds. A current cross-project evaluation of all data from large-scale bird migration monitoring for offshore wind farm projects showed a clear gradient of decreasing migration intensities with increasing distance from the coast for nocturnal bird migration over the North Sea, which is dominated by songbirds (WELCKER 2019). According to systematic migration observations, a number of songbirds migrating primarily during the day have a lower migratory intensity on Heligoland than on Sylt or Wangerooge (Hüppop et al. 2009). For shore bird migration, radar observations confirm a decreasing intensity towards the offshore area, for example (DAVIDSE et al. 2000, LEOPOLD et al. 2004, HÜPPOP et al. 2006). Comparative studies by DIERSCHKE (2001) of the visible daily migration of waders and waterfowl between Heligoland and the (former) North Sea Research Platform (FPN) located 72 km west of Sylt also indicate a gradient between the coast and the open North Sea. This assumption is confirmed in the BeoFINO final report, as the results of visual observations presented show a clear concentration of waterbirds near the coast. Only a few bird species are found in the offshore area in equal or larger numbers of individuals (e.g. red-throated diver, pink-footed goose).

The following Figure 13 shows a detailed section of broad-fronted migration over the south-eastern North Sea. It should be emphasised here that the distances between the lines of individual migration flows merely indicate the direction of a gradient. Therefore, no conclusions about the magnitude of spatial trends may be drawn from the figure under any circumstances. Also the thickness of the lines only illustrates differences in intensity between the migration flows in qualitative terms.

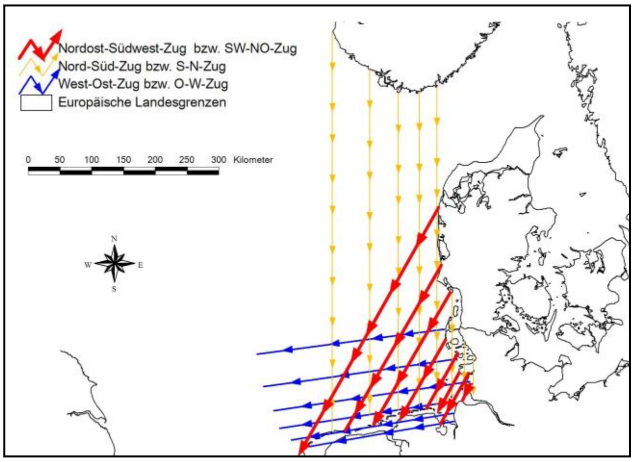


Figure 13: Scheme of main migration routes over the south-eastern North Sea (shown for autumn, from HÜPPOP et al. 2005a)

Seasonal north-eastern-south-western or south-western-north-eastern migration dominates over a large area (see Figure 13), although certain differences in the direction of migration and the degree of coastal orientation may apply. HÜPPOP et al. (2009) and AVITEC RESEARCH GBR (2015b) also identified a clear main south-southwest direction in their studies using radar on the FINO1 research platform in autumn (departure). In spring, a clear direction (north-east) was also visible, but only at night when no foraging birds were active.

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. In general, birds wait for favourable weather conditions (e.g. tailwind, no precipitation, good visibility) for their migration to optimise the use of energy. This means that bird migration is concentrated on individual days or nights in autumn and spring. 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 of large-scale bird migration over the German Bight can be found in the environmental report on the Site Development Plan 2019 for the German North Sea (BSH 2019a).

2.8.3 Bird migration in the vicinity of site N-3.8

2.8.3.1 Species spectrum

As part of current studies of the 'North of Borkum' cluster, in which site N-3.8 is located, a total of 53 species were identified in 2017 by means of visual observations in the light phase and nocturnal migration call recordings. In previous years, 62 (2015) to 87 species (2013) were identified (AVITEC RESEARCH GBR 2018).

In the overall study for the years 2013 to 2017, seagulls dominated migration during the light phase and accounted for relative shares of 42% in autumn to 45.7% in spring of all migratory birds (n = 9,869 individuals or 8,390 individuals) observed. Among the gulls, the lesser black-backed gull was the most common species over the entire period, followed by the little gull, common gull, black-legged kittiwake and black-headed gull in varying frequencies.

Other species groups and families regularly observed in the area of site N-3.8 include terns and ducks (Anatidae). Occurrence is very variable interannually and seasonally, however.

Sandwich terns were the second most common species in spring 2017 (71 individuals out of a total of 758 birds observed), but there were no sightings in autumn 2017. On the whole, the species group of terns accounted for 11% of the birds observed in spring and 12% of those observed in autumn in the entire period 2013 – 2017 (AVITEC RESEARCH GBR 2018).

The family of ducks has shown a high variability in terms of occurrence over the years. More than one bird in four was a goose (26%) over all periods considered. However, observations of geese were almost completely lacking in spring 2013 (AVITEC RESEARCH GBR 2015a), while in spring 2017 only a few geese were observed. Only one in ten birds was a goose in the autumn in the period 2013 – 2017. The more common species include the greylag goose, brent goose, pink-footed goose and, in the case of ducks, the common scoter (AVITEC RESEARCH GBR 2018).

In addition, gannets, cormorants and auks reached frequencies > 2% of the total number of individuals. Songbirds in the light phase were observed more often in autumn than in spring (AVITEC RESEARCH GBR 2018).

In the dark phase from 2013 to 2017, five to 17 species were identified each year in spring and eight to 15 species in autumn by recording migratory calls. Nightly autumn migration was dominated by songbirds: songbird calls were included in 97% of bird-positive files. Throughout the entire period, thrushes dominated the recorded songbird population. Among the most common species were the song thrush, redwing and fieldfare. The skylark, meadow pipit, starling and robin were also recorded regularly and in higher numbers. Non-oscine birds were only rarely detected in autumn (3.1%). In spring, non-singing birds were detected more frequently in the period 2013 – 2017. Here, the common gull (AVITEC RESEARCH GBR 2018) dominated.

2.8.3.2 Migration intensities, migration heights, migration direction

The bird migration surveys carried out by FINO 1 as part of the studies of the 'North of Borkum' cluster showed that bird migration was detected throughout the entire period 2013 – 2017 on the basis of entire migratory nights or days. Bird migration was concentrated in spring in the first half of April and in autumn in October. A look at individual years of data collection reveals seasonal and interannual differences. Over the years, bird migration has occurred to varying extents, up to and including migration according to the definition of the long-term site-specific scale (AVITEC RESEARCH GBR 2018).

Migration intensities

In 2017, extrapolated to the entire spring season, 94,333 bird movements or 94 echoes/h*km were recorded during the day. During the night, 204,228 bird movements or 309 echoes/h*km were recorded in spring. During the autumn migration, 142,875 bird movements or 111 echoes/h*km per day and 193,417 bird movements or 187 echoes/h*km were recorded (AVITEC RESEARCH GBR 2018). Compared to the previous year 2016, the extrapolated bird migration movements in spring were therefore lower (2016 spring, day: 142.764.6 bird movements or 121 echoes/h*km; 2016 spring, night: 265,039.5 bird movements; 358 echoes/h*km), in autumn the figures matched the previous year (2016 autumn, day: 127,648 bird movements or 129 echoes/h*km; 2016 autumn, night: 203,236 bird movements; 217 echoes /h*km) (AVITEC RESEARCH GBR 2017).

Migration intensities averaging over 1,000 echoes/h*km were only exceeded on four nights in spring 2017 and not at all during the day. The situation was similar in autumn 2017, when 1,000 echoes/h*km were exceeded in just one night (AVITEC RESEARCH GBR 2018). In 2016, corresponding exceedances occurred only on nine nights and on one day in spring, while in autumn 2016, migration intensities above 1,000 echoes/h*km were determined on only one night (AVITEC RESEARCH GBR 2017).

An analysis of the daytime occurrence of bird migration in the vicinity of site N-3.8 in the period 2013 – 2017 shows that bird migration was recorded at all times of the day, but that night-time bird migration was predominant. Bird migration activity was highest in the second and third quarters of the night. In the light phase, the most intense activity was recorded in the first quarter of the day. In view of the temporal pattern with often flowing transitions to preceding night migration, it can be assumed that migratory activity in the first daylight quarter is particularly attributable to birds that have not yet reached the mainland again at sunrise (AVITEC RESEARCH GBR 2018).

Migration heights

A consideration of flight altitudes based on vertical radar observations in the migration periods of the years 2013 – 2017 shows that migratory birds within the detection range up to 1,000 m predominantly choose low migration altitudes up to a few hundred metres.

In an individual analysis, 20.9% of all calculated migration movements in spring (n = 298,562) and 43.0% of all migration movements in autumn (n = 336,304) were recorded at altitudes of up to 100 m during the 2017 migration periods (AVITEC RESEARCH GBR 2018). In spring, differences in the height distribution were observed during the day. During the day, 87.8% of all flight movements registered and calculated were at altitudes of up to 300 metres. In the dark phase, the share was only 60.1%, with only 17.4% of all flight movements being registered at altitudes of up to 100 m. For the autumn migration 2017, no comparable daytime differences were found. On the whole, the stronger concentration of bird migration was at lower altitudes in the light phase over all years (2013 – 2017) (AVITEC RESEARCH GBR 2018).

In general, deviations from the altitude profile described above can be observed for homeward and outward migration periods as well as for light and dark phases on migration days or nights with particularly strong bird migration activity.

During the very intense bird migration night of 29-30 April 2017, 81.8% of all bird movements were recorded at altitudes above 500 m (AVITEC RESEARCH GBR 2017). During the intense bird migration night of 25-26 October 2016, the altitude range above 900 m to 1,000 m was the most heavily used, suggesting that bird migration was underestimated that night and a high (but unknown) proportion of migrating birds flew above the radar range. Even during the very intense migration night of 9-10 November, bird migration shifted comparatively markedly to higher altitudes (AVITEC RESEARCH GBR 2017). In its expert opinions, Avitec Research therefore assumes that at least 2/3 of all bird migration are recorded on average by vertical radar in a detection range of up to 1,000 m altitude. 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 a cross-project evaluation of monitoring data from bird migration surveys, WELCKER (2019) found that during nights of high bird migration intensity, migration takes place at higher altitudes. On intense nights, bimodal flight altitude distributions can also be observed. In the night of 7-8 November 2017, 38.3% of the migration movements were determined at altitudes up to 100 m and 39.3% between 600 – 800 m (AVITEC RESEARCH GBR 2018).

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. Based on of these records, it appears that bird migration in the wider surroundings of site N-3.8 manly takes place during the daytime within the lower 20 -50 m. In the period 2013 – 2017, more than 80% of all recorded birds flew at altitudes of up to 50 m during the migration period. In spring 2017, 70.5% of all recorded birds were detected at altitudes up to 20 m, in 2016 the figure was 85%. In autumn 2016 and 2017, 75% of all recorded birds flew up to 20 m in height (AVITEC RESEARCH GBR 2017, AVITEC RESEARCH GBR 2018).

Migration direction

The migration directions according to horizontal radar detection for the years 2014-2017 in spring indicate clear north-easterly homeward migration and south-westerly outward migration. The variability between the individual years was very small, but a comparison of individual nights shows some variation. Differences can result from adjustments in the flight direction according to the prevailing wind conditions in order to either benefit from local wind conditions or at least minimise the use of excess energy. Furthermore, different main orientations may result from the origin of the migrants involved from different regions of departure (AVITEC RESEARCH GBR 2018).

2.8.4 Status assessment and significance of site N-3.8 and its surroundings for bird migration

The status assessment of the protected object of migratory birds and the significance of site N-3.8 and its surroundings for bird migration is based on the following evaluation criteria:

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

Unless otherwise stated, the following comments refer to bird migration as a whole.

2.8.4.1 The large-scale importance of bird migration

Special migratory corridors are not recognisable for any migratory bird species in the EEZ in the North Sea area. Bird migration takes place in unspecified broad-fronted migration across the North Sea with a tendency towards coastal orientation. Site N-3.8 and its surroundings north of the East Frisian islands are therefore of medium importance.

2.8.4.2 Assessment of occurrence

In the area around site N-3.8, bird migration occurs continuously during migration periods. Occasionally there is very intense bird migration ('mass migration') on a site-specific scale. However, the temporarily high migration rates are in line with overall bird migration over the German Bight (see detailed explanations in BSH 2019a). Migration activity and its intensity in the vicinity of site N-3.8 are therefore assigned medium importance.

2.8.4.3 Rarity and vulnerability

In the study years 2013 – 2017, 53 (2017) to 87 (2013) species were identified annually by means of standardised migration observations and nocturnal call recording. Between 5 (autumn 2015 and 2016) and 12 (spring 2013) species of Annex I of the Birds Directive were recorded per migration period. Among the most frequently recorded species were the red-throated diver, the little gull and the sandwich tern, common tern and Arctic tern. Rarely and only in the form of single individuals were the black-throated diver, red kite, barnacle goose, osprey, gull-billed tern, short-eared owl, merlin, Mediterranean gull, whooper swan, black kite, peregrine falcon, marsh harrier, golden plover, bar-tailed godwit, black-tailed godwit, great northern diver, Balearic shearwater, storm petrel, Leach’s storm petrel and woodlark observed or acoustically recorded in the course of monitoring according to the standard investigation concept (StUK). In view of the number of species recorded in the vicinity of site N-3.8 in relation to the species spectrum of bird migration over the entire German Bight (see 2.8.2), the number of species is rated as average and the endangered status as above average.

2.8.4.4 Existing cumulative effects

Anthropogenic factors contribute to the mortality of migratory birds in a variety of ways and can, in complex interaction, influence population size and determine current migratory patterns.

Key anthropogenic factors that increase mortality among migratory birds include active hunting, collisions with anthropogenic structures and, for waterfowl and seabirds, environmental pollution by oil or chemicals (CAMPHUYSEN et al. 1999). The various factors have a cumulative impact, so it is usually difficult to determine the significance of each in isolation. There is still insufficient statistical coverage of hunting (HÜPPOP & HÜPPOP 2002), especially in Mediterranean countries. TUCKER & HEATH (1994) conclude that more than 30% of European species characterised by population decline are under threat from hunting.

The proportion of birds ringed on Heligoland and birds killed indirectly by humans has increased in the past in all species groups and regions, mainly due to collisions with buildings and vehicles (HÜPPOP & HÜPPOP 2002). Surveys of collision victims at four lighthouses in the German Bight show that songbirds dominate strongly. Starlings, thrushes (song thrush, redwing, fieldfare) and blackbirds stand out in particular. Similar findings are available for FINO1 (Hüppop et al. 2009), the North Sea Research Platform (Müller 1981) and former lighthouses on the west coast of Denmark (Hansen 1954). A total of 770 dead birds (35 species) were found on 36 of 159 visits to the FINO1 research platform with bird control between October 2003 and December 2007. The most common, with a total of 85%, were thrushes and starlings. The species in question are characterised by night migration and relatively large populations. It is noticeable that almost 50% of the collisions recorded at FINO1 took place over just two nights. On both nights, there were south-easterly winds which could have promoted migration over the sea, along with poor visibility, which could have led to a reduction in flight altitude and increased the attraction of the illuminated platform (HÜPPOP et al. 2009). The surroundings of site N-3.8 are already partly covered with wind farms.

Global warming and climate change also have measurable effects on bird migration, e.g. due to changes in phenology or changes in arrival and departure times, which do, however, vary according to species and region (see BAIRLEIN & HÜPPOP 2004, CRICK 2004, BAIRLEIN & WINKEL 2001). There is also evidence of a clear relationship between large-scale climate cycles such as the North Atlantic Oscillation (NAO) and vernal migration of captured songbirds, for example (HÜPPOP & HÜPPOP 2003). Climate change can affect the conditions in breeding, resting and wintering areas and what these partial habitats have to offer.

The existing cumulative effects are assessed as medium to temporarily high overall

2.8.4.5 Conclusion

On the whole, based on the above criteria and their respective evaluation, site N-3.8 and its surroundings are of medium importance for bird migration.

2.9 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. However, migratory movements of bats across the North Sea are still scarcely documented and largely unexplored.

2.9.1 Data situation

The data basis on bat migration over the North Sea is not sufficient for a detailed description of the occurrence and intensity of bat migration in the offshore area. Reference is made below to general literature on bats, findings from systematic surveys on Heligoland and acoustic surveys from the FINO1 research platform as well as other sources of information in order to illustrate the latest information available. In view of the need for further data on bat migration over the North Sea, the following can be stated:

- There is a lack of knowledge regarding the quality and quantity of migrating bat populations across the North 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.

2.9.2 Spatial distribution and status assessment

Bats exhibit very high levels of mobility. 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 movements, migration activity takes place periodically or seasonally. Both the general movement patterns and the migratory behaviour of bats are highly variable. On the one hand, differences can occur depending on species and gender. On the other hand, movement patterns and also migration activity can already vary considerably within the populations of a species. Based on their general movement patterns, bats are divided into short-distance, medium-distance and long-distance species.

In their search for nesting, feeding and resting places, bats travel short and medium distances. Corridors along flowing waters, around lakes and mudflats are known for medium distances (BACH & MEYER-CORDS 2005). There has been virtually no investigation of long-distance movement to date, however. There has been virtually no description of migration routes for bats. This is particularly true of migration movements across the open sea. In contrast to bird migration, which has been confirmed by extensive studies, bat migration remains largely unresearched due to the lack of suitable methods or large-scale special monitoring programmes.

Long-distance migratory species include the common noctule *(Nyctalus noctula*), Nathusius's pipistrelle *(Pipistrellus nathusii*), parti-coloured bat *(Verspertilia murinus*) and lesser noctule *(Nyctalus leisleri*). For these four species, regular movements over a distance of 1,500 to 2,000 km have been recorded (TRESS et al. 2004, HUTTERER et al. 2005).

Long-distance migratory movements are also suspected for the species soprano pipistrelle *Pipistrellus pygmaeus* and common pipistrelle *Pipistrellus pipistrellus* (BACH & MEYER-CORDS 2005). Some long-distance migratory species occur in Germany and countries bordering the North Sea and have occasionally been encountered on islands, ships and platforms in the North Sea.

However, based on observations of bats on Heligoland, the number of bats migrating from the Danish coast across the German North Sea in autumn is estimated at around 1,200 individuals

(SKIBA 2007). An evaluation of observations of bats migrating from south-west Jutland to the North Sea arrives at the same conclusion (SKIBA 2011).

Although visual observations, e.g. on the coast or on ships and offshore platforms, provide initial indications, they are hardly suited to gaining a full understanding of the migration behaviour of nocturnally active and nocturnally migrating bats over the sea. The recording of ultrasonic calls of bats by suitable detectors (so-called 'bat detectors') provides good results on land in terms of indicating the occurrence and migration of bats (SKIBA 2003). However, the results obtained so far from the use of bat detectors in the North Sea provide only initial indications. The acoustic recordings of the bat migration over the North Sea on the research platform FINO1 revealed detections of only at least 28 individuals between August 2004 and December 2015 (HÜPPOP & HILL 2016).

When surveying bat migration over the open sea, the general occurrence, species composition and migration routes as well as the heights at which bats migrate are important factors in assessing the potential risk of collision with offshore wind farms. The individuals surveyed by HÜPPOP & HILL (2016) were recorded between 15 – 26 m at mean sea level, depending on location and methods, which includes the area between the lower rotor blade tip and the water surface in the majority of wind farms. BRABANT et al (2018) investigated bat occurrence at Thornton Bank wind farm using bat detectors at heights of 17 m and 94 m. Only 10% of the 98 bat photographs, significantly less than at 17 m, were taken at higher altitudes.

Some species such as the Nathusius's pipistrelle and the common noctule are listed in Annex II of the 1979 Convention on the Conservation of Migratory Species of Wild Animals (CMS), 'Bonn Agreement'. 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 have near-threatened status, the common pipistrelle and the Nathusius's pipistrelle are considered to be 'of least concern'. The data situation is deemed to be deficient for assessment of the endangered status of the lesser noctule.

The data available for the EEZ in the North Sea and the area of site N-3.8 are fragmentary, and insufficient data are available to allow conclusions to be drawn about the migratory movements of bats. It is not possible, on the basis of existing data, to obtain specific knowledge about migratory species, migratory directions, migratory altitudes, migratory corridors and possible concentration ranges. Information available to date confirms merely that bats, especially species that travel long distances, fly over the North Sea. In view of this, there is currently a lack of any scientific and technical basis for describing and evaluating the occurrence of bats in the vicinity of site N-3.8 and, accordingly, the status of the protected object of bats.

2.10 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. Of the known 33 animal phyla, 32 are found in the sea, and 15 of these are actually exclusively marine (VON WESTERNHAGEN & DETHLEFSEN 2003).

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. Since the North Sea, as a relatively shallow marginal sea, is more easily accessible than the deep sea, for example, intensive marine and fisheries research has been taking place for about 150 years, leading to an increase in knowledge of its fauna and flora. This makes it possible to use inventory lists and species catalogues to document possible changes (VON WESTERNHAGEN & DETHLEFSEN 2003). According to results from the Continuous Plankton Recorder (CPR), about 450 different plankton taxa (phytoplankton and zooplankton) in the North Sea have been identified to date. Some 1,500 marine species of macrozoobenthos are known. An estimated 800 of these are found in the German North Sea region (Rachor et al. 1995). According to YANG (1982), the fish fauna of the North Sea comprises 224 fish and lamprey species. 189 species are reported for the German North Sea (Fricke et al. 1995). In the EEZ in the North Sea, 19 seabirds and resting birds regularly occur in larger populations. Three of these species are listed in Annex I of the Directive.

With regard to the current state of biodiversity in the North Sea, there is ample evidence of changes in biodiversity and species composition at all systematic and trophic levels in the North 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. Using the Red Lists, it can be seen that 32.2% of all currently assessed macrozoobenthos species in the North Sea and Baltic Sea (RACHOR et al. 2013) and 27.1% of the fish and lamprey species established in the North Sea (THIEL et al. 2013, FREYHOF 2009) are assigned to a Red List category. Marine mammals form a species group in which all representatives are currently endangered, with the bottlenose dolphin already having disappeared from the German North Sea area (VON NORDHEIM et al. 2003). Of the 19 regularly occurring seabirds and resting birds, three 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.

2.11 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 1 January 2015, stricter regulations have been in force for shipping in the North Sea as an emission control area, the so-called 'Sulphur Emission Control Area' (SECA). According to Annex VI, Regulation 14 MARPOL, ships may only use heavy fuel oil with a maximum sulphur content of 0.10% in this area. A limit of 3.50% is currently still in force worldwide. According to a decision by the International Maritime Organisation (IMO) in 2016, this limit is to be reduced worldwide to 0.50% from 2020.

Emissions of nitrogen oxides are particularly relevant to the North Sea as an additional nutrient contamination. To this end, the IMO decided in 2017 that the North 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)).

2.12 Climate

The German North Sea lies in the temperate climate zone. An important influencing factor is warm Atlantic water from the North Atlantic Current. Icing can occur in coastal areas, but is rare and only occurs at intervals of several years. 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. Global warming is also expected to have a significant impact on the North Sea, both through sea level rise and changes in the ecosystem. In recent years, for example, there has been an increase in the spread of species that were previously found only further to the south, along with significant changes to the habits of long-established resident species.

2.13 Landscape

The marine landscape is characterised by large open spaces surrounded by offshore wind turbines. In the German Bight, for example, there are several wind turbines that can be seen on the horizon from the coast.

The buildings include platforms and measuring masts for research purposes which are located inside or in the immediate vicinity of wind farms. In future, the landscape will continue to change due to the expansion of offshore wind energy; and the necessary lighting may also impair the visual appearance of the landscape. Spatial Plan No. 3.5.1 (8) according to the Maritime Spatial Plan for the German Exclusive Economic Zone in the North Sea provides for a height limit of 125 m for wind turbines within sight of the coast and islands. Due to this, height deviations are clarified in target deviation procedures according to the ROG (Regional Planning Act).

The extent to which the landscape is impaired by vertical structures is greatly dependent on visibility. The space in which a building becomes visible in the landscape is known as the visual 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).

In the case of platforms and offshore wind farms or areas planned at a distance of at least 30 km from the coastline, there is not much of an impact on the landscape as perceived from land. The platforms and wind farms are very visible at such a distance, even when visibility is good. This also applies to safety lighting at night. Site N-3.8, which has not yet been built on, is located among existing wind farms at a relevant distance from the coast.

2.14 Cultural heritage and other material assets

Indications of possible material assets or cultural heritage are present in the German EEZ 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).

No wrecks have yet been recorded at site N-3.8. Furthermore, the German Maritime Museum has not provided any information on possible ground monuments or other material assets. Evaluations of the side-scan sonar recordings did not provide any information either.

2.15 Human beings, including human health

All in all, the planning area in which wind farms are to be constructed in the German North Sea EEZ is of little significance for human beings as a protected object. In a broader sense, this 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 numerous existing and planned wind farm projects are resulting in an increase in activity around site N-3.8. Its importance as a working environment can therefore be regarded as medium. The EEZ of the North Sea as a whole is of little importance for active recreational use. Direct use for recreation and leisure only occurs sporadically by sports boats and tourist watercraft. Special significance of the planning areas for human health and well-being cannot be inferred.

2.16 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 biological protected objects of plankton, benthos, fish, marine mammals and birds, as described individually in the North Sea environmental report (BSH, 2019) for the FEP and in Chapter 1.6 are dependent upon one another within the 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 cod populations in the Baltic Sea had a positive impact on the development of European sprat populations (ÖSTERBLOM et al. 2006).

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, frontal formation, 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. What is more, shipping and mariculture are an additional factor that may lead to positive or negative changes in marine food chains through the introduction of non-native species. 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 detail in the description of the individual protected objects.

The complex interactions between the various components ultimately result in changes in the entire marine ecosystem of the North Sea. The changes as already described in Chapter 1.6 in relation to protected objects can be summarised as follows for the marine ecosystem in the North Sea:

- There have been slow changes in the living marine environment since the early 1980s.
- 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: change in species composition (phytoplankton and zooplankton, benthos, fish), introduction and partial establishment of non-native species (phytoplankton and zooplankton, benthos, fish), change in abundance and dominance conditions (phytoplankton and zooplankton), change in available biomass (phytoplankton), extension of the growth phase (phytoplankton, copepods), delay of the growth phase after a warm winter (spring diatom bloom), food organisms of fish larvae have brought forward the start of growth (copepods), decline of many species typical of the region (plankton, benthos, fish), decline in the food source for upper predators (seabirds), relocation of populations from southern to northern latitudes (Atlantic cod), relocation of populations from northern to southern latitudes (harbour porpoises).

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 'provides [...] a reference state against which the changes occurring as a result of the plan or programme can be measured (WULFHORST 2011 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 (HOPPE/ BECKMANN/KMENT in UVPG, section 40, margin note 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 (HOPPE/ BECKMANN/KMENT in UVPG, section 40, margin note 46.).

3.1 Soil/ground

Whether or not the construction project were to be implemented, soil or ground as a protected object would be subject to intense use in some instances at site N-3.8 due to various factors such as the extraction of raw materials or fishing. 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 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.

Potential impacts on the soil during the construction phase of the wind turbines, platforms and submarine cable systems (direct disturbance of near-surface sediments, resuspension of sediment, pollutant discharge and sediment shifts) are eliminated by not carrying out the project, as is permanent, locally narrowly confined seabed sealing.

3.2 Water

Water as a protected object would be affected by various uses, e.g. extraction of raw materials and shipping to some extent, both during implementation and in the event of non-implementation of the construction project at site N-3.8. 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 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 N-3.8.

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 installation of so-called suction bucket monopiles is currently being tested.

The power transmission from site N-3.8 to the land is realised by means of direct current cables. The operation of DC cables is state-of-the-art for the distances required for connecting offshore wind farms in the EEZ in the North Sea at site N-3.8.

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 N-3.8 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 N-3.8 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. The possible relocation of harbour porpoise populations already mentioned could also be linked to climate change. On the whole, however, this development is independent of the installation and operation of offshore wind turbines at site N-3.8.

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 N-3.8 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 N-3.8. However, existing cumulative effects of already realised projects and other uses in the vicinity of site N-3.8 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. However, if the plan were not implemented, site N-3.8 would not be available to meet the development targets for offshore wind energy.

3.8 Migratory birds

Even if the plan were not implemented, the protected object of migratory birds would still be affected in parts by the impacts of various uses, such as shipping and fishing, as described in Chapter 2.8.4.4. 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 N-3.8 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 N-3.8. However, existing cumulative effects of already realised projects and other uses in the vicinity of site N-3.8 would still exist.

3.9 Bats and bat migration

Migratory movements of bats across the North Sea are still scarcely documented and largely unexplored. There is a lack of concrete information on migratory species, migratory corridors, migratory heights and concentrations. Previous evidence only confirms that bats fly over the North Sea, especially long-distance migratory species. Based on previous findings, however, e.g. the distribution and habitat preferences of bats, some effects of climate change can be predicted. For example, the loss of resting places along migratory routes, the decimation of breeding habitats and changes in the food supply can be expected. 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.

Local impacts on habitat diversity and biodiversity, e.g. due to the insertion of hard substrate through the foundations and scour protection of the wind turbines, would not occur if the plan were not implemented. On the other hand, there would be no recovery of benthos and fish communities with corresponding impacts on biodiversity due to the suspension of fishing if the plan is not implemented. Large-scale impacts on biodiversity are not expected even if the plan is not implemented.

3.11 Air

With increasing intensity of use, shipping traffic in the North Sea also increases, which can have a negative impact on air quality. However, this development is largely independent of the construction of a wind farm at site N-3.8, as the construction and operation of the turbines and the internal cabling in the area would not have any measurable impact 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 N-3.8.

Negative impacts on the climate from the construction of wind turbines are not expected, as there are no measurable climate-related emissions during construction or operation.

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. 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. If the construction project is not carried out at site N-3.8, the development of the landscape is not expected to differ significantly from the development that would occur if the construction project were to be carried out, since site N-3.8 is almost completely enclosed by other wind farms that are expected to be erected in advance.

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 N-3.8. In view of this, neither the implementation or the non-implementation of the construction project at site N-3.8 will have any significant impacts on the protected object “Cultural heritage and other material assets”.

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 2.15). If the construction project is not implemented, the site would theoretically be available for these uses. 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 construction project were not carried out. Site N-3.8 is already used as a working environment due to the construction activities of the surrounding wind farms. This use would continue if the construction project were not carried out. Development would increase the importance of site N-3.8 as a working environment as compared to non-development. 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. Reference is therefore made at this point to 2.16.

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 2. 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 and transformer platform

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

Deep foundation is a method of anchoring the foundation of a wind turbine or platform to the seabed using one or more steel piles. The foundation piles are generally driven into the ground.

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

The wind turbines and platforms have a locally limited environmental impact with regard to the protected object of soil. The sediment is only permanently affected in the immediate vicinity by the insertion of foundation elements (including scour protection, if necessary) and the resulting space usage.

Construction-related: During foundation work for wind turbines and platforms, sediments are briefly stirred up and turbidity plumes are formed.

The extent of resuspension depends mainly on the fine grain content of the soil. As the surface sediments in the area of site N-3.8 mainly consist of fine sands, the released sediment will quickly settle directly at the construction site or in its immediate vicinity. The expected impairments due to increased turbidity remain limited to within a small area.

In the short term, pollutants and nutrients can be released from the sediment into the bottom water. The possible introduction of pollutants to the water column by swirled up sediment is negligible due to the relatively low fine-grain content (silt and clay), the low level of pollution and the relatively rapid resedimentation of the sands. This also applies in view of the fact that the sandy sediments are naturally stirred up and rearranged (e.g. during storms) by swells and currents that touch the ground.

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. As part of the preparatory measures for the construction of gravity foundations, it may be necessary to excavate excavation pits. The movement of the excavated soil will result in additional areas being affected.

From an installation-related perspective, the seabed is permanently sealed only locally and to a very limited extent by the insertion of the foundation elements of deep-foundation wind turbines or platforms. The affected areas essentially comprise the diameter of the foundation piles with any scour protection that may be required. The space usage (sealing) for transformer and converter platforms, which are almost exclusively based on jacket constructions (without scour protection), is approx. 600 m^2 to 900 m^2 depending on the size of the platform. Wind turbines are also almost exclusively constructed as deep foundations.

By far the most common type of foundation here is the monopile. With a monopile diameter of 8.5 m, including scour protection, the total space usage is about 1,400 m^2.

From an operation-related perspective, the interaction of foundation and hydrodynamics in the immediate vicinity of the installation may lead to permanent turbulence and a rearrangement of the sandy sediments. In the immediate vicinity of the installations, scouring may occur. Based on experience gained so far, flow-induced permanent sediment shift can only be expected in the immediate vicinity of the platform. According to the findings of the accompanying geological investigations in the 'alpha ventus' offshore test field (LAMBERS-HUESMANN & ZEILER 2011) and on the FINO1 and FINO3 research platforms, these will be located locally around the individual foundation piles (local scour). Due to the predominant soil properties and 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 assessment that the seabed at site N-3.8 is poorly structured with a homogeneous sediment distribution of fine sands, the SEA concludes that no significant impacts on the soil as a protected object are to be expected from the approval of the plant or platform sites.

4.1.2 Internal cabling

As a result of sediment uplift during cable-laying work, the turbidity of the water column increases due to construction work. This turbidity is distributed over a more extensive area due to the influence of tidal currents. The extent of the resuspension depends mainly on the laying method and the fine grain content of the soil. Due to the predominant sediment composition within the site under consideration, site N-3.8, most of the released sediment will settle 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. The results of investigations from various procedures in the North Sea show that the seabed levels out relatively quickly in some cases due to the natural sediment dynamics along the affected routes.

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 and low heavy metal concentrations in the sediment.

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.

From an operation-related perspective, both direct current and three-phase submarine cable systems cause the surrounding sediment to heat up radially around the cable systems. The heat emission results from the thermal losses of the cable system during energy transfer.

With regard to possible negative impacts of heat release from cable systems, the 2K criterion represents a precautionary value which, according to the BfN, ensures with sufficient probability, based on the current state of knowledge, that significant negative impacts of cable heating on nature or the benthic biotic community are avoided. In order to ensure compliance with the '2 K criterion', i.e. a maximum temperature increase of 2 degrees at 20 cm below the seabed surface, the relevant principle for sediment warming has already been included in the Spatial Offshore Grid Plan - North Sea (BFO-N), continued in the FEP and now included as a guideline in the draft suitability determination (section 6). The 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.

Energy loss in cable systems depend on a number of factors. The following initial parameters have a significant influence:

- Transmission technology: In principle, a higher level of heat emission due to thermal 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:
  In the EEZ, and therefore also at site N-3.8, predominantly water-saturated sands occur, to whose specific thermal resistance a range of 0.4 to 0.7 KmW-1 applies, taking into account various sources (Smolczyk 2001, Bartnikas & Srivastava 1999, VDI 1991, Barnes 1977). According to this, more efficient heat dissipation can be assumed for water-saturated coarse sands than for finer-grained sands.

Table 9: Thermal properties of water-saturated soils (according to SMOLCZYK 2001)

Soil type	**Minimal thermal conductivity**	**Maximum thermal conductivity**	**Maximum specific thermal resistance**	**Minimum specific thermal resistance**
	W / (K*m)	W / (K*m)	K*m/ W	K*m/ W

Soil type	Minimal thermal conductivity	Maximum thermal conductivity	Maximum specific thermal resistance	Minimum specific thermal resistance
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 carried out on an internal three-phase cable system at the Danish offshore wind farm “Nysted” revealed a sediment heating of max. 1.4 K directly above the cable (transmission power of 166 MW) 20 cm below the seabed (Meissner et al. 2007). In addition, intense water movement near the bottom of the North Sea leads to the rapid removal of local heat.

Taking the above results and forecasts into account, it can be assumed that the so-called '2 K criterion' is complied with at a laying depth of at least 1.50 m. . Since the concrete effects of a cable system also depend on its cross-section and other properties, the definition of a uniformly applicable value for the covering to be produced without knowledge of the concrete project parameters does not appear to be expedient. 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.

If the 2K criterion is met, it can be assumed at the present stage that no significant impacts, such as structural and functional changes, are to be expected from cable-induced sediment heating on the soil as a protected object. Due to the low proportion of organic material in the sediment, no significant release of pollutants is expected from sediment heating.

4.2 Water

4.2.1 Wind turbines and transformer platform

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. 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 modelling of flow conditions in offshore wind farms has already been carried out for the GIGAWIND project (ZIELKE et al. 2001, MITTENDORF & ZIELKE 2002, GIGAWIND / UNI HANNOVER 2003 and 2004).

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. Due to mixing within the water column, stratified water bodies can lead to increased oxygen discharge at greater water depths.

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 is expected to result in slight attenuation, although the effect of large offshore wind farms on the wake of the wind field and thus on the wave field is the subject of current research.

The changes in the current regime and sea heave resulting from offshore wind turbines or offshore wind farms are long-term and medium-term. The intensity of the effects is low. Based on this intensity assessment, the structural and functional changes are slight.

4.2.1.3 Operation-related effects

To ensure the operation of offshore installations (wind turbines and platforms), 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) can be 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, emissions from wind turbines, for example, are around 150-700 kg per turbine 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. When assessing this impact, it must also be taken into account that discharge from corrosion protection is distributed in the North Sea system by distribution and dilution processes and does not necessarily accumulate locally and lead to 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.

For this reason, the effects from corrosion protection are assessed according to current knowledge 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 used to reduce the oil content of these waste waters. Depending on the technical availability and the current state of implementation, the oil content must 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, in exceptional cases, 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 a small crew, this waste water must always be collected and disposed of ashore. For the purpose of installation cooling, closed-loop cooling systems without material discharge have become generally established on platforms. Only in atypical exceptional cases can 'open' sea cooling water systems be approved according to the state of the art. 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. 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 and transformer platform

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 protected in accordance with section 30 BNatSchG or FFH habitat types at site N-3.8. Direct utilisation of protected biotopes by the installations and the transformer platform can thus be ruled out. The effects of sedimentation and habitat changes are limited to a small area and/or short-term. This means that considerable construction-related, installation-related and operation-related effects of the installations on protected biotopes can be ruled out.

If, after final evaluation of the objects identified in the course of the preliminary geological offshore site investigation, there are indications of the presence of legally protected biotopes at site N-3.8, these will be taken into account accordingly in the suitability assessment.

4.3.2 Internal cabling

According to current knowledge, there are no biotopes protected in accordance with section 30 BNatSchG or FFH habitat types at site N-3.8. Direct utilisation of protected biotopes by the submarine cable systems and the transformer platform can thus be ruled out. The effects of sedimentation and habitat changes due to intersection structures are limited to a small area and/or short-term. This means that considerable construction-related, installation-related and operation-related of the submarine cable systems on protected biotopes can be ruled out.

If, after final evaluation of the objects identified in the course of the preliminary geological offshore site investigation, there are indications of the presence of legally protected biotopes at site N-3.8, these will be taken into account accordingly in the suitability assessment.

4.4 Benthos

The construction of the transformer platform and wind turbines, as well as the installations themselves, may have an impact on macrozoobenthos.

Site N-3.8 is of average importance with regard to the species inventory of benthic organisms. Also, the identified benthic transitional community of the *Tellina fabula* and *Nucula nitidosa* coenoses does not exhibit any special features as it is typical of the German North Sea based on the predominant sediments. The species inventory found and the number of Red List species indicate average importance of site N-3.8 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 and transformer platform

Construction-related: Deep foundations of the wind turbines and the transformer platform 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 and the platform. 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.

For scour protection, therefore, only fills of natural stones or biologically inert and natural materials are to be used in accordance with the corresponding specification in the draft of the suitability determination (section 15), so facility-related emissions of pollutants are not to be expected.

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

Operationally induced effects due to cooling water discharge are not a cause of concern since, according to the specifications set out in the draft suitability determination, closed-loop cooling systems are to be used for installation cooling and the corrosion protection has to be as free of pollutants and a low in emissions as possible. Waste water (grey water and black water) must primarily be collected in the correct manner, transported ashore and disposed of appropriately. Therefore, according to the present state of knowledge and taking into account the above-mentioned specifications in the draft suitability determination, no significant impacts are to be expected from the discharge of waste water and the use of corrosion protection systems.

As an interim result, it can be stated that, according to the current state of knowledge, the construction and operation of the wind turbines and the transformer platform are not expected to have any significant impacts on the protected object benthos at site N-3.8. 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 German Bight, 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.

For the area of cable crossings, according to the specifications in the draft suitability determination, only fills of natural stone or biologically inert and natural materials are to be used. The use of cable protection systems containing plastic is only permitted in exceptional cases and must be kept to a minimum. 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. Compliance with the 2 K criterion is specified in the draft suitability assessment (section 6)

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 in site N-3.8 reflects the typical species composition of the German Bight. The demersal fish community throughout the North of Borkum sea area is also dominated by characteristic flatfish species.
According to current knowledge, the proposed site does not constitute a preferred habitat for any of the fish species protected under the Red List and Habitats Directive. As a result, the fish population at the planned site N-3.8 is not ecologically exceptional.

4.5.1 Wind turbines and transformer platform

At the current stage of planning, two project-specific scenarios are used as a basis for estimating the impacts of construction and dismantling as well as the installation-related and operation-related effects of a wind farm on the fish community (cf. 1.5.6.3). The parameters relevant to fish fauna are shown in Table 10. In scenario 1, planning is based on 42 wind turbines, while scenario 2 considers the installation of 25 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 10: Relevant wind farm parameters for the assessment of the effects of the model wind farm scenarios on the fish fauna.

	Scenario 1	Scenario 2
Number of turbines	42	25
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]	1,420	2830

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 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 use of 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 wind turbines is shorter than in scenario 2 due to the smaller foundations. However, the installation of 42 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. The construction of the wind farm is not expected to have a significant adverse effect on the protected object of fish if aversive and mitigation measures are implemented.

Sedimentation and turbidity plumes: The construction work on the foundations and transformer platform causes sediment turbulence and turbidity plumes, which – although temporary and species-specific – can have physiological impairments and deterrence effects. Predators hunting in open water such as mackerel *Scomber scombrus* and horse mackerel *Trachurus trachurus* avoid areas with high sediment loads so as to avoid the risk of gill adhesion (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 *Pleuronectes platessa* and sole *Solea solea*, 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 adult species. 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. Although the concentration of suspended particles can reach levels that are harmful to certain organisms, the effects on fish must be regarded as relatively low, since such concentrations are only present for a limited period of time and within a small area, and they are quickly broken down again by 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 more construction activities take place at site N-3.8, the greater the sedimentation and turbidity plumes. As such, increased sediment suspension is expected in the immediate vicinity of the 42 foundation structures of the first scenario, compared to the construction of 25 wind turbines in the model wind farm. 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.

Installation-related effects

- Space usage
- Insertion of hard substrate
- Fishing ban

Insertion of hard substrate: The construction of wind farms is changing the habitat structure of site N-3.8 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. 2002). In the North Sea, large adult predators such as cod *Gadus morhua* and saithe *Pollachius virens* are increasingly being observed above wrecks and stone fields (EHRICH 2003), and some of them are fished there by means of wreck fishing using gillnets. Increased densities of flatfish have been found near 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 (LEONHARD 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). The effective radius is assumed to be 200 to 300 m for pelagic fish and up to 100 m for benthic fish. (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. Transferred to the foundations of the wind turbines, it can be assumed that, due to the distance between the individual turbines, each individual foundation, regardless of the foundation type, acts as a separate, relatively unstructured substrate and the effect does not extend across the entire wind farm area. 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 installations, thereby potentially increasing biodiversity at site N-3.8 more than in scenario 2. As a result of colonisation by benthic invertebrates, more fish individuals could accumulate in the vicinity of the 25 wind turbines than at 15 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 N-3.8 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 offshore wind farms 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 N-3.8, thus creating retreat areas for fish fauna.

4.5.2 Internal cabling

Construction-related effects

- Noise emissions
- Sedimentation and turbidity plumes

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 N-3.8, 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.

Installation-related effects

- Habitat changes due to cable crossings

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.

Operation-related effects

- Warming of the sediment
- Electric/electromagnetic fields

Sediment warming in the immediate vicinity of the cables is specified in the draft suitability assessment and experience has shown that it will not exceed the precautionary value of 2 K at a sediment depth of 20 cm. Therefore, no significant impact on the fish fauna is 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

According to current knowledge, it can be assumed that the German EEZ is used by harbour porpoises for crossing and resting, and also as a food and area-specific breeding ground. On the basis of the available knowledge, in particular from the current studies for offshore wind farms and the monitoring of Natura 2000 areas, the area of site N-3.8 can be determined as of medium to seasonally high importance for harbour porpoises. Site N-3.8 is of medium significance for harbour seals and grey seals.

4.6.1 Wind turbines and transformer platform

Construction-related:

Noise emissions during the construction of offshore wind turbines and the transformer station can pose a threat to harbour porpoises, grey seals and harbour seals if no prevention and mitigation measures are implemented. Depending on the foundation method, impulse sound or continuous sound can be introduced. The discharge of impulse sound, which is generated when driving piles with hydraulic hammers, for example, has been well investigated. The current state of knowledge regarding impulse sound contributes significantly to the development of technical sound reduction systems. On the other hand, the current state of knowledge on the introduction of continuous noise as a result of the installation of foundation piles using alternative methods is very limited.

The German Environment Agency (UBA) recommends compliance with noise control limits when installing foundations for offshore wind turbines. The Sound Exposure Level (SEL) should not exceed 160 dB (re 1 µPa) outside a radius of 750 m around the pile driving or placement site. The maximum peak sound pressure level should not exceed 190 dB. The UBA recommendation does not include any further specifications regarding the SEL noise control limit (http://www.umweltdaten.de/publikationen/fpdf-l/4118.pdf, status: May 2011).

The noise control limit recommended by UBA was developed through preliminary work as part of 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. Due to the uncertainties in the evaluation of the exposure time described here, the limit value used in approval practice is below the limit proposed by SOUTHALL et al (2007).

As part of the development of a measurement specification for recording and evaluating underwater noise from offshore wind farms, the BSH has specified the requirements of the UBA recommendation (UBA 2011) and the findings of the research projects with regard to noise control limits and standardised them as far as possible. The BSH's measurement regulations for underwater sound measurements define the SEL_5 value as the assessment level, i.e. 95% of the measured individual sound exposure levels must be below the statistically determined SEL_5 value (BSH 2011). The extensive measurements carried out as part of the efficiency check show that the SEL_5 is up to 3 dB higher than the SEL_{50}. By defining the SEL_5 value as an assessment level, further tightening of the noise control limit has been introduced to take account of the precautionary principle.

In its overall assessment of the available expert information, the BSH therefore assumes that the Sound Exposure Level (SEL_5) outside a circle with a radius of 750 m around the pile driving or placement site must not exceed 160 dB (re 1 µPa) in order to be able to rule out adverse effects on harbour porpoises with the necessary certainty.

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 $\mu Pa^2/Hz$, 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).

Without the use of noise-reducing measures, considerable disturbance to marine mammals during foundation pile driving cannot be ruled out. The driving of piles for the wind turbines and the transformer station will therefore only be permitted in the draft of the suitability determination and later in the specific approval procedure if effective noise reduction measures are applied. To this end, specifications are included as part of the draft suitability determination (section 8). These state that pile driving work when installing the foundations of offshore wind turbines and platforms can only be carried out in compliance with strict noise reduction measures. 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 maximum 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.

Current technical developments in the field of reducing underwater noise show that the use of suitable systems can significantly reduce or even completely prevent the effects of noise pollution on marine mammals (Bellmann, 2020, in preparation).

Taking into account the current state of knowledge, conditions will be imposed in the specific approval procedure with a knowledge of the foundation types to be constructed, with the aim of avoiding effects on harbour porpoises caused by noise pollution as far as possible. The extent of the required conditions is determined at the approval level for each site and project by examining the structural design of the respective project based on the requirements of species protection law and territorial protection law.

The noise control concept has also been in force since 2013 (BMU 2013). The BMU noise control concept is habitat-related. According to the noise control concept, pile driving activities must be coordinated in time in such a way that sufficiently large areas are kept free of effects caused by impact noise caused by pile driving, especially within the German EEZ in the North Sea and especially within the conservation areas and the main concentration area of harbour porpoise in the summer months.

In general, the considerations made for harbour porpoises regarding noise exposure from the construction and operation of wind turbines and platforms also apply to all other marine mammals present in the immediate vicinity of the structures.

Particularly during pile driving, direct disturbances of marine mammals at the individual level are to be expected locally around the pile driving site and for a limited time, whereby – as explained above – the duration of the work also has an impact on the exposure limit. In order to prevent any resulting threat to the marine environment, the assessment of suitability must include the requirement that the effective pile-driving period (including aversive action) be kept to a minimum (section 8). The effective pile driving time to be observed in each case (including aversive action) is to be specified later as part of the approval procedure for each site 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.

Given the functionally dependent importance of the areas for harbour porpoises and taking into account the noise control concept (BMU 2013) to prevent disturbances as well as the regulations laid down in the Site Development Plan (BSH 2019c), the specifications contained in the draft of the suitability determination and the requirements as part of individual approval procedures for the reduction of noise disturbances, an assessment is made of the impacts of noise-intensive construction work on harbour porpoises. The exclusion effect of wind farms in conservation areas and the implementation of the requirements of the noise control concept (BMU 2013) reduce the risk to harbour porpoises in key feeding and nursery areas.

According to current knowledge, <u>operation-related</u> noise from the wind turbines and the transformer station has no effect on highly mobile animals such as marine mammals.

It is known from oil and gas platforms that the attraction of different fish species leads to an enrichment of the food supply (Fabi et al., 2004; Lokkeborg et al., 2002). Surveys of harbour porpoise activity in the immediate vicinity of platforms have also shown an increase in harbour porpoise activity associated with foraging during the night (TODD et al., 2009). It can therefore be assumed that the potentially increased food supply in the vicinity of the transformer platform is likely to be attractive to marine mammals.

As a result, it can be concluded that, according to the current state of knowledge, no significant impacts on the protected object mammal species are to be expected from the construction and operation of offshore wind turbines and the transformer station at site N-3.8.

4.6.2 Internal cabling

<u>Construction-related:</u> 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.

<u>Operation-related</u> 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 N-3.8 is determined and an offshore wind farm project is realised at this site, the following general impacts 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 N-3.8 are to be assessed as local in terms of both space and time. Construction-related shipping traffic will not exceed the level of impact on seabirds from regular shipping in the area between the two traffic separation schemes north of Borkum. Likewise, turbidity plumes will only occur locally and for a limited time. With regard to possible lure effects caused by lighting, the suitability determination will include a requirement for minimising emissions according to the present draft, so as to decrease light emissions to a necessary minimum level and therefore also reduce 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 (BSH 2019c), 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 1.5.6.3). 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 (Larus) herring gull, lesser black-backed gull and great black-backed gull flew at altitudes of 30 – 150 m in the majority of the recorded flights. Species such as the black-legged kittiwake, common gull, little gull and northern gannet, on the other hand, were mainly observed at lower altitudes 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 northern gannet, black-legged kittiwake and the large gull species herring gull, great black-backed gull and lesser black-backed gull, likewise using the rangefinder (SKOV et al. 2018). The flight level measurements for the large gull species and the northern gannet showed heights comparable to those determined by MENDEL et al (2015). Black-legged kittiwakes, on the other hand, were mostly observed at a height of about 33 m.

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.

For the terns listed in Annex I of the Bird Directive, there is likewise no danger of collision with the installations, as they prefer low flight altitudes and are extremely agile flyers (GARTHE & HÜPPOP 2004).

On the whole, the realisation of the wind turbines specified in scenarios 1 and 2 at site N-3.8 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.

Red-throated and black-throated divers exhibit very pronounced avoidance behaviour towards 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 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.

For the study cluster 'North of Borkum', effects up to 2 – 4 km were determined based on large-scale digital flight recording up until 2016 (IFAÖ et al. 2017). By contrast, study years 2017 and 2018 showed more extensive avoidance effects up to 10 km (IFAÖ et al. 2018, IFAÖ et al. 2019). Again, this is partial rather than complete avoidance. According to the experts, the avoided distances determined in the 'North of Borkum' cluster studies would therefore be similar to those in the studies carried out in the main diver concentration area (cf. HEINÄNEN 2018 and GARTHE et al. 2018). At the same time, the experts point out the wide spread of the data and the overall heterogeneous distribution pattern of divers (IFAÖ et al. 2019). It can be expected that further studies will provide a clearer picture of the avoidance behaviour of divers in the area north of Borkum. Detailed information on the avoidance behaviour of divers, particularly in the main concentration area west of Sylt, can be found in the relevant chapters of the environmental report on the Site Development Plan for the German North Sea (BSH 2019a).

For site N-3.8, the results of the 'North of Borkum' cluster studies mean that a wind farm in this area will be likewise subject to the avoidance behaviour of divers. However, site N-3.8 is more than 40 km away from the main concentration area of divers, the most important resting area in the North Sea EEZ. In view of the low seasonal and spatial occurrence of divers in the vicinity of site N-3.8 (see Chapter 2.7.3), significant impacts can be ruled out with the necessary certainty. A consideration of cumulative impacts is provided in Chapter 4.12.4.

For other species such as northern gannets, little gulls, terns, guillemots and razorbills, there are findings on small-scale avoidance behaviour towards wind farms. According to the evaluation of the data from the 'North of Borkum' cluster, these range up to a maximum distance of 2 km from the wind farm in the case of the little gull and northern gannet, and possibly up to 4 km in the case of the guillemot and razorbill. Here again, this only involves partial avoidance. For terns, avoidance of wind farm areas is becoming apparent, but this does not go beyond the boundaries of a wind farm (IfAÖ et al. 2017, IfAÖ et al. 2018, IfAÖ et al. 2019). The little gull and northern gannet only occur sporadically or during migration periods in the vicinity of site N-3.8. Guillemots and razorbills are widely distributed throughout the EEZ in the North Sea. As things stand at present, these species are not expected to be significantly affected.

4.7.2 Internal cabling and transformer platform

The impacts of platforms and submarine cable systems have already been examined and assessed at the level of the Strategic Environmental Assessment for the Site Development Plan for the German North Sea (BSH 2019a). 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.

4.8 Migratory birds

The endangerment of bird migration is a reason for the rejection of offshore wind farm projects pursuant to section 48(4)(1b) WindSeeG.

4.8.1 Wind turbines

If the suitability of site N-3.8 is determined and an offshore wind farm project is realised on this site, the following general effects may occur:

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 N-3.8 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. Collision events may occur at the vertical structures (such as rotors and support structures of the wind turbines). Poor weather conditions – especially at night and in strong winds – increase the risk of 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 N-3.8, the threat potential is considered on a species-group-specific basis. In most cases, a species-specific analysis is not possible due to methodological limitations in bird migration recording.

Detailed information on the general risk potential to bird migration and the assessment criteria can be found in the relevant chapters of the environmental report for the Site Development Plan for the German North Sea (BSH 2019a).

Within the scope of the suitability assessment, as in the Site Development Plan (BSH 2019c), 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. In the following individual species or species groups, only those species are taken into account that were recorded in significant numbers in the vicinity of site N-3.8.

Gulls

In the area around site N-3.8, seagulls have dominated migration during the light phase in previous years (see Chapter 2.8.3.1). The populations of the most common gull species are generally large. The lesser black-backed gull was the most common gull species across all migration periods recorded from 2013 to 2017 (AVITEC RESEARCH GBR 2018). The population of the subspecies *Larus fuscus intermedius*, which dominates in Germany, is currently estimated at 566,000 – 699,000 individuals (WETLANDS INTERNATIONAL 2018). Among the gulls, the herring gull is the only species with a classification in SPEC Category 2 (species concentrated in Europe with negative population development and unfavourable conservation status). Both the sub-species *Larus argentatus argentatus* and the sub-species *Larus argentatus argenteus* occur in the German North Sea. The size of the two populations is estimated to be 1,300,000 – 1,600,000 individuals and 710,000 – 790,000 individuals respectively (WETLANDS INTERNATIONAL 2018).

When examining the flight altitude distribution during the light phase in spring 2017, it was determined at FINO 1 on days with proportionately strong large gull migration that large gulls mostly flew at altitudes of over 20 m (AVITEC RESEARCH GBR 2018). Within the scope of research projects, flight altitude measurements using rangefinders for the large gull species herring gull, lesser black-backed gull and great black-backed gulls showed altitudes of 30 – 150 m. By contrast, small gull species such as the black-legged kittiwake and common gull were mainly observed at altitudes of up to 30 m (MENDEL et al. 2015, SKOV et al. 2018).

In general, both 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. Seagulls can also land on the water in bad weather and wait for better migratory conditions. On the whole, therefore, considerable impacts on seagulls can be ruled out with the required degree of certainty as a result of development at site N-3.8, also in view of the technical scenarios under consideration here.

Pursuant to Article 4(1) of the Birds Directive, special protection measures (in particular the designation of conservation areas) must be applied to the species listed in Annex 1 of the Directive with regard to their habitats.

In addition, Article 4(2) of the Birds Directive requires Member States to take appropriate measures for the regularly occurring migratory species not listed in Annex 1 in terms of their reproduction, moulting, wintering and resting areas. However, there is no generally applicable and binding list for the migratory bird species to be protected. Nonetheless, indications of the species' worthiness of protection are provided, among other things by the classification of the species in the European SPEC categories (Species of European Conservation Concern), the EU25 threat categories (EUR25 threat status) and the status of the species under the Action Plan for the 'Agreement on the Conservation of African-Eurasian Migratory Waterbirds' (AEWA).

In the following, the impacts on the **species requiring special protection under Annex I** and other species requiring protection in accordance with **Article 4(2) of the Birds Directive** are considered and assessed in a differentiated manner.

As regards the impact on **species of Annex I** of the Birds Directive, the following applies:

Species group – terns

Terns were among the most frequently observed species groups in the cluster studies on bird migration carried out so far at the FINO 1 site (period 2013 – 2017), in the vicinity of site N-3.7. Among them, the sandwich tern *(Thalassesus sandvicensis*) was the most common species, while the common tern and Arctic tern were only rarely distinguished from one another.

The population size of the relevant biogeographic population of the sandwich tern is currently estimated at 160,000 – 186,000 individuals; the population trend is increasing. The size of the biogeographic populations of the Arctic tern *(Sterna paradisaea*) and common tern *(Sterna hirundo*) are estimated at 2,000,000 – 5,000,000 and 760,000 – 1,600,000 individuals respectively (WETLANDS INTERNATIONAL 2018).

With the help of data from 2008 – 2012 collected via day migration observations, AVITEC RESEARCH GBR (2014) carried out estimates of the quantity of the species (group) specific migration for the sea area around FINO 1 – for the first time for an offshore location in the area of the German Bight based on observations over several years. It turned out that along an imaginary line running at right angles to the main direction of migration with a length of 6 – 20 km in the NW-SE direction with FINO 1 in the centre, extrapolated to the centre, about 10,000 sandwich terns could be expected to pass through per year, i.e. about 6.0% of the biogeographic population. Furthermore, the passage of about 1% of the biogeographic population of common terns was to be expected during the autumn migration period. As a result, the surroundings of site N-3.8 have been assigned considerable importance in the past with regard to tern migration.

These projections were based on sightings of 20 (autumn 2009) to 901 sandwich tern (spring 2012) and 13 (autumn 2009) to 228 common tern (autumn 2010) (AVITEC RESEARCH GBR 2014).

Visual observations of recent years since the start of offshore wind energy development in the vicinity of site N-3.8 have resulted in sightings of 34 (autumn 2017) to 304 (spring 2015) sand terns and 6 (autumn 2017) to 20 (autumn 2015) common terns (AVITEC RESEARCH GBR 2016; AVITEC RESEARCH GBR 2018). These sightings correspond to just 0.2% of the biogeographic population of the sandwich tern and 0.001% of the biogeographic population of the common tern.

For the sandwich tern, the current cluster studies show a decrease in migratory event rates in the sectors away from the wind farm and a simultaneous increase in the migratory event rate in sectors near the wind farms. This change indicates that the birds are diverting their flight around the wind farm projects. Common terns and Arctic terns have been observed more frequently passing along the outer boundaries of wind farms (AVITEC RESEARCH GBR 2018). In view of the sometimes extremely long total distance of the migration paths, it can be assumed that diverting the flight path around a wind farm only marginally extends the migration path. With regard to the risk of collision, the danger of collision is considered low due to the extreme manoeuvrability of terns. Their preferred flight altitudes are in the range of the lower 20 meters and thus outside the danger zone of the rotor blades of both wind farm scenarios.

The risk potential for terns is therefore estimated to be low, despite the previously high importance of site N-3.8 in terms of Arctic tern migration.

Species group – divers

The species group of the divers is made up of the species red-throated diver (*Gavia stellata*) and black-throated diver *(Gavia Arctica*). The relevant biogeographic populations are estimated to comprise 216,000 – 429,000 individuals (red-throated diver) and 266,000 – 473,000 individuals (black-throated diver) (WETLANDS INTERNATIONAL 2018). Sea divers are considered to be particularly sensitive to disturbance and exhibit pronounced avoidance behaviour towards offshore wind farms during rest periods (see Chapter 4.7.1). According to GARTHE & HÜPPOP (2004), red-throated divers and black-throated divers received the highest wind farm sensitivity indices of 43 and 44 respectively. Due to their avoidance behaviour, the risk of collision can be regarded as very low. In addition, divers have been observed regularly but only in small numbers in the past few years as part of the bird migration survey for the 'North of Borkum' cluster (AVITEC RESEARCH GBR 2018). Furthermore, divers fly mainly near the water surface and at heights of about 10 m (GARTHE & HÜPPOP 2004). Significant impacts on the group of divers in the sense of a threat to bird migration can be ruled out with the necessary certainty.

Little gull (Hydrocoloeus minutus)

The little gull is also one of the species listed in Annex I of the Birds Directive and is therefore considered separately from the other gull species observed at site N-3.8.

According to current estimates, the biogeographic population of the little gull comprises 71,000 – 136,000 individuals (WETLANDS INTERNATIONAL 2018). It was observed regularly in the vicinity of site N-3.8 but only in small numbers of individuals during the daytime bird migration survey. In addition, rangefinder measurements of flight altitudes showed that little gulls prefer flight altitudes in the lower 30 m range (MENDEL et al. 2015). As such, the lower rotor blade tips of the turbines from scenario 1 could in principle reach the preferred flight levels of little gulls. However, GARTHE & HÜPPOP (2004) classified the little gull as relatively insensitive to offshore wind farms (WSI 12.8), partly because of its extreme agility. Significant effects on little gulls can be ruled out with the necessary certainty, taking into account knowledge of their occurrence, population and flight behaviour.

With regard to the effects on the species to be protected in accordance with **Article 4(2) of the Birds Directive**, the following applies:

Species group – geese and ducks

From the group of geese and ducks protected or endangered according to at least one of the above-mentioned agreements or risk assessments, the common scoter *(Melanitta nigra*), brent goose *(Branta bernicla*), pink-footed goose *(Anser brachyrhynchus*) and greylag goose *(Anser anser*) have been observed in significant numbers in the vicinity of site N-3.8 in recent years.

Common scoters are classified by AEWA as B 2a (populations with an individual number of more than about 100,000 for which special attention is needed due to the concentration on a small number of sites at each stage of their annual cycle). The size of the biographic population of the common scoter is currently estimated at 687,000 – 815,000 individuals (WETLANDS INTERNATIONAL 2018).

Brent geese are classified as B 2b (populations of more than 100,000 individuals for which special attention is required due to the fact that they are assigned to a critically endangered habitat type) according to AEWA. The size of the relevant biogeographic population is currently estimated at 211,000 individuals (WETLANDS INTERNATIONAL 2018).

Pink-footed geese are listed in AEWA category B1 (populations of about 25,000 and 100,000 individuals not meeting the requirements for column A). According to current estimates, the relevant biogeographic population comprises 86,000 individuals (WETLANDS INTERNATIONAL 2018).

Greylag geese are classified in AEWA category C1 (populations of more than about 100,000 individuals for which international cooperation could be of considerable benefit and which do not meet the requirements for column A or B). According to current estimates, the relevant biogeographic population comprises 960,000 individuals (WETLANDS INTERNATIONAL 2018).

During the visual observations of bird migration in the 'North of Borkum' cluster, individuals of the above species were regularly recorded in the past years (2013 – 2017). Most of the sightings of common scoters were recorded in spring 2016 with 166 individuals (AVITEC RESEARCH GBR 2017). This corresponds to about 0.02% of the biogeographic population. The highest sightings for brent goose, pink-footed goose and greylag goose were 303 individuals (spring 2014), 171 individuals (autumn 2015) and 80 individuals (spring 2016) (AVITEC RESEARCH GBR 2015b; AVITEC RESEARCH GBR 2016; AVITEC RESEARCH GBR 2017). This corresponds to 0.14% of the respective biogeographic population for the brent goose, 0.2% for the pink-footed goose and 0.008% for the greylag goose.

All the species mentioned here mainly migrate during the day. It is therefore to be expected that they will be able to detect and fly around vertical obstacles in time due to their good visual abilities. In addition, visual observations at the FINO 1 site in recent years have shown that daytime migration takes place mainly at lower altitudes of 20 – 50 metres (see Chapter 2.8.3.2). In view of the possible size scenarios of the turbines, daytime migration usually takes place below the lower tip of the rotor blades.

Due to the small share of the population involved in migration in the vicinity of site N-3.8 and the flight behaviour of the species under consideration, significant impacts on duck and goose species occurring regularly and in significant numbers can be ruled out with the necessary certainty.

Species group – waders

In the vicinity of site N-3.8, only a few wading bird species were recorded in very small numbers of individuals in the course of investigations on bird migration in the past years, both at night and during the day. It can therefore be assumed that a wind farm at site N-3.8 will not have a significant impact on waders. In summary, it can be stated for diurnal migrants that they mostly fly at altitudes of less than 50 meters and therefore also under the lower rotor tip according to the above-mentioned scenarios 1 and 2. It is generally assumed that diurnal migrants are able to orient themselves visually and, where the diurnal migrants are seabird or waterbird species, can land on the water. As a result, significant impacts on predominantly diurnal species are not to be expected.

Songbirds

Songbirds dominate nocturnal bird migration. Taking into account the migratory behaviour of small birds, there is a particular risk of collision during the nocturnal migration of small birds due to migration in the dark, high migratory bird volumes and strong attraction 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 a recent study, BRUST et al (2019) found that the migratory behaviour of thrushes is not only influenced by the prevailing wind conditions but also by individual stamina and behaviour. Individuals who stayed longer at intermediate stations along the coast tended more often to cross the North Sea along an offshore route rather than follow the coastline. In addition, among the birds who favoured clear weather conditions for their migration, collisions with 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. A potential hazard situation, on the other hand, is caused by unexpected fog and rain, which leads to poor visibility and low flight altitudes. One particular problem is the coincidence of bad weather conditions with so-called mass migration events. According to information from various environmental impact studies, mass migratory events in which birds of different species fly over the North Sea simultaneously occur about 5 to 10 times a year. On average, two to three of these coincide with poor weather.

Among the most common species based on bird call recordings from studies conducted in recent years in the area of site N-3.8 are the thrush species song thrush, redwing, and fieldfare. Skylark, meadow pipit, starling and robin were also recorded regularly and in higher numbers (see Chapter 2.8.3.2).

The large number of songbird species crossing the area is the result of populations consisting of very large numbers of individuals. Starting from the main migration direction of SW or NE, the German Bight is crossed mainly by songbirds from the Fennoscandian area. The migratory birds identified are therefore probably mainly attributable to the breeding populations of Northern Europe. There are currently no more recent estimates of the population sizes of Northern European breeding populations. According to BIRDLIFE INTERNATIONAL (2004), the Northern European breeding populations were reported as follows: redwing – 3,250,000 to 5,500,000 individuals, song thrush – 3,300,000 to 5,700,000 individuals, starling – 1,380,000 to 2,660,000 individuals, skylark – 2,000,000 to 3,100,000 individuals and meadow pipit – 2,230,000 to 7,245,000 individuals. According to the available studies from the FINO 1 site, the listed songbird species do not occur in the assessment area with significant population shares (> 1 percent of the total individual breeding population of Northern Europe). In view of the size of the Northern European breeding populations, the assessment area is of no particular importance for songbird populations during migration.

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 lighthouses 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. 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 recommended the use of red light in cloudy weather conditions to reduce lure effects in poor visibility

The danger of bird strike due to the lure effects of wind turbine lighting seems to be more likely to occur in the above-mentioned – large – populations and therefore does not indicate a threat to nocturnal bird migration. 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.

On the whole, the species-specific individual assessment shows that for the migratory bird species occurring in the project area and their relevant biogeographic populations, considerable impacts from a wind farm at site N-3.8 can be ruled out with the necessary certainty. However, the potentially increased risk of collision due to the higher turbines according to scenarios 1 and 2 must be taken into account in the cumulative consideration of several wind farm projects in the vicinity of site N-3.8 and in the concrete planning of the individual project.

4.8.2 Internal cabling and transformer platform

The impacts of platforms and submarine cable systems have already been examined and assessed at the level of the Strategic Environmental Assessment for the Site Development Plan (BSH 2019a). 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

Migratory movements of bats across the North Sea are still scarcely documented and largely unexplored. There is a lack of concrete information on migratory species, migratory corridors, migratory heights and concentrations. Previous evidence only confirms that bats fly over the North Sea, especially long-distance migratory species.

At present, there are no reliable data on migration corridors and migration behaviour of bats over the North Sea to realistically assess the potential impact of a wind farm at site N-3.8. It is expected that any adverse effects on bats can be prevented and reduced by the same measures used to protect bird migration.

4.10 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.

The CO_2 savings associated with the expansion of offshore wind energy are expected to have positive long-term impacts on the climate.

4.11 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. 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 development of the landscape will not be significantly affected by the construction of the project at site N-3.8, as this area is almost completely enclosed by other offshore wind energy projects that are expected to be built in the future.

4.12 Cumulative impacts

In the following, in accordance with the comments in Chapter 1.5.6.1, an assessment is carried out as to whether the cumulation of impacts can be expected to have significant environmental impacts on the protected objects.

4.12.1 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 essentially be 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 375 MW for site N-3.8 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 42 (scenario 1) and 25 (scenario 2).

On the basis of the model wind farm parameters, this results in area sealing of 61,603 m^2 (scenario 1) and 72,713 m^2 (scenario 2), including assumed scour protection and a transformer platform. Compared to the total area of site N-3.8 of approx. 23 km^2, the model wind farm scenarios result in calculated area sealing of between 0.27% (scenario 1) and 0.32% (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 N-3.8 is temporarily impaired by approx. 45 km of cabling within the wind farm, which corresponds to temporary space usage of 0.20% of the total area of N-3.8.

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 N-3.8. Therefore, according to current knowledge, no significant, cumulative impairments are expected that would endanger the marine environment with regard to the seabed and benthos.

4.12.2 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 have an impact on 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.

4.12.3 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 innovative Fauna Guard System was intensively monitored, data was analysed and the results are being evaluated in a study.

Cumulative impacts on the population of the harbour porpoise due to the erection of offshore wind turbines and the transformer station at site N-3.8 and possibly at site N-3.8, which are being tendered simultaneously, are considered in accordance with the specifications of the BMU noise control concept of the BMU 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.

4.12.4 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 II of the nature conservation area 'Sylt Outer Reef – Eastern German Bight' and species for which avoidance behaviour towards structures has already been established must be considered with regard to cumulative impacts.

When assessing the cumulative impacts of the realisation of offshore wind farms, special attention must be paid to the group of divers, including the endangered and also disturbance-sensitive species of red-throated and black-throated divers. GARTHE & HÜPPOP (2004) confirm that divers are very sensitive to structures. When considering cumulative impacts, both neighbouring wind farms and those located in the same coherent functional spatial unit defined by physically and biologically significant properties for a species must be taken into account. In addition to the structures themselves, impacts from shipping traffic (including the shipping deployed for the operation and maintenance of cables and platforms) must also be taken into account. Recent findings from studies confirm the deterrence effect on divers caused by ships. Red-throated divers and black-throated divers are among the most sensitive bird species in the German North Sea to shipping (MENDEL et al. 2019, FLIESSBACH et al. 2019, BURGER et al. 2019).

Since 2009, the BSH has carried out the qualitative assessment of cumulative impacts on divers in the context or approval procedures, in reference to the main concentration area in accordance with the BMU position paper (2009).

The definition of the main concentration area of divers in the German EEZ in the North Sea in the BMU's position paper (2009) is an important measure to ensure species protection of the disturbance-sensitive species red-throated diver and black-throated diver. The BMU decreed that under future approval procedures for offshore wind farms, the main concentration area should be used as a benchmark for the cumulative assessment of diver habitat loss.

The main concentration area takes into account the period of particular importance for the species, namely spring. Based on the data available at the time the main concentration area was defined in 2009, the main concentration area was home to around 66% of the German North Sea diver population and around 83% of the EEZ population in spring, which is why it is particularly important in terms of population biology (BMU 2009) and constitutes an important functional component of the marine environment with regard to seabirds and resting birds. In view of current population assessments, the importance of the main concentration area for divers in the German North Sea and within the EEZ has further increased (SCHWEMMER et al. 2019). The delimitation of the main concentration area of divers is based on the data situation, which is considered to be very sound, and on expert analyses which have gained broad scientific acceptance. The area includes all areas of very high density and most of the areas of high diver density in the German Bight.

Current findings from the operational monitoring of offshore wind farms and research projects unanimously show that the avoidance behaviour of divers towards offshore wind farms is far more pronounced than was anticipated in the original approval decisions for the wind farm projects (see Chapter 4.7.1). Spatial impairment in the main concentration area by offshore wind farms in the main concentration area is already greater than originally assumed (cf. BSH 2019a).

The area where site N-3.8 is located is used by divers mainly as a transit area during migration periods. According to current knowledge, this site and its surroundings lie outside of the main resting areas of divers in the German North Sea.

On the basis of the available data from research projects and monitoring of wind farm clusters, the BSH comes to the conclusion that site N-3.8 and its surroundings are not of high importance to the resting population of divers in the German North Sea. Site N-3.8 is located at a distance > 40 km from the main concentration area west of Sylt. The realisation of an offshore wind farm at site N-3.8 can therefore rule out cumulative impacts with the necessary certainty.

4.12.5 Migratory birds

The risk potential to bird migration results not only from the effects of the individual project, in this case a project at site N-3.8, but also cumulatively in connection with other approved or already constructed wind farm projects in the vicinity of site N-3.8 or in the main migration direction.

The surroundings of site N-3.8 in area N-3 have already been partially developed with wind turbines which are up to 50 m and up to 120 m lower than the turbines according to scenario 1 and 2 respectively. This creates a step effect: visibility of the higher installations is limited, as the installations can only be partially seen. This is especially true of scenario 1, as the rotating rotors will mainly be visible in this case. In scenario 2 with a hub height of 175 m, the massive nacelle will usually also be visible. The following consideration of the collision risk is based on the main migration directions north-east (spring) and south-west (autumn).

Two wind farm projects are already in operation to the west of site N-3.8. The wind turbines have a total height of 187 m. East of site N-3.8, a wind farm project is currently in the planning stage. It is expected that the turbines of this project will have similar dimensions to those of a project at site N-3.8. For site N-3.8, the above described step effect therefore occurs in spring, as the birds on their migration to the breeding areas would first encounter the lower installations before reaching N-3.8. This would not be the case in autumn, as migration would first pass over the installations of the neighbouring eastern project, which are also higher.

Under normal migratory conditions favoured by migratory birds, no evidence has been found so far for any species that the birds typically migrate in the danger zone of the installations and/or do not recognise and avoid these obstacles.

Potential hazard situations include unexpectedly occurring fog and rain, which lead to poor visibility and low flight altitudes. One particular problem is the coincidence of bad weather conditions with so-called mass migration events. According to research results obtained at the FINO1 research platform, however, this forecast could be put into perspective. It was found that birds migrate higher in very poor visibility (less than 2 km) than in medium (3 to 10 km) or good visibility (> 10 km). However, these results were based on only three measurement nights (HÜPPOP et al. 2005).

The risk of collision for birds migrating during the day and seabirds is generally considered to be low (see Chapter 4.8.1).

Cumulative impacts could also lead to an extension of the migratory route for migratory birds. The potential impairment of bird migration in the sense of a barrier effect depends on many factors, in particular the orientation of the wind farms towards the main migration directions. With the assumed main direction of movement from southwest to northeast and vice versa, the wind farms adjoining each other in this orientation in the same or another area form a uniform barrier, so a single evasive movement is sufficient. It is known that wind farms are avoided by birds, i.e. they fly around them horizontally or fly over them. In addition to observations on land, this behaviour has also been demonstrated in the offshore area (e.g. KAHLERT et al. 2004, AVITEC RESEARCH GBR 2015b). Lateral evasive reactions are apparently the most common reaction (HORCH & KELLER 2005). Evasive reactions occurred in different directions, but no reversal was detected (KAHLERT et al. 2004). AVITEC RESEARCH GBR (2015) found avoidance behaviour in ducks, gannets, auks, little gulls and black-legged kittiwakes during the long-term studies.

Site N-3.8 is located east of two wind farms already in operation, and a further project east of site N-3.8 is currently being planned. In the medium term, these projects would form a barrier of approx. 50 km to the main north-eastern or south-western direction of migration when all of them have been realised, so the diversion that may be necessary for migratory birds in the main direction of migration would be a maximum of 70 km when the original migratory route is resumed after the evasive movement. Providing migratory birds maintain their north-eastern migratory route, a further evasive reaction is possible with regard to a project located more than 50 km to the north-east in FEP area N-5, so migratory birds would have to make a diversion of approximately 20 km – in addition to the 70 km diversion already mentioned – in order to bypass the northern wind farm in area N-5.

The flight distance to cross the North Sea is sometimes several hundreds of kilometres. According to BERTHOLD (2000), the non-stop flight performance of the majority of migratory bird species is in the order of magnitude of over 1,000 km. This also applies to small birds. It is therefore unlikely that the possibly required additional energy would endanger bird migration due to a possible diversion of about 50 km.

An analysis of the knowledge available on the migratory behaviour of the various bird species, the usual flight altitudes and the distribution of bird migration over the day allows the conclusion to be drawn that, based on current knowledge, a threat to bird migration due to the construction and operation of a wind farm at site N-3.8 is unlikely to arise from the cumulative consideration of already approved offshore wind farm projects. The possible bypassing of the projects does not currently indicate a significant negative effect on the further development of the populations.

It must be taken into account that, according to the current state of science and technology, this forecast is made under assumptions that are not yet suitable for satisfactorily securing the basis for bird migration. Gaps in knowledge exist especially with regard to species-specific migration behaviour in bad weather conditions (rain, fog).

4.13 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 cause and effect relationships 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.

Sediment shift and turbidity plumes

During the construction phase of wind farms and platforms or the laying of a submarine cable system, sediment shifting and turbidity plumes 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.

Noise pollution

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. At present, there is still a lack of empirical values and data to assess possible interactions caused by such indirect operation-related noise emissions.

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, benthic-eating seabirds in deeper water areas are not affected by the loss of feeding areas due to area sealing, as the water is too deep for effective food acquisition.

Insertion of artificial hard substrate

The insertion of artificial or exogenous hard substrate (platform foundations, cable crossing structures) leads locally to a change in soil and sediment conditions. As a result, the composition of macrozoobenthos can change. According to KNUST et al (2003), the insertion of artificial hard substrate into sandy soils leads to the colonisation of additional species. 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 sandy soil communities by non-native species is low. However, settlement areas of the sandy soil fauna are lost at these points. 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).

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).

Prohibition of use and shipping

A fishing ban is expected to be imposed within the wind farms. The resulting discontinuation of fishing can lead to an increase in the population of both target fish species and non-utilised fish species, and a shift in the length spectrum of these fish species is also conceivable. If fish populations increase, the food supply for marine mammals 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 and the complexity of the food web and material cycles, interactions can only be described very imprecisely overall. In principle, the SEA concludes that, according to current knowledge, no significant effects on existing interactions are discernible that might endanger the marine environment when the plan is implemented.

4.14 Transboundary effects

As things stand at present, site N-3.8 has no significant impact on the areas of neighbouring countries bordering on the German EEZ in the North Sea.

Transboundary environmental impacts are defined pursuant to section 2(3) UVPG as environmental impacts in another country.

Whether the development of site N-3.8 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.

Following the assumptions made in the agreement on the implementation of cross-border participation between Germany and the Netherlands ('Joint Declaration on Cooperation in the Conducting of Transboundary Environmental Impact Assessments and Transboundary Strategic Environmental Assessments in the Dutch-German Border Area between the Ministry of Infrastructure and the Environment of the Netherlands and the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety of the Federal Republic of Germany' 2013), which distinguishes between projects located up to 5 km from the border and those located beyond this distance, impacts are more likely to occur in close proximity.

Site N-3.8 is located centrally in the German EEZ in the North Sea. The distance to the Dutch EEZ is at least 47 km. Denmark (or the Danish EEZ) is even further away, at least 126 km. For this reason, local impacts on benthos, soil or biotopes in 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.

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.

As shown above, no significant impacts on the protected objects of air and water or on the climate are to be expected.

Possible significant transboundary effects could at most 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. According to the above impact forecasts for the individual protected objects, however, this is not the case.

With regard to fish as a protected object, the SEA comes to the conclusion that, according to current knowledge, no significant impacts on the protected object are to be expected from site N-3.8, since on the one hand the area does not have a prominent function for the fish fauna and on the other hand the recognisable and predictable effects are of a small-scale and temporary nature. This also rules out transboundary effects.

According to current knowledge and taking into account impact-minimising and damage-limiting measures, significant (transboundary) effects can also be ruled out for the protected marine mammal species. For example, the installation of the foundations of wind turbines and the transformer platform is only permitted with the use of effective noise reduction measures.

For seabirds and resting birds, the distance to the Dutch or Danish border means that significant transboundary effects can also be ruled out with the necessary certainty.

Bird migration over the North Sea takes place over a broad, non-delimitable front with a tendency towards coastal orientation. Guidelines and fixed migration paths are not yet known. The individual species-specific analysis (Chapter 4.8.1) did not reveal any significant impacts. An examination of the available knowledge on the migratory behaviour of the various bird species, the usual flight altitudes and the distribution of bird migration over the day allows the conclusion to be drawn that, based on current knowledge, a threat to bird migration due to the construction and operation of a wind farm at site N-3.8 is unlikely to arise from the cumulative consideration of already approved offshore wind farm projects, although more knowledge of species-specific migratory behaviour is still needed. As a result, significant transboundary effects are also considered unlikely.

Migratory movements of bats across the North Sea are still scarcely documented and largely unexplored. There is a lack of concrete information on migratory species, migratory corridors, migratory heights and concentrations. Previous evidence only confirms that bats fly over the North Sea, especially long-distance migratory species. A technically comprehensible assessment of possible impacts, including transboundary effects, is therefore not possible at this stage. It is expected that any adverse impacts can be prevented and reduced by the same measures used to protect bird migration. In addition, reference is made to the results of the impact forecasts for the individual protected objects in Chapter 4.8.1.

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 biotic community refers to a community of organisms of different species in a definable habitat (Schütte/ Gerbig in Schlacke-GK, BNatSchG section 7, margin note 36). For Germany, 764 biotope types are distinguished (Hendrischke/ Kieß in Schlacke GK, BNatSchG section 30, margin note 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, margin note 8).

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 marine 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 N-3.8.

In the geological studies of the area carried out as part of the site investigations, 35 objects were recorded at site N-3.8 in addition to a very homogeneous sediment composition. For ten of these objects, the possible presence of marine erratic boulders as defined in the reef mapping instructions of the BfN cannot be examined until further investigations are completed which are currently in progress.

If, after final evaluation of the objects identified in the course of the preliminary geological offshore site investigation, there are indications of the presence of legally protected biotopes at site N-3.8, these will be taken into account accordingly in the suitability assessment.

5.3 Result of the assessment

Since no biotopes protected in accordance with section 30 BNatSchG occur at site N-3.8 according to current knowledge, significant impairments of legally protected biotopes within the meaning of section 30(2) BNatSchG must be ruled out.

6 Assessment under species protection law

When implementing the plan for 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 (Gellermann in Landmann/Rohmer BNatSchG section 44 margin note 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. A distinction is neither drawn as to whether a relevant damage or disturbance is based on reasonable grounds, nor if motives, inducements or subjective tendencies play a role in meeting the criteria of the bans (GELLERMANN IN LANDMANN/ROHMER BNATSCHG SECTION 44 MARGINAL NOTE 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, a disturbance applies within the meaning of Article 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 document BT 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 OVG Berlin 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 (GELLERMANN IN LANDMANN/ROHMER BNATSCHG SECTION 44 MARGINAL NOTE 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 margin note 258) or the existence of low-disturbance alternative areas which can be used by the animals (GELLERMANN IN LANDMANN/ROHMER BNATSCHG SECTION 44 MARGINAL NOTE 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 N-3.8 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 N-3.8 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 N-3, which also includes site N-3.8, 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)

Under section 44(1) (1) BNatSchG, the killing or injury of wild animals of specially protected species, i.e. including animals listed in Annex IV to 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 accordance with the draft of 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 section 44 marginal note 3),

by means of which the violation of the prohibition can be excluded and the intensity of any impairments can be reduced. 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 summary, the above-mentioned reduction and prevention measures make it possible to rule out the criteria for the ban on killing being met. The use of appropriate deterrent measures will ensure that the animals are outside the 750-metre area around the point of emission. In addition, the required degree of noise mitigation specified in the draft suitability determination means that it can be assumed that outside this area no lethal and no long-term impairing noise emissions will occur.

The measures specified by the BSH 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 installations nor the laying and operation of the internal cabling 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 North 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 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 determination of suitability, based on subsequent orders in the individual BSH approval procedure, and taking into account the specifications from the noise control concept (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 draft 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.

As outlined above, aversive measures and a 'soft-start' procedure must 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 current study commissioned by the BMU (BELLMANN, 2020) 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 N-3.8, 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 (section 8(4)).

Suitable monitoring is also specified for the operating phase of the individual project at site N-3.8 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-3.8 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 N-3.8 and its surroundings. 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).

Site N-3.8 and its surroundings are of no particular importance for harbour seals and grey seals. The nearest frequently used breeding and resting sites are located more than 60 km from Heligoland and more than 30 km from the East Frisian Islands.

According to the current state of knowledge, the laying and operation of the internal wind farm cabling will not cause any disturbance to marine mammals relevant under species protection law pursuant to section 44(1)(2) BNatschG.

6.3 Avifauna (seabirds, resting and migratory birds)

The suitability of site N-3.7 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).

The area around site N-3.8 is home to protected bird species listed in Annex I of the Birds Directive (in particular red-throated diver, black-throated diver, little gull, sandwich tern, common and Arctic tern) and regularly occurring migratory bird species (in particular petrel and lesser black-backed gull, fulmar, northern gannet, black-kegged kittiwake, guillemot and razorbill) 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 N-3.8 and its surroundings are of medium importance for seabirds, including species listed in Annex I of the Birds Directive. Site N-3.8 lies outside the concentration centres of various bird species listed in Annex I of the Directive such as divers, little gulls and terns.

Site N-3.8 and its surroundings are of average to above-average importance for migratory bird species. It is expected that significant numbers of songbirds breeding in northern Europe migrate across the North Sea. However, guidelines and concentration areas for bird migration do not exist in the EEZ. There is evidence that the intensity of migration decreases with the distance from the coast.

6.3.1 Section 44(1)(1) BNatSchG (prohibition of killing and injury)

Pursuant to section 44(1)(1) BNatSchG in combination with Art. 5 of the Birds Directive, it is prohibited to hunt, capture, injure or kill wild animals of specially protected species. Species of special protection include European bird species: the aim is to protect species listed in Annex I of the Birds Directive, species whose habitats and habitats are protected in nature conservation areas, as well as characteristic species and regularly occurring migratory bird species (in particular the common gull and lesser black-backed gull, fulmar, northern gannet, black-legged kittiwake, guillemot and razorbill). Accordingly, the injury or killing of resting birds as a result of collisions with wind turbines must be ruled out as a matter of principle. The risk of collision depends on the behaviour of the individual animals and is directly related to the species and environmental conditions involved. For example, the collision of divers is not to be expected due to their pronounced avoidance behaviour towards vertical obstacles.

As already explained, pursuant to section 44(5)(2)(1) BNatSchG, there is no infringement of the prohibition on killing and injury '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.' This exception was included in BNatSchG based on corresponding high court rulings, since in the planning and approval of public infrastructure and private construction projects, it must regularly be assumed that unavoidable operational fatalities or injuries of specific individuals (e.g. through collision of birds with wind turbines) may occur; however, as the realisation of socially acceptable risks, these should not fall within the scope of the prohibition (Bundestag document BT Printed Document. 16/5100, p. 11 and 16/12274, p. 70 f.). An attribution is only made if the risk of success of the project is significantly increased due to special circumstances, such as the construction of the installations, the topographical conditions or the biology of the species. Risk avoidance and reduction measures must be included in the assessment (cf. HEUGEL, SECTION 44 BNATSCHG, MARGINAL NOTE 8; Federal Administrative Court (BVerwG), judgement of 12 March 2008; Ref. 9 A3.06; Federal Administrative Court (BVerwG), judgement of 9 July 2008, Ref. 9 A14.07, Lau in Frenz/Müggenborg, BNatSchG section 44, marginal note 14.

In its statements, the BfN regularly states that the changes in technical size parameters of the wind turbines in current offshore wind farm projects, compared to realisation from 2011 to 2014, generally result in an increase in vertical obstacles in the airspace. However, according to current knowledge, an increased risk of bird strikes cannot be quantified by the simultaneous reduction in the number of installations. It is true that collision-related individual losses cannot be completely ruled out due to the construction of a fixed installation in previously obstacle-free areas. However, the measures ordered such as minimisation of light emissions, ensure that a collision with offshore wind turbines is avoided as far as possible or at least that this risk is minimised. In addition, effect monitoring is to be carried out during the operating phase in order to verify the current nature conservation assessment of the actual risk of bird strike posed by the installations and, if necessary, to make adjustments. According to the provisions of WindSeeG, ordering further measures is possible within the framework of the planning approval and also later during implementation. In view of this, the BSH is of the opinion that there is no reason to fear a significant increase in the risk of killing or injury to migratory birds. The realisation of offshore wind turbines together with ancillary installations such as a transformer station and internal cabling therefore does not violate the prohibition of killing and injury pursuant to section 44(1)(1) BNatSchG. The BfN came to the same conclusion in its statement in the context of the preparation of the 2019 Site Development Plan.

According to current knowledge, a site-related significantly increased risk of collision of individual resting bird species at site N-3.8 is not discernible.

It is therefore not to be assumed that the prohibition of killing and injury of section 44(1)(1) BNatSchG will be implemented in the context of offshore wind energy use at site N-3.8.

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.

The assessment under species protection law pursuant to section 44(1)(2) BNatSchG relates to population-relevant disturbances of local populations. 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 N-3.8. 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 (BSH 2019a). The following is a brief summary of the results of the assessment under species protection law of the Site Development Plan (BSH 2019c) in terms of section 44(1)(2) BNatSchG.

Summary of the assessment under species protection law in accordance with section 44(1)(2) BNatSchG (prohibition of disturbance) for the FEP (BSH 2019)

The focus of the assessment was on the group of divers, which, based on the results of the operational monitoring of offshore wind farms in the German EEZ, research projects and published technical literature, has been shown to be particularly sensitive to disturbance from wind farms.

The assessment found that divers are highly sensitive in population biology terms, that the main concentration area is of high importance in terms of the conservation of the local population, and that the adverse effects of their avoidance behaviour towards offshore wind farms are intense and lasting.

To avoid the deterioration of the conservation status of the local population due to the cumulative impacts of the wind farms, the main concentration area currently available to divers outside of the impact zones of previously implemented wind farms must be kept free of new wind farm projects.

The BSH concluded that a significant disturbance within the meaning of section 44(1)(2) BNatSchG can be ruled out with the necessary certainty as a result of the implementation of the plan (FEP) if it is ensured that no additional habitat loss will occur in the main concentration area.

As a result, based on the results of the assessment of the cumulative adverse impacts on the conservation status of the local population of divers, area N-5.4 was excluded from further planning for offshore wind turbines and areas N-4 and N-5 were placed under review for subsequent use.

For areas N-1 to N-3, N-6 to N-13, the assessment in accordance with section 44(1)(2) BNatSchG came to the conclusion that, based on current knowledge, it cannot be assumed that the criteria for a disturbance violation are met, which also applies to other species listed in Annex I of the Birds Directive as well as to characteristic species and regularly occurring migratory bird species.

Assessment under species protection law pursuant to section 44(1)(2) BNatSchG for site N-3.8

The result of the assessment within the framework of the preparation of the FEP (BSH 2019a) can be confirmed based on the available data and information for site N-3.8.

Site N-3.8 and its surroundings are home to protected species, as explained above. These include species listed in Annex I of the Birds Directive, species whose habitats and living spaces are protected in nature conservation areas, as well as characteristic species and regularly occurring migratory bird species (in particular the common gull and lesser black-backed gull, fulmar, northern gannet, black-legged kittiwake, guillemot and razorbill). In view of this, compatibility of the use of wind energy at site N-3.8 with section 44(1)(2) BNatSchG in combination with Art. 5 of the Birds Directive must be ensured.

The area where site N-3.8 is located is used by divers mainly as a transit area during migration periods. According to current knowledge, this area and its surroundings lie outside the main concentration area of divers identified in the German Bight. Based on the data available from research projects and monitoring of wind farm clusters, the BSH comes to the conclusion that site N-3.8 and its surroundings are not of high importance to the resting population of divers in the German North Sea. Site N-3.8 is located at a distance of more than 40 km from the main concentration area of divers. In this respect, no disturbance of the local population can be assumed.

Due to the relatively low densities of little gulls observed in the vicinity of site N-3.8 and the temporally limited association with species-specific main migration times, it can be assumed that the environment of site N-3.8 is of low to at most medium importance for little gulls. Determined maximum densities are subject to interannual fluctuations. Cumulative impacts on the population are not expected based on current knowledge. With regard to little gulls, it is not assumed based on current knowledge that a wind farm project at site N-3.8 fulfils the criteria for disturbance in accordance with section 44(1)(2) BNatSchG.

Based on the available knowledge on the occurrence of terns in the vicinity of site N-3.8, the BSH does not assume, according to current knowledge, a disturbance of the tern population resulting from an offshore wind farm project at site N-3.8. Previous findings from the cluster studies on 'North of Borkum' indicate that wind farm areas are partly avoided, but this avoidance does not extend beyond the boundaries of a wind farm. In addition, terns use the indirect surroundings of site N-3.8 only as a transit area during migration periods. According to current knowledge, it cannot therefore be assumed that the criteria for disturbance in accordance with section 44(1)(2) BNatSchG are fulfilled.

Based on current knowledge, no significant impact on the population of guillemots and razorbills caused by an offshore wind farm at site N-3.8 is expected due to the large total population and the large geographical spread. Finally, according to current knowledge, it is not assumed that an offshore wind farm at site N-3.8 fulfils the criteria for a disturbance in accordance with section 44(1)(2) BNatSchG.

Little is known so far about the fulmar’s reactions to offshore wind farms under construction or in operation, as generally low sighting rates and insufficient data do not allow for reliable statements to be made. Experts assume that fulmars are very insensitive to disturbances from wind farms. Based on current knowledge, no significant effects on the population of the fulmar are expected from an offshore wind farm at site N-3.8.

For northern gannets there are some statistically insignificant studies which suggest potential avoidance behaviour towards wind turbines. Clear statements are frequently not possible due to the increased mobility of the species and, like the fulmar, low sighting rates and small samples.

In view of the low, interannually fluctuating occurrence of the northern gannet, site N-3.8 is not very important as a resting and feeding area. Based on current knowledge, no significant impact on the population of the northern gannet is expected from an offshore wind farm at site N-3.8.

Among the gulls, the common gull and black-legged kittiwake have an unfavourable conservation status, but in general, offshore wind turbines seem to attract the majority of gull species. They are also known as prominent ship followers. Based on current knowledge, no significant effects on the population of either of these species are to be expected from an offshore wind farm at site N-3.8. In conclusion, the construction and operation of offshore wind turbines and ancillary installations (transformer station, internal cabling of the wind farm) at site N-3.8 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 N-3.8, 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

Migratory movements of bats across the North Sea are still scarcely documented and largely unexplored. There is a lack of concrete information on migratory species, migratory corridors, migratory heights and concentrations. Previous evidence only confirms that bats fly over the North Sea, especially long-distance migratory species.

6.4.1 Section 44(1)(1) and (2) BNatSchG

In Germany, 25 bat species are currently listed in Annex IV of the Habitats Directive and are therefore strictly protected in accordance with section 7(1)(14) BNatSchG. The risk of isolated collisions with wind turbines cannot be ruled out according to expert knowledge. In terms of species protection law, the same considerations apply in principle as those already set out in the assessment of avifauna. Collision with offshore structures does not constitute intentional killing. Here, explicit reference can be made to the guidance document on the strict system of protection for animal species of Community interest under the Habitats Directive, which assumes in II.3.6 margin note 83 that the killing of bats constitutes unintentional killing which must be continuously monitored pursuant to Art. 12(4) of the Habitats Directive.

Experiences and results from research projects or from wind farms already in operation will also be adequately considered in further procedures.

The data available for the EEZ in the North Sea are fragmentary, and insufficient data are available to allow conclusions to be drawn about the migratory movements of bats. It is not possible, on the basis of existing data, to obtain specific knowledge about migratory species, migratory directions, migratory altitudes, migratory corridors and possible concentration ranges. Information available to date confirms merely that bats, especially species that travel long distances, fly over the North Sea.

However, it is expected that any adverse effects of wind turbines on bats can be countered by the same prevention and mitigation measures that are designed to protect bird migration.

According to current knowledge, the construction and operation of offshore wind turbines and ancillary installations (transformer station, cabling within the wind farm) at site N-3.8 are not expected to result in either killing and injury 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/territorial protection law assessment

As part of this SEA for determining the suitability of site N-3.8 for offshore wind energy use, an assessment is made of its compatibility with the protection purposes of nature conservation areas. The impact assessment of site N-3.8 carried out here is based on the results of the impact assessment for areas and sites of the FEP (BSH 2019c) and takes into account current findings without replacing the corresponding assessment at the level of the planning approval procedure. 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 the planning approval procedure and taking into account the design of the project in order to exclude any impairment of the conservation objectives of the conservation areas arising from use inside or outside a nature conservation area.

7.1 Legal basis

According to section 36 in conjunction with 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 site 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 N-3.8 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 N-3.8 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 FFH 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 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 North 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, 2019a).

In principle, the construction of artificial installations and structures in nature conservation areas is prohibited. Also pursuant to section 5(3(5)(a), 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” (GELLERMANN IN LANDMANN/ROHMER UMWELTR, section 34 BNatSchG, margin note 10.) (cf. for example section 5(4) NSGBRgV– Ordinance on the Designation of the “Borkum Reef Ground” Nature Conservation Area). 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 (cf. also section 5(2) and (4) NSGBRgV). The protection purposes result from the ordinances on conservation areas or other stipulations.

The German EEZ in the North Sea contains the nature conservation areas 'Sylt Outer Reef – Eastern German Bight' (Ordinance on the Designation of the 'Sylt Outer Reef – Eastern German Bight' Nature Conservation Area of 22 September 2017 (NSGSylV)), 'Borkum Reef Ground' (Ordinance on the Designation of the 'Borkum Reef Ground' Nature Conservation Area of 22 September 2017 (NSGBRgV)) and 'Dogger Bank' (Ordinance on the Designation of the 'Dogger Bank' Nature Conservation Area of 22 September 2017 (NSGDgbV)).

Accordingly, the habitat types 'reef' (EU code 1170) and 'sandbank' (EU code 1110) according to Annex I of the Habitats Directive with their characteristic and endangered biocoenoses and species, as well as protected species, specifically fish (river lamprey, twait shad), marine mammals according to Annex II of the Habitats Directive (harbour porpoise), grey seal and harbour seal), as well as protected bird species listed in Annex I of the Birds Directive (in particular red-throated diver, black-throated diver, little gull, Arctic tern, common tern and Arctic tern) and regularly occurring migratory bird species (in particular petrel and lesser black-backed gull, fulmar, northern gannet, black-legged kittiwake, guillemot and razorbill) are to be analysed within the framework of the impact assessment.

The nature conservation area 'Borkum Reef Ground' with a surface area of 625 km^2 is the closest to site N-3.8 in the German EEZ. The shortest distance of site N-3.8 to the nature conservation area is 20.4 km.

The 'Lower Saxony Wadden Sea National Park' FFH area (EU code) is also located 21.7 km from site N-3.8: DE 2306-301, Law on the Lower Saxony Wadden Sea National Park of 11 July 2001 (NWattNPG)) in the territorial sea. The FFH area in the territorial sea was already included in the list of Sites of Community Importance (SCI) in the Atlantic biogeographic region pursuant to Article 4(2) of the Habitats Directive by a decision of the European Commission of 7 December 2004 (Official Journal of the EU, 29 December 2004, L387/1).

The nature conservation area 'Sylt Outer Reef – Eastern German Bight' has a surface area of 5,603 m^2 and is located in the southern North Sea. The shortest distance to site N-3.8 is 51.2 km.

The nature conservation area 'Dogger Bank' has a surface area of 1,692 m^2 and is located in the so-called 'Duck's Bill' area of the German EEZ. The shortest distance to site N-3.8 is 215.5 km.

The impact assessment also considers possible remote effects on these two conservation areas in the German EEZ and conservation areas in the adjacent waters of neighbouring countries.

7.2 Impact assessment with regard to habitat types

The conservation or, where necessary, the restoration to a favourable conservation status of the habitat types "sandbanks with only weak permanent inundation by seawater" and "reefs" is the protective purpose of area I of the nature conservation area "Sylt Outer Reef – Eastern German Bight" under section 4(1)(1) NSGSylV and also the protective purpose of the nature conservation area "Borkum Reef Ground" under section 3(3)(1) NSGBRgV. 'Sandbanks' are also protected pursuant to section 3(3)(1) NSGDgbV in the 'Dogger Bank' nature conservation area and are value-determining habitat types in the 'Lower Saxony Wadden Sea National Park' in the territorial sea.

Due to the shortest distance from site N-3.8 of at least 20.4 km to the nature conservation area 'Borkum Reef Ground' in the German EEZ and of 21.7 km to the 'Lower Saxony Wadden Sea National Park' FFH area in the territorial sea, construction-related, installation-related and operation-related impacts on the FFH habitat types 'reef' and 'sandbank' in the 'Borkum Reef Ground' nature conservation area and the FFH habitat types in the 'Lower Saxony Wadden Sea National Park' with their characteristic and endangered communities and species can be ruled out. The distance of site N-3.8 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 FFH area components relevant to the conservation objectives or the protection purpose.

7.3 Impact assessment with regard to protected species

7.3.1 Protected marine mammal species

7.3.1.1 Impact assessment according to section 34 (1) BNatSchG in conjunction with Article 6(3) of the FFH Directive and section 5 (6) the Ordinance on the Designation of the "Borkum Reef Ground" Nature Conservation Area

Under section 34 (1) BNatSchG in conjunction with section 5 (1), (4) and (6) NSGBRgV, projects and plans must be examined for their compatibility with the conservation objectives of a conservation area before they are approved or implemented if, either individually or in conjunction with other projects or plans, they are likely to have a significant impact on the nature conservation area.

The assessment of the impacts of the realisation of offshore wind turbines together with ancillary installations at site N-3.8 is based on the protection purposes of the nearest conservation area in the German EEZ 'Borkum Reef Ground'. In accordance with section 3(1) NSGBRgV, the purpose of protection is to achieve the conservation objectives of the Natura 2000 area. Pursuant to section 3(2)(3) in combination with para. 2 NSGBRgV, the conservation and restoration of the area's specific ecological values and functions, in particular the populations of harbour porpoise and harbour seal, as well as their habitats and natural population dynamics, must be protected.

According to section 3 para. 5 nos. 1–5 NSGBRgV, the conservation and restoration of the mammal species mentioned are necessary for their protection:

- No.1: the natural population densities of these species, with the aim of achieving a favourable conservation status, their natural spatial and temporal distribution, health status and reproductive fitness, taking into account natural population dynamics and genetic exchanges with populations outside the area,

- No. 2: the area as a largely undisturbed habitat, unaffected by local pollution, of the species of marine mammals referred to in para. 3(2) and in particular as a habitat of supra-regional importance for harbour porpoises in the East Frisian Wadden Sea area,
- No. 3: unfragmented habitats and the possibility of migration of the species of marine mammals referred to in para. 3(2) NSGBRgV within and in particular to neighbouring conservation areas of the Wadden Sea and off Heligoland,
- No. 4: the essential food sources of the species of marine mammals referred to in para. 3(2) NSGBRgV, in particular natural population densities, age-group distributions and distribution patterns of the organisms serving as food sources for these marine species of marine mammals, and

Site N-3.8 is located within area N-3 of the Site Development Plan (BSH 2019c) in the German EEZ in the North Sea. The shortest distance to the nature conservation area 'Borkum Reef Ground' is 20.4 km

The FEP (BSH 2019c) has defined 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 has shown that the construction and operation of offshore wind turbines and platforms in area N-3 will not have a significant adverse impact on marine mammals.

In this assessment, possible impacts from the construction and operation of offshore wind turbines at the specific site N-3.8 and in interaction with the existing wind turbines at the neighbouring offshore wind farms “NordseeOne”, “GodeWind01” and “GodeWind02” as well as with the planned wind turbines in site N-3.7 and at the offshore wind farm “GodeWind03” were taken into account.

The assessment showed that noise from pile driving during the installation of foundations for offshore wind turbines and platforms can have a significant impact on marine mammals, in particular harbour porpoises, if no noise control measures are taken. The exclusion of significant impacts, in particular from disturbance of the local population and the population of the species concerned, requires the implementation of strict noise control measures. The determination of the suitability of site N-3.8 will include a number of specifications in this regard. Within the framework of the assessment under species protection law, noise control measures were also described in accordance with the scientific and technological state of the art, the application of which, according to current knowledge, rules out any significant disturbance of the population at site N-3.8, in its surroundings and in the German EEZ in the North Sea. In 2008, the BSH introduced regulations in its approval notices that include binding limits for impulse-based noise pollution from pile driving. The introduction of mandatory limits is based on findings on the triggering of temporary hearing threshold shifts in harbour porpoises (Lucke et al., 2008, 2009). Compliance with the limits (160 dB single Sound Exposure Level (SEL05) re 1µPa^{2}s and 190 dB re 1µPa at a distance of 750 m is monitored by the BSH by applying standardised measurement and evaluation methods. Additional noise control measures with regard to the coordination of parallel pile driving and to reduce the impact on nature conservation areas are also derived from the noise control concept (BMU 2013), are designed within the context of the suitability assessment and are adapted, ordered and strictly monitored in the individual approval procedures by the BSH, adapted to site-specific and project-specific characteristics. Since 2011, all pile driving work in German waters of the North and Baltic Sea has been carried out using noise reduction systems. The monitoring of the noise control measures has shown that they have been very effective since 2014, so a significant disturbance of the populations and any consequent impact on the local population in the German EEZ in the North Sea can be ruled out.

An impairment of the protection purposes of the nature conservation area 'Borkum Reef Ground' as a result of the erection and operation of offshore wind energy turbines together with the cabling within the wind farm at site N-3.8 can be excluded with the required degree of certainty, taking into account the specifications from the draft of the suitability determination and the instructions from the planning approval decision.

However, at this stage the assessment cannot take into account the design of the installations and the construction process. For this reason, an update of the impact assessment is required within the framework of the subsequent planning approval procedure in which site-specific and project-specific characteristics of the installations are additionally examined and suitable protection measures are ordered if necessary.

7.3.1.2 Impact assessment pursuant to section 34(1) BNatSchG in combination with Article 6(3) of the Habitats Directive with regard to the 'Lower Saxony Wadden Sea National Park' FFH area

The same applies to the FFH area 'Lower Saxony Wadden Sea National Park'. According to the standard data sheet, the species harbour porpoise and harbour seal are also to be found in this area in addition to the habitat types 'reef' (EU code 1170) and 'sandbank' (EU code 1110) based on the current state of scientific knowledge (Official Journal of the European Communities 2011, No. L 107/4, DE 2306-301, update of 08/2011). However, the shortest distance to site N-3.8 is more than 21 km, so if the noise control measures are complied with, significant impairment within the meaning of section 34 BNatSchG can be ruled out here as well. Accordingly, the construction of offshore wind turbines at site N-3.8 is not likely to significantly compromise the conservation objectives relating to this FFH area.

7.3.1.3 Requirement of an impact assessment pursuant to section 34(1) BNatSchG in combination with Article 6(3) of the Habitats Directive with regard to the 'Sylt Outer Reef – Eastern German Bight' and 'Dogger Bank' habitat areas

An impact assessment of the implementation of offshore wind energy use at site N-3.8 pursuant to section 34 BNatSchG in connection with the protection purposes of the nature conservation areas 'Sylt Outer Reef – Eastern German Bight' and 'Dogger Bank' with regard to marine mammals is not necessary due to the large distance (>50 km) of the site from the nature conservation areas.

7.3.1.4 Result

In the final analysis, a significant impairment of the protection purposes of the nature conservation areas in the German EEZ 'Borkum Reef Ground', 'Sylt Outer Reef – Eastern German Bight', 'Dogger Bank' and 'Lower Saxony Wadden Sea National Park' in the territorial sea in relation to marine mammals as a result of the construction and operation of offshore wind turbines at site N-3.8 can be ruled out with the necessary certainty, taking into account noise control specifications.

7.3.2 Protected bird species

7.3.2.1 Assessment of impact based on the protection purposes and conservation objectives of area II of the nature conservation area 'Sylt Outer Reef – Eastern German Bight' with regard to avifauna – long-distance effects

Pursuant to section 5(1)(1) NSGSylV, the conservation or, where necessary, restoration to a favourable conservation status, of bird species listed in Annex I of the Birds Directive and migratory bird species that regularly occur in this area is among the protection purposes of the nature conservation area.

Under section 5(1)(1) SGNSylV, the species red-throated diver (*Gavia stellata*, EU code A001) and black-throated diver (*Gavia Arctica*, EU code A002) are mentioned, among others.

The ordinance then sets objectives for area II under section 5(2)(1) to (4) SGNSylV to ensure the conservation and restoration of the bird species listed in section 5(1) SGNSylV and the functions of area II pursuant to (1).

Conservation and restoration of the following:

- No.1: qualitative and quantitative populations of bird species with the aim of achieving a favourable conservation status, taking into account natural population dynamics and population trends; special attention must be paid to bird species with negative trends in their biogeographic population,
- No. 2: the main organisms serving as food sources for bird species, particularly their natural population densities, age-group distributions and distribution patterns,
- No.3: increased biological productivity at the vertical front formations, as is characteristic of the area, and the geomorphological and hydromorphological characteristics with their species-specific ecological functions and effects, and
- No.4: the natural quality of habitats with their respective species-specific ecological functions, their non-fragmentation and spatial interrelationships, and unimpeded access to adjacent and neighbouring marine areas.

According to current knowledge, site N-3.8 is of no significance with regard to the occurrence of protected bird species in area II of the nature conservation area 'Sylt Outer Reef – Eastern German Bight' due to its distance.

A significant impairment of the protection purposes and conservation objectives of area II of the nature conservation area 'Sylt Outer Reef – Eastern German Bight' as a result of the implementation of offshore wind energy use at site N-3.8 can be ruled out due to the distance.

7.3.3 Other species

Pursuant to section 3(3)(2) NSGBRgV, the conservation objectives pursued in the nature conservation area include the maintenance or, where necessary, the restoration of the twait shad *(Alosa fallax*, EU code 1103) to a favourable conservation status as a species in accordance with Annex II of the Habitats Directive.

Pursuant to section 2(3) in connection with Annex 5 NWattNPG, the areas of the national park also serve to maintain or restore a favourable conservation status of the twait shad, river lamprey *(Lampetra fluviatilis*) and sea lamprey *(Petromyzon marinus*).

However, due to the shortest distance from site N-3.7 of at least 20.4 km to the nature conservation area 'Borkum Reef Ground' in the German EEZ and 21.7 km to the FFH area 'Lower Saxony Wadden Sea National Park' in the territorial sea, construction-related, installation-related and operation-related impacts on these species or their conservation status in the nature conservation area can be ruled out.

7.4 Results of the impact assessment

In the final analysis, a significant impairment of the protection purposes of the nature conservation areas “Borkum Reef Ground”, the protection purposes of the nature conservation area “Sylt Outer Reef – Eastern German Bight”, the protection purposes of the nature conservation area “Dogger Bank”, the protection purposes of the FFH area “Lower Saxon Wadden Sea National Park” and the conservation areas outside the German EEZ can be ruled out with the necessary certainty in the implementation of the FEP plan and, taking into account avoidance and mitigation measures for FHH habitat types, marine mammals, avifauna and other groups of animals protected under the FFH.

It should be noted that the FFH impact assessment carried out here was not able to consider project-specific properties which will only be specified and determined by project developers in the course of planning approval procedures. For this reason, the impact assessment is carried out in the context of planning approval procedures for the respective project in a more concrete manner, with the aim of deriving and defining the necessary avoidance and mitigation measures at project level.

Based on current knowledge, significant impairment of the FFH habitat types 'reefs' and 'sandbanks with only weak permanent inundation by seawater' can be ruled out even if the plan and existing projects for the nature conservation areas 'Borkum Reef Ground', 'Sylt Outer Reef – Eastern German Bight' and 'Dogger Bank' as well as for the 'Lower Saxony Wadden Sea National Park' in the territorial sea are considered cumulatively, firstly due to the limited spatial effects and secondly due to the distances from the respective areas.

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. By strictly adhering to avoidance and reduction measures, in particular to reduce noise in the construction phase and the avoidance of light emissions, significant impacts can be avoided in the implementation of a project at the site.

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. On the basis of the above descriptions and assessments, the Strategic Environmental Assessment concludes, also with regard to possible interactions, that, according to current knowledge and at the comparatively more abstract level of spatial offshore grid planning, no significant impacts on the marine environment within the area under investigation are to be expected from the construction and operation of an offshore wind farm at site N-3.8. 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 in the context of downstream planning stages.

9 Planned 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.

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 draft of 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 the FEP (BSH 2019a), 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 N-3.8, 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 9.

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 433 MW at site N-3.8 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' (HOPPE 2018), 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 1.5.6.3.

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 9.

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 N-3.8, as corresponding impairments can be excluded by specifications in accordance with the draft of the suitability determination. 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 1.5.6.3 and applied to site N-3.8.

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: 42 installations, as compared to scenario 2: 25 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 1.5.6.3, 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.

Suction bucket, vibro pile and gravity foundation are discussed as conceivable alternatives for the foundation of installations. Bored piles, on the other hand, are out of the question for use in the sandy soils of the German EEZ in the North Sea, as the necessary drilling fluid in the porous sandy soil cannot be retained in the borehole.

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 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.

For example, the different types of foundations cannot be compared with regard to their noise emissions during construction and operation, as there is a lack of knowledge about both noise emissions involved in construction and continuous noise during operation. It is therefore not possible to assess the possible impact of the foundation alternatives on the marine environment. This applies to the use of vibration hammers, for example, as well as to so-called suction buckets. Only gravity foundations, if they can be installed without sheet piling, can potentially be described as low-noise. However, significant other effects of gravity foundations, such as the sealing of large areas and the associated change in the functions of the seabed, would then also have to be assessed with regard to environmental compatibility. Again, insufficient information is available.

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 N-3.8. 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. The procedure envisaged for this purpose, the planned measures for monitoring the potential impacts of the plans and the required data are described in the environmental report on the Site Development Plan for the German North Sea in Chapter 10 (particularly in Chapter 10.1 on the potential impacts of areas and sites for offshore wind turbines) (BSH 2019a).

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. 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 N-3.8, 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.

In addition to the basic determination of suitability and the capacity to be installed, the statutory ordinance to be issued based on a positive suitability assessment contains specifications for the project at the site if suitability would otherwise have to be denied due to impairments of the marine environment or other concerns 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 (BSH 2017) and the FEP (BSH 2019c) 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
- Seabirds and resting birds
- Migratory birds
- Bats
- Biological diversity
- Air
- 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 of the individual protected objects

12.3.1 Soil/ground

The surface sediments at site N-3.8 show a homogeneous sediment composition and a largely structureless seabed. It is a typical fine sand area, as found in almost the entire North 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. 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. 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.

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

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. However, these impacts on water as a protected object are not significant because they occur only within a small area or for a short period of time. Project-related emissions are prevented by specifying avoidance and reduction measures.

12.3.3 Biotope types

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

Due to the predominant sediment composition, impairments caused by covering are likely to be limited in space and temporary, as the released sediment will settle quickly. Permanent habitat changes are limited to the immediate area of the foundations and crossing structures for cable crossings. The required cable crossings are secured with a stone fill which permanently constitutes a hard substrate that is exogenous to the location. This provides new habitats for benthic organisms that love hard substrates and can lead to a change in the species composition. These small-scale habitat changes 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.

Permanent habitat changes are limited to the immediate area of the foundations and stone fills, which are required in the case of 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

Site N-3.8 is not of outstanding importance with regard to the population of benthic organism species. The benthic communities identified do not show any special features either, as they are typical of the EEZ in the North Sea due to the predominant sediments. Investigations of macrozoobenthos during the offshore site investigation have revealed communities typical of the German North Sea. The species inventory found and the number of Red List species indicate an average importance of site N-3.8 for benthic organisms.

Deep foundations of the wind turbines and the transformer platform cause disturbances of the seabed, sediment turbulence and 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, due to the predominant sedimentary composition, these impairments will only take effect within a small area and are limited in time. As a rule, the concentration of the suspended material decreases very quickly with removal. 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.

Due to the installation of the wind farm's internal cabling, only small-scale and short-term disturbances of the benthos by sediment turbulence and turbidity plumes in the area of the cable routes are to be expected. Possible effects on benthos depend on the installation methods used. 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. Due to the predominant sediment composition in the EEZ in the North Sea, most of the released sediment will settle directly at the construction site or in its immediate vicinity.

Benthic habitats are directly overbuilt in the area of necessary stone fills for cable crossings. 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. Given sufficient installation depth and taking into account that the effects will occur within a small area, no significant impacts on benthic communities are expected according to current knowledge. 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. The same assumptions apply to electric and electromagnetic fields.

The ecological impacts are limited to a small area and mostly short-term.

12.3.5 Fish

The fish fauna show typical species composition at site N-3.8. In all areas, the demersal fish community is dominated by characteristic species of flatfish, which is typical of the German Bight. 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 N-3.8 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, the transformer platform 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. Therefore, according to current knowledge, the impairment is limited in space and time and is not significant. In addition, the fish fauna is adapted to the natural sediment turbulence caused by storms that are typical of the area. 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 N-3.8 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

According to current knowledge, it can be assumed that the German EEZ is used by harbour porpoises for crossing and resting, and also as a food and area-specific breeding ground. Based on the information available, it can be concluded that the EEZ is of medium to high importance for harbour porpoises. Use varies in different areas of the EEZ. This also applies to harbour seals and grey seals. Site N-

3.8 is of medium to high importance for harbour porpoises, but of low to medium importance for grey seals and harbour seals in spring.

Hazards to marine mammals can be caused by noise emissions during pile driving of the foundations of offshore wind turbines and the transformer station. Without the use of noise-reducing measures, significant disturbance to marine mammals during pile driving might not be ruled out. The driving of piles for the wind turbines and the transformer station will therefore only be permitted in the specific approval procedure if effective noise reduction measures are applied. To this end, the draft suitability determination for site N-3.8 sets out specifications for the protection of the living marine environment from impulse-based noise disturbances.

These state that the installation of the foundations must be carried out using effective noise reduction measures to comply with applicable noise control limits. 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 maximum 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.

Current technical developments in the field of reducing underwater noise show that the use of suitable systems can significantly reduce the effects of noise pollution on marine mammals. The BMUB noise control concept has also been in force since 2013. According to the noise control concept, pile driving activities must be coordinated in such a way that sufficiently large areas, especially within the conservation areas and the main concentration area of harbour porpoise in the summer months, are kept free of the effects of pile driving noise. According to current knowledge, significant impacts on marine mammals from the operation of offshore wind turbines and transformer stations can be ruled out.

The exclusion of the installation of offshore wind turbines and converter platforms in Natura 2000 areas, already stipulated in the FEP, contributes to reducing the risk to harbour porpoises in important feeding and breeding areas.

Given implementation of the reduction measures to be ordered in the individual procedure to comply with applicable sound exposure limits in accordance with the planning principle from the Site Development Plan (BSH 2019c) and the requirements from the draft suitability determination for site N-3.8, no significant adverse impacts on marine mammals are currently to be expected from the construction and operation of the planned offshore wind turbines and the transformer station. No significant impact on marine mammals is expected from the laying and operation of submarine cable systems.

12.3.7 Seabirds and resting birds

According to current knowledge, the surroundings of site N-3.8 are of medium importance for resting and foraging seabirds. On the whole, typical seabird species of the EEZ in the North Sea have been identified (BSH 2019), but often only in lower densities. This is mainly due to the fact that the area characteristics do not correspond to the species-specific preferences of some seabird species.

Impacts during the construction phase due to deterrence effects are expected to be local and temporary at most. Due to the high mobility of the birds, significant impacts can be ruled out with the necessary certainty.

Wind turbines can have a permanent disturbing and deterrence effect on species sensitive to disturbance such as red-throated divers and black-throated divers. Current findings show a more pronounced avoidance behaviour on the part of divers towards existing wind farms than was originally anticipated. No findings on habituation effects are available to date. Given the location of site N-3.8 in the middle of wind farm projects that already exist (or will exist at the time of implementation) in the east of area N-3, it is likely that there will be an overlap of avoidance effects. In addition, site N-3.8 is more than 40 km away from the main concentration area of divers, the most important resting area in the EEZ in the North Sea. In view of the low seasonal and spatial occurrence of divers in the vicinity of site N-3.8 (see Chapter 2.7.3), significant impacts can be ruled out with the necessary certainty.

12.3.8 Migratory birds

On the whole, site N-3.8 and its surroundings are of medium importance for bird migration.

Possible effects may be that the wind turbines constitute a barrier or a collision risk. In the clear weather conditions preferred by birds for their migration, the probability of a collision with a wind turbine or platform is low. Bad weather conditions increase the risk. On the whole, the species-specific individual assessment shows that for the migratory bird species occurring in the project area and their relevant biogeographic populations, considerable impacts from a wind farm at site N-3.8 can be ruled out with the necessary certainty. However, the potentially increased risk of collision due to the higher turbines according to scenarios 1 and 2 must be taken into account in the cumulative consideration of several wind farm projects in the vicinity of site N-3.8 and in the concrete planning of the individual project.

12.3.9 Bats

Migratory movements of bats across the North Sea are still scarcely documented and largely unexplored. There is a lack of concrete information on migratory species, migratory corridors, migratory heights and concentrations. Previous evidence only confirms that bats fly over the North Sea, especially long-distance migratory species.

Hazards to individuals from collisions with wind turbines and platforms cannot be ruled out. There is no evidence of possible significant adverse effects on the bat migration over the EEZ in the North Sea given the current state of knowledge. 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.

12.3.10 Biological diversity

Biological diversity 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.

With regard to the current state of biodiversity in the North Sea, there is ample evidence of changes in biodiversity and species composition at all systematic and trophic levels in the North 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. Possible impacts on biodiversity are dealt with in the environmental report for the individual protected objects. In summary, according to current knowledge, the planned expansion of offshore wind energy and the corresponding grid connections are not expected to have a significant impact on biodiversity.

12.3.11 Air

The construction and operation of the wind turbines and the laying of the internal wind park cabling have no measurable impact on air quality.

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.

Due to the considerable distance from the nearest coast (> 30 km), the development of the landscape will not change significantly as a result of the implementation of the construction project at site N-3.8, especially as the site in question is located north of existing 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 N-3.8. Under this condition, no significant impacts on the protected object of cultural heritage and other material assets are to be expected at site N-3.8.

12.3.15 Human beings, including human health

On the whole, site N-3.8 is of low importance for human health and well-being. There is no direct use for the purpose of recreation and leisure. People are not directly affected by the plan; site N-3.8 is already used as a working environment by the construction activities of the surrounding wind farms. This use will be increased by the development at site N-3.8, but no special importance of this area for human health and well-being can be inferred.

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 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.

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.

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.

12.3.17 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.

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 essentially be 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 375 MW for site N-3.8 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 42 (scenario 1) and 25 (scenario 2).

On the basis of the model wind farm parameters, this results in area sealing of 61,603 m² (scenario 1) and 72,713 m² (scenario 2), including assumed scour protection and a transformer platform. Compared to the total area of site N-3.8 of approx. 23 km², the model wind farm scenarios result in calculated area sealing of between 0.27% (scenario 1) and 0.32% (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 N-3.8 is temporarily impaired by approx. 45 km of cabling within the wind farm, which corresponds to temporary space usage of 0.20% of the total area of N-3.8.

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 N-3.8. Therefore, according to current knowledge, no significant, cumulative impairments are expected that would endanger the marine environment with regard to the seabed and benthos.

12.3.17.1 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 considerably impaired by the fact that – if pile driving is carried out in other areas within the EEZ at the same time – there is not enough space available for evasion,

Cumulative impacts of the plan on the population of harbour porpoise are considered in accordance with the requirements of the BMU's 2013 noise control concept. Pile-driving activities which have the potential to cause disturbance to harbour porpoise through noise disturbances in the nature conservation areas or in the entire EEZ in the North Sea will be coordinated in such a way that the proportion of the area affected remains below 10% or below 1% in sub-area I of the 'Sylt Outer Reef – Eastern German Bight' nature conservation area at all times.

12.3.17.2 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 are considered on a site-specific and project-specific basis within the scope of the environmental impact assessment and are monitored within the subsequent 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.

Since 2009, the BSH has carried out the qualitative assessment of cumulative impacts on divers in the context or approval procedures, in reference to the main concentration area in accordance with the BMU position paper (2009).

The definition of the main concentration area of divers in the German EEZ in the North Sea in the BMU's position paper (2009) is an important measure to ensure species protection of the disturbance-sensitive species red-throated diver and black-throated diver. The BMU decreed that under future approval procedures for offshore wind farms, the main concentration area should be used as a benchmark for the cumulative assessment of diver habitat loss.

The main concentration area takes into account the period of particular importance for the species, namely spring. Based on the data available at the time the main concentration area was defined in 2009, the main concentration area was home to around 66% of the German North Sea diver population and around 83% of the EEZ population in spring, which is why it is particularly important in terms of population biology (BMU 2009) and constitutes an important functional component of the marine environment with regard to seabirds and resting birds. In view of current population assessments, the importance of the main concentration area for divers in the German North Sea and within the EEZ has further increased (SCHWEMMER et al. 2019). The delimitation of the main concentration area of divers is based on the data situation, which is considered to be very sound, and on expert analyses which have gained broad scientific acceptance. The area includes all areas of very high density and most of the areas of high diver density in the German Bight.

The area where site N-3.8 is located is used by divers mainly as a transit area during migration periods. According to current knowledge, this site and its surroundings lie outside of the main resting areas of divers in the German North Sea.

On the basis of the available data from research projects and monitoring of wind farm clusters, the BSH comes to the conclusion that site N-3.8 and its surroundings are not of high importance to the resting population of divers in the German North Sea. Site N-3.8 is located at a distance > 40 km from the main concentration area west of Sylt. The realisation of an offshore wind farm at site N-3.8 can therefore rule out cumulative impacts with the necessary certainty.

12.3.17.3 Migratory birds

The risk potential to bird migration results not only from the effects of the individual project, in this case a project at site N-3.8, but also cumulatively in connection with other approved or already constructed wind farm projects in the vicinity of site N-3.8 or in the main migration direction.

The surroundings of site N-3.8 in area N-3 have already been partially developed with wind turbines which are up to 50 m and up to 120 m lower than the turbines according to scenario 1 and 2 respectively. This creates a step effect: visibility of the higher installations is limited, as the installations can only be partially seen. This is especially true of scenario 1, as the rotating rotors will mainly be visible in this case. In scenario 2 with a hub height of 175 m, the massive nacelle will usually also be visible. The following consideration of the collision risk is based on the main migration directions north-east (spring) and south-west (autumn).

Two wind farm projects are already in operation to the west of site N-3.8. The wind turbines have a total height of 187 m. East of site N-3.8, a wind farm project is currently in the planning stage. It is expected that the turbines of this project will have similar dimensions to those of a project at site N-3.8. For site N-3.8, the above described step effect therefore occurs in spring, as the birds on their migration to the breeding areas would first encounter the lower installations before reaching N-3.8. This would not be the case in autumn, as migration would first pass over the installations of the neighbouring eastern project, which are also higher.

Under normal migratory conditions favoured by migratory birds, no evidence has been found so far for any species that the birds typically migrate in the danger zone of the installations and/or do not recognise and avoid these obstacles.

Potential hazard situations include unexpectedly occurring fog and rain, which lead to poor visibility and low flight altitudes. One particular problem is the coincidence of bad weather conditions with so-called mass migration events. According to research results obtained at the FINO1 research platform, however, this forecast could be put into perspective. It was found that birds migrate higher in very poor visibility (less than 2 km) than in medium (3 to 10 km) or good visibility (> 10 km). However, these results were based on only three measurement nights (HÜPPOP et al. 2005).

The risk of collision for birds migrating during the day and seabirds is generally considered to be low (see Chapter 4.8.1).

Cumulative impacts could also lead to an extension of the migratory route for migratory birds. The potential impairment of bird migration in the sense of a barrier effect depends on many factors, in particular the orientation of the wind farms towards the main migration directions. With the assumed main direction of movement from southwest to northeast and vice versa, the wind farms adjoining each other in this orientation in the same or another area form a uniform barrier, so a single evasive movement is sufficient. It is known that wind farms are avoided by birds, i.e. they fly around them horizontally or fly over them. In addition to observations on land, this behaviour has also been demonstrated in the offshore area (e.g. KAHLERT et al. 2004, AVITEC RESEARCH GBR 2015b). Lateral evasive reactions are apparently the most common reaction (HORCH & KELLER 2004). Evasive reactions occurred in different directions, but no reversal was detected (KAHLERT et al. 2004). AVITEC RESEARCH GBR (2015) found avoidance behaviour in ducks, gannets, auks, little gulls and black-legged kittiwakes during the long-term studies.

Site N-3.8 is located east of two wind farms already in operation, and a further project east of site N-3.8 is currently being planned. In the medium term, these projects would form a barrier of approx. 50 km to the main north-eastern or south-western direction of migration when all of them have been realised, so the diversion that may be necessary for migratory birds in the main direction of migration would be a maximum of 70 km when the original migratory route is resumed after the evasive movement. Providing migratory birds maintain their north-eastern migratory route, a further evasive reaction is possible with regard to a project located more than 50 km to the north-east in FEP area N-5, so migratory birds would have to make a diversion of approximately 20 km – in addition to the 70 km diversion already mentioned – in order to bypass the northern wind farm in area N-5.

The flight distance to cross the North Sea is sometimes several hundreds of kilometres. According to BERTHOLD (2000), the non-stop flight performance of the majority of migratory bird species is in the order of magnitude of over 1,000 km. This also applies to small birds. It is therefore unlikely that the possibly required additional energy would endanger bird migration due to a possible diversion of about 50 km.

An analysis of the knowledge available on the migratory behaviour of the various bird species, the usual flight altitudes and the distribution of bird migration over the day allows the conclusion to be drawn that, based on current knowledge, a threat to bird migration due to the construction and operation of a wind farm at site N-3.8 is unlikely to arise from the cumulative consideration of already approved offshore wind farm projects. The possible bypassing of the projects does not currently indicate a significant negative effect on the further development of the populations.

It must be taken into account that, according to the current state of science and technology, this forecast is made under assumptions that are not yet suitable for satisfactorily securing the basis for bird migration. Gaps in knowledge exist especially with regard to species-specific migration behaviour in bad weather conditions (rain, fog).

12.4 Transboundary effects

The SEA concludes that, as things stand at present, site N-3.8 has no significant impact on the areas of neighbouring countries bordering the German EEZ in the North Sea. Site N-3.8 is centrally located in the German EEZ in the North Sea. The distance to the Dutch EEZ is at least 47 km. Denmark (or the Danish EEZ) is even further away, at least 126 km.

For the protected objects of soil, water, plankton, benthos, biotope types, landscape, cultural heritage and other material goods, and human beings including human health, significant transboundary impacts can be excluded in principle due to these distances. Possible significant transboundary effects could at most only arise when considering all planned wind farm projects in the area of the German North Sea for the highly mobile protected objects of fish, marine mammals, seabirds and resting birds, as well as cumulatively migratory birds and bats.

With regard to fish as a protected object, the SEA comes to the conclusion that, according to current knowledge, no significant transboundary impacts on the protected object are to be expected from site N-3.8, since on the one hand the area does not have a prominent function for the fish fauna and on the other hand the recognisable and predictable effects are of a small-scale and temporary nature.

According to current knowledge and taking into account impact-minimising and damage-limiting measures, significant transboundary effects can also be ruled out for the protected marine mammal species. For example, the installation of the foundations of wind turbines and the transformer platform will only be permitted within the framework of the draft of the suitability determination if effective noise reduction measures are implemented and if noise-intensive construction work is coordinated with neighbouring projects.

Bird migration over the North Sea takes place over an indefinably broad front with a tendency towards coastal orientation. Guidelines and fixed migration paths are not yet known. The individual species-specific analysis did not reveal any significant impacts. An examination of the available knowledge on the migratory behaviour of the various bird species, the usual flight altitudes and the distribution of bird migration over the day allows the conclusion to be drawn that, based on current knowledge, a threat to bird migration due to the construction and operation of a wind farm at site N-3.8 is unlikely to arise from the cumulative consideration of already approved offshore wind farm projects, although more knowledge of species-specific migratory behaviour is still needed. As a result, significant transboundary effects are also considered unlikely.

12.5 Assessment under species protection law

The assessment under species protection law pursuant to section 44(1) BNatSchG comes to the conclusion that, according to current knowledge and in strict compliance with avoidance and mitigation measures and implementation of the requirements of the BMU's noise control concept, no significant negative impacts will be associated with the erection of a wind farm at site N-3.8 that would meet the criteria for violation of species protection law.

12.6 Impact assessment

The following nature conservation areas are located in the German EEZ of the North Sea: 'Sylt Outer Reef – Eastern German Bight' at a distance of 49.8 km from site N-3.8, 'Borkum Reef Ground' at a distance of 20.4 km, 'Dogger Bank' at a distance of 202.7 km and the 'Lower Saxony Wadden Sea National Park', which is located in the territorial sea at a distance of 21.7 km.

According to section 34 BNatSchG, the compatibility of plans or projects must be assessed and it must be determined whether, individually or in combination with other plans or projects, they may significantly impair the conservation objectives of a Natura 2000 area or the protection purposes of a nature conservation area. This also applies in principle to projects outside the area.

In line with the protection purposes of the nature conservation areas mentioned, the habitat types 'reef' and 'sandbank' with their characteristic and endangered communities and species, as well as protected species, the impact assessment is specifically to consider fish, certain marine mammals according to Annex II of the Habitats Directive (harbour porpoise, grey seal and harbour seal), protected bird species listed in Annex I of the Birds Directive (in particular red-throated diver, black-throated diver, little gull, sandwich tern, common tern and Arctic tern) and also regularly occurring migratory bird species (in particular petrel and lesser black-backed gull, fulmar, northern gannet, black-legged kittiwake, guillemot and razorbill).

Due to the shortest distance from site N-3.8 of at least 20.4 km to the nature conservation area 'Borkum Reef Ground' in the German EEZ or of 21.7 km to the 'Lower Saxony Wadden Sea National Park' FFH area in the territorial sea, construction-related, installation-related and operation-related impacts on the FFH habitat types 'reef' and 'sandbank' with their characteristic and endangered communities and species can be ruled out. The distance of site N-3.8 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 FFH area components relevant to the conservation objectives or the protection purpose. The same applies to fish and cyclostomes because of the distances from the areas.

Significant impairment of the nature conservation areas in the German EEZ 'Borkum Reef Ground' and the 'Lower Saxony Wadden Sea National Park' in the territorial sea with regard to the harbour porpoises, grey seals and seals protected there can also be ruled out with the necessary certainty, taking into account the noise control requirements. In particular, possible effects of construction-related noise emissions can be efficiently prevented by specifying noise reduction measures and coordinating them with the construction measures of other projects.

With regard to the seabird species protected in the nature conservation area 'Sylt Outer Reef – Eastern German Bight' (Sylt Outer Reef – Eastern German Bight), site N-3.8 – and therefore also an offshore wind farm on this site – is of no significance according to current knowledge due to the distance.

12.7 Measures to prevent, reduce and compensate significant negative impacts of the Site Development Plan 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 as part of the 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.

Within the framework of the upstream SEA for 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 N-3.8, 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 in particular with regard to the number of installations to be built to achieve the capacity to be installed (scenario 1 with 42 as compared to scenario 2 with 25 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). 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 the foundation of installations by means of pile-driven foundations, suction bucket, vibro pile or gravity foundation are being discussed for the German EEZ in the North Sea.

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 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.

12.9 Planned measures to monitor the impacts of the Site Development 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 N-3.8. 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. The procedure envisaged for this purpose, the planned measures for monitoring the potential impacts of the plans and the required data are described in the environmental report on the Site Development Plan 2019 for the German North Sea in Chapter 10 (particularly in Chapter 10.1 on the potential impacts of areas and sites for offshore wind turbines) (BSH 2019a).

13 Bibliography

ABT K (2004) Robbenzählungen im schleswig-holsteinischen Wattenmeer. Bericht an das Landesamt für den Nationalpark Schleswig-Holsteinisches Wattenmeer. Landesamt für den Nationalpark Schleswig-Holsteinisches Wattenmeer. Tönning, Germany. 34 pages.

ABT KF, HOYER N, KOCH L & ADELUNG D (2002) The dynamics of grey seals (*Halichoerus grypus*) off Amrum in the south-eastern North Sea - evidence of an open population. Journal of Sea Research 47: 55−67.

ABT KF, TOUGAARD S, BRASSEUR SMJM, REIJNDERS PJH, SIEBERT U & STEDE M (2005) Counting harbour seals in the wadden sea in 2004 and 2005 - expected and unexpected results. Waddensea Newsletter 31: 26−27.

AHLÉN I (2002) Wind turbines and bats – a pilot study. Final Report to the Swedish National Energy Administration, 5 pages.

AK SEEHUNDE (2005) Protokoll Arbeitskreis Seehunde vom 27.10.2005. Arbeitskreis Seehunde, Hotel Fernsicht, Tönning, 27.10.2005. Landesamt für den Nationalpark Schleswig-Holsteinisches Wattenmeer. Tönning. 6 pages.

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.

ANONYMOUS (1992) 11th North Sea Bird Club Annual Report. North Sea Bird Club, Aberdeen.

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 (2000a) On the spatial scale needed for community monitoring in the coastal North Sea. Journal of Sea Research 43: 121−133.

ARMONIES W (2000b) What an introduced species can tell us about the spatial extension of benthic populations. Marine Ecology Progress Series 209: 289−294.

ARMONIES W (2010) Analyse des Vorkommens und der Verbreitung des nach §30 BNatSchG geschützten Biotoptyps 'Artenreiche Kies-, Grobsand- und Schillgründe'. – Study on behalf of the Federal Agency for Nature Conservation, Vilm office.

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.

ASCOBANS (2005) Workshop on the Recovery Plan for the North Sea Harbour Porpoise, 6−8 December 2004, Hamburg, report released on 31.01.2005, 73 pages.

AVITEC RESEARCH GBR (2015a) 'Cluster Nördlich Borkum' StUK-Monitoring des Jahres 2013. Fachgutachten Zugvögel. Unpublished report commissioned by Umweltuntersuchung Nördlich Borkum GmbH (UMBO) by Avitec Research GbR. Osterholz-Scharmbeck, January 2015.

AVITEC RESEARCH GBR (2015b) 'Cluster Nördlich Borkum' StUK-Monitoring des Jahres 2014. Fachgutachten Zugvögel. Unpublished report commissioned by Umweltuntersuchung Nördlich Borkum GmbH (UMBO) by Avitec Research GbR. Osterholz-Scharmbeck, May 2015.

AVITEC RESEARCH GBR (2016) 'Cluster Nördlich Borkum' StUK-Monitoring des Jahres 2015. Unpublished report commissioned by UMBO GmbH. Osterholz-Scharmbeck, December 2016.

AVITEC RESEARCH GBR (2017) 'Cluster Nördlich Borkum' StUK-Monitoring des Jahres 2016. Unpublished report commissioned by UMBO GmbH. Osterholz-Scharmbeck, September 2017.

AVITEC RESEARCH GBR (2018) 'Cluster Nördlich Borkum' StUK-Monitoring des Jahres 2017. Unpublished report commissioned by UMBO GmbH. Osterholz-Scharmbeck, October 2018.

AWI, DOLCH T (2019) Das Seegras ist zurück. Last retrieved online on 03.01.2020 https://www.awi.de/im-fokus/nordsee/seegraswiesen-im-wattenmeer.html

BACH L & C MEYER-CORDS (2005) Lebensraumkorridore für Fledermäuse (Entwurf). 7 pages.

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 (2009) Leitfaden zur Strategischen Umweltprüfung (SUP). *Texts 08/09*. Dessau-Roßlau, Saxony-Anhalt, Germany: German Environment Agency.

BARNES CC (1977) Submarine Telecommunication and Power Cables. P. Peregrinus Ltd, Stevenage.

BARTNIKAS R & SRIVASTAVA KD (1999) Power and Communication Cables, McGraw Hill, New York.

BARZ K & ZIMMERMANN C (ed.) Fischbestände online. Thünen Institute of Baltic Sea Fisheries. Electronic publication at www.fischbestaende-online.de, Accessed on 12.03.2018.

BAUER K & GLUTZ VON BLOTZHEIM UN (1966) Handbuch der Vögel Mitteleuropas. Volume 1. Frankfurt am Main: Akademische Verlagsgesellschaft.

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.

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.

BETKE K & MATUSCHEK R (2011) Messungen von Unterwasserschall beim Bau der Windenergieanlagen im Offshore-Testfeld ‘alpha ventus’. Abschlussbericht zum Monitoring nach StUK3 in der Bauphase.

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, ELBRÄCHTER M, GAUL H, GOEBEL J, HANSLIK M, PETENATI T & WILTSHIRE K (2005) Nährstoffe. In: Zustandsbericht 1999-2002 für Nord- und Ostsee, Bund- Länder Messprogramm für die Meeresumwelt von Nord- und Ostsee, BSH (ed.), p. 25−32.

BEUSEKOM JEE VAN, PETENATI T, HANSLIK M, HENNEBERG S & GAUL H (2003) Zustandsbericht 1997−1998 für Nord- und Ostsee, Bund-Länder Messprogramm für die Meeresumwelt von Nord- und Ostsee, BSH (ed.), p.13−21.

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: In: von Storch H, Meinke I & Claußen M (eds.) Hamburger Klimabericht – Wissen über Klima, Klimawandel und Auswirkungen in Hamburg und Norddeutschland. Springer Spektrum, Berlin, Heidelberg.

BfN, Federal Agency for Nature Conservation (2011a) Kartieranleitung 'Artenreiche Kies-, Grobsand- und Schillgründe im Küsten- und Meeresbereich'. /Marine-Biotoptypen/Biotoptyp-Kies-Sand-Schillgruende.pdf, status: 06.05.2014.

BFN, FEDERAL AGENCY FOR NATURE CONSERVATION (2011B) KARTIERANLEITUNG 'SCHLICKGRÜNDE MIT GRABENDER MEGAFAUNA'. HTTP://WWW.BFN.DE/FILEADMIN/MDB/DOCUMENTS/THEMEN/MEERESUNDKUESTENSCHUTZ/DOWNLOADS/MARINE

-BIOTOPTYPEN/BIOTOPTYP-SCHLICKGRUENDE.PDF; STATUS 06.05.2014.

BFN, FEDERAL AGENCY FOR NATURE CONSERVATION (2018) BfN-Kartieranleitung für 'Riffe' in der deutschen ausschließlichen Wirtschaftszone (AWZ). Geschütztes Biotop nach § 30 Abs. 2 S. 1 Nr. 6 BNatSchG, FFH – Anhang I – Lebensraumtyp (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 (2011) Varianten eines Kabelkorridors ('Harfe') im Bereich Borkum Riffgrund. Vergleich der Varianten und Vorschlag einer Vorzugsvariante aus ökologischer Sicht, Bremen.

BIOCONSULT (2016a) Kurzstudie 'Gode Wind 04'. Datenanalyse im Zusammenhang mit dem OWP-Vorhaben 'Gode Wind 04'.

BIOCONSULT (2016b) Biotoperfassung 'Artenreiche Kies-, Grobsand- und Schillgründe' (KGS) 'Borkum Riffgrund West 1 und 2'. Unpublished report commissioned by DONG energy, 02.05.2016. 42 pages.

BIOCONSULT (2017) Betroffenheit des gesetzlichen Biotopschutzes nach § 30 BNatSchG in den Vorhabengebieten OWP West und Borkum Riffgrund West 2. Untersuchungskonzept 'Artenreiche Kies-, Grobsand- und Schillgründe' (KGS). Unpublished report commissioned by DONG energy, 21.09.2017. 10 pages.

BIOCONSULT (2018) Offshore Windpark 'EnBW Hohe See'. Ergänzende Untersuchungen zur Basisaufnahme vor Baubeginn. Abschlussbericht Makrozoobenthos & Fische auf der Grundlage der StUK-Erfassungen im Frühjahr und Herbst 2015 sowie im Herbst 2016. Unpublished report commissioned by EnBW Hohe See GmbH, April 2018.

BIOCONSULT SH & IFAÖ (2014) Offshore Windpark 'alpha ventus' Fachgutachten Rastvögel Abschlussbericht. Basisaufnahme, Bauphase und Betrieb (Februar 2008 – März 2013) Unpublished Report commissioned by Deutsche Offshore-Testfeld- und Infrastruktur GmbH & Co. KG (DOTI), Husum, October 2014.

BIOCONSULT SH (2012a) Abschlussbericht des 3. Untersuchungsjahres 'DanTysk'.

BIOCONSULT SH (2012b) Abschlussbericht des 3. Untersuchungsjahres 'Butendiek'.

BIOCONSULT SH (2015) OWP 'Butendiek'. Abschlussbericht Baumonitoring. Rastvögel. Berichtszeitraum: März 2014 bis Juni 2015. Unpublished report commissioned by OWP Butendiek GmbH & Co. KG, Husum, December 2015.

BIOCONSULT SH (2017) OWP 'Butendiek'. 1. Untersuchungjahr der Betriebsphase Rastvögel. Berichtszeitraum: Juli 2015 bis Juni 2016. Unpublished report commissioned by Deutsche Windtechnik AG, Husum, April 2017.

BIOCONSULT SH GMBH & CO.KG (2017) OWP 'Butendiek'. 1. Untersuchungjahr der Betriebsphase Rastvögel. Berichtszeitraum: Juli 2015 bis Juni 2016. Unpublished report commissioned by Deutsche Windtechnik AG, Husum, April 2017.

BIOCONSULT SH GMBH & CO.KG (2018) OWP 'Butendiek 2'. Untersuchungjahr der Betriebsphase Rastvögel. Berichtszeitraum: Juli 2016 bis Juni 2017. Unpublished report commissioned by Deutsche Windtechnik AG, Husum, January 2018.

BIRDLIFE INTERNATIONAL (2004) Birds in Europe: population estimates, trends and conservation status. BirdLife Conservation Studies No.12, Cambridge.

BIRDLIFE INTERNATIONAL (2015) European Red List of Birds. Luxembourg: Office for Official Publication of the European Communities.

BLASIUS R (1900−1903) Vogelleben an den deutschen Leuchthürmen 1900−1903. Ornis Internationale Zeitschrift für die gesamte Ornithologie. Organ des permanenten internationalen ornithologischen Comités. Ed.: Prof. Dr. R. Blasius, Braunschweig.

BMU, FEDERAL MINISTRY FOR THE ENVIRONMENT, NATURE CONSERVATION AND NUCLEAR SAFETY (2018) Zustand der deutschen Nordseegewässer 2018. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Department WR I 5, Meeresumweltschutz, Internationales Recht des Schutzes der marinen Gewässer. 191 pages.

BMU, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2009) Positionspapier des Geschäftsbereichs des Bundesumweltministeriums zur kumulativen Bewertung des Seetaucherhabitatverlusts durch Offshore-Windparks in der deutschen AWZ der Nord- und Ostsee als Grundlage für eine Übereinkunft des BfN mit dem BSH, BMU 09.12.2009.

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, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2013) Konzept für den Schutz der Schweinswale vor Schallbelastungen bei der Errichtung von Offshore-Windparks in der deutschen Nordsee (Schallschutzkonzept).

BMU, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (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, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (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, Federal Ministry of Food and Agriculture and BMU, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2020): Nitratbericht 2020

Bohnsack J A & Sutherland D L (1985) Artificial Reef Research: A Review with Recommendations for Future Priorities. Bulletin of Marine Science, Volume 37. pp. 11-39(29).

Bolle LJ, Dickey-Collas M, van Beek JK, Erftemeijer PL, Witte JI, van der Veer HW & Rijnsdorp AD (2009) Variability in transport of fish eggs and larvae. III. Effects of hydrodynamics and larval behaviour on recruitment in plaice. Marine Ecology Progress Series, 390 195−211.

Bosselmann A (1989) Entwicklung benthischer Tiergemeinschaften im Sublitoral der Deutschen Bucht. Dissertation University of Bremen, 200 pages.

Brabant R, Laurent Y & Jonge Poerink B (2018) First ever detections of bats made by an acoustic recorder installed on the nacelle of offshore wind turbines in the North Sea. *In*: Degraer S, Brabant R, Rumes B & Vigin L (eds.) Environmental Impacts of Offshore Wind Farms in the Belgian Part of the North Sea: Assessing and Managing Effect Spheres of Influence: 129 – 136. Royal Belgian Institute of Natural Sciences, OD Natural Environment, Marine Ecology and Management, Brussels. 136 pages.

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, Höschle C, Diederichs A, Betke K, Matuschek R & Nehls G (2013) Seal Scarers as a tool to deter harbour porpoises from offshore construction sites. Marine Ecology Progress Series 421: 205−216.

Brandt MJ,Dragon AC, Diederichs A, Bellmann M, Wahl V, Piper W, Nabe-Nielsen J & Nehls G (2018) Disturbance of harbour porpoises during construction of the first seven offshore wind farms in Germany. Marine Ecology Progress Series 596: 213−232.

Brockmann U., Topcu D., Schütt M., Leujak W. (2017) Third assessment of the eutrophication status of German coastal and marine waters 2006–2014 in the North Sea according to the OSPAR Comprehensive Procedure. University of Hamburg, German Environment Agency, 108 pages. https://www.meeresschutz.info/berichte-art-8-10.html?file=files/meeresschutz/berichte/art8910/zyklus18/doks/HD_Nordsee_Dritte_Anwendung_COMP_DE_Gewaesser.pdf

BROCKMANN, U., D. TOPCU, M. SCHÜTT & W. LEUJAK (2017) Eutrophication assessment in the transit area German Bight (North Sea) 2006–2014 – Stagnation and limitations. Marine Pollution Bulletin 136:68-78.

BRUST V, MICHALIK B & HÜPPOP O (2019) To cross or not to cross – thrushes at the German North Sea coast adapt flight and routing to wind conditions. Movement Ecology 7:32.

BSH, FEDERAL MARITIME AND HYDROGRAPHIC AGENCY (1994) Klima und Wetter der Nordsee. Federal Maritime and Hydrographic Agency, Hamburg and Rostock, Sonderdruck Nr. 2182, 73−288.

BSH, FEDERAL MARITIME AND HYDROGRAPHIC AGENCY (2005) Nordseezustand 2003. Berichte des Bundesamtes für Seeschifffahrt und Hydrographie 38:217pp. BSH Hamburg and Rostock. http://www.bsh.de/de/Produkte/Buecher/Berichte_/Bericht38/index.jsp.

BSH, FEDERAL MARITIME AND HYDROGRAPHIC AGENCY (2009) Umweltbericht zum Raumordnungsplan für die deutsche ausschließliche Wirtschaftszone (AWZ) in der Nordsee. Federal Maritime and Hydrographic Agency, 537 pages.

BSH, FEDERAL MARITIME AND HYDROGRAPHIC AGENCY (2013) Standard Untersuchung der Auswirkungen von Offshore-Windenergieanlagen auf die Meeresumwelt (StUK4). 86 pages.

BSH, FEDERAL MARITIME AND HYDROGRAPHIC AGENCY (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 (2019a) Umweltbericht zum Flächenentwicklungsplan 2019 für die deutsche Nordsee. Bundesamt für Seeschifffahrt und Hydrographie, BSH-Nummer 7608, Hamburg, 28 June 2019.

BSH, BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE (2019b) Umweltbericht zum Flächenentwicklungsplan für die deutsche ausschließliche Wirtschaftszone (AWZ) in der Ostsee. Federal Maritime and Hydrographic Agency, 346 pages.

BSH, BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE (2019c) Flächenentwicklungsplan 2019 für die deutsche Nordsee. Bundesamt für Seeschifffahrt und Hydrographie, Hamburg, 28 June 2019.

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.

BUREAU WAARDENBURG (1999) Falls of migrant birds − An analysis of current knowledge. Report prepared for the Directoraat-Generaal Rijksluchtvaartdienst, Postbus 90771, 2509 LT Den Haag, Programmadirectie Ontwikkeling Nationale Luchthaven, Ministerie van Verkeer en Waterstaat.

BURGER C (2018) DIVER – Auswirkungen der Offshore-Windkraft auf Habitatnutzung und Bewegungsmuster überwinternder Seetaucher in der Deutschen Bucht. Presentation at the 28th BSH-Meeresumwelt-Symposium on 13 June 2018 in Hamburg.

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

CADIOU B & DEHORTER O (2003) Marée noire de l'Erika – Contribution à l'étude de l'impact sur l'avifaune. Analyse des reprises/contrôles de bagues. Rapport Bretagne Vivante-SEPNB, CRBPO, DIREN Bretagne.

CAMPHUYSEN CJ (2002) Post-fledging dispersal of common guillemots *Uria aalge* guarding chicks in the North Sea: the effect of predator presence and prey availability at sea. Ardea 90 (1): 103−119.

CAMPHUYSEN CJ, WRIGHT PJ, LEOPOLD M, HÜPPOP O & REID JB (1999) A review of the causes, and consequences at the population level, of mass mortalities of seabirds. ICES Cooperative Research Report 232: 51−63.

CHAKRABARI, S.K. 1987*) Hydrodynamics of Offshore Structures. Computational Mechanics, 1987, 440 p.

CRESPIN L, HARRIS MP, LEBRETON J-D, FREDERIKSEN M & WANLESS S (2006) Recruitment to a seabird population depends on environmental factors and on population size. Journal of Animal Ecology 75:228−238.

CRICK HQP (2004) The impact of climate change on birds. Ibis 146 (supplement 1): 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.

DAAN N, BROMLEY PJ, HISLOP JRG & NIELSEN NA (1990) Ecology of North Sea fish. Netherlands Journal of Sea Research 26 (2−4): 343–386.

DÄHNE M, TOUGAARD J, CARSTENSEN J, ROSE A & NABE-NIELSEN J (2017) Bubble curtains attenuate noise levels from offshore wind farm construction and reduce temporary habitat loss for harbour porpoises. Marine Ecology Progress Series 580: 221−237.

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.

DÄNHARDT A (2017) Biodiversität der Fische und ihre Bedeutung im Nahrungsnetz des Jadebusens. Jahresbericht im Auftrag der Nationalparkverwaltung Niedersächsiches Wattenmeer. In Kooperation mit dem Institut für Vogelforschung 'Vogelwarte Helgoland', Lüllau, Wilhelmshaven, 52 pages.

DANNHEIM J, BREY T, SCHRÖDER A, MINTENBECK K, KNUST R & ARNTZ WE (2014) Trophic look at soft-bottom communities — Short-term effects of trawling cessation on benthos. Journal of Sea Research 85: 18−28.

DANNHEIM J, GUSKY M, & HOLSTEIN J (2014) Bewertungsansätze für Raumordnung und Genehmigungsverfahren im Hinblick auf das benthische System und Habitatstrukturen. Statusbericht zum Projekt. Unpublished report commissioned by the Federal Maritime and Hydrographic Agency, 113 pages.

DANNHEIM J, GUTOW L, HOLSTEIN J, FIORENTINO D, BREY T (2016) Identifizierung und biologische Charakteristika bedrohter benthischer Arten in der Nordsee. Presentation at the 26th BSH-Meeresumwelt-Symposium on 31 May 2016 in Hamburg.

DAVENPORT J & LÖNNING S (1980). Oxygen uptake in developing eggs and larvae of the cod, *Gadus morhua* L. Journal of Fish Biology. 16. 249 - 256. 10.1111/j.1095-8649.1980.tb03702.x.

DAVIDSE CT, HARTE M & BRANDERHORST H (2000) Estimation of bird strike rate on a new island in the North Sea. International Bird Strike Committee IBSC25/WP-AV7, Amsterdam, 17 − 21 April 2000.

DAVOREN GK, MONTEVECCHI WA & ANDERSON JT (2002) Scale-dependent associations of predators and prey: constraints imposed by flightlessness of common murres. Marine Ecology Progress Series 245: p. 259−272.

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 (eds.) (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.

DEUTSCHE ORNITHOLOGEN-GESELLSCHAFT (1995) Qualitätsstandards für den Gebrauch vogelkundlicher Daten in raumbedeutsamen Planungen. MFN, Medienservice Natur, 1995, 34 pages.

DICKEY-COLLAS M, BOLLE LJ, VAN BEEK JK, & ERFTEMEIJER PL (2009) Variability in transport of fish eggs and larvae. II. Effects of hydrodynamics on the transport of Downs herring larvae. Marine Ecology Progress Series, 390, 183−194.

DICKEY-COLLAS M, HEESSEN H & ELLIS J (2015) 20. Shads, herring, pilchard, sprat (Clupeidae) In: HEESSEN H, DAAN N, ELLIS JR (eds.) Fish atlas of the Celtic Sea, North Sea, and Baltic Sea: based on international research-vessel surveys. Academic Publishers, Wageningen, pages 139−151.

DICKSON DL (1993) Breeding biology of Red-throated Loons in the Canadian Beaufort Sea region. Arctic 46: 1-7.

DIERSCHKE J, DIERSCHKE V, HÜPPOP K, HÜPPOP O & JACHMANN KF (2011) Die Vogelwelt der Insel Helgoland. OAG Helgoland (ed.). 1st edition. Druckwerkstatt Schmittstraße, 632 pages.

DIERSCHKE V & GARTHE S (2006) Literature review of offshore wind farms with regard to seabirds. Ecological Research on Offshore Wind Farms: International Exchange of Experiences. BfN scripts 186: 131–198.

DIERSCHKE V (2001) Vogelzug und Hochseevögel in den Außenbereichen der Deutschen Bucht (südöstliche Nordsee) in den Monaten Mai bis August. Corax 18: 281−290.

DIERSCHKE V, FURNESS RW & GARTHE S (2016) Seabirds and offshore wind farms in European waters: Avoidance and attraction. Biological Conservation 202: 59−68.

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.

DNV GL (2010), Cathodic Protection Design, Recommended Practice DNV-RP-B401

DUINEVELD GCA, KÜNITZER A, NIERMANN U, DE WILDE PAWJ & GRAY JS (1991) The macrobenthos of the North Sea. Netherlands Journal of Sea Research 28 (1/2): 53 – 65.

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.

EASTWOOD E & RIDER GC (1965) Some radar measurements of the altitude of bird flight. British Birds 58 (10): 393−426.

EDWARDS M & RICHARDSON AJ (2004) The impact of climate change on the phenology of the plankton community and trophic mismatch. Nature 430: 881-884.

EDWARDS M, JOHN AWG, HUNT HG & LINDLEY JA (2005) Exceptional influx of oceanic species into the North Sea late 1997. Journal of the Marine Biological Association of the UK 79:737−739.

EEA, EUROPEAN ENVIRONMENT AGENCY (2015) State of the Europe's seas. EEA Report No 2/2015. Publications Office of the European Union, Luxembourg (European Environment Agency website).

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, p.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 (eds.) Offshore Wind Energy. Research on Environmental Impacts. 372 pages.

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.

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.

ESSINK K (1996) Die Auswirkung von Baggergutablagerungen auf das Makrozoobenthos: Eine Übersicht über niederländische Untersuchungen. – Mitteilung der Bundesanstalt für Gewässerkunde Koblenz 11: p. 12−17.

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 (European Environment Agency website).

EVANS, P. (2020) EUROPEAN WHALES, DOLPHINS, AND PORPOISES: MARINE MAMMAL CONSERVATION IN PRACTICE, ACADEMIC PRESS, ISBN: 978-0-12-819053-1

EXO K-M, HÜPPOP O & GARTHE S (2002) Offshore-Windenergieanlagen und Vogelschutz. Seevögel 23 (4): 83−95.

EXO K-M, HÜPPOP O & GARTHE S (2003) Birds and offshore wind farms: a hot topic in marine ecology. Wader Study Group Bulletin 100: 50−53.

FABI G, GRATI F, PULETTI M & SCARCELLA G (2004) Effects on fish community induced by installation of two gas platforms in the Adriatic Sea. Marine Ecology Progress Series 273: 187−197.

FAUCHALD P (2010) Predator-prey reversal: a possible mechanism for ecosystem hysteresis in the North Sea. Ecology 91: 2191–2197.

FIGGE K (1981) Erläuterungen zur Karte der Sedimentverteilung in der Deutschen Bucht 1: 250 000 (Map No. 2900). Deutsches Hydrographisches Institut.

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.

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.

FREDERIKSEN M, EDWARDS M, RICHARDSON AJ, HALLIDAY NC & WANLESS S (2006) From plankton to top predators: bottom-up control of a marine food web across four trophic levels. Journal of Animal Ecology 75: 1259−1266.

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 (eds.) Rote Liste gefährdeter Tiere, Pflanzen und Pilze Deutschlands, Band 1: Wirbeltiere. Naturschutz und Biologische Vielfalt 70 (1): 291–316.

FRICKE R, BERGHAHN R & NEUDECKER T (1995) Rote Liste der Rundmäuler und Meeresfische des deutschen Wattenmeer- und Nordseebereichs (mit Anhängen: nicht gefährdete Arten). *In*: Nordheim H von & Merck T (eds.) Rote Listen der Biotoptypen, Tier- und Pflanzenarten des deutschen Wattenmeer- und Nordseebereichs. Landwirtschaftsverlag Münster, Schriftenreihe für Landschaftspflege und Naturschutz 44: 101–113.

FRICKE R, BERGHAHN R, RECHLIN O, NEUDECKER T, WINKLER H, BAST H-D & HAHLBECK E (1994) Rote Liste und Artenverzeichnis der Rundmäuler und Fische (Cyclostomata & Pisces) im Bereich der deutschen Nord- und Ostsee. In: Nowak E, Blab J & Bless R (eds.) Rote Listen der gefährdeten Wirbeltiere in Deutschland. Kilda-Verlag Greven, Schriftenreihe für Landschaftspflege und Naturschutz 42: 157–176.

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 (eds.) 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 (2019) FishBase. World Wide Web electronic publication. www.fishbase.org, version (08/2019).

FROESE R & PAULY D (HRSG) (2000) FishBase 2000: concepts, design and data sources. ICLARM, Los Baños, Laguna, Philippines. 344 pages. www.fishbase.org, access on 14.03.2018.

GARTHE S (2000) Mögliche Auswirkungen von Offshore-Windenergieanlagen auf See- und Wasservögel der deutschen Nord- und Ostsee. In: MERCK T & VON NORDHEIM H (eds.) Technische Eingriffe in marine Lebensräume. Federal Agency for Nature Conservation workshop, International Academy for Nature Conservation Isle of Vilm, 27–29 October 1999: BfN scripts 29: 113–119. Bonn/Bad Godesberg.

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, MARKONES N, MÜLLER S & SCHWEMMER P (2015) Verbreitung, Jahresdynamik und Bestandentwicklung der Seetaucher *Gavia* spec. in der Deutschen Bucht (Nordsee). Vogelwarte 53: 121 – 138.

GARTHE S, SCHWEMMER H, MÜLLER S, PESCHKO V, MARKONES N & MERCKER M (2018) Seetaucher in der Deutschen Bucht: Verbreitung, Bestände und Effekte von Windparks. Bericht für das Bundesamt für Seeschifffahrt und Hydrographie und das Bundesamt für Naturschutz. 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, SCHWEMMER H, MÜLLER S, PESCHKO V, MARKONES N & MERCKER M (2019) Ergebnisse aus Forschung und Monitoring zum Meideverhalten von Seetaucher. Vortrag beim fachlichen Informationsaustausch zum Seetaucher am 18.03.2019 im BSH Hamburg.

GASSNER E, WINKELBRAND A & BERNOTAT D (2005) UVP – Rechtliche und fachliche Anleitung für die Umweltverträglichkeitsprüfung. 476 pages.

GHODRATI SHOJAEI M, GUTOW L, DANNHEIM J, RACHOR E, SCHRÖDER A & BREY T (2016) Common trends in German Bight benthic macrofaunal communities: Assessing temporal variability and the relative importance of environmental variables. Journal of Sea Research 107 (2) 25−33.

GILL AB (2005) Offshore renewable energy: ecological implications of generating electricity in the coastal zone. Journal of Applied Ecology 42: 605−615.

GILLES A ET AL. (2006) MINOSplus – Zwischenbericht 2005, Teilprojekt 2, pages 30−45.

GILLES A, VIQUERAT S & SIEBERT U (2014) Monitoring von marinen Säugetieren 2013 in der deutschen Nord- und Ostsee, itaw im Auftrag des Bundesamtes für Naturschutz.

GILLES A, VIQUERAT S, BECKER EA, FORNEY KA, GEELHOED SCV, HAELTERS J, NABENIELSEN J, SCHEIDAT M, SIEBERT U, SVEEGAARD S, VAN BEEST FM, VAN BEMMELEN R & AARTS G (2016) Seasonal habitat-based density models for a marine top predator, the harbor porpoise, in a dynamic environment. Ecosphere 7(6): e01367. 10.1002/ecs2.1367.

GILLES, A, DÄHNE M, RONNENBERG K, VIQUERAT S, ADLER S, MEYER-KLAEDEN O, PESCHKO V & SIEBERT U (2014) Ergänzende Untersuchungen zum Effekt der Bau- und Betriebsphase im Offshore-Testfeld 'alpha ventus' auf marine Säugetiere. Schlussbericht zum Projekt Ökologische Begleitforschung am Offshore-Testfeldvorhaben alpha ventus zur Evaluierung des Standarduntersuchungskonzeptes des BSH StUKplus.

GLUTZ VON BLOTZHEIM UN & BAUER KM (1982) Handbuch der Vögel Mitteleuropas. Volume 8. Charadriiformes (3.Teil) Akademische Verlagsgesellschaft, Wiesbaden.

GOLLASCH S & TUENTE U (2004) Einschleppung unerwünschter Exoten mit Ballastwasser: Lösungen durch weltweites Übereinkommen. Wasser und Abfall 10: 22−24.

GOLLASCH S (2003) Einschleppung exotischer Arten mit Schiffen. In: Lozan JL, Rachor E, Reise K, Sündermann J & von Westernhagen H (eds.): Warnsignale aus Nordsee & Wattenmeer – Eine aktuelle Umweltbilanz. Scientific evaluations, Hamburg 2003. 309-312.

GREVE W, LANGE U, REINERS F & J NAST (2001) Predicting the seasonality of North Sea zooplankton. Senckenbergiana maritima 31: 263−268.

GREVE W, REINERS F, NAST J & HOFFMANN S (2004) Helgoland Roads meso- and macrozooplankton time-series 1974 to 2004: lessons from 30 years of single spot, high frequency sampling at the only offshore island of the North Sea. Helgoland Marine Research 58: 274−288.

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.

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, Volume 1: 247−272.

HAGMEIER E & BAUERFEIND E (1990) Phytoplankton. In: Warnsignale aus der Nordsee. LOZAN JL, LENZ W, RACHOR E, WATERMANN B & VON WESTERNHAGEN H (eds.), Paul Parey, Hamburg.

HAMMOND PS & MACLEOD K (2006) Progress report on the SCANS-II project, Paper prepared for ASCOBANS Advisory Committee, Finland, April 2006.

HAMMOND PS, BERGGREN P, BENKE H, BORCHERS DL, COLLET A, HEIDE-JORGENSEN MP, HEIMLICH-BORAN, S, HIBY AR, LEOPOLD MF & OIEN N (2002) Abundance of harbour porpoise and other small cetaceans in the North Sea and adjacent waters. Journal of Applied Ecology 39: 361−376.

HAMMOND PS, LACEY C, GILLES A, VIQUERAT S (2017) Estimates of cetacean abundance in European Atlantic Waters in summer 2016 from the SCANS-III aerial and shipboard surveys. Thttps://synergy .st-andrews.ac.uk/scans3/files/2017/04/SACANS-III-design-based-estimates-2017-0428-final.pdf.

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.

HASLØV & KJÆRSGAARD (2000): Vindmøller syd for Rødsand ved Lolland – vurderinger af de visuelle påvirkninger. SEAS Distribution A.m.b.A. Part of the background investigations for the environmental compatibility assessment.

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.

HEESSEN HJL (2015) 56. Goatfishes (Mullidae). In: HEESSEN H, DAAN N, ELLIS JR (eds.) Fish atlas of the Celtic Sea, North Sea, and Baltic Sea: based on international research-vessel surveys. Academic Publishers, Wageningen, pages 344–348.

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.

HEINÄNEN S (2018) Assessing Red-throated diver displacement from OWF – based on aerial digital surveys and accounting for the dynamic environment. Presentation at the final workshop of the HELBIRD and DIVER reaesrch projects on 13.12.2017 at the BSH in Hamburg.

HEIP C, BASFORD D, CRAEYMEERSCH JA, DEWARUMEZ JM, DÖRJES J, WILDE P, DUINEVELD GCA, ELEFTHERIOU A, HERMAN PMJ, NIERMANN U, KINGSTON P, KÜNITZER A, RACHOR E, RUMOHR H, SOETAERT K & SOLTWEDEL K (1992) Trends in biomass, density and diversity of North Sea macrofauna. ICES Journal of Marine Science 49: 13−22.

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 scripts 23. Federal Agency for Nature Conservation (ed.). Bonn Bad Godesberg, 2000. 20−33.

HESSE K-J (1988) Zur Ökologie des Phytoplanktons in Fronten und Wassermassen der Deutschen Bucht. Dissertation University of Kiel, 153 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.

HILL K & HILL R (2010) Fachgutachten zum baubegleitenden Monitoring des Schutzgutes Zugvögel am Offshore-Testfeld 'alpha ventus' im Frühjahr und Herbst 2009. Stiftung Offshore-Windenergie.

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 (eds.) Fish atlas of the Celtic Sea, North Sea, and Baltic Sea: based on international research-vessel surveys. Academic Publishers, Wageningen, p. 186–194.

HOFFMANS G.J.C.M., VERHEIJ H.J. 1997*) Scour Manual, CRC Press, 224 S.

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.

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.

http://www.bfn.de/fileadmin/MDB/documents/themen/meeresundkuestenschutz/downloads

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 K & HÜPPOP O (2004) Atlas zur Vogelberingung auf Helgoland. Teil 2: Phänologie im Fanggarten von 1961 bis 2000. Die Vogelwarte 42: 285−343.

HÜPPOP K, DIERSCHKE J, HILL R & HÜPPOP O (2012) Jahres- und tageszeitliche Phänologie der Vogelrufaktivität über der deutschen Bucht. Vogelwarte 50: 87−108.

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 (2005a) AWZ-Vorhaben: Analyse und Bewertungsmethoden von kumulativen Auswirkungen von Offshore-WKA auf den Vogelzug; FKZ 804 85 004, Abschlussbericht.

HÜPPOP O, DIERSCHKE J & WENDELN H (2005b) Zugvögel und Offshore Windkraftanlagen: Konflikte und Lösungen. Berichte für Vogelschutz 41: 127−218.

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 (2005) 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 (eds.) Ökologische Begleitforschung zur Windenergienutzung im Offshore-Bereich auf Forschungsplattformen in der Nord- und Ostsee (BeoFINO) - Endbericht Juni 2005, Bremerhaven: 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.

IBL UMWELTPLANUNG GMBH (2016b) Cluster 'Nördlich Helgoland', Jahresbericht 2015. Ergebnisse der ökologischen Untersuchungen. Unpublished report commissioned by E.ON Climate & Renewable GmbH, RWE International SE and WindMW GmbH, 30.06.2016. 847 pages.

IBL Umweltplanung GmbH, BioConsult SH GmbH & Co KG, IfAÖ Institut für Angewandte Ökosystemforschung GmbH (2016a) Umweltmonitoring im Cluster 'Östlich Austerngrund' - Jahresbericht 2015/16 (April 2015 − März 2016). Ergebnisse der ökologischen Untersuchungen für das Schutzgut Rastvögel. Unpublished report commissioned by EnBW Hohe See GmbH & Co. KG, EnBW Albatros GmbH, Global Tech I Offshore Wind GmbH, November 2016.

IBL Umweltplanung GmbH, BioConsult SH GmbH & Co KG, IfAÖ Institut für Angewandte Ökosystemforschung GmbH (2017a) Cluster 'Nördlich Helgoland' Jahresbericht 2017. Ergebnisse der ökologischen Untersuchungen für das Schutzgut Rastvögel. Unpublished report commissioned by E.ON Climate & Renewables GmbH, innogy SE and WindMW GmbH, Oldenburg, June 2018.

IBL Umweltplanung GmbH, BioConsult SH GmbH & Co KG, IfAÖ Institut für Angewandte Ökosystemforschung GmbH (2017b) Umweltmonitoring im Cluster 'Östlich Austerngrund' Jahresbericht 2016/17 (April 2016 – März 2017). Ergebnisse der ökologischen Untersuchungen für das Schutzgut Rastvögel. 2. UJ der Betriebsphase 'Global Tech 1', 2. UJ der Aktualisierung der Basisuntersuchung 'EnBW Hohe See' und 'Albatros' Unpublished report commissioned by EnBW Hohe See GmbH & Co.KG, EnBW Albatros and Global Tech I Offshore Wind GmbH, Oldenburg, October 2017.

IBL Umweltplanung GmbH, BioConsult SH GmbH & Co KG, IfAÖ Institut für Angewandte Ökosystemforschung GmbH (2018) Cluster 'Nördlich Helgoland' Jahresbericht 2017. Ergebnisse der ökologischen Untersuchungen für das Schutzgut Rastvögel. Unpublished report commissioned by E.ON Climate & Renewables GmbH, innogy SE and WindMW GmbH, Oldenburg, June 2018.

ICES, International Council for the Exploration of the Sea (1992) Effects of Extraction of Marine Sediments on Fisheries. ICES Cooperative Reserach Report No. 182, Copenhagen.

ICES, International Council for the Exploration of the Sea (2017a) Fisheries overview-Greater North Sea Ecoregion. 29 pages, DOI: 10.17895/ices.pub.3116.

ICES, International Council for the Exploration of the Sea (2017b) ICES Advice on fishing opportunities, catch, and effort Celtic Seas and Greater North Sea Ecoregions. Published 30 June 2017, DOI: 10.17895/ices.pub.3058.

ICES, International Council for the Exploration of the Sea (2017c) 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, International Council for the Exploration of the Sea (2018) Fisheries overview – Baltic Sea Ecoregion. 24 pages, DOI: 10.17895/ices.pub.4389.

ICES, International Council for the Exploration of the Sea (2018a) Fisheries overview - Greater North Sea Ecoregion. 31 pages, DOI: 10.17895/ices.pub.4647.

ICES, International Council for the Exploration of the Sea (2018c) Report of the Working Group on Bycatch of Protected Species (WGBYC), 1-4 May 2018, Reykjavik, Iceland. ICES CM 2018/ACOM:25. 130 pages.

ICES, International Council for the Exploration of the Sea 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, International Council for the Exploration of the Sea WGEXT (1998) Cooperative Research Report, Final Draft, April 24, 1998.

ICES, International Council for the Exploration of the Sea WGNSSK (2006/2013) Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak.

IFAF, Institut für angewandte Forschung GmbH (2004) Fachgutachten Fischbiologische Beschreibung & Bewertung des Projektes 'Hochsee Windpark Nordsee' der EOS Offshore AG. 2004-08-30

IfAÖ (2019) Untersuchungen der Schutzgüter Benthos, Biotoptypen und Fische im Bereich der Fläche 'N-3.8'. Zwischenbericht über das 1. Jahr der

Flächenvoruntersuchung. Bericht Version 3 vom 02.12.2019.

IfAÖ Institut für Angewandte Ökosystemforschung GmbH (2015a) Spezielle biotopschutzrechtliche Prüfung (SBP) zum Bau und Betrieb des Offshore-Windparks GAIA I Nord. Unpublished report commissioned by Northern Energy GAIA I. GmbH, August 2015. 22 pages.

IfAÖ Institut für Angewandte Ökosystemforschung GmbH (2015b) Spezielle biotopschutzrechtliche Prüfung (SBP) zum Bau und Betrieb des Offshore-Windparks GAIA V Nord. Unpublished report commissioned by Northern Energy GAIA V. GmbH, August 2015. 22 pages.

IfAÖ Institut für Angewandte Ökosystemforschung GmbH (2015c) Fachgutachten Benthos. Untersuchungsgebiet GAIA I Nord. Unpublished report commissioned by Northern Energy GAIA I. GmbH, August 2015. 144 pages.

IfAÖ Institut für Angewandte Ökosystemforschung GmbH (2015d) Fachgutachten Benthos. Untersuchungsgebiet GAIA V Nord. Unpublished report commissioned by Northern Energy GAIA V. GmbH, August 2015. 143 pages.

IfAÖ Institut für Angewandte Ökosystemforschung GmbH (2016) Monitoringbericht für das Schutzgut 'Benthos'. Offshore-Windparkprojekt 'Global Tech I'. Betrachtungszeitraum: Herbst 2015. Unpublished report commissioned by Global Tech I Offshore Wind GmbH, April 2016.

IfAÖ Institut für Angewandte Ökosystemforschung GmbH (2016a) Fachgutachten Schutzgut 'Rastvögel' für das 1. UJ Betriebsmonitoring OWP 'DanTysk' und Baumonitoring OWP 'Sandbank' im Windpark-Cluster 'Westlich Sylt' Betrachtungszeitraum: Januar 2015 – Dezember 2015. Unpublished report commissioned by DanTysk Offshore Wind GmbH and Sandbank Offshore Wind GmbH c/o Vattenfall Europe Windkraft GmbH, Hamburg, July 2016.

IfAÖ Institut für Angewandte Ökosystemforschung GmbH (2016b) Fachgutachten Vögel – Vorhabengebiet: Witte Bank. Vorhabenträger: Projekt Ökovest GmbH. Betrachtungszeitraum Mai 2010 bis April 2012. Unpublished report commissioned by Projekt Ökovest GmbH, Neu Brodersdorf, February 2016.

IfAÖ Institut für Angewandte Ökosystemforschung GmbH (2017) Fachgutachten Schutzgut 'Rastvögel' für das 2. UJ Betriebsmonitoring OWP 'DanTysk' und Baumonitoring OWP 'Sandbank' im Windpark-Cluster 'Westlich Sylt' Betrachtungszeitraum: Januar 2016 – Dezember 2016. Unpublished report commissioned by DanTysk Offshore Wind GmbH & Co.KG and Sandbank Offshore Wind GmbH c/o Vattenfall Europe Windkraft GmbH, Hamburg, July 2017.

IfAÖ Institut für Angewandte Ökosystemforschung GmbH (2018) Fachgutachten Schutzgut 'Rastvögel' für das 3. UJ Betriebsmonitoring OWP 'DanTysk' und das Bau- und Betriebsmonitoring OWP 'Sandbank' im Windpark-Cluster 'Westlich Sylt' Betrachtungszeitraum: Januar 2017 – Dezember 2017. Unpublished report commissioned by DanTysk Offshore Wind GmbH & Co.KG and Sandbank Offshore Wind GmbH c/o Vattenfall Europe Windkraft GmbH, Hamburg, August 2018.

IfAÖ Institut für Angewandte Ökosystemforschung GmbH, IBL Umweltplanung GmbH, BioConsult SH GmbH & Co KG (2015a) Cluster 'Nördlich Borkum'. Ergebnisbericht Umweltmonitoring Rastvögel. Untersuchungsjahr 2014 (Januar – Dezember 2014). Unpublished report commissioned by UMBO GmbH, Hamburg, June 2015.

IfAÖ Institut für Angewandte Ökosystemforschung GmbH, IBL Umweltplanung GmbH, BioConsult SH GmbH & Co KG (2015b) Cluster 'Nördlich Borkum'. Fachgutachten Rastvögel – Untersuchungsjahr 2013 (März 2013 – Dezember 2013). Unpublished report commissioned by UMBO GmbH, Hamburg, March 2015.

IfAÖ Institut für Angewandte Ökosystemforschung GmbH, IBL Umweltplanung GmbH, BioConsult SH GmbH & Co KG (2016) Cluster 'Nördlich Borkum'. Ergebnisbericht Umweltmonitoring Rastvögel. Untersuchungsjahr 2015 (Januar – Dezember 2015). Unpublished report commissioned by UMBO GmbH, Hamburg, December 2016.

IfAÖ Institut für Angewandte Ökosystemforschung GmbH, IBL Umweltplanung GmbH, BioConsult SH GmbH & Co KG (2017)

Cluster 'Nördlich Borkum'. Ergebnisbericht Umweltmonitoring Rastvögel. Untersuchungsjahr 2016 (Januar – Dezember 2016). Unpublished report commissioned by UMBO GmbH, Hamburg, October 2017.

IFAÖ Institut für Angewandte Ökosystemforschung GmbH, IBL Umweltplanung GmbH, BioConsult SH GmbH & Co KG (2018) Cluster 'Nördlich Borkum'. Ergebnisbericht Umweltmonitoring Rastvögel. Untersuchungsjahr 2017 (Januar – Dezember 2017). Unpublished report commissioned by UMBO GmbH, Hamburg, October 2017.

IFAÖ Institut für Angewandte Ökosystemforschung GmbH, IBL Umweltplanung GmbH, BioConsult SH GmbH & Co KG (2019) Cluster 'Nördlich Borkum'. Ergebnisbericht Umweltmonitoring Rastvögel. Untersuchungsjahr 2018 (Januar – Dezember 2018). Unpublished report commissioned by UMBO GmbH, Hamburg, October 2017.

Ilicev VD & Flint VE (1985) Handbuch der Vögel der Sowjetunion. Band 1 Erforschungsgeschichte, Gaviiformes, Podicipediformes, Procellariiformes. Wiesbaden: AULA-Verlag.

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, International Union for the Conservation of Nature (2014) IUCN Red List of Threatened Species. Version 2014.1. (www.iucnredlist.org).

Jellmann J (1979) Flughöhen ziehender Vögel in Nordwestdeutschland nach Radarmessungen. Die Vogelwarte 30: 118−134.

Jellmann J (1989) Radarmessungen zur Höhe des nächtlichen Vogelzuges über Nordwestdeutschland im Frühjahr und im Hochsommer. Die Vogelwarte 35: 59−63.

Joschko T (2007) Influence of artificial hard substrates on recruitment success of the zoobenthos in the German Bight. Dissertation University of Oldenburg, 210 pages.

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.

Ketten DR (2004) Marine mammal auditory systems: a summary of audiometric and anatomical data and implications for underwater acoustic impacts. Polarforschung 72: p. 79−92.

King M (2013) Fisheries Biology, assessment and management. John Wiley & Sons.

Kirches G, Paperin M, Klein H, Brockmann C & Stelzer K (2013a) The KLIWAS climatology for sea surface temperature and ocean colour fronts in the North Sea. Part a: Methods, data, and algorithms. KLIWAS Schriftenreihe. KLIWAS -23a/2013. doi:10.5675/kliwas_climatology_northsea_a, 37 pages.

Kirches G, Paperin M, Klein H, Brockmann C & Stelzer K (2013b) The KLIWAS climatology for sea surface temperature and ocean colour fronts in the north sea. Part b: SST products. KLIWAS Schriftenreihe. KLIWAS -23b/2013. doi:10.5675/kliwas_climatology_northsea_b, 40 pages.

Kirches G, Paperin M, Klein H, Brockmann C & Stelzer K (2013c) The KLIWAS climatology for sea surface temperature and ocean colour fronts in the north sea. Part c: Ocean colour products. KLIWAS Schriftenreihe. KLIWAS -23c/2013. doi:10.5675/kliwas_climatology_northsea_c, 32 pages.

Klein B, Klein H, Loew P, Möller J, Müller-Navarra S, Holfort J, Gräwe U, Schlamkow C & Seiffert R (2018) Deutsche Bucht mit Tideelbe und Lübecker Bucht. in: von Storch H, Meineke I & Claussen M (eds.) (2018) Hamburger Klimabericht – Wissen über Klima, Klimawandel und Auswirkungen in Hamburg und Norddeutschland, Springer Verlag.

Klein H & Mittelstaedt E (2001) Gezeitenströme und Tidekurven im Nahfeld von Helgoland. Federal Maritime and Hydrographic Agency reports No. 27, 48 pages.

Klein H (2002) Current statistics German Bight. BSH/DHI current measurements 1957. Federal Maritime and Hydrographic Agency, internal report, 60 pages.

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. Study on behalf of the BfN, Federal Research Centre for Fisheries. Final report, Hamburg, 82 pages.

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 research and development project No. 200 97 106 of the German Environment Agency, 454 pages with Annexes.

KRÄGEFSKY S (2014) Effects of the alpha ventus offshore test site on pelagic fish. In: Beiersdorf A, Radecke A (eds.) 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.

KRAUSE G, BUDEUS G, GERDES D, SCHAUMANN K & HESSE KJ (1986) Frontal systems in the German Bight and their physical and biological effects. In: Nihoul J.C.J. (ed.): Marine Interfaces Ecohydrodynamics. Amsterdam, Elsevier p. 119-140.

KRÖNCKE I (1985) Makrofaunahäufigkeiten in Abhängigkeit von der Sauerstoffkonzentration im Bodenwasser der östlichen Nordsee. Dissertation University of Hamburg, 124 pages.

KRÖNCKE I (1995) Long-term changes in North Sea benthos. Senckenbergiana maritima 26 (1/2): 73−80.

KRÖNCKE I, DIPPNER JW, HEYEN H & ZEISS B (1998) Long-term changes in macrofaunal communities off Norderney (East Frisia, Germany) in relation to climate variability. Marine Ecology Progress Series 167: 25−36.

KRÖNCKE I, REISS H, EGGLETON JD, ALDRIDGE J, BERGMAN MJN, COCHRANE S, CRAEYMEERSCH JA, DEGRAER S, DESROY N, DEWARUMEZ J-M, DUINEVELD GCA, ESSINK K, HILLEWAERT H, LAVALEYE MSS, MOLL A, NEHRING S, NEWELL R, OUG E, POHLMANN T, RACHOR E, ROBERTSON M, RUMOHR H, SCHRATZBERGER M, SMITH R, VANDEN BERGHE E, VAN DALFSEN J, VAN HOEY G, VINCX M, WILLEMS W & REES HI (2011) Changes in North Sea macrofauna communities and species distribution between 1986 and 2000. Estuarine, coastal and shelf science 94(1): 1−15.

KRÖNCKE I, STOECK T, WIEKING G & PALOJÄRVI A (2004) Relationship between structural and functional aspects of microbial and macrofaunal communities in different areas of the North Sea. Marine Ecology Progress Series 282: 13−31.

KRONE R, DEDERER G, KANSTINGER P, KRAMER P, SCHNEIDER C & SCHMALENBACH I (2017) Mobile demersal megafauna at common offshore wind turbine foundations in the German Bight (North Sea) two years after deployment − increased production rate of *Cancer pagurus*. Marine Environmental Research 123: 53−61.

KRUMPEL A., B. LIMMER, I. KAMMIGAN, A. SCHUBERT, A. DIEDERICHS (2017) Cluster ‚Nördlich Borkum‘ Ergebnisbericht Umweltmonitoring Marine Säugetiere - Untersuchungsjahr 2016.

KRUMPEL A., B. LIMMER, I. KAMMIGAN, S. PREUß, A. SCHUBERT, N. GRIES, A. DIEDERICHS (2018). Cluster ‚Nördlich Borkum‘ Ergebnisbericht Umweltmonitoring Marine Säugetiere - Untersuchungsjahr 2017).

KRUMPEL A., I. KAMMIGAN, B. LIMMER, M. LACZNY, S. PREUß, A. SCHUBERT (2019) Cluster ‚Nördlich Borkum‘ Ergebnisbericht Umweltmonitoring Marine Säugetiere - Untersuchungsjahr 2018).

KUHBIER J & PRALL U (2010) Probleme bei der Planung und Genehmigung von Offshore-Windenergieanlagen, p. 385 – 398. In: Thomé-Kozmiensky K.J. & M. Hoppenberg (eds.), Immissionsschutz, Band 1 – Planung, Genehmigung und Betrieb von Anlagen. TK Verlag Karl Thomé-Kozmiensky (2010) ISBN 978-3-935317-59-7.

KULLINCK U & MARHOLD S (1999) Abschätzung direkter und indirekter biologischer Wirkungen der elektrischen und magnetischen Felder des Eurokabel/ Viking Cable HGÜ-Bipols auf Lebewesen der Nordsee und des Wattenmeeres. Study on behalf of Eurokabel/Viking Cable: 99 pages.

KÜNITZER A, BASFORD D, CRAEYMEERSCH JA, DEWARUMEZ JM, DÖRJES J, DUINEVELD GCA, ELEFTHERIOU A, HEIP C, HERMAN P, KINGSTON P, NIERMANN U, RACHOR E, RUMOHR H& DE WILDE PAJ (1992) The benthic infauna of the North Sea: species distribution and assemblages. ICES Journal of Marine Science 49: 127−143.

LAMBERS-HUESMANN M & ZEILER M (2011) Untersuchungen zur Kolkentwicklung und Kolkdynamik im Testfeld 'alpha ventus', publications of the Grundbauinstitut of Technische Universität Berlin, booklet No. 56, Berlin 2011, presentation at the 'Gründungen von Offshore-Windenergieanlagen' workshop on 22 and 23 March 2011.

LAMBRECHT, H. & J. TRAUTNER (2007). Fachinformationssystem und Fachkonventionen zur Bestimmung der Erheblichkeit im Rahmen der FFH-VP. Endbericht zum Teil Fachkonventionen. Hanover, Filderstadt: 239 pages.

LAURER W-U, NAUMANN M & ZEILER M (2013) Sedimentverteilung in der deutschen Nordsee nach der Klassifikation von Figge (1981). http://www.gpdn.de.

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.

LEOPOLD M., SKOV H, DURINCK J (1995) The distribution and numbers of Red-throated Divers *Gavia stellata* and Black throated Divers *Gavia arctica* in the North Sea in relation to habitat characteristics, Limosa 68, p 125.

LEOPOLD MF, CAMPHUYSEN CJ, TER BRAAK CJF, DIJKMAN EM, KERSTING K & LIESHOUT SMJ (2004) Baseline studies North Sea wind farms: lot 5 Marine Birds in and around the future sites Nearshore Windfarm (NSW) and Q7 (No. 1048. Alterra.

LINDEBOOM HJ & DE GROOT SJ (eds.) (1998) The effects of different types of fisheries on the North Sea and Irish Sea benthic ecosystems. –NIOZ Report 1998-1: 404 pages.

LINDLEY JA & BATTEN SD (2002) Long-term variability in the North Sea zooplankton. Journal of the Marine Biological Association of the U.K. 82. 31−40.

LØKKEBORG S, HUMBORSTAD OB, JØRGENSEN T & SOLDAL AV (2002) Spatio-temporal variations in gillnet catch rates in the vicinity of North Sea oil platforms. ICES Journal of Marine Science 59 (Suppl): 294−S299:

LÖWE P, BECKER G, BROCKMANN U, FROHSE A, HERKLOTZ K, KLEIN H & SCHULZ A (2003) Nordsee und Deutsche Bucht 2002. Ozeanographischer Zustandsbericht. Federal Maritime and Hydrographic Agency reports No. 33, 89 pages.

LÖWE P, KLEIN H, FROHSE A, SCHULZ A & SCHMELZER N (2013) Temperatur. In: LOEWE P, KLEIN H, WEIGELT S (eds.) System Nordsee – 2006 & 2007: Zustand und Entwicklungen. Federal Maritime and Hydrographic Agency reports No. 49:142−155. 308pp: BSH Hamburg and Rostock. www.bsh.de/de/Produkte/Buecher/Berichte_/Bericht 49/index.jsp.

LOZAN JL, RACHOR E, WATERMANN B & VON WESTERNHAGEN H (1990) Warnsignale aus der Nordsee. Wissenschaftliche Fakten. Verlag Paul Parey, Berlin und Hamburg. 231–249.

LUCKE K, LEPPER P, HOEVE B, EVERAARTS E, ELK N & SIEBERT U (2007) Perception of low-frequency acoustic signals by harbour porpoise *Phocoena phocoena* in the presence of simulated 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 Acoustical Society of America 125(6): 4060−4070.

LUCKE K, SUNDERMEYER J & SIEBERT U (2006) MINOSplus Status Seminar, Stralsund, Sept. 2006, Presentation.

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.

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 scripts 29: 19–30.

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. On behalf of the Federal Agency for Nature Conservation (BfN).

MARKONES N, GUSE N, BORKENHAGEN K, SCHWEMMER H & GARTHE S (2014) Seevogel-Monitoring

2012/2013 in der deutschen AWZ von Nord- und Ostsee. On behalf of the Federal Agency for Nature Conservation (BfN).

MARKONES N, GUSE N, BORKENHAGEN K, SCHWEMMER H & GARTHE S (2015) Seevogel-Monitoring 2014 in der deutschen AWZ von Nord- und Ostsee. On behalf of the Federal Agency for Nature Conservation (BfN).

MCCONNELL BJ, FEDAK MA, LOVELL P & HAMMOND PS (1999) Movements and foraging areas of grea seals in the North Sea. Journal of Applied Ecology 36: 573−590.

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 (eds.) (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. Presentation at the marine environment symposium 2006, CHH Hamburg.

MENDEL B, KOTZERKA J, SOMMERFELD J, SCHWEMMER H, SONNTAG N & GARTHE S (2014) Effects of the alpha ventus offshore test site on distribution patterns, behaviour and flight heights of seabirds. In: Ecological Research at the Offshore Windfarm Alpha Ventus. Springer Fachmedien, Wiesbaden, pp. 95–110.

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, booklet 59, 437 pages.

MERCKER M (2018) Influence of offshore wind farms on distribution and abundance of Gaviidae: Methodological overview. BIONUM. https://www.ftz.uni-kiel.de/de/forschungsabteilungen/ecolab-oekologie-mariner-tiere/laufende-projekte/offshore-windenergie.

MITTENDORF, K, ZIELKE, W. (2002): Untersuchung der Wirkung von Offshore-Winenergie-Parks auf die Meersstroemung, Hanover 2002. (https://www.gigawind.de/f2002.html)

MLIKOVSKY J (1998) A new loon (Aves: Gaviidae) from the middle Miocene of Austria. Annalen des Naturhistorischen Museums in Wien 99: 331-339.

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.

NIERMANN U (1990) Oxygen deficiency in the south eastern North Sea in summer 1989. ICES C.M./mini, 5: 1−18.

NIERMANN U, BAUERFEIND E, HICKEL W & VON WESTERNHAGEN H (1990) The recovery of benthos following the impact of low oxygen content in the German Bight. Netherlands Journal of Sea Research 25: 215−226.

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.

NORDHEIM H VON, RITTERHOFF J & MERCK T (2003) Biodiversität in der Nordsee – Rote Listen als Warnsignal. In LOZÁN JL, RACHOR E, REISE K, SÜNDERMANN J & VON WESTERNHAGEN H (eds.) Warnsignale aus Nordsee & Wattenmeer. Eine aktuelle Umweltbilanz. Wissenschaftliche Auswertungen, Hamburg 2003. 300−305.

OGAWA S, TAKEUCHI R. & HATTORI H (1977) An estimate for the optimum size of artificial reefs. Bulletin of the Japanese. Society of Fisheries and 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.

OREJAS C, JOSCHKO T, SCHRÖDER A, DIERSCHKE J, EXO K-M, FREDRICH E, HILL R, HÜPPOP O, POLLEHNE F, ZETTLER M & BOCHERT R (2005) BeoFINO Endbericht: Ökologische Begleitforschung zur Windenergienutzung im Offshore-Bereich auf Forschungsplattformen in der Nord- und Ostsee (BeoFINO). 356 pages.

ORTHMANN T (2000) Telemetrische Untersuchungen zur Verbreitung, zum Tauchverhalten und zur Tauchphysiologie von Seehunden *Phoca vitulina vitulina*, des Schleswig-Holsteinischen Wattenmeeres. Dissertation. Christian-Albrechts-Universität, Kiel, Germany.

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.

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.

OTTO L, ZIMMERMANN JTF, FURNES GK, MORK M, SAETRE R & BECKER G (1990) Review of the Physical Oceanography of the North Sea. Netherlands Journal of Sea Research 26(2−4), 161−238.

PASCHEN M, RICHTER U & KÖPNIK W (2000) TRAPESE – Trawl Penetration in the Sea Bed, final report EU project No. 96-006, Rostock.

PEDERSEN, S. A., H. O. FOCK & A. F. SELL (2009) Mapping fisheries in the German exclusive economic zone with special reference to offshore Natura 2000 sites. Marine Policy 33 (4):571-590.

PEHLKE, H. (2005): Prädiktive Habitatkartierung für die Ausschließliche Wirtschaftszone (AWZ) der Nordsee. Vechta University.

PERRY AL, LOW PJ, ELLIS JR & REYNOLDS JD (2005) Climate change and distribution shifts in marine fishes. Science 308: 1912–1915.

PETERS, HEINZ-JOACHIM / BALLA, STEFAN / HESSELBARTH, THORSTEN - Gesetz über die Umweltverträglichkeitsprüfung – Handkommentar, 4th edition 2019, 664 p.

PETERSEN I K, CHRISTENSEN T K, KAHLERT J, DESHOLM M & FOX A D (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).

PFEIFER G (2003) Die Vögel der Insel Sylt. Husum Druck- und Verlagsgesellschaft, Husum. 807 pages.

PGU, PLANUNGSGEMEINSCHAFT UMWELTPLANUNG OFFSHORE WINDPARK (2012a) Offshore-Windpark 'Bernstein'. Umweltverträglichkeitsstudie. Unpublished report commissioned by BARD Holding GmbH, 12.04.2012. 609 pages.

PGU, PLANUNGSGEMEINSCHAFT UMWELTPLANUNG OFFSHORE WINDPARK (2012b) Offshore-Windpark 'Citrin'. Umweltverträglichkeitsstudie. Unpublished report commissioned by BARD Holding GmbH, 13.04.2012. 605 pages.

PGU, PLANUNGSGEMEINSCHAFT UMWELTPLANUNG OFFSHORE WINDPARK (2013) HVAC- Netzanbindung OWP Butendiek. Umweltfachliche Stellungnahme: Gefährdung der Meeresumwelt / Natura 2000-Gebietsschutz / Artenschutz.

PGU, PLANUNGSGEMEINSCHAFT UMWELTPLANUNG OFFSHORE WINDPARK (2015) Offshore-Windpark 'Atlantis II'. Umweltverträglichkeitsstudie. Unpublished report commissioned by PNE WIND Atlantis I GmbH, 13.05.2015. 637 pages.

PGU, PLANUNGSGEMEINSCHAFT UMWELTPLANUNG OFFSHORE WINDPARK (2017) Clustermonitoring Cluster 6. Bericht Phase I (01/15 – 03/16).

Ausführlicher Bericht. Unpublished report compiled on behalf of British Wind Energy GmbH, Hamburg, 27.02.2017. 404 pages.

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.

PRYSMIAN (2016) T900-BorWin3- RK-K-01. Cable Dimensioning with 2K considering the wind load (Case 1a). Unpublished report compiled on behalf of DC Netz BorWin3 GmbH, 22.12.2016. 6 pages.

QUANTE M, COLIJN F & NOSCCA AUTHOR TEAM (2016) North Sea Region Climate Change Assessment. Regional Climate Studies. Springer-Verlag Berlin Heidelberg, doi:10.1007/978-3-319-39745-0.

RACHOR E & GERLACH SA (1978) Changes of Macrobenthos in a sublittoral sand area of the German Bight, 1967 to 1975. Rapports et procès-verbaux des réunions du Conseil International de Exploration de Mer 172: 418−431.

RACHOR E & NEHMER P (2003) Erfassung und Bewertung ökologisch wertvoller Lebensräume in der Nordsee. Final report for BfN. Bremerhaven, 175 p. and 57 p. Annexes.

RACHOR E (1977) Faunenverarmung in einem Schlickgebiet in der Nähe Helgolands. Helgoländer wissenschaftliche Meeresuntersuchungen 30: 633−651.

RACHOR E (1980) The inner German Bight - an ecologically sensitive area as indicated by the bottom fauna. Helgoländer wissenschaftliche Meeresuntersuchungen 33: 522−530.

RACHOR E (1990a) Veränderungen der Bodenfauna. In: Lozan JL, Lenz W, Rachor E, Watermann B & von Westernhagen H (eds.): Warnsignale aus der Nordsee. Paul Parey 432 pages.

RACHOR E (1990b) Changes in sublittoral zoobenthos in the German Bight with regard to eutrophication. Netherlands Journal of Sea Research 25 (1/2): 209−214).

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. Volume 2: Meeresorganismen, Bonn.

RACHOR E, HARMS J, HEIBER W, KRÖNCKE I, MICHAELIS H, REISE K & VAN BERNEM K-H (1995) Rote Liste der bodenlebenden Wirbellosen des deutschen Wattenmeer- und Nordseebereichs.

READ AJ & WESTGATE AJ (1997) Monitoring the movements of harbour porpoise with satellite telemetry. Marine Biology 130: 315−322.

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 JB, EVANS PGH & NORTHRIDGE SP (2003) Atlas of the cetacean distribution in north-west European waters, Joint Nature Conservation Committee, Peterborough.

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: 295−331.

REISE K & BARTSCH I (1990) Inshore and offshore diversity of epibenthos dredged in the North Sea. Netherlands Journal of Sea Research 25 (1/2): 175−179.

REISS H, GREENSTREET SPR, SIEBEN K, EHRICH S, PIET GJ, QUIRIJNS F, ROBINSON L, WOLFF WJ & KRÖNCKE I (2009) Effects of fishing disturbance on benthic communities and secondary production within an intensively fished area. Marine Ecology Progress Series 394: 201−213.

RICHARDSON JW (2004) Marine mammals versus seismic and other acoustic surveys: Introduction to the noise issue. Polarforschung 72 (2/3), p. 63−67.

ROSE A, DIEDERICHS A, NEHLS G, BRANDT MJ, WITTE S, HÖSCHLE C, DORSCH M, LIESENJOHANN T, SCHUBERT A, KOSAREV V, LACZNY M, HILL A & PIPER W (2014) OffshoreTest Site Alpha Ventus; Expert Report: Marine Mammals. Final Report: From baseline to wind farm operation. On behalf of the Federal Maritime and Hydrographic Agency.

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/.

SALZWEDEL H, RACHOR E & GERDES D (1985) Benthic macrofauna communities in the German Bight. Publications of the Institut für Meeresforschung, Bremerhaven 20: 199−267.

SCHEIDAT M, GILLES A & SIEBERT U (2004) Erfassung der Dichte und Verteilungsmuster von Schweinswalen (*Phocoena phocoena*) in der deutschen Nord- und Ostsee. MINOS sub-project 2, final report, p. 77−114.

SCHEIDAT M,TOUGAARD J,BRASSEUR S, CARSTENSEN J,VAN POLANEN-PETEL T,TEILMANN J & REIJNDERS P (2011) Harbour porpoises (*Phocoena phocoena*) and windfarms: a case study in the Dutch North Sea. Environmental Research Letters 6 (2): 025102.

SCHMELZER N, HOLFORT J & LÖWE P (2015) Klimatologischer Eisatlas für die Deutsche Bucht (mit Limfjord) Digitaler Anhang/Digital supplement: Eisverhältnisse in 30-jährigen Zeiträumen 1961–1990, 1971–2000, 1981–2010. Federal Maritime and Hydrographic Agency.

SCHMUTZ JA (2014) Survival of Adult Red-Throated Loons (*Gavia stellata*) May be Linked to Marine Conditions. Waterbirds 37(sp1):118-124.

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, Volume 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.

SCHWARZ J & HEIDEMANN G (1994) Zum Status der Bestände der Seehund- und Kegelrobbenpopulationen im Wattenmeer. Published in: Warnsignale aus dem Wattenmeer, Blackwell, Berlin.

SCHWEMMER H, MARKONES N, MÜLLER S, BORKENHAGEN K, MERCKER M & GARTHE S (2019) Aktuelle Bestandsgröße und –entwicklung des Sterntauchers (Gavia stellata) in der deutschen Nordsee. Report for the Federal Maritime and Hydrographic Agency and the Federal Agency for Nature Conservation. Pubished at http://www.ftz.uni-kiel.de/de/forschungsabteilungen/ecolab-oekologie-mariner-tiere/laufende-projekte/offshore-windenergie/Seetaucher_Bestaende_Ergebnisse_FTZ_BIONUM.pdf.

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, p: 1851–1860. DOI: 10.2307/23023122.

SKIBA R (2003) Europäische Fledermäuse: Kennzeichen, Echoortung und Detektoranwendung. Westarp Wissenschaften-Verlags GmbH, Hohenwarsleben.

SKIBA R (2007) Die Fledermäuse im Bereich der Deutschen Nordsee unter Berücksichtigung der Gefährdungen durch Windenergieanlagen (WEA), Nyctalus, 12: 199−220.

SKIBA R (2011) Fledermäuse in Südwest-Jütland und deren Gefährdung an Offshore-Windenergieanlagen bei Herbstwanderungen über die Nordsee. Nyctalus 16: 33−44.

SKOV H & PRINS E (2001) Impact of estuarine fronts on the dispersal of piscivorous birds in the German Bight. Marine Ecology Progress Series 214: 279–287.

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.

SMOLCZYK U (2001) Grundbau Taschenbuch Teil 2, Geotechnische Verfahren: Anhaltswerte zur Wärmeleitfähigkeit wassergesättigter Böden. Ernst & Sohn-Verlag, Berlin.

SOLDAL AV, SVELLDINGEN I, JøRGENSEN T & LøKKEBORG S (1998) Rigs-to-reefs in the North Sea: hydroacoustic quantification of fish associated with a 'semi-cold' platform. ICES J Mar Sci 59: p. 281–S287

SOMMER A (2005) Vom Untersuchungsrahmen zur Erfolgskontrolle. Inhaltliche Anforderungen und Vorschläge für die Praxis von Strategischen Umweltprüfungen, Wien.

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 & WILSON CA (1997) Seasonal and spatial variation in abundance and size distribution of fishes associated with a petroleum platform in the northern Gulf of Mexico. Can J Fish Aquat Sci 54:1166–1176

STRIPP K (1969a) Jahreszeitliche Fluktuationen von Makrofauna und Meiofauna in der Helgoländer Bucht. Publications of the Institut für Meeresforschung, Bremerhaven 12: 65−94.

STRIPP K (1969b) Die Assoziationen des Benthos in der Helgoländer Bucht. Publications of the Institut für Meeresforschung, Bremerhaven 12: 95−142.

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.

TARDENT P (1993) Meeresbiologie. Eine Einführung. 2nd newly revised and expanded edition. Georg Thieme Verlag, Stuttgart, New York, 305 pages.

TASKER ML, WEBB A, HALL AJ, PIENKOWSKI MW 6 LANGSLOW DR (1987) Seabirds in the North Sea. Nature Conservancy Council, Peterborough.

TEMMING A & HUFNAGL M (2014) Decreasing predation levels and increasing landings challenge the paradigm of non-management of North Sea brown shrimp (Crangon crangon) ICES Journal of Marine Science 72(3): 804–823.

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 H (2007) Erfassung von FFH-Anhang II Fischarten in der deutschen AWZ von Nord- und Ostsee (ANFIOS). FKZ 803 85 220: 1-114.

TILLIT DJ, THOMPSON PM & MACKAY A (1998) Variations in harbour seal *Phoca vitulina* diet and dive-depths in relation to foraging habitat. Journal of Zoology 244: 209−222.

TODD VLG, PEARSE WD, TREGENZA NC, LEPPER PA & TODD IB (2009) Diel echolocation activity of harbour porpoises (*Phocoena phocoena*) around North Sea offshore gas installations. ICES Journal of Marine Science 66: 734–745.

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.

TUCKER GM & HEATH MF (1994) Birds in Europe: their conservation status. BirdLife Conservation Series 3, Cambridge.

TULP I, MCCHESNEY S & DEGOEIJ P (1994) Migratory departures of waders from north-western Australia- behavior, timing and possible migration routes. Ardea 82(2): 201−221.

TUNBERG BG & NELSON WG (1998) Do climatic oscillations influence cyclical patterns of soft bottom macrobenthic communities on the Swedish west coast? Marine Ecology Progress Series 170: 85−94.

VALDEMARSEN JW (1979) Behavioural aspects of fish in relation to oil platforms in the North Sea. Int Counc Explor Sea CM 1979/B:27

VAN BEUSEKOM JEE, 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 (eds.) Hamburger Klimabericht – Wissen über Klima, Klimawandel und Auswirkungen in Hamburg und Norddeutschland. Springer Spektrum, Berlin, Heidelberg.

VBV WEIGT GMBH (2018) Geophysikalische Untersuchungen N-03.08. Bericht zur Flächenvoruntersuchung im Auftrag des Bundesamtes für Seeschifffahrt und Hydrographie, RefNr. VBW_P15180033_BSH_N-03-08_DR_REP_2018_V00.DOCX, Ziesendorf, 66 pages.

VDI (1991) VDI-Wärmeatlas, VDI-Verlag, Düsseldorf.

VELASCO F, HEESSEN HJL, RIJNSDORP A & DE BOOIS I (2015) 73. Turbots (Scophthalmidae). 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, page 429–446.

VLIETSTRA LS (2005) Spatial associations between seabirds and prey: effects of large-scale prey abundance on small-scale seabird distribution. Marine Ecology Progress Series 291: 275−287.

VON LANDMANN R & ROHMER G (2018) Umweltrecht Band I − Kommentar zum UVPG, Munich.

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

WARDEN ML (2010) Bycatch of wintering common and red-throated loons in gillnets off the USA Atlantic coast, 1996-2007. Aquat Biol 10:167-180. https://doi.org/10.3354/ab00273

WASMUND N, POSTEL L & ZETTLER ML (2009) Biologische Bedingungen in der deutschen ausschließlichen Wirtschaftszone der Nordsee im Jahre 2009. Leibniz Institute for Baltic Sea Research Warnemünde on behalf of the Federal Maritime and Hydrographic Agency.

WASMUND N, POSTEL L & ZETTLER ML (2011) Biologische Bedingungen in der deutschen ausschließlichen Wirtschaftszone der Nordsee im Jahre 2010. Leibniz Institute for Baltic Sea ResearchWarnemünde, Meereswissenschaftliche Berichte 85: 89−169.

WASMUND N, POSTEL L & ZETTLER ML (2012) Biologische Bedingungen in der deutschen ausschließlichen Wirtschaftszone der Nordsee im Jahre 2011. Leibniz Institute for Baltic Sea Research Warnemünde on behalf of the Federal Maritime and Hydrographic Agency.

WATLING L & NORSE EA (1998). Disturbance of the seabed by mobile fishing gear: a comparison to forest clearcutting. Conservation Biology 12(6), 1180−1197.

WEILGART L (2018) The impact of ocean noise pollution on fish and invertebrates. Report for Oceancare, Switzerland. 34 pp.

WEINERT M, MATHIS M, KRÖNCKE I, NEUMANN H, POHLMANN T & REISS H (2016) Modelling climate change effects on benthos: Distributional shifts in the North Sea from 2001 to 2099. Estuarine, Coastal and Shelf Science 175: 157−168.

WELCKER J (2019) Patterns of nocturnal bird migration in the German North and Baltic Seas. Technical report. BioConsult SH, Husum. 70 pp (not yet published).

WELCKER, J. & G. NEHLS, (2016). Displacement of seabirds by an offshore wind farm in the North Sea. Marine Ecology Progress Series 554:173−182.

WESTERNHAGEN H VON & DETHLEFSEN V (2003) Änderungen der Artenzusammensetzung in Lebensgemeinschaften der Nordsee. In LOZÁN JL, RACHOR E, REISE K, SÜNDERMANN J & WESTERNHAGEN H VON (eds.): Warnsignale aus Nordsee & Wattenmeer. Eine aktuelle Umweltbilanz. Wissenschaftliche Auswertungen, Hamburg 2003. 161−168.

WESTERNHAGEN H VON, HICKEL W, BAUERFEIND E, NIERMANN U & KRÖNCKE I (1986) Sources and effects of oxygen deficiencies in the south-eastern North Sea. Ophelia 26 (1): 457−473.

WETLANDS INTERNATIONAL (2012) Waterbird Population Estimates 2012. wpe.wetland.org

WETLANDS INTERNATIONAL (2018). *Annex 1 to the 7th edition of the AEWA Conservation Status Report*. Retrieved from http://wpe.wetlands.org/search?form%5Bspecies%5D=&form%5Bpopultion%5D=&form%-5Bpublication%5D

WILTSHIRE K & MANLY BFJ (2004) The warming trend at Helgoland Roads, North Sea: phytoplankton response. Helgoland Marine Research 58: 269−273.

WOLF R (2004) Rechtsprobleme bei der Anbindung von Offshore-Windenergieparks in der AWZ an das Netz. ZUR, 65−74.

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.

YANG J (1982) The dominant fish fauna in the North Sea and its determination. Journal of Fish Biology 20: 635−643.

ZIEGELMEIER E (1978) Macrobenthos investigations in the eastern part of the German Bight from 1950 to 1974. Rapports et procès-verbaux des réunions du Conseil International de Exploration de Mer 172: 432−444.

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 colloquium, Hanover 2001.